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DOE/RL-2009-124
Revision 1

200 West Area Pump-and-Treat Facility Operations and Maintenance Plan

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

P.O. Box 550
Richland, Washington 99352

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Concurrence Page

Title: *200 West Area Pump-and-Treat Facility Operations and Maintenance Plan*

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Executive Summary

This operations and maintenance (O&M) Plan outlines the activities necessary to operate, maintain, and monitor the performance of the 200 West Area groundwater pump-and-treat (P&T) system, from the completion of construction through decommissioning of the system. The 200 West Area groundwater P&T system is a major component of the remedial action (RA) selected for cleanup of the 200-ZP-1 Groundwater Operable Unit (OU), located in the 200 West Area of the Hanford Site Central Plateau.

The remedy selected in EPA et al., 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington*[1] (hereafter referred to as the ROD), combines installation of a groundwater P&T system, monitored natural attenuation (MNA), flow path control, and institutional controls (ICs). These remedy components combine to meet the objective of achieving established groundwater cleanup levels for all contaminants of concern (COCs) in the 200-ZP-1 OU within 125 years. The COCs identified for the 200-ZP-1 OU are carbon tetrachloride, total chromium (trivalent [III] and hexavalent [VI]), nitrate, trichloroethylene, iodine-129, technetium-99, and tritium.

The ROD also requires that a large fraction of the mass of contamination (i.e., 95 percent of the dissolved mass of COCs) be removed in 25 years. This mass removal will primarily be accomplished by the operation of the 200 West Area P&T system, which is designed to capture and treat contaminated groundwater to reduce the mass of COCs throughout the 200-ZP-1 OU. Treated water will be re-injected into the aquifer to attain flow path control. This O&M plan addresses the activities required to operate, maintain, and monitor the 200 West Area groundwater P&T system to ensure that these objectives are met. Implementation and oversight of the remedy's IC provisions will be performed under DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions*.[2]

This plan outlines the steps necessary for commissioning of the P&T system including acceptance and operational testing prior to release of the facility for unrestricted

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[1] EPA, DOE, and Ecology, 2008, *Record of Decision Hanford 200 Area 200 ZP 1 Superfund Site Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r2008100003103.pdf.

[2] DOE/RL-2001-41, 2009, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions*, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0095932.

operation. This document also discusses the operational philosophy of the P&T system and the programs and procedures in place for preventative, routine, and corrective maintenance after the system is fully operational and functional. These measures ensure that the system will perform as intended and operate safely and efficiently.

Short-term and long-term performance monitoring will be conducted to ensure that the system is performing in accordance with the objectives of the ROD. This plan outlines how this monitoring will be conducted and the periodic reporting that will document system performance and monitoring results. This periodic reporting includes five-year reviews under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[3] (CERCLA).

After remedial action objectives (RAOs) have been attained, the P&T system will be shut down and permanently taken out of service through a process known as decontamination and decommissioning (D&D). This O&M plan provides a summary of plan documents that will likely be developed to guide both interim and final D&D activities.

Finally, safe operation of the P&T system is an overarching goal that affects all activities associated with operating and maintaining the plant. This plan provides an overview of the health and safety plan (HASP) that will address safe operation of the P&T system, including key hazards that may be encountered during O&M of the system, design features, and procedures for mitigating those hazards.

[3] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq. Available at: http://uscode.house.gov/download/pls/42C103.txt.

Contents

Appendices

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Figures

Tables

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Terms

(CRIII)	trivalent chromium
(CRVI)	hexavalent chromium
AMP	air monitoring plan
ATP	acceptance test procedure
ARAR	applicable or relevant and appropriate requirement
BOD	biochemical oxygen demand
CAT	construction acceptance test(ing)
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CHPRC	CH2M HILL Plateau Remediation Company
CLARC	Cleanup Levels and Risk Calculations
CMP	compliance monitoring plan
COC	contaminant of concern
CTET	carbon tetrachloride
DA	Design Authority
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EQAPP	environmental quality assurance program plan
ETF	Effluent Treatment Facility
ERDF	Environmental Restoration Disposal Facility
FAT	facility acceptance test(ing)
FBR	fluidized bed reactor
FFTF	Fast Flux Test Facility
GAC	granular activated carbon
gpm	gallons per minute
HAB	Hanford Advisory Board

HASP	health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCP EIS	*Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
HLAN	Hanford Local Area Network
HDCS	Hanford Document Control System
I&C	instrumentation and controls
IC	institutional control
IDW	investigation-derived waste
IRM	Interim Remedial Measures
IX	ion exchange
JCS	job control system
MCL	maximum contaminant level
MBR	membrane bioreactor
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NCP	National Contingency Plan
NPL	National Priorities List
O&M	operations and maintenance
OM	Operations Manager
OMM	operations and maintenance manual
OP&S	operating properly and successfully
OSHA	Occupational Safety and Health Administration
OTP	operational test procedure
OU	operable unit
P&T	pump-and-treat
PMP	Performance Monitoring Plan
PPE	personal protective equipment
PSTF	Purgewater Storage and Treatment Facility
QA	quality assurance

QAPP	quality assurance program plan
QC	quality control
RA	remedial action
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1974*
RD	remedial design
RDR	remedial design report
RI	remedial investigation
RL	DOE Richland Operations Office
ROD	record of decision
RR&R	repair, replacement, and rehabilitation
RW	remediation waste
SAP	sampling and analysis plan
SOW	Statement of Work
TA	Test Authority
TC	Test Coordinator
TCE	trichloroethylene
TPA	Tri-Party Agreement (*Hanford Federal Facility Agreement and Consent Order)*
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
TSD	treatment, storage, and disposal
TSS	total suspended solids
USGS	U.S. Geological Survey
VOC	volatile organic compound
VPGAC	vapor phase granular activated carbon
WAC	*Washington Administrative Code*
WMP	waste management plan

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1 Introduction

The 200 West Area Groundwater Pump-and-Treat (P&T) system is a major component of the final remedial action (RA) selected in EPA et al., 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington* (hereafter referred to as the ROD). This Operations and Maintenance (O&M) Plan outlines the activities necessary to operate, maintain, and monitor performance of the 200 West Area Groundwater P&T Facility from completion of construction through decommissioning. The scope of this plan includes facility testing and acceptance, startup, O&M, performance monitoring and reporting, five-year remedy reviews, health and safety, and quality assurance (QA).

The O&M Plan was prepared by the U.S. Department of Energy (DOE) Richland Operations Office (RL) in accordance with the following:

- DOE/RL-2008-78, 200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan.
- Code of Federal Regulations (CFR) 40 CFR 300.435(f), "National Oil and Hazardous Substances Pollution Contingency Plan," "Remedial Design/Remedial Action, Operation and Maintenance," and "Operation and Maintenance."
- EPA 540-F-01-004, Operation and Maintenance in the Superfund Program (OSWER Directive 9320.2-09A-P).

This O&M Plan presents information that is based on the current design development and, as such, portions of this document may be updated as substantive changes are made through final design, construction acceptance testing (CAT), factory acceptance testing (FAT), facility acceptance testing, operational testing, and release for unrestricted operations. This O&M Plan is not intended to be updated or revised each time a minor change to the designed or constructed facility is made or each time a facility operational procedure is modified, but rather it will be updated or revised when relevant or substantive changes are made to the operating system or its supporting primary documents. Examples of a substantive change would include altering the ion exchange (IX) resin types or adding capacity to the treatment system (additional treatment trains). It is assumed that the O&M Plan will be updated or revised annually, or every other year, to allow for incorporation of minor changes to the plan's primary supporting documents as the remedy moves through its life cycle. Supporting documents include the compliance monitoring plan, the sampling and analysis plans (SAPs), the performance monitoring plan (PMP), and the waste management plan.

1.1 Purpose of This Plan

An adequate and functioning O&M program throughout a remedy's lifecycle is critical for successful implementation and ultimate achievement of the remedial action objectives (RAOs). The O&M measures described in this document are designed to provide guidance on implementation of the requirements necessary for maintaining the remedy to ensure protection of human health and the environment.

The O&M plan serves as an administrative document that describes how O&M of the remedy will be conducted. The O&M is a separate document from an O&M manual (OMM), which typically contains purely technical information used to guide operations and maintenance staff through day-to-day O&M activities. Engineering and operations staff will create the system's O&M procedure documentation that typically resides in an OMM. This information will reside in an electronic information management platform used for creating, storing, and updating the typical components of an OMM on the facility-wide intranet, i.e., the Hanford Local Area Network (HLAN). This O&M program is described further in Chapter 2.

Although a majority of this O&M Plan addresses the activities necessary for the long-term O&M of the 200 West Area groundwater P&T system, requirements for O&M of the other remedy components are also described, including site-specific inspection, sampling and analysis, and routine reporting. Institutional controls (ICs) for the Hanford Site are already in place as described in DOE/RL-2001-41, *Site-wide Institutional Controls Plan for Hanford CERCLA Response Actions*. Therefore, inspection and annual reporting on ICs for the 200-ZP-1 Operable Unit (OU) will be performed under DOE/RL-2001-41.

1.1.1 Organization and Content of this Plan

This O&M Plan contains the following information:

- Chapter 1 – Introduction. Presents a detailed description of the various components comprising the selected remedy.
- Chapter 2 – Pump-and-Treat System Startup, Inspections, and Initial Conditions. Provides a description of the inspection and testing that will be performed before the 200 West Area groundwater P&T system becomes operational and functional.
- Chapter 3 – Operations and Maintenance. Describes routine O&M activities that will be conducted to ensure that the P&T system achieves its operational uptime goal. This chapter also describes several potential upset conditions that may occur over the P&T system's lifetime and the response actions that will be undertaken to address an upset condition should it occur.
- Chapter 4 – Monitoring. Describes routine sampling and analysis of the groundwater treatment plant's influent and effluent that will be conducted to ensure that applicable or relevant and appropriate requirements (ARARs) are met. This chapter also describes the sampling and analysis that will be conducted within the OU's groundwater monitoring well network to track RA progress. Sampling within the groundwater treatment plant to assess the performance of individual treatment processes is not addressed within this O&M Plan but will be covered in operational procedures.
- Chapter 5 – Periodic Reporting and Closure. Describes the periodic reports that will be prepared to summarize RA progress and the approach that may be used to transition the remedy from active P&T operations to natural attenuation, implementation of ICs, and eventual closure once RAOs have been met.
- Chapter 6 – Decontamination and Decommissioning. Summarizes the process that will be used to decontaminate and decommission P&T equipment once a determination has been made that the equipment is no longer required.
- Chapter 7 – Safety, Health, and Quality. Summarizes health and safety practices and other measures that will be employed to ensure overall safety during implementation of the selected remedy.
- Chapter 8 – References. Provides a list of references that are cited in this document.

The O&M Plan also provides additional information on the scope of routine activities to be conducted in conjunction with implementation of the selected remedy. The following appendices are included:

- Appendix A – Compliance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action. Summarizes the approach to be used to ensure that the fully implemented remedy complies with the ARARs indentified in Appendix A of the ROD.

- Appendix B – Waste Management Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action. Describes how the various waste streams associated with implementation of the selected remedy and routine operation of the P&T system will be managed.
- Appendix C – Air Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action. Describes the evaluation that was performed to assess potential atmospheric air affects associated with groundwater treatment operations, and the sampling and analysis that will be conducted to ensure that air discharges comply with ARARs.
- Appendix D – 200 West Area Groundwater Treatment Facility Sampling and Analysis Plan. Describes the sampling and analysis that will be conducted to characterize the treatment plant's influent, effluent, and associated waste streams.
- Appendix E – Groundwater Sampling and Analysis Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action. Presents information on implementation of the sampling design presented in the PMP.

1.2 Statement of Remedy Goals

The following RAOs are specified in the ROD for the 200-ZP-1 Groundwater OU:

- RAO No. 1: Return 200-ZP-1 OU groundwater to beneficial use (restore groundwater to achieve domestic drinking water levels) by achieving the cleanup levels (provided in ROD, Table 11). This objective is to be achieved within the entire 200-ZP-1 OU groundwater plumes. The estimated timeframe to achieve cleanup levels is within 150 years[1].
- RAO No. 2: Apply ICs to prevent the use of groundwater until the cleanup levels (provided in EPA et al., 2008, Table 11) have been achieved. Within the entire OU groundwater plumes, ICs must be maintained and enforced until the cleanup levels are achieved, which is estimated to be within 150 years[1].
- RAO No. 3: Protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU. This final objective is applicable to the entire 200-ZP-1 OU groundwater plume. Protection of the Columbia River from impacts caused by 200-ZP-1 OU contaminants must last until the cleanup levels are achieved, which is estimated to be within 150 years.[1]

The final cleanup levels for 200-ZP-1 OU groundwater contaminants of concern (COCs), following implementation of the selected remedy, are identified in the ROD and listed in Table 1-1. The cleanup levels were developed using federal drinking water maximum contaminant levels (MCLs); the criteria and equations provided in WAC 173-340-720(4)(b)(iii)(A) and (B), "Model Toxics Control Act—Cleanup," "Ground Water Cleanup Standards," "Method B Cleanup Levels for Potable Ground Water," "Standard Method B Potable Ground Water Cleanup Levels," "Human Health Protection," "Noncarcinogens," and "Carcinogens," and WAC 173-340-720(7)(b), "Adjustments to Cleanup Levels," "Adjustments to Applicable State and Federal Laws," and the federal and drinking water standards for radionuclides.

[1] The RAOs identify the estimated timeframe to achieve cleanup is within 150 years. The expected outcome of the selected remedy is that the 200-ZP-1 OU groundwater will be returned to a level that supports future use as a potential domestic drinking water supply in 125 years (EPA et al., 2008).

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

COC	Units	Final Cleanup Level	Cleanup Level Basis
Carbon tetrachloride	µg/L	3.4[c, d]	MTCA – Method B
Chromium (total)	µg/L	100	Federal/State MCL
Hexavalent chromium	µg/L	48[a]	MTCA – Method B
Nitrate-Nitrogen	µg/L	10,000[b]	Federal/State MCL
Trichloroethylene (TCE)	µg/L	1[c, d]	MTCA – Method B
Iodine-129	pCi/L	1	Federal MCL
Technetium-99	pCi/L	900	Federal MCL
Tritium	pCi/L	20,000	Federal MCL

Notes:

a. There is no MCL specific to hexavalent chromium.

b. Nitrate may be expressed as total nitrate (NO_3) or as nitrogen (N). The MCL for nitrate as NO_3 is 45,000 µg/L, and the same concentration expressed as Nitrate-N is 10,000 µg/L.

c. The Model Toxics Control Act Method B cleanup levels for carbon tetrachloride and TCE are from the Washington State Department of Ecology (Ecology) Cleanup Levels and Risk Calculations (CLARC) table current as of September 25, 2008 (Ecology, 2008).

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

1.3 Remedy Description

The DOE's 200 Area National Priorities List (NPL) site, which is commonly referred to as the Central Plateau, encompasses approximately 190 km^2 (75 mi^2) within the 1,517 km^2 (586 mi^2) Hanford Site (Figure 1-1) located in south-central Washington State. The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) site identification number for the 200 Areas is No. WA 1890090078. The 200-ZP-1 Groundwater OU is one of four groundwater OUs located on the Central Plateau. Each groundwater OU has its own plan of study and enforceable schedule and will eventually have its own ROD and cleanup action as needed.

The selected remedy for the 200-ZP-1 Groundwater OU combines P&T, monitored natural attenuation (MNA), flow path control, and ICs to meet the objective of achieving cleanup levels for all COCs in the 200-ZP-1 OU in 125 years (Table 1-1). The effectiveness of the P&T system will diminish over time as COC concentrations are reduced, whereas the effectiveness of natural attenuation is relatively constant. As a result, natural attenuation will eventually become the dominant mechanism for continued reduction of COC concentrations. The effectiveness of the remedy is further enhanced by controlling the direction and rate of groundwater flow throughout the 200-ZP-1 OU using strategically placed extraction and injection wells for flow path control. ICs provide protection from exposure to groundwater contamination for both site workers and potential future users of groundwater until the remedy is complete (see Section 1.3.2.3).

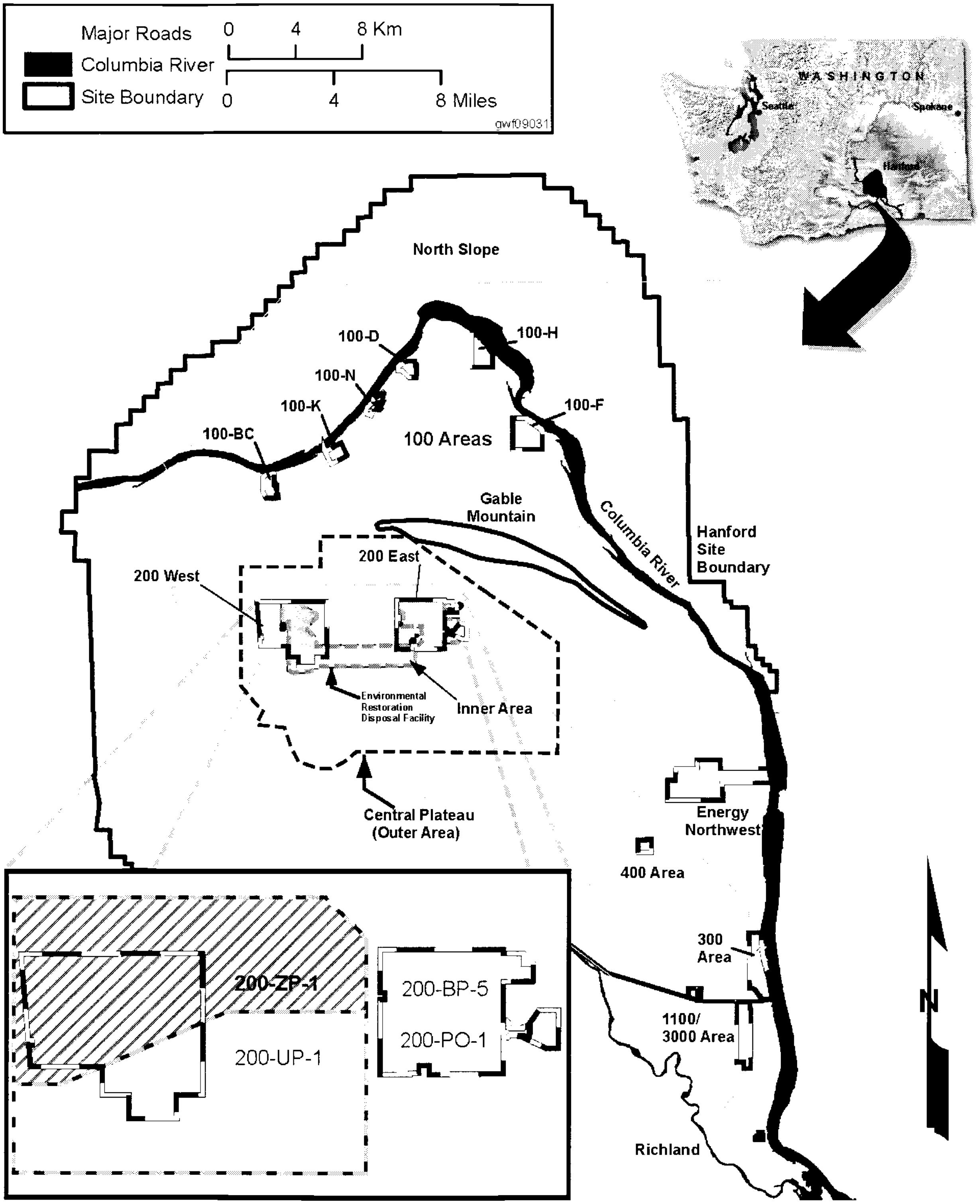

Figure 1-1. Hanford Site Map Showing Central Plateau Groundwater Operable Units

1.3.1 Pump-and-Treat System Description

The 200 West Area groundwater P&T system is designed to capture and treat contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium – trivalent (CrIII) and hexavalent (CrVI), nitrate, trichloroethylene (TCE), iodine-129, and technetium-99 throughout the 200-ZP-1 OU. The system design also includes provisions for future treatment of groundwater from the 200-UP-1 OU, including removal of uranium. Following treatment, the water is injected back into the aquifer to serve as a recharge source and to promote flow path control (Figure 1-2). The new 200 West Area groundwater treatment facility will be located south of T-Plant in the 200 West Area (Figure 1-3).

The 200 West Area groundwater P&T system is currently in pre-final design, and final decisions are being made regarding the final facility configuration as the design process moves toward the 100 percent design submittal. The system will be constructed in calendar years 2010 and 2011. The 90 percent design will be presented in DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Facility Remedial Design Report*.

Construction of the treatment facility will provide an initial installed capacity to treat up to 2,500 gallons per minute (gpm) of extracted groundwater utilizing two parallel treatment trains. CAT is scheduled for completion on September 30, 2010. The initial extraction and injection well network is projected to include 15 extraction wells and 5 injection wells. The number and location of these wells are being finalized and will depend on site-specific conditions.

After full system startup, groundwater treatment operations at the existing 200-ZP-1 OU Interim Remedial Measures (IRM) groundwater P&T system may be idled, used for intermediation operations such as a transfer building, mothballed, or decommissioned. There are existing injection wells in the IRM system that may be used for injection of treated groundwater from the new 200 West Area groundwater treatment facility.

Upon completion of construction, facility commissioning, and initial startup, the system is projected to operate at approximately 1,000 gpm, including an estimated 50 gpm of groundwater extracted from the 200-UP-1 OU Waste Management Area S-SX. By December 31, 2012, additional wells will be brought on line, based on aquifer performance, to utilize additional treatment capacity at the facility. Figure 1-4 provides the proposed layout of the injection wells, extraction wells, and conveyance piping in the 200 West Area.

Design of the facility includes the ability to add a third treatment train (also in parallel) within the existing facility footprint and infrastructure, increasing the design flow rate to 3,750 gpm. The need for additional treatment capacity will be based on the treatment capacity required for the 200-ZP-1 OU groundwater, and groundwater that may be extracted as part of the final remedy for the 200-UP-1 OU.

The groundwater treatment approach involves multiple treatment steps to remove the various COCs (Table 1-1). The relationship between each unit process and the targeted COCs is presented in Table 1-2. Additional information on each treatment step is provided in the following subsections.

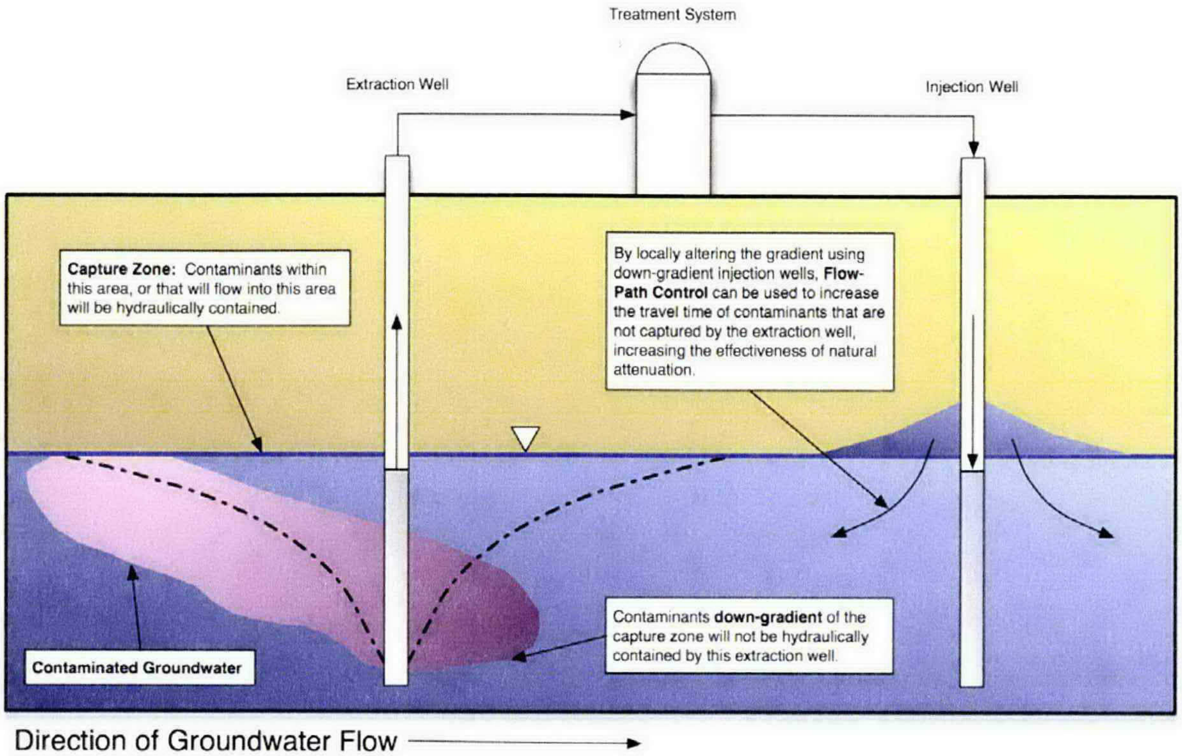

Figure 1-2. Conceptual Summary of the 200 West Area Groundwater Pump-and-Treat System

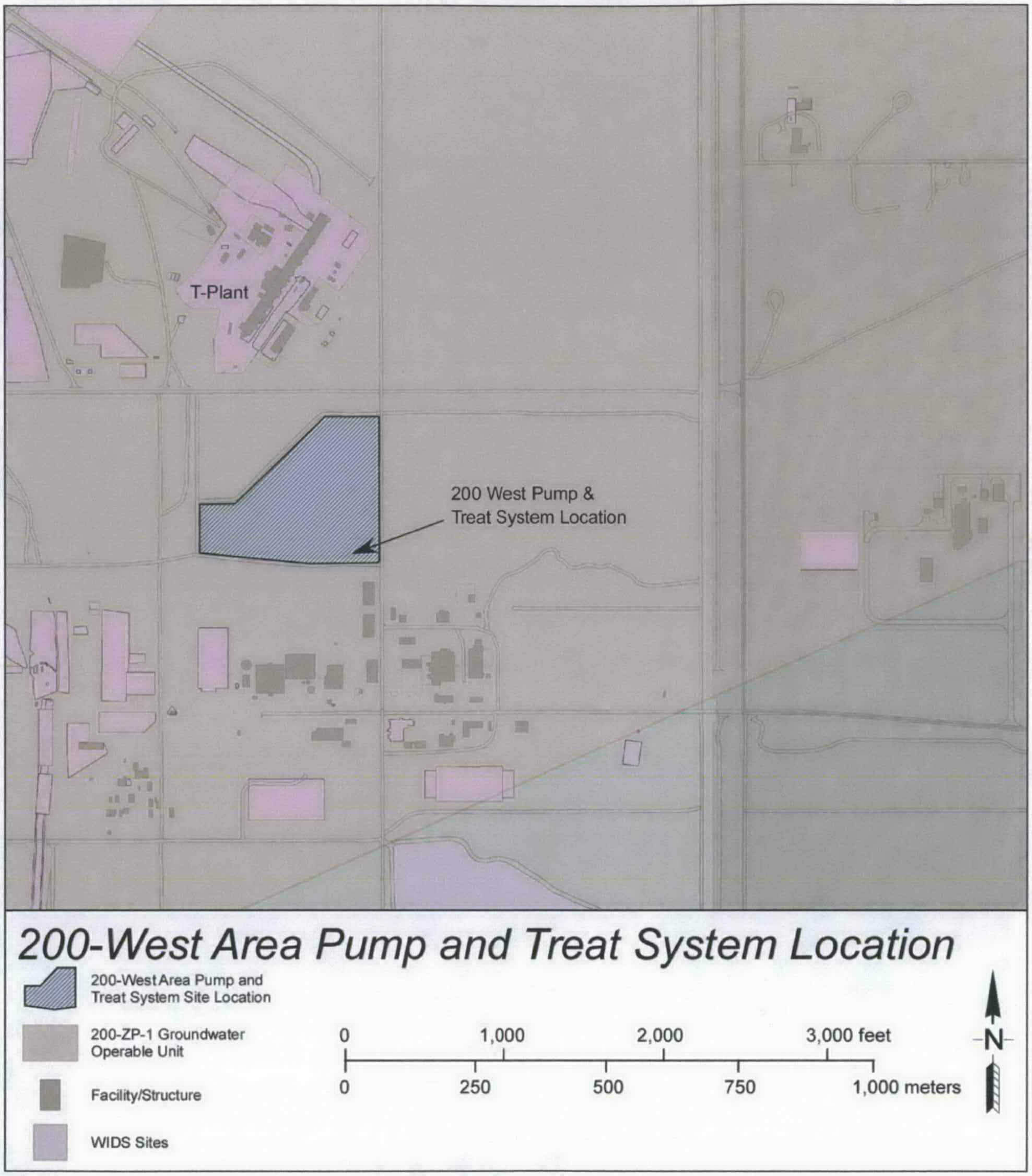

Figure 1-3. 200 West Area Groundwater Pump-and-Treat System Location

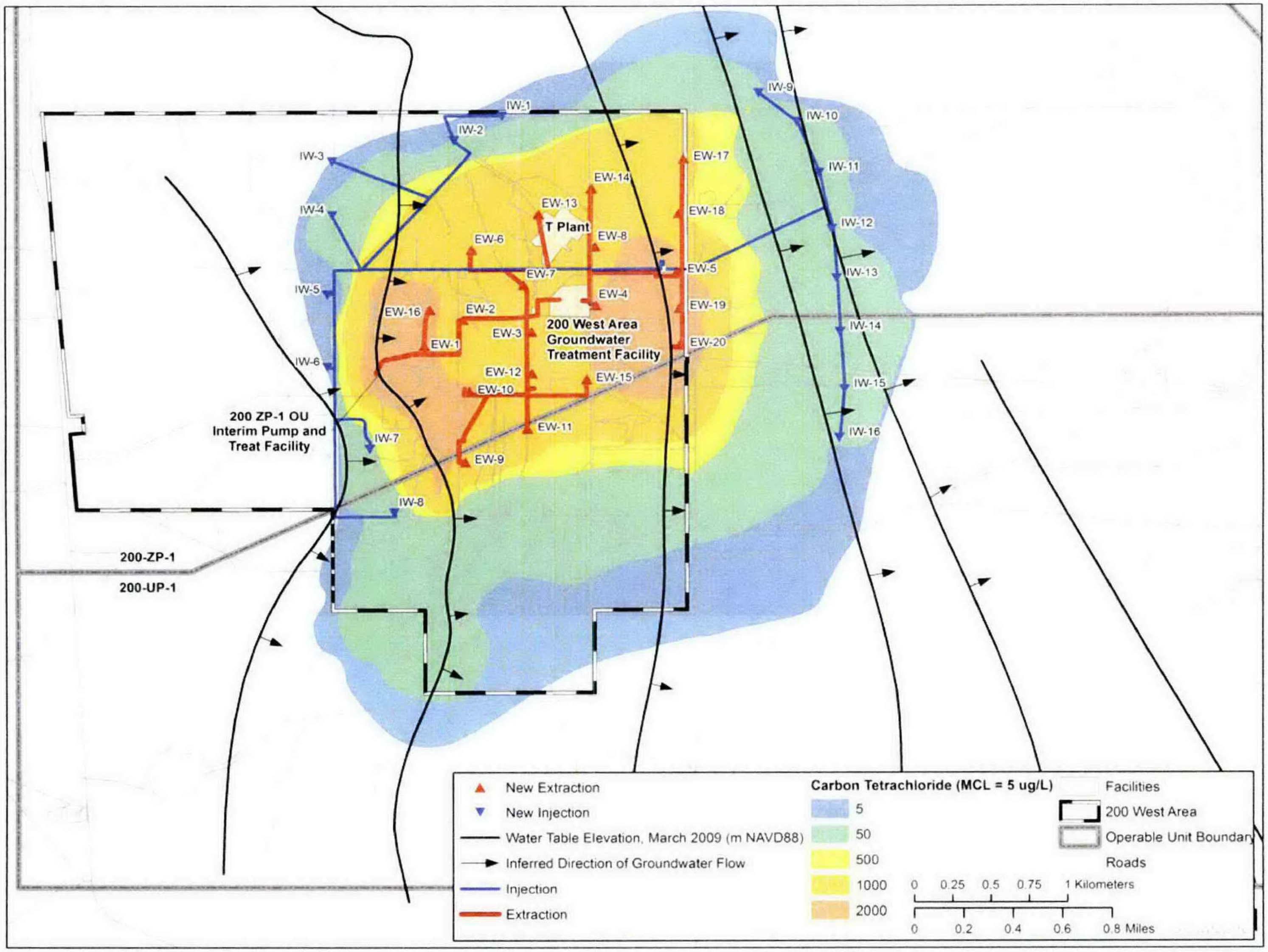

Figure 1-4. Proposed Extraction and Injection Well Locations and Conveyance Pipe Routing for the 200 West Area Groundwater P&T System

Table 1-2. 200 West Area Groundwater Pump-and-Treat System Unit Process Descriptions

Unit Process	Process Benefit	Targeted Parameter
Ion Exchange (IX)	Removal of Technetium-99, uranium, and iodine-129	Technetium-99 Iodine-129 Uranium*
Anoxic/Anaerobic Biodegradation (fluidized bed reactor or FBR)	Removal of nitrate and carbon tetrachloride and conversion of hexavalent chromium to trivalent form	Nitrate Carbon Tetrachloride Hexavalent Chromium Trichloroethylene
Aerobic Biodegradation	Degradation/removal of residual organic carbon substrate	Biochemical Oxygen Demand (BOD)
Membrane Filtration	Removal of particles, biomass, and precipitated trivalent chromium	Trivalent Chromium Turbidity and BOD
Air Stripping	Removal of volatile organic compounds(VOCs) – carbon tetrachloride and trichloroethylene	Carbon Tetrachloride Trichloroethylene
Sludge Thickening	Thicken biological solids for dewatering process	Solids Content
Sludge Dewatering	Reduce water content to allow for landfill disposal	Water Content
Treated Water Chemistry Adjustment	Provide treated water stability	pH and Alkalinity

Notes:

* Uranium treatment is only required for groundwater from the 200-UP-1 OU.

1.3.1.1 Technetium-99 Ion Exchange System

Groundwater from selected wells in the 200-ZP-1 OU and 200-UP-1 (after separate pre-treatment for uranium) is pre-treated to reduce technetium-99 to less than 900 pCi/L (Figure 1-5). Influent groundwater is first filtered to remove fine particulate matter, then flows to the technetium-99 ion exchange (IX) vessels before passing through a final set of filters and transfer to the 200 West Area groundwater treatment facility.

Prior to the IX resin reaching its loading limit, it will be removed from the vessel by sluicing it with treated water from the 200 West Area groundwater treatment facility into a carbon tetrachloride stripping tank (Figure 1-6) where the resin will be fully submerged with treated water. The tank will be heated and air will be bubbled through the resin bed to mix the bed and strip off carbon tetrachloride. The stripping water will be pumped to the equalization tank at the 200 West Area groundwater treatment facility for treatment. The vapor emissions will be treated with vapor phase granular activated carbon (VPGAC).

The resin in the strip tank will be sluiced with treated water to a geotextile tube placed in a container to allow drainage (Figure 1-7). The filtrate from the geotextile tube will be collected and pumped back into the feed tank (Figure 1-5). The dewatered resin will be transported for placement at the Environmental Restoration Disposal Facility (ERDF). The spent resin will be profiled to verify that the ERDF limits for technetium-99, iodine-129, uranium, and carbon tetrachloride are met. If these limits cannot be met, stabilization of the resin may be required.

1.3.1.2 Uranium Ion Exchange System

The design also considers, as necessary, the need for treatment of other constituents (such as uranium) that may be captured by the 200-ZP-1 OU extraction wells. While they are not COCs for the 200-ZP-1 OU, these constituents may be encountered during restoration from sources related to the other adjacent groundwater OUs such as the 200-UP-1 OU. Additionally, in anticipation of future expansion, the 200 West Area groundwater treatment system will also be capable of treating some contaminated groundwater (including uranium) from the 200-UP-1 OU. Following initial operations, it is anticipated that the 200 West Area groundwater P&T system will be expanded to provide the necessary treatment capabilities for additional contaminated groundwater from the 200-UP-1 OU following issuance of a ROD for that OU.

Based on the need to address uranium concentrations, groundwater from these sources will be pre-treated to remove uranium using IX resin vessels prior to conveyance to the technetium-99 IX pre-treatment system. The uranium IX pre-treatment system will be similar to the technetium-99 IX system described above.

1.3.1.3 200 West Area Groundwater Treatment Facility

The treatment processes for carbon tetrachloride and nitrate removal at the 200 West Area groundwater treatment facility are configured in two parallel 1,250 gpm treatment trains to accommodate increasing flow ranges up to 2,500 gpm. The treatment facility infrastructure is designed to accommodate a third treatment train, if required, to increase the total treatment capacity to 3,750 gpm.

Water from the technetium-99 IX system flows to the 200 West Area groundwater treatment facility where it is blended in an equalization tank (Figure 1-8) with the extracted groundwater conveyed, through extraction transfer pumps serving several extraction wells or directly to the facility from individual extraction wells. Water is pumped from the equalization tank to a recycle tank and then to a fluidized bed reactor (FBR), where nitrate is converted to nitrogen gas. Carbon tetrachloride is also treated in the FBR, which operates under anoxic conditions (i.e., in the absence of dissolved oxygen).

Water is pumped into the bottom of the FBR creating upflow to suspend the granular activated carbon (GAC) bed media to which microorganisms attach and grow anaerobically. The FBR will be seeded with microbes that are suited for nitrate/nitrogen removal (denitrification) and carbon tetrachloride degradation under anoxic conditions. An organic carbon substrate and phosphorus will be added into the FBR to serve as the electron donor and nutrient to promote microbial growth. As the microbes grow on the GAC, the fluidized bed height will expand, and excess biomass will be removed by shear forces resulting from normal flow through the FBR. Additional excess biomass will be removed with a biomass separator and will flow out with the effluent.

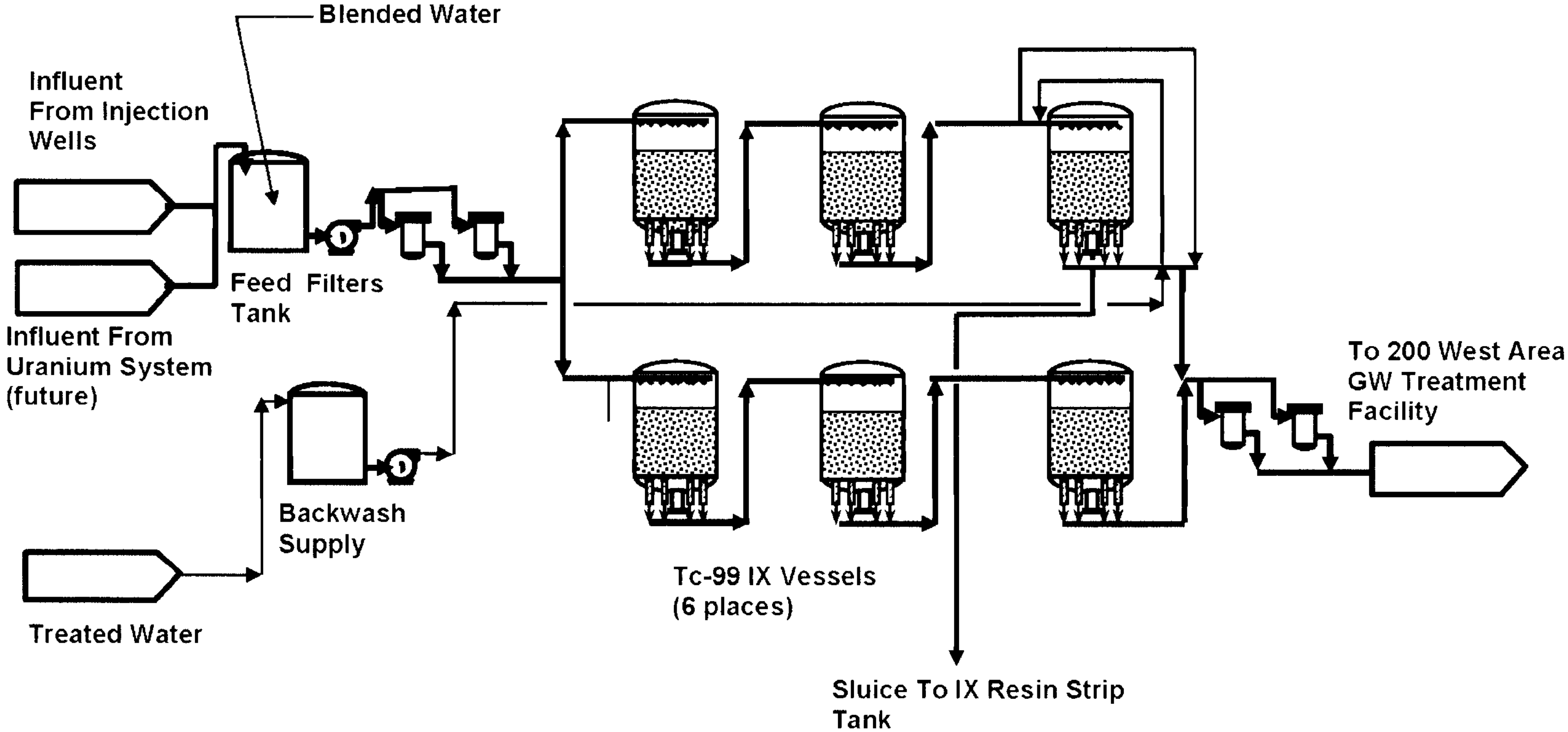

Figure 1-5. Technetium-99 IX Process Schematic

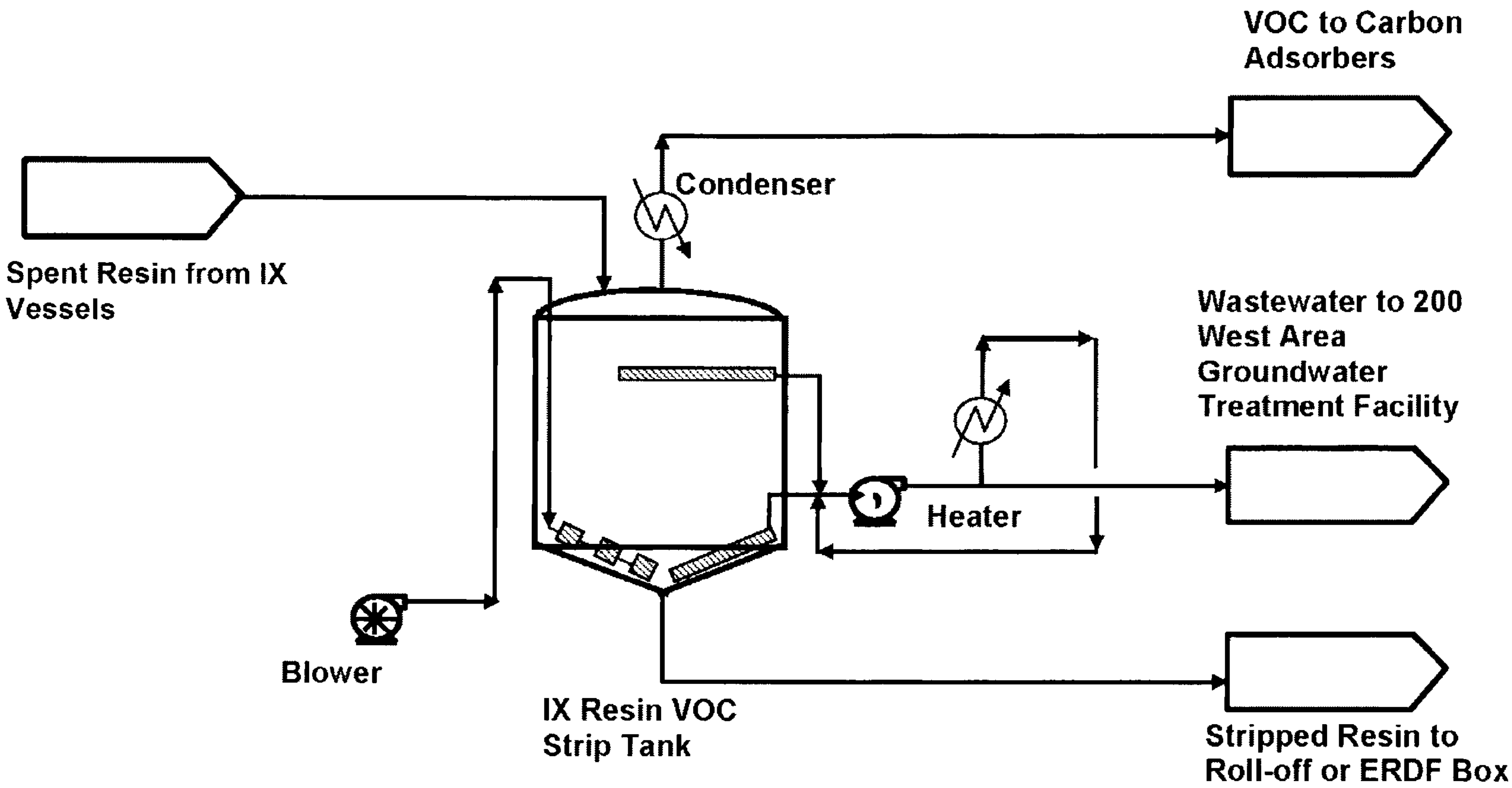

Figure 1-6. Technetium-99 IX Resin Strip Tank Schematic

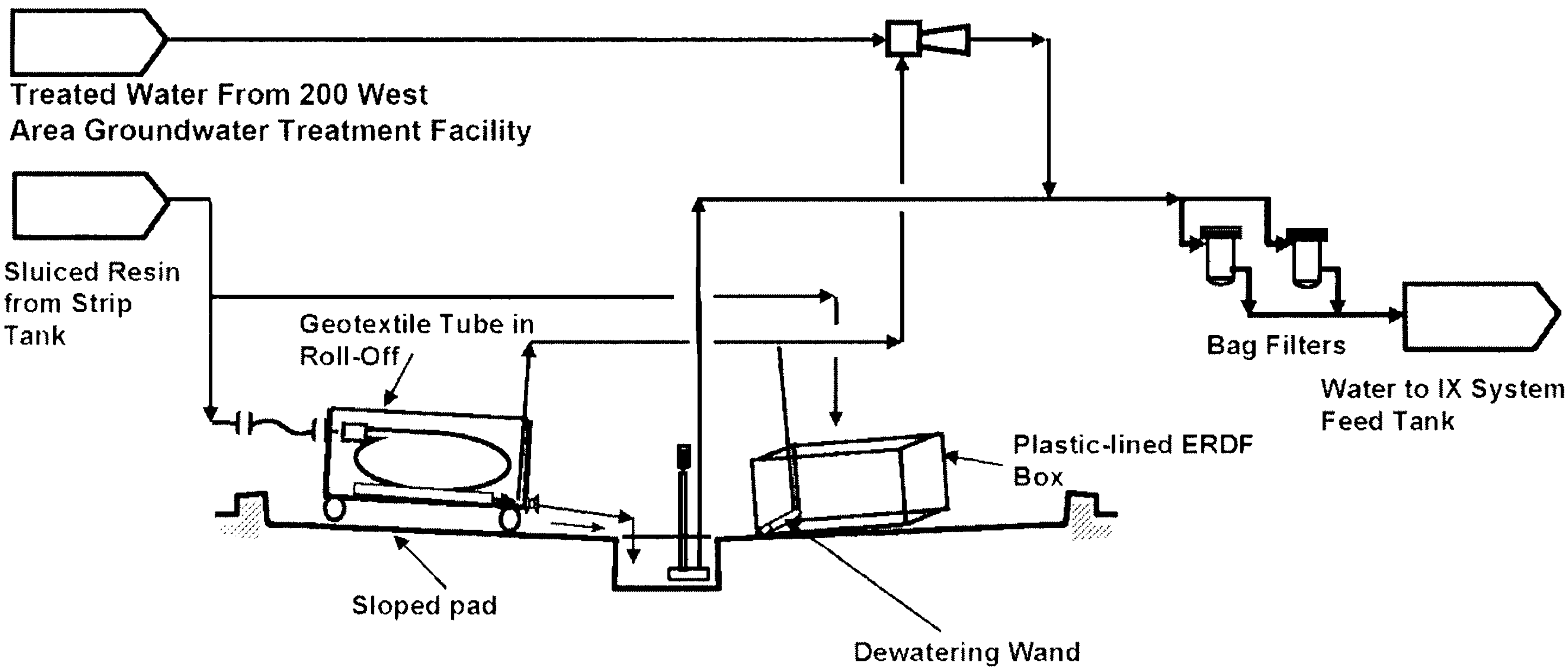

Figure 1-7. Technetium-99 IX Resin Dewatering Schematic

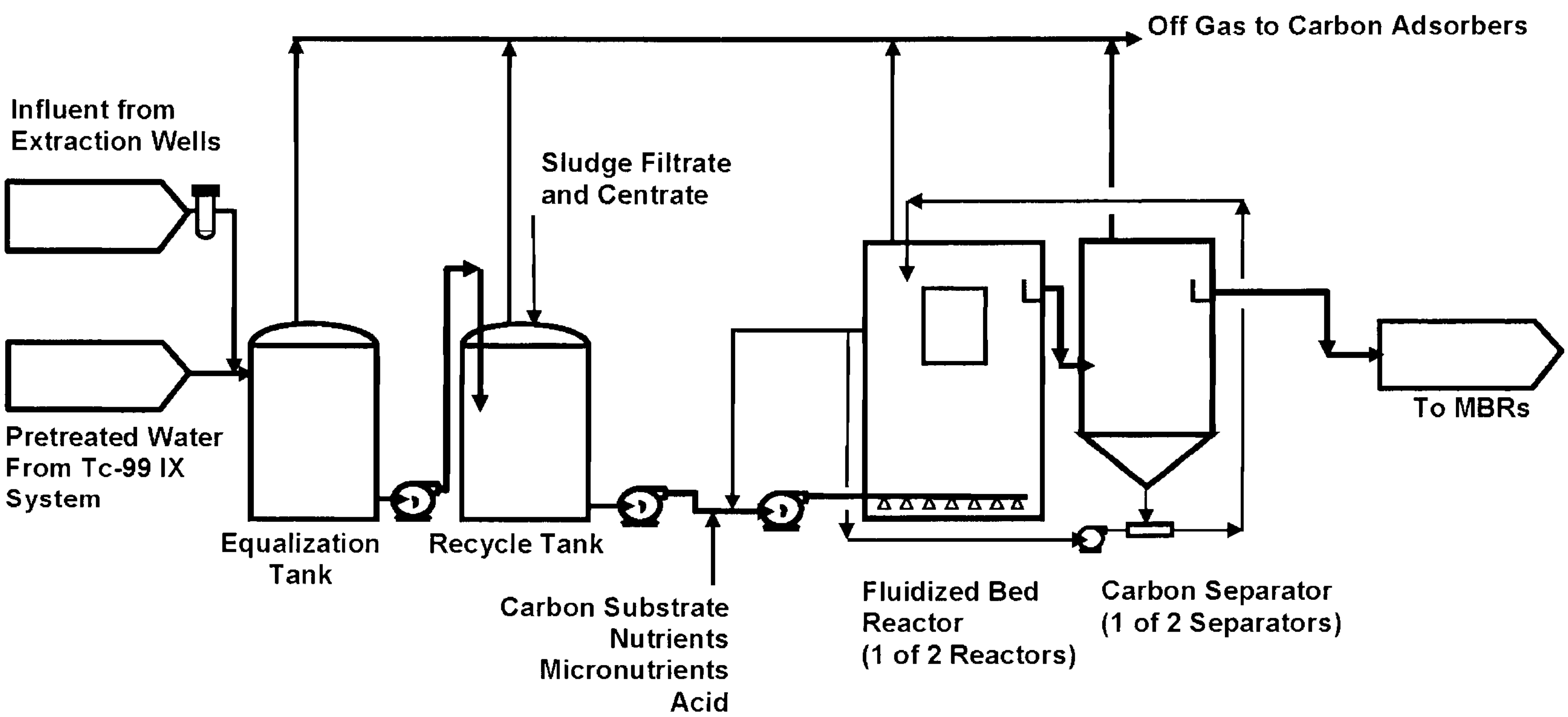

Figure 1-8. Biological Process – Anoxic FBR Schematic

The effluent from the FBR flows by gravity to aerobic membrane tanks (Figure 1-9) for removal of residual carbon substrate through aerobic biodegradation and removal of total suspended solids (TSS), including biomass generated in the FBR. The membrane tanks have aeration capacity to provide sufficient oxygen for maintaining the aerobic biological process to reduce the residual carbon substrate. The membrane tanks have an aeration zone followed by a membrane zone with submerged membranes for filtration. The aeration zone is maintained by a blower that diffuses air into the tank. A second blower for the membrane zone provides air scouring to remove accumulated organic debris from the membrane surface to maintain its water permeability. The aeration and air scouring processes will strip off carbon tetrachloride. Vapor emissions will be collected for treatment with VPGAC.

In the membrane zone, there are multiple modules of vertically or horizontally strung membrane fibers. Water is filtered by applying a slight vacuum to the end of each fiber which draws the water through the tiny pores into the fibers. The filters remove solids which are retained in the tank concentrate. A portion of the concentrate is recycled to the first compartment of the membrane tank to maintain the biomass concentration necessary to reduce biochemical oxygen demand (BOD).

Solids from the membrane tanks are pumped to rotary drum thickeners (Figure 1-10). Thickened sludge leaving the rotary drum thickeners is sent to aeration tanks. A bypass line is used to maintain the solids content in the aeration tanks within an optimum range. As the solids concentration in the aeration tanks decreases, less flow is bypassed around the thickeners; conversely, as the solids concentration in the tank increases, more flow is bypassed around the thickening process. Polymer is added upstream of the rotary drum thickeners, as necessary, to thicken the solids. The aeration tanks also provide further digestion of biomass and maintain aerobic conditions for odor control.

The thickened solids are then pumped from the sludge holding tank to centrifuges for dewatering (Figure 1-11). Polymer is added upstream of the centrifuges to aid in solids dewatering. A screw conveyor is used to move the dewatered sludge from the centrifuge to a lime stabilization system where a mechanical mixer (e.g., pug mill) will mix lime with the thickened sludge. This controls free water to meet ERDF disposal criteria and prevents further decomposition and generation of objectionable gasses and odors. Once the lime is added, the conditioned sludge will be transferred by screw conveyor into ERDF containers for disposal. The filtrate from the rotary drum thickeners and centrate from the centrifuges are piped to a collection tank and then to the recycle tank located upstream of the FBR.

The treated water from the membranes is pumped to an air stripper (Figure 1-12) for removal of the remaining carbon tetrachloride and other volatile organic compounds (VOCs). The air stripper effluent is then pumped to an effluent tank. Acid is added upstream of the effluent tank through an inline static mixer to adjust pH.

Off-gas from the stripper, influent equalization tank, strip tanks (technetium-99 and uranium), FBRs, membrane tanks, sludge holding tanks, rotary drum thickeners, and centrifuges is combined and treated by VPGAC. To avoid build-up of radionuclides in the VPGAC, air streams to the VPGAC system will be pretreated by a demister to minimize liquid carryover.

The air stripper tower is piped so that this treatment step can occur before the FBR in the event degradation of the carbon tetrachloride in the FBR is less than anticipated. For the latter scenario, the water from the influent equalization tank is pumped through strainers to remove larger particles before entering the air strippers. Process monitoring conducted during initial operations will be used to determine the optimum configuration of the air stripper.

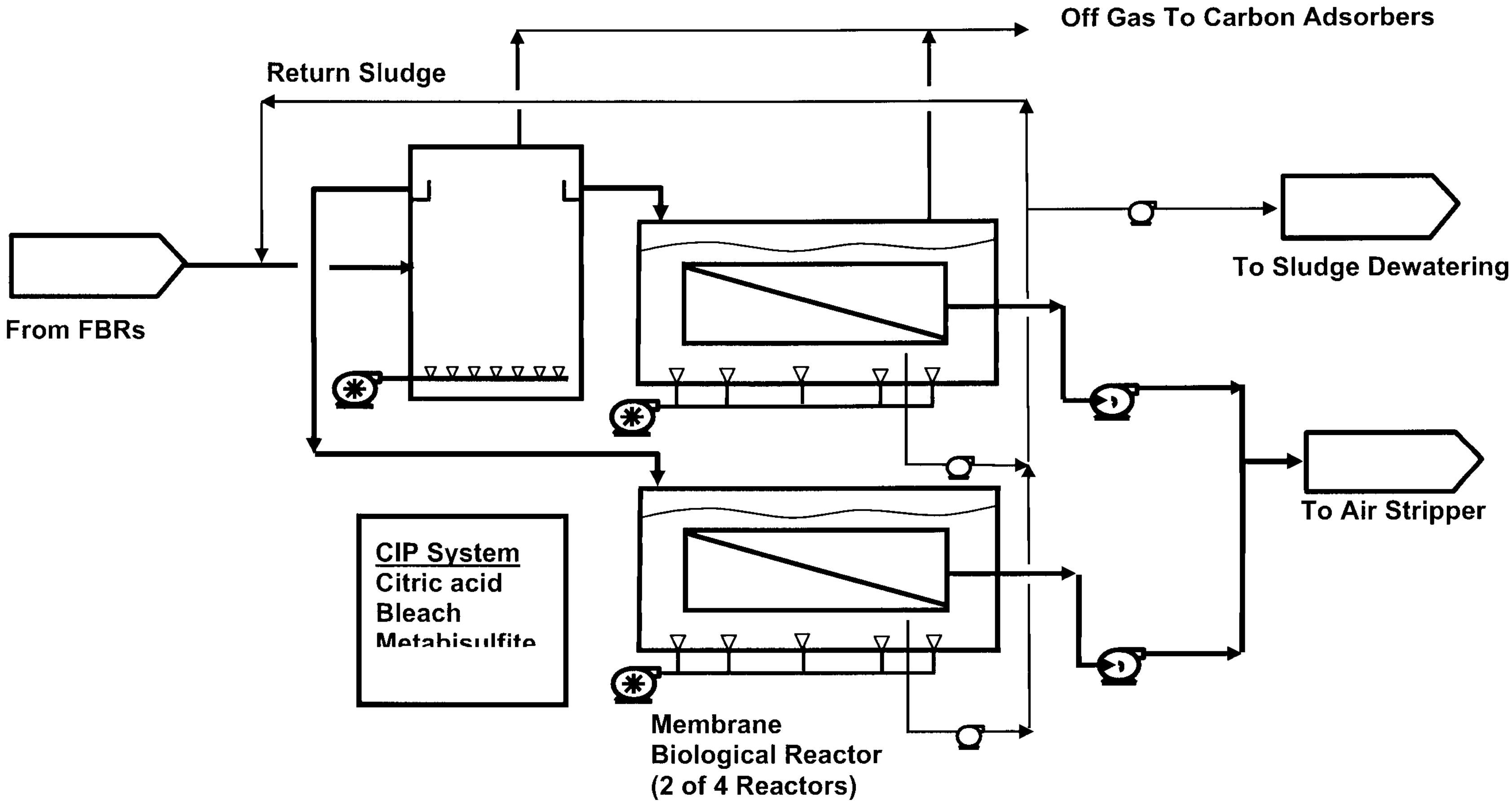

Figure 1-9. Biological Process – Aerobic MBR Schematic

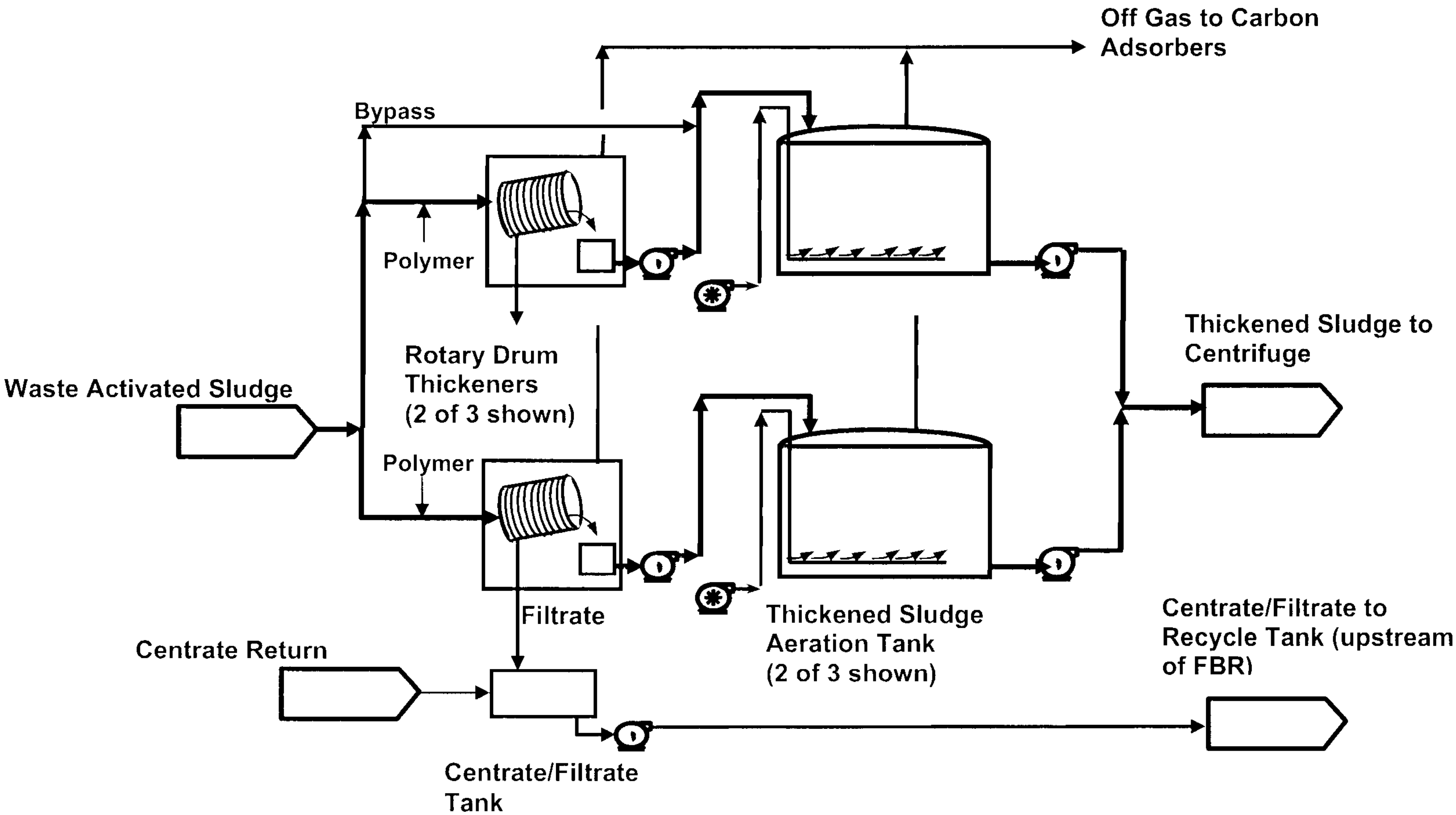

Figure 1-10. Solids Handling System – Thickeners and Thickened Sludge Aeration Tank Schematic

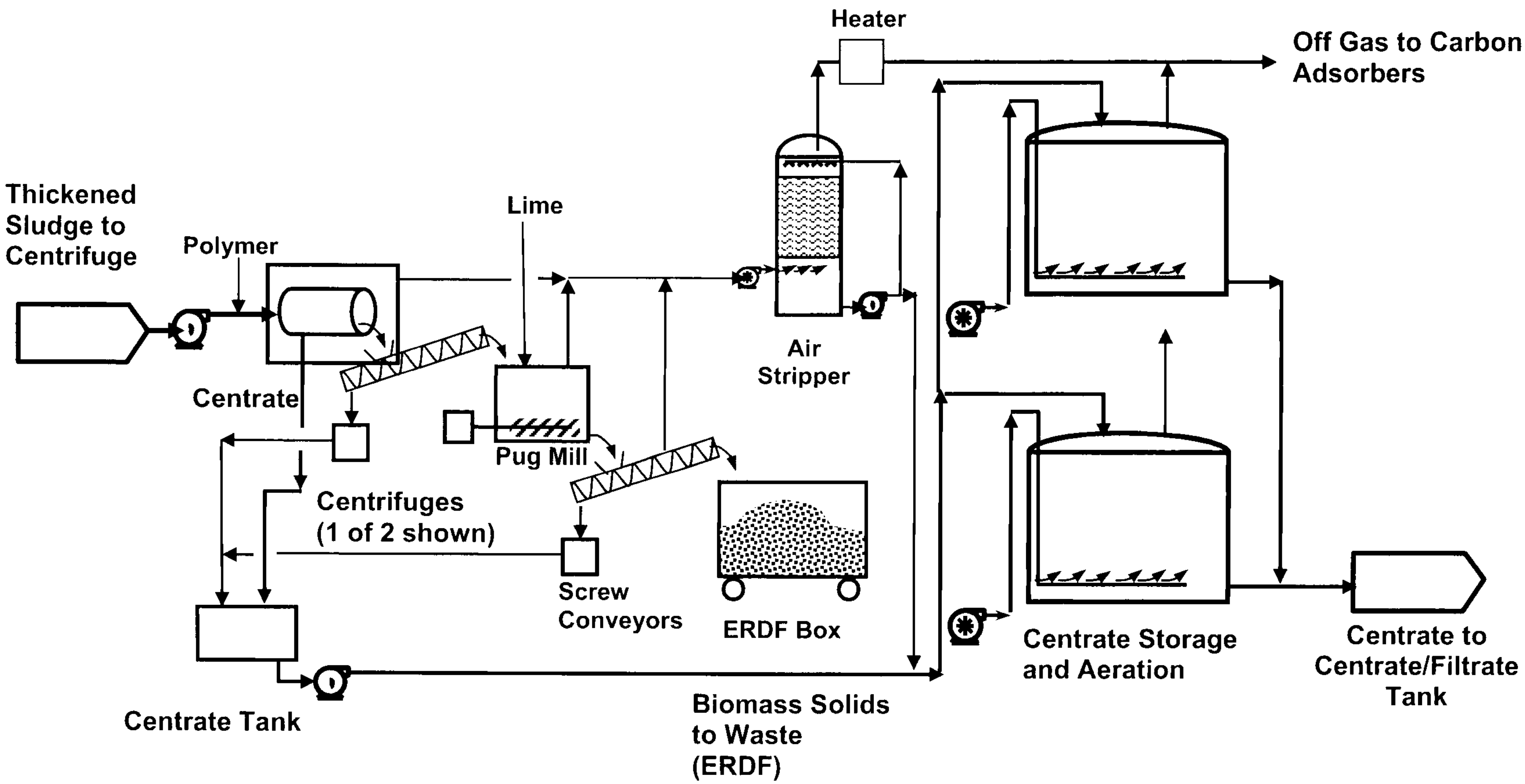

Figure 1-11. Solids Handling System – Centrifuge Dewatering and Lime Treatment Schematic

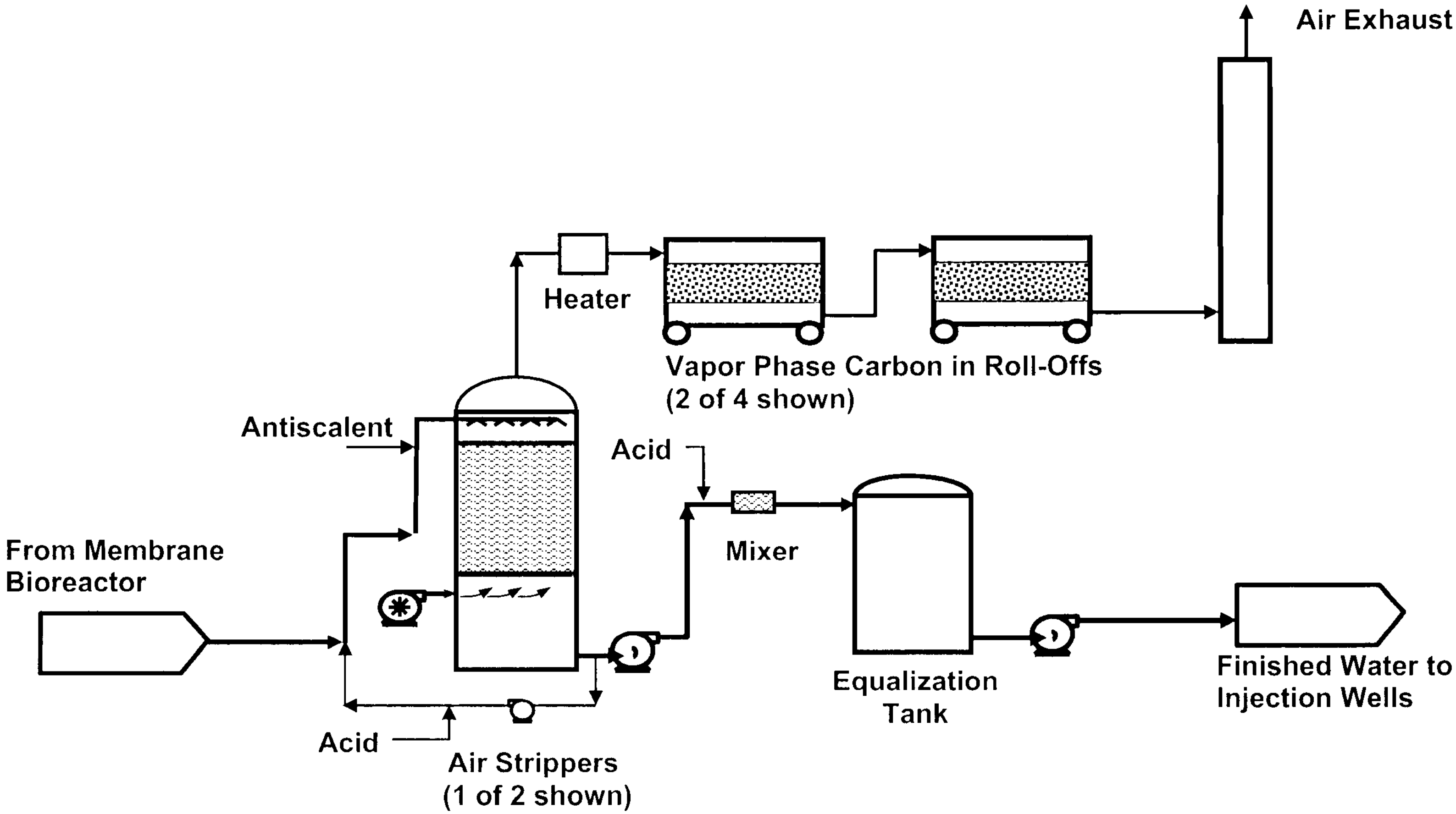

Figure 1-12. Air Stripper System Schematic

1.3.2 Other Remedy Components

This section describes the additional components of the groundwater remedy that augment the P&T system.

1.3.2.1 Monitored Natural Attenuation

In addition to the P&T system, the remedy for the 200-ZP-1 OU includes natural attenuation processes for reducing COC concentrations to the cleanup levels. Natural attenuation will eventually become the dominant mechanism for continued reduction of COC concentrations in the 200-ZP-1 OU as the effectiveness of the P&T system decreases over time. Because there is no viable treatment technology for tritium from the groundwater in the P&T system, the short half-life of tritium will allow natural attenuation to reduce its concentration to meet the cleanup levels.

For the remaining portion of the carbon tetrachloride and nitrate (as well as tritium) not captured by the P&T component, natural attenuation processes will be used to reduce concentrations to the cleanup levels.

Natural attenuation processes, to be relied on as part of this component, include biotic and abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring conducted under this O&M Plan will be used to evaluate the effectiveness of the P&T system and natural attenuation processes as described in Chapters 4 and 5. Fate and transport analyses conducted as part of DOE/RL-2007-28, *Feasibility Study Report for the 200-ZP-1 Groundwater Operable Unit*, indicate that the timeframe necessary to reduce the remaining COC concentrations to acceptable levels through MNA will be approximately 100 years.

1.3.2.2 Flow Path Control

The flow path control component of the 200-ZP-1 Groundwater OU RA consists of injecting treated groundwater into the aquifer to the west and east of the groundwater contaminant plume. Injecting water at these locations contains the contaminant plume and, as a result, keeps the higher concentration areas within the extraction well capture zone while also increasing the time available for natural attenuation processes to reduce contaminant concentrations not captured by the extraction wells.

Flow path control is also used to minimize the potential for groundwater in the northern portion of the aquifer to flow northward through Gable Mountain Gap towards the Columbia River. The injection wells are located to re-direct groundwater flow to the east, which provides the longest flow path to the river (about 26 km [16 mi]). Monitoring data conducted under this O&M Plan will be assessed to determine the effectiveness of flow path control as described in Chapters 4 and 5.

1.3.2.3 Institutional Controls

The 200-ZP-1 OU ROD requires ICs for 200-ZP-1 groundwater until cleanup levels are met. A description of these controls and their implementation is provided in DOE/RL-2001-41. The following specific controls are required by the ROD for the 200-ZP-1 OU:

- No intrusive work shall be allowed in the 200-ZP-1 OU unless the U.S. Environmental Protection Agency (EPA) has approved the plan for such work and that plan is followed.
- The DOE shall prohibit well drilling in the 200-ZP-1 OU, except for monitoring, characterization, or remediation wells authorized in EPA-approved documents.
- Groundwater use in the 200-ZP-1 OU is prohibited, except for limited research purposes, monitoring, and treatment authorized in EPA-approved documents. The site-wide IC plan will contain the ICs and

implementing details prohibiting well drilling and groundwater use in the 200-ZP-1 OU, as defined in the ROD.

- The DOE shall post and maintain warning signs along pipelines conveying untreated groundwater that caution site visitors and workers of potential hazards from the 200-ZP-1 OU groundwater.
- In the event of any unauthorized access to the site (e.g., trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and will consider administrative debarment of the trespasser as well as prosecution in state or federal court as deemed appropriate.
- Activities that would disrupt or lessen the performance of the P&T, MNA, and flow path control components of the remedy are to be prohibited.
- The DOE shall prohibit activities that would damage the P&T, MNA, and flow path control components (e.g., extraction wells, injection wells, piping, treatment plant, and monitoring wells).
- The DOE shall report on the effectiveness of ICs for the 200-ZP-1 OU remedy in an annual report, or on an alternative reporting frequency specified by EPA. Such reporting may be for this OU alone or may be part of a Hanford Site report.
- The DOE will prevent the development and use of property above the 200-ZP-1 OU for residential housing, elementary and secondary schools, childcare facilities, and playgrounds.
- Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and exposure and EPA authorizes the removal of restrictions.

Most of the land within the 200-ZP-1 OU has been designated by DOE, through the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE/EIS-0222-F, 1999), for industrial exclusive use for the foreseeable future. Because it contains facilities which will have long-term responsibility for disposal or storage of hazardous substances, the possibility that this property could qualify for transfer of title out of the federal government is remote, especially in light of the exacting requirements of CERCLA Section 120(h) for transfers of contaminated federal land. Because the 200 Area was principally withdrawn from the public domain, if the land ever became surplus to the needs of DOE, federal law requires that it be turned over to the Bureau of Land Management. Nevertheless, as a general policy to ensure continuity of ICs that have been selected as part of RAs at the Hanford Site, DOE has made the following commitments to EPA Region 10:

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

2 Pump-and-Treat System Startup, Inspections, and Initial Conditions

This chapter describes startup activities, inspections, and initial operating conditions that will precede full-scale operation of the 200 West Area groundwater P&T system. Many of these startup and inspection procedures will also apply to any future expansion or significant modifications to the system. Figure 2-1 provides an organization chart showing the current organizational structure that supports existing P&T systems in both the 100 and 200 Areas and that will be involved in operating and maintaining the 200 West Area groundwater P&T system.

2.1 Startup and Operational Testing

This section describes startup and operational testing performed prior to full scale operation of the 200 West Area groundwater P&T system. This section also describes engineering inspections, development of an O&M program, and operator training programs. A test plan will be developed that outlines startup and operational testing requirements including FAT, CAT, engineering inspections, acceptance testing procedures (ATPs), and the operational test procedure (OTP). These steps are discussed in the following sections. Figure 2-2 provides an overview of the design, construction, testing, and startup process for the 200 West Area groundwater P&T system.

2.1.1 Testing Personnel

The following personnel are involved in facilitating implementation of the startup and operational testing:

Constructor. The Constructor is the contractor, and subcontractor(s), responsible for construction of the 200 West Area groundwater P&T system, in accordance with the design plans and specifications.

Chief Engineer. The Chief Engineer has overall management responsibility for the practice of engineering within the CHPRC Soil and Groundwater Remediation Project. The chief engineer is responsible for the assignment and approval of qualifications for the design authorities (DAs).

Design Authority. The DA is responsible and accountable for review and approval of the functional design criteria and for final acceptability of a structure, system, or component. The DA also identifies applicable regulatory and safety requirements. The DA's responsibilities related to startup and testing include:

- Review and approval of the functional design criteria, design changes, construction submittals, and requests for information
- Performance of engineering inspection for design compliance
- Review and approval of construction testing and ATP procedures

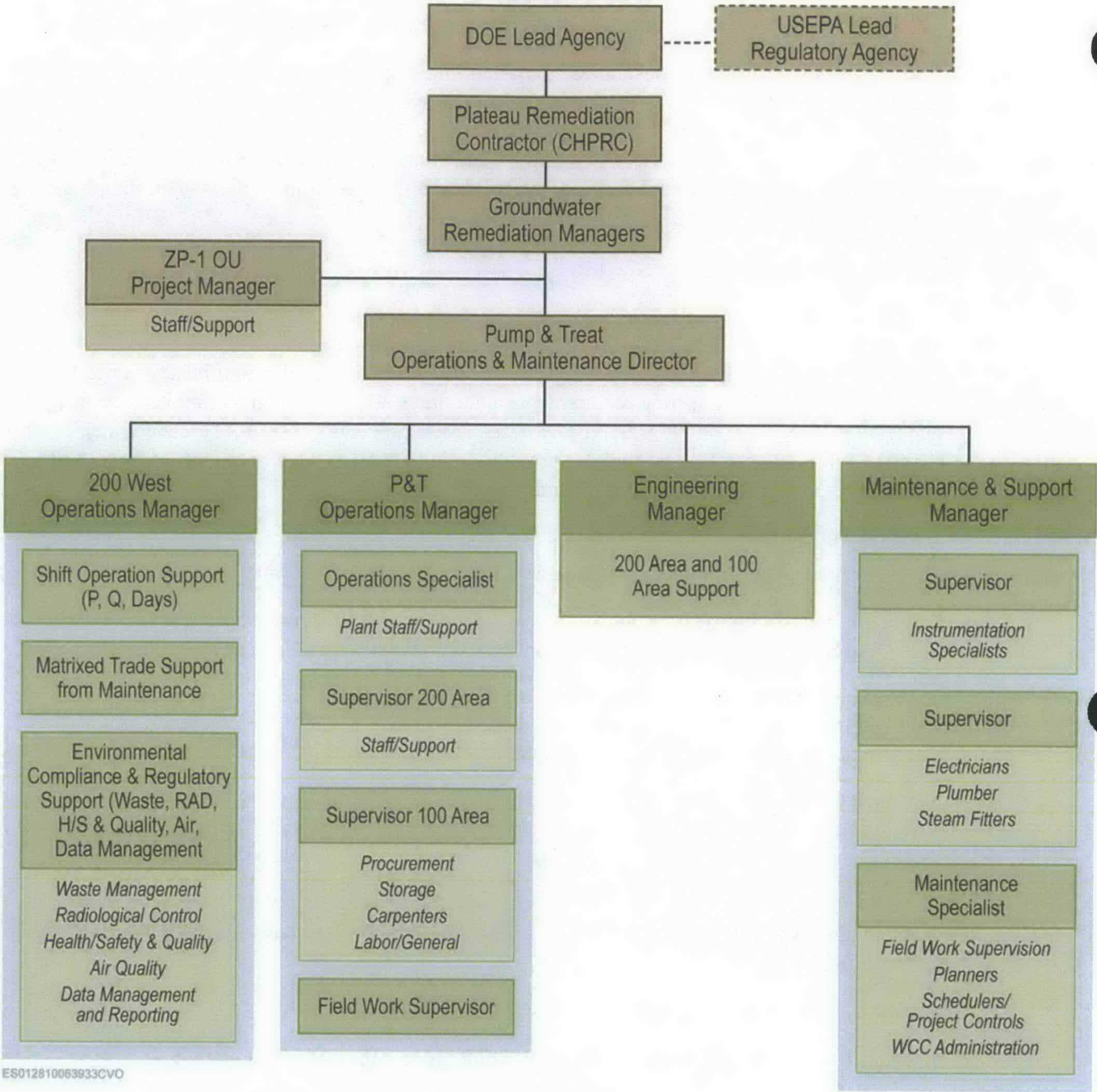

Figure 2-1. Current Operations and Maintenance Organization Chart

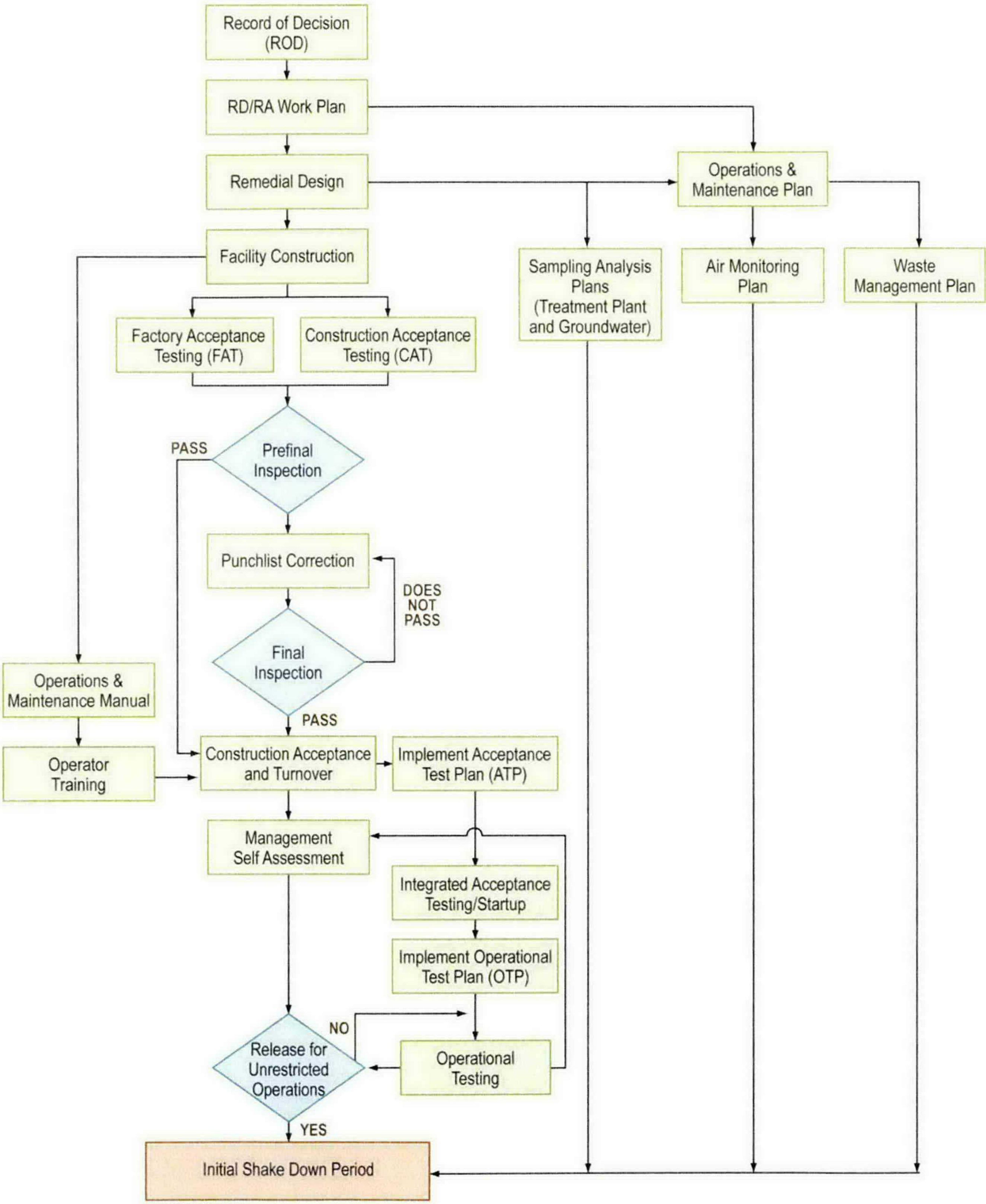

Figure 2-2. System Design, Construction, Testing, and Startup

Prior to design and construction of a new facility, a **New Facility DA** is assigned; whereas, once a new facility is operational, a **Facility Operations DA** is assigned for design modifications made during operation of the system. The New Facility DA may transition into the role of the Facility Operations DA.

Operations/Maintenance Manager (OM). The OM is responsible and accountable for O&M of the P&T system. The OM's responsibilities related to startup and testing include:

- Integrate operation, maintenance, and plant engineering support activities during design of the facility.
- Ensure that appropriate operations support functions (e.g., Radiological Protection and Safety) are available to support operations activities associated with construction and testing.
- Facilitate and lead the development of the OTP.
- Verify that O&M procedures have been prepared and approved.

Project Manager. The Project Manager has overall responsibility for the design, construction, startup, and operation of the 200 West Area groundwater P&T system.

Test Authority (TA). The TA is responsible for coordinating the test, reviewing the results, and taking corrective action as necessary. The TA has overall responsibility for performance of the test.

Test Coordinator (TC). The Test Coordinator (TC) is responsible for individual testing activities in the field. The TC provides technical support to the TA. Multiple TCs, reporting to the TA, are anticipated for testing activities associated with construction and startup testing for the 200 West Area groundwater P&T system.

2.1.2 Factory Acceptance Testing

FATs are performed by the equipment vendor at the manufacturer's facility to verify that an equipment component or system operates according to its specification prior to delivery. The design engineer develops FAT requirements, which are defined in procurement specifications or Statement of Work (SOW) requirements. FAT requirements are approved by the DA, and after completion of the FAT, test results are submitted to the DA for acceptance. The DA is responsible for transmittal of acceptance to the Project Manager.

2.1.3 Construction Acceptance Testing

CATs are performed to ensure that equipment is installed as designed and that individual components operate as expected in order to allow full system operation with minimal issues during the ATP. CAT requirements are developed by design engineers and are approved by the DA. CAT requirements are typically defined in the construction specifications or SOW. CATs are performed during construction using the Constructor's procedures. The Constructor provides documentation of completed CATs by formal submittal of test results to the DA, with test documentation retained in the Constructor's construction work package. The DA is responsible for acceptance of CAT test results and transmittal of acceptance to the Project Manager. The result of CAT is a systematic demonstration that systems were installed per the design, and the system is ready for functional testing during the ATP.

2.1.4 Engineering Inspection

Engineering inspections are conducted by the design engineer, for the equipment or system being installed, to ensure that installation is conducted per design requirements. Engineering inspections include a walk down by the appropriate discipline design engineer. A walk down is a physical inspection of the equipment, system or component being installed and tested.

2.1.5 Acceptance Testing

Acceptance tests are performed to demonstrate that fabrication, assembly, installation, and construction requirements have been met as required in design documents. The objective of the ATP is to demonstrate system compliance with the design and to verify that final systems and sub-systems are installed successfully. The ATP is conducted under the control of the construction organization with assistance from operations personnel as required. The engineering leads provide a test procedure for conducting of the ATP.

Results of the completed test are approved by the DAs. A test report is released to the Project Manager to provide documentation of the completed test for the project files. This process is the basis for project acceptance and turnover to operations for the start of the OTP.

2.1.6 Management Self Assessment

Concurrent with the operational testing, a management self assessment is conducted to review operational systems and functions. Outstanding issues identified during the self assessment are resolved and closed prior to the pre-final inspection(s) to determine that the facility is ready to operate. This includes a review of operating procedures, operator training, and other items necessary to operate the system safely.

2.1.7 Operational Test Procedure

The objective of the OTP is to validate operating procedures and complete operator training. The OTP is written, conducted, and approved by qualified personnel in accordance with the published test plan. The OTP is under control of the OM. Essential and support drawings are updated to reflect as-built conditions and issued prior to start of the OTP. The approved test procedure is issued and controlled. Any remaining construction items are tracked on the project punch list. The OTP is completed upon release of the facility for unrestricted operations utilizing issued operating procedures.

2.1.8 O&M Program

The system managers and operators have developed an O&M program currently in use for O&M of existing P&T systems in the 100 and 200 Areas (e.g., 200-ZP-1 Interim P&T System). This O&M program relies on an automated electronic information management platform for creating, storing, and updating the components of the O&M program on HLAN. This O&M program contains the O&M procedure documentation that typically resides in an OMM (e.g., manufacturer's technical information and data, protocols, process parameters, staff needs/requirements, training, and maintenance schedules [EPA 540-F-01-004]).

This O&M program will be adopted for O&M of the 200 West Area groundwater P&T system. O&M program information, specific to the 200 West Area groundwater P&T system, will be uploaded into the electronic platform after finalization of the remedial design report (RDR) and receipt of vendor information submittals during construction. The electronic information residing in this platform will reference the location of any supporting information not contained within the system (e.g., hard copy vendor submittal information). The information contained within the electronic platform will address the following topics, as appropriate:

- System description, including an overview of system equipment and treatment processes
- Operating parameters and procedures for the facility, including each critical unit processes (e.g., biological systems and air stripping)
- Vendor equipment specifications (e.g., fundamental technical information concerning each unit process step, construction materials, and pump curves)

- System O&M information, including equipment manufacturer and vendor supplied OMMs (specific to individual system components or equipment)
- Preventive and corrective maintenance information for monitoring system equipment and process operation
- Standard operating procedures addressing system and component repair(s)
- Master equipment and spare parts list
- System transient condition response actions and procedures
- Emergency response plan
- Warranty data and information
- Training procedures
- Staffing information
- Process liquid stream sampling and reporting requirements

2.1.9 Operator Training

The operator training necessary to run and maintain the P&T system is provided prior to startup of the facility and includes required health and safety and specialized training by equipment vendors or design personnel. A training plan will be issued and included in the O&M program.

A dynamic simulation model of the 200 West Area groundwater P&T system was developed to facilitate system design. This model is undergoing further development to facilitate simulation-based operator training which allows training of operators prior to startup. Examples of some of the operating scenarios are provided below:

- Facility startup
- Facility shutdown
- Flow settings for wells, transfer buildings, and major unit processes
- Flow balancing for extraction and injection well fields
- Equipment failure
- Equipment sequencing
- Emergency conditions
- Other scenarios developed in pre-training workshops

The simulator also allows running software modifications to see how the revisions might impact the system before uploading to the facility control system.

2.2 Pre-Final and Final Inspection

Pre-final inspections, typically performed in the latter stages of construction, determine outstanding construction requirements and actions necessary to resolve any issues identified. Results from the pre-final inspections then determine the date for the final inspection(s). Inspections may be conducted by unit process (e.g., IX or FBR) or by work element (e.g., conveyance piping or electrical).

2.2.1 Pre-Final Inspection Checklist

A checklist is used during the pre-final inspection to document any unresolved or open items and the required actions for their resolution or completion. The checklist contains specific project systems and components that are inspected for acceptance of construction activities. The focus is on system elements pertinent to meeting the requirements of the ROD. Backup sheets may be required to describe each item on the checklist and the criteria for acceptance and rejection of each item. Results of inspections are documented in a pre-final inspection report. An example pre-final inspection checklist is provided in Table 2-1. The issued inspection checklist will be completed in compliance with Hanford Site procedures for startup readiness evaluations.

2.2.2 Pre-Final Inspection Report

The purpose of brief pre-final inspection report is to document the results of the pre-final inspection and to summarize the requirements listed on the pre-final inspection checklist. The pre-final inspection report focuses on documenting the RA elements significant to meeting the requirements of the ROD. The report is typically organized with the following information:

- The names of inspection participants
- Specific project elements/hold points that were inspected
- Completed pre-final inspection checklist documenting the performance of the inspection and inspection findings
- Open items identified during the inspections
- Corrective actions to be taken to close open items or correct deficiencies, acceptance criteria or standards, and planned dates for completion of the actions
- Date of final inspection (if required)

2.2.3 Final Inspection and Final Inspection Report

The need for a final inspection is based on the results of the pre-final inspections and the content of pre-final inspection report. The final inspection confirms the resolution of outstanding items identified in the pre-final inspection and verifies that the remediation has been completed in accordance with the requirements of the ROD and RD/RA Work Plan. The results of the final inspection are incorporated in a final inspection report, which will contain the following elements, as appropriate:

- Results of the system operational testing
- Results of the final inspection
- An evaluation of the effectiveness in meeting treatment system performance requirements based on monitoring results from the shakedown period
- A completed inspection checklist, including resolution of outstanding items
- Any remaining open items with planned completion dates
- An explanation of significant system changes from the RDR

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Table 2-1. Example Pre-Final Inspection Checklist

Project Title: 200 West Area Groundwater Pump-and-Treat System					
Item No.	**Item Description**	**Status**	**Due**	**Person Responsible**	**Comments**
1.	Project Documents				
a.	Environmental checklist is approved and on file				
b.	Health and safety plan is approved and issued				
c.	Remedial action work plan is approved and issued				
d.	Remedial design report is approved and issued				
e.	O&M Plan is approved and issued				
f.	Sampling and analysis plan is approved and issued				
g.	Waste management plan is approved and issued				
h.	Interim decontamination plan is approved and issued				
i.	Essential as-built drawings are completed				
j.	Exposure assessment is completed				
2.	Procedures and Work Control Documents				
a.	Required material safety data sheets are available				
b.	Hazard checklist and walk down are complete				
c.	Emergency notification list is posted				
d.	Hazardous waste determinations for identified waste streams are complete				
e.	Daily inspection requirements have been established				
f.	O&M procedures are approved and issued				
3.	Personnel Qualification and Training				
a.	Operators have been identified and are available				
b.	Operators have been trained in the following as applicable:				
	• OSHA 29 CFR 1910.120 40-hour HAZWOPER				
	• OSHA 29 CFR 1910.120 8-hour Supervisor				
	• First Aid/Cardio Pulmonary Resuscitation				
	• Site Health and Safety Plan				
	• Lock-out/Tag-out training				
	• Operations procedures				
	• Log keeping				
c.	RCRA emergency coordinators are trained on-site				

Table 2-1. Example Pre-Final Inspection Checklist

Project Title: 200 West Area Groundwater Pump-and-Treat System					
Item No.	Item Description	Status	Due	Person Responsible	Comments
4.	Equipment and System Readiness				
a.	Subcontractor has completed checkout and component testing and deficiencies have been corrected				
b.	Personal protective equipment is identified and available				
c.	Medical and first aid supplies are identified and available				
d.	Fire protection equipment is identified and available				
e.	Emergency communication equipment is identified and available				
f.	Sampling equipment required to support sampling efforts is identified and available				
g.	Sample analysis support services have been arranged				
h.	Freeze protection is in place				
i.	Recommended spare parts are available				
j.	Components have been appropriately labeled				
k.	Groundwater level monitoring equipment is available and in place				
5.	Operation of Safety Systems				
a.	System shutdown mechanisms have been satisfactorily tested				
b.	Operational limits have been established and tested				
6.	Management Programs				
a.	Personnel responsibilities and line of authority are clearly defined				
b.	Primary and secondary emergency evacuation routes are posted in each building				
c.	Management self assessment is completed				
7.	Routine and Emergency Operations Program				
a.	System shutdown notification system is in place and has been tested for proper operation				
b.	Security surveillance and notification requirements have been established with the facility security organization				

Notes:
CFR = *Code of Federal Regulations*
HAZWOPER = Hazardous Waste Operations and Emergency Response
OSHA = Occupational Safety and Health Administration
RCRA = *Resource Conservation and Recovery Act of 1974*

2.3 Initial Operations and Shakedown Period

After the system is released for unrestricted operation, an assessment of system performance is conducted during an initial operations period. The initial operational period is used to monitor P&T system operations to ensure that each system is operating in accordance with the approved specifications, and is operational and functional. Data collected during this period include:

- Process monitoring data
- Performance monitoring data
- Air monitoring data
- Waste management data
- Preventative and corrective maintenance data

The data collected during the initial operational period will be used for process optimization. Figure 2-3 provides an overview of operations, maintenance, and monitoring inputs to process optimization after the initial shakedown period. Process optimization is an ongoing process that will rely on remedy performance monitoring data. This data will be evaluated to make a decision on the scope of the future modifications and expansion to the 200 West Area groundwater P&T system.

Performance monitoring, air monitoring, and waste management data will be provided to EPA in a quarterly briefing presentation, and will be summarized in the Performance Monitoring Report described in Section 5.1 of this O&M Plan.

Figure 2-3 also shows the decision process that will be used to determine whether RAOs are being achieved, and whether system expansion or modification is necessary. If it is determined that RAOs are not achievable, even with additional system expansion or modification, a demonstration of technical impracticability and modification of RAOs may be necessary.

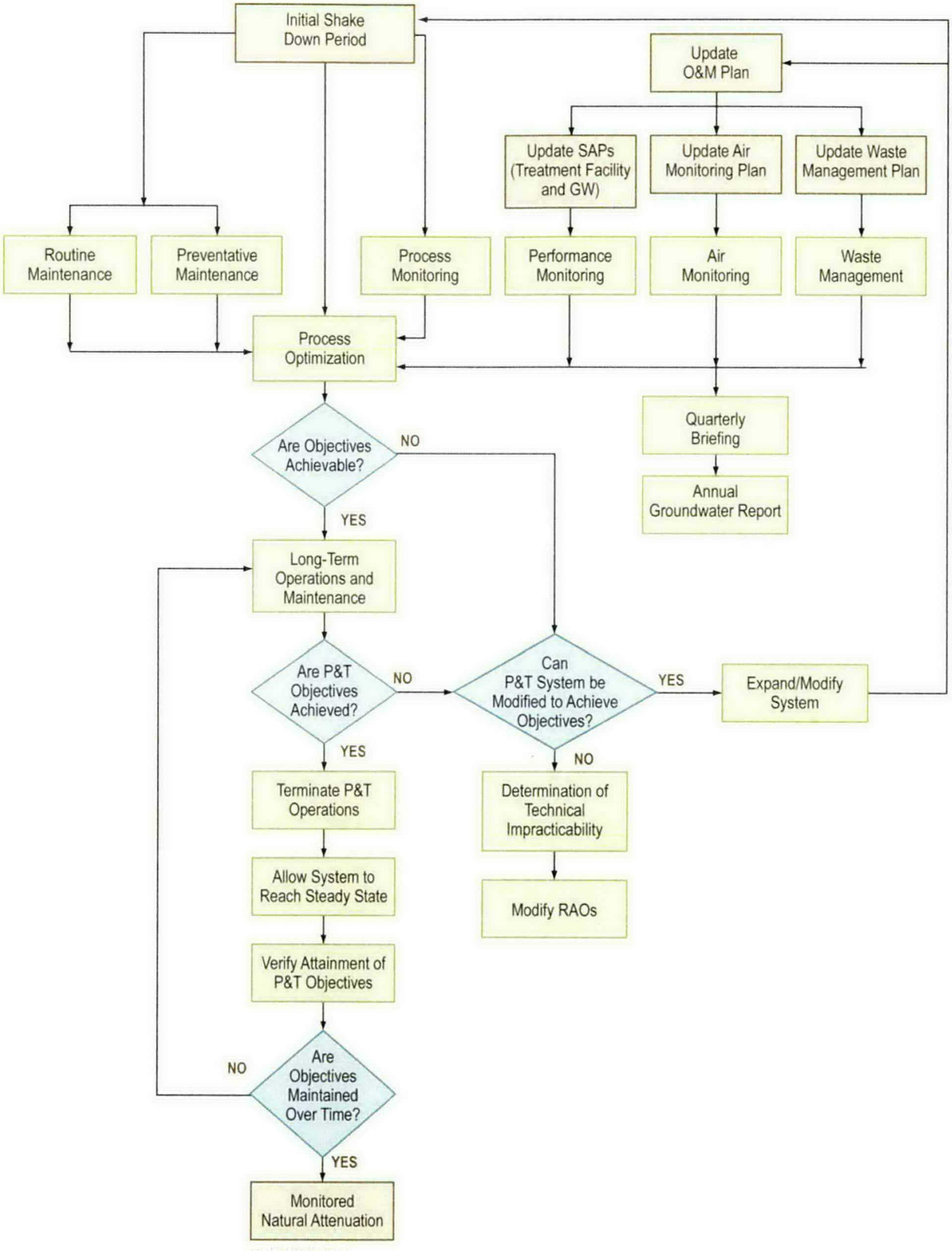

Figure 2-3. System Optimization, Modification, and Long-Term Operation

3 Operations and Maintenance

An effective O&M program for the 200 West Area P&T system is essential for successful completion of the 200-ZP-1 OU RA. A thorough and well implemented preventative maintenance program ensures that equipment is properly maintained while providing a tool for early detection of problems. This section presents general information associated with routine and non-routine O&M of the 200 West Area P&T system and other remedy components requiring O&M.

3.1 P&T System Operational Criteria

Routine operation of the 200 West Area P&T system will generally consist of drawing groundwater from a network of extraction wells, pre-treating a portion of the flow to remove technetium-99 and uranium (from the 200-UP-1 OU), combining the pre-treated stream with the balance of flow, and conveying the blended stream to the 200 West Area groundwater treatment facility for COC and other constituent removal. Following treatment, the treated water is returned to the aquifer through a series of injection wells.

After construction in September 2011, the treatment system will have the capacity to treat 2,500 gpm. However, initial operations, (which are expected to begin in October 2011) will draw water from the extraction well network at rates up to 1,000 gpm. The initial operations period will allow aquifer and contaminant plume response to pumping to be evaluated, extraction well flows to be adjusted to maximize wellfield effectiveness, and experience to be gained with the individual treatment processes. As additional extraction and injection wells are brought online, treatment rates will be increased to 2,500 gpm. Operational uptimes are expected to average 80 percent. During the initial shakedown period following startup, the operational criteria may fall below 80 percent. However, as the facility operators gain more experience with the system, the uptime criteria is expected to exceed 80 percent. The operational uptime calculation will be performed on a monthly basis. After one year of operation, and monthly thereafter, the operational uptime will be calculated using a 12-month rolling average.

3.2 Routine and Preventive O&M

Routine and preventative maintenance of P&T system components will be performed in accordance with engineering evaluations per existing procedures. An overall preventative maintenance schedule will be developed for major equipment (e.g., extraction well pumps, transfer pumps, and blowers) using the information provided in these procedures and per manufacturer/vendor guidelines. The schedule will be incorporated into O&M program.

Routine and preventative maintenance activities will be documented per work control procedures, and the work packages will be maintained in project records. A general summary of maintenance activities will be provided in the annual report.

3.3 Transient Conditions

During routine P&T system operation, there may be instances where periodic sampling or other information identifies the presence of COCs in the final effluent stream at concentrations above the ROD cleanup levels, or where the influent stream contains a new contaminant (not identified in the ROD) at concentrations greater than a federal or state drinking water MCL or other protective level. In these situations, confirmation sampling may be performed and individual treatment processes may be evaluated to assess treatment efficiency. During such events, the P&T system will continue to operate at the previous flow rate or the throughput rate may be reduced.

If the presence of a transient condition is confirmed, the event will be documented in the operating record along with the following information:

1. The concentration of COCs detected that exceeded ROD cleanup levels, or the concentration of new contaminants that exceeded MCLs or other protective concentrations
2. The location(s) and date(s) sampled
3. Concentrations of COCs or new contaminants detected during previous sampling events
4. Corrective actions taken

Significant transient conditions will be discussed with the regulatory agencies at the periodic briefings and summarized in the Performance Monitoring Report.

If modifications to existing treatment components, or new components, are needed to address new contaminants, the situation will be discussed with the regulatory agencies and, with their concurrence, the system may be allowed to continue operating in its current configuration until the modification or new component can be incorporated.

3.4 Corrective Maintenance

Corrective maintenance consists primarily of unplanned repairs or replacement of system components after they have failed. Typical examples include worn-out pumps, leaky pipe joints, and failed electronic components. If a failure occurs, the system will be evaluated to determine if there is an alternative operating configuration, what the possible cause is, and what actions should be taken to correct the problem. Corrective maintenance activities will then be performed in accordance with existing maintenance procedures or the manufacturer's recommended procedures.

Corrective maintenance activities will be documented in the job control system, and a summary of these activities will be provided in the Performance Monitoring Report. Depending on the scope of corrective maintenance activities, the routine and preventative maintenance schedule may be reviewed and modified.

3.5 Operations and Maintenance Practices, Inspection, and Training

Routine inspection and maintenance activities are necessary to ensure the long-term integrity and success of the remedy. This section summarizes typical inspection and maintenance needs for the proper care and efficient operation of each remedy component with primary emphasis on the 200 West Area P&T system. Equipment-specific inspection forms, and a preventative maintenance schedule, will be developed during the construction phase using information contained in the manufacturer/vendor-supplied owner manuals. The forms will be incorporated into the OM program.

Anticipated repair, replacement, and rehabilitation (RR&R) are also discussed in this section. Repair is considered to entail those activities of a routine nature that maintain the remedy in a well-kept condition. Replacement covers those activities taken when a worn-out component, or portion thereof, is replaced. Rehabilitation refers to a set of activities, performed as necessary, to bring deteriorated equipment back to its original condition. RR&R actions are expected to conform to the original as-built plans and specifications.

A majority of the inspection and maintenance work will be performed using existing or manufacturer recommended procedures. The following subsections summarize several of the key activities associated with 200 West Area P&T system's inspection and maintenance program.

3.5.1 Personnel Training Program

Operations personnel will undergo classroom, on-the-job, and simulator-based training. This training will cover facility startup, facility shutdown, operation adjustments, and other topics to be determined. The training will enable the operators to experience a number of routine and non-routine events prior to actual hands-on contact. The simulator training can also be used as a refresher tool, and to mimic actual or predicted treatment system configurations as determined by the operator(s).

In addition to operator training, operations personnel undergo other Hanford Site training as required. The 200 West Operations Manager will periodically review the training records of active operations personnel to determine what additional or refresher training is required.

3.5.2 Hazard Communication Program

CH2M HILL Plateau Remediation Company (CHPRC) maintains a hazard communication program to inform employees of the hazards they may encounter in the work place. The scope of this training is covered under an existing operating procedure in accordance with the Occupational Safety and Health Administration (OSHA) Standards 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response."

3.5.3 Routine Procedures

A number of new routine procedures will be developed for inclusion in the O&M program to provide operators with the information necessary to perform the following typical day-to-day activities:

- Housekeeping inspections
- Conveyance piping inspections
- Waste storage area inspections
- Instrument calibrations
- Inspections of facility equipment and machinery and routine adjustments
- Inspections of tanks, secondary containment devices, and sumps

3.5.4 Treatment Facility Operation Procedures

Treatment system startup and shutdown will be described in an operation procedure similar to that covering the existing 200-ZP-1 IRM groundwater P&T system. This procedure provides the necessary information and direction to start up, operate, and shut down the radionuclide pre-treatment facilities and the 200 West Area groundwater treatment facility properly. These procedures include the operational steps needed to place the system into a normal operating lineup and to place the system in service. These procedures will also include the steps for performing a routine system shutdown. In addition to this procedure, the following operating procedures may also be prepared as individual activities as determined by operations for inclusion in the O&M program:

- IX resin changeout
- VPGAC changeout for regeneration
- FBR and MBR operations
- Filter changeout
- Changeout of chemical tank and bulk chemical storage

3.5.5 Treatment Process Monitoring

Sampling of influent and effluent from individual treatment processes to assess performance and change-out requirements (IX resin and VPGAC), and to ensure optimum FBR, membrane aeration tank, and air stripper performance will be conducted under one or more operating procedures. These procedures will be developed based on information supplied in the equipment owner manuals and experience gained during startup operations. When complete, these procedures will be incorporated into the O&M program.

3.5.6 Waste Handling Procedures

All waste streams associated with construction, operation, and decommissioning of the 200 West Area P&T system will be managed in accordance with the Waste Management Plan, included as Appendix B.

3.5.7 Safety Equipment Procedures

Existing operating procedures or new procedures will be developed to address the use and maintenance of safety equipment within the radionuclide pre-treatment facilities and the 200 West Area groundwater treatment facility.

3.5.8 Emergency Equipment Inspection and Maintenance Procedures

Existing operating procedures will be adapted or new procedures will be developed to address the use, inspection, and maintenance of portable fire extinguishers, emergency lights, tank alarms, spill cleanup, and other protection systems.

3.5.9 Emergency Response Procedures

Existing operating procedures will be adapted or new procedures will be developed to address the steps to be taken when an emergency indicator is triggered or an abnormal condition occurs. These procedures include the operational steps to check for the cause of an emergency, isolate it, and shut down the system, if necessary, so that no influent or effluent may be discharged from within the containment system.

3.6 Inspection Requirements

This section describes typical inspections for the 200 West Area groundwater P&T system.

3.6.1 Extraction and Injection Well Inspection and Rehabilitation

Extraction and injection wellhead piping and fittings will be visually inspected to detect leaks. The inspection frequency will be the same as the above-ground conveyance piping. The inspection findings will be documented in a paper or electronic format that will be maintained in the work control system.

Injection well performance often declines over time resulting in lower injection rates, which in turn could affect 200 West Area groundwater treatment facility throughput. Injection well fouling, if it occurs, will be corrected using routine well development and rehabilitation procedures. Extraction well pumping rates may also decrease over the long term due to microbiological fouling within the upper portions of the well screen interval where aerobic and anaerobic water mixing can occur. The potential for this type of fouling can be reduced by maintaining the pumping water level above the top of the well screen. Microbiological fouling may be corrected using shock chlorination and routine well development procedures. Periodic disinfection of problem wells may also be required.

To assess the need for well maintenance, extraction well pumping and injection well rates will be correlated annually, or on a more frequent basis if warranted, with water level measurements at each well to detect changes that could potentially affect well performance. Steadily declining pumping water levels at extraction wells and steadily increasing water levels at injection wells may indicate the need for well maintenance. An extraction and injection well monitoring and maintenance plan is being developed to support the 200 West P&T system operations. Extraction and injection well maintenance and rehabilitation will be discussed in an annual performance monitoring report.

3.6.2 Monitor Well Inspections

The physical condition of monitor wells will be documented in field logs during each sampling event. Conditions requiring maintenance or repair will be noted and communicated to the 200 West Area Operations Manager.

3.6.3 Conveyance Piping Inspection

A majority of the conveyance piping between the extraction wellheads and the treatment building will be placed above ground. Visual inspection of the piping will be conducted to confirm system integrity. The frequency of these inspections will be determined during construction. Inspections will be documented in an electronic or paper log to be maintained in the job control system.

3.6.4 Tank Systems

Influent and effluent storage tanks and treatment vessels will be inspected in accordance with WAC 173-303, "Dangerous Waste Regulations," requirements. The inspection will consist of checks for visible leakage, signs of corrosion, and leak detection system function where applicable. Inspection observations will be recorded in an electronic or paper format and maintained in the job control system.

3.6.5 General Inspections

Daily observations and inspections will be performed, as specified, in facility-specific procedures. Facility component specific inspections (tank inspections, fence and posting observations, and site physical conditions) will be performed. Monthly inspections will be performed for support systems such as decontamination equipment, spill kits, eye washes, safety showers, and fire extinguishers. Inspections of non-routine activities, such as groundwater monitoring, sampling, or short-term tests, will be completed as indicated in the individual plans controlling those activities.

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4 Monitoring

As described in the ROD, and summarized in Chapter 1, the selected remedy combines P&T, MNA, flow path control, and ICs to achieve RAOs. This chapter describes the monitoring program that will be implemented to assess performance of the 200-ZP-1 Groundwater OU remedy. The sampling design presented in this section is based on the evaluations presented in DOE/RL-2009-115, *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action* (draft).

Monitoring data will be collected over the life of the RA to evaluate its performance and optimize its effectiveness. Groundwater quality and groundwater elevation data will be collected, and this information will be evaluated to determine progress toward the specific performance monitoring goals shown in Table 4-1. The monitoring locations, monitoring period and frequency, parameters measured, and data uses are summarized in Table 4-2. Performance monitoring consists of short-term and long-term monitoring tasks that will be collected during various periods of the RA.

4.1 Performance Monitoring

The performance monitoring program consists of water level measurements and groundwater sampling using a full and reduced monitoring well network. The full monitoring well network currently includes 125 well locations, and the reduced network has 67 well locations. The following subsections briefly summarize planned data collection associated with pre-system startup (baseline) monitoring, short-term monitoring (first to third years), and long-term monitoring (fourth to twenty-fifth years). Groundwater monitoring activities are described further in the Groundwater Sampling and Analysis Plan included as Appendix E to this O&M Plan.

4.1.1 Baseline Monitoring

Baseline monitoring will be conducted in 2011 to characterize the initial groundwater flow field and COC distribution. Future data will be compared with baseline conditions to evaluate changes resulting from pumping operations.

A single round of groundwater elevation data will be collected from the monitor well network described in Appendix E to provide a baseline set of hydraulic data that will be used to evaluate pre-startup groundwater flow directions and gradients (horizontal and vertical) in the 200 West Area. The hydraulic monitoring well network (see Figure 4-1) includes a network of monitor wells screened at depth intervals within the aquifer that cover elevations ranging from the basalt bedrock to the water table surface. A few monitor wells are located in close proximity to several of the extraction wells. The monitor wells cover a spatial area that exceeds the boundaries of the COC (except nitrate) plumes and the proposed P&T system. A majority of the measurements will be collected manually but may be supplemented with data obtained from approximately 30 wells that are equipped with transducers and data loggers. The data from the baseline event will be used to construct groundwater elevation contour maps for determining groundwater elevations, flow directions, and gradients before system startup.

During the baseline sampling event, groundwater samples will be collected from the monitoring well network (Figure 4-2), and the samples will be analyzed for the COCs and other potential contaminants listed in Table 4-3 and the biogeochemical and field screening parameters listed in Table 4-4.

Baseline samples will also be collected from the groundwater extraction wells (Figure 4-2) during the well installation and development process and from the combined treatment plant influent once the facility is online in 2012. The samples will be analyzed for the contaminants listed in Table 4-3.

Table 4-1. Performance Monitoring Goals and Data Requirements

Performance Monitoring Goals[a]	Data Requirements			
	Groundwater Sample Data from Monitoring Wells	Sample Data from Extraction Wells/ Treatment Plant Influent	Groundwater Elevations	Extraction & Injection Well & System Flow Data[b]
1a. Determine if there are any new releases of COCs.	X			
1b. Determine if any new releases of COCs could impact the treatment process (the effectiveness of the remedy).	X	X		X
1c. Evaluate if any new releases are outside of the hydraulic capture zone of the P&T system.			X	
2. Determine if potentially toxic and/or mobile transformation products are being generated within the OU groundwater.	X			
3. Determine if changes are occurring in environmental conditions (hydrogeological, geochemical, or microbial) that may reduce the efficacy of the P&T system, natural attenuation processes, and the flow path control actions.	X		X	
4. Verify that contamination is not expanding down gradient, laterally or vertically.	X		X	
5a. Verify and/or predict if the P&T system will remove at least 95 percent of the mass of COCs in 25 years or less.	X	X	X	X
5b. Determine if the current remedy design is predicted to achieve cleanup levels for all COCs within 125 years.	X	X	X	X
6. Determine if remediation has been successfully completed.	X	X	X	

Notes:

a. EPA et al., 2008, page 3.

b. Extraction rate, injection rate, flow volumes.

Table 4-2. Performance Monitoring Plan

Data	Location(s)[a]	Monitoring Period: Baseline	Monitoring Period: Short-Term (Initial) P&T Operations and Optimization[b]	Monitoring Period: Long-Term Operations and Monitoring[c]	Monitoring Period: Post P&T	Frequency[d]	Parameter(s)[d]	Data Use(s)
Groundwater Elevations	Hydraulic Monitoring Network	X				Once	Manual or automatic measurement of groundwater levels.	Constructing groundwater elevation contour maps for determining groundwater elevations, flow directions, and gradients before system startup.
	Hydraulic Monitoring Network		X	X		Annually to semi-continuously	Combination of manual and automatic measurement of groundwater levels.	Monitoring sustainability of extraction rates, rebalancing flow rates. Constructing contour maps for evaluating groundwater flow directions and hydraulic gradients, and hydraulic capture and flow control.
	Hydraulic Monitoring Network				X	At least every 5 years	Combination of manual and automatic measurement of groundwater levels.	Evaluating flow directions and hydraulic gradients.
Groundwater Monitoring (contaminants, biogeochemical, and field screening)	Contaminant Monitoring Network (Full)	X				Once	COCs and other contaminants (Table 4-3). Biogeochemical and field screening (Table 4-4).	Determining groundwater contaminant distribution and geochemistry before system startup; constructing baseline 3-D contaminant plume shells for each COC.
	Contaminant Monitoring Network (Full or Reduced Network, depending on year) (Networks to be evaluated annually)		X	X		Annually Alternate between Full and Reduced Networks, starting with Full Network after Year 1 of P&T. (Evaluate reduction in frequency at some wells from annually to biennially)	COCs and other contaminants (Table 4-3). Biogeochemical and field screening (Table 4-4). To be reviewed periodically for reductions in analytes.	Constructing 3-D contaminant plume shells, evaluating concentration trends, evaluating plume boundaries, evaluating plume capture, determining if there are any new releases or transformation products, predicting and confirming progress toward performance goals.
	Contaminant Monitoring Network (to be evaluated)				X	At least every 5 years To be evaluated	Selected COCs and other contaminants (Table 4-3). Biogeochemical and field screening (Table 4-4).	Evaluating progress toward monitored natural attenuation performance goals.

Table 4-2. Performance Monitoring Plan

Data	Location(s)[a]	Monitoring Period: Baseline	Short-Term (Initial) P&T Operations and Optimization[b]	Long-Term Operations and Monitoring[c]	Post P&T	Frequency[d]	Parameter(s)[d]	Data Use(s)
Influent Monitoring (contaminants)	Extraction wells	X				Once	All contaminants in Table 4-3.	Determining groundwater contaminant distribution before system startup.
	Extraction wells		X[a]	X		Monthly during first few years of P&T operation. Possible reduction to quarterly after contaminant plume stabilizes. Reviewed periodically for reduction in analytes.	All contaminants in Table 4-3.	Calibrating COC plume shells, calculate mass removal and optimizing mass removal performance for each well, monitoring for new COCs.
	Combined treatment plant influent		X			Monthly	Table 4-3.	Calculating contaminant mass removal.
Flow Rates and Volumes	Extraction wells, injection wells, and combined treatment plant influent		X	X		Semi-continuously	Automatic measurements of instantaneous flow and totalized flow rates.	Monitoring sustainability of extraction and injection rates, rebalancing flow rates, calculating COC mass removal. Input to groundwater model and plume shell calibration. Evaluating flow control.

Notes:

a. Hydraulic and contaminant monitoring networks, shown in the following figures, will be reviewed periodically, and individual wells will be added or dropped, as appropriate:
- Figure 4-1: Hydraulic Monitoring Network
- Figure 4-2: Contaminant Monitoring Network (Full)
- Figure 4-3: Contaminant Monitoring Network (Reduced)

b. During the first three years of P&T.

c. After the first three years of P&T [after contaminant concentrations and system operations have stabilized].

d. Monitoring frequencies and parameters will be periodically evaluated for each location.

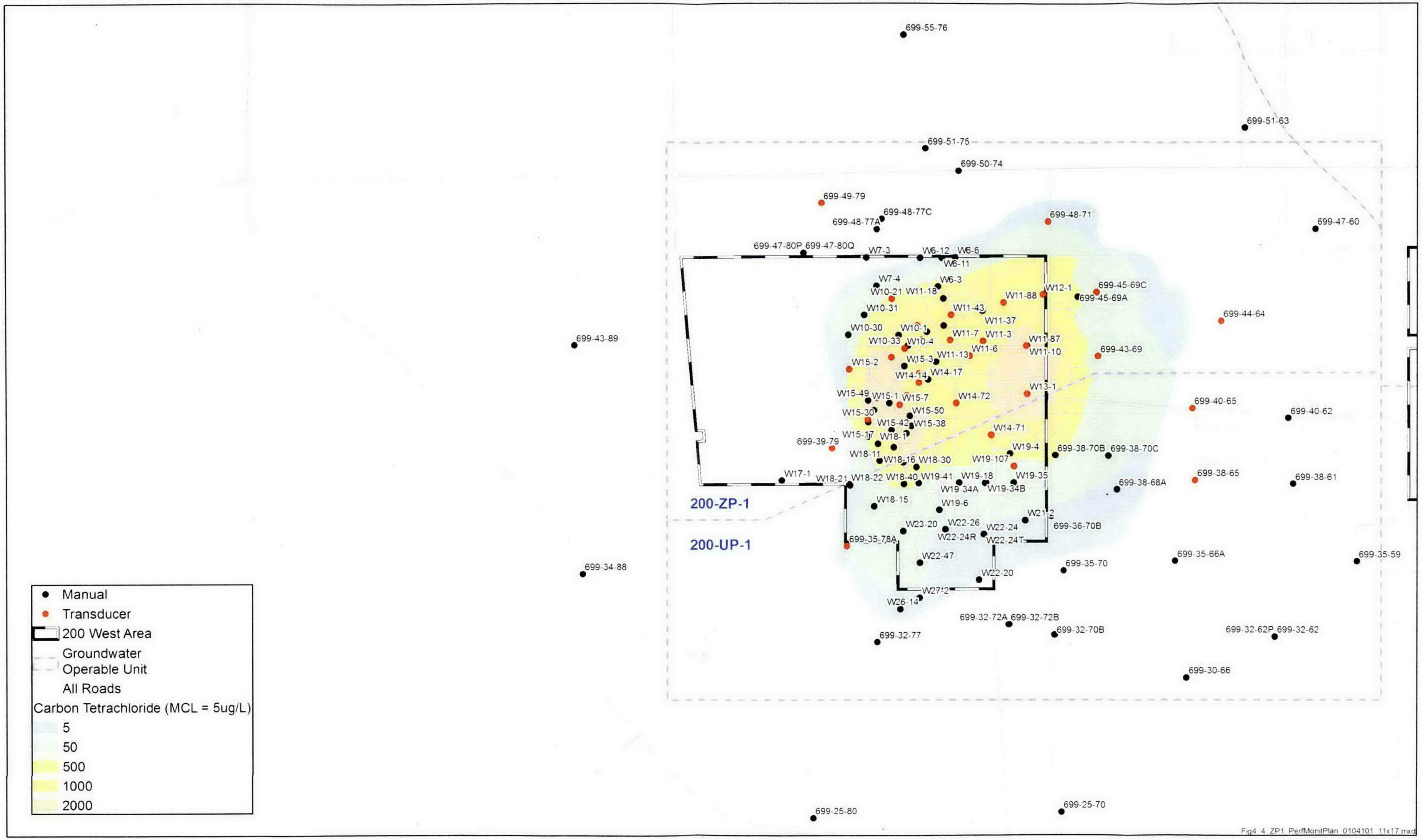

Figure 4-1. Hydraulic Monitoring Well Network

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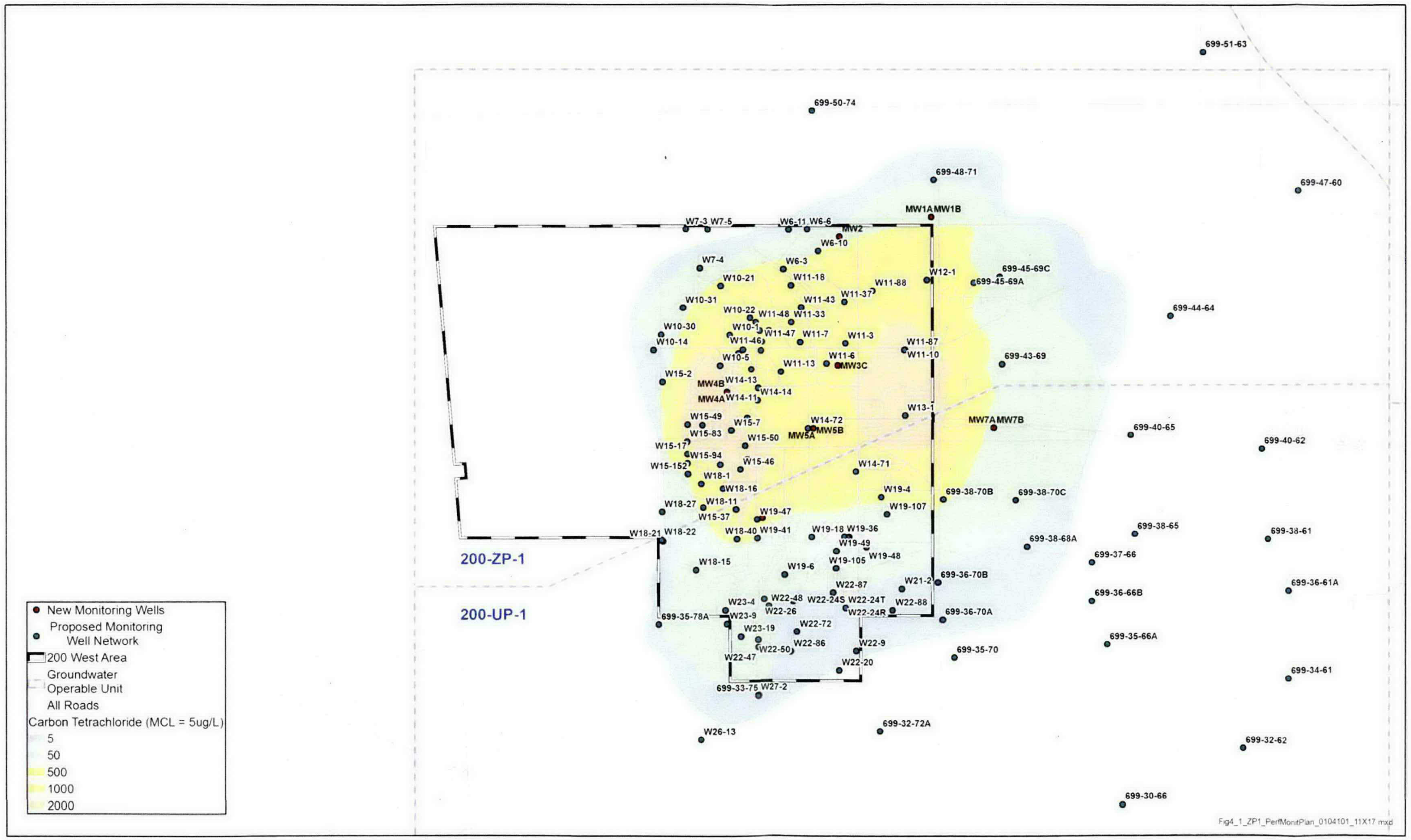

Figure 4-2. Contaminant Monitoring Well Network (Full)

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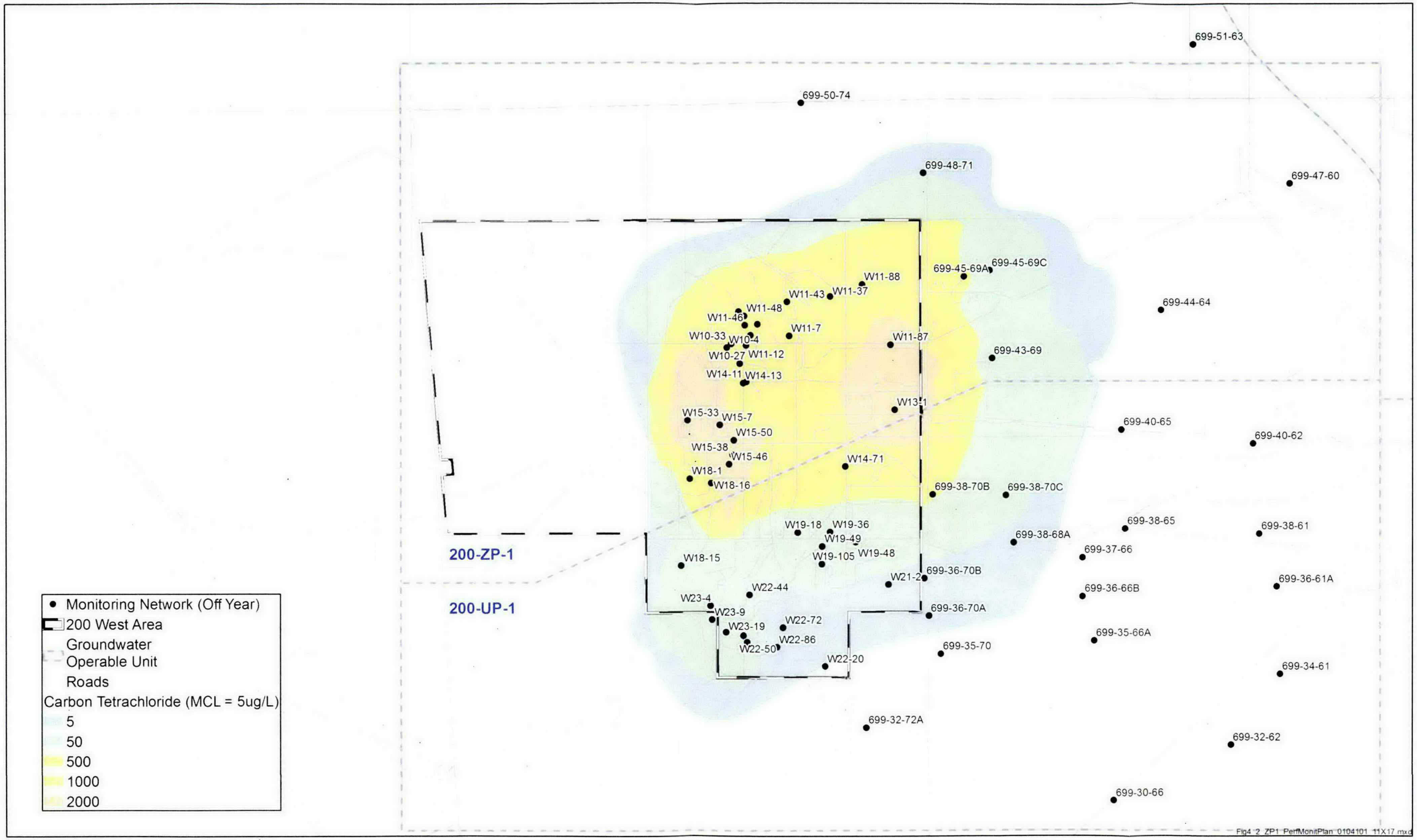

Figure 4-3. Contaminant Monitoring Well Network (Reduced)

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Table 4-3. Contaminant Monitoring Constituents

Constituent	Acceptable Detection Limit	Units	Data Use
Contaminants of Concern			
Carbon Tetrachloride (CTET)	3.4	μg/L	Delineate CTET Plume
Chromium (total)	100	μg/L	Delineate Cr Plume
Hexavalent Chromium	48	μg/L	Delineate Cr Plume
Nitrate	10,000[b]	μg/L as N	Delineate NO_3 Plume
Trichloroethylene (TCE)	1[a]	μg/L	Delineate TCE Plume
Iodine-129	1	pCi/L	Delineate I-129 Plume
Technetium-99	900	pCi/L	Delineate Tc-99 Plume
Tritium	20,000	pCi/L	Delineate Tritium Plume
Other Potential Contaminants			
Uranium (from 200-UP-1 OU)	30[b]	μg/L	Delineate U Plume
Chloroform	70[b]	μg/L	Evaluate CTET Natural Attenuation
Dichloromethane	5[b]	μg/L	Evaluate CTET Natural Attenuation
Chloromethane	NA[c]	NA	Evaluate CTET Natural Attenuation
cis-1,2-Dichloroethene	70[b]	μg/L	Evaluate TCE Natural Attenuation
Vinyl Chloride	2[b]	μg/L	Evaluate TCE Natural Attenuation
Chloride	1,000	μg/L	Evaluate chlorinated solvent natural attenuation
Nitrite	1000[b]	μg/L as N	Evaluate NO_3 Natural Attenuation

Notes:

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

b. Federal drinking water standard.

c. No federal drinking water standard has been promulgated for this constituent.

CTET = carbon tetrachloride
mg/L = milligrams per liter
NA = not available
NO_3 = nitrate
OU = operable unit
pCi/L = picocuries per liter
TCE = trichloroethylene
μg/L = micrograms per liter

Table 4-4. Biogeochemical and Field Screening Monitoring Parameters

Constituent	Preferred Method	Units	Data Use
	Biogeochemical Parameters		
Total Organic Carbon	EPA 415.1*	mg/L	Evaluate Natural Attenuation
Total Dissolved Solids	EPA 160.1*	mg/L	Evaluate Natural Attenuation, Identify New Releases
Sulfate	EPA 300.0A*	mg/L	Evaluate Natural Attenuation
Sulfide	EPA 9215*	mg/L	Evaluate Natural Attenuation
Iron (total and dissolved)	EPA 6010B*	µg/L	Evaluate Natural Attenuation
Manganese (total and dissolved)	EPA 6010B*	µg/L	Evaluate Natural Attenuation
Alkalinity	EPA 310.1*	mg/L as CO_3	Evaluate Natural Attenuation
Carbonate Content (bicarbonate and carbonate)	EPA 310.1*	mg/L as CO_3 and HCO_3	Evaluate Natural Attenuation
	Field Screening Parameters		
Temperature	Hach HQ40d or equivalent	°C	Evaluate Well Purge for Sampling
pH	Hach HQ40d or equivalent	pH unit	Evaluate Well Purge for Sampling
Specific Conductance	EPA 1201.1*	mS/cm	Evaluate Well Purge for Sampling
Turbidity	Hach 2100P Turbidimeter HQ40d or equivalent	NTU	Evaluate Well Purge for Sampling
Dissolved Oxygen	Hach HQ40d or equivalent	mg/L	Evaluate Natural Attenuation
Redox Potential	USGS, *National Field Manual for the Collection of Water-Quality Data*	mV	Evaluate Natural Attenuation

Notes:

* SW-846. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. Third Edition: Final Update IV B*

CO_3 = carbonate

HCO_3 = bicarbonate

°C = degrees Celsius

mg/L = milligrams per liter

mS/cm = milliSiemens per centimeter

mV = millivolts

NO_3 = nitrate

NTU = nephelometric turbidity unit

USGS = U.S. Geological Survey

4.1.2 Short-Term Performance Monitoring

Performance monitoring will be conducted during the early phase (first three years) of P&T operations to obtain data that will be used for evaluating progress, assessing aquifer and COC plume response to pumping, and optimizing extraction well and injection well pumping rates for system performance.

While the P&T system is operating, a synoptic set of groundwater elevation data will be manually collected from the hydraulic monitor well network, on an annual basis. The need for semi-continuously measured groundwater elevations from transducer equipped hydraulic monitoring wells will be evaluated. Additional wells will be equipped with transducers or existing transducer locations will be shifted, as needed. Water level data will be used to monitor the sustainability of extraction rates and the need to rebalance flow rates to optimize capture zone boundaries. Water level data will also be used to construct groundwater elevation contour maps for evaluating groundwater flow directions, hydraulic gradients, and hydraulic capture and flow control.

Flow rates will be measured in each extraction well, injection well, and for the combined treatment plant influent using inline flow meters on a semi-continuous basis. This information will be recorded by the programmable logic controller, and the information will be extracted as needed for use in optimizing flow rates and calculating COC mass removed. Results will also be used as input parameters to the numerical groundwater flow and plume shell models described in DOE/RL-2009-115.

During the first three years of P&T operations, groundwater samples will be collected from the monitor well network annually, alternating between the expanded well list (Figure 4-2) and the reduced well list (Figure 4-3). The samples will be analyzed for the COCs and other potential contaminants listed in Table 4-3 and the biogeochemical and field screening parameters listed in Table 4-4. The monitoring plan will be re-evaluated annually to determine if wells should be dropped or added to the network, or if any monitoring frequency changes are warranted. Results will be used to construct three-dimensional contaminant plume shells; evaluate concentration trends, plume boundaries, and plume capture; and determine if there are any new releases or occurrences of COC transformation products. The concentration trends and plume models will be used to confirm and predict progress toward performance goals.

Samples will be collected from the groundwater extraction wells and the combined treatment plant influent monthly. The samples will be analyzed for the contaminants listed in Table 4-3. Results will be used to calculate COC mass removed. Sample frequencies may be adjusted as the results are evaluated.

Monitoring results will be communicated in quarterly briefings and documented in the Performance Monitoring Report.

4.1.3 Long-Term Performance Monitoring

This section briefly summarizes the requirements for long-term performance monitoring of P&T system operations and post-P&T MNA.

4.1.3.1 Long-Term Operations and Monitoring During Pump-and-Treat

Long-term P&T system monitoring includes collecting a synoptic set of groundwater elevation data on an annual basis. The need for semi-continuously measured groundwater elevations, from transducer equipped hydraulic monitoring wells, will continue to be evaluated. Results will be used to confirm continued hydraulic capture and flow control.

Flow rates will be measured in each extraction well and injection well, and for the combined treatment facility influent using inline flow meters on a semi-continuous basis. Results will be used to adjust (increase, decrease, or shut down) extraction and injection well flow rates to optimize flow patterns and calculate COC mass removed. Results will also be used as input parameters to the groundwater and plume shell models.

Groundwater samples will be collected from the monitor well network annually or biennially. The monitoring program will be re-evaluated prior to initiating long-term operations to adjust monitoring locations and frequencies. Samples will be analyzed for the COCs and other potential contaminants listed in Table 4-3, and the biogeochemical and field screening parameters listed in Table 4-4. Results will be used to construct three-dimensional contaminant plume shells; evaluate concentration trends, plume boundaries, and plume capture; and determine if there are any new releases or transformation products. The concentration trends and plume models will be used to confirm and predict progress toward performance goals.

Samples will be collected from the groundwater extraction wells and the combined treatment plant influent monthly; however, sample frequencies may be adjusted as the results are evaluated. The samples will be analyzed for the contaminants listed in Table 4-3. Results will be used to calculate COC mass removed.

Monitoring results will be communicated in quarterly briefings and documented in the Performance Monitoring Report.

4.1.3.2 Long-Term Operations and Monitoring After Pump-and-Treat

The frequency of hydraulic monitoring in monitor wells will be evaluated based on how rapidly the water table stabilizes after the P&T system is shut down. At a minimum, a synoptic set of hydraulic monitoring data will be collected from the hydraulic monitor well network every five years in accordance with the 5-year review requirement described in the ROD. Results will be used to evaluate groundwater flow patterns, hydraulic gradients, and COC plume migration.

Groundwater samples will be collected from the monitor well network at least every five years. The monitoring plan will be re-evaluated at the completion of long-term operations to determine monitoring locations and frequencies. The samples will be analyzed for the COCs; other potential contaminants are listed in Table 4-3, and the biogeochemical and field screening parameters are listed in Table 4-4. Concentration trends and plume models will be used to confirm and predict progress toward natural attenuation performance goals.

Monitoring results will be communicated in quarterly briefings and documented in the Performance Monitoring Report.

4.2 Compliance Monitoring Plan

The compliance monitoring plan (CMP) for the 200-ZP-1 OU is presented in Appendix A. The purpose of the CMP is to consolidate 200-ZP-1 OU compliance requirements such as federal and Washington State applicable, or relevant and appropriate, requirements (ARARs) and other conditions established in the ROD and in DOE/RL-2008-78.

The CMP assembles, in one location, a comprehensive summary of compliance requirements for the selected remedy when it is operational including air and groundwater monitoring obligations and associated reporting requirements. The overarching objective of the CMP is to provide the 200 West Area P&T project team, particularly the Project Manager, the Environmental Compliance Officer, and the

Waste Management Representative, with the means to track the status of remedy requirements. This capability will confirm that compliance performance is satisfactory and avoid, or rapidly correct, potential noncompliance issues. The CMP does not replicate specific project methodologies and procedures used to meet required actions (e.g., the PMP or the air monitoring plan [AMP]), but rather provides the most expedient means for a reviewer to locate where this reference information can be obtained. As a practical reference, the CMP is formatted into a table of the 200-ZP-1 OU requirements that addresses the remedy's RAOs and ARARs. The table cites a particular requirement, the source and location of the requirement (i.e., ROD or approved RD/RA work plan), a brief description of the requirement, whether the requirement has been achieved, and/or the location where compliance procedures and methods for meeting the requirement are documented.

The 200-ZP-1 OU requirements presented in the CMP table match the arrangement of ARARs listed in Tables A1 and A2 of the ROD and Appendix A of DOE/RL-2008-78 as follows:

- Groundwater
- Air
- Waste Management
- Cultural and Ecological

The CMP is a dynamic tool that should be updated to document the status of the required reduction of COCs throughout the 200-ZP-1 OU in the specific time periods approved by the ROD.

4.3 Air Emissions

The AMP, provided in Appendix C of this O&M Plan, is required because contaminated groundwater from the 200-ZP-1 OU will be treated in an above-ground facility with the potential to emit hazardous air pollutants. As required by the ROD, the groundwater treatment design will reduce the mass of COCs and other contaminants or treatment by-products. The treatment system consists of ion exchange for removal of radionuclides (technetium-99 and uranium); an anaerobic fluidized bed bio-reactor for removal of nitrate, metals, and carbon tetrachloride; an aerobic membrane bed reactor for the removal of residual carbon substrate, TSS, biomass, carbon tetrachloride; and an air stripper to remove remaining carbon tetrachloride. Off-gas from the stripper, FBR, membrane bed reactor, and biomass sludge thickener is commingled and treated with VPGAC prior to discharge via powered exhaust. A scrubber is used to remove any ammonia associated with biomass sludge. Compliance with State of Washington requirements for radiologic and air toxic emissions has been demonstrated by calculations and modeling that are described in the AMP. Abatement controls and environmental monitoring for air toxic and radiological constituents are described in Section 3 and Section 4 of the AMP, respectively.

4.4 Waste Management

The WMP, in Appendix B of this O&M Plan, is required because waste from the extraction and treatment of groundwater from the 200-ZP-1 OU will be generated and will need to be managed consistently with the substantive requirements of federal and Washington State regulations that have been identified as ARARs, in accordance with CERCLA Section 121. Throughout the conduct of this P&T project, every effort will be made to minimize waste generation. All 200-ZP-1 OU investigation-derived waste (IDW) and remediation waste (RW) will be managed in accordance with the WMP. The WMP establishes the requirements for management and disposal of the RW generated from the groundwater P&T system and the IDW generated from the groundwater investigation and monitoring activity at the 200-ZP-1 Groundwater OU.

In addition to the wastes generated from P&T operations, the WMP also includes the requirements for management and disposal of IDW generated from the installation, monitoring, sampling, maintenance, and decommissioning of wells at the 200-ZP-1 Groundwater OU in accordance with Ecology et al., 1999, *Environmental Restoration Program Strategy for Management of Investigation Derived Waste.*

4.5 Cultural/Ecological Resources

Managing the cultural and biological resources of the Hanford Site is an essential component of DOE/RL resource trust responsibilities. Effective cultural and biological resource management is accomplished by implementing a program to ensure that all DOE facilities and programs comply with existing cultural resources and biological executive orders, laws, and regulations. The DOE Hanford Cultural and Historic Resources Program conducts resource reviews on the Hanford Site before any project is initiated that involves disturbances to the land. If 200-ZP-1 Groundwater OU P&T activities extend to areas beyond those previously surveyed, a *Request for Cultural and/or Ecological Resources Review for the Hanford Site* (Hanford form RL-665) will be prepared and submitted to Pacific Northwest National Laboratory who will conduct the work. This review will establish compliance monitoring requirements, as appropriate, consistent with the Cultural and Historic Resources Program. Remedial activities will be coordinated to comply with any restrictions identified by the review with regards to endangered species, critical habitat, migratory birds, and cultural and archaeological resources.

5 Periodic Reporting and Closure

This section describes periodic reporting for the 200 West Area P&T system while in operation, and final remedial action closure reporting once the 200-ZP-1 Groundwater OU RAOs have been met. This section also includes a brief description of the CERCLA 5-year review process. The reports discussed in this chapter may be prepared as individual, project-specific reports, or may be combined into area-specific (i.e., Central Plateau Annual Report) or Hanford Site level reports.

5.1 Periodic System Operations and Remedy Performance Report

The water level and groundwater quality monitoring data to be collected as described in Chapter 4 will be evaluated and initially reported on an annual basis. The data evaluation and reporting frequency may change in the future as aquifer and plume response to pumping are better understood. A suggested performance monitoring report outline, which is applicable for the early years of P&T system operation, is shown below. Not all of the report elements included in the suggested outline may be applicable to each report.

Suggested Performance Monitoring Report Outline

1. Introduction
- 1.1. Purpose
- 1.2. Period of Performance
- 1.3. Report Organization

2. Remedial System Operation
- 2.1. Overview of Remedial System
- 2.2. Remedial System Monitoring Data
  - 2.2.1. Extraction and Injection Well Flow Rates
  - 2.2.2. Extraction Well Sampling Data
  - 2.2.3. Treatment Plant Influent and Effluent Flow Rates
  - 2.2.4. Treatment Plant Influent and Effluent Sampling Data
- 2.3. Analysis of Remedial System Monitoring Data
  - 2.3.1. Extraction Well Mass Removal
  - 2.3.2. Treatment Plant Mass Removal

3. Hydraulic Monitoring
- 3.1. Hydraulic Monitoring Network
- 3.2. Hydraulic Monitoring Data
  - 3.2.1. Synoptic Survey Data
  - 3.2.2. Transducer Data
- 3.3. Analysis of Hydraulic Monitoring Data
  - 3.3.1. Evaluation of Two-Dimensional Water Table
  - 3.3.2. Impacts to Remedy from Changing Groundwater Elevations

4. Contaminant Monitoring
- 4.1. Contaminant Monitoring Network and Parameters
- 4.2. Contaminant Monitoring Data
  - 4.2.1. Contaminants of Concern
  - 4.2.2. Natural Attenuation Daughter Products and Field Parameters
- 4.3. Analysis of Contaminant Monitoring Data
  - 4.3.1. Evaluation of Two-Dimensional Contaminant of Concern Plume Boundaries
  - 4.3.2. Contaminant Plume Cross-Sections
  - 4.3.3. New Releases of Contaminants of Concern

4.3.4. Downgradient Plume Expansion
4.3.5. Natural Attenuation Rates and Transformation Products
4.4. Plume Shell Development
4.4.1. Contaminant Data Sets
4.4.2. Interpolation of Contaminant Concentrations
4.4.3. Plume Shell Masking
4.4.4. Contaminant Mass and Volume
4.4.5. Plume Shell Uncertainty

5. Groundwater Flow Model Development
5.1. Model Calibration
5.1.1. Model Calibration Data Set
5.1.2. Analysis of Calibration Residuals
5.2. Simulated Three-Dimensional Hydraulic Capture
5.3. Impact of Calibration Residuals on Simulated Hydraulic Capture

6. Contaminant Transport Modeling
6.1. Contaminant Transport Parameters
6.2. Contaminant Transport Model Calibration
6.2.1. Comparison of Observed and Simulated Extraction Well Concentrations
6.2.2. Comparison of Observed and Simulated Remedial System Mass Removal
6.3. Predictive Contaminant Transport Simulations
6.3.1. Evaluation of 25-Year 95 Percent Contaminant of Concern Mass Removal Milestone
6.3.2. Evaluation of 125-Year Contaminant of Concern Cleanup Milestone

7. Progress Toward Meeting Remedial Action Objectives

8. Conclusions
8.1. Changes to the Site Conceptual Model
8.2. Key Decisions Addressed by Performance Monitoring Data Collection
8.2.1. Decision Statement #1
8.2.2 Decision Statement #2
8.2.3 Decision Statement #3
8.2.4 Decision Statement #4
8.2.5 Decision Statement #5
8.2.6 Decision Statement #6
8.2.7 Decision Statement #7
8.2.8 Decision Statement #8
8.2.9 Decision Statement #9

9. Recommendations

10. References

5.2 CERCLA 5-Year Review

In accordance with 40 CFR 300.430[f][4][ii], "National Oil and Hazardous Substances Pollution Contingency Plan," "Remedial Investigation/Feasibility Study and Selection of Remedy," DOE and EPA have agreed to conduct 5-year reviews for the 200 Area because the selected remedy will not achieve levels that allow for unlimited use and unrestricted exposure within five years. Reviews will begin within five years or less after initiation of the remedial action, at the time of the next periodic site-wide Hanford Site consolidated five year review, and will be conducted for this OU every five years until cleanup levels established in the ROD are attained. The reviews will be conducted pursuant to CERCLA 121(c) and as provided in the current EPA guidance (EPA 540-R-01-007, *Comprehensive Five-Year Review Guidance*).

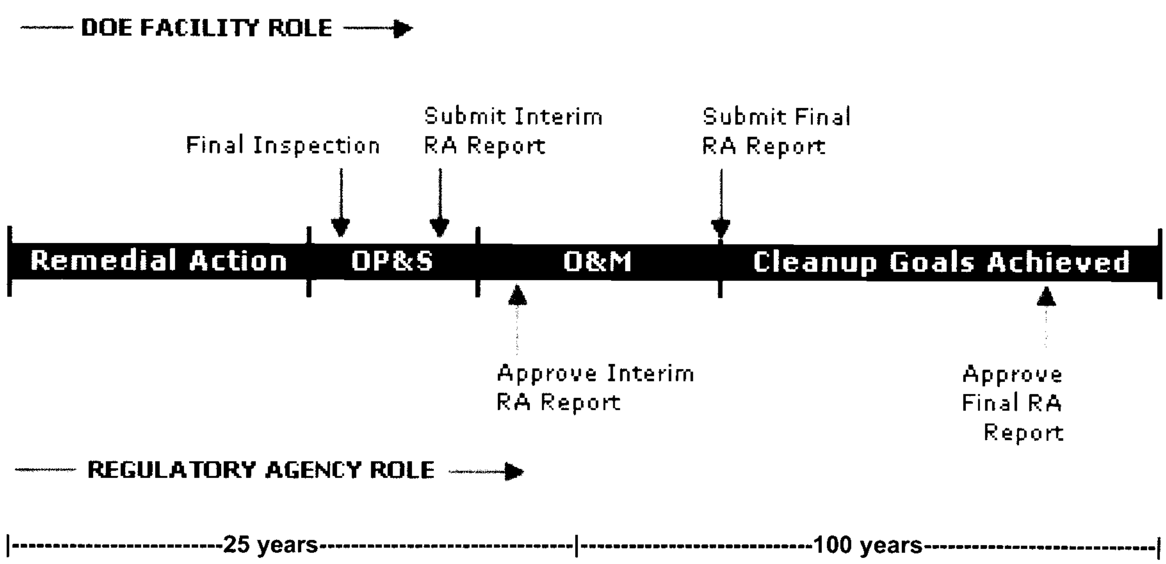
5.3 Closure Report

This section describes the interim and final remedial action closure report and provides a brief summary of the typical report contents. Figure 5-1 depicts the remedial action process and provides a generalized reporting timeline for the 200-ZP-1 Groundwater OU.

The remedy implementation process includes a remedial action phase, which involves construction of the 200 West Area groundwater P&T system. The operating properly and successfully (OP&S) phase begins after construction is complete. This phase involves testing the P&T system to confirm that it is operating as designed and that the treatment process achieves the cleanup levels identified in the ROD. An interim remedial action (RA) report is prepared after construction has been completed, the system is operating as intended, the final inspection has been completed, and any wells necessary to monitor natural attenuation have been installed. The final inspection for the interim RA report must be completed and included with the report.

The OP&S phase is followed by routine O&M activities that are required to maintain the remedy's effectiveness and integrity. The O&M phase is completed when groundwater cleanup goals specified in the ROD are achieved. For the 200-ZP-1 Groundwater OU, the O&M phase will include operation of the 200 West Area P&T system, and MNA following P&T system shutdown.

A final RA report is prepared to document the cleanup activities that took place and compliance with ROD requirements. The interim RA report can be amended to create the final RA report. The amendment would add information on activities that occurred after the interim RA report was completed.



OP&S = Operating Properly and Successfully

Figure 5-1. Remedial Action Progress and Reporting Timeline for the 200-ZP-1 Groundwater OU

The interim RA report and final RA report will be prepared using the format shown in EPA 540-R-98-016, *Close Out Procedures for National Priorities List Sites*. The interim RA report includes the following primary sections:

Suggested Interim Remedial Action Report Outline
1. Introduction
2. Operable Unit Background
3. Construction Activities
4. Chronology of Events
5. Performance Standards and Construction Quality Control
6. Final Inspection and Certifications
7. Operation and Maintenance
8. Summary of Project Costs
9. Observations and Lessons Learned
10. Operable Unit Contact Information
11. Appendix A: Cost and Performance Summary

The final RA report includes the following sections:

Suggested Final Remedial Action Report Outline
1. Introduction
2. Summary of Site Conditions
3. Demonstration of Cleanup Activity QA/QC
4. Monitoring Results
5. Performance Standards and Construction Quality Control
6. Summary of Operation and Maintenance
7. Summary of Remediation Costs
8. Protectiveness
9. Five Year Review
10. References

Additional information on the interim and final RA report is provided in EPA 540-R-98-016.

5.4 Records Management

This section describes management of records associated with O&M of the 200 ZP-1 Groundwater OU remedial action.

The following records are associated with O&M of the 200 West Area P&T system:

- Operating logs
- Field logbooks and laboratory reports
- Operating costs
- Emergency and transient condition events
- P&T system maintenance

6 Decontamination and Decommissioning

This section specifies the plans that will be in place to address decontamination and decommissioning (D&D) of the P&T system, once RAOs have been attained, and summarizes the anticipated future land use after completion of P&T system D&D.

Decontamination is a process whereby contaminants that have accumulated on or in equipment, tools, or treatment systems are removed or neutralized so they no longer present a hazard to human health or the environment. Decontamination efforts associated with 200 West Area groundwater P&T system have been grouped into two activities: those that are interim (i.e. involved with day-to-day operations), and those that are associated with the final shutdown and decommissioning of the facility.

Decommissioning is the process of removing a no longer needed facility from service and removing and/or disposing of equipment and materials in a manner that protects worker and public health and the environment. Under authority delegated by Executive Order 12580, *Superfund Implementation*, DOE is responsible for evaluating whether conditions at sites under the DOE's jurisdiction pose a significant threat of release of hazardous substances, as defined by CERCLA. If a significant threat of release is identified, DOE is authorized to conduct removal action, RA, and any other response measures consistent with the National Contingency Plan (NCP).

DOE and EPA, 1995, *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)*, establishes that decommissioning activities at facilities located on DOE sites will be conducted as non-time-critical removal actions under CERCLA, unless the circumstances at the facility make it inappropriate. DOE will conduct a removal site evaluation, as directed by the NCP, to assess site conditions and determine whether a release or substantial threat of release exists at the facility. At any facility for which DOE conducts a removal site evaluation, DOE will consult with EPA and will provide them, as requested, with such information necessary for EPA to review such evaluation. At any facility where DOE determines that a release or substantial threat of release has not occurred, DOE will consult with EPA and provide any information necessary for EPA to evaluate such determination. Further guidance on decommissioning of DOE facilities is provided by DOE G 430.1-4, *Decommissioning Implementation Guide*.

6.1 Interim Decontamination and Decommissioning

Detailed procedures for decontamination of equipment and other miscellaneous items will be developed as part of an interim D&D plan. Decontamination of the tanks, containers, and equipment associated with the 200 West Area groundwater P&T system involves removal and disposal of wastes present in containers, and decontamination of the interiors of tanks, containers, and associated ancillary equipment that were in contact with waste, as necessary. Decontamination and disposal of equipment and miscellaneous items will be conducted, in accordance with the procedures and criteria of the decontamination plan including, as appropriate, the requirements of WAC 173-303-070, "Dangerous Waste Regulations," "Designation of Dangerous Waste" and 40 CFR 268.45, "Land Disposal Restrictions," "Treatment Standards for Hazardous Debris" (as adopted in entirety by WAC 173-303-140, "Dangerous Waste Regulations," "Land Disposal Restrictions"). Disposal of waste streams from decontamination and decommissioning is discussed in the Waste Management Plan (Appendix B). In general, spent decontamination water and other liquid waste streams generated during the decontamination process that are compatible with the 200 West Area P&T system will be reintroduced into the P&T system for treatment. Those waste streams that are not compatible with 200 West Area P&T system and all decontamination fluids (i.e., water and/or nonhazardous cleaning solutions) generated from cleaning equipment, tools, and materials will be contained and transported to the Purge water Storage and

Treatment Facility (PSTF) or Effluent Treatment Facility (ETF) if the waste acceptance criteria can be met. If acceptance criteria cannot be met, pretreatment may be necessary, or another suitable disposal facility may be identified, as authorized by EPA.

6.2 Final Decontamination and Decommissioning

Final D&D of the 200 West Area groundwater P&T system will be addressed after DOE, EPA, and Ecology (Tri-Parties) determine that the active remediation is complete or the treatment system is no longer required. The D&D requirements will be addressed in a future D&D plan which will be developed and submitted with the O&M report near the end of the active remediation timeframe. This will likely occur at least 25 years after start up of the P&T system. D&D of the 200 West Area groundwater P&T system will be performed in accordance with ARARs and applicable guidance.

Decontamination of the P&T system is expected to include the following activities:

- Remove and dispose liquids from tanks, piping, and process equipment.
- Remove and dispose IX and other resins, filters, and media.
- Remove and dispose of all waste solids.
- Drain transfer piping and dispose of liquid.
- Winterize buildings and leave the facility for evaluation of further use at a later date. Periodic inspections of the buildings will be necessary for long-term care.

Once a determination is made that no further use of the 200 West Area groundwater P&T system is required, decommissioning is expected to include the following activities:

- Removal and disposal of conveyance and process piping
- Salvage of equipment and materials that can be used elsewhere at the Hanford Site
- Demolition of building, tanks, and structures
- Site restoration

Extraction and injection wells will be evaluated for use as groundwater monitoring wells (sampling and water levels). Those not retained for monitoring purposes will be decommissioned in accordance with WAC 173-160-381, "Minimum Standards for Construction and Maintenance of Wells," "What Are the Standards for Decommissioning a Well?"

The site will be returned to its pre-operational condition to the extent feasible considering cost and intended future use (see Section 6.3). The wells that are used in conjunction with the 200 West Area P&T system will continue to be used for groundwater monitoring. If a well is no longer needed, it will be decommissioned in accordance with WAC 173-160-381. Waste materials generated as part of D&D activities will be managed and disposed of as addressed in the WMP.

6.3 Future Land and Groundwater Use

This section describes the anticipated future land, groundwater, and surface water uses applicable to the 200-ZP-1 OU. The following sections summarize the anticipated uses presented in the ROD.

6.3.1 Anticipated Future Land Use

The reasonably anticipated future land use for the core zone of the Central Plateau is industrial (DOE worker) for at least 50 years and then industrial (DOE or non-DOE worker) thereafter. The DOE worked for several years with cooperating agencies to define land-use goals for the Hanford Site. The cooperating agencies and stakeholders included the National Park Service, Tribal Nations, the states of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests.

The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group (Drummond, 1992), 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 DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS) and associated HCP EIS ROD (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement [HCP EIS]") in 1999. The HCP EIS analyzes the potential environmental impacts of alternative land-use plans for Hanford and considers the land-use implication of ongoing and proposed activities. Under the preferred land-use alternative selected in the HCP EIS ROD, the Central Plateau was designated for industrial exclusive use, defined as areas suitable and desirable for treatment, storage, and disposal (TSD) of hazardous, dangerous, radioactive, and nonradioactive wastes, as well as related activities.

Subsequent to the HCP EIS, the Hanford Advisory Board (HAB) issued 02-HAB-0006, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area." The HAB acknowledged that some waste would remain in the core zone of the Central Plateau when cleanup is complete. The goal identified within 02-HAB-0006 is for the core zone to be as small as possible and not to include contaminated areas outside the Central Plateau's fenced areas. The HAB further stated that waste within the core zone should be stored and managed to make it inaccessible to inadvertent intruding humans and biota, and that the DOE should maximize the potential for any beneficial use of the accessible areas of the core zone. The HAB advised that risk scenarios for the waste management areas of the core zone should include a reasonable maximum exposure to a worker/day user and to an intruder.

In response to 02-HAB-0006, and for the purposes of the 200-ZP-1 OU RA, the Tri-Parties have agreed to assume the following reasonably anticipated future land use: continuing industrial land use for at least 50 years, including ongoing active waste treatment, storage and/or new disposal (especially in the CERCLA Environmental Restoration Disposal Facility, ERDF) of hazardous, dangerous, radioactive, and non-radioactive wastes. Following that period, the area above the 200-ZP-1 OU area is anticipated to continue in industrial use. Starting at least 100 years after active waste management (roughly 150 years from present), the potential for inadvertent intrusion into subsurface waste may increase because the majority of the present Hanford Site will have been opened to non-industrial uses and less-restrictive public access, and knowledge of residual hazards within the remaining controlled access area may not be as widely held among the public as at present. As long as residual contamination remains above levels that allow for unrestricted use, ICs will continue to be required..

6.3.2 Potential Future Ground and Surface Water Uses

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

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

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

7 Health, Safety, and Quality

7.1 Health and Safety

The 200 West Area groundwater P&T system health and safety plan (HASP) governs operations and work activities associated with the 200 West Area groundwater P&T system, and is intended to meet the requirements of 29 CFR 1910.120. The HASP contains applicable core functions and guiding principles of the Integrated Safety Management System. The HASP also governs safe performance of routine facility operations and maintenance activities, including facility inspection and surveillance, equipment replacement, maintenance, housekeeping, and sampling. It also governs personnel safety training requirements, control of recognized health and safety hazards, use of personal protective equipment, facility access requirements, and contingencies such as fire, spills, accidents, personnel injuries, and incident reporting.

The HASP is not a stand-alone document. It is supplemented by other procedures governing work control, conduct of operations, industrial safety, maintenance, and waste handling. Major elements of the HASP are summarized in the sections below.

7.1.1 Visitor Requirements

Visitors to the site shall sign in (and out) at the site office and be briefed on the HASP. Visitors are not allowed into control zones when the process system is breached unless the following training requirements are met:

- Monitoring/sampling protocols
- Site control measures
- Spill containment/control
- Decontaminations procedures
- Medical surveillance

7.1.2 Facility Upset Conditions

The HASP covers procedures and requirements for the following potential facility upset conditions:

- Minor and life threatening injuries
- Fire
- Chemical exposure
- Radiological exposure
- Area alarms
- Entryway warning lights

7.1.3 Hazard Control

Control of the following hazards that are likely present during O&M activities is a primary element of the HASP:

- Biological hazards
- Compressed air
- Chemical hazards
- Radiological hazards
- Waste control
- Elevated work
- Electrical hazards
- Fire hazards
- Pinch points
- Hand tools
- Portable ladders
- Scaffolding
- Manual lifting
- Noise
- Powered industrial trucks (forklifts)
- Man lifts, cranes, and rigging
- Pressure systems
- Sanitation
- Vehicle parking
- Walking and work surfaces (slip/trip/fall)

7.1.4 Facility Response Plan

The HASP also includes a facility response plan which includes the following elements:

- Emergency response organization
- Emergency equipment (location descriptions and capabilities)
- Implementation procedures for the facility response plan
- Emergency response procedures
- Plan location and amendment procedures

7.2 Quality

Overall QA for the O&M Plan will be implemented in accordance with the CHPRC Quality Assurance Program Management Plan and Environmental Quality Assurance Program Plan (EQAPP).

The management plan includes the overall structure, requirements, implementation methods, and responsibilities which require that program and project plans be developed to ensure effective implementation of the QA requirements for CHPRC's environmental activities.

The EQAPP is a management tool that documents the quality system for planning, implementing, documenting, and assessing the effectiveness of the environmental activities, TPA implementation, data operations, and other environmental programs. The EQAPP includes quality assurance project plan (QAPP) requirements for implementation of the Soil & Groundwater Remediation Project and D&D Project.

These QA activities use a graded approach based on the potential impact on the environment, safety, health, reliability, and continuity of operations. QA for sampling activities and performance monitoring is discussed in Appendices D and E.

SAPs prepared to support the 200 West Area groundwater P&T system will contain a QAPP, which will be used to support the sampling and characterization activities. Other specific activities will include QA implementation, responsibilities and authority, document control, QA records, and audits.

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Appendix A

Compliance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action

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Contents

Tables

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Terms

ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CMP	compliance monitoring plan
COC	contaminant of concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
IC	institutional control
OU	operable unit
O&M	operations and maintenance
P&T	pump-and-treat
RA	remedial action
RAO	remedial action objective
RD	remedial design
RL	DOE Richland Operations Office

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A1 Introduction and Purpose

This compliance monitoring plan (CMP) presents requirements established for the 200-ZP-1 groundwater Operable Unit (OU) remedial action (RA). This is the final action selected in the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington* (EPA et al, 2008), referred to as the ROD. The CMP is Appendix A to the Operations & Maintenance (O&M) Plan (DOE/RL-2009-124) for the 200 West Area groundwater P&T system.

The purpose of the CMP is to consolidate 200-ZP-1 groundwater OU compliance requirements such as federal and state of Washington applicable or relevant and appropriate requirements (ARARs) and other conditions included in the ROD and DOE/RL, 2008-78, *200 West Area ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan* (hereafter referred to as the RD/RA Work Plan) approved by the U.S. Environmental Protection Agency (EPA). The RD/RA Work Plan provides a plan and schedule for implementing tasks to design, install, and operate the 200 West Area groundwater pump-and-treat (P&T) system. The P&T portion of the selected remedy includes a groundwater treatment facility, groundwater extractions wells, treated groundwater injection wells, and a performance monitoring plan to obtain information on remedy performance. The 200 West Area groundwater P&T system will be operated to extract and treat contaminated groundwater to reduce contaminant of concern (COC) concentrations (except tritium) throughout the 200-ZP-1 groundwater OU. Monitored natural attenuation, groundwater flow path control, and institutional controls (ICs) will supplement the P&T system.

The CMP assembles, in one location, a comprehensive summary of compliance requirements for the selected remedy when it is operational including air and groundwater monitoring obligations and associated reporting requirements. The overarching objective of the CMP is to provide the 200 West Area project team, particularly the Project Manager, the Environmental Compliance Officer, and the Waste Management Representative, with the means to track the status of remedy requirements. This capability will ensure confirmation that compliance performance is satisfactory and to avoid, or rapidly correct, potential noncompliance issues. The CMP does not replicate specific project methodologies and procedures used to meet required actions, but rather provides the most expedient means for a user to locate where this reference information can be obtained.

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A2 Organization and Use

As a practical reference, the CMP is formatted into a table of the 200-ZP-1 groundwater OU requirements that addresses the remedy's remedial action objectives (RAOs) and ARARs (Table A2-1). Table A-1 cites a particular requirement, the source and location of the requirement (i.e., ROD or approved RD/RA Work Plan), a brief description of the requirement, whether the requirement has been achieved and/or the location where compliance procedures and methods for the meeting the requirement are described.

The 200-ZP-1 groundwater OU requirements, presented in Table A-1, match the arrangement of ARARs listed in Tables A1 and A2 of the ROD and Appendix A of the RD/RA Work Plan as follows:

- Groundwater
- Air
- Waste Management
- Cultural and Ecological

DOE/RL-2009-124, *200 West Area Pump-and-Treat Facility Operations and Maintenance Plan*, that contains the CMP, was prepared in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989a) by the U.S. Department of Energy (DOE) Richland Operations Office (RL). It addresses the activities and requirements for the long-term operation and maintenance of the 200 West Area groundwater P&T system. Appendices to the O&M Plan include much of the information that describes how compliance elements will be carried out and are, therefore, referenced in this CMP. These appendices, in order, include:

- A – Compliance Monitoring Plan for the 200-ZP-1 OU Remedial Action
- B – Waste Management Plan for the 200-ZP-1 OU Remedial Action
- C – Air Monitoring Plan for the 200-ZP-1 OU Remedial Action
- D – 200 West Area Groundwater Treatment Facility Sampling and Analysis Plan
- E – Groundwater Sampling and Analysis Plan for the 200-ZP-1 OU Remedial Action

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Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
		Statutory or Administrative		
Proximity of Noncontiguous Facilities CERCLA (104[d][4]).	ROD Section 5.0 Page 6.	When noncontiguous facilities are reasonable close to one and another and waste at these sites are compatible for selected treatment or disposal, the lead agency may treat these related facilities as one site without having to obtain a permit.	The 200-ZP-1 OU and ERDF are considered to be a single site for response purposes.	None required
CERCLA Five-year reviews (40 CFR 300.430[f][4][ii])	ROD Section 5.0 Page 6.	Required at a minimum every 5 years if a remedy is selected that result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure.	DOE and EPA have agreed to conduct five year reviews in accordance with 40 CFR 300.430[f][4][ii], until COCs are reduced below the cleanup levels established in this ROD.	Reviews begin five years after initiation of the remedial action (2012) to ensure that the selected remedy is protective of human health and the environment.
Principal Threat Wastes (40 CFR 300.430(a)(iii)(A) and (B) "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."-From a sitewide perspective, the wastes (i.e., source materials) present in the RCRA regulated units and the 24 source-control OUs on the Central Plateau overlying the four Central Plateau groundwater OUs represent the principal threat materials for the Hanford 200 Area NPL site.	ROD Sections 4.2 Pg. 2 and 13.5 Pg. 72.	The remedial action decisions for the source-control OUs are being made under the enforcement strategies and schedules contained in the Hanford Tri-Party Agreement and will consider the nature and characteristics of the principal threat materials found in the source-control OUs. The closure and cleanup decisions made for the RCRA regulated units will also consider the nature and characteristics of the principal threat materials found in those units.	*"There are no known contaminant source materials such as NAPLs in the 200-ZP-I-OU groundwater that would serve as a source of principal threat materials"* (ROD Section 11.0 Pg 54).	No Further Action Required for 200-ZP-1 OU.
Compliance with ARARs	ROD Section 13.2 Pgs 70 & 71, Appendix A, Tables A1 and A2. Approved RD/RA Work Plan Appendix A, Table A.	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.	Appendix A of the ROD provides a definitive list of ARARs to be attained by the selected remedy, organized by federal requirements (Table A-1) and Washington State requirements (Table A-2). Table A-3 describes "to be considered" criteria that were used in developing the remedy. These ARARs are repeated in the RD/RA Work Plan, Appendix A, Table A-1.	See below for chemical-, location-, and action-specific requirements by corresponding compliance category.
Major Remedy Changes	ROD Section 12.3, Pg. 61.	New information and data collected during the engineering design or implementation of the selected remedy.	Major changes will be documented in the form of a memorandum in the Administrative Record file, a CERCLA ESD, or a ROD Amendment, as appropriate.	As necessary
		Groundwater		
Selected Remedy - Groundwater Extraction and Treatment Pump and Treat Component A groundwater P&T system will be designed, installed, and operated in accordance with an approved RD/RA work plan. The P&T component will be designed and implemented in combination with MNA to achieve cleanup levels listed in the ROD (Table 11, Final Cleanup Levels) for all COCs in 125 years. There is no viable treatment technology to remove tritium from the groundwater. However, the half life of tritium is sufficiently short, so tritium will decay below the cleanup standard before it leaves the industrial land-use zone. The treated groundwater will then be returned to the aquifer through injection wells. Specific extraction and injection well locations, treatment equipment design, operational requirements, and other system details will be determined during the remedial design phase and will be documented in the "RD/RA documents."	ROD Sections 4.3.1 Pgs. 2-3, and 12.2.1 Pg. 56, and Section 12.4 Pg. 67.	The system will capture and treat contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium (chromium III and chromium VI), nitrate, trichloroethylene, iodine-129, and technetium-99, throughout the 200-ZP-I OU by a minimum of 95 percent in 25 years. Following extraction, COCs in groundwater (except tritium) will be treated to achieve the cleanup levels listed in the ROD (Table 11, Final Cleanup Levels).The remedial design will also consider as necessary, the need for treatment of other constituents (such as uranium) that may be captured by the 200-ZP-1 OU extraction wells. Monitoring shall be conducted to evaluate the performance of P&T system in accordance with the approved RD/RA documents. Monitoring shall demonstrate whether or not the P&T system will remove at least 95% of the mass of COCs in 25 years or less.	Remedy design details are provided in the approved RD/RA Work Plan (DOE/RL-2008-78); the Remedial Design Report (DOE/RL 2010-13), the Performance Monitoring Plan (DOE/RL 2009-115); and the Operations and Maintenance Plan (DOE/RL 2009-124).	Contaminant treatment and monitoring procedures associated with the groundwater pump and treatment system are provided in DOE/RL-2009-115, and the following Appendices of the O&M Plan: Appendix D-200 West Area Groundwater Treatment Facility Sampling and Analysis Plan, and Appendix E - Groundwater Sampling and Analysis Plan for the 200-ZP-1 Operable Unit Remedial Action. Performance of the 200 West Area groundwater P&T system will be communicated to EPA during quarterly briefings and summarized in the Performance Monitoring Report.

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
Selected Remedy **Groundwater Extraction and Treatment MNA Component** Natural attenuation processes to be relied on as part of this component include abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Fate and transport analyses conducted as part of the FS (DOE/RL-2007-28) indicate that the timeframe necessary to reduce the remaining COC concentrations to acceptable levels through MNA will be approximately 100 years. The overarching requirement is to meet the groundwater cleanup levels identified in this ROD within 125 years.	ROD Sections 4.3.2 Pg. 3-4 and 12.2.2 ,Pgs. 56 and 57 RD/RA Work Plan Section 2.1.1, Pg. 2-1.	Monitoring locations, points of compliance and specifications will be developed as part of RD/RA documents to provide data on performance. Monitoring will: • Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of the pump and treat system, natural attenuation processes, and the flow path control actions. • Identify potentially toxic and/or mobile transformation products. • Verify that contamination is not expanding downgradient, laterally or vertically subsequent to the period of time over which the P&T component has been functional. • Detect new releases of contaminants of concern to the environment that could impact the effectiveness of the remedy. • Verify attainment of remediation requirements. RD/RA documents will be reviewed and approved by EPA.	MNA design details are provided in the approved RD/RA Work Plan (DOE/RL 2008-78); the Remedial Design Report (DOE/RL 2010-13), the Performance Monitoring Plan (DOE/RL 2009-115); and the Operations and Maintenance Plan (DOE/RL 2009-124).	Natural attenuation monitoring, and hydraulic control measures are described in the O&M Plan and in its Appendix E-Groundwater Sampling and Analysis for the 200-ZP-1 OU Remedial Action. MNA performance will be summarized in the Performance Monitoring Report.
Selected Remedy - Groundwater Flow Path Control Component	ROD Section 4.3.3 Page 4 and 12.2.3 Pg 57. RD/RA Work Plan; Section 2.1.3, Pg. 2-3.	Groundwater modeling is required to locate extraction wells, estimate rates, and locate injection wells for flow path control in accordance with RD/RA documents. Flow path control shall be used to: Slow natural eastward flow of most groundwater to keep COCs in the capture zone. Minimize potential for groundwater in northern portion of aquifer to flow through Gable Cap to Columbia River. RD/RA documents will be reviewed and approved by EPA.	Flow path control details are provided in the approved RD/RA Work Plan (DOE/RL 2008-78); the Remedial Design Report (DOE/RL 2010-13), the Performance Monitoring Plan (DOE/RL 2009-115); and the Operations and Maintenance Plan (DOE/RL 2009-124).	Flow path control monitoring methods are described in the Performance Monitoring Plan (DOE/RL 2009-115), O&M Plan, and Appendix E-Groundwater Sampling and Analysis Plan for the 200-ZP-1 OU Remedial Action. Flow path control performance will be summarized in the Performance Monitoring Report.

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
Selected Remedy-Groundwater Institutional Controls Component	ROD Sections 4.3.4 Pgs.4 and 5 12.2.4 Pgs. 58 & 59. RD/RA Work Plan; Section 2,1,3, Pg. 2-3.	200-ZP-1 OU groundwater use will be restricted through ICs and land-use controls until cleanup levels are achieved. No later than 180 days after the ROD is signed, DOE shall update the *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions* (DOE/RL-2001-41) to include ICs required by this ROD and specify the implementation and maintenance actions that will be taken, including periodic inspections. A land-use control boundary map for the 200-ZP-1 OU is required. ICs required of DOE through the completion of this 200-ZP-1 OU remedy are: – Control access to prevent unacceptable exposure of humans to contaminants in groundwater. Visitors entering any site areas must be badged and escorted at all times. – Prohibit intrusive work unless approved in a plan by EPA. – Prohibit well drilling except for authorized wells. – Prohibit groundwater use except for authorized research purposes, monitoring, and treatment. – Post and maintain warning signs along pipelines conveying untreated groundwater that caution site visitors and workers of potential hazards. – Report any unauthorized access to the Site (e.g., trespassing) to Benton Co. Sheriff's Office for investigation and evaluation of possible prosecution. – Prohibit activities that disrupt or lessen the performance of the P&T, MNA, and flow path control. – Prohibit activities that damage P&T, MNA, and flow path control components (e.g., extraction, injection. monitoring wells, piping, or treatment plant). – Report on effectiveness of institutional controls in an annual report, or an alternative reporting frequency specified by EPA. Reporting may be for this OU alone or part of a sitewide report. – Provide notice to EPA at least six months prior to any transfer or sale of any land subject to ICs (including federal-to-federal transfers). If not possible, then no later than 60 days prior to transfer or sale. In addition provide a copy of executed deed or transfer assembly to EPA. – Prevent development and use of property for residential housing, elementary and secondary schools, childcare facilities and playgrounds. – Maintain ICs until cleanup levels are achieved. concentrations of hazardous substances are at levels that allow unrestricted use and exposure, and EPA authorizes removal of ICs.	Implementation, maintenance, and periodic inspection requirements for ICs at the Hanford Site are described in DOE/RL-2001-41.	A land-use control map has been prepared and is included in the ROD as Figure 12. DOE/RL-2001-41 will be updated concurrent with the startup of this remedial action.

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
RCRA LDRs and reinjection of Groundwater RCRA Sections 3004(f), (g), and (m)	ROD Section 13.2 Pg. 71.	EPA OSWER Directive 9234.1-06, Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26 (dated December 27, 1989), provides guidance on issues regarding whether LDRs apply to reinjection of groundwater.	This guidance states that EPA construes the provisions of RCRA Section 3020 to be applicable instead of LDR provisions contained in RCRA Sections 3004(f), (g), and (m), to reinjection of contaminated groundwater into an underground source of drinking water, which is part of a CERCLA response action.	Per the ROD, LDRs do not apply to reinjection of treated groundwater from the 200-ZP-1 Groundwater OU because this is a CERCLA action.
ARAR: Cleanup levels Maximum Contaminant Levels/Nonzero Maximum Contaminant Level Goals for Organics/Inorganics/ Radionuclides 40 CFR 141.61,141.62,and 141.66 Standard Method B Potable Groundwater Cleanup Levels WAC 173-340-720(4)(b)(iii)(A) and (B) Adjustments to Cleanup Levels WAC 173-340-720(7)(b)	ROD–Table 11, Pg. 67, and Approved RD/RA Work Plan Appendix A, Table A.	The final cleanup levels identified in the ROD for 200-ZP-1 OU Groundwater are Federal and State drinking water MCLs and State groundwater cleanup standards (where more stringent than MCLs). <u>**COC Cleanup Level**</u> Carbon Tetrachloride: 3.4 ug/L Chromium (total): 100 ug/L Chromium (hexavalent): 48 ug/L Nitrate (as Nitrate-N): 10,000 ug/L Trichloroethylene (TCE): 1 ug/L Iodine-129: 1 pCi/L Technetium-99: 900 pCi/L Tritium: 20,000 pCi/L	Groundwater wells will be sampled to monitor the progress of remediating contaminated groundwater to achieve final cleanup levels. Monitoring will begin during the early stages of construction and will continue throughout treatment and closure to ensure that cleanup levels have been met. Following extraction, the COCs in groundwater (except tritium) will be treated to achieve cleanup levels. The treated groundwater will then be returned to the aquifer through injection wells. COC biological degradation products will be treated as part of the P&T and MNA components of the remedy.	MCL/MCLG measurements are described in the O&M Plan, and in the following Appendices of the O&M Plan: <u>Appendix D</u> – 200 West Area Groundwater Treatment Facility Sampling and Analysis Plan. <u>Appendix E</u> - Groundwater Sampling and Analysis Plan for the 200-ZP-1 OU Remedial Action.
ARAR: Underground Injection Wells UIC Well Classification Including Allowed and Prohibited Wells WAC 173-218-040 - 42 U.S.C. 6939b, Sec. 3020(b) Interim Control of Hazardous Waste Injection Decommissioning Injection Wells WAC 173-218-120	ROD – Table A-1, and Approved RD/RA Work Plan Appendix A, Table A.	Establishes requirements to allow injection of groundwater that contains hazardous waste back into the aquifer during implementation of a CERCLA remedy. Injection wells used to return treated groundwater to an aquifer must meet the classification criteria of a Class IV well, and shall be abandoned following completion of the remedial action.	Extracted groundwater from the 200-ZP-1 OU will be treated to achieve cleanup levels before returning it to the aquifer through the injection wells. Treated effluent will be periodically tested prior to injection into the aquifer. Periodic testing (grab samples) will be used to demonstrate compliance. Treatment system may continue to operate if discharge concentrations are greater than cleanup levels. Injection wells will be decommissioned in accordance with the standards specified in the regulation.	Effluent measurements are described in the O&M Plan, and, as appropriate, in the following Appendices of the O&M Plan: <u>Appendix D</u> – 200 West Area Groundwater Treatment Facility Sampling and Analysis Plan. <u>Appendix E</u> - Groundwater Sampling and Analysis Plan for the 200-ZP-1 OU Remedial Action.
Well Construction Standards WAC 173-160-161 WAC 173-160-171 WAC 173-160-181 WAC 173-160-400 WAC 173-160-420 WAC 173-160-430 WAC 173-160-440 WAC 173-160-450 WAC 173-160-460	ROD – Table A-2, and Approved RD/RA Work Plan Appendix A, Table A.	Well planning and construction. Well location requirements. Preserving natural barriers between aquifers. Standards for resource protection wells and geotechnical borings. Construction requirements for resource protection wells. Minimum casing standards. Equipment cleaning standards. Well sealing requirements. Decommissioning for resource protection wells.	All monitoring, injection and extraction wells completed for the 200-ZP-1 OU remediation activities will meet the substantive requirements of these regulations.	Well construction information is provided in the following documents: Hanford Site Well Management Plan (DOE/RL-2003-13 Rev.0, June 2003) Sampling and Analyses Plan for the First Set of Remedial Action Wells in the 200-ZP-1 Groundwater Operable Unit (DOE/RL-2008--57, Rev. 0., December 2008)

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
		Wastes		
Treatment Residuals	ROD Section 12.1 Pgs. 55 and 56.	Treatment residuals generated as part of this action are expected to meet waste disposal criteria for onsite disposal in the ERDF. Waste that does not meet ERDF waste acceptance criteria will be sent offsite for treatment and disposal. Any offsite disposal will require a facility acceptability determination by EPA that the facility can receive CERCLA waste.	200-ZP-1 OU treatment residuals meeting the Waste Acceptance Criteria will be disposed of in ERDF. Waste that does not meet ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex (e.g. CWC). Wastes shipped to the CWC will meet acceptability criteria for a disposal facility under the CERCLA Off-site Rule.	Treatment Residual disposal/treatment occurs on an as needed basis and will follow applicable waste management functions identified in the O&M Plan, Appendix B - Waste Management Plan for the 200-ZP-1 OU Remedial Action. As described in Appendix B, Waste Management Plan for the 200-ZP-1 OU Remedial Action, 200-ZP-1 investigation-derived waste (IDW) and remediation waste (RW) will be stored in the OU. CERCLA dangerous wastes and temporary storage areas for waste awaiting sampling and designation will be inspected weekly. Non-dangerous waste storage areas will be inspected monthly or at the frequency defined in the Waste Control Plan that was developed for IDW for the 200-ZP-1 OU. Accumulation, staging, storage, profiling, packaging, and labeling details for each waste are documented on the Waste Packaging and Labeling Instruction Sheet (WPLIS). Disposal records are maintained in the Hanford Site Solid Waste Information and Tracking System (SWITS).
ARAR: "Identifying Solid Waste" WAC 173-303-016	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Identifies those materials that are and are not solid wastes.	Waste materials generated from the 200-ZP-1 OU remedial action will be evaluated for solid waste properties in accordance with the substantive requirements of WAC 173-303-016.	O&M Plan Appendix B - Waste Management Plan for the 200-ZP-1 OU Remedial Action- Waste designation and corresponding waste profiles are completed by the Waste Management Representative. The waste profiles are documented on the Waste Packaging and Labeling Instruction Sheet (WPLIS).
ARAR: WAC 173-303-017, "Recycling Processes Involving Solid Waste"	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Identifies materials that are and are not solid wastes when recycled.	IDW and RW generated during the 200-ZP-1 OU remedial action that can be recycled will meet the substantive portion of these requirements.	O&M Plan Appendix B - Waste Management Plan for the 200-ZP-1 OU Remedial Action - Waste designation and corresponding waste profiles are completed by the Waste Management Representative. The waste profiles are documented on the WPLIS.
ARAR: "Designation of Dangerous Waste" WAC 173-303-070(3)	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Establishes whether a solid waste is, or is not, a dangerous waste or an extremely hazardous waste.	Substantive requirements apply to IDW and RW generated from 200-ZP-1 OU remedial activities. Media and treatment residuals generated from the 200-ZP-1 OU will be designated according to the procedures identified in WAC 173-303-070(2).	The O&M Plan Appendix B - Waste Management Plan for the 200-ZP-1 OU Remedial Action states that IDW and RW that come into contact with the 200-ZP-1 OU groundwater will be designated with a F001 through F005 RCRA listed waste codes, at a minimum. Waste designation and corresponding waste profiles are completed by the Waste

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
				Management Representative. The waste profiles are documented on the WPLIS.
ARAR: "Excluded Categories of Waste" WAC 173-303-071	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Describes those categories of wastes that are excluded from the requirements of WAC 173-303 (excluding WAC 173-303-050), because they are generally not dangerous or are regulated under other state and federal programs or are recycled in ways that do not threaten public health or the environment.	Wastes generated from the 200-ZP-1 OU remedial action will be reviewed against the categories identified in WAC 173-303-071.	O& M Plan Appendix B-Waste Management Plan for the 200-ZP-1 OU Remedial Action-Waste designation and corresponding waste profiles are completed by the Waste Management Representative. The waste profiles are documented on the WPLIS.
ARAR: "Conditional Exclusion of Special Wastes" WAC 173-303-073	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Establishes the conditional exclusions and the management requirements of special wastes, as defined in WAC 173-303-040.	IDW and RW generated during the remedial action will be reviewed against these exclusions.	O& M Plan Appendix B - Waste Management Plan for the 200-ZP-1 OU Remedial Action -Waste designation and corresponding waste profiles are completed by the Waste Management Representative. The waste profiles are documented on the WPLIS.
ARAR: "Requirements for Universal Waste" WAC 173-303-077	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	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.	IDW and RW generated from the 200-ZP-1 OU remedial action will be reviewed against universal waste criteria and will comply with the substantive requirements provided in WAC 173-303-573.	O& M Plan Appendix B-Waste Management Plan for the 200-ZP-1 OU Remedial Action-Waste designation and corresponding waste profiles are completed by the Waste Management Representative. The waste profiles are documented on the WPLIS.
ARAR: "Recycled, Reclaimed, and Recovered Wastes" WAC 173-303-120 Specific subsections: WAC 173-303-120(3) WAC 173-303-120(5)	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	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.	IDW and RW generated from the 200-ZP-1 OU remedial action will be reviewed against the requirements for recyclable materials. If recyclable materials are generated, they will be managed according to the substantive requirements of WAC 173-303-120(3).	O&M Plan Appendix B-Waste Management Plan for the 200-ZP-1 OU Remedial Action-Waste designation and corresponding waste profiles are completed by the Waste Management Representative. The waste profiles are documented on the WPLIS.
ARAR: "Land Disposal Restrictions" WAC 173-303-140(4)	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Establishes state standards for land disposal of dangerous waste and incorporates, by reference, the Federal restrictions of 40 CFR 268 that are relevant and appropriate to solid waste that is designated as dangerous or mixed waste. The requirements prohibit the placement of restricted RCRA hazardous waste in land-based units such as landfills surface impoundments, and waste piles until treated to standards considered protective for disposal. Specific treatment standards are included in requirements.	200-ZP-1 OU RW and IDW dangerous waste destined for onsite land disposal will be managed in accordance with these restrictions.	Treatment residuals disposal/treatment occurs on an as needed basis and will follow applicable waste management functions identified in the O&M Plan Appendix B-Waste Management Plan for the 200-ZP-1 OU Remedial Action. Waste designation and corresponding waste profiles are completed by the Waste Management Representative. The waste profiles are documented on the WPLIS. Waste acceptance criteria for disposal at ERDF including LDRs are provided in WCH-191, Environmental Restoration Disposal Facility Waste Acceptance Criteria.

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
ARAR:–"Requirements of Generators of Dangerous Wastes" Secondary containment for tank systems and ancillary equipment WAC 173-303-170 and WAC 173-303-200	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Establishes the requirements for dangerous waste generators. For purposes of this remedial action, WAC 173-303-170(3) includes the substantive provisions of WAC 173-303-200 by reference. WAC 173-303-200 further includes certain substantive standards from WAC 173-303-630 and -640 by reference. These requirements include the substantive portions of WAC 173-303-630 ("Use and Management of Containers") and WAC 173-303-640 ("Tank Systems"). Dangerous waste will be treated by the selected remedy, thus the substantive portions of WAC 173-303-640(4), "Containment and Detection of Releases (from Tank Systems)," apply to key design and operational requirements: Secondary containment for new tank systems and ancillary equipment which includes the collection piping must be provided with secondary containment **except for** the following: aboveground piping that is visually inspected for leaks daily. A variance from daily inspections may be obtained per the requirements of WAC 173-303-640 (4) (9) and as approved by Ecology.	IDW and RW generation actions will meet the substantive requirements of WAC 173-303-170 and-200. Aboveground piping in the 200-ZP-1 OU without secondary containment will be visually inspected and recorded in accordance with these requirements, and approved variances.	Daily inspection of applicable piping will be completed until request for variance has been approved.
ARAR: "Corrective Action" WAC 173-303-64620 (4)	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Establishes requirements for Corrective Action for releases of dangerous wastes and dangerous constituents including releases from solid waste management units.	Corrective Action Requirements for the 200-ZP-1 OU will be completed under CERCLA authority. The selected remedy of this ROD meets the State of Washington's requirements as an acceptable final remedy.	Washington's RCRA-authorized *Hazardous Waste Management Act* and dangerous waste regulations give Ecology corrective action jurisdiction over the 200-ZP-1 OU concurrent with CERCLA. As stated in the ROD (Section 10.8 Page 53 State Acceptance), Ecology supports and accepts the 200-ZP-1 OU remedy under the Tri-Party Agreement and the CERCLA program as satisfying Corrective Action requirements.
ARAR: "On-site Storage, Collection and Transportation Standards" WAC 173-350-300	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Establishes requirements for the onsite storage of solid wastes that are not radioactive or dangerous wastes. Establishes the requirements for managing temporary storage of solid waste in onsite containers and the collection and transportation of solid waste.	Solid Wastes generated from the 200-ZP-1 OU solid wastes will be stored onsite and managed in leak proof containers that meet the substantive requirements of this standard. IDW and RW solid wastes stored in the 200-ZP-1 OU will meet the substantive requirements of this standard.	O&M Plan Appendix B-Waste Management Plan for the 200-ZP-1 OU Remedial Action-200-ZP-1 IDW and RW solid wastes stored onsite will be managed to meet the requirements of this standard. Wastes destined for solid waste landfills shall also meet applicable requirements. Non-dangerous waste storage areas will be inspected monthly or at the frequency defined in the Waste Control Plan that was developed for IDW O&M Plan Appendix B-Waste Management Plan for the 200-ZP-1 OU Remedial Action-Non-dangerous solid wastes will be accumulated in safe and sanitary containers and will be inspected monthly or at the frequency defined in the Waste Control Plan. Waste accumulation, staging, storage, profile, packaging, and labeling details for each waste is documented on the WPLIS.

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
		Air Emissions		
"National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities" ARAR: WAC-246-247-035(1)(a)(ii)	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Incorporates requirements of 40 CFR 61, Subpart H by reference. Requires that emissions of radionuclides to the ambient air from DOE facilities shall not exceed amounts that would cause any member of the public to receive in any year an effective dose equivalent of >10 mrem/yr.	200-ZP-1 OU emission control equipment will meet the substantive requirements of these standards The emission control equipment for radionuclides include: • Ion exchange columns to remove technetium-99, uranium, and iodine-129.	O&M Plan Appendix C-Air Monitoring Plan for the 200-ZP-1 OU Remedial Action has results that show control equipment is consistent with applicable best or reasonably achieved control technologies. The DOE Guide, Calculating Potential-to-Emit Radionuclide Releases and Doses (DOE/RL-2006-29), was used to calculate the unabated release potential for radiological constituents. The modeled results show that potential radionuclide emissions are determined be from a minor source per WAC 246-247. Periodic confirmatory measurement will be used to monitor radiological emissions that consist of engineering calculations combined with the Hanford Site Near Facility Monitoring Program results (HNF-EP-0538, June 2008) which is summarized in an annual environmental monitoring report. Notification will be provided to EPA in the event any air sample that exceeds 10% of the values listed in Table 2 of Appendix E in the Code of Federal Regulations Title 40 Part 61, as measured in the Hanford Near Facility ambient air monitors.
ARAR: "General Standards for Radioactive Emissions" WAC 246-247-040 WAC 246-247-040(3) **ARAR:** Monitoring, Testing and Quality Assurance" WAC 246-247-040(4) WAC 246-247-075 (1)(2)(3)(4)(8)	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Requires that emissions be controlled to assure radiation emission standards are not exceeded from new construction and existing sources. Establishes monitoring, testing, and quality assurance requirements for emissions.	200-ZP-1 OU emission control equipment will meet the substantive requirements of these standards. The emission control equipment for radionuclides include: • Ion exchange columns to remove technetium-99, uranium, and iodine-129. DOE Guide, Calculating Potential-to-Emit Radionuclide Releases and Doses (DOE/RL-2006-29) was used to calculate the unabated release potential for radiological constituents. Modeled results show that potential radionuclide emissions are determined to be from a minor source as described in WAC 246-247.	Periodic confirmatory measurement, as described in O&M Plan Appendix D–200 West Area Groundwater Treatment Facility Sampling and Analysis Plan, will be used to confirm l emissions do not exceed criteria. Measurements consist of engineering calculations combined with the *Hanford Site Near-Facility Environmental Monitoring Program* (HNF-EP-0538) which is summarized in an annual environmental monitoring report. Existing near facility monitoring network will be used. Monitoring locations will be added if needed.
ARAR: "Ambient air quality standards and emission limits for radionuclides" WAC 173-480-050(1) **ARAR:** "Emission Monitoring and Compliance Procedures" WAC 173-480-070(2) (ARARs)	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Radionuclide emission control units are required to meet the emission standards identified in WAC 246-247 (as applicable). Requires every reasonable effort to maintain radioactive materials in effluents to unrestricted areas as low as reasonably achievable (ALARA). Control equipment of facilities operating under ALARA shall be defined as reasonably achievable control technology (RACT). Requires compliance with the public dose standard by calculating exposure (in curies) at maximum point of exposure and compare to public dose standard.	200-ZP-1 OU emission control equipment to assure radiation emission standards are not exceeded include: • Ion exchange columns to remove technetium-99, uranium and iodine-129. DOE Guide, *Calculating Potential-to-Emit Radionuclide Releases and Doses (*DOE/RL-2006-29*)* was used to calculate the unabated release potential for radiological constituents. Modeled results show that potential radionuclide emissions are determined to be from a minor source per WAC 246-247.	Periodic confirmatory measurement as described in O&M Plan Appendix C-Air Monitoring Plan for the 200-ZP-1 OU Remedial Action will be used to confirm emissions do not exceed criteria. Measurements consist of engineering calculations combined with The Hanford Site Near-Facility Environmental Monitoring Program results (HNF-EP-0538, June 2008) which is summarized in an annual environmental monitoring report. Existing near facility monitoring network will be used with monitoring locations added if needed.

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
ARAR: "General regulations for Air Pollution Sources" WAC 173-400-040 **ARAR:** "General Regulations for Maximum Emissions" WAC 173-400-113	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Requires all sources of air contaminants to meet emission standards for visible, particulate, fugitive, odors, and hazardous air emissions. Requires use of reasonably available control technology. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	200-ZP-1 OU emission control equipment to assure air toxics emission standards are not exceeded include: • Anaerobic fluidized bed bio-reactor for removal of nitrate, metals and carbon tetrachloride. • Aerobic membrane bed reactor for removal of residual carbon substrate, total suspended solids, biomass and carbon tetrachloride. • Packed-bed tower air stripper to remove remaining carbon tetrachloride and other volatile organic compounds. • Off-gas from the air stripper, fluidized bed reactor, membrane bed reactor and sludge thickener will be comingled and treated by granular activated carbon prior to discharge via powered exhaust. • Biomass sludge will be treated with lime to reduce odors and ammonia. A scrubber will be used to remove ammonia.	As described in O&M Plan, Appendix C-Air Monitoring Plan for the 200-ZP-1 OU Remedial Action, and Appendix D–200 West Area Groundwater Treatment Facility Sampling and Analysis Plan, quarterly sampling for annual determination of compliance with SQERs and acceptable source impact levels (ASILs) will be performed. Sample results will be documented in the Performance Monitoring Report Additional modeling to confirm compliance with ASILs will be completed if emissions exceed calculated/ modeled values.
ARAR: "Controls for New Sources of Toxic Air Pollutants WAC 173-460 Specific subsections: WAC 173-460-030 WAC 173-460-060 **ARAR:** "Ambient Impact Requirement" WAC 173-460-070	ROD Appendix A, Table A-2 and Approved RD/RA Work Plan Appendix A, Table A.	Requires that new sources of air emissions meet emission requirements. The owner/operator of a new toxic air pollutant source that is likely to increase toxic air pollutant emissions shall demonstrate that emissions from the source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects.	200-ZP-1 OU new emission control equipment to assure toxics emission standards are not exceeded include: • Anaerobic fluidized bed bio-reactor for removal of nitrate, metals and carbon tetrachloride. • Anaerobic membrane bed reactor for removal of residual carbon substrate, total suspended solids, biomass and carbon tetrachloride. • Packed-bed tower air stripper to remove remaining carbon tetrachloride and other volatile organic compounds. • Off-gas from the stripper, fluidized bed reactor, membrane bed reactor and sludge thickener will be comingled and treated by granular activated carbon prior to discharge via powered exhaust. • Biomass sludge will be treated with lime to reduce odors and ammonia. A scrubber will be used to remove ammonia.	As described in O&M Plan, Appendix C-Air Monitoring Plan for the 200-ZP-1 OU Remedial Action and Appendix D–200 West Area Groundwater Treatment Facility Sampling and Analysis Plan, quarterly sampling will be performed for annual determination of compliance with SQERs and ASILs. Sample results will be documented in the Performance Monitoring Report. Additional modeling to confirm compliance with ASILs would be completed if emissions exceed calculated/modeled values.
		Environmental and Cultural		
ARAR: *Endangered Species Act of 1973* 16 U.S.C.1531(a), et seq. and 16 U.S.C. 1536(c)	ROD Appendix A, Table A-1 and Approved RD/RA Work Plan Appendix A, Table A.	Prohibits actions by Federal agencies that are 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.	Results from previous surveys documented in ECR-2009-200-22/23. *Hanford Draft Tank Closure and Waste Management EIS for the Hanford Site, Richland Washington*, (DOE/EIS-0391 October 2009). Compliance procedures with EIS requirements are established in *Ecological Compliance Assessment Management Plan* (DOE/RL-95-11 Rev. 2-September 2006) and *Hanford Site Biological Resources Management Plan* (DOE/RL-96-32, 2001).	Evidence of listed species and/or their critical habitat requires a Request for Cultural and/or Ecological Resources Review (Hanford Form RL-655). Responsibility for conducting the Ecological Compliance Review (ECR) Is assigned to the PNNL. Actions requiring an ECR include: 1) if project occurs outside of a building, 2) if biota are present at the affected site, or 3) if an excavation permit is required for the action.

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details
ARAR: *Native American Graves Protection and Repatriation Act*, 25 U.S.C. 3001, et seq.	ROD Appendix A, Table A-1 and Approved RD/RA Work Plan Appendix A, Table A.	Establishes federal agency responsibility for discovery of human remains, associated and unassociated funerary objects, sacred objects, and items of cultural patrimony. Requires Native American Tribal consultation in the event of discovery.	Comprehensive archaeological resource surveys of the fenced portions of the 200 Areas indicate minimal resources exist in project area (Hanford Draft Tank Closure and Waste Management EIS for the Hanford Site, Richland Washington, DOE/EIS-0391 October 2009). Compliance procedures with cultural and archaeological requirements are provided in *Hanford Cultural Resources Management Plan* (DOE/RL-98-10).	Expansion of 200-ZP-1 groundwater OU remedial action activities to areas beyond those previously surveyed require a Cultural Resource Review Request (Hanford Form RL-655) from PNNL.
ARAR: Archaeological and Historic Preservation Act,16 U.S.C. 469 aa-mm, et seq.	ROD Appendix A, Table A-1 and Approved RD/RA Work Plan Appendix A, Table A.	Requires that remedial actions at the 200-ZP-1 OU do not cause the loss of any archaeological or historic data. This act mandated preservation of data and does not require protection of the actual historical sites.	Comprehensive archaeological resource surveys of the fenced portions of the 200 Areas indicate minimal resources exist in project area. (Hanford Draft Tank Closure and Waste Management EIS for the Hanford Site, Richland Washington, DOE/EIS-0391 October 2009). Compliance procedures with cultural and archaeological requirements are provided in *Hanford Cultural Resources Management Plan* (DOE/RL-98-10).	Expansion of 200-ZP-1 groundwater OU remedial action activities to areas beyond those previously surveyed require a Cultural Resource Review Request (Hanford Form RL-655) from PNNL.
ARAR: National Historic Preservation Act of 1966, 16 U.S.C. 470, Section 106, et seq.	ROD Appendix A, Table A-1 and Approved RD/RA Work Plan, Appendix A, Table A.	Requires Federal agencies to consider the impacts of their undertaking on cultural properties through identification, evaluation, and mitigation processes.	Comprehensive archaeological resources surveys of the fenced portions of the 200 Areas indicate minimal resources exist in project area. (Hanford Draft Tank Closure and Waste Management EIS for the Hanford Site, Richland Washington, DOE/EIS-0391 October 2009). Compliance procedures with cultural and archaeological requirements are provided in *Hanford Cultural Resources Management Plan* (DOE/RL-98-10).	Expansion of 200-ZP-1 OU groundwater OU remedial action activities to areas beyond those previously surveyed require a Cultural Resources Review Request (Hanford Form RL-655) from PNNL.

Table A2-1. 200 West Area Groundwater Pump and Treat Remedial Action Compliance Monitoring Plan

Remedy Compliance Element	Source	Compliance Requirement and Responsibility	Implementation Methods/Source Documents	Status/Schedule and Reporting Details

Notes:

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
ASIL = acceptable source impact level
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC = contaminant of concern
CWC = Central Waste Complex
DOE = U.S. Department of Energy
ECR = ecological compliance review
EIS = Environmental Information System
EPA = U.S. Environmental Protection Agency
ERDF = Environmental Restoration and Disposal Facility
ESD = explanation of significant difference
GAC = granular activated carbon
IC = institutional control
IDW = investigation-derived waste
LDR = land disposal restrictions
LD = lethal dose
MCL = maximum contaminant level
MCLG = maximum contaminant level goal
MNA = monitored natural attenuation
NAPL = nonaqueous-phase liquid
NCP = "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300)
NPL = "National Priorities List" (40 CFR 300, Appendix B)
O&M = operations and maintenance
OSWER = Office of Solid Waste and Emergency Response
OU = operable unit
PNNL = Pacific Northwest National Laboratory
RACT = reasonably achievable control technology
RCRA = *Resource Conservation and Recovery Act of 1976*
RD/RA = remedial design/remedial action
ROD = record of decision
RW = remediation waste
SAP = Sampling and Analysis Plan
SQER = Small Quantity Emission Rate
UIC = underground injection control
WAC = *Washington Administrative Code*
WMP = Waste Management Plan
WPLIS = Waste Packaging and Labeling Instruction Sheet

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A3 References

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Appendix B

Waste Management Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action

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Contents

Figures

Tables

Terms

AL	authorized limit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CWC	Central Waste Complex
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
GAC	granular activated carbon
IDW	investigation-derived waste
IX	ion exchange
MSW	miscellaneous solid waste
NA	not assigned
O&M	operations and maintenance
OU	operable unit
P&T	pump-and-treat
PSTF	Purgewater Storage and Treatment Facility
ROD	record of decision
RW	remediation waste
WAC	*Washington Administrative Code*
WMP	waste management plan

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B1 Purpose

This waste management plan (WMP) establishes the requirements for management and disposal of investigation-derived waste (IDW) and remediation waste (RW) generated from construction and operation of the 200 West Area groundwater pump-and-treat (P&T) facility.

The 200 West Area groundwater P&T system is being constructed to capture and treat contaminated groundwater in the 200-ZP-1 operable unit (OU) as required in the *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington* (hereinafter referred to as the ROD) (EPA et al. 2008). The system will be designed, installed, and operated as generally defined in DOE/RL-2008-78, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan.*

The 200 West Area groundwater P&T system involves pumping groundwater from a network of extraction wells, and treating the contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium, e.g., trivalent (CrIII) and hexavalent (CrVI), nitrate, trichloroethylene, iodine-129, technetium-99, and other constituents within the 200-ZP-1 OU. Treated water, cleaned up to the levels specified by the ROD, will be injected into the aquifer through a network of injection wells. The mass of contaminants removed from the treated water will constitute waste streams that will require appropriate characterization prior to disposal. The waste generated by this remedial activity is considered RW and is managed in accordance with waste management requirements as established in the ROD (EPA et al., 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington*).

This document also includes the requirements for management and disposal of IDW generated from the installation, monitoring, sampling, maintenance, and decommissioning of wells at the 200-ZP-1 OU in accordance with Ecology et al., 1999, *Environmental Restoration Program Strategy for Management of Investigation Derived Waste.*

Table B1-1, Table B1-2, and Table B1-3 provide the well numbers, and Figure B1-1, Figure B1-2, and Figure B1-3 illustrate the well locations at the 200-ZP-1 OU. If additional wells are identified to support groundwater monitoring or remediation activities, this WMP will be updated. If revisions to the WMP are necessary, they will be made on an annual basis.

Table B1-1. 200-ZP-1 Operable Unit Groundwater Wells

299-W10-1	299-W11-87	299-W15-763
299-W10-10	299-W11-88	299-W15-8
299-W10-13	299-W12-1	299-W15-83
299-W10-14	299-W13-1	299-W15-9
299-W10-15	299-W14-11	299-W15-94
299-W10-16	299-W14-13	299-W17-1
299-W10-17	299-W14-14	299-W18-1
299-W10-19	299-W14-15	299-W18-10
299-W10-2	299-W14-16	299-W18-11
299-W10-20	299-W14-17	299-W18-12

Table B1-1. 200-ZP-1 Operable Unit Groundwater Wells

299-W10-21	299-W14-18	299-W18-16
299-W10-22	299-W14-19	299-W18-23
299-W10-23	299-W14-5	299-W18-24
299-W10-24	299-W14-6	299-W18-27
299-W10-26	299-W14-72	299-W18-28
299-W10-27	299-W15-1	299-W18-3
299-W10-28	299-W15-11	299-W18-36
299-W10-29	299-W15-14	299-W18-38
299-W10-30	299-W15-15	299-W18-39
299-W10-31	299-W15-152	299-W18-6
299-W10-33	299-W15-16	299-W18-7
299-W10-4	299-W15-17	299-W18-9
299-W10-5	299-W15-2	299-W6-10
299-W10-8	299-W15-224	299-W6-11
299-W11-10	299-W15-29	299-W6-12
299-W11-12	299-W15-3	299-W6-2
299-W11-14	299-W15-30	299-W6-3
299-W11-18	299-W15-31A	299-W6-4
299-W11-22	299-W15-32	299-W6-6
299-W11-26	299-W15-33	299-W6-7
299-W11-28	299-W15-34	299-W6-9
299-W11-29	299-W15-35	299-W7-1
299-W11-3	299-W15-36	299-W7-10
299-W11-30	299-W15-38	299-W7-11
299-W11-31	299-W15-39	299-W7-12
299-W11-37	299-W15-40	299-W7-2
299-W11-39	299-W15-41	299-W7-3
299-W11-40	299-W15-42	299-W7-4
299-W11-41	299-W15-43	

Table B1-2. 200 West Area Pump-and-Treat Wells

Well Code	Well ID	Well Number
Extraction Wells		
EW-1	C7017	299-W15-225
EW-2	C7018	299-W14-20
EW-3	C7021	299-W14-73
EW-4	C7024	299-W14-74
EW-5	C7027	299-W12-2
EW-6	C7020	299-W11-50
EW-7	C7022	299-W11-90
EW-8	C7026	299-W11-93
EW-9	C7577	299-W17-3
EW-10	C7576	299-W17-2
EW-11	NA	NA
EW-12	C7019	299-W11-49
EW-13	NA	NA
EW-14	NA	NA
EW-15	C7494	299-W14-21
EW-16	NA	NA
EW-17	NA	NA
EW-18	C7028	299-W12-3
EW-19	C7029	299-W12-4
EW-20	C7030	299-W14-22
Injection Wells		
IW-1	NA	NA
IW-2	NA	NA
IW-3	NA	NA
IW-4	C7573	299-W10-35
IW-5	C7574	299-W15-226
IW-6	C7575	299-W15-227
IW-7	NA	NA
IW-8	NA	NA
IW-9	C7577	299-W17-3

Table B1-2. 200 West Area Pump-and-Treat Wells

Well Code	Well ID	Well Number
IW-10	NA	NA
IW-11	C7578	699-45-67
IW-12	NA	NA
IW-13	C7579	699-43-67
IW-14	NA	NA
IW-15	NA	NA
IW-16	NA	NA

Notes:

NA = not assigned

Table B1-3. Interim Remedial Measure Pump-and-Treat Wells

Extraction Wells	Injection Wells
299-W15-1	299-W15-29
299-W15-6	299-W18-36
299-W15-7	299-W18-37
299-W15-11	299-W18-38
299-W15-34	299-W18-39
299-W15-35	
299-W15-36	
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299-W15-47	

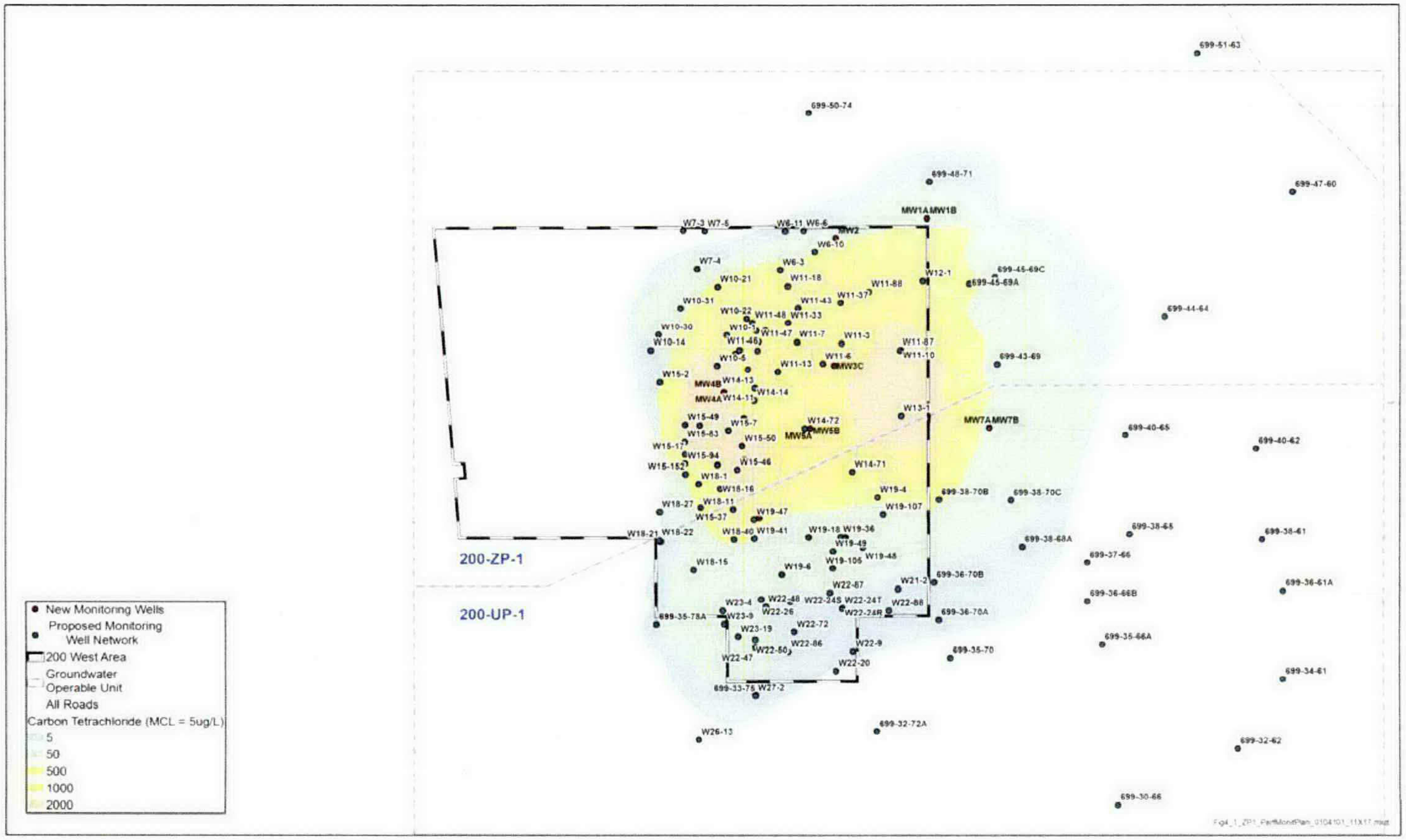

Figure B1-1. Proposed New and Existing 200-ZP-1 Operable Unit Groundwater Well Locations

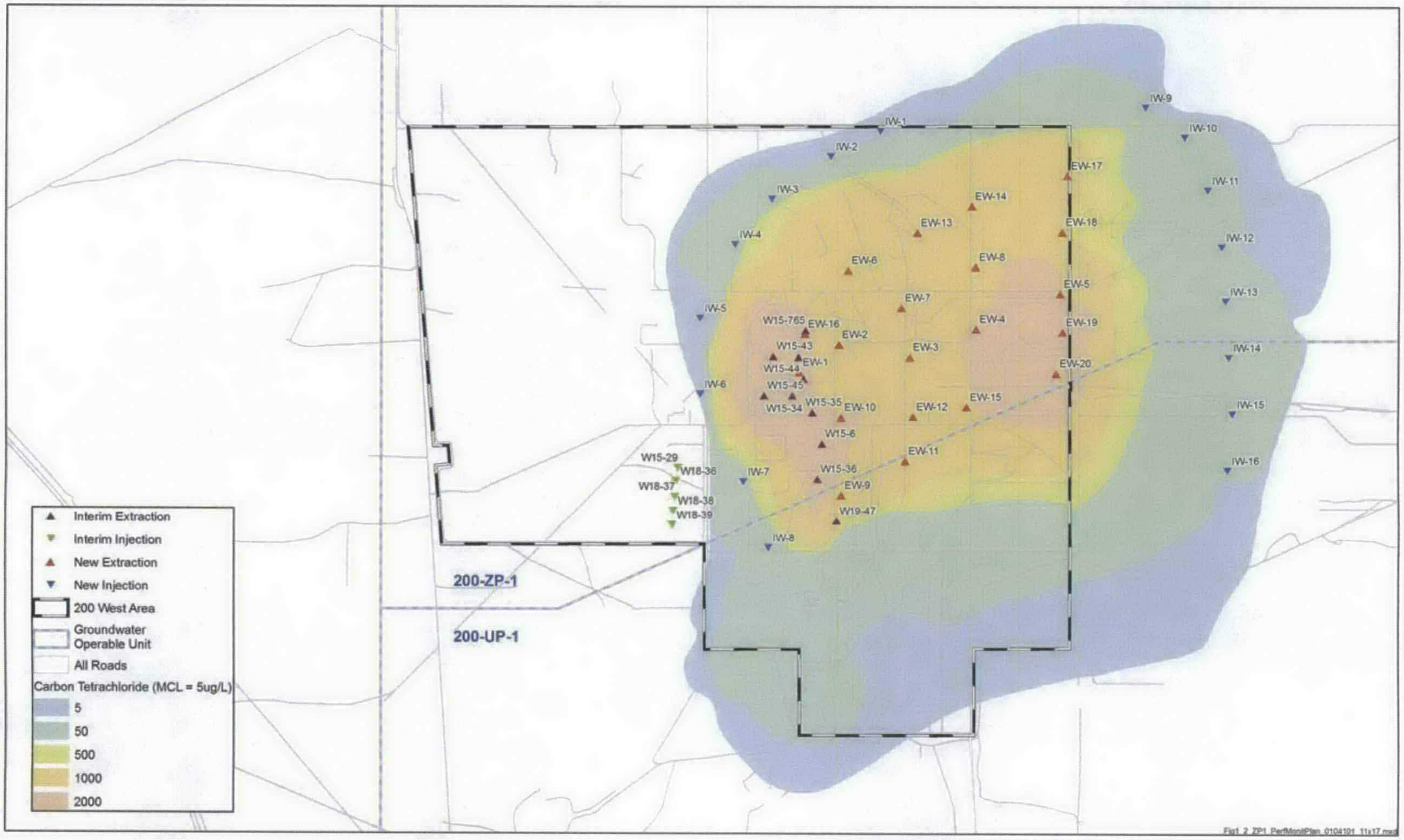

Figure B1-2. Proposed 200 West Area Groundwater Pump-and-Treat Well Locations

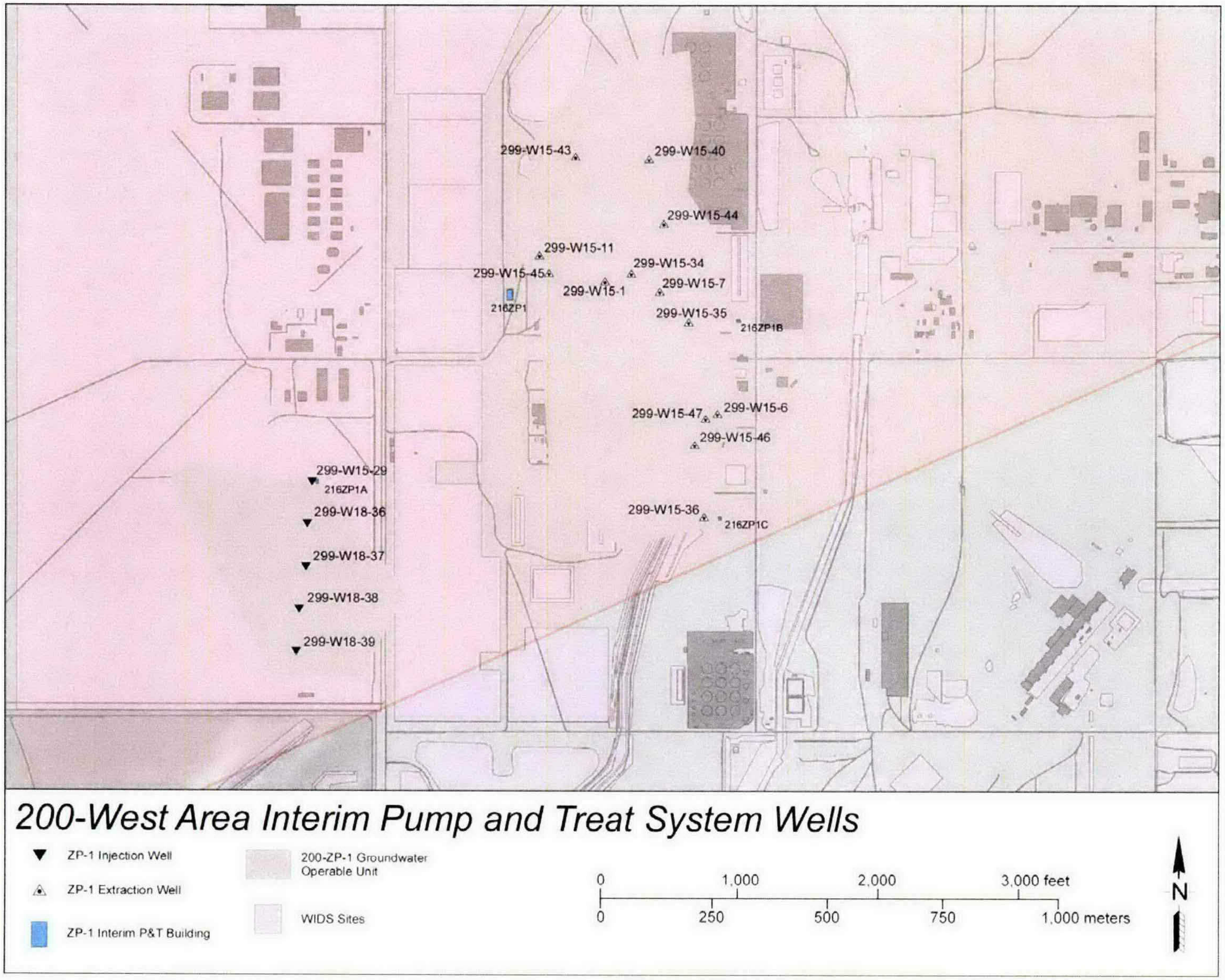

Figure B1-3. Interim Remedial Measure Pump-and-Treat Well Locations

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B2 Waste Generation Activities and Projected Waste Streams

The following activities are expected to generate waste subject to the requirements of this WMP:

- Construction, modification, and operations and maintenance (O&M) of the 200 West Area groundwater P&T system.
- Installation, development, testing, monitoring, sampling, O&M, and decommissioning of groundwater monitoring, extraction, and injection wells.
- Subsurface characterization activities.
- Decontamination of equipment, tools, and material.

The following waste streams are likely to be generated from the investigation and remediation activities described above:

- Loaded and spent granular activated carbon (GAC), resin, sludge, and filter elements. Loaded GAC has reached its sorption capacity, is in good physical condition, and is able to be regenerated. Spent GAC has reached its sorption capacity and is no longer capable of being regenerated.
- Biosolids.
- Drill cuttings (vadose and saturated zone soil).
- Miscellaneous solid waste (MSW) (e.g., paper, wipes, personal protective equipment, cloth, tools, pumps, metal, and plastic).
- Decommissioning debris (e.g., concrete, wood, rebar, metal/plastic pipe and screens, wire, bentonite, sand, gravel, equipment, pumps, and tanks).
- Equipment and construction materials (e.g., well casing, drill strings, drive barrels, construction equipment and material, sampling equipment, and wooden pallets).
- Spent or expired chemicals/reagents and used oil.
- Unplanned releases and associated cleanup material.
- Liquids include, but are not limited to, the following:
  - Purgewater generated during well installation, development, testing, sampling, monitoring, maintenance, decommissioning, and decanting of saturated zone soil and water drained from GAC
  - Algae treatment fluid
  - Decontamination fluid
  - Liquid from sample analysis and screening
  - Liquid from unplanned release
- Sampling-related waste from any field laboratory (if used) testing as well as other Hanford Site laboratory 200-ZP-1 OU sample returns.
- Treatability test waste in support of the remedial action and P&T process.

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B3 Waste Management Requirement

200-ZP-1 OU IDW and RW will be managed in accordance with this WMP and the applicable federal and state regulations. Every effort will be made to minimize waste generated from investigation and remediation activities.

B3.1 Waste Generation

All waste generated from drilling activities will be recorded in the geologist's and/or the Buyer's Technical Representative's logbook, with such details as the location and type of waste, depth of sample, date of initial placement into container, date container was sealed, and Package Identification Number.

B3.2 Waste Packaging and Labeling

Waste packaging and labeling will be performed in accordance with a Waste Packaging and Labeling Instruction Sheet or as directed by the Waste Management Specialist.

Packaging and labeling during storage and transportation must meet *Washington Administrative Code* (WAC) requirements (WAC 173-303, "Dangerous Waste Regulations") and U.S. Department of Transportation (DOT) requirements, as appropriate. For onsite waste shipments, non-DOT packaging may be used if the container will provide an equivalent degree of safety and approval documents are in place. Materials requiring collection will be placed in containers appropriate for the material and the receiving facility. DOT approved drums may be used for some materials (e.g., drill cuttings); however, packaging and containment for large or irregular waste or large volume waste (e.g., GAC and resin) may require containers other than drums. The packaging and containment may include, but is not limited to, plastic wrap, 4 ft by 4 ft by 8 ft boxes, Environmental Restoration Disposal Facility (ERDF) Roll-On/Roll-Off containers and GAC canisters.

Waste generated from groundwater monitoring activities such as well sampling, well maintenance, well decommissioning, and geophysical logging will be bagged, taped, and labeled with the well number and the date the waste was generated. The bagged material will be transported in a protective manner (i.e., containment of the material is maintained) while proceeding from well to well in the OU. Waste bags will be placed in appropriate containers and stored at the OU established storage location, or may also be disposed directly at ERDF without storage, as directed by the Waste Management Specialist.

Containers will be labeled and marked appropriately to match the waste designation established for each waste stream. The containers will be labeled as either IDW or RW. The containers will be sealed and shipped to the identified disposal facility or storage area.

B3.3 Waste Storage

Segregation and staging of waste containers/packages will be performed in accordance with the Waste Packaging and Labeling Instruction Sheet or as directed by the Waste Management Specialist. The amount of waste stored at the storage area should be kept to a minimum. Full containers should be prepared for disposal as quickly as economically feasible. Designated dangerous waste will be stored in a temporary storage area meeting substantive requirements of WAC 173-303-630, "Use and Management of Containers." *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) waste, and waste awaiting sampling in the temporary storage areas, will be inspected weekly. Non-dangerous waste storage areas will be inspected monthly or at the frequency directed by the Waste Management Specialist.

RW waste (e.g., resin, sludge, spent GAC, bag filters, and MSW) destined for disposal, and loaded GAC for offsite regeneration, will be stored on the pad within the 200 West Area groundwater P&T system boundary for up to one year (Figure B3-1).

The IDW waste (e.g., drill cuttings) may be temporarily accumulated near the point of generation, and then moved to the central waste storage location while awaiting analytical laboratory test results (Figure B3-2). If IDW must be stored for longer than 6 months after designation, concurrence from the lead regulatory agency will be obtained on storage, treatment, and disposal options of the waste along with the disposition schedule.

Radioactive waste will be managed separately from nonradioactive waste. The containers bearing radioactive waste will be sealed, labeled, and shipped to the appropriate identified disposal facility in accordance with the criteria established for the respective material. The U. S. Department of Energy (DOE) is evaluating the need for ion exchange (IX) resin stabilization. If DOE elects to proceed with IX resin stabilization, the WMP will be revised accordingly.

B3.4 Waste Designation

Waste will be designated in accordance with WAC 173-303 using process knowledge, historical analytical data, and laboratory analyses. According to CCN 081034, *Application of Listed Waste Codes to Secondary Solid Waste Related to Well Construction, Maintenance and Sampling*, groundwater associated with the 200-ZP-1 OU has been determined to carry the following listed waste codes:

- F001 - (carbon tetrachloride, 1,1,1 trichloroethane)
- F002 - (methylene chloride)
- F003 - (acetone, methyl isobutyl ketone)
- F004 - [cresols and cresylic acid (o-cresols and p-cresols)]
- F005 - (methyl ethyl ketone)

Therefore, IDW and RW that come into contact with 200-ZP-1 OU contaminated groundwater will also carry F001 through F005 listed waste codes.

B3.5 Waste Disposal

IDW and RW generated at the 200-ZP-1 groundwater OU may be disposed at ERDF if the wastes meet ERDF waste acceptance criteria as defined in WCH-191, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, and 0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility*. Waste that does not meet the ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility. If additional treatment is deemed necessary, treatment options will be evaluated based on the characteristics of the waste and concentration reduction requirements. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex (e.g., Central Waste Complex [CWC]) as authorized by the U.S. Environmental Protection Agency (EPA). In accordance with the *Code of Federal Regulations* (CFR), 40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions," an offsite determination is also required prior to shipment of waste to the CWC.

B3.6 Records

Original copies of all waste inventory documentation will be forwarded to the assigned Waste Management Specialist to be included in the waste file and to initiate waste tracking in the Solid Waste Information Tracking System. The completed waste files will be included in the project file following final waste disposition in accordance with applicable records management processes.

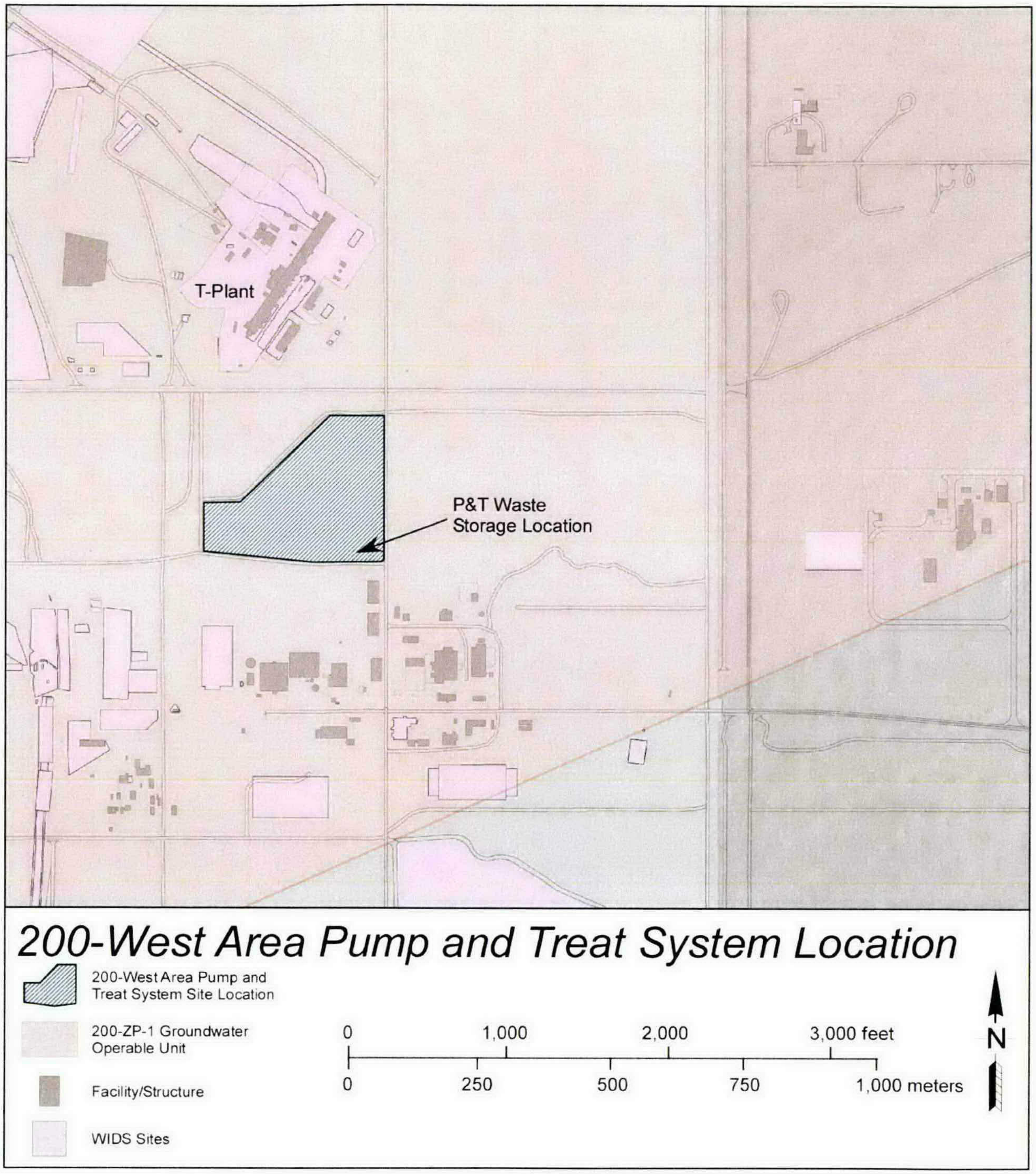

Figure B3-1. 200 West Area Pump-and-Treat System Waste Storage Location

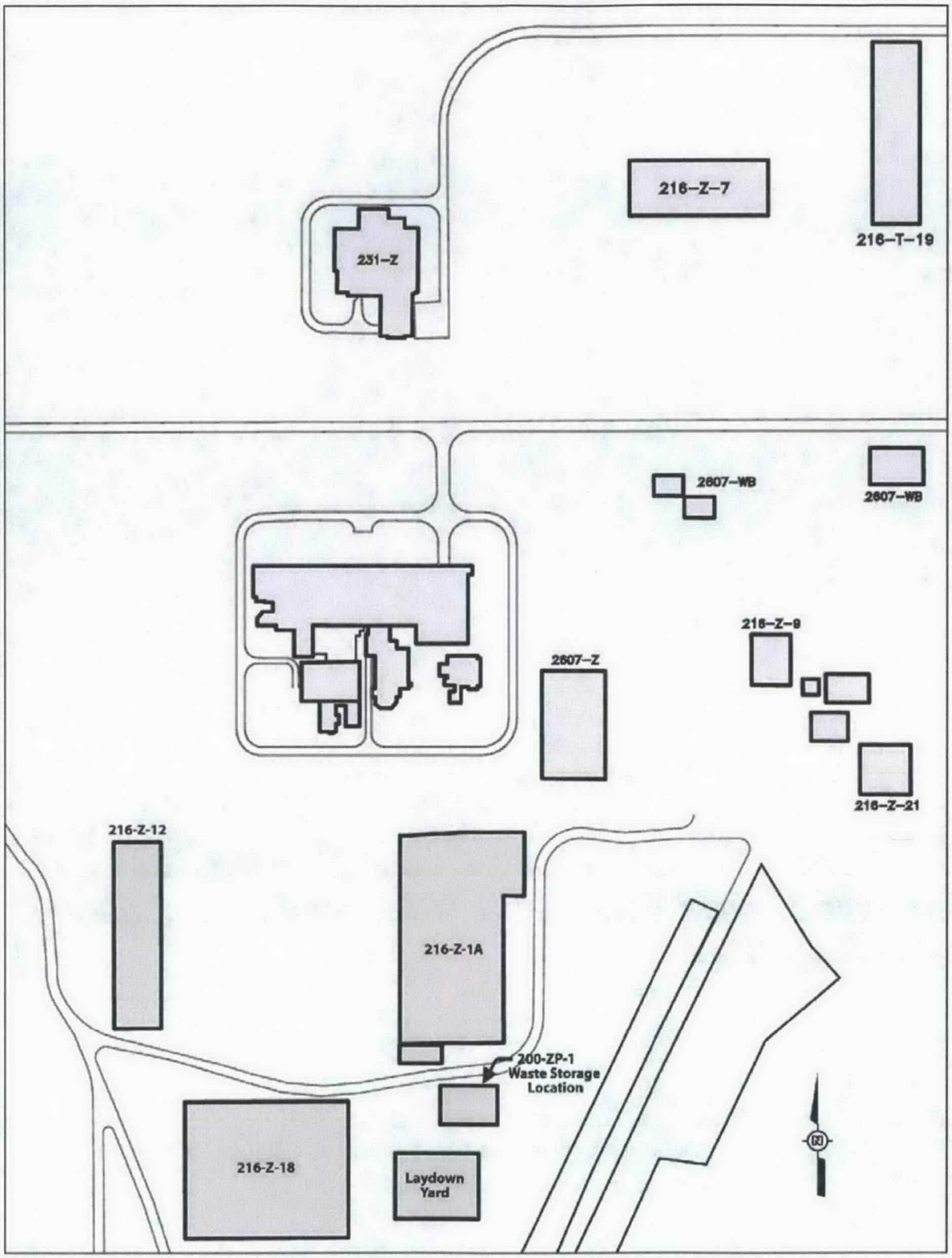

Figure B3-2. 200-ZP-1 Operable Unit Waste Storage Location

B4 Stream-Specific Waste Management Requirement

Specific waste management guidance for each projected waste stream is provided below.

B4.1 Loaded and Spent Granular Activated Carbon

Loaded GAC may be sent offsite for regeneration at an EPA-approved facility, Siemens Water Technologies in Parker, Arizona. The GAC may be re-used in the treatment system in accordance with 40 CFR 300.440. The GAC sent offsite must meet the authorized limit (AL) requirements listed in 09-SED-0003, "Contract No. DE-AC06-08RL14788 – Request for Approval of Use of Authorized Limits for Regeneration of Ion Exchange Resin and Granular Activated Carbon," Attachment 2, "Authorized Limits Approved for Use by CHPRC for Off-Site Shipment and Regeneration of Granular Activated Carbon from the 200-ZP-1 and 200-PW-1 Pump and Treat Operations," as summarized below.

The transfer of the GAC canisters to the offsite regeneration facility constitutes a release from DOE control. Therefore, before this GAC is sent to the regeneration facility, the potential for residual radioactive contamination on the GAC and demonstration of compliance with the requirements of DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, must be assessed. For any potential residual radioactive contamination, DOE Order 5400.5 requires that radiological release criteria (i.e., ALs) be developed and submitted to the applicable DOE field office. DOE Order 5400.5 requires that: *"The authorized limits shall be established to 1) provide that, at a minimum, the basic dose limits ... will not be exceeded*, or 2) *be consistent with applicable generic guidelines."* Since generic guidelines have not been established for volumetric residual radioactivity for the radionuclides of concern for the GAC, the following ALs have been established low enough to ensure that the public dose limit of 100 mrem per year is not approached. If any radionuclide listed in Table B4-1 is detected at an activity greater than the AL shown in Table B4-1, then each canister or drum must be reanalyzed separately for that radionuclide to ensure that the AL is not exceeded for the radionuclide in question.

If the loaded GAC canisters and drums cannot meet the ALs as listed below, the GAC canisters may be disposed at ERDF if they meet ERDF waste acceptance criteria. GAC waste that does not meet ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex. Spent GAC will be similarly evaluated for ERDF disposal and additional treatment if necessary.

B4.2 Filter Elements

The 200 West Area groundwater P&T system has bag filters and other filter elements. Fine particles present in the groundwater collect on the bag filters located in filter housings. The bag filters are removed from the filter housings and replaced as needed to maintain system efficiency. The bag filters are dewatered and transferred into appropriate containers for onsite shipment to the ERDF. Water from the filter removal process will be reintroduced to the influent side of the P&T system.

Table B4-1. Authorized Limits for Off-Site Transfer of 200 West Area Pump-and-Treat Granular Activated Carbon

Radionuclide	Authorized Limit (pCi/g)
Carbon-14	10,000
Cesium-137	250
Tritium	940,000
Iodine-129	170
Neptunium-237	170
Protactinium-231	38
Selenium-79	6,200
Strontium-90	320
Technetium-99	1,600
Uranium-234	360
Uranium-235	390
Uranium-238 + short lived progeny	370

Notes:

pCi/g = picocuries per grams

B4.3 Drill Cuttings

Drill cuttings are considered to be IDW and are managed in accordance with the Ecology et al., 1999, *Environmental Restoration Program Strategy for Management of Investigation Derived Waste.*

Drill cuttings (vadose zone or saturated, suspect, or non-suspect contaminated) will be segregated. Vadose zone drill cuttings may be stockpiled on plastic or placed in containers near the point of generation. To mitigate the potential spread of contaminants to the environment, the cuttings are covered during non-work periods. Soil samples collected during drilling are generally screened using field instruments to determine whether or not the cuttings are contaminated.

As described in procedure GRP-EE-02-14.5, *Returning Vadose Zone Drill Cuttings/Soils to the Environment*, vadose zone drill cuttings that are not designated as dangerous waste in accordance with WAC 173-303, are below WAC 173-340-740 - "Model Toxics Control Act Cleanup – "Unrestricted Land Use Soil Cleanup Standards." Method B cleanup standards that have been determined low risk for radiological contamination and have been released from a radiological perspective may be returned to the environment.

Vadose zone drill cuttings that do not meet the return-to-environment criteria will be disposed at ERDF if ERDF waste acceptance criteria are met. If the acceptance criteria cannot be met, the material will be evaluated for additional treatment at an onsite or offsite facility. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex.

Saturated zone drill cuttings will be placed in containers near the point of generation. Contained drilling slurries (decanted water) will be safely removed from the containers (i.e., suctioned, ladled, or drained), and free liquids greater than 1 percent remaining in the container will be reduced by evaporation and/or stabilized by the addition of sorbent material prior to disposal. Removed drilling slurries will be managed as purgewater.

Drill cuttings will also be sampled in accordance with project-specific sampling and analysis plans, and characterized in accordance with project-specific waste management DQO summary reports.

B4.4 Liquids

Various liquid wastes are generated from the O&M of well-related activities (as described in Section B2) and 200 West Area groundwater P&T system operations.

B4.4.1 Purgewater

Purgewater generated from investigation and remediation activity within the 200-ZP-1 OU will be managed in accordance with *Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington* (90-ERB-076).

Purgewater associated with installation, development, testing, monitoring, sampling, maintenance, and any water decanted from saturated drill cuttings is generally collected in a purgewater truck at the time of generation and transported to the Purgewater Storage and Treatment Facility (PSTF) or the Effluent Treatment Facility (ETF). In instances where this does not occur, such as during drilling activities, the purgewater is stored near the point of generation until the analytical results are returned and/or the proper waste shipping papers are completed for final disposal.

Contaminated groundwater/liquids generated at the 200 West Area groundwater P&T system will be returned to the influent side of the treatment facility, or will be sent to the PSTF or ETF, as appropriate. Small volumes of liquid that have been stabilized may also be disposed at ERDF if the waste meets ERDF waste acceptance criteria. Liquid waste that cannot be pre-treated to meet the ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex.

B4.4.2 Water Drained from Granular Activated Carbon and Resin Geotubes

During replacement/removal of GAC and IX resin at the 200 West Area groundwater P&T system, water may be drained from the GAC and resin geotubes. Water drained from the GAC and resin geotubes will be reintroduced to the influent site of the treatment system.

B4.4.3 Algae Removal Liquids

Water generated during algae removal activities will be contained and sent to PTSF or ETF.

B4.4.4 Decontamination Fluids

Decontamination fluids (i.e., water and/or nonhazardous cleaning solutions) generated from cleaning equipment, tools, and materials will be contained and transported to PSTF or ETF (if the waste acceptance criteria can be met), or other approved facility. Small volumes (generally less than 55 gal) of decontamination fluids may be stabilized to less than or equal to 1 percent free liquid and disposed at the ERDF if the waste acceptance criteria can be met.

Decontamination of some equipment (e.g., split-spoon samplers) may be conducted at the Waste Sampling and Characterization Facility because decontamination and containment systems are already established at this location. The decontamination waste will be managed in accordance with applicable regulations.

B4.4.5 Sample Analysis and Screening Liquids

Unaltered liquid waste (unused groundwater) generated during sample screening and analysis will be managed as purgewater. Altered samples will be contained and disposed at ETF, ERDF, or other appropriate facility depending on the waste designation. Some liquids may be neutralized and/or stabilized to meet the disposal facility's waste acceptance criteria.

B4.4.6 Liquids from Unplanned Releases

Water generated by unplanned releases from the 200 West Area groundwater P&T system will be returned to the influent side of the treatment facility. If liquids cannot be returned to the treatment facility, they will be managed in accordance with the appropriate containment, storage, and disposal requirements. Liquids may be evaporated or stabilized (generally less than 55 gal) and stabilized material transported to the ERDF if the waste acceptance criteria are met.

B4.5 Incidental Solid Waste

Equipment and tools having only incidental non-routine contact with contaminated groundwater will be air dried to remove volatile organic compounds. After the materials have been dried, the equipment/ tools will no longer be considered contaminated with F001 through F005 listed waste, in accordance with WAC 173-303-070(2)(c)(ii).

In addition, water washing, spraying, or high-pressure steam cleaning of equipment and tools with or without nonhazardous cleaning solutions meets the alternative treatment standards for hazardous debris identified in 40 CFR 268.45, "Land Disposal Restrictions," "Treatment Standards for Hazardous Debris," Table 1. These equipment and tools will no longer be considered contaminated with F001 through F005 listed waste, provided the equipment and tools meet the definition of a clean debris surface, as described in 40 CFR 268.45, "Clean debris surface" means that the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste, except that residual staining from soil and waste consisting of light shadows, light streaks, or minor discolorations, and soil and waste in cracks, crevices, and pits may be present, provided that such staining and waste and soil in cracks, crevices, and pits shall be limited to no more than 5 percent of each square inch of surface area."

B4.6 Miscellaneous Solid Waste

MSW may be generated from the construction and O&M activities at the 200 West Area groundwater P&T system. MSW may also be generated from well-related activities. Contaminated and non-contaminated MSW that has contacted potentially contaminated materials will be segregated from other materials. MSW will be placed in containers that are appropriate for the material, the contaminant, and the disposal facility. MSW that has contacted contaminated media may be disposed at the ERDF if the facility's waste acceptance criteria are met. If the waste acceptance criteria cannot be met, the waste will be evaluated for additional treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex. MSW that has not contacted chemically or radiologically contaminated media, and is not WAC 173-303 dangerous waste, may be disposed at an offsite solid waste landfill or recycled if releasable per PRC-PRO-RP-40026, *Standard Radiological Release Surveys for Material and Equipment.*

B4.7 Decommissioning Debris

Decommissioning debris (e.g., concrete, wood, rebar, metal/plastic pipe and screens, wire, bentonite, sand, gravel, equipment, and pumps) is generated during the decommissioning of wells. Debris that has contacted contaminated media may be disposed at the ERDF if the facility's waste acceptance criteria are met. If ERDF waste acceptance criteria cannot be met, the waste will be evaluated for additional treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex. Debris that has not contacted potentially contaminated media, is not WAC 173-303 dangerous waste, and has been radiologically released per PRC-PRO-RP-40026, may be disposed offsite at a solid waste landfill or at an onsite demolition landfill, or the debris may be recycled, as appropriate.

B4.8 Spent or Expired Chemicals/Reagents and Used Oil

Spent or expired chemicals/reagents that are generated during field sampling and analysis, or from the 200 West Area groundwater P&T system operations will be managed, designated, and disposed as appropriate for the specific chemical or reagent. Used oil generated during operation of the treatment systems will be sent offsite for recycling or disposal, as appropriate.

Offsite facilities that receive CERCLA contaminated waste must be approved by EPA in accordance with 40 CFR 300.440. The exceptions are used oil, spent or expired chemical/reagents, and solid waste that has not contacted contaminated media and is recycled or disposed at an offsite solid waste landfill.

B4.9 Sampling Related Waste

Screening and analysis of solid and liquid samples may be conducted in the field during treatment system operations. Once testing is complete, liquid sample material may be returned to the influent side of the treatment system.

B4.10 Treatability Test Waste

Wastes generated by treatability testing is support of the remedial action and P&T process will be managed, designated, and disposed at ETF, ERDF, or other appropriate facilities, depending on the waste designation. If waste acceptance criteria can't be met, the waste will be evaluated for additional treatment at an onsite or offsite facility prior to disposal. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex.

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Appendix C

Air Monitoring Plan

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Contents

Tables

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Terms

AMP	air monitoring plan
ARAR	applicable or relevant and appropriate requirement
ASIL	acceptable source impact level
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
DOE	U.S. Department of Energy
EDE	effective dose equivalent
ERDF	Environmental Restoration Disposal Facility
ROD	record of decision
EPA	U.S. Environmental Protection Agency
gpm	gallons per minute
IX	ion exchange
OU	operable unit
P&T	pump-and-treat
RCW	*Revised Code of Washington*
scfm	standard cubic feet per minute
SQER	small quality emission rate
TAP	toxic air pollutant
USC	United States Code
WAC	*Washington Administrative Code*

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C1 Introduction

The *Record of Decision, Hanford 200 Area, 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al, 2008) requires the design, construction, and operation of a new groundwater pump-and-treat (P&T) facility to clean up contaminants of concern (COCs) in the 200 West Area carbon tetrachloride plume. As required by the record of decision (ROD), the 200 West Area groundwater P&T system will capture and treat contaminated groundwater to reduce the mass of COCs (carbon tetrachloride, total chromium, chromium VI, nitrate, trichloroethylene, iodine-129, and technetium-99 specified in the ROD and other constituents. This Air Monitoring Plan (AMP) is needed because groundwater treatment activities may cause emission of *Washington Administrative Code* (WAC) criteria/toxic compounds (WAC 173-400, "General Regulations for Air Pollution Sources," and WAC 173-460, "Controls for New Sources of Toxic Air Pollutants") to the atmosphere and because there is also a potential for release of radionuclides to the atmosphere such that substantive requirements from WAC 246-247 apply so far as abatement controls and emissions monitoring. These activities will be conducted under the authority of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) in the 200-ZP-1 Operable Unit (OU). Table C-1 identifies other contaminants, not specified in the ROD, which may either be present in the extracted groundwater or may be present as by-products of the treatment processes within the treatment facility. These include tritium; uranium; 1,1,1–trichloroethane; 1,2 dichloroethane; benzene; acetone; chloroform; dibromochloromethane; dichloromethane; 1,1-dichloroethylene; and vinyl chloride.

The treatment system will consist of a radiological processing facility with ion exchange (IX) columns for removal of technetium-99, isotopes of uranium, and iodine-129 (as particulate). The main treatment facility will consist of an anaerobic fluidized bed bioreactor for removal of nitrate, metals, and carbon tetrachloride; an aerobic membrane bed reactor for removal of residual carbon substrate, total suspended solids, biomass and carbon tetrachloride; and a packed bed tower air stripper to remove remaining carbon tetrachloride and other volatile organic compounds. Biomass sludge will undergo thickening prior to disposal as waste. Off-gas from the stripper, fluidized bed reactor, membrane bed reactor, and sludge thickener will be comingled and treated by granular activated carbon prior to discharge via powered exhaust. The maximum groundwater through put will be 2,500 gallons per minute (gpm), and the associated powered exhaust average flow rate will be up to 40,000 standard cubic feet per minute (scfm), as modeled, for a single stack. The biomass sludge will be treated with lime to reduce odors and ammonia. A scrubber will be used to remove ammonia. Extracted groundwater will be pumped directly to the radiological processing facility or to the main treatment facility depending on the contaminants present.

The emission rate for each air toxic compound exceeding de minimis values was compared to its small quantity emission rate (SQER) for the appropriate averaging period. Most were below their respective SQER value. The model approved by the U.S. Environmental Protection Agency (EPA), *TSCREEN model version 95250*, was used to calculate maximum ambient concentrations of toxic air pollutants (TAPs) that are expected to exceed the SQER values following treatment. The modeled concentrations of the air toxics were compared to the acceptable source impact level (ASIL) for each compound as specified in WAC 173-460. In each case, the modeled emission value was less than the ASIL for the respective compound.

DOE/RL-2006-29, *Calculating Potential-to-Emit Radiological Releases and Doses*, was used to calculate the unabated release potential for radiological constituents. Accordingly, the potential emissions would be from a minor source according to WAC 246-247, "Radiation Protection—Air Emissions."

Abatement controls and environmental monitoring for air toxic and radiological constituents are described in Section C3 and Section C4.

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C2 Air Emissions

Federal and state ambient air quality standards require that pollution control equipment be used to control emissions from new and existing sources. Because the 200 West Area groundwater treatment facility has the potential to discharge hazardous air pollutants, an evaluation was conducted to estimate the activity of radionuclides and concentration/mass of toxic air pollutants that could potentially be emitted from groundwater treatment operations. The results of this evaluation are presented in the following subsections.

C2.1 Radiological Air Emissions

The *Revised Code of Washington* (RCW) 70.94, "Public Health and Safety," "Washington Clean Air Act," requires regulation of radioactive air pollutants. WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," sets standards that are as or more stringent than the *United States Code* (USC) federal *Clean Air Act of 1990*, and under the *Code of Federal Regulations* (CFR) federal implementing regulation, 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities."

The EPA partial delegation of the 40 CFR 61 authority to the State of Washington includes all substantive emissions monitoring, abatement, and reporting aspects of the federal regulation. The state standards protect the public by conservatively establishing exposure standards applicable to the maximally exposed (public) individual, be that individual real or hypothetical. To that end, the standards address any member of the public, at the point of maximum annual air concentration, in an unrestricted area where any member of the public may be.

All combined radionuclide airborne emissions from the U.S. Department of Energy (DOE) Hanford Site "facility" are not to exceed amounts that would cause an exposure to any said member of the public of greater than 10 millirem per year effective dose equivalent (EDE). WAC 246-247 which adopts the WAC 173-480 standards and the 40 CFR 61, Subpart H standard, requires verification of compliance with the 10 millirem per year standard, and would be applicable or relevant and appropriate to this remedial action.

The WAC 246-247 addresses potential radioactive airborne emissions from point sources and from fugitive or diffuse sources by requiring monitoring of such sources. Such monitoring requires physical measurement of the effluent or ambient air and quality assurance measures to assure the precision, accuracy, and completeness of the environmental measurements. The substantive provisions of WAC 246-247 that require monitoring of radioactive airborne emissions would be applicable or relevant and appropriate to this remedial action.

The above state implementing regulations further address control of radioactive airborne emissions where economically and technologically feasible (WAC 246-247-040(3) and -040(4), "Radiation Protection-Air Emissions," "General Standards"). To address the substantive aspect of these requirements, best or reasonably achieved control technology will be addressed by ensuring that applicable emission control technologies (those successfully operated in similar applications) will be used when economically and technologically feasible (i.e., based on cost/benefit).

C2.2 Criteria/Toxic Air Emissions

Under WAC 173-400 and WAC 173-460, requirements are established for the regulation of TAP emissions. Operation of the new 200 West Area groundwater P&T facility will constitute a new source of air toxics emissions. Potential criteria/toxic emissions resulting from this remedial action could be gaseous in nature. In accordance with WAC 173-400-040, "General Regulations for Air Pollution Sources," "General Standards for Maximum Emissions," reasonable precautions must be taken to prevent the release of air contaminants associated with point sources and fugitive emissions resulting from excavation, materials handling, or other operations. The use of treatment technologies for emissions of TAPs that would be subject to the substantive applicable requirements of WAC 173-460 and WAC 173-400 is anticipated to be a part of this remedial action. Calculations show that, after application of toxics best available control technology, maximum potential concentrations would be below regulatory thresholds.

Treatment of some waste encountered during this remedial action may be required to meet Environmental Restoration Disposal Facility (ERDF) waste acceptance criteria. In most cases, the type of treatment anticipated would consist of solidification/stabilization techniques such as macroencapsulation or grouting, and WAC 173-460 would not be considered an applicable or relevant and appropriate requirement (ARAR). If more aggressive treatment is required that would result in the emission of regulated air pollutants, the substantive requirements of WAC 173-460-060, "Controls for New Sources of Toxic Air Pollutants," "Control Technology Requirements," would be evaluated to determine applicability.

Treatment by-products may occur during processing start up and operations. N-nitrosodimethylamine may be produced in the first hour of operation of a new technetium-99 resin bed at levels expected to be less than the de minimis value over the annual averaging period. Break down products of carbon tetrachloride may occur in the fluidized bed reactor. These constituents are already present in the 200-ZP-1 groundwater and are included in the evaluation versus de minimis values, small quantity emission rates and ASILs. Ammonia is anticipated to be generated from the waste sludge at levels requiring lime treatment. Minor amounts of particulates are expected during lime load-in operations.

C2.3 Radiological Airborne Source Information

The radiological constituents of concern for the 200-ZP-1 OU final remedy are technetium-99, iodine-129, and tritium. Isotopes of uranium are added because uranium is present in the adjacent 200-UP-1 groundwater OU, and it is anticipated that the zone of influence for the 200 West Area groundwater P&T operations will eventually extend to the 200-UP-1 groundwater plume. Also, future remedial actions in the 200-UP-1 OU are anticipated to include pumping contaminated groundwater from the 200-UP-1 OU and piping it directly to the 200 West Area groundwater P&T facility. The 200-UP-1 groundwater OU currently has an interim action P&T system for removal of technetium-99 and uranium (EPA et al., 1997, *Declaration of Record of Decision for 200-UP-1 OU*) wherein pumped groundwater is piped to the 200 East Area Effluent Treatment Facility for treatment and disposal.

DOE/RL-2006-29 is used to calculate the unabated release potential for radiological constituents. As such, Method 1, which is prescribed in 40 CFR Part 61, Appendix D and in WAC 246-247-030"Radiation Protection—Air Emissions," "Definitions," (21), is used. Method 1 states, "Multiply the annual possession quantity of each radionuclide by the release fraction for that radionuclide," depending on its physical state. Use the following release fractions:

- 1 for gasses
- 10^{-3} (E-03) for liquids or particulate solids
- 10^{-6} (E-06) for solids

A release fraction of 1 is conservatively used for iodine-129 as a gas, although its removal in the treatment system is as a particulate. Tritium is also conservatively considered as a gas for dose calculation. A release fraction of E-03 is used for technetium-99 and for uranium isotopes. Uranium-233 is used to represent all uranium isotopes because its use in dose calculations results in a higher dose.

The unabated annual possession quantity for the 200 West Area groundwater P&T facility is conservatively calculated by applying the maximum design flow for the entire facility to each constituent for a period of one year operating 24 hours per day, 365 days per year. The concentrations of the radiological constituents are provided in the integrated mass balance determination (CH2M HILL, Calculation #382519-CALC-050, October 2009). Any isotope may be present in the influent. However, the representative isotopes and quantities, which are conservatively utilized, represent all isotopes potentially present. The uranium IX unit, technetium-99 IX unit and the main treatment facility are located in series, with the uranium treatment unit at the head end. Depending upon contaminant concentrations, untreated groundwater is piped directly to the uranium treatment unit, the technetium-99 treatment unit or to the main treatment facility. Additional groundwater extraction wells are being installed to optimize removal of contaminants. For instance, extraction wells are being drilled in areas with the highest technetium-99 concentrations. Extracted groundwater from these wells will be piped directly to the technetium-99 treatment unit. The treated effluent from the technetium-99 treatment unit becomes the influent, along with other untreated groundwater, to the main treatment facility. Groundwater treated in the uranium IX unit flows through the technetium-99 IX unit to the main treatment facility.

- The technetium-99 concentration is obtained by summing the concentration of influent to the technetium-99 IX treatment unit and the concentration of untreated groundwater to the main treatment facility.
  - 14,700 pCi/L + 175 pCi/L = 14,875 pCi/L
- The (technetium-99 concentration) x (annual pumpage) = (annual possession quantity).
  - (14,875 pCi/l) x (3.7854 l/gal) x (2,500 gal/min) x (1,440 min/day) x (365 days/yr) x (E-12 Ci/pCi) = 7.40 E+01 Ci/yr
- The (annual possession quantity) x (release fraction) = (unabated release rate).
  - (7.40 E+01 Ci/yr) x (1E-03) = 7.4 E-02 Ci/yr
- The iodine-129 concentration is obtained by summing the concentrations of raw groundwater influent to the uranium IX treatment unit, raw groundwater influent to the technetium-99 IX unit, and untreated groundwater to the main treatment facility.
  - 1.3 pCi/L + 0.825 pCi/L + 0.054 pCi/L = 2.18 pCi/L
- The (I-129 concentration) x (annual pumpage) = (annual possession quantity).
  - (2.18 pCi/L) x (3.7854 L/gal) x (2,500 gal/min) x (1,440 min/day) x (365 days/yr) x (E-12 Ci/pCi) = 1.08 E-02 Ci/yr
  - The (annual possession quantity) x (release fraction) = (unabated release rate)

    (1.08 E-02Ci/yr) x (1E00) = 1.08 E-02 Ci/yr
- The tritium concentration is obtained from the combined influent to the main treatment facility.
  - 9,250 pCi/L
- The (tritium concentration) x (annual pumpage) = (annual possession quantity).
  - (9,250 pCi/L) x (3.7854 L/gal) x (2,500 gal/min) x (1,440 min/day) x (365 days/yr) x (E-12 Ci/pCi) = 4.6 E+01 Ci/yr

- The (annual possession quantity) x (release fraction) = (unabated release rate).

  (4.6 E+01 Ci/yr) x (1E00) = 4.6 E+01 Ci/yr

- The uranium concentration is obtained from summing the concentrations of untreated groundwater influent to the uranium IX treatment unit, untreated groundwater influent to the technetium-99 IX unit, and untreated groundwater influent to the main treatment facility.
  - 570 pCi/L + 3.96 pCi/L + 3.47 pCi/L = 577.43 pCi/L
- The (uranium concentration) x (annual pumpage) = (annual possession quantity)
  - (577.43 pCi/L) x (3.7854 L/gal) x (2,500 gal/min) x (1,440 min/day) x (365 days/yr) x (E-12 Ci/pCi) = 2.87 E00 Ci/yr

    The (annual possession quantity) x (release fraction) = (unabated release rate)

    (2.87 E00 Ci/yr) x (1 E-03) = 2.87 E-03 Ci/yr
- The annual total effective dose equivalent to the maximally exposed individual is conservatively determined by multiplying the unabated release rate for each representative radiological constituent by the highest applicable unit dose conversion factors from DOE/RL-2006-29.
  - Technetium-99: (7.4 E-02 Ci/yr) x (1.8 E-02 mrem/Ci) = 1.33 E-03 mrem/yr
  - Iodine-129: (1.08 E-02 Ci/yr) x (7.62 E-02 mrem/Ci) = 8.21 E-04 mrem/yr
  - Tritium: (4.6 E+01 Ci/yr) x (2.5 E-05 mrem/Ci) = 1.15 E-04 mrem/yr
  - Uranium-233: (2.87 E-03 Ci/yr) x (8.6 mrem/Ci) = 2.47 E-02 mrem/yr

Total: = 2.70 E-02 mrem/yr

Accordingly, the potential emissions would be from a minor source according to WAC 246-247.

C2.4 Criteria/Toxic Airborne Source Information

Compliance with the state air toxic rule was demonstrated according to requirements in WAC 173-460. A sort of the groundwater database was completed to identify chemical compounds detected in the 200-ZP-1 groundwater OU, beyond those already identified as COCs, which are also listed as WAC 173-460 air toxic compounds. Table C2-1 provides the constituents that were identified.

If de minimis and SQER values were exceeded, the constituent was further screened (CH2M HILL, Calculation #382519-CALC-033 and Calculation #382519-CALC-48). The integrated mass balance calculation applies best available control technology for toxics (T-BACT) to the remaining constituents (CH2M HILL, Calculation #382519-CALC-050, October 2009). After application of T-BACT, the value was compared to the SQER for each TAP. If the emissions were lower than the SQER, no further air quality impact analysis was conducted. The comparison of emission rates to the SQERs is presented in Table C2-2.

Table C2-1. Potential Air Toxic Constituents

Constituent	CAS Number	De Minimis Value (lb/averaging period)	SQER Value	Averaging Period
1,1,1-Trichloroethane	71-55-6	6.570	131.0	day
1,1-Dichloroethane	75-34-3	6.000	120.0	year
1,1-Dichloroethylene	75-35-4	1.31	26.3	day
1,2-Dichloroethane	107-06-2	0.369	7.39	year
1,2-Dichloropropane	78-87-5	0.959	19.2	year
1,4-Dichlorobenzene	106-46-7	0.872	17.4	year
2-Napthylamine	91-59-8	0.0188	0.376	year
Ammonia	7664-41-7	0.465	9.31	day
Benzene	71-43 -2	0.331	6.62	year
Beryllium	7440-41-7	0.004	0.08	year
Bromoform	75-25-2	8.720	174,0	year
Cadmium	7440-43-9	0.00228	0.457	year
Carbon disulfide	75-15-0	5.26	105.0	day
Carbon tetrachloride	56-23-5	0.228	4.57	year
Chlorobenzene	108-90-7	6.57	131	day
Chloroform	67-66-3	0.417	8.35	year
Chromium (VI)	18540-29-9	6.4E-05	0.00128	year
Cobalt	7440-48-4	0.000657	0.013	day
Copper	7440-50-8	0.011	0.219	hour
Dibromochloromethane	124-48-1	0.355	7.10	year
Ethylbenzene	100-41-4	3.84	76.8	year
Fluoride	7782-41-4	0.0854	1.71	day
Lead	7439-92-1	10.0	16.0	year
Manganese	7439-96-5	0.000263	0.00526	day
Mercury	7439-97-6	0.000591	0.0118	day
Methyl Tertiary Butyl Ether	1634-04-4	36.90	739.0	year
Methylene Chloride	75-09-2	9.59	192.0	year
o-Xylene	95-47-6	1.45	29.0	day
Phenol	108-95-2	1.31	26.3	day
Selenium	7782-49-2	0.131	2.63	day
Styrene	100-42-5	5.91	118.0	day
Toluene	108-88-3	32.90	657.0	day
Trichloroethene	79-01-6	4.80	95.9	year
Vanadium	7440-62-2	0.00131	0.0263	day
Vinyl Chloride	75-01-4	0.123	2.46	year

Table C2-2. Comparison of Emission Rates to Small Quantity Emission Rates

Pollutant	Daily Emission Rate (lb/day)	Averaging Period	SQER (lb/averaging period)	Emission Rate (lb/averaging period)	Modeling Required
Carbon Tetrachloride	7.90E-02	year	4.57	3.03E+01	yes
Trichloroethylene	1.47E-04	year	95.9	5.71E-02	no
1,1,1-TCA	1.08E-03	24-hour	131	1.12E-03	no
1,2-DCA	6.93E-04	year	7.39	2.60E-01	no
Benzene	3.92E-03	year	6.62	1.48E+00	no
Acetone	1.81E-04	N/A	N/A	N/A	no
Chloroform	6.00E-01	year	8.35	2.27E+02	yes
DBCM	5.69E-04	year	7.1	2.13E-01	no
Methylene Chloride	1.11E-01	year	192	41.98E+00	no
1,1-Dichloroethylene	6.36E-04	24-hour	26.3	6.71E-04	no
Vinyl Chloride	1.86E-02	year	2.46	7.15E+00	yes

Notes:

N/A = This pollutant is not listed as a TAP in WAC 173-460.

If the expected emissions were above the SQER, ambient air quality modeling was completed (CH2M HILL Calculation #382519-CALC-053, January 2010). Modeling was performed according to the procedures in 40 CFR 51, Requirements for Preparation, Adoption, and Submittal of Implementation Plans," Appendix W, "Guideline on Air Quality Models." WAC 173-460 requires that new stationary sources that have the potential to emit TAPs demonstrate that the TAP emissions would be sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects.
The EPA-approved model, *TSCREEN model version 95250* was used to calculate maximum ambient concentrations of TAPs that are expected to exceed the SQER values.

Concentrations from the ambient air quality analysis are compared to the ASIL to show compliance with WAC 173-460. The model output from *TSCREEN* is the maximum 1-hour concentration at the ambient boundary (nearest distance to State Route 240) in ug/m^3. Plant emissions are from a single stack.

Recommended EPA persistence factors from EPA-454/R-92-019, *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources*, were applied to the maximum 1-hour concentration at the ambient boundary to estimate the concentrations for the desired averaging period results. The persistence factor is 0.08 for an annual averaging period, which applies to the TAPs modeled.

$$(0.0149 \text{ ug/m}^3)(0.08) = 0.0012 \text{ ug/m}^3$$

Table C2-3 presents the model results compared to the applicable standards. Model results show no TAPs that would exceed the applicable ASIL.

Table C2-3. Comparison of Concentrations to Acceptable Source Impact Level

Pollutant	Maximum 1-Hour Concentration (μg/m^3)	Annual Average Concentration (μg/m^3)	Annual Acceptable Source Impact Level (μg/m^3)
Carbon Tetrachloride	0.0149	0.0012	0.0238
Chloroform	0.1120	0.0090	0.0435
Vinyl Chloride	0.0035	0.0003	0.0128

Plant emissions were estimated for a single stack. Model results show that carbon tetrachloride, chloroform, and vinyl chloride would not exceed their applicable ASIL.

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C3 Emission Controls

Highly efficient IX columns will be used for removal of technetium-99, uranium isotopes, and iodine-129. Purolite-A53E resin was selected for technetium-99 removal based on treatability testing conducted in the 200-ZP-1 groundwater OU in 2008. Iodine-129 is also expected to be removed by the Purolite-A53E resin. Dowex-21K resin was selected for uranium removal based on its highly successful performance for remediation of uranium contaminated groundwater at the Frenald, Ohio DOE site. Other resins may be used if treatability testing reveals comparable or better performance. An anaerobic fluidized bed bioreactor will be used for removal of nitrate, metals, and carbon tetrachloride. An aerobic membrane bed reactor will be used for removal of residual carbon substrate, total suspended solids, biomass, and carbon tetrachloride. A packed bed tower air stripper will be used to remove remaining carbon tetrachloride and other volatile organic compounds. Off-gas from the stripper, fluidized bed reactor, membrane bed reactor, and waste sludge thickener will be comingled and treated by granular activated carbon prior to discharge via powered exhaust. The biomass sludge will be treated with lime to reduce odors and ammonia. A scrubber will be used to remove ammonia, and a bag-house (or equivalent) will be used for reduction of lime particulate.

Tritium, which is bound with the groundwater, will be removed with water vapor in a demister located upstream from the granular activated carbon treatment unit and comingled with the treated groundwater, prior to injection back into the aquifer.

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C4 Monitoring

Quarterly sampling will occur for annual determination of compliance with SQERs and ASILs. Grab samples will be collected in each stack. Additional modeling to confirm compliance with ASILs would be completed only if needed and if emissions are higher than previously calculated/modeled.

Periodic confirmatory measurement will be used to confirm low radiological air emissions. This will consist of engineering calculations combined with the Hanford Site Near Facility Monitoring Program results. The existing near facility monitoring network will be used. The nearest air monitors are N161, N304, N975, and N987. Furthermore, EPA will be informed if any air sample exceeds 10 percent of the values listed in Table 2 of Appendix E in 40 CFR 61, as measured by the Hanford Site near facility ambient air monitors.

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C5 References

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Appendix D

200 West Area Groundwater Treatment Facility Sampling and Analysis Plan

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Contents

Figure

Tables

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Terms

Action Plan	Ecology et al. (1989b), *Hanford Federal Facility Agreement and Consent Order Action Plan*
ALARA	as low as reasonably achievable
BTR	Buyer's Technical Representative
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CGET	General Employee Training
CHPRC	CH2M Hill Plateau Remediation Company
CMP	Compliance Monitoring Plan
COC	contaminant of concern
DOE	U.S. Department of Energy
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
ECO	environmental compliance officer
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FBR	fluidized bed reactor
FTB	field trip blank
FTR	Field Technical Representative
FWS	Field Work Supervisor
FXR	field transfer blank
GAC	granular activated carbon
gpm	gallons per minute
HEIS	*Hanford Environmental Information System*
IX	ion exchange
NCO	Nuclear Chemical Operator
OU	operable unit

P&T	pump-and-treat
PMP	Performance Monitoring Plan
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	radiological control technician
RD/RA	Remedial Design/Remedial Action Work Plan
RDL	required detection limit
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
RPD	relative percent difference
SAP	sampling and analysis plan
Tri-Party Agreement	Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*
VOA	volatile organic analysis
VOC	volatile organic compound
VPGAC	vapor-phase granular activated carbon

D1 Introduction

This sampling and analysis plan (SAP) has been prepared to support the 200 West Area groundwater pump-and-treat (P&T) remedial action for the 200-ZP-1 groundwater Operable Unit (OU). The P&T system is a principal component of the selected remedy presented in the Record of Decision (ROD) for the OU (EPA et al. 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington*). The system is expected to become operational in 2011.

The P&T system is designed to extract contaminated groundwater from the 200-ZP-1 OU and treat the water to reduce the concentrations of carbon tetrachloride, total chromium – trivalent (CrIII) and hexavalent (CrVI), nitrate, trichloroethylene, iodine-129, technetium-99, and other constituents. Extracted groundwater, treated to the levels identified in the ROD, will be re-injected into the aquifer. It is expected the P&T system will be expanded in the future to treat groundwater from the adjacent 200-UP-1 groundwater OU. Contaminated groundwater from the 200-UP-1 OU will require treatment to remove uranium.

The mass of contaminants removed from the treated groundwater will constitute waste streams requiring appropriate characterization for designation prior to disposal. The focus of this SAP is characterization of the untreated groundwater streams entering the treatment facility, the treated groundwater leaving the facility, and the waste streams requiring disposal. Samples will be tested for the contaminants of concern (COCs) specified in the ROD. Atmospheric discharge of volatile organic compounds (VOCs) will also be monitored according to the Air Monitoring Plan included as Appendix C to DOE/RL-2009-124, *200 West Area Groundwater Pump-and-Treat Facility Operations and Maintenance Plan*. This SAP does not include routine sampling, analysis, and related process control measurements on materials and flow streams contained wholly within the treatment facility. Process control measurements are covered under other operation and maintenance documents.

The effect of the P&T system on the 200-ZP-1 groundwater OU will be monitored as described in DOE/RL-2009-115, *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action*, and Appendix E – Groundwater Sampling and Analysis Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action included as Appendix E to DOE/RL-2009-124.

The following documents were used to prepare this SAP:

- EPA et al., 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington.*
- DOE/RL-2008-78, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan* (RD/RA).
- DOE/RL-2009-124, *Appendix A - Compliance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action.*
- DOE/RL-2009-124, *Appendix B - Waste Management Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action.*
- DOE/RL-2009-124, *Appendix C - Air Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action.*
- DOE/RL-2009-115, *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action.*

- Design Documents – includes description and engineering design of the P&T process for the 200-ZP-1 OU.

The specific objectives of the SAP are to facilitate the following:

- Provide a schedule for sampling and analysis of 200 West Area groundwater treatment facility untreated influent water, treated effluent water, and process waste streams to meet the waste management (Appendix B) and re-injected water (Appendix E) analytical data requirements.
- Supply data needed for periodic evaluation of P&T system performance and process efficiency based on a calculated mass balance.
- Monitoring atmospheric discharge of VOCs from unit operations and storage tanks within the main treatment facility (Appendix C).

D1.1 Planned Operations

Initial P&T system operations will commence in 2011 by treating groundwater from an estimated 15 new extraction wells in the 200-ZP-1 OU. Five new injection wells will receive the treated water. The final number and locations of the new wells will depend on site-specific conditions.

The initial installed design capacity of the P&T system is 2,500 gallons per minute (gpm) with two parallel treatment trains. Startup throughput is estimated to be approximately 1,000 gpm. Additional extraction and injection wells will be brought on line to utilize the remaining treatment capacity.

The treatment facility design includes provisions for a third treatment train for a total design capacity of 3,750 gpm. The need for the additional treatment capacity will be determined based on well field performance for the 200-ZP-1 groundwater OU, and the amount of groundwater that may be generated as part of the final remedy for the 200-UP-1 OU.

D1.2 Description of Unit Operations

The following descriptions of the basic unit operations within the P&T system provide the basis for identifying the waste streams and other sampling points to meet the objectives of this SAP.
The descriptions are taken from the engineering design documents.

D1.2.1 Uranium Ion Exchange

Groundwater from 200-UP-1 OU will be pre-treated using ion exchange (IX) resin to reduce uranium concentrations. Incoming groundwater will be sent through bag filters to remove fine particulate matter. Filtered water flows to the IX columns (two in series) containing Dowex-21K resin which has a demonstrated ability to reduce uranium concentrations. The IX effluent will flow through bag filters serving as a resin trap to the technetium-99 IX treatment system. The IX resin once fully loaded will be disposed.

D1.2.1.1 Technetium-99 Ion Exchange

Groundwater from extraction wells in the 200-ZP-1 OU and the 200-UP-1 OU (after uranium pretreatment), which contains technetium-99 activity greater than 900 pCi/L, will be pretreated separately with IX resin to reduce the technetium-99 activity to less than 900 pCi/L.

Influent groundwater will be sent through bag filters to remove fine particulate matter. The filtered water then flows to the IX columns (up to three in series) containing Purolite-A53E resin which has demonstrated ability to reduce technetium-99 concentrations. The IX effluent will flow through bag filters serving as a resin trap to the main treatment facility for further treatment.

When the IX resin reaches its loading limit, it will be removed from the column by sluicing it with treated water into a carbon tetrachloride stripping tank (Strip Tank). In the Strip Tank, the resin is submerged in treated water and heated to a temperature of approximately 200 °F. Air is then bubbled through the resin to mix the bed and strip off the carbon tetrachloride. The vapor emission will be treated with small vapor-phase granular activated carbon (VPGAC) adsorbers. After treatment, the stripping water will be pumped to the influent side of the main treatment facility for treatment. The resin will be sluiced with treated water to a geotextile tube placed in a container to allow drainage. The drainage will be collected and pumped to the bag filters at the end of the technetium-99 IX system.

D1.2.1 Main Treatment Facility

Water from the technetium-99 IX treatment system will flow to the main treatment facility equalization tank where it will be blended with the extracted groundwater from the remainder of the well field and ultimately sent to the fluidized bed reactor (FBR) for nitrate and chromium removal. Treatment for carbon tetrachloride and other contaminants will also likely occur in the FBR.

The FBR will be operated under anoxic condition (no dissolved oxygen) where heterotrophic facultative bacteria will reduce nitrate to nitrogen gas (denitrification). Water is pumped into the bottom of the FBR creating an upflow pattern to suspend the granular activated carbon (GAC) media to which the microorganisms attach. The FBR will initially be seeded with microbes that are suited for nitrate removal and possibly carbon tetrachloride degradation.

The effluent from the FBR will flow by gravity to covered membrane filtration tanks for removal of residual carbon substrate and total suspended solids including biomass carryover from the FBR. The membrane tanks will have aeration capacity to provide oxygen needed for the aerobic biological process.

The treated water from the membranes will be pumped to a packed bed tower air stripper for removal of the remaining carbon tetrachloride and other VOCs. Off-gas from the stripper, influent equalization tank, FBR(s), membrane tanks, sludge holding tank(s), rotary drum thickeners, and centrifuges will be combined and treated by VPGAC.

Solids from the membrane filter tanks will be pumped to rotary drums for sludge thickening. The thickened solids will be periodically pumped from the sludge holding tank to centrifuges for dewatering.

D1.2.2 Additional VPGAC Requirements

The VPGAC train that serves the air stripper(s) will also receive off-gas from the equalization tank, the FBR(s), membrane tanks, sludge holding tank(s), recycle tank, rotary drum thickeners, strip tank(s), and centrifuges. The storage tanks in Extraction Transfer Buildings 1 and 2 will be fitted with separate VPGAC absorbers.

D1.3 Waste Streams

Table D1-1 lists the individual waste streams associated with the unit processes described above, along with a brief description of their principal expected contaminants.

Table D1-1. 200 West Area Groundwater Treatment Facility Waste Streams

Waste Stream	Contaminants
Uranium Ion Exchange System	
Inflow bag filters	Fine mineral particulates
Outflow bag filters	U-bearing resin particles, possible VOCs
Dewatered loaded resin	Uranium, VOCs
Loaded GAC (U-system strip tank)	Carbon tetrachloride, TCE
Technetium-99 Ion Exchange System	
Inflow bag filters	Fine mineral particulates
Outflow bag filters	Tc-99-bearing resin particles, possible VOCs
Dewatered loaded resin	Tc-99, possible VOCs, traces I-129 and U
Loaded GAC (Tc-99 system strip tank)	Carbon tetrachloride, TCE
Fluidized Bed Reactor/Aeration Filters	
Dewatered sludge	Carbon (GAC), biomass, inorganic particulates
Air Stripper	
Loaded GAC	Carbon tetrachloride, TCE
Extraction Transfer Building Storage Tanks	
Loaded GAC	Carbon tetrachloride, TCE

Notes:
GAC = granular activated carbon
OU = operable unit
Tc-99 = technetium-99
TCE = trichloroethylene
VOC = volatile organic compound

D1.4 Sampling Points

For the purpose of this SAP, sampling points reflect entry or exit of untreated water, treated water, and wastes from the treatment facilities. The sampling points fall into five general categories, as described in the following subsections. Requirements for characterizing and designating waste streams are addressed in DOE/RL-2009-124, Appendix B – Waste Management Plan.

D1.4.1 Well Field Extraction and Re-Injection Streams

Well field operations include untreated groundwater from extraction wells and re-injection of treated water into the aquifer. Incoming flow from the extraction wells to the treatment facilities occurs as three separate flow streams, while the outgoing flow of treated water returned to the aquifer is considered a single flow stream. Specific sampling points to the treatment facilities include:

- Well field inflow from extraction wells.

- Inflow to uranium pretreatment IX system from the 200-UP-1 OU well.
- Inflow to the technetium-99 pretreatment IX system directly from wells not requiring uranium pretreatment and wells requiring uranium pretreatment.
- Balance of well field inflow (requiring neither uranium nor technetium-99 pretreatment).

- Treated water directed to injection wells.

D1.4.2 Air Emissions Stacks

The VPGAC trains remove VOCs from air. Stacks from each VPGAC train discharge air directly to the atmosphere. The performance of the VPGAC trains must be verified by monitoring carbon tetrachloride, trichloroethylene, and other organic contaminants potentially present as described in DOE/RL-2009-124, Appendix C – Air Monitoring Plan. The discharge stacks include:

- Main VPGAC stack from air stripper and other plant sources described earlier.
- Extraction Transfer Building 1 and Building 2 holding tank VPGAC stacks.

D1.4.3 Process Waste Streams

Waste streams destined for disposal at the Environmental Restoration Disposal Facility (ERDF) will need to be batch-sampled and characterized for waste designation prior to disposal. These waste streams include:

- Loaded uranium IX resin
- Loaded technetium-99 IX resin
- FBR/aeration filter sludge

D1.4.4 Miscellaneous Waste

Bag filters used to prevent particulates from well field inflow from entering the IX columns may be handled as miscellaneous waste. Bag filters used as resin traps may be handled similarly on the assumption that the trapped mass of resin is minimal.

D1.4.5 Loaded GAC

GAC loaded with carbon tetrachloride, trichloroethylene, etc., from the main VPGAC train will be sampled and analyzed (see Section D3.5) and then shipped to an offsite regeneration facility.

D1.5 Untreated Water Quality

Initial COC concentration estimates for the untreated groundwater entering the treatment facilities is presented in Table D1-2. This information is based on historical groundwater sampling and analysis from selected monitoring wells in the 200-ZP-1 OU and the 200-UP-1 OU.

D1.6 Treated Water Quality

The 200 West Area groundwater treatment system is designed to meet or exceed the requirements of the ROD (EPA et al. 2008) for the treated (effluent) water re-injected into the aquifer. The treated water quality standards, shown in Table D1-3 and specified in the ROD, reflect Federal and state drinking water maximum contaminant levels and state groundwater cleanup standards (where more stringent that the maximum contaminant levels) that are the applicable or relevant and appropriate requirements for the selected remedy (EPA et al., 2008). The design treatment goals in Table D1-3 are more conservative than the ROD cleanup levels to provide operational margins during periods of stressed or transient operation.

Table D1-2. Estimated Influent Water Quality to Unit Processes[a]

Analyte	Uranium Pretreatment	Technetium-99 Pretreatment	Main Treatment Facility
Contaminants of Concern[b]			
Carbon Tetrachloride	365 ug/L	491 ug/L	661 μg/L
Chromium (Total)	8.3 ug/L	159 ug/L	47 μg/L
Hexavalent Chromium	8.3 ug/L	161 ug/L	47 μg/L
Nitrate as Nitrogen	320 mg/L	69 mg/L	40 mg/L
Contaminants of Concern[b]			
Trichloroethylene	3.6 ug/L	3.2 ug/L	4.1 μg/L
Iodine-129	1.3 pCi/L	0.86 pCi/L	0.27 pCi/L
Technetium-99	9,050 pCi/L	14,700 pCi/L	273 pCi/L
Tritium	6,480 pCi/L	23,800 pCi/L	9,250 pCi/L
Other Constituents[c]			
Uranium	570 ug/L	5.9 ug/L	3.6 μg/L
Alkalinity (as $CaCO_3$)	108 mg/L	103 mg/L	110 mg/L
Calcium	276 mg/L	75 mg/L	69 mg/L
Chloride	107 mg/L	18 mg/L	20 mg/L
Chloroform	0.007 mg/L	0.025 mg/L	0.041 mg/L
Fluoride	0.48 mg/L	0.37 mg/L	0.35 mg/L
Iron (Dissolved)	0.98 mg/L	0.19 mg/L	0.25 mg/L
Magnesium	89 mg/L	24 mg/L	21 mg/L
Manganese (Dissolved)	0.035 mg/L	0.049 mg/L	0.084 mg/L
Potassium	12 mg/L	7 mg/L	5 mg/L
Sodium	43 mg/L	24 mg/L	21 mg/L
Sulfate	73 mg/L	34 mg/L	37 mg/L
TOC	1.3 mg/L	1.3 mg/L	1.6 mg/L
TSS	5.0 mg/L	3.0 mg/L	1.9 mg/L
TDS	2150 mg/L	614 mg/l	484 mg/L

Notes:

a. The COCs are those identified in the ROD. The other constituents are identified as of interest in the PMP. Concentrations are based on estimates included in 60 percent engineering design documents.

b. Concentrations for COCs represent the expected maxima except for total chromium which is a 5-year average.

c. Concentrations for other constituents are 5-year averages except for uranium which represents the expected maximum.

COC = contaminant of concern
mg/L = milligrams per liter
pCi/L = picocuries per liter
PMP = Performance Monitoring Plan
ROD = Record of Decision
TDS = total dissolved solid
TOC = total organic carbon
TSS = total suspended solids
ug/L = micrograms per liter

Table D1-3. Treated Water Quality Requirements and Treatment System Design Goals

Parameter	Where Measured	Treated Water Quality Standards		Acceptance Standard Description	Design Treatment Goal
		Value	Unit		
Carbon Tetrachloride*	Pipeline to injection wells	3.4	ug/L	Specified by ROD	2 ug/L
Chromium (Total)	Pipeline to injection wells	100	ug/L	Federal MCL	60 to 100 ug/L
Hexavalent Chromium	Pipeline to injection wells	48	ug/L	Specified by ROD	29 to 48 ug/L
Nitrate as Nitrogen	Pipeline to injection wells	10,000	ug/L	Federal MCL	2,000 ug/L
Trichloroethylene[a]	Pipeline to injection wells	1	pCi/L	Specified by ROD	0.6 to 1 ug/L
Iodine–129	Pipeline to injection wells	1	pCi/L	Federal MCL	0.6 to 1 ug/L
Technetium–99	Pipeline to injection wells	900	pCi/L	Federal MCL	540 pCi/L
Tritium	Pipeline to injection wells	20,000	pCi/L	Federal MCL	12,000 to 20,000 pCi/L

Table D1-3. Treated Water Quality Requirements and Treatment System Design Goals

Parameter	Where Measured	Treated Water Quality Standards		Acceptance Standard Description	Design Treatment Goal
		Value	Unit		

Notes:

* DOE will clean up COCs for the 200-ZP-1 OU subject to WAC 173-340, "Model Toxics Control Act--Cleanup" which includes carbon tetrachloride and trichloroethylene, so that the excess lifetime cancer rick does not exceed 1 x 10^{-5} at the conclusion of the remedy.

DOE = U.S. Department of Energy

MCL = maximum contaminant level

pCi/L = picocuries per liter

ROD = Record of Decision

ug/L = micrograms per liter

D1.7 Air Emissions Quality

The treatment facility will require emissions control for off-gases from the equalization tank, air stripper(s). FBR(s). membrane tanks, sludge holding tank(s). recycle tank. rotary drum thickeners. and centrifuges. Preliminary estimates of air emissions toxicity values indicated that the off-gas treatment system would require a minimum capture rate of 94 percent to meet the proposed local air emission limit for carbon tetrachloride. Table D1-4 presents the modeled ambient emission levels and acceptable concentrations limits for three volatile organics. Additional information is provided in DOE/RL-2009-124, Appendix C - Air Monitoring Plan.

Table D1-4. Comparison of Concentrations to Acceptable Source Impact Level

Pollutant	Maximum Ambient Concentration (ug/m^3)	Acceptable Source Impact Level (ug/m^3)
Carbon Tetrachloride	0.0017	0.0238
Chloroform	0.0127	0.0435
Vinyl Chloride	0.0004	0.0128

D1.8 Data Needs

The P&T facility is an engineered system designed to remove contaminants from groundwater, to return the treated water to the aquifer, and to segregate and contain the mass of contaminants removed from the water for eventual disposal. For the purposes of this SAP, the data needs may be summarized as the body of measurements required to characterize the mass/volume of influent water and COCs entering the treatment facility, and the treated water and separate waste streams exiting the treatment facility (total effluents). This body of measurements will suffice to independently evaluate treatment system performance to determine if treatment objectives and quality requirements for water re-injection are met. Additional characterization to support the waste designation may be required per DOE/RL-2009-124, Appendix B - Waste Management Plan.

Some trace constituents in the 200-ZP-1 groundwater OU, that are not included in Table D1-2, may become concentrated in some waste streams (e.g., by sorption onto IX resins or onto the GAC/biomass sludge from the main treatment facility). These other constituents, also shown in Table D1-2, are also considered for waste designation.

D1.9 Sampling Design

The sampling design proposed is systematic and designed to verify reported treatment system performance and compliance with the requirements in the 200-ZP-1 OU ROD for treated water quality. It relies neither on statistical interpretation nor on professional expertise. The measurements are a subset of those needed to operate and control the treatment facility.

D1.10 Project Schedule

Operations are targeted to begin in 2011 (EPA et al. 2008). Additional wells will be brought on line to fully use the treatment system's design capacity. The sampling activities described herein will commence once the facility has been released for unrestricted operations.

D1.10.1 Reporting Requirements

The sample collection and laboratory analysis results obtained under this SAP will be reported in periodic briefings and in the performance monitoring reports as described in DOE/RL-2009-124.

D2 Quality Assurance Project Plan

This Quality Assurance Project Plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. This QAPjP complies with the requirements of the following:

- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document.*
- DOE O 414.1C, *Quality Assurance.*
- 10 CFR 830, Subpart A, "Quality Assurance Requirements."
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations,* EPA QA/R-5, as amended.

Section 6.5 and Section 7.8 of Ecology et al. (1989b), *Hanford Federal Facility Agreement and Consent Order Action Plan* (Action Plan) require the quality assurance (QA)/quality control (QC) and sampling and analysis activities to specify the QA requirements for treatment, storage, and disposal units, as well as for past practice processes. Therefore, this QAPjP follows the QA elements of EPA/240/B-01/003. This QAPjP demonstrates conformance to Part B requirements of ANSI/ASQC E4-2004, *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs.*

In addition to the requirements cited above, the following reference was also used as a resource for identification of QAPjP elements:

- EPA-505-B-04-900A, *Intergovernmental Data Quality Task Force, Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Part 1: UFP-QAPP Manual.*

EPA-505-B-04-900A is not imposed through the Action Plan (Ecology et al. 1989b); however, it is a valuable resource and provides a comprehensive treatment of quality elements that should be addressed in a SAP. It was also designed to be compatible with EPA/240/B-01/003, which forms the basis for this QAPjP.

This QAPjP is divided into the following four sections which describe the quality requirements and controls applicable to this investigation. These sections include: D2.1 – Project Management, D2.2 – Data Generation and Acquisition, D2.3 – Assessment and Oversight, and D2.4 – Data Validation and Usability.

D2.1 Project Management

The following subsections address the basic aspects of project management and are designed to ensure that the project has defined goals, that the participants understand the goals and the approaches used, and that the planned outputs are appropriately documented. Project management roles and responsibilities discussed in this section apply to the major activities covered under the SAP.

D2.1.1 Project/Task Organization

CH2M HILL Plateau Remediation Company (CHPRC), the contractor or its approved subcontractor, is responsible for planning, coordinating, sampling, preparation, packaging, and shipping samples to the laboratory. The project organization (in regard to sampling and characterization) is described in the following subsections and is shown graphically in Figure D2-1. The CHPRC Project Manager maintains a list of individuals or organizations as points of contact for each functional element in the figure. For each functional primary contractor role, there is a corresponding oversight role within the U.S. Department of Energy (DOE).

Regulatory Project Manager. The U.S. Environmental Protection Agency (EPA) has assigned Project Managers responsible for oversight of cleanup projects and activities. The EPA has approval authority as lead regulatory agency for the work being performed under this SAP. EPA will work with DOE Richland Operations Office (RL) to resolve concerns over the work as described in this SAP in accordance with Ecology et al., *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement).

RL Project Manager. The RL Project Manager is responsible for authorizing the Contractor to perform activities under *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA), *Resource Conservation and Recovery Act of 1976* (RCRA), the *Atomic Energy Act of 1954*, and the Tri-Party Agreement for the Hanford Site. The RL Project Manager is also responsible to obtain lead regulatory agency approval of the SAP prior to implementing field sampling activities.

RL Technical Lead. The RL Technical Lead is responsible for overseeing day-to-day activities of the Contractor performing the work scope, working with the Contractor and the regulatory agencies to identify and resolve issues, and providing technical input to the RL Project Manager.

Contractor Department Manager. The Contractor Department Manager oversees activities and coordinates with the DOE, regulators, and primary contractor management in support of sampling activities. In addition, the Contractor Department Manager provides support to the Project Manager to ensure the safe and cost-effective performance of work.

Project Manager. The Project Manager is responsible for managing sample planning document preparation, field activities, subcontracted tasks, and ensuring the project file is properly maintained. The Project Manager ensures that the sampling design requirements are converted into field instructions (e.g., work packages) providing specific direction for field activities. The Project Manager works closely with QA, Health and Safety, the Field Work Supervisor (FWS), and the Construction Management Lead to integrate these and other lead disciplines in planning and implementing the work scope. The Project Manager maintains a list of individuals or organizations filling each of the functional elements of the project organization (Figure D2-1). In addition, the Project Manager is responsible for version control of the SAP to ensure that personnel are working to the most current job requirements. The Project Manager also coordinates with the RL Technical Lead on all sampling activities, and supports. The Project Manager may also support RL in coordinating sampling activities with the Regulator Project Manager.

Quality Assurance. The QA point of contact is matrixed to the Project Manager and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements, reviewing project documents (including DQO summary report, SAP, and the QAPjP), and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA point of contact must be independent of the unit generating the data.

Environmental Compliance Officer. The Environmental Compliance Officer (ECO) provides technical oversight, direction, and acceptance of project and subcontracted environmental work, and also develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The ECO also reviews plans, procedures, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues that affect operations and develops cost-effective solutions; and responds to environmental/regulatory issues or concerns raised by RL and/or the lead regulatory agency. The ECO also oversees project implementation for compliance with applicable internal and external environmental requirements.

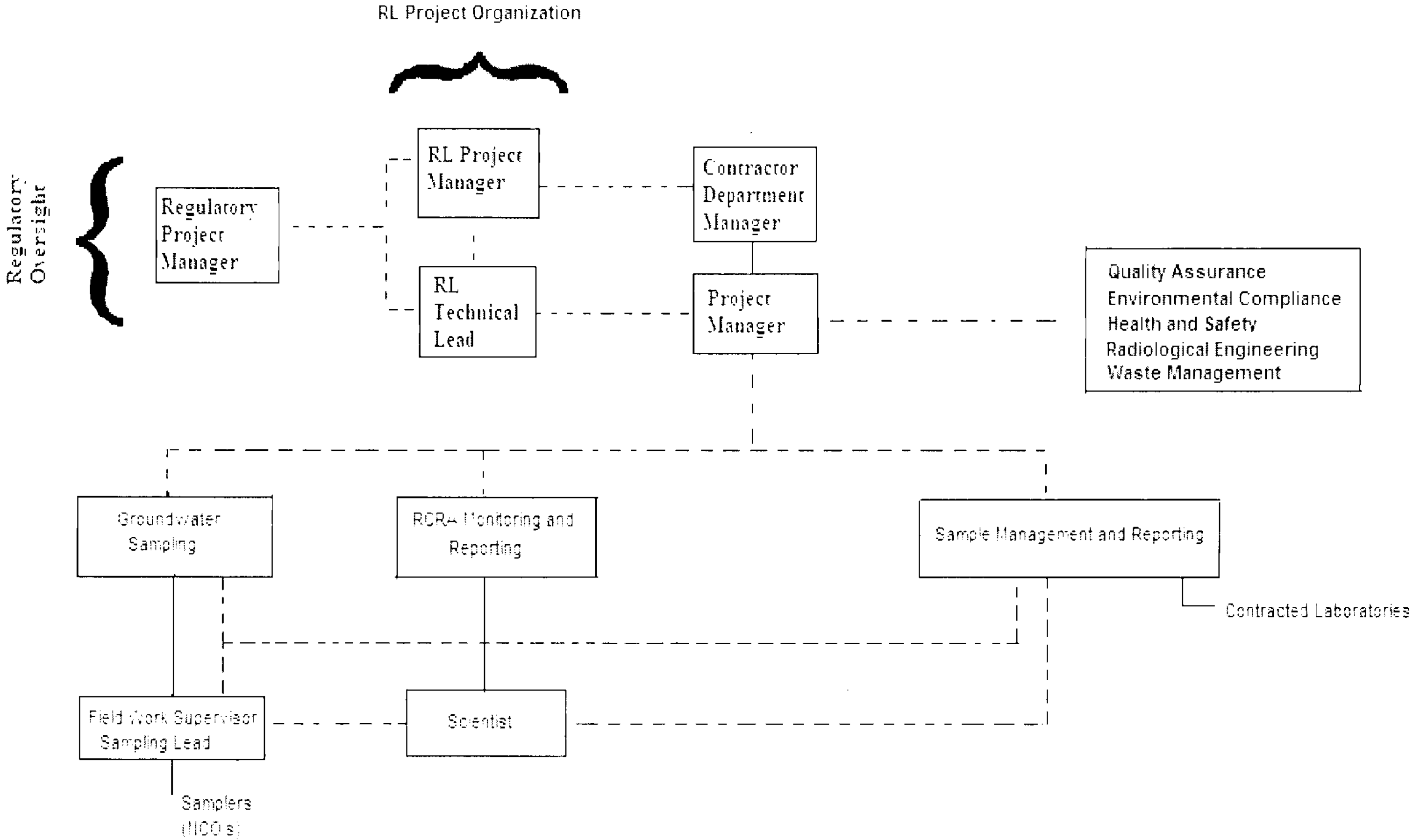

Figure D2-1. Example Project Organization

Health and Safety. The Health and Safety organization is responsible for coordinating industrial safety and health support within the project, as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by Federal regulation or by internal primary contractor work requirements. In addition, the Health and Safety organization provides assistance to project personnel in complying with applicable health and safety standards and requirements. The Health and Safety organization coordinates with Radiological Engineering to determine personal protective clothing requirements.

Radiological Engineering. The Radiological Engineering lead is responsible for radiological/health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for all work planning. In addition, the Radiological Engineer lead identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA (e.g., requiring personal protective equipment). The Radiological Engineering lead also interfaces with the project Health and Safety contact, and plans and directs Radiological Control Technician (RCT) support for all activities.

Sample Management and Reporting. Sample Management and Reporting coordinates laboratory analytical work, ensuring that the laboratories conform to Hanford Site internal laboratory QA requirements (or their equivalent), as approved by DOE and EPA. Sample Management and Reporting receives the analytical data from the laboratories, performs the data entry into the *Hanford Environmental Information System* (HEIS), and arranges for data validation. Sample Management and Reporting is responsible for informing the Project Manager of any issues reported by the analytical laboratory. Sample Management and Reporting develops and oversees the implementation of the letter of instruction to the analytical laboratories, oversees data validation, and works with the Project Manager to prepare a characterization report on the sampling and analysis results.

Sample Management and Reporting is also responsible for conducting the DQO process, or equivalent. Additional related responsibilities include development of the DQOs and SAP, including the sampling design, preparing associated presentations, resolving technical issues, and preparing revisions to the SAP.

Contract Laboratories. The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanation of results in support of data validation. The laboratories must meet site-specified QA requirements and must have an approved QA plan in place.

Waste Management. Waste Management communicates policies and procedures, and also ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. In addition, Waste Management is responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance, interpreting the characterization data to generate waste designations and profiles, and preparing and maintaining other documents confirming compliance with waste acceptance criteria.

Field Work Supervisor. The Field Work Supervisor is responsible for planning and coordinating field sampling resources. The Field Work Supervisor ensures samplers are appropriately trained and available. Additional related responsibilities include ensuring the sampling design is understood and can be performed as specified, by directing training, mock-ups, and practice sessions with field personnel.

The Field Work Supervisor directs the Nuclear Chemical Operators (NCOs). The NCOs collect groundwater, soil, vapor, and multimedia samples, including replicates/duplicates, and prepare sample blanks in accordance with the SAP, corresponding standard procedures, and work packages. The NCOs complete field logbook entries, chain-of-custody forms, and shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

Field Technical Representative. The Field Technical Representative (FTR) acts as a technical interface between the Project Manager and the field crew supervisors (the Field Work Supervisor Lead and the Field Work Supervisor-Buyer's Technical Representatives [BTR]) and ensures technical aspects of the field work will be met. The Field Work Supervisor-BTR oversees daily operations at the job site. The FTR reviews the SAP for field sample collection concerns, analytical requirements, and special sampling requirements, and generates appropriate field sampling paperwork. The FTR, in consultation with the Project Manager, resolves issues arising from translation of technical requirements to field operations and coordinates resolution of sampling issues.

D2.1.2 Problem Definition/Background

Sampling under this SAP will be confined to monitoring the 200 West Area Groundwater P&T system and to characterizing the associated waste streams.

D2.1.3 Project/Task Description

No field sampling (i.e., internal to the P&T system) will be conducted under this SAP. All sampling will occur within the engineered system for the purpose of operation and compliance monitoring.

D2.1.4 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance providing data of known and appropriate quality. Data quality indicators (DQI) describe data quality by evaluation against identified DQOs and the work activities identified in this SAP. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. The principal DQIs are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity. These DQIs are defined for the purposes of this document in Table D2-1. The DQIs will be evaluated during the data quality assessment (DQA) process (Section D2.4.3).

Quality objectives and project-specific measurement requirements are presented in Table D2-2 for untreated and treated water.

D2.1.5 Special Training/Certification

A graded approach is used to ensure that workers receive a level of training commensurate with responsibilities and that complies with applicable DOE orders and government regulations. The Field Work Supervisor, in coordination with the CHPRC Project Manager, will ensure special training requirements for field personnel are met.

Typical training requirements or qualifications have been instituted by the contractor's management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirement documents, American National Standards Institute/American Society of Mechanical Engineers, *Washington Administrative Code*. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically have completed the following training before starting field work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training and supervised 24-hour hazardous waste site experience
- 8-Hour Hazardous Waste Worker Refresher Training
- CH2M HILL Plateau Remediation Company (CHPRC) General Employee Training (CGET)
- Radiological Worker Training (as required)

Project-specific safety training, geared specifically to the project and the day's activity, will be provided, and will include the following:

- Training requirements or qualifications needed by sampling personnel will be in accordance with QA requirements.
- Samplers are required to have training and/or experience in the type of sampling that is being performed in the field.
- Qualification requirements for Radiological Control Technicians (RCTs) are established by the Radiation Protection Program. The RCTs assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

In addition, pre-job briefings will be performed to evaluate an activity and associated hazards by considering many factors including the following:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety procedures applicable to the job
- Training requirements for individuals assigned to perform the work
- Level of management control
- Proximity of emergency contacts

Training records are maintained for each individual employee in an electronic training record database. The contractor's training organization maintains the training records system. The Field Work Supervisor or Project Manager will be used to confirm that an individual employee's training is appropriate and up-to-date prior to performing any field work.

D2.1.6 Documents and Records

The Project Manager is responsible for ensuring that the current version of the SAP is being used and for providing any updates to field personnel. Version control is maintained by the administrative document control process. Significant changes to the SAP will be reviewed and approved by DOE and the lead regulatory agency prior to implementation. Table D2-3 defines the types of changes that may be made to the sampling design and the documentation requirements.

The Field Work Supervisor or BTR is responsible for ensuring that the field instructions are maintained and aligned with any revisions or approved changes to the SAP. The Field Work Supervisor or BTR will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook or on nonconformance report forms) in accordance with internal corrective action procedures.

The Project Manager, Field Work Supervisor, or designee, is responsible for communicating field corrective action requirements and ensuring immediate corrective actions are applied to field activities.

Table D2-1. Data Quality Indicators

Data Quality Indicators	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Actions
Precision	The measure of agreement among repeated measurements of the same property under identical or substantially similar conditions; calculated as either the range or as the standard deviation. May also be expressed as a percentage of the mean of the measurements, such as relative range, relative percent difference, or relative standard deviation (coefficient of variation).	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory or have two or more laboratories analyze identical samples with the same method. Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements. Collect, process, and analyze collocated samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	Field precision: At randomly selected locations, duplicate samples will be taken one per 20 samples per media. Laboratory precision; analysis of laboratory duplicate or matrix spike duplicate. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity). • Request re-analysis or re-measurement. • Qualify the data before use.
Accuracy	A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample); usually expressed either as percent recovery or as a percent bias.	Laboratory accuracy determination based on matrix spikes and matrix spike duplicates. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If recovery does not meet objective: • Qualify the data before use. • Request re-analysis or re-measurement.

Table D2-1. Data Quality Indicators

Data Quality Indicators	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Actions
Representativeness	A qualitative term to express "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition." (ANSI/ASQC E4-2004).	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	Samples will be collected as described in the sampling design. Judgment sampling ensures areas most likely to be contaminated, based on current information, will be evaluated. Random sampling is based on ensuring all members of the group are equally likely to be chosen and allows probability statements to be made about the quality of estimates derived from the data. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If results are not representative of the system sampled: • Identify the source of the non-representation. • Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system that the data represent. • Redefine sampling and measurement requirements and protocols. • Resample and reanalyze.
Comparability	A qualitative term expressing the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.	Compare sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols.	Sampling personnel will use the same sampling protocols. Samples will be submitted to the same laboratories when possible (based on laboratory contracts) for analysis by the same methods, thus data results will be comparable. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.

Table D2-1. Data Quality Indicators

Data Quality Indicators	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Actions
Completeness	A measure of the amount of valid data needed to be obtained from a measurement system.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/acceptance criteria).	The percent complete will be determined during data validation. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If data set does not meet completeness objective: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.
Sensitivity	The capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.	Determine the minimum concentration or attribute to be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit). The practical quantitation limit is the lowest level which can be routinely quantified and reported by a laboratory.	Ensure sensitivity, as measured detection limits, is appropriate for the action levels. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If sensitivity does not meet objective: • Request reanalysis or re-measurement. • Qualify/reject the data before use.

Notes:

* Field sampling requirements are noted. Laboratories will follow contract requirements for use and interpretation of laboratory control samples.

ANSI/ASCQ E4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use.*

DQI = data quality indicator

QA = quality assurance

Table D2-2. Analytical Performance Requirements for Untreated and Treated Water

Chemical Abstracts Service CAS #	Analyte	Method	RDL – Water (µg/L)*	Precision	Accuracy
		Contaminants of Concern			
56-23-5	Carbon Tetrachloride	Aromatic & halogenated VOA–8021	1	≤20%	80-120%
79-01-6	Trichloroethylene		1	≤20%	80-120%
14797-55-8	Nitrate	Anions by IC – 300.0	250	≤20%	80-120%
18540-29-9	Hexavalent Chromium	Chromium (hex) – 7196	10	≤20%	80-120%
7440-47-3	Chromium (total)	ICP metals – 6010	10	≤20%	80-120%
15046-84-1	Iodine-129	Iodine-129 low level	1 pCi/L	≤30%	70-130%
		Iodine-129	N/A	≤30%	70-130%
14133-76-7	Technetium-99	Technetium-99	15 pCi/L	≤30%	70-130%
10028-17-8	Tritium	Tritium (H-3)	400 pCi/l	≤30%	70-130%

Notes:

* Units except as otherwise noted.

CAS = Chemical Abstracts Service
IC = ion chromatography
ICP = inductively-coupled plasma
N/A = not applicable
pCi/L = picocuries per liter
RDL = required detection limit
RPD = relative percent difference
VOA = volatile organic analysis

Table D2-3. Change Control for Sampling Projects

Type of Change	Action	Documentation
Temporary (≤ 1 event) adding constituents, locations, or increasing sampling frequency.	Project management approval; notify regulatory agency POC if appropriate.	Project's schedule tracking system.
Permanent (>1 event or year) adding constituents, locations, or increasing sampling frequency.	Revise SAP; obtain regulatory approval; distribute plan.	Letter report documenting changes or revised plan.

Notes:

POC = point of contact

SAP = sample and analysis plan

Logbooks are required for field activities. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook and only authorized persons may make entries in logbooks. Logbooks will be signed by the field manager, supervisor, cognizant scientist/engineer, or other responsible individual. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

The Project Manager is responsible for ensuring that a project file is properly maintained. The project file will include the following, as appropriate:

- Field logbooks or operational records
- Data forms
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports
- Interim progress reports
- Final reports
- Laboratory data packages
- Verification and validation reports

The project file will contain the records or references to their storage locations.

The laboratory is responsible for maintaining, and having available upon request, the following:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements of the Tri-Party Agreement.

D2.2 Data Generation and Acquisition

The following subsections address data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

D2.2.1 Sampling Process Design

The sampling design is systematic, where samples are taken at regular, specified intervals from specific locations at the treatment facility. No statistical analysis is needed for these samples, which are taken to monitor and/or confirm that the system is functioning correctly.

D2.2.2 Sampling Methods

Sampling is described in Section D3.5, and specific information includes the following:

- Sampling methods
- Sample preservation, containers, and holding times
- Corrective actions for sampling activities
- Decontamination of sampling equipment

D2.2.3 Sample Handling and Custody

A sampling and data tracking database is used to track the samples from the point of collection through the laboratory analysis process. Samplers should note any anomaly with a sample (e.g., sample appears unusual or sample is sludge) to prevent laboratory batching across similar matrices. If anomalies are found, the sampler should write "DO NOT BATCH" on the chain-of-custody form and inform the Sample Management and Reporting.

Laboratory analytical results are entered and maintained in the HEIS database. The HEIS sample numbers are issued to the sampling organization for the project. Each chemical, radiological, and physical properties sample is identified and labeled with a unique HEIS sample number.

Specific sample handling information is provided in Section D3.7 and includes the following:

- Container requirements
- Container labeling and tracking process
- Sample custody requirements
- Shipping and transportation

Sample custody during laboratory analysis is addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by the Sample Management and Reporting organization.

D2.2.4 Analytical Methods

Information on analytical methods is provided in Table D2-2. These analytical methods are controlled in accordance with the laboratory's QA Plan and the requirements of this QAPjP. Sample Management and Reporting participates in overseeing off-site analytical laboratories to qualify them for performing Hanford Site analytical work.

If the laboratory uses a nonstandard or unapproved method, then the laboratory must provide method validation data to confirm that the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Deviations from the analytical methods noted in Table D2-2 must be approved by the Sample Management and Reporting organization in consultation with Project Manager.

Laboratories providing analytical services in support of this SAP will have a corrective action program in place that addresses analytical system failures and documents the effectiveness of any corrective actions. Issues that may affect analytical results are to be resolved by the Sample Management and Reporting organization in coordination with the Project Manager.

(Note: Include any discussion on the use of non-routine or alternate methods chosen to meet detection limit requirements or other special needs.)

D2.2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Field QC sampling will include the collection of full trip blank, field transfer blank (FXR), and field duplicate samples. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table D2-4.

D2.2.5.1 Field QC samples

Field QC samples will be collected to evaluate the potential for cross-contamination, and to provide information pertinent to field sampling variability and laboratory performance. Field blanks are typically prepared using high purity reagent water. The QC samples and the required frequency for collection are described in this section.

Table D2-4. Project Quality Control Sampling Summary

Quality Control Sample Type	Purpose	Frequency
	Field Quality Control	
Trip Blank	Assess contamination from containers or transportation.	One per 20 samples per media sampled.
Field Transfer Blank	Assess contamination from sampling site.	One per day when volatile organics are sampled per media sampled.
Field Duplicates	Estimate precision, including sampling and analytical variability.	One per batch*, 20 samples maximum of each media sampled.
Equipment rinsate	Verify adequacy of sampling equipment decontamination Solids: Minimum of one per each sample train or 1 per 10 locations, whichever is greater.	Water: Minimum of one for each sample train or 1 per 10 locations, which ever is greater. If disposable equipment is used, then an equipment rinsate blank is not required.

Table D2-4. Project Quality Control Sampling Summary

Quality Control Sample Type	Purpose	Frequency
	Laboratory Quality Control*	
Method Blank	Assess response of an entire laboratory analytical system.	One of each media sampled up to a maximum of 20.
Matrix Spike	Identify analytical (preparation + analysis) bias; possible matrix affect on the analytical method used.	One of each media sampled up to a maximum of 20.
Matrix Duplicate or Matrix Spike Duplicate	Estimate analytical bias and precision.	One of each media sampled up to a maximum of 20.
Laboratory Control Samples	Assess method accuracy.	One per batch*, 20 samples maximum or as identified by the method guidance per media sampled.
Surrogates	Estimate recovery/yield.	As identified by the method guidance.

Notes:

* Batching across projects is allowed for similar matrices (e.g., the Hanford Site groundwater).

Field Trip Blank. Field trip blanks (FTBs) are prepared by the sampling team prior to traveling to the sampling site. The preserved bottle set is either for volatile organic analysis (VOA) only or identical to the set that will be collected in the field. It is filled with reagent water or silica sand, as appropriate to the primary sample media. The bottles are sealed and will be transported, unopened, to the field in the same storage containers used for samples collected the same day. The FTBs are typically analyzed for the same constituents as the samples from the associated sampling event. FTBs are used to evaluate potential contamination of the samples attributable to the sample bottles, preservative, handling, storage, and transportation.

Field Transfer Blanks. FXRs are preserved VOA sample bottles filled at the sample collection site with reagent water or silica sand (as appropriate to the primary sample media), transported to the field. The samples will be prepared during sampling to evaluate potential contamination attributable to field conditions. After collection, FXR bottles will be sealed and placed in the same storage containers with the samples collected the same day for the associated sampling event. FXR samples will be analyzed for VOCs only.

For the field blanks (i.e., FTB, FXR) results greater than two times the method detection limit are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit.

Field Duplicates. Field duplicates are independent samples collected as close as possible to the same time and from the same location as the parent sample. Field duplicates are two separate samples collected from the same source, placed in separate sample containers, and analyzed independently. The field duplicates should be collected generally from an area expected to have some contamination so valid comparisons between the samples can be made (i.e., some constituents will likely be greater than detection limit).

Solid matrix field duplicate samples will be collected and homogenized before dividing into two separate samples in the field. VOA soil duplicates will be sampled as collocated samples, described below. Field duplicates will be stored and transported together, and analyzed for the same constituents. The field duplicate samples will be used to determine precision for both sampling and laboratory measurements.

Collocated samples are two samples collected as close as possible to the same time and location which are not homogenized. This sampling protocol is used when homogenizing samples for split or duplicate samples could impact the quality of data.

Results of field duplicates must have precision within 20 percent, as measured by the relative percent difference (RPD). Only field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity will be evaluated. Evaluation of the results can provide an indication of intra-laboratory variability. Large RPDs can be an indication of potential laboratory performance problems and may be investigated.

Equipment Blanks. Or equipment rinsate blanks are samples in which high purity reagent water is passed through the sample collection tool or put in contact with the sampling surfaces of the equipment and the water collected and transferred into the appropriate containers. EB samples need only be collected from equipment that undergoes decontamination and is used for repeated sample collection. The EB sample bottles are placed in the same storage containers with the samples from the associated sampling event. EB samples are analyzed for the same constituents as the samples from the associated sampling event. EBs are used to evaluate the effectiveness of the cleaning process to ensure samples are not cross -contaminated from previous sampling events or between locations.

High purity water is Type II American Society for Testing and Materials (ASTM) organic-free water if samples for volatile organic compound (VOC), inorganic and radionuclides analysis are being collected that day, or certified deionized water if samples for only inorganic and radionuclide constituents are being collected. For EB type samples, laboratory results greater than twice the method detection limit may indicate the presence of cross-contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the threshold is five times the method detection limit. For radiological analytical data, blank results are flagged if they are greater than two times the total minimum detectable activity.

D2.2.5.2 Laboratory QC samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, and matrix spike) are defined for the three-digit EPA methods (EPA/600/4-79/20, *Methods for Chemical Analysis of Water and Wastes*) and for the four-digit EPA methods (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*), and will be run at the frequency specified in the respective reference unless superseded by agreement.

The QC checks outside of control limits will be reflected in the data validation process and during the DQA, if performed, described in Section D2.4.

D2.2.5.3 QC Requirements

Table D2-4 includes the field QC requirements for sampling. If no VOC samples are collected, then a FXR is not required. Field blanks are not required when transferring samples to the field gas chromatograph for analysis.

Field duplicates must agree within 20 percent, as measured by the RPD, to be acceptable. Only those field duplicates with at least one result greater than five times the appropriate detection limit are evaluated.

Field duplicate results not satisfying evaluation criteria will be qualified and flagged in HEIS, as appropriate.

For chemical analyses, the control limits for laboratory duplicate samples, matrix spike samples, matrix spike duplicate samples, surrogate recoveries, and laboratory control samples are typically derived from historical data at the laboratories in accordance with SW-846. Typical control limits are within 25 percent of the expected values, although the limits may vary considerably depending upon the method and analyte. For radiological analyses, the control limits for laboratory QC samples are specified in the laboratory contract.

Holding time is the elapsed time period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the analytical method, as specified for three-digit EPA methods (EPA/600/4-79/020) or for the four-digit EPA methods (SW-846).

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The CHPRC Soil and Groundwater Remediation Project periodically audits the analytical laboratories to identify, resolve, and prevent quality problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

Failure of QC will be determined and evaluated during data validation and DQA processes. Data will be qualified, and flagged in HEIS, as appropriate.

D2.2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Equipment used for collection, measurement, and testing will meet applicable standards (e.g., American Society for Testing and Materials) or have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications. The Field Work Supervisor, FTR, or equivalent, will ensure the data generated from instructions using a software system are backed up and/or downloaded on a regular basis. Software configuration will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory directly affecting the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with the three-digit EPA methods (EPA/600/4-79/020) and four-digit EPA methods (SW-846), as amended, or with auditable DOE Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed per SW-846 requirements and will be appropriate for their use.

D2.2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in Section D3.4. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

D2.2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes described in the contractor acquisition system. Responsibilities and interfaces necessary to ensure that items procured/acquired by the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

D2.2.9 Non-Direct Measurements

Non-direct measurements are not needed for this project.

D2.2.10 Data Management

The Sample Management and Reporting organization, in coordination with the Project Manager, is responsible for ensuring that analytical data is appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Action Plan (Ecology et al. 1989b).

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish their resolution with the Project Manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

Planning for sample collection and analysis will be in accordance with the programmatic requirements governing fixed laboratory sample collection activities, as discussed in the sampling procedures. In the event that specific procedures do not exist for a particular work evolution, or if it is determined that additional guidance is needed to complete certain tasks is needed, a work package will be developed to adequately control the activities, as appropriate. Examples of sampling procedure requirements include activities associated with the following:

- Chain of custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks
- Checklists
- Sample packaging and shipping

Approved work control packages and procedures will be used to document field activities including radiological and non-radiological measurements when this SAP is implemented. Field activities will be recorded in the field logbook.

D2.3 Assessment and Oversight

The elements in assessment and oversight address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

D2.3.1 Assessments and Response Actions

Contractor management, Regulatory Compliance, QA, and/or Health and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this

SAP, project work packages, the project quality management plan, procedures, and regulatory requirements. The Project Manager will determine whether a DQA will be performed for the activities identified in this SAP. The DQA process, if performed, is discussed in Section D2.4. The results of the DQA will be provided to the project manager. No other planned assessments have been identified.

If circumstances arise in the field dictating the need for additional assessment activities, then additional assessments would be performed. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions/deficiencies in accordance with the contractor QA program, the corrective action management program, and associated procedures implementing these programs.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The contractor oversees offsite analytical laboratories and qualifies the laboratories for performing Hanford Site analytical work.

D2.3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to the Sample Management and Reporting organization, which then initiates a sample issue resolution form in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the Project Manager.

A DQA report will be prepared to determine whether the type, quality, and quantity of collected data met the quality objectives described in this SAP.

D2.4 Data Validation and Usability

The elements in data validation and usability address the QA activities occurring after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying the project objectives.

D2.4.1 Data Review, Verification, and Validation

The criteria for verification include, but are not limited to, review for completeness (samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

Data validation will be performed to ensure that the data quality goals established during the planning phase have been achieved. Data validation will be in accordance with internal procedures. The criteria for data validation are based on a graded approach. The primary contractor has defined five levels of validation, A through E. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of all data (e.g., calibration data, calculations of representative samples from the data set).

Data validation will be performed to contractor Level C. Level C validation consists of a review of the QC data and specifically requires verification of deliverables, requested versus reported analytes, and qualification of the results based on evaluation of analytical holding times, method blank results, matrix spike/matrix spike duplicate results, surrogate recoveries, and duplicate sample results. Level C data validation will be performed on at least 5 percent of the data by matrix and analyte group. Analyte group refers to categories, such as radionuclides, volatile organic compounds, semivolatile organics, metals, and anions. The goal is to cover the various analyte groups and matrices during the data validation process.

Relative to analytical data in sample media, physical data and/or field screening results are of lesser importance in making inferences regarding risk. Physical data and field QA/QC results will be reviewed to ensure that physical property data and/or field screening results are usable.

D2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines. Data validation may be performed by Sample Management and Reporting organization and/or by a party independent of both the data collector and the data user. Data validation qualifiers must be compatible with the HEIS database.

When outliers or questionable results are identified, additional data validation will be performed. The additional validation will be performed for up to 5 percent of the statistical outliers and/or questionable data. The additional validation will begin with Level C and may increase to Levels D and E, as needed, to ensure that the data are usable. Note that Level C validation is a review of the QC data, while Level D and Level E include review of calibration data and calculations of representative samples from the data set. Data validation results will be documented in data validation reports. An example of questionable data is a positive detection greater than the practical quantitation limit or reporting limit in soil from a site that should not have exhibited contamination. Similarly, results less than background would not be expected and could trigger a validation inquiry. The determination of data usability will be conducted and documented in a DQA report.

Data validation results will be documented in data validation reports which will be included in the project file.

D2.4.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine whether quantitative data are of the correct type and are of adequate quality and quantity to meet the project requirements. The results of the DQA will be used in interpreting the data and determining if the objectives of this activity have been met.

D2.4.4 Corrective Actions

The responses to data quality defects identified through the DQA process will vary and may be data-or measurement-specific. Some pre-identified corrective actions are included in Section D2.1.4.

D3 Field Sampling Plan

The previous sections presented an overall description of the P&T plant design, the COCs, and project performance and quality requirements. This section provides additional detail regarding the schedule and performance of on-site activities.

D3.1 Site Background and Objectives

A description of the treatment system was provided as site background information in Section D1. In addition, waste streams, sampling points, and COCs were presented in Table D1-1 through Table D1-4. Specific objectives of sampling plan presented here are to establish a sampling schedule, target analytes for individual sampling points, and procedural requirements for conducting and documenting field activities.

D3.2 Documentation of Field Activities

Logbooks or data forms are required for on-site activities. Requirements for the logbook are provided in Section D2.1.6. Data forms may be used to collect specific information; however, the data forms must follow the same requirements as those for logbooks presented below and the data forms must be referenced in the logbooks. The following is a summary of information to be recorded in logbooks:

- Purpose of activity
- Day, date, time, and weather conditions, as appropriate
- Names, titles, and organizations of personnel present
- Deviations from the QAPjP or procedures
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (e.g., preparation, splits, duplicates, matrix spikes, and blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations and surveys and equipment identification numbers as applicable
- Equipment decontaminated, number of decontaminations, and variations to any decontamination procedures
- Equipment failures or breakdowns and descriptions of any corrective actions
- Telephone calls relating to field activities

D3.3 Sampling Design

The sampling design presented in this SAP is systematic. Samples associated with this SAP will be collected on a routine basis and at specified locations during treatment system operations.

D3.4 Calibration of Equipment

Field water-quality parameters including pH, specific conductance, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential will be measured and recorded when the untreated and treated water samples are collected (Section D3.5.1 and Section D3.5.2). Portable air monitoring equipment (e.g., photoionization detector) may also be used during GAC change out or during stack emissions sampling. The sampling lead is responsible for ensuring portable equipment is calibrated appropriately. Field water quality instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from instrument calibration activities are recorded in logbooks and/or work packages; either hard copy or electronic versions will be maintained.

Calibrations must be performed as follows:

- Before initial use (start of project)
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria

Instrument, calibration, and QA checks will be performed in accordance with the following:

- Calibration of radiological field instruments on the Hanford Site is performed by Pacific Northwest National Laboratory, as specified in its program documentation.
- Daily calibration checks are performed and documented for each instrument used to characterize the media being evaluated. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Measurement times will be sufficient to establish detection efficiency and resolution.

D3.5 Sample Location and Frequency

The physical locations for sampling untreated and treated water streams, air emissions, sludge, and loaded GAC and resin are expected to occur within the treatment system building or transfer buildings. Precise locations will be established upon final design and construction.

D3.5.1 Untreated Water from Extraction Wells

Sampling of the three untreated water streams will be performed monthly. The target analytes will be those COCs shown in Table D1-2. Twice annually, the analyte list will be expanded to include the other constituents shown in Table D1-2. At the time of collection, field parameters including pH, specific conductance, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential will be measured and recorded.

D3.5.2 Treated Water

The treated water stream sent to the injection well field will be sampled monthly for the COCs listed in Table D1-3. Depending on treatment system performance and untreated water characteristics, the analyte list may be expanded to include the other constituents listed in Table D1-2.

D3.5.3 VPGAC Stacks

A gas sample of air emitted from each VPGAC stack will be collected quarterly and submitted for analysis of VOCs listed in Table D1-4. Field air monitoring using a photoionization detector may be performed and the measurements recorded during air emissions sampling.

D3.5.4 Loaded GAC

Loaded GAC will be batch sampled. The actual schedule will depend on the rate at which individual canisters become loaded and must be exchanged. Measurement of VOCs per Table D1-4 will be performed to determine if the canister(s) may be shipped offsite. Assuming release for off-site shipping, the canisters will be shipped offsite for regeneration.

D3.5.5 Loaded IX Resin

Loaded IX resin will be batch sampled. The actual sampling schedule will depend on the loading rate and resin capacity. Analytes will include the COCs from Table D1-3. During startup or at major changes to well field operations, additional characterization for waste designation may be needed. The need for this testing will be determined on a case-by-case basis.

D3.5.6 Dewatered Sludge

The dewatered sludge from the aeration filters will be batch sampled as each container is filled. The analytes will be the COCs (except tritium) as shown in Table D1-3. During startup or at major changes to well field operations, additional characterization for waste designation may be needed. The need for this testing will be determined on a case-by-case basis.

These sampling requirements are summarized in Table D3-1 and Table D3-2.

Table D3-1. Periodic Water and Air Sampling and Analysis Requirements

Sampling Point	Monthly	Semi-Annually	Reference
Water Quality Analysis			
Untreated water to uranium IX system	COCs	COCs and other constituents	Table D1-2
Untreated water to Technetium-99 IX system	COCs	COCs and other constituents	Table D1-2
Balance of well field inflow	COCs	COCs and other constituents	Table D1-2
Treated water	COCs	COCs and other constituents if necessary	Table D1-3, Table D1-2
Air Quality Monitoring			
Main VPGAC stack	VOCs at VPGAC stacks		Table D1-4
Extraction Transfer Buildings			

Notes:

CMP = Compliance Monitoring Plan (Appendix A)

COC = contaminant of concern

IX = ion exchange

PMP = Performance Management Plan (Appendix E)

VOC = volatile organic compound

VPGAC = vapor-phase granular activated carbon

Table D3-2. Waste Stream Batch Sampling and Analysis Requirements

Waste Type	Initial Waste Profile	Routine Batch Analysis
Loaded uranium IX resin	Table D1-3 COCs + COPCs from DQO	COCs (except tritium)
Loaded Technetium-99 IX resin	Table D1-3 COCs + COPCs from DQO	COCs (except tritium)
Dewatered aeration filter sludge	Table D1-3 COCs + COPCs from DQO	COCs (except tritium)
Loaded granular activated carbon	Table D1-4 COCs + COPCs from DQO	VOCs from Table 1-4

Notes:

COC = contaminant of concern

COPC = contaminant of potential concern

DQO = data quality objective (project-specific report as required by Appendix B)

IX = ion exchange

VOC = volatile organic compound

D3.6 Sampling Methods

Ports for sampling untreated and treated water flow streams will be specified and marked upon completion of the pretreatment and main treatment facility. Access to and operation of sample ports and valves will be controlled by plant operating procedures. Methods for practical collection of samples of resins, sludge, and loaded GAC will depend upon the physical characteristics of plant apparatus, and will be included in plant operating procedures.

D3.6.1 Corrective Actions

The project lead, sampling lead, or designee must document deviations from procedures or other problems pertaining to sample collection, chain-of-custody, target analytes, contaminants of potential concern, sample transport, or other noncompliance. As appropriate, such deviations or problems will be documented in the field logbook or on nonconformance report forms in accordance with corrective action procedures. The project lead, sampling lead, or designee will be responsible for communicating field corrective action requirements and for ensuring immediate corrective actions are applied to sampling activities.

D3.6.2 Decontamination of Sampling Equipment

Equipment used during sampling of resins, sludge, or loaded GAC will be decontaminated in accordance with the plant operating procedure. To prevent contamination of the samples, care should be taken to use clean or dedicated equipment for each sampling activity. Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers.
- Contaminating the equipment or sample container by setting the equipment/sample container on or near potential contamination sources.
- Handling bottles or equipment with dirty hands or gloves.
- Improperly decontaminating equipment before sampling or between sampling events.

D3.6.3 Radiological Screening

Radiological screening of waste samples will be performed by the RCT or other qualified personnel. The RCT will record field measurements.

The following information will be disseminated to personnel performing work in support of this SAP.

- Instructions will be provided to RCT on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the Geiger-Müller, portable alpha meter, dual phosphors beta/gamma, and sodium iodide portable instruments, will include a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. These instruments are commonly used on the Hanford Site for obtaining measurements of removable surface contamination and direct measurements of total surface contamination.
- Information on the characteristics associated with the hand-held probes to be used in the performance of direct radiological measurements will include a physical description of the probe, the radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. The hand-held probe is an alpha detection instrument commonly used on the Hanford Site for measuring removable surface contamination and direct measurements of the total surface contamination.

D3.7 Sample Handling

Level I EPA pre-cleaned sample containers will be used for waste and water samples collected for chemical analysis. Container material, minimum volume or weight of sample, sample preservation, and holding times are summarized in Table D3-3.

D3.7.1 Container Labeling

The sample location, depth, and corresponding HEIS numbers are documented in the sampler's field logbook. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to detect potential tampering.

Each sample container will be labeled with the following information on firmly affixed, water-resistant labels:

- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable)
- Sampling authorization form number

In addition to the above information, sample records must include the following:

- Analysis required
- Source of sample
- Matrix
- Field data (pH, radiological readings)

Except for VOA samples, a custody seal will be affixed to the lid of each sample container. The custody seal will be inscribed with the sampler's initials and the date. Custody seals are not applied directly to VOA bottles because of a potential for affecting analytical results. Custody seals and any other required labels/documentation can be fixed to the exterior of a plastic bag holding vials in such a manner to detect potential tampering.

D3.7.2 Sample Custody

Sample custody will be maintained in accordance with existing CHPRC procedures to ensure the maintenance of sample integrity throughout the analytical process. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory. Shipping requirements will determine how sample shipping containers are prepared for shipment. The analysis requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to Sample Management and Reporting within 48 hours of shipping.

The following information is recorded on a completed chain-of-custody form:

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer
- Requested analyses or reference thereto

D3.7.3 Sample Transport

Sample transportation will be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste mandated by the U.S. Department of Transportation (49 CFR, "Transportation," Chapter I, "Pipeline and Hazardous Materials Safety Administration, Department of Transportation," Part 171, "General Information, Regulations, and Definitions," through Part 177, "Carriage By Public Highway") in association with the International Air Transportation Authority, DOE requirements, and applicable program-specific implementing procedures.

Table D3-3. Analytical Methods, Sample Containers, Preservation, and Holding Times

Analytical Method	Container and Amount of Sample	Preservative	Holding Time
Aromatic & halogenated VOA – 8021 or 8260	G, 40 mL VOA vial (water) 125 mL jar (solid)	Cool to ≤4°C	14 day
Chromium (hex) - 7196	P, G, 400 mL (water) 100 g (solid)	Cool to ≤4°C	24 hour (water) 30 day until extraction (solid)
ICP metals - 6010	P, G, 1 L (water) 200 g (solid)	HNO_3 to pH<2 (water) None (solid)	6 month
Radionuclides	P, G	HNO_3 to pH<2 (water) None (solid)	6 month

Notes:

G = glass
P = polyethylene
g = gram
ICP = inductively-coupled plasma
L = liter
mL = milliliter
VOA = volatile organic analysis
HNO_3 = nitric acid
pH = $-\log_{10}[H^+]$

D3.8 Waste Management

All waste (including unexpected waste) generated by sampling activities will be managed in accordance with Appendix B, *Waste Management Plan for the 200-ZP-1 Groundwater Operable Unit*. Pursuant to 40 CFR 300.440, "Procedures for Planning and Implementing Off-Site Response Actions," approval from the DOE/RL Project Manager is required before returning unused samples or waste from offsite laboratories. Laboratories located on the Hanford Site (such as the 222-S Analytical Laboratories or Waste Sampling and Characterization Facility) are outside the "areal extent of contamination" and are thus considered "offsite" (EH-231-020/0194, *The Off-Site Rule*). Authority is granted per the signature on this SAP that unused samples and associated laboratory waste for the analysis will be disposed in accordance with the laboratory contract and agreements for return to the project site.

D4 Health and Safety

Sampling operations will be performed in accordance with health and safety requirements and appropriate CHPRC Soil and Groundwater Remediation Project requirements. Additionally, work control documents will be prepared to provide further control of site operations. Safety documentation will include an activity hazard analysis and, as applicable, radiological work permits. The sampling procedures and associated activities will implement ALARA practices to minimize the radiation exposure to the sampling team, consistent with the requirements defined in 10 CFR 835, "Occupational Radiation Protection."

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D5 References

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Appendix E

Groundwater Sampling and Analysis Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action

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Contents

Figures

Tables

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Terms

ALARA	as low as reasonably achievable
amsl	above mean sea level
ANSI/ASME	American National Standards Institute/American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
CFR	*Code of Federal Regulations*
COC	contaminant of concern
DOE	U.S. Department of Energy
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DS	decision statement
DTW	depth to water
DUP	field duplicates
EB	equipment blank
ECO	environmental compliance officer
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
GPS	global positioning system
HEIS	*Hanford Environmental Information System* database
IC	institutional control
ICP	inductively coupled plasma
IDW	investigation-derived waste
MCL	maximum contaminant level
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NA	not applicable
OU	operable unit
P&T	pump-and-treat
PMP	performance monitoring plan

POC	point-of-contact
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	radiological control technician
ROD	record of decision
RL	Richland Operations Office
SAP	sampling and analysis plan
TAL	target analyte list
TBD	to be determined
TPA	Tri-Party Agreement
VOC	volatile organic compound
WAC	*Washington Administrative Code*

E1 Introduction

This groundwater sampling and analysis plan (SAP) describes field monitoring activities associated with implementation of the selected remedy for the 200-ZP-1 Groundwater Operable Unit (OU) as presented in the *Record Of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington* (EPA et al., 2008). The objective for the groundwater SAP is to describe the methods that will be used to collect the data necessary to assess performance of the 200-ZP-1 groundwater OU remedial action, specifically the pump-and-treat (P&T), monitored natural attenuation (MNA) and flow path control elements of the selected remedy. This groundwater SAP is expected to run concurrently with, and eventually supplant, DOE/RL-2002-17, *Sampling and Analysis Plan for the 200-ZP-1 Groundwater Monitoring Well Network* when the 200-ZP-1 Interim Action P&T system is shut down in 2011 or 2012. This SAP will also complement the 200 Area CERCLA Monitoring Plan, which is currently in development.

This groundwater SAP was prepared using the sampling design presented in DOE/RL-2009-115, *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action.* The groundwater SAP complements the *200 West Area Groundwater Treatment Facility Sampling and Analysis Plan* included as Appendix D to the Operations and Maintenance Plan. The treatment facility SAP provides guidance for activities associated with the sampling and analysis of the treatment system's untreated and treated groundwater, and its air, liquid, and solid waste streams.

E1.1 Operable Unit Description

The 200-ZP-1 groundwater OU includes several groundwater contaminant plumes that span an approximate 10 square km (4 square mi) area beneath the Hanford Site's 200 West Area (Figure E1-1). The 200 West Area contains permanent waste management facilities, and former reprocessing facilities associated with plutonium concentration and recovery operations at the Z-Plant and plutonium-separation operations at the T-Plant.

E1.1.1 Physical Setting

The 200 Area (East and West) is located on a broad, relatively flat plain that constitutes a local topographic high, commonly referred to as the Central Plateau. The plateau is a remnant paleo-flood bar (Cold Creek Bar) that trends east-west, with ground surface elevations varying between 197 and 225 m (647 to 740 ft) above mean sea level (amsl). The 200-ZP-1 OU underlies the northern portion of the 200 West Area, located at the western end of the Central Plateau. The 200 West Area lies about 8 km (5 mi) south of the Columbia River and 11 km (7 mi) from the nearest Hanford Site boundary.

The geology underlying the 200 West Area is comprised of, in descending order, the Hanford formation, the Cold Creek Unit, the Ringold Formation, and the Columbia River Basalt Group. The Hanford formation, Cold Creek Unit, and Ringold Formation vadose zone and aquifer sediments are about 169 m (555 ft) thick and comprised of gravel, sand, and silt mixtures (Figure E1-2, Figure E1-3, and Figure E1-4).

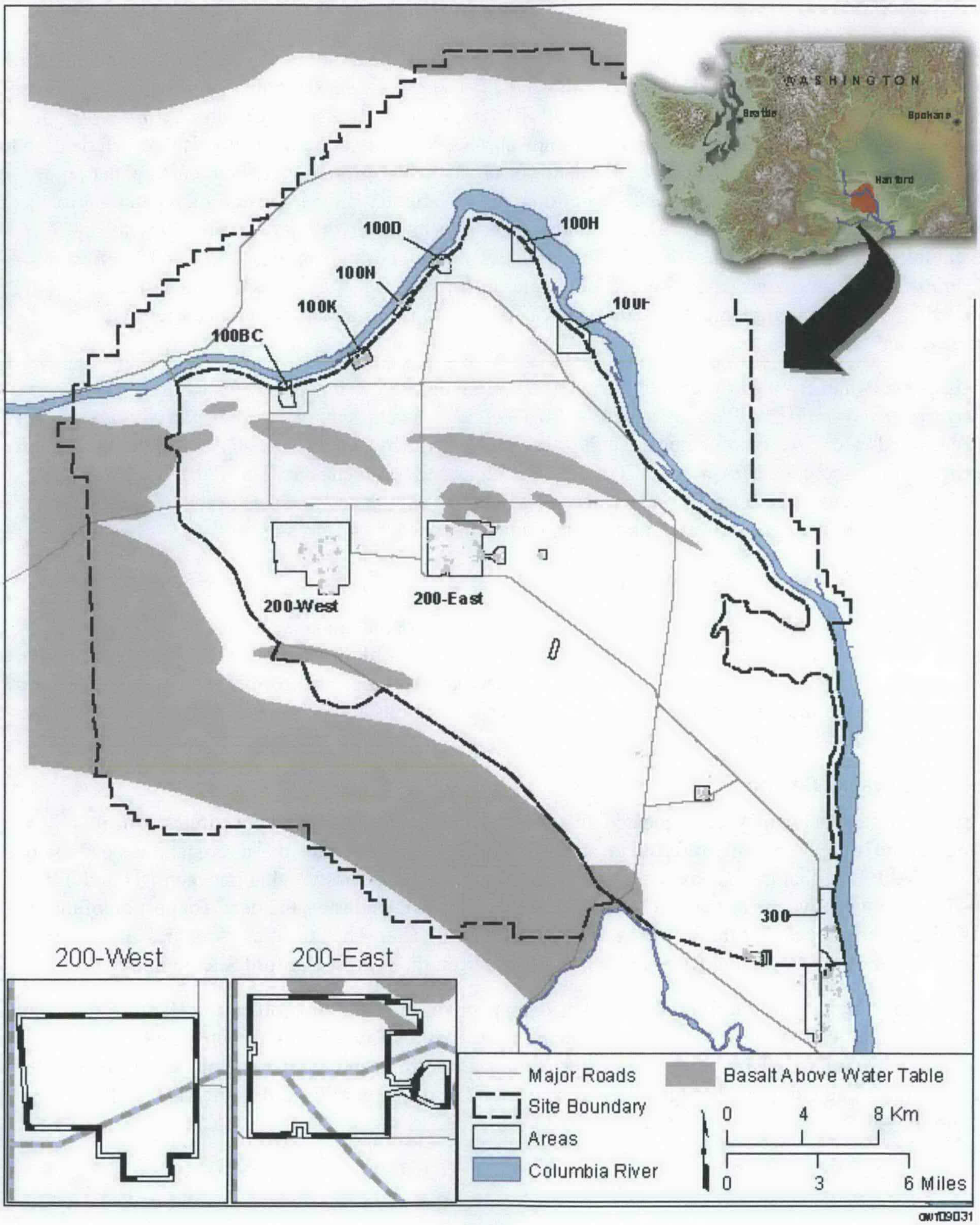

Figure E1-1. Site Location

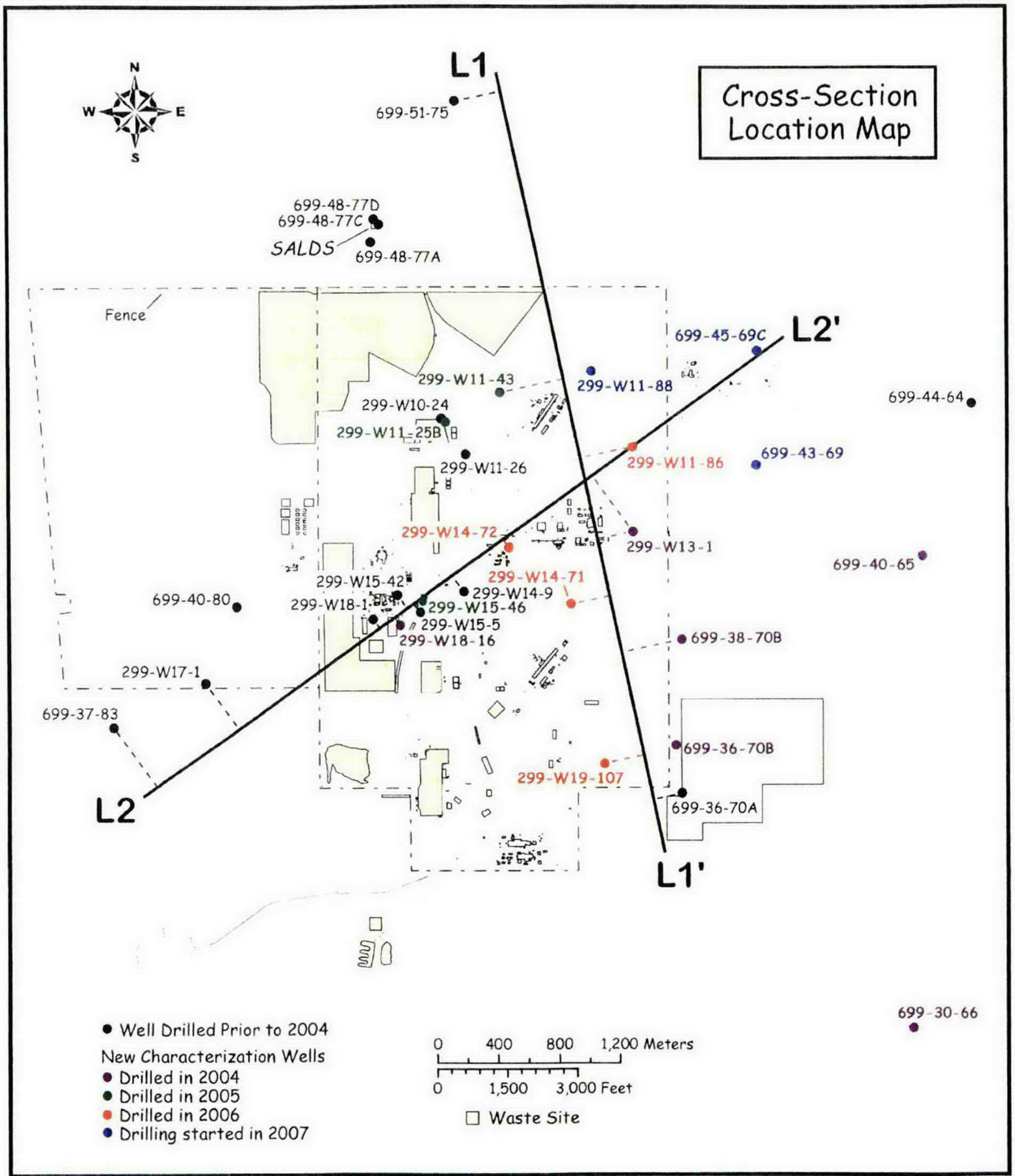

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Figure E1-2. Location of Geologic Cross-Sections

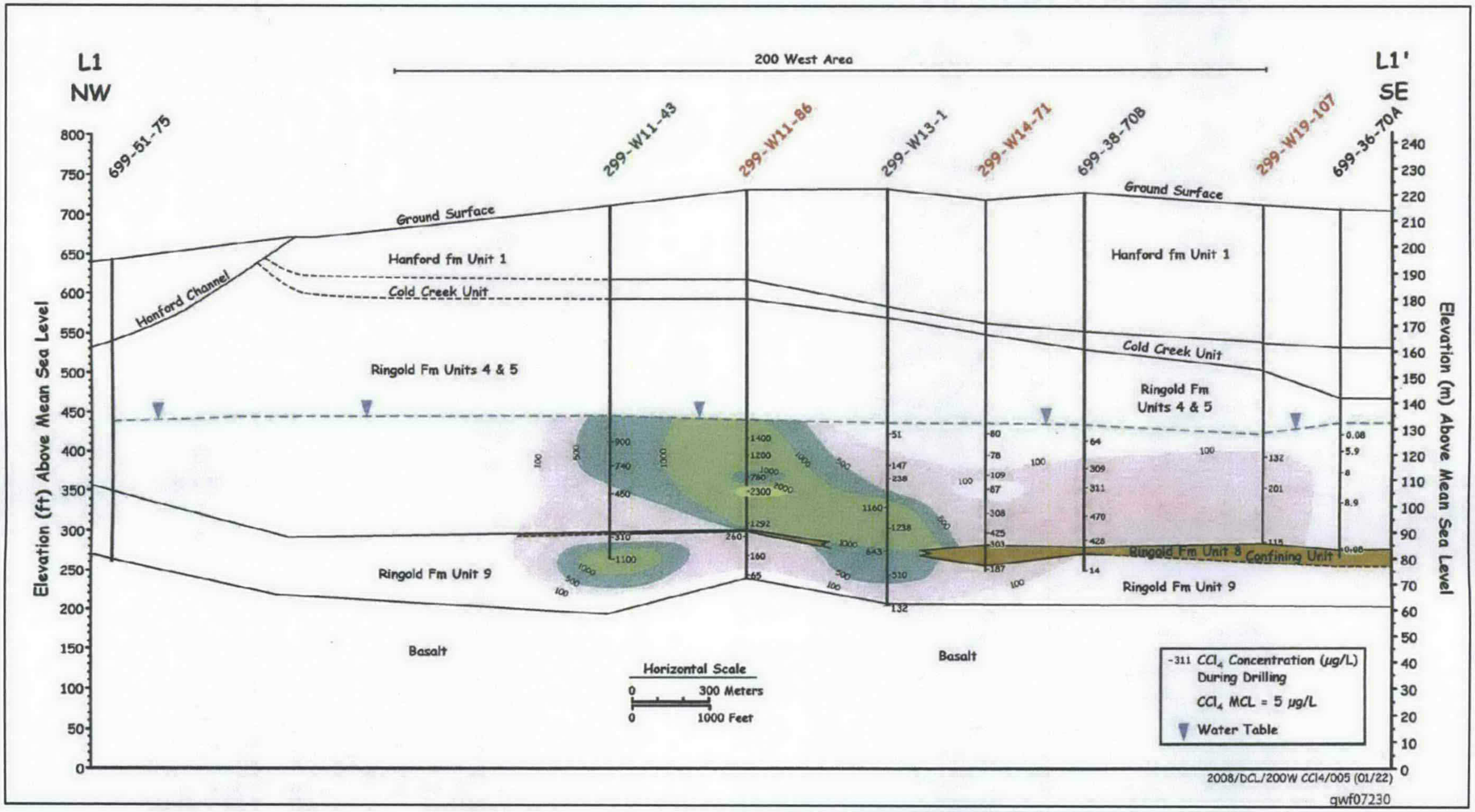
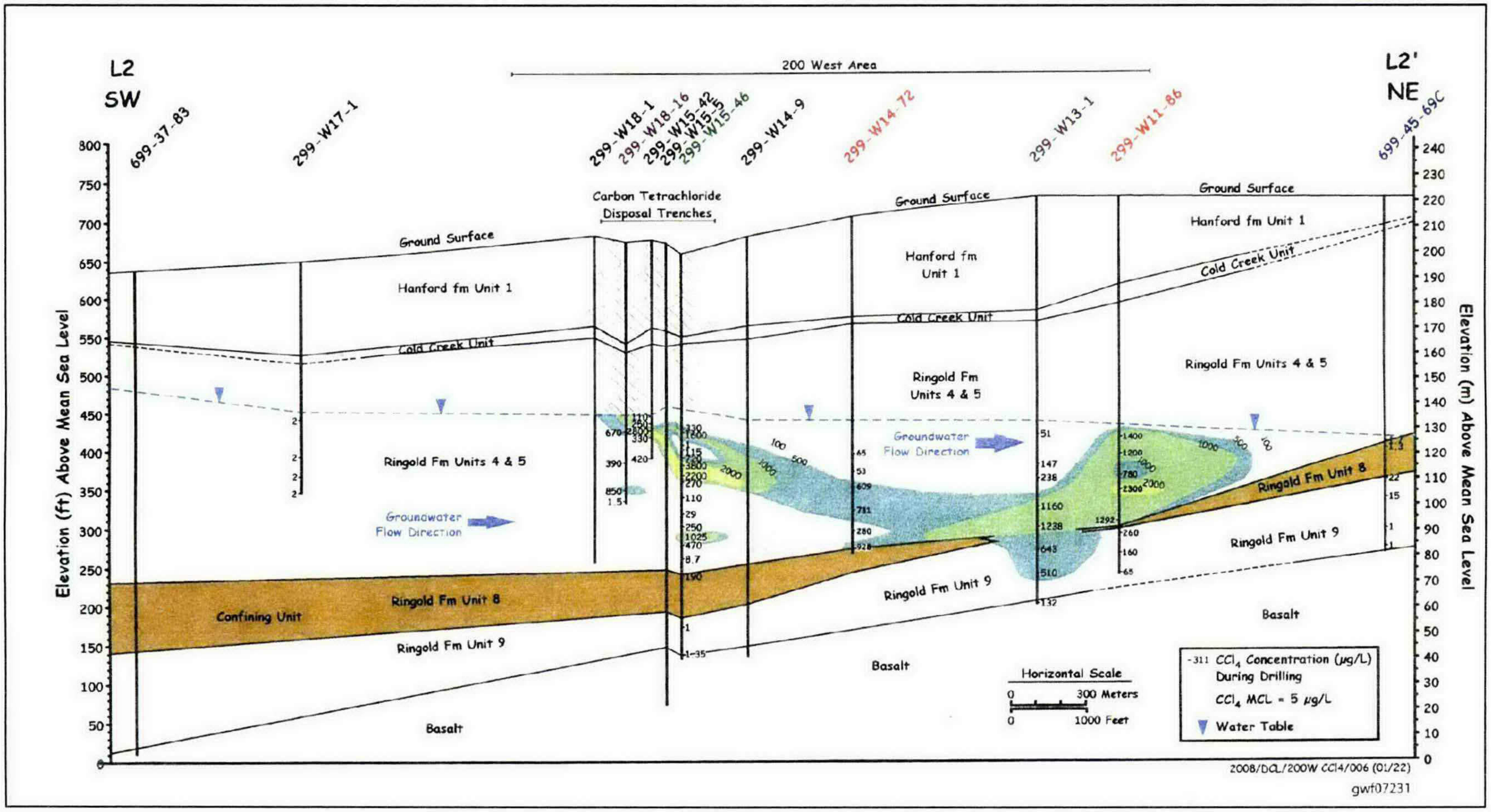


Figure E1-3. Geologic Cross Section L1 to L1' (Northwest to Southeast)



Notes:

modified from Remedial Investigation Report for the 200-ZP-1 Groundwater Operable Unit, DOE/RL-2006-24, Revision 0

Figure E1-4. Hydrogeologic Cross Section L2 to L2' (Southwest to Northeast)

The uppermost aquifer in the 200-ZP-1 OU is an unconfined aquifer which occurs in the Ringold Formation. Groundwater in the unconfined aquifer flows from areas where the water table is higher (west of the Hanford Site) to areas where it is lower (the Columbia River). The water table depth in the 200 West Area varies from about 50 m (164 ft) in the southwest corner near the former 216-U-1 Pond to greater than 100 m (328 ft) to the north.

Groundwater flows beneath the Central Plateau in a predominantly easterly direction from the 200 West Area to the 200 East Area (Figure E1-5) at velocities typically ranging from 0.0001 to 0.5 m per day (0.00033 to 1.64 ft per day) in the vicinity of the 200-ZP-1 OU. Historical effluent discharges in the 200 Area altered the groundwater flow regime, especially around the 216-U-10 Pond in the 200 West Area and the 216-B3-3 Pond in the 200 East Area. Seepage from these ponds raised the water table elevation, which in turn temporarily deflected groundwater flow to the north. As these discharges ceased, the water table has declined, and the natural easterly groundwater flow pattern has been restored.

E1.1.2 Nature and Extent of Contaminants

The contaminants of concern (COCs) identified in the Record of Decision (ROD) included: carbon tetrachloride, total chromium (trivalent [III] and hexavalent [VI]), nitrate, trichloroethene (TCE), iodine-129 (I-129), technetium-99 (Tc-99), and tritium. Carbon tetrachloride is the primary COC, with the other COCs (except nitrate) occurring in smaller comingled plumes that lie within the carbon tetrachloride plume boundary. Figure E1-3 and Figure E1-4 show the vertical distribution of carbon tetrachloride in the 200-ZP-1 Groundwater OU. The lateral distribution of carbon tetrachloride and proposed extraction and injection well locations are shown in Figure E1-5.

E1.2 Remedy Description

The selected remedy for the 200-ZP-1 groundwater OU includes: 1) groundwater P&T; 2) MNA; 3) flow path control; and 4) institutional controls (ICs). The first three components, which are the subject of this SAP, require periodic groundwater monitoring and data evaluation to assess remedy performance and to determine when the remedial action is complete. The fourth component does not require groundwater monitoring and is addressed separately in DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions*.

E1.2.1 Pump-and-Treat System

Implementation of the 200 West Area P&T remedy component will initially include drawing groundwater from a network of extraction wells at rates up to 1,000 gallons per minute (gpm) (3,785 liters per minute). As additional extraction wells are installed and brought online, and aquifer and contaminant plume response to pumping are defined, the pumping rate will be increased to rates up to 2,500 gpm (9,460 liters per minute).

The treatment system will include several unit operations/processes to reduce COC concentrations to the levels specified in the ROD. Treated water will be returned to the aquifer through an injection well network.

E1.2.2 Monitored Natural Attenuation

Natural attenuation processes will be used with P&T to reduce COC concentrations to the cleanup levels specified in the ROD. During the early stages of remedy implementation, the P&T system will account for a majority of the contaminant mass removal. In the outer regions of the plume, and during the latter stages of P&T system operation, natural attenuation will play an increasingly larger role in reducing COC concentrations. Natural attenuation processes expected to contribute to COC concentration reductions include abiotic degradation, volatilization, dispersion, sorption, and radioactive decay. Based on evaluations presented in the ROD, it is estimated that natural attenuation processes will reduce COC concentrations to the ROD cleanup levels within 100 years of ceasing P&T operations.

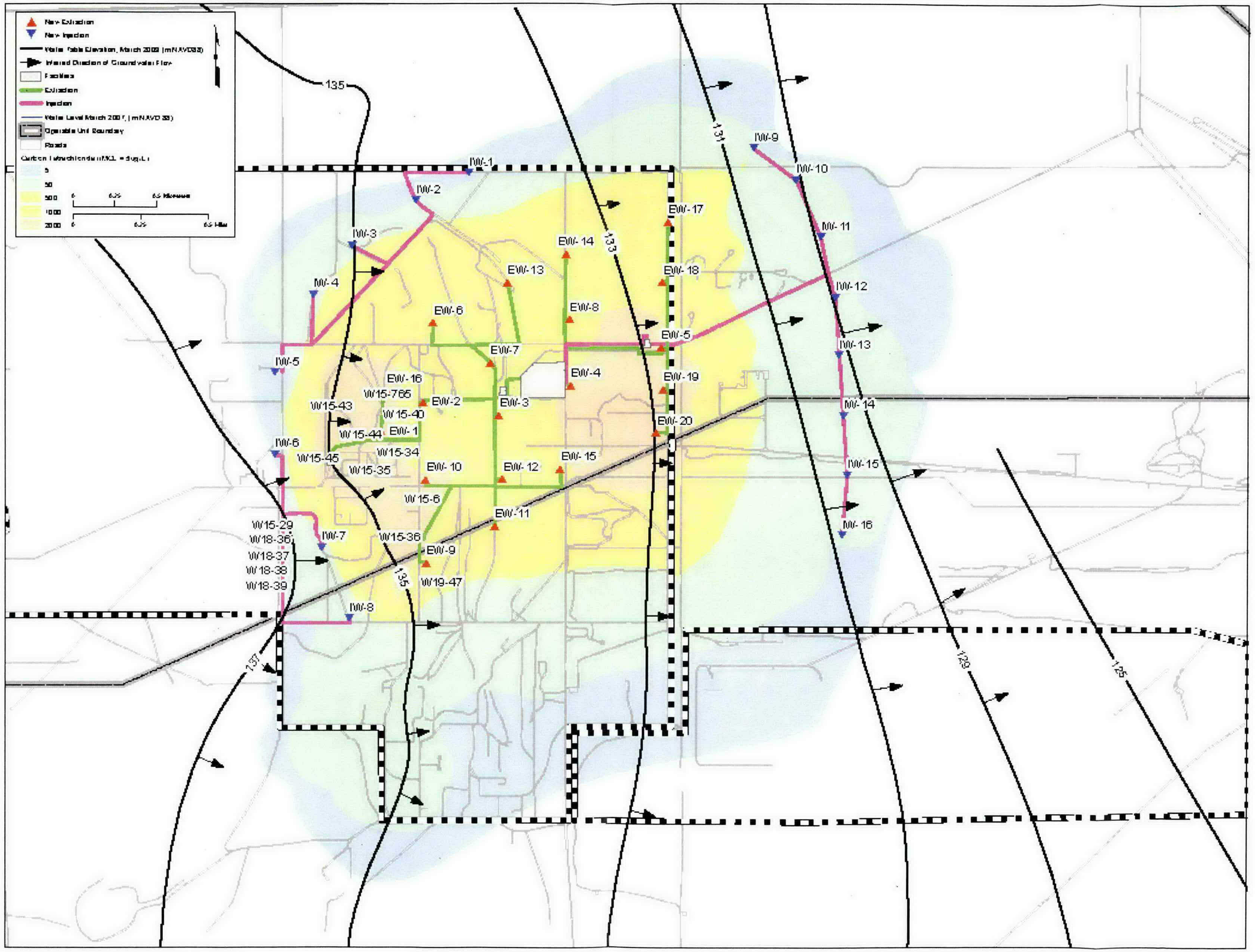


Figure E1-5. Carbon Tetrachloride Plume and 200 West Area Pump-and-Treat System Well Layout

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E1.2.3 Flow Path Control

Flow path control consists of injecting treated groundwater around the carbon tetrachloride plume's perimeter. Injecting treated water at these locations will slow the plume's natural eastward movement and keep COCs within the extraction well hydraulic capture zone. Flow path control will also increase the time available for natural attenuation processes to reduce COC concentrations in areas not captured by the extraction wells. Flow path control also reduces the potential for groundwater to flow northward through the Gable Mountain Gap toward the Columbia River.

E1.2.4 Groundwater Cleanup Levels

The final cleanup levels for 200-ZP-1 OU groundwater are presented in Table E1-1. These cleanup levels were developed using federal drinking water maximum contaminant levels (MCLs); the criteria and equations in the Model Toxics Control Act (MTCA) Method B cleanup levels for potable groundwater (WAC 173-340-720[4][b][iii][A], "Model Toxics Control Act Cleanup," "Ground Water Cleanup Standards," "Method B Cleanup Levels for Potable Ground Water," "Standard Method B Potable Ground Water Cleanup Levels," "Human Health Protection," "Noncarcinogens;" WAC 173-340-720[4][b][iii][B], "Model Toxics Control Act Cleanup," "Ground Water Cleanup Standards," "Method B Cleanup Levels for Potable Ground Water," "Standard Method B Potable Ground Water Cleanup Levels," "Human Health Protection," "Carcinogens;" and WAC 173-340-720[7][b], "Model Toxics Control Act—Cleanup," "Ground Water Cleanup Standards." "Adjustments to Cleanup Levels," "Adjustments to Applicable State and Federal Laws;" and the federal standards for radionuclides.

Table E1-1. Final Cleanup Levels for 200-ZP-1 Operable Unit Groundwater

COC	Units	Initial Estimated Concentration[a]	Final Cleanup Level
Carbon Tetrachloride	µg/L	738	3.4
Trichloroethylene (TCE)	µg/L	3.7	1[b]
Chromium (total)	µg/L	Insufficient Data	100
Hexavalent Chromium	µg/L	27	48
Nitrate-Nitrogen	mg/L	35	10
Iodine-129	pCi/L	0.46	1
Technetium-99	pCi/L	8,240	900
Tritium	pCi/L	20,200	20,000

Notes:

a. Reference Table 2 (radionuclides) and Table 4 (inorganics) – 382519-TMEM-003, Rev 4, *Hanford 200 West Area Pump and Treat Facility, Preliminary Basis of Design for Process Selection.*

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

pCi/L = picocuries per liter

µg/L = micrograms per liter

E1.3 Data Quality Objectives

The U.S. Environmental Protection Agency's (EPA) seven-step data quality objectives (DQOs) process (EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*) was used to guide development of the selected remedy's groundwater performance monitoring program. This section summarizes the key outputs arising from the DQO process. Additional information on the DQO process in presented in DOE/RL-2009-115.

E1.3.1 Statement of the Problem

The first step in the DQO process is to define the problem. For the 200-ZP-1 groundwater OU remedy, monitoring data must be collected and evaluated to effectively operate the P&T system, assess the effectiveness of MNA and flow path controls, confirm that contaminated groundwater is restored to the cleanup levels identified in the ROD, and to confirm that the Columbia River and its ecological resources are protected from degradation and adverse impact associated with potential COC migration from the 200-ZP-1 groundwater OU.

E1.3.2 Identify the Goals of the Study

Step two of the DQO process identifies the key decisions that must be addressed to achieve the final solution to the problem. As stated in the ROD, the selected remedy combines P&T, MNA, flow path control, and ICs to solve the problem. The key questions that the data collection program must address, along with the alternative actions that may result based on the analysis of the collected data, are presented below as series of decision statements (DSs).

Decision Statement 1 - Determine if there are any new releases of COCs that could impact the effectiveness of the remedy and necessitate changes to the remedial action and/or the performance monitoring plan (PMP); otherwise, continue with the current remedial action and PMP.

Decision Statement 2 - Determine if potentially toxic and/or mobile transformation products are being generated at concentrations large enough to justify their inclusion in the list of COCs with associated cleanup levels; otherwise, continue with the current list of COCs and associated cleanup levels.

Decision Statement 3 - Determine if changes are occurring in environmental conditions that may reduce the efficacy of the P&T system, natural attenuation processes, and flow path control actions, thereby necessitating changes to the remedial action and/or PMP; otherwise, continue with the current remedial action and PMP.

Decision Statement 4 - Determine if the P&T system will remove at least 95 percent of the mass of COCs in 25 years or less, and thereby achieve remedy goals for the P&T phase of the remedy; otherwise, evaluate modifications to the P&T system that could achieve the stated goal for the P&T phase of the remedy.

Decision Statement 5 - Determine if contamination is expanding downgradient, laterally, or vertically after the P&T component has been turned off, thereby necessitating an evaluation of the predicted success of the remedial action; otherwise, continue with the current remedial action and PMP.

Decision Statement 6 - Determine if the current remedy design is predicted to achieve cleanup levels for all COCs within 125 years, and thereby achieve the overall remedial goal; otherwise, evaluate modifications to the remedial action that could achieve the stated goal for the overall remedy.

Decision Statement 7 - Determine if remediation has been successfully completed and a recommendation can be made for no further action; otherwise, continue with the current remedial action and PMP or determine if a technical impractability waiver should be invoked.

Decision Statement 8 - Determine if certain areas of the contaminant plumes are not responding to P&T remediation as expected, and therefore require the evaluation of other technologies for a more focused or "hot spot" remedy; otherwise, no new action is required.

Decision Statement 9 - Once 95 percent of the mass of COCs have been removed, determine if there is rebound in COC concentrations, which would require the P&T to be turned back on; otherwise, leave the P&T system off and continue with MNA.

E1.3.3 Identify the Information Inputs and Analytical Approach

Step 3 and Step 5 of the DQO process identify the data and analytical approach necessary to resolve the DSs listed in Section E1.3.2. This information is summarized in Table E1-2.

E1.3.4 Define the Boundaries of the Study

In Step 4 of the DQO process, the spatial and temporal boundaries of the study area are identified. The 200-ZP-1 groundwater monitoring network must verify that cleanup levels have been achieved throughout the OU for all COCs. Spatially, this extends from the western injection well boundary to the northern and eastern leading edge of the COC plumes. Vertically, the study area boundaries range from the top of the basalt bedrock to the water table surface. The current 200-ZP-1 OU conceptual site model does not show COC concentrations greater than ROD cleanup levels in the basalt bedrock. Temporally, groundwater monitoring is expected to continue until cleanup levels have been achieved, which is estimated to occur within 125 years.

E1.3.5 Specify Performance or Acceptance Criteria

The sixth step of the DQO process involves deriving the performance or acceptance criteria that the collected data must achieve to minimize the possibility of either making erroneous conclusions or failing to keep estimates within acceptable levels. This may often take the form of a statistical hypothesis test. However, statistical tests of the monitoring data to support the end of this remedial action have not been developed, and may not be applicable. Therefore, typically accepted performance criteria for the data to be gathered under this SAP are described in Table E1-3.

E1.3.6 Develop the Plan for Obtaining Data

Step seven of the DQO process develops the sampling and analysis design to generate the data needed to address the seven DSs. The rationale used to select monitor wells for sampling and analysis is presented in DOE/RL-2009-115. The monitoring well network to be used under this SAP is described in Section E1.4, and the design for the water level, flow rate, COC, and MNA program is presented in Section E3.

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Table E1-2. DQO Step 2 and Step 5 – Information Inputs and Analytical Approach

DS Number	Data Inputs*	Analytical Approach*
1 – Detect new releases of COCs that could impact remedy effectiveness and necessitate changes to the remedial action and/or the PMP.	Groundwater quality data collected from the contaminant monitoring well network. Hydraulic monitoring data, extraction and injection well flow rate data, and extraction well contaminant sampling data.	Groundwater contaminant sampling data will be evaluated to determine if new releases of COCs have occurred. Contaminant concentration trends will be evaluated, and the sampling data will be used to update the 3-dimensional plume shell for each contaminant. If contaminant concentrations in a monitoring well are stable and/or increasing, and there is no known upgradient dissolved-phase contaminant source to support these stable and/or increasing concentrations, then there may be a new release.
2 – Determine if potentially toxic and/or mobile transformation products are being generated at concentrations large enough to justify their inclusion in the list of COCs with associated cleanup levels	Groundwater quality data collected from the contaminant monitor well network.	This evaluation is performed by analyzing concentration trends in the parent COC and the COC daughter products, and applies to COCs that are commonly degraded in the environment. For the 200-ZP-1 groundwater OU it includes carbon tetrachloride, trichloroethylene, and nitrate. The rates of decline in the parent compound and the formation of the daughter products will be used to derive transformation or decay rates. The decay rates will be used as inputs for the 200 West Area groundwater flow and contaminant transport model to evaluate whether natural attenuation will achieve cleanup levels within the time period specified in the ROD.
3 – Determine if changes are occurring in environmental conditions that may reduce the efficacy of the P&T system, natural attenuation processes, and the flow-path control actions, thereby necessitating changes to the remedial action and/or PMP	Hydraulic monitoring data and groundwater quality data.	The potentiometric surface of water table elevations will be defined using hydraulic monitoring data to interpret groundwater flow directions in the 200-ZP-1 groundwater OU. Testing for biogeochemical parameters will be performed to identify if the appropriate conditions exist in the aquifer to support COC transformation. Biogeochemical parameters and other monitoring constituents can be used in mass balance calculations to determine if decreases in contaminant and electron acceptor/donor concentrations can be directly correlated to increases in daughter compounds. Additionally, mapping of concentration changes in reactants (contaminants, electron acceptors and donors) or products of the biogeochemical process (e.g. dissolved iron and chloride) that degrade or immobilize the contaminants will be performed. These maps can be used to determine if transformation processes are active at the site. Biodegradation (decay) rate constants can be calculated COC concentration time-series data s in conjunction with aquifer hydrogeologic parameters such as seepage velocity and dilution.
4 – Determine if the P&T system will remove at least 95 percent of the COC mass in 25 years or less, and thereby achieve remedy goals for the P&T phase of the remedy	Groundwater quality data, extraction and injection well flow rate data, and extraction well and treatment plant untreated and treated water contaminant concentration data.	The 200 West Area groundwater flow and contaminant transport model will be used to predict if the P&T system will remove at least 95 percent of the COC mass in 25 years. This analysis will be accomplished by using the 3-D contaminant plume shell, for each COC, as the starting concentration in the model, and transporting the contaminant plume forward in time for at least 25 years. Current and future anticipated extraction and injection well flow rates will be input to the model. Using the simulated extraction well contaminant concentrations and flow rates, the contaminant mass removed by each extraction is calculated. The percentage mass removed, for each COC, will be calculated by summing the simulated mass removed by each extraction well and dividing that by starting mass for each COC. Starting masses for each COC are provided in DOE/RL-2009-38.
5 – Determine if contamination is expanding downgradient, laterally or vertically after the P&T system has been turned off, thereby necessitating an evaluation of the predicted success of the remedial action	Groundwater quality data collected from the monitoring well network.	Trends in measured concentrations for downgradient monitoring wells will be analyzed to draw conclusions about the expansion and/or migration of the COC plumes. Three-dimensional contaminant plume shells will be updated for each COC using the most current sampling data. Plume volume and contaminant mass statistics can be generated from the plume shells. The contaminant distributions and statistics will be compared to those from the previous plume shell versions to evaluate expansion or contraction of each COC plume. If evaluation of groundwater sampling data indicates that a COC plume may be expanding downgradient and the remedial system is still operating, several courses of action may be taken. Extraction and injection well flow rates and/or production intervals may be adjusted to improve hydraulic capture, or new extraction wells may be installed to capture escaped contaminant mass contributing to downgradient plume expansion.
6 – Determine if the current remedy design is predicted to achieve cleanup levels for all COCs within 125 years, and thereby achieve the overall remedial goal.	Groundwater quality data, extraction and injection well flow rate data, and extraction well groundwater quality data.	The 200 West Area groundwater flow and contaminant transport model will be used to predict if the current remedy design will achieve cleanup levels for all COCs within 125 years. This analysis is accomplished by using the 3-D contaminant plume shell, for each COC, as the starting concentration in the model, and transporting the contaminant plume forward in time for at least 125 years. Current and future anticipated extraction and injection well flow rates, as well as COC decay rates, can be supplied to the model as input. An animation can be made for each COC displaying the contaminant concentrations greater than or equal to the cleanup level as the plume contracts over time. If the simulated contaminant concentrations remain significantly above the cleanup level during the 125 year period, the remedy goal may not be achieved within the desired remedial timeframe.
7 – Determine if remediation has been successfully completed and a recommendation can be made for no further action	Groundwater quality data.	Groundwater quality data will be evaluated to determine if the remediation has been successfully completed. If contaminant concentrations in all monitoring wells, for all COCs, have decreased to below the cleanup levels for at least 5 years, then a recommendation will be made for no further action.

Table E1-2. DQO Step 2 and Step 5 – Information Inputs and Analytical Approach

DS Number	Data Inputs*	Analytical Approach*
8 - Determine if certain areas of the contaminant plumes are not responding to P&T remediation as expected, and therefore require the evaluation of other technologies for a more focused or "hot spot" remedy.	Groundwater quality data.	Groundwater quality data will be evaluated to determine if any areas of the contaminant plumes are not responding to P&T remediation. If one or more areas are identified, options will be evaluated.
9 - Once 95 percent of the COC mass has been removed, determine if there is rebound in COC concentrations, which would require the P&T system to be turned back on.	Groundwater quality data.	Groundwater quality data will be evaluated and the results trended to determine if there is rebound in COC concentrations.

Notes:

* A summary of the Data Inputs and Analytical Approach is provided in Table E1-2. A detailed explanation is provided in DOE/RL-2009-115.

P&T = pump-and-treat

COC = contaminant of concern

OU = operable unit

ROD = record of decision

Table E1-3. Data Quality Objective Step 6 – Typical Acceptance and Performance Criteria

DS Number	Required Data	Acceptance/Performance Criteria
1, 3	Groundwater level (top of casing elevation, coordinates, and depth to water [DTW])	Top of Casing = 0.03 m (0.1 ft) Coordinates = 0.03–1.5 m (0.1-5 ft) DTW = 0.003 m (0.01 ft)
1, 3, 4, 6	Pumping rates (instantaneous and total)	Varies based on meter type and calibration frequency. Target is 1 – 2 percent of observed rates.
1-9	Contaminant concentrations	Precision = ≤ 20 percent
2, 3, 5, 6	Biogeochemical parameters	Precision = ≤ 20 percent
2, 3	Groundwater quality parameters	Precision = ≤ 20 percent

Notes:

DTW = depth to water

E1.4 Groundwater Monitoring Well Network

The data necessary to address the DSs described in Section E1.3.2 will be collected over the expected 125 year life of the remedial action to evaluate performance, optimize effectiveness, and determine when the remedial action is complete.

As described further in the following subsections, the monitoring program will obtain data from a network of existing and newly installed monitor wells and sampling of a full and reduced list of monitor wells. Biennial sampling of the full monitor well network will generate sufficient data for quantitative analysis in support of addressing all nine DSs. Whereas, sampling from the reduced monitor well list will provide data for assessing DSs 1, 2, and 5. This includes determining if there are any new releases of COCs, evaluating concentration trends in high concentration areas of the plumes, and determining if contamination is expanding downgradient, laterally, or vertically. The 125 monitor wells comprising the groundwater monitoring network are described further in Section E3.

E1.4.1 Existing Monitor Wells

The monitor well network will change over time as the active P&T and MNA remedy components lower COC concentrations and reduce the size of the contaminant plume footprints. Additionally, some areas within the aquifer will cleanup more quickly. Therefore, it will be necessary to re-evaluate the monitor well network periodically. No changes are anticipated during the initial P&T system operations period. However, some existing monitor wells will likely be dropped and others added for long-term operation. These changes will be presented in an amended version of this SAP.

E1.4.2 New Monitor Wells

DOE/RL-2009-115 identified several areas where existing monitor well coverage may be inadequate to evaluate remedial action effectiveness. To address potential gaps in the monitor well network, up to 14 new monitor wells (Table E1-4) will be installed. These wells will be installed using procedures similar to those described in DOE/RL-2008-57, *Sampling and Analysis Plan for the First Set of Remedial Action Wells in the 200-ZP-1 Groundwater Operable Unit.*

Table E1-4. Proposed New Monitoring Wells

Well No.	Well Name	Easting (m)	Northing (m)	Estimated Mid-Screen Elevation (m amsl)	Priority
1	MW1A	568369	137743	90	3
2	MW1B	568369	137743	110	4
3	MW2	567591	137577	111	10
4	MW3A	567578	136476	73	5
5	MW3B	567578	136476	92	6
6	MW3C	567578	136476	112	7
7	MW4A	566638	136251	80	11
8	MW4B	566638	136251	100	12
9	MW5A	567374	135941	70	8
10	MW5B	567374	135941	110	9
11	MW6A	566941	135175	80	13
12	MW6B	566941	135175	106	14
13	MW7A	568900	135945	100	2
14	MW7B	568900	135945	120	1

E2 Quality Assurance Project Plan

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements for the following:

- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document.*
- DOE O 414.1C, *Quality Assurance.*
- 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements."
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans.*

Section 6.5 and Section 7.8 of Ecology, EPA, and DOE, 2003, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement), Attachment 2: Action Plan*, require the quality assurance (QA) and quality control (QC), and sampling and analysis activities to specify the QA requirements for treatment, storage, and disposal units as well as for past practice processes. The organization of this QAPjP is patterned after the QA elements of EPA/240/B-01. The QAPjP demonstrates conformance to Part B requirements of ANSI/ASQC E4-1994, *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs.*

The QAPjP is divided into the following four sections (designated in EPA/240/B-01/003 by a, b, c, and d) which describe the quality requirements and controls applicable to the work described herein:

1. Project Management (Section E2.1) – This section addresses project management, including the project history and objectives and roles and responsibilities of the participants. These elements ensure that the project has a defined goal, that the participants understand the goal, and that the approach to be used and the planning outputs are documented.
2. Data Generation and Acquisition (Section E2.2) – This section addresses all aspects of project design and implementation. Implementation of these elements ensures that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and properly documented.
3. Assessment and Oversight (Section E2.3) – This section addresses the activities for assessing project implementation effectiveness and the associated QA and QC activities. The purpose for the assessment activity is to ensure that the QAPjP is implemented as described.
4. Data Validation and Usability (Section E2.4) – This section addresses the QA activities that occur after the data collection or generation phase of the project is completed. Implementation of these elements ensures that the data conform to the specified criteria, thus achieving the project objectives.

E2.1 Project Management

The following subsections address the basic aspects of project management to ensure that the project has defined goals, that the participants understand the goals, and that the approaches used and the planned outputs are appropriately documented.

E2.1.1 Project/Task Organization

The contractor, CH2M HILL Plateau Remediation Company (CHPRC), and its subcontractors are responsible for the planning, preparation, coordination, sampling, packaging, and shipment of all samples collected under this SAP to the laboratory. The project organization, in regard to sampling and characterization, is described in the subsections that follow and is shown graphically in Figure E2-1.

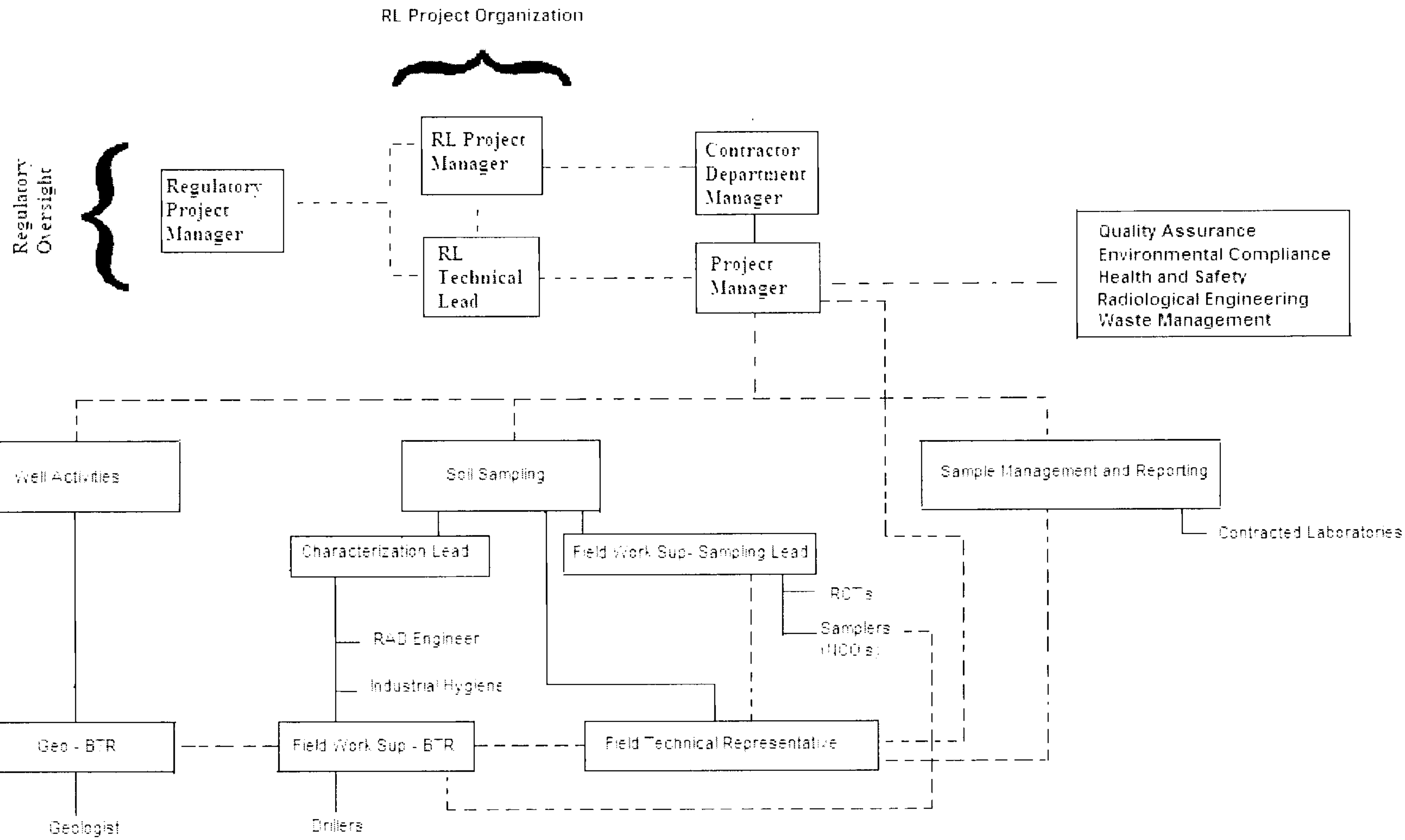

Figure E2-1. Project Organization

The CHPRC Project Manager will maintain a list of individuals or organizations that are the points-of-contact (POCs) for each functional element in the organization chart (Figure E2-1) as these individuals are assigned to the project.

E2.1.1.1 Regulatory Project Manager

The U.S. Environmental Protection Agency (EPA) is responsible for oversight of remedial action activities. EPA as the lead regulatory agency has approval authority for the work being performed under this SAP and will coordinate with the U.S. Department of Energy (DOE) Richland Operations Office (RL) to resolve concerns over the work described in this SAP in accordance with the Tri-Party Agreement (TPA).

E2.1.1.2 RL Project Manager

RL is responsible for the Hanford Site cleanup. The RL Project Manager is responsible for authorizing CHPRC to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), *Resource Conservation and Recovery Act of 1976* (RCRA), *Atomic Energy Act of 1954*, and the TPA for the Hanford Site. RL is also responsible to obtain lead regulatory agency approval of the SAP that authorizes field sampling activities.

E2.1.1.3 RL Technical Lead

The RL Technical Lead is responsible for day-to-day oversight of CHPRC and subcontractor staff performing the work, coordinating with CHPRC and the regulatory agency project managers or POCs to identify and resolve technical issues as they arise, and providing technical input to the RL Project Manager.

E2.1.1.4 CHPRC Project Manager

The CH2M HILL Plateau Remediation Company (CHPRC or contractor) Project Manager is responsible for direct management of the project's planning documents and requirements, field activities, and subcontracted tasks and for ensuring that the project file is properly maintained. The Project Manager ensures that the sampling design requirements are converted into field instructions (e.g., work packages) that provide specific direction for field activities. The Project Manager works closely with QA, Health and Safety, the Field Work Supervisor, and the Construction Management Lead as necessary to integrate these and the other lead disciplines in planning and implementing the work. The Project Manager maintains a list of individuals or organizations filling each of the functional elements of the Project Organization (Figure E2-1). In addition, the Project Manager is responsible for version control of the SAP to ensure that personnel are working to the most current job requirements. The Project Manager also coordinates with and reports to the RL Project manager or RL Technical Lead on all sampling activities. The Project Manager will also support RL in coordinating sampling activities/schedules with the Regulatory Project Manager.

E2.1.1.5 Quality Assurance

The QA POC is matrixed to the Project Manager and is responsible for QA issues on the project. Responsibilities include oversight of implementation of the project's QA requirements; review of project documents, including DQO summary reports, SAPs, and the QAPjP; and participation in QA assessments on sample collection and analysis activities, as appropriate. The QA POC must be independent of the unit generating the data.

E2.1.1.6 Environmental Compliance Officer

The Environmental Compliance Officer (ECO) provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The ECO also reviews plans, procedures, and technical documents to ensure that all environmental requirements have been addressed, identifies environmental issues that affect operations, develops cost effective solutions, and responds to environmental/regulatory issues or concerns raised by DOE and/or regulatory agency staff. The ECO may also oversee project implementation for compliance with applicable internal and external environmental requirements.

E2.1.1.7 Health and Safety

The Health and Safety organization is responsible for coordination of industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulation or by internal contractor work requirements. In addition, the Health and Safety organization provides assistance to project personnel in complying with applicable health and safety standards and requirements. The Health and Safety organization coordinates with Radiological Engineering to determine personnel protective clothing requirements.

E2.1.1.8 Radiological Engineering

The Radiological Engineering Lead is responsible for radiological/health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for all work planning. In addition, the Radiological Engineering Lead identifies radiological hazards and implements appropriate controls to maintain worker exposure ALARA (e.g., requiring personal protective equipment). Also, the Radiological Engineering Lead interfaces with the project health and safety contact and plans and directs support of radiological control technicians (RCTs) for all activities.

E2.1.1.9 Sample Management and Reporting

Sample Management and Reporting coordinates laboratory analytical work ensuring that the laboratories conform to Hanford Site internal laboratory QA requirements, or their equivalent, as approved by DOE and EPA. Sample Management and Reporting receives the analytical data from the laboratories, performs the data entry into the Hanford Environmental Information System (HEIS), and arranges for data validation. Sample Management and Reporting is responsible for informing the CHPRC Project Manager of any issues reported by the analytical laboratory. Sample Management and Reporting develops and oversees implementation of the letter of instruction to the analytical laboratories, oversees data validation, and works with the CHPRC Project Manager to prepare a field summary or characterization report on the sampling and analysis results.

Sample Management and Reporting is also responsible for performance of EPA's DQO process, or equivalent that results in the development of the SAP. Responsibilities include documentation as well as development of the DQOs and the SAP, including sampling design, associated presentations, resolution of technical issues, and any revisions to the SAP.

E2.1.1.10 Contract Laboratories

The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanation of results in support of data validation. The laboratories must meet site specified QA requirements and must have an approved QA plan in place.

E2.1.1.11 Waste Management

Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking of investigation-derived waste (IDW) in a safe and cost-effective manner. In addition, the Waste Management Plan (Appendix B to the O&M Plan) is responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance, interpreting the characterization data to generate waste designations and profiles, and preparing and maintaining other documents that confirm compliance with waste acceptance criteria.

E2.1.1.12 Field Work Supervisor

The Field Work Supervisor is responsible for planning and coordinating field sampling resources. The Field Work Supervisor ensures the availability of trained samplers, equipment, and supplies and directs any required training, mock-ups, and practice sessions with field personnel to ensure that the sampling design and equipment use are understood and can be performed as specified.

The Field Work Supervisor directs the samplers who collect the multi-media samples, including field replicates/duplicates, and oversees the preparation of all other field blank samples according to the SAP and corresponding standard procedures and work packages. The samplers also complete the field logbook and chain-of-custody forms, as well as any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

E2.1.2 Problem Definition/Background

Sufficient monitoring data must be collected to assure 200-ZP-1 groundwater OU remedy effectiveness, verify that contaminated groundwater is restored to a level that supports future use as a potential domestic drinking water supply, and verify that the Columbia River and its ecological resources are protected from degradation and unacceptable impact potentially associated with 200 ZP-1 OU COC migration.

E2.1.3 Project/Task Description

The field activities described in this SAP include measurement and sampling of groundwater. Radiological field measurements will also be performed to screen samples from selected monitor wells following collection. Sampling requirements for IDW disposal determinations are addressed in the Waste Management Plan included as Appendix B to the O&M Plan.

E2.1.4 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality is assessed by data quality indicators (DQIs), by evaluation against identified DQOs and the work activities identified in this SAP. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. The principal DQIs are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity. These DQIs are defined for the purposes of this document in Table E2-1. The DQIs are evaluated during the data quality assessment (DQA) process described further in Section E2.4.3. The quality objectives and criteria for groundwater measurement data are presented in Table E2-2.

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Table E2-1. Data Quality Indicators

DQI	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Actions
Precision	A measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; calculated as either the range or as the standard deviation. May also be expressed as a percentage of the mean of the measurements, such as relative range, relative percent difference, or relative standard deviation (coefficient of variation).	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory or have two or more laboratories analyze identical samples with the same method. Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements. Collect, process, and analyze collocated samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	Field precision: at one randomly selected location duplicate samples will be taken. Laboratory precision; analysis of laboratory duplicate or matrix spike duplicate sample.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity). • Request re-analysis or re-measurement. • Qualify the data before use.
Accuracy	A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample); usually expressed either as percent recovery or as a percent bias.	Laboratory accuracy determination based on matrix spikes and matrix spike duplicates. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If recovery does not meet objective: • Qualify the data before use. • Request re-analysis or re-measurement.
Representativeness	A qualitative term that expresses "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition." (ANSI/ASQC 1995).	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	Samples will be collected as described in the sampling design. Judgmental sampling ensures that areas most likely to be contaminated, based on current information, will be evaluated. Random sampling is based on ensuring all members of the group are equally likely to be chosen and allows probability statements to be made about the quality of estimates derived from the data.	If results are not representative of the system sampled: • Identify the source of the non-representation. • Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system that the data represent. • Redefine sampling and measurement requirements and protocols. • Resample and re-analyze.
Comparability	A qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.	Compare sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols.	All sampling personnel will use the same sampling protocols. Samples will be submitted to the same laboratories when possible (based on laboratory contracts) for analysis by the same methods, thus data results will be comparable.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or re-analyze if needed. • Revise sampling/analysis protocols to ensure future comparability.

Table E2-1. Data Quality Indicators

DQI	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Actions
Completeness	A measure of the amount of valid data needed to be obtained from a measurement program.	Compare number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (DQO performance/ acceptance criteria).	The percent complete will be determined during data validation.	If data set does not meet completeness objective: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or re-analyze if needed. • Revise sampling/analysis protocols to ensure future comparability.
Sensitivity	The capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.	Determine the minimum concentration or attribute that can be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit). The practical quantitation limit is the lowest level which can be routinely quantified and reported by a laboratory.	Ensure that sensitivity, as measured by detection limits, is appropriate for the action levels.	If sensitivity does not meet objective: • Request re-analysis or re-measurement. • Qualify/Reject the data before use.

Notes:

ANSI/ASQC = American National Standards Institute/American Society of Mechanical Engineers

DQO = data quality objective

QA = quality assurance

Table E2-2. Groundwater Analytical Performance Requirements

Chemical Abstracts Service No.	Analyte	Survey or Analytical Method	Units	Action Level	Target Detection Limit (µg/L)	Precision Required (%)	Accuracy Required (%)
56-23-5	Carbon Tetrachloride (COC)	SW-846, Method 8260	µg/L	3.4	2	≤20%	±80-120%
67-66-3	Chloroform (TP)	SW-846, Method 8260	µg/L	7.17	5	≤20%	±80-120%
75-09-2	Dichloromethane (TP)	SW-846, Method 8260	µg/L	5	5	≤20%	±80-120%
74-87-3	Chloromethane (TP)	SW-846, Method 8260	µg/L	NA	5	≤20%	±80-120%
79-01-6	Trichloroethylene (COC)	SW-846, Method 8260	µg/L	1	2	≤20%	±80-120%
156-59-2	cis-1,2-Dichloroethene (TP)	SW-846, Method 8260	µg/L	70	5	≤20%	±80-120%
75-01-4	Vinyl Chloride (TP)	SW-846, Method 8260	µg/L	2	1	≤20%	±80-120%
7440-47-3	Chromium – Total (COC)	SW-846, SW6010/7000	µg/L	100	10	≤20%	±80-120%
18540-29-9	Hexavalent Chromium (COC)	Method 7196	µg/L	48	10	≤20%	±80-120%
14697-55-8	Nitrate –N (COC)	SW-846, Method 9056 or EPA 300.0	mg/L	10	0.25	≤20%	±80-120%
14797-65-0	Nitrite –N (TP)	EPA 300.0	mg/L	1	0.1	≤20%	±80-120%
15046-84-1	Iodine-129 (COC)	Low Energy Photon Spectroscopy	pCi/L	1	1	≤20%	±80-120%
14133-76-7	Technetium-99 (COC)	Liquid Scintillation	pCi/L	900	15	≤20%	±80-120%
10028-17-8	Tritium (COC)	Liquid Scintillation	pCi/L	20,000	400	≤20%	±80-120%
7440-61-1	Uranium (from 200-UP-1 OU)	SW-846, SW6010/7000 or EPA 200.8	µg/L	30	1	≤20%	±80-120%
NA	Total Organic Carbon (NAP)	EPA 415.1	µg/L	NA	1	≤20%	±80-120%
NA	Total Dissolved Solids	EPA 160.1	mg/L	500	1	≤20%	±80-120%
14808-79-9	Sulfate (NAP)	EPA 300.0A	mg/L	250	4	≤20%	±80-120%
12597-04-50	Sulfide (NAP)	EPA 9215	mg/L	NA	0.1	≤20%	±80-120%
7439-89-6	Iron – Total and Dissolved (NAP)	SW-846, SW6010/7000	µg/L	300	10	≤20%	±80-120%
7439-96-5	Manganese - Total and Dissolved (NAP)	SW-846, SW6010/7000	µg/L	50	10	≤20%	±80-120%
NA	Alkalinity (NAP)	EPA 310.1	mg/L	NA	1	≤20%	±80-120%
16887-00-6	Chloride	EPA 300.0	mg/L	250	1,000	≤20%	±80-120%

Table E2-2. Groundwater Analytical Performance Requirements

Chemical Abstracts Service No.	Analyte	Survey or Analytical Method	Units	Action Level	Target Detection Limit (µg/L)	Precision Required (%)	Accuracy Required (%)
Field Measured Water Quality Parameters							
NA	Temperature	Hach HQ40d or equivalent)	° C	NA	0.0 to 80.0	NA	±0.3
NA	pH	Hach HQ40d or equivalent)	Standard Units	6.5-8.5	0.0 to 14.0	NA	±0.1 of the buffer solution
NA	Dissolved Oxygen	Hach HQ40d or equivalent)	mg/L	NA	0.1 to 20.0	NA	±0.1 for 0.1 to 8.0, ≤0.2 for > 8.0
NA	Specific Conductance	Hach HQ40d or equivalent)	µS/cm	NA	0.01 to 200.0	NA	±0.5% of reading
NA	Turbidity	Hach 2100P Turbidimeter HW40D or equivalent)	National Turbidity Units (NTU)	NA	0 to 1000	NA	±2% for 0 to 499, ≤3 for 500 to 1000
NA	Redox Potential	USGS National Manual for the Collection of Water-Quality Data, 1997	mV	NA	-500 to 500	NA	±1.0

Notes:

COC = contaminant of concern

TP = transformation product

NA = not applicable

NAP = natural attenuation evaluation parameter

E2.1.5 Special Training Requirements/Certification

A graded approach is used to ensure that workers receive a level of training that is commensurate with their responsibilities and that complies with applicable DOE orders and government regulations. The Field Work Supervisor, in coordination with the CHPRC Project Manager, will ensure that all field personnel meet all special training requirements. Typical training requirements or qualifications have been instituted by the CHPRC management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirement documents, the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME), and the *Washington Administrative Code* (WAC).

For example, the environmental, safety and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically will have completed the following training before starting work:

- Occupational Safety and Health Administration 40-hour hazardous waste worker training and supervised 24-hour hazardous waste site experience
- 8-hour hazardous waste worker refresher training
- Hanford general employee radiation training
- Hanford general employee training
- Radiological worker training (as required)

Project specific safety training, geared specifically to the project and the day's activity, will be provided. Project specific training may include:

- Training requirements or qualifications needed by sampling personnel in accordance with QA requirements.
- Samplers are required to have training and/or experience in the type of sampling that is being performed in the field.

Qualification requirements for Radiological Control Technicians (RCTs) are established by the Radiation Protection Program; RCTs assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

In addition, pre-job briefings will be performed to evaluate an activity and its hazards by considering the following factors:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety procedures applicable to the job
- Training requirements for individuals assigned to perform the work

- Level of management control
- Proximity of emergency contacts

Training records are maintained for each individual in an electronic training record database. The contractor training organization maintains the training records system. Line management will be used to confirm that employee training is appropriate and up-to-date prior to performing any field work.

E2.1.6 Documents and Records

The CHPRC Project Manager is responsible for distributing copies of the SAP and any addendums to field sampling personnel. Version control is maintained by the administrative document control process. Significant changes to the SAP will be reviewed and approved by DOE and EPA prior to implementation. Table E2-3 defines the types of changes that may be made to the sampling design and the appropriate documentation requirements.

Table E2-3. Change Control for Sampling Projects

Type of Change	Action	Documentation
Temporary (≤ 1 event) adding constituents, locations, or increasing sampling frequency.	Project management approval; notify regulatory agency POC if appropriate.	Project's schedule tracking system.
Permanent (>1 event or year) adding constituents, locations, or increasing sampling frequency.	Revise SAP; obtain regulatory approval; distribute plan.	Letter report documenting changes or revised plan.

Notes:

POC = point of contact

SAP = sample and analysis plan

The Field Work Supervisor is responsible for ensuring that field instructions are maintained, up to date, and aligned with any revisions to the SAP. The Field Work Supervisor will ensure that all deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook or on nonconformance report forms) in accordance with internal corrective action procedures.

The CHPRC Project Manager, Field Work Supervisor, or designee, will be responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

Logbooks are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for logbooks shall be identified in the front of the notebook, and only authorized persons may make entries in logbooks. Logbooks will be signed by the field manager, supervisor, or other assigned field personnel. Logbooks shall have the following characteristics:

- Permanently bound
- Waterproof
- Ruled with sequentially numbered pages

Pages shall not be removed from logbooks for any reason. Entries shall be made in indelible ink. Corrections shall be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the change.

The CHPRC Project Manager is responsible for ensuring that a project file is properly maintained. The project file will include the following items, as appropriate:

- Field logbooks or operational records
- Data forms
- Global positioning system (GPS) data
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports
- Interim progress reports
- Final reports (laboratory data packages and validation reports)

The project file will contain the records or references to their storage locations.

The laboratory is responsible for maintaining, and having available upon request, the following information:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the TPA will be managed in accordance with TPA requirements.

E2.2 Data Generation and Acquisition

The following subsections address data generation and acquisition to ensure that project methods for sampling, measurement and analysis, data collection and generation, data handling, and QC activities are appropriate and documented.

E2.2.1 Sampling Process Design

The sample design presented in Section E3 of this SAP uses a judgmental sampling approach based on an existing monitor well grid. The field team will note in the daily field sampling log any instance where samples cannot be collected at the designated location because of field conditions. These events will be discussed in the follow-on CERCLA documentation (periodic briefings and performance monitoring report).

E2.2.2 Sampling Methods

Sampling methods are described in Section E3, and are based on previously approved operating procedures developed for similar field characterization activities conducted at the Hanford Site.

E2.2.3 Sample Handling and Custody

A sample and data tracking database is used to track the samples from the point of collection through the laboratory analysis process. Laboratory analytical results are entered and maintained in the HEIS database. HEIS sample numbers are issued to the sampling organization for the project. Each chemical, radiological, and physical property sample is identified and labeled with a unique HEIS sample number.

Laboratory sample custody is addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by Sample Management and Reporting.

E2.2.4 Analytical Methods

Information on the analytical methods to be used under this SAP are provided in Table 2-2. These analytical methods are controlled in accordance with the laboratory's QA Plan and the requirements of this QAPjP. CHPRC participates in oversight of off-site analytical laboratories to qualify them for performing Hanford Site analytical work. If the laboratory uses a non-standard or unapproved method, then the laboratory must provide method validation data to confirm that the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Deviations from the analytical methods noted in Table E2-2 must be approved by Sample Management and Reporting in consultation with the CHPRC Project Manager.

Laboratories providing analytical services in support of this SAP will have in place a corrective action program that addresses analytical system failures and documents on the effectiveness of any corrective actions. Issues that may affect analytical results are to be resolved by Sample Management and Reporting in coordination with the CHPRC Project Manager.

E2.2.5 Quality Control

QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC sampling frequency is summarized in Table E2-4, and the sample types are described further in the following subsections.

E2.2.5.1 Field QC Samples

Field QC samples for this SAP will include equipment blanks (EB), field duplicates (DUP), full trip blank (FTB), and field transfer blank (FXR).

Field Duplicates - are two samples that are collected as close as possible to the same time and same location and are intended to be identical. DUP are generally collected from an area that is expected to have some contamination, so that valid comparisons between the samples can be made. DUP for water are collected by filling similar analyte containers from the same sampling tool. DUP are stored and transported together and are analyzed for the same constituents. The DUP are used to determine precision for both sampling and laboratory measurements.

DUP results must have precision within 20 percent, as measured by the relative percent difference. Only DUP with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated.

Equipment Blanks - or equipment rinsate blanks are samples in which high purity reagent water is passed through the sample collection tool or put in contact with the sampling surfaces of the equipment and the water collected and transferred into the appropriate containers. EB samples need only be collected from equipment that undergoes decontamination and is used for repeated sample collection.

Table E2-4. Project Quality Control Sampling Summary

QC Sample Type	Purpose	Frequency
	Field Quality Control	
Field Duplicates	Estimate precision, including sampling and analytical variability.	Minimum of one sample for each sample media type or 1 per 20 sample locations, whichever is greater.
Equipment rinsate	Verify adequacy of sampling equipment decontamination.	Solids: Minimum of one per each sample train or 1 per 10 locations, whichever is greater. Water: Minimum of one for each sample train or 1 per 10 locations, which ever is greater. If disposable equipment is used, then an equipment rinsate blank is not required.
Full Trip Blank (FTB)	Assess contamination from containers or transportation.	1 per 20 well trips
Field Transfer Blank (FXR)	Assess contamination from sampling site.	One per day when volatile organics are sampled.
	Laboratory Quality Control	
Method Blank	Assess response of an entire laboratory analytical system	One per batch* 20 samples maximum, of each matrix type or as required by laboratory contract.
Matrix Spike	Identify analytical (preparation + analysis) Bias; possible matrix affect on the analytical method used	One per batch*, 20 samples maximum, of each matrix type or as required by laboratory contract.
Matrix Duplicate or Matrix Spike Duplicate	Estimate analytical Bias and Precision	One per batch*, 20 samples maximum, of each matrix type or as required by laboratory contract.
Laboratory Control Samples	Assess method accuracy	One per batch*, 20 samples maximum, of each matrix type or as required by laboratory contract.
Surrogates	Estimate recovery/yield	As required by laboratory contract.

Notes:

* Batching across projects is allowed for similar matrices.

The EB sample bottles are placed in the same storage containers with the samples from the associated sampling event. EB samples are analyzed for the same constituents as the samples from the associated sampling event. EBs are used to evaluate the effectiveness of the cleaning process to ensure samples are not cross-contaminated from previous sampling events or between locations.

High purity water is Type II American Society for Testing and Materials (ASTM) organic-free water if samples for volatile organic compound (VOC), inorganic and radionuclides analysis are being collected that day, or certified deionized water if samples for only inorganic and radionuclide constituents are being collected. For EB type samples, laboratory results greater than twice the method detection limit may indicate the presence of cross-contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the threshold is five times the method detection limit. For radiological analytical data, blank results are flagged if they are greater than two times the total minimum detectable activity.

Full Trip Blank. Full Trip Blanks (FTB), also known as Trip Blanks (TB) or Daily's are prepared by the sampling team prior to traveling to the sampling site. The preserved bottle set is either for volatile organic analysis (VGA) only or identical to the set that will be collected in the field. It is filled with high purity reagent water (or dead water from well 699-SI 1-12AP for low-level tritium FTBs). The bottles are sealed and transported, unopened, to the field in the same storage containers used for samples collected that day. Collected FTBs are analyzed for the same constituents as the samples. FTBs are used to evaluate potential contamination of the samples due to the sample bottles, preservative, handling, storage and transportation.

Field Transfer Blanks. Field Transfer Blanks (FXR), also known as Field Blanks (FB), are preserved VGA sample bottles that are filled at the sample collection site with high purity reagent water that has been transported to the field. After collection, FXR bottles are sealed and placed in the same storage containers with the samples from the associated sampling event. FXR samples are analyzed for volatile organic compounds (VOC) only. FXRs are used to evaluate potential contamination caused by conditions in the field.

E2.2.5.2 Laboratory QC

Laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, and matrix spike) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III A*, as amended, and will be run at the frequency specified in that reference unless superseded by agreement. QC checks outside of control limits will be identified in the data validation process and during the DQA as described in Section E2.4. Laboratory QC samples include method blanks, matrix spike/matrix spike duplicate, control and surrogates.

Method Blanks - assess response of an entire laboratory analytical system. One sample is routinely processed per batch (20 samples maximum) by the laboratory for each matrix type, or as required by laboratory contract, or project specific requirements.

Matrix Spike and Matrix Spike Duplicate - identifies analytical (preparation + analysis) bias; possible matrix affect on the analytical method used. One sample per batch, 20 samples maximum, of each matrix type or as required by laboratory contract. This type of sample requires that triple the normal volume of sample be collected in the field. The need for this sample type will be defined on the Sample Authorization Form.

Laboratory Control Samples - assess method accuracy. One sample is routinely processed per batch (20 samples maximum) by the laboratory for each matrix type, or as required by laboratory contract, or project specific requirements.

Surrogates - estimate recovery/yield. Frequency is specified by laboratory contract.

For chemical analyses, the acceptance criteria for laboratory duplicates, matrix spikes, matrix spike duplicates, surrogates, and laboratory control samples are generally derived from historical data at the laboratories in accordance with SW-846. Typical acceptance limits are within 25 percent of the expected values, although the limits may vary considerably with the method and analyte. For radiological analyses, the acceptance limits for laboratory QC samples are specified in the laboratory contract.

Holding time is the elapsed time period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, decay or other physical-chemical alterations. Recommended holding times depend on the analytical method, as specified in SW-846 or EPA/600/4-79/020, *Methods of Chemical Analysis of Water and Wastes*. Holding times are specified in laboratory contracts. Data associated with exceeded holding times are flagged with an "H" in HEIS.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The Soil and Groundwater Remediation Project periodically audits the analytical laboratories to identify and solve quality problems or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

Failure of QC will be determined and evaluated during data validation and DQA process. Data will be qualified as appropriate.

E2.2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Equipment used for collection, measurement, and testing, will meet the applicable standards (e.g., ASTM) or have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications. The Field Work Supervisor, Field Technical Representative, or equivalent will ensure that the data generated from instructions using a software system are backed up and/or downloaded on a regular basis. Any software configuration will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (such as documentation of routine maintenance) will be included in the individual laboratory and the onsite organization QA plan or operating procedures (as appropriate). Maintenance of laboratory instruments will be performed in a manner consistent with SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, as amended, or with auditable DOE Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed per SW-846 requirements and will be appropriate for their use.

E2.2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in Section E3.4 of this SAP. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory QA plan.

E2.2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables that are used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the contractor acquisition system and the responsibilities and interfaces necessary to ensure that items procured/acquired by the contractor meet the specific technical and quality requirements. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

E2.2.8.1 Non-direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. Non-direct measurements (historic data) will not be evaluated in conjunction with the acquisition of new data. It's assumed that all historic data has been evaluated and deemed usable for the remedial action project.

E2.2.9 Data Management

Sample Management and Reporting, in coordination with the CHPRC Project Manager, is responsible for ensuring that analytical data is appropriately reviewed, managed and stored in accordance with the applicable programmatic requirements governing data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the TPA Action Plan (Ecology et al. 2003).

Planning for sample collection and analysis will be in accordance with the programmatic requirements governing fixed laboratory sample collection activities, as discussed in the sample team's procedures. In the event that specific procedures do not exist for a particular work evolution, or it is determined that additional guidance to complete certain tasks is needed, a work package will be developed to adequately control the activities, as appropriate. Examples of the sample team's requirements include activities associated with the following:

- Chain of custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks
- Checklists
- Sample packaging and shipping

Approved work control packages and procedures will be used to document field activities, including radiological measurements when this SAP is implemented. All field activities will be recorded in the field logbook. Examples of the types of documentation for field radiological data include the following:

- Instructions regarding the minimum requirements for documenting radiological controls information as per 10 CFR 835, "Occupational Radiation Protection."
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of primary contractor radiological records.
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related records.
- The indoctrination of personnel on the development and implementation of sample plans.
- The requirements associated with preparing and transporting regulated material.
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

Laboratory errors are reported to Sample Management and Reporting on a routine basis. For reported laboratory errors a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish their resolution with the Project Manager. The sample disposition records become a permanent part of the analytical data package for future reference and for records management.

E2.3 Assessment and Oversight

This section describes the methods to be used for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

E2.3.1 Assessments and Response Actions

CHPRC management, regulatory compliance, quality and/or health and safety representatives may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements. The CHPRC Project Manager will determine if a DQA will be performed for the activities identified in this SAP. The results of the DQA will be provided to the CHPRC Project Manager.

If circumstances arise in the field that would dictate the need for additional assessment activities, as determined by the CHPRC Project Manager or Field Work Supervisor, then they would be performed and recorded. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. CHPRC management representatives shall coordinate the corrective actions/deficiencies in accordance with the CHPRC QA program, the corrective action management program, and associated procedures that implant these programs.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The contractor conducts oversight of off-site analytical laboratories to qualify them for performing Hanford Site analytical work.

E2.3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to Sample Management and Reporting, and documented in a sample disposition record. This process is used to document analytical or sample issues and to establish resolution with the CHPRC Project Manager.

Depending on the type, significance, and visibility of the project, a DQA report may be prepared to determine if the type, quality, and quantity of the collected data met the quality objectives described in this SAP.

E2.4 Data Validation and Usability

This section describes the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether or not the data conform to the specified acceptance criteria.

E2.4.1 Data Review, Verification, and Validation

The criteria for verification may include review for: completeness (all samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, correct application of conversion factors. Laboratory personnel may perform data verification.

Data validation will be performed to ensure that the data quality goals established during the planning phase have been achieved. As recommended in EPA guidance (Bleyler 1988a, *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*; Bleyler 1988b, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*) the criteria for data validation are based on a graded approach. Based on contract requirements, five levels of validation, A–E, have been defined. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of all data (e.g., calibration data; calculations of representative samples from the data set).

Validation will be performed to Level C. Level C validation is a review of the QC data and specifically requires verification of deliverables and requested versus reported analyses and qualification of the results based on: analytical holding times; method blank results; matrix spike/matrix spike duplicate; surrogate recoveries; duplicates; and analytical method blanks. Level C validation will be performed on at least five percent of the data by matrix and analyte group. Analyte group refers to categories, such as volatile organic compounds, radionuclides, metals, anions, etc. The goal is to cover the various analyte groups and matrices during the validation.

Relative to analytical data in sample media, physical data and/or field screening results are of lesser importance. Field QA/QC will be reviewed to ensure that physical property data and/or field screening results are consistent with expectations and useable.

E2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines (Bleyler 1988a and Bleyler 1988b). Data validation may be performed by Sample Management and Reporting, and/or by an party independent of both the data collector and the data user. Data qualifiers must be compatible with the HEIS database.

When outliers or questionable results are identified, additional data validation will be performed. The additional validation will be performed for up to five percent of the statistical outliers and/or questionable data. The additional validation will begin with Level C and may increase to Levels D and E as needed to ensure that the data are usable. Note that Level C validation is a review of the QC data, while Levels D and E include review of calibration data and calculations of representative samples from the data set. All data validation will be documented in data validation reports, which will placed in the project file.

E2.4.3 Reconciliation with User Requirements

The DQA process (EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide* and EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners*) compares completed field sampling activities to those described in the SAP and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the DQOs. The CHPRC Project Manager is responsible for determining if a DQA is necessary and ensuring that, if required, one is performed. The results of the DQA will be used in interpreting the data and determining if the objectives have been met. The type of DQA performed may vary depending on whether the sample design was statistical or not. DQA activities typical of a statistical based sample design may include:

- Step 1. Review DQOs and Sampling Design. This step requires a comprehensive review of the sampling and analytical requirements outlined in the project-specific DQO summary report and SAP. As appropriate:
  - Verify that the hypothesis or estimate chosen is consistent with the project's objective and meets the project's performance and acceptance criteria.

  - Translate study objectives into statistical terms.
  - List any deviations from the planned sampling design.
  - Determine the potential effect of any deviations.

- Step 2. Conduct a Preliminary Data Review. Compare the actual QA/QC achieved (e.g., precision, accuracy, completeness) with the requirements identified in the SAP. Document in the final DQA report any significant deviations. Calculate the basic statistics from the analytical data and include an evaluation of the distribution of the data. As appropriate determine:
  - Central tendency of the data (e.g., mean, median, mode)
  - Relative standing of individual datum (e.g., percentiles; quantiles)
  - Dispersion of the data (e.g., range, variance, standard deviation)
  - Association, i.e. relationship between two or more variables, of the data (e.g., correlation coefficients)

If appropriate, this information can be determined and/or displayed graphically.

- Step 3. Select the Data Analyses. Select the appropriate statistical hypothesis test(s) or graphical data analyses and justify this selection. As appropriate determine:
  - The null hypothesis
  - Alternative hypothesis
  - Statistic test (t-test)
  - Critical value (regulatory threshold)
  - Conclusion

- Step 4. Verify the Assumptions. Assess the validity of the data analyses (Step 3) by determining if the data support the underlying assumptions necessary for the analyses or if the data set must be modified (e.g., transposed, augmented with additional data) before further analysis. This step is necessary because the validity of the selected method depends on the validity of key assumptions underlying the test. As appropriate determine:
  - Assumptions required for data analyses test (e.g., independent data, approximate normal distribution)
  - If data meet the assumptions

Assumptions might be determined qualitatively by reviewing the sampling plan, qualitatively inspecting the shape of a histogram, and quantitatively applying an appropriate test for distributions assumptions. If it is determined that one or more of the assumptions is not met, then an alternate plan is needed (selection of a different statistical method or collection of additional data).

- Step 5. Draw Conclusions from the Data. Apply the statistical method selected in Step 3. Clearly document any calculations used. As appropriate determine:
  - If the data reject the null hypothesis

- If the data fail to reject the null hypothesis
- Confidence interval (qualitatively or quantitatively)
- Tolerance interval

E2.4.4 Corrective Actions

The responses to data quality defects identified through the DQA process will vary and may be data- or measurement-specific.

E3 Field Sampling Plan

E3.1 Sampling Objectives

The objective for the field sampling plan (FSP) portion of this SAP is to identify and clearly describe the sampling and analysis activities necessary to achieve the identified DQOs. The FSP implements the sampling design developed through DOE/RL-2009-115 and presents the design using figures and tables to identify sampling locations, the total number of samples to be collected, sampling procedures to be implemented, sample container requirements and the analyses to be performed.

E3.2 Documentation of Field Activities

Logbooks or data forms are required for all field activities. Water level measurement and groundwater quality sampling data forms may be used to record field information; however, they must follow the same requirements for logbooks and must be referenced in the logbooks.

Information to be recorded in logbooks or data forms shall include:

- Purpose of activity
- Day, date, time, weather conditions
- Names, titles, organizations of personnel present
- Deviations from the QAPjP or procedures
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (preparation, splits, duplicates, matrix spikes, equipment blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations and surveys, and equipment identification numbers as applicable
- Equipment decontaminated, number of decontaminations, and variations to any decontamination procedures
- Equipment failures or breakdowns and descriptions of any corrective actions
- Telephone calls associated with field activities

E3.3 Sampling Design

The sampling design employed under this SAP is judgmental and was developed based on the information presented in DOE/RL-2009-115. Monitor well locations and measurement parameters were selected based on knowledge of the feature or condition under investigation, professional judgment, and ROD requirements.

E3.4 Calibration of Field Equipment

The Field Work Supervisor, or designated personnel, is responsible to ensure that all field equipment is calibrated appropriately. All on-site environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from all instrument calibration activities are recorded in logbooks and/or work packages; either hard copy or electronic are acceptable. Calibrations must be performed as follows:

- Prior to initial use of a field analytical measurement system
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria

Field instrumentation, calibration, and QA checks will be performed in accordance with the following:

- Calibration of radiological field instruments on the Hanford Site is performed under contract by Pacific Northwest National Laboratory, as specified in their program documentation.
- Daily calibration checks will be performed and documented for each instrument used to measure physical-chemical properties. These checks will be made using reference standards that are sufficiently like the matrix under consideration so that direct comparison of the data can be made.
- Standards used for calibration will be traceable to a nationally or internationally recognized source or measurement system, if available.

Non-radiological equipment requiring field calibration includes water quality meters (pH, temperature, specific conductance, redox potential, and dissolved oxygen). Selection of the pH buffers and specific conductance standards shall account for the range of conditions present within 200-ZP-1 groundwater OU.

E3.5 Sample Locations and Frequency

The groundwater monitoring well network is comprised of two well groups: monitor wells for water level measurements, and monitor wells for COC and MNA sampling and analysis. Monitor well locations are shown on Figure E3-1 (water level monitoring network), Figure E3-2 (full monitor well network), and Figure E3-3 (reduced monitor well network). General information on each of the water level measurement wellsis provided in Table E3-1, and information on groundwater quality monitor wells provided in Table E3-2 and Table E3-3.

E3.5.1 Water Level Measurements

The water level monitoring network includes 118 locations (Figure E3-1). Pressure transducers are installed at 31 of the locations (Table E3-1). Water level measurements will be collected as follows:

- During the baseline 2011 sampling event performed prior to system startup.
- During each subsequent groundwater monitoring event from the full or the reduced monitor well list.

Periodic water level data recorded by the pressure transducers will be downloaded on a quarterly to annual basis depending on the measurement frequency.

Water level measurements may also be collected during non-routine events when a significant change in P&T operation occurs such as a system-wide shutdown, or when a group of wells is temporarily or permanently idled for a period of seven days or more, or when pumping rates are simultaneously altered at three or more wells for a period of 7 days or more. The CHPRC Project Manager will have the discretion to determine if a non-routine water level measurement event is warranted.

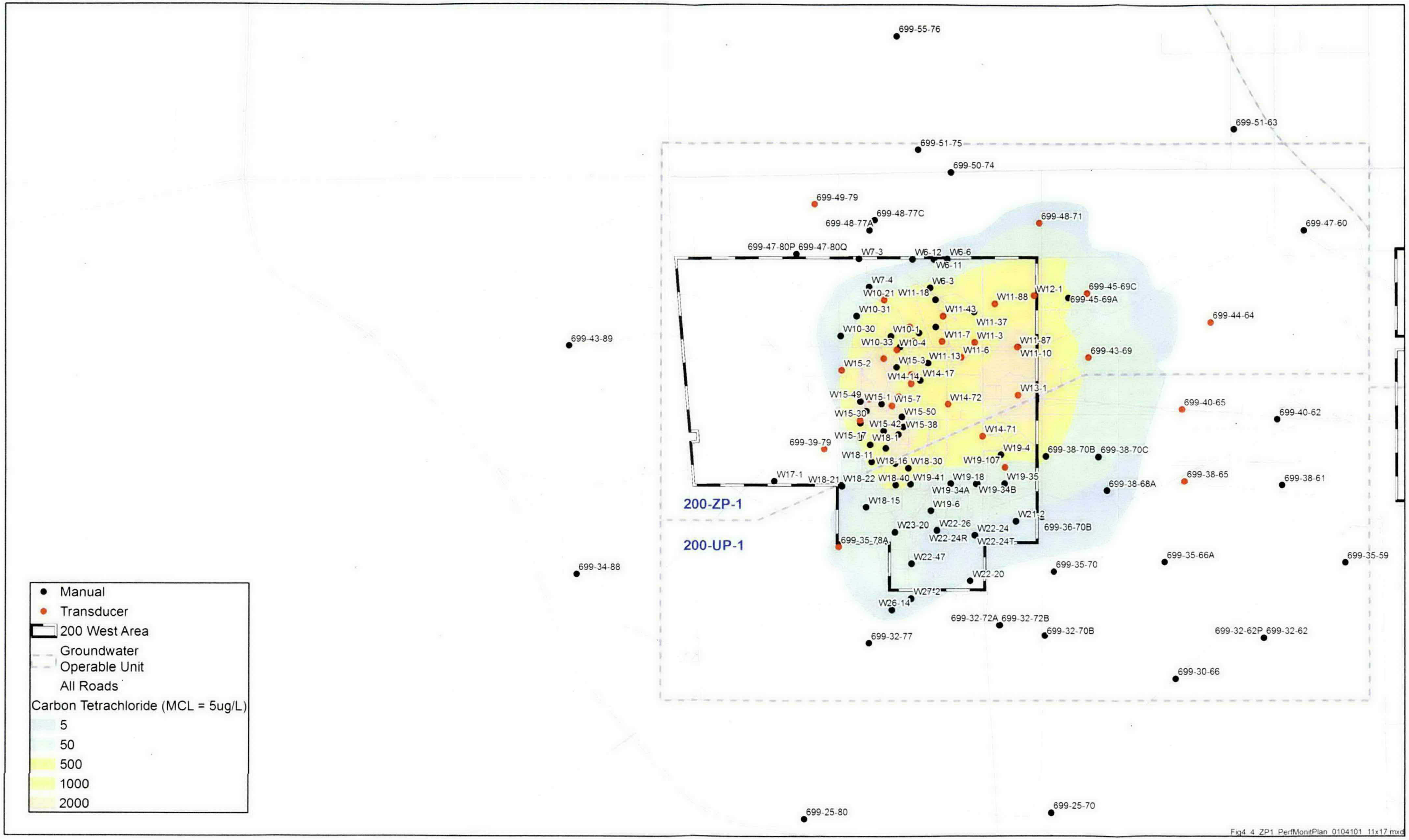

Figure E3-1. Water Level Monitoring Network

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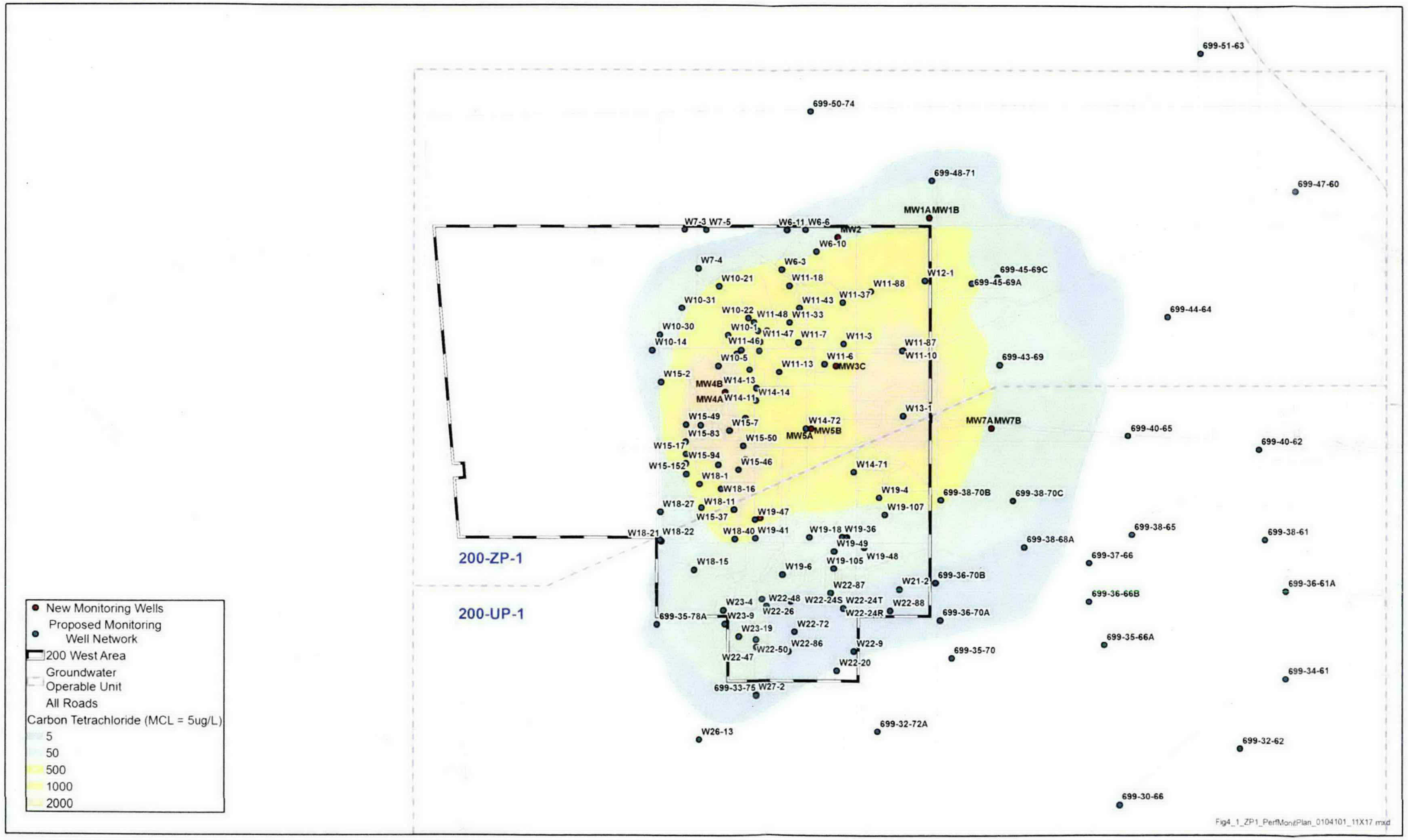

Figure E3-2. Groundwater Monitor Well Sampling Network (Full Well List)

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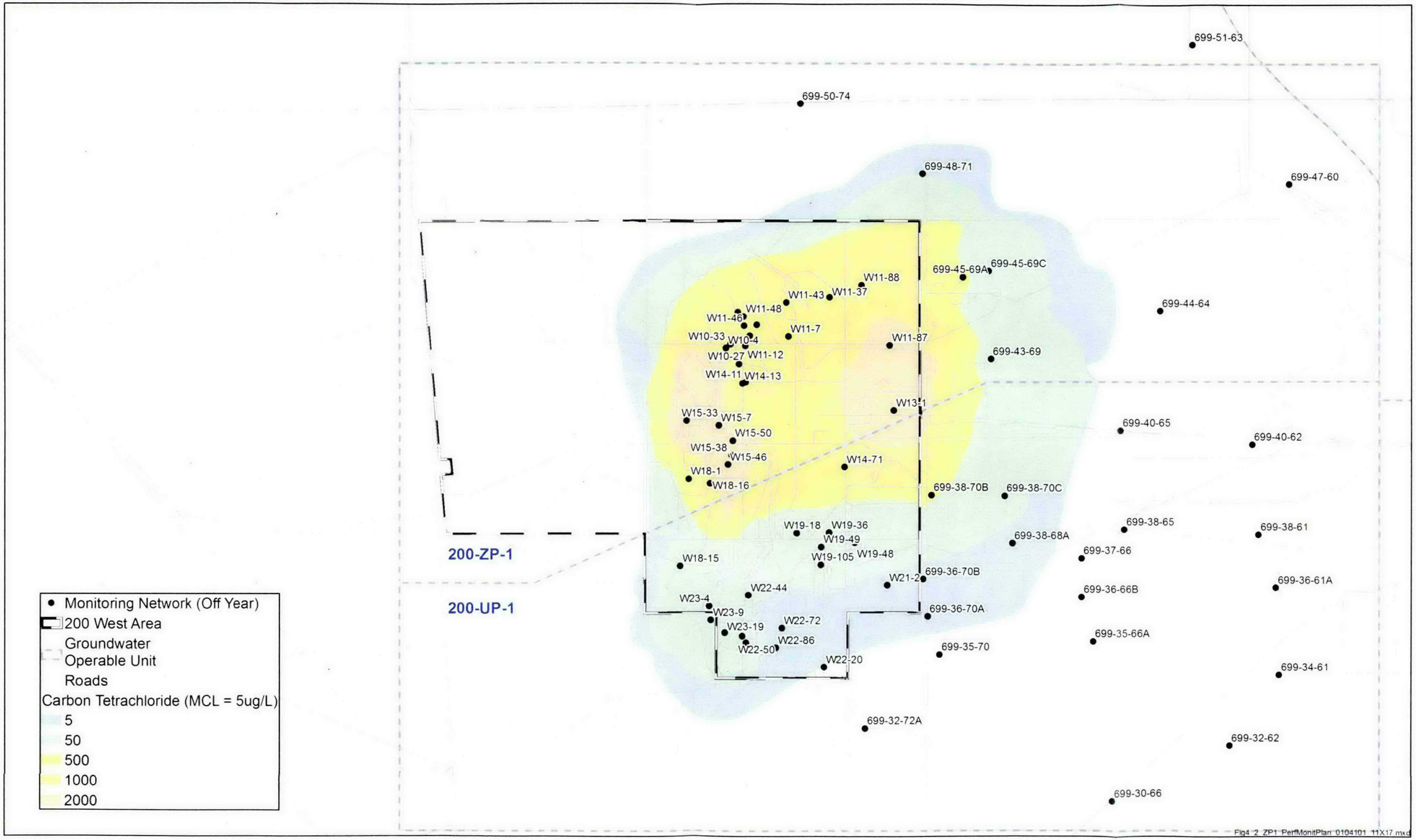

Figure E3-3. Groundwater Monitor Well Sampling Network (Reduced Well List)

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Table E3-1. 200-ZP-1 Groundwater OU Hydraulic Monitoring Well Network

Well Number	Well Name	Easting (m)	Northing (m)	Surface Elevation (m amsl)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation* (m)
1	299-W10-1	566663	136735	207.459	NA	NA	08/07/47	No	137.36
2	299-W10-21	566584	137155	206.49	63.78	69.87	08/27/93	Yes	--
3	299-W10-27	566844	136442	205.624	67.36	78.02	03/23/01	No	--
4	299-W10-30	566083	136739	211.647	73.86	84.53	03/14/06	No	--
5	299-W10-31	566266	136968	210.384	73.13	83.82	04/20/06	No	--
6	299-W10-33	566773	136610	205.986	118.87	124.96	06/15/07	No	--
7	299-W10-4	566735	136578	205.524	NA	NA	11/10/52	Yes	138.96
8	299-W10-5	566579	136475	205.962	NA	NA	05/18/54	Yes	145.76
9	299-W11-10	568148	136610	223.187	NA	NA	04/16/56	No	137.84
10	299-W11-13	567099	136424	211.935	NA	NA	07/31/61	No	106.93
11	299-W11-18	567182	137161	216.537	NA	NA	03/01/67	No	136.98
12	299-W11-3	567642	136664	220.019	NA	NA	08/29/56	Yes	132.54
13	299-W11-33	567185	136844	217.237	74.41	91.17	09/09/94	No	--
14	299-W11-37	567635	137018	221.609	NA	NA	07/07/94	No	136.64
15	299-W11-43	567270	136971	217.528	129.44	134.01	05/23/05	Yes	--
16	299-W11-45	566993	136776	213.614	85.73	90.18	09/02/05	No	--
17	299-W11-47	566934	136681	210.403	83.58	92.89	01/06/06	Yes	--
18	299-W11-48	566882	136846	209.7	84.56	112.01	11/29/06	Yes	--
19	299-W11-6	567482	136493	219.772	NA	NA	07/05/51	Yes	132.29
20	299-W11-7	567261	136675	217.108	NA	NA	09/17/51	Yes	135.57
21	299-W11-87	568141	136609	223.642	116.36	120.94	03/01/07	Yes	--
22	299-W11-88	567875	137113	221.9	135.66	147.85	10/03/07	Yes	--
23	299-W12-1	568331	137206	222.444	NA	NA	05/09/56	Yes	133.59
24	299-W13-1	568149	136049	223.54	119.15	129.81	02/10/04	Yes	--
25	299-W14-11	566902	136288	205.092	NA	NA	04/26/05	No	123.10
26	299-W14-14	566898	136181	205.432	66.13	76.81	11/12/98	Yes	--
27	299-W14-17	567007	136218	205.853	67.64	78.32	10/24/00	No	--
28	299-W14-71	567733	135568	219.41	125.17	129.74	07/27/06	Yes	--

Table E3-1. 200-ZP-1 Groundwater OU Hydraulic Monitoring Well Network

Well Number	Well Name	Easting (m)	Northing (m)	Surface Elevation (m amsl)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation* (m)
29	299-W14-72	567328	135941	216.387	126.18	130.76	08/15/06	Yes	--
30	299-W15-1	566554	135943	206.993	NA	NA	05/02/47	No	NA
31	299-W15-11	566412	136001	208.261	NA	NA	03/08/68	Yes	NA
32	299-W15-152	566309	135550	209.869	71.94	82.61	09/15/05	No	--
33	299-W15-17	566307	135719	209.783	128.77	131.82	10/28/87	No	--
34	299-W15-2	566094	136336	212.411	NA	NA	08/12/54	Yes	139.87
35	299-W15-3	566729	136371	205.385	NA	NA	09/30/52	No	NA
36	299-W15-30	566305	135749	210.126	66.47	78.63	05/05/95	Yes	--
37	299-W15-31A	566377	135856	208.48	64.76	76.93	05/26/95	No	--
38	299-W15-37	566716	135248	203.028	NA	NA	05/16/96	No	132.68
39	299-W15-38	566813	135673	203.691	NA	NA	05/17/96	No	137.31
40	299-W15-41	566758	136032	203.484	65.81	70.39	01/17/00	Yes	--
41	299-W15-42	566582	135627	207.391	69.50	84.74	02/26/02	No	--
42	299-W15-46	566752	135587	204.222	63.86	88.23	10/03/03	No	--
43	299-W15-49	566307	135973	209.127	71.86	82.52	11/01/04	No	--
44	299-W15-50	566793	135791	203.236	74.19	84.85	02/28/05	No	--
45	299-W15-7	566676	135920	204.249	NA	NA	03/30/66	Yes	123.17
46	299-W17-1	565311	135039	199.174	NA	NA	12/17/03	No	NA
47	299-W18-1	566422	135465	209.058	NA	NA	01/12/59	No	113.77
48	299-W18-11	566440	135266	209.468	57.91	67.05	01/04/69	No	--
49	299-W18-15	566380	134733	202.219	NA	NA	04/25/80	No	130.74
50	299-W18-16	566605	135426	208.58	71.47	82.13	10/20/04	No	--
51	299-W18-21	566098	134979	204.9	59.59	68.73	07/29/87	No	--
52	299-W18-22	566089	134990	204.857	126.94	136.39	09/25/87	No	--
53	299-W18-30	566871	135194	206.117	60.20	71.23	11/14/91	No	--
54	299-W18-40	566723	134996	203.413	66.53	77.20	09/28/01	No	--
55	299-W19-107	567998	135206	217.419	94.65	99.22	03/31/06	Yes	--
56	299-W19-18	567361	135012	213.983	NA	NA	12/12/85	No	125.90
57	299-W19-34A	567674	135012	215.331	NA	NA	05/18/94	No	113.34

Table E3-1. 200-ZP-1 Groundwater OU Hydraulic Monitoring Well Network

Well Number	Well Name	Easting (m)	Northing (m)	Surface Elevation (m amsl)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation* (m)
58	299-W19-34B	567663	135011	215.475	NA	NA	NA	No	87.57
59	299-W19-35	567992	135015	213.63	NA	NA	04/20/94	No	135.18
60	299-W19-4	567950	135351	219.023	NA	NA	02/15/60	No	98.30
61	299-W19-41	566897	135005	206.531	67.07	77.76	09/23/98	No	--
62	299-W19-6	567133	134694	210.341	NA	NA	12/13/68	No	89.79
63	299-W21-2	568124	134574	214.85	79.29	89.96	11/22/04	No	--
64	299-W22-20	567593	133879	207.091	NA	NA	06/19/57	No	130.28
65	299-W22-24	567648	134411	212.16	NA	NA	09/08/60	No	93.29
66	299-W22-24P	567648	134411	212.224	NA	NA	09/08/60	No	43.98
67	299-W22-24R	567648	134411	212.224	NA	NA	09/08/60	No	82.84
68	299-W22-24T	567648	134411	212.218	NA	NA	09/08/60	No	119.41
69	299-W22-26	567205	134465	208.379	NA	NA	12/31/63	No	132.48
70	299-W22-47	566909	134076	206.275	69.70	80.37	01/19/05	No	--
71	299-W23-20	566718	134446	203.795	65.68	76.35	08/21/00	No	--
72	299-W26-14	566683	133539	205.43	68.08	78.75	04/03/03	No	--
73	299-W27-2	566908	133670	207.404	123.79	126.87	12/18/92	No	--
74	299-W6-11	567163	137635	215.248	76.47	82.60	05/21/92	No	--
75	299-W6-12	566916	137635	212.091	73.83	78.45	04/14/92	No	--
76	299-W6-3	567118	137299	214.373	124.82	127.95	10/15/91	No	--
77	299-W6-6	567319	137639	217.469	127.58	130.84	10/24/91	No	--
78	299-W7-3	566292	137639	207.185	136.85	145.29	11/23/87	No	--
79	299-W7-4	566409	137308	205.833	61.87	71.01	11/19/87	No	--
80	699-25-70	568545	131172	192.966	NA	NA	08/31/48	No	99.24
81	699-25-80	565676	131106	188.994	NA	NA	11/30/48	No	122.28
82	699-30-66	569991	132739	210.481	117.34	120.39	10/13/04	No	--
83	699-32-62	571010	133216	216.562	NA	NA	04/06/60	No	98.46
84	699-32-62P	571010	133216	216.585	NA	NA	04/06/60	No	65.72
85	699-32-70B	568462	133242	204.204	NA	NA	08/09/57	No	122.37
86	699-32-72A	567943	133363	204.661	NA	NA	07/31/57	No	66.74

Table E3-1. 200-ZP-1 Groundwater OU Hydraulic Monitoring Well Network

Well Number	Well Name	Easting (m)	Northing (m)	Surface Elevation (m amsl)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation* (m)
87	699-32-72B	567935	133362	205.118	65.41	74.56	05/18/94	No	--
88	699-32-77	566417	133152	200.341	NA	NA	05/15/51	No	129.48
89	699-34-88	563012	133950	194.039	NA	NA	12/20/48	No	78.06
90	699-35-59	571956	134096	222.116	94.48	106.67	10/31/85	No	--
91	699-35-66A	569858	134099	222.452	NA	NA	06/13/57	No	133.76
92	699-35-70	568566	133988	212.326	71.01	77.11	09/08/48	No	--
93	699-35-78A	566064	134271	202.383	NA	NA	08/17/50	Yes	132.02
94	699-36-70B	568428	134626	215.24	80.51	91.17	06/09/04	No	--
95	699-38-61	571219	134997	228.167	101.83	107.92	11/16/93	No	--
96	699-38-65	570090	135040	230.709	NA	NA	12/31/59	Yes	117.93
97	699-38-68A	569180	134932	218.899	NA	NA	06/21/94	No	132.05
98	699-38-70B	568469	135331	222.559	123.96	128.53	02/03/04	No	--
99	699-38-70C	569084	135326	226.67	120.60	125.18	02/17/04	No	--
100	699-39-79	565891	135412	206.45	NA	NA	09/07/48	Yes	NA
101	699-40-62	571164	135764	228.943	NA	NA	01/17/49	No	120.88
102	699-40-65	570057	135881	231.028	NA	NA	02/03/04	Yes	124.14
103	699-43-69	568967	136488	227.362	121.98	132.64	12/11/07	Yes	--
104	699-43-89	562917	136620	197.72	NA	NA	01/16/51	No	133.41
105	699-44-64	570391	136897	222.203	NA	NA	01/31/60	Yes	106.67
106	699-45-69A	568729	137183	222.138	NA	NA	06/22/48	No	124.60
107	699-45-69C	568947	137234	222.569	111.86	116.43	07/13/07	Yes	--
108	699-47-60	571474	137969	199.578	NA	NA	07/20/48	No	118.50
109	699-47-80AP	565562	137693	NA	NA	NA	11/30/83	No	7.35
110	699-47-80AQ	565562	137693	NA	NA	NA	11/30/83	No	62.77
111	699-48-71	568388	138057	210.864	NA	NA	09/26/56	Yes	128.42
112	699-48-77A	566413	137969	206.674	64.74	70.83	05/04/92	No	--
113	699-48-77C	566469	138087	206.585	NA	NA	04/01/94	No	114.42
114	699-49-79	565771	138271	211.077	NA	NA	07/03/48	Yes	136.07
115	699-50-74	567360	138647	201.409	68.07	78.74	07/12/05	No	--

Table E3-1. 200-ZP-1 Groundwater OU Hydraulic Monitoring Well Network

Well Number	Well Name	Easting (m)	Northing (m)	Surface Elevation (m amsl)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation* (m)
116	699-51-63	570664	139148	175.302	NA	NA	11/06/56	No	123.49
117	699-51-75	566978	138906	196.561	NA	NA	10/31/57	No	NA
118	699-55-76	566723	140226	178.727	NA	NA	01/18/59	No	123.56

Notes

* Mid-screen elevations were obtained from the 2008 carbon tetrachloride plume shell data set and are included in this table because the top and bottom screen elevation were not available. Top and bottom screen elevations are not available from the Hanford Environmental Information System database but are likely available from other data sources and/or databases because they were available to construct the plume shell data set.

amsl = above mean sea level

NA = not available

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Table E3-2. 200-ZP-1 Groundwater OU Contaminant Monitoring Well Network (Full)

Well No.	Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Bottom (m)	Depth to Screen Top (m)	Date Drilled	Mid-Screen Elevation* (m)
1	299-W10-1	566663	136735	207.5	149.5	125.2	8/7/47	137.4
2	299-W10-14	566017	136609	214.3	84.1	78.0	11/18/87	81.1
3	299-W10-21	566584	137155	206.5	142.7	136.6	8/27/93	139.7
4	299-W10-22	566833	136883	209.0	143.3	134.1	10/2/94	138.7
5	299-W10-30	566083	136739	211.6	137.8	127.1	3/14/06	132.4
6	299-W10-31	566266	136968	210.4	137.3	126.6	4/20/06	131.9
7	299-W10-33	566773	136610	206.0	87.1	81.0	6/15/07	84.1
8	299-W10-4	566735	136578	205.5	147.6	130.8	11/10/52	139.0
9	299-W10-5	566579	136475	206.0	152.6	138.9	5/18/54	145.8
10	299-W11-10	568148	136610	223.2	145.2	130.5	4/16/56	137.8
11	299-W11-12	566927	136604	208.2	147.2	132.0	12/21/53	139.6
12	299-W11-13	567099	136424	211.9	145.5	68.4	7/31/61	106.9
13	299-W11-18	567182	137161	216.5	147.3	126.6	3/1/67	137.0
14	299-W11-3	567642	136664	220.0	142.6	122.5	8/29/56	132.5
15	299-W11-37	567635	137018	221.6	142.3	132.8	7/7/94	136.6
16	299-W11-43	567270	136971	217.5	88.1	83.5	5/23/05	85.8
17	299-W11-45	566993	136776	213.6	127.9	123.4	9/2/05	125.7
18	299-W11-46	566915	136773	210.9	130.7	124.6	7/26/05	127.6
19	299-W11-47	566934	136681	210.4	126.8	117.5	1/6/06	122.2
20	299-W11-48	566882	136846	209.7	125.1	97.7	11/29/06	111.4
21	299-W11-6	567482	136493	219.8	139.9	124.7	7/5/51	132.3
22	299-W11-7	567261	136675	217.1	142.4	128.7	9/17/51	135.6
23	299-W11-87	568141	136609	223.6	107.3	102.7	3/1/07	105.0
24	299-W11-88	567875	137113	221.9	86.2	74.0	10/3/07	80.1
25	299-W12-1	568331	137206	222.4	138.9	128.3	5/9/56	133.6
26	299-W13-1	568149	136049	223.5	104.4	93.7	2/10/04	99.1
27	299-W14-11	566902	136288	205.1	125.3	122.3	4/26/05	123.1
28	299-W14-13	566902	136282	205.1	138.7	128.7	8/31/98	133.7
29	299-W14-14	566898	136181	205.4	139.3	128.6	11/12/98	134.0

Table E3-2. 200-ZP-1 Groundwater OU Contaminant Monitoring Well Network (Full)

Well No.	Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Bottom (m)	Depth to Screen Top (m)	Date Drilled	Mid-Screen Elevation* (m)
30	299-W14-71	567733	135568	219.4	94.2	89.7	7/27/06	92.0
31	299-W14-72	567328	135941	216.4	90.2	85.6	8/15/06	87.9
32	299-W15-152	566309	135550	209.9	137.9	127.3	9/15/05	132.6
33	299-W15-17	566307	135719	209.8	81.0	78.0	10/28/87	79.5
34	299-W15-2	566094	136336	212.4	146.0	133.8	8/12/54	139.9
35	299-W15-33	566433	135967	206.8	142.4	127.9	12/31/95	135.2
36	299-W15-37	566716	135248	203.0	140.3	125.1	5/16/96	132.7
37	299-W15-38	566813	135673	203.7	141.2	135.1	5/17/96	137.3
38	299-W15-42	566582	135627	207.4	137.9	122.7	2/26/02	130.3
39	299-W15-46	566752	135587	204.2	140.4	116.0	10/3/03	128.2
40	299-W15-49	566307	135973	209.1	137.3	126.6	11/1/04	131.9
41	299-W15-50	566793	135791	203.2	129.0	118.4	2/28/05	123.7
42	299-W15-7	566676	135920	204.2	148.8	97.6	3/30/66	123.2
43	299-W15-763	566809	136029	202.9	138.4	127.7	1/17/01	133.1
44	299-W15-83	566305	135826	209.3	137.7	127.0	8/9/05	132.4
45	299-W15-94	566308	135640	209.9	137.9	127.2	9/19/05	132.6
46	299-W18-1	566422	135465	209.1	149.6	79.5	1/12/59	113.8
47	299-W18-15	566380	134733	202.2	142.8	118.7	4/25/80	130.7
48	299-W18-16	566605	135426	208.6	137.1	126.4	10/20/04	131.8
49	299-W18-21	566098	134979	204.9	145.3	136.2	7/29/87	140.7
50	299-W18-22	566089	134990	204.9	77.9	68.5	9/25/87	73.2
51	299-W18-27	566090	135227	211.4	145.3	139.1	5/7/91	142.2
52	299-W18-40	566723	134996	203.4	136.9	126.2	9/28/01	131.6
53	299-W19-105	567565	134745	213.0	135.2	124.5	12/13/05	129.8
54	299-W19-107	567998	135206	217.4	122.8	118.2	3/31/06	120.5
55	299-W19-34A	567674	135012	215.3	116.5	111.8	5/18/94	113.3
56	299-W19-36	567635	135017	215.4	140.8	127.1	9/1/95	133.9
57	299-W19-40	567974	134847	210.8	140.5	134.4	8/21/95	137.5
58	299-W19-41	566897	135005	206.5	139.5	128.8	9/23/98	134.1
59	299-W19-48	567823	134926	212.9	133.0	122.3	10/5/04	127.6

Table E3-2. 200-ZP-1 Groundwater OU Contaminant Monitoring Well Network (Full)

Well No.	Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Bottom (m)	Depth to Screen Top (m)	Date Drilled	Mid-Screen Elevation* (m)
60	299-W19-49	567568	134894	214.2	135.1	124.5	8/30/05	129.8
61	299-W21-2	568124	134574	214.9	135.6	124.9	11/22/04	130.2
62	299-W22-20	567593	133879	207.1	144.6	116.0	6/19/57	130.3
63	299-W22-26	567205	134465	208.4	147.4	117.5	12/31/63	132.5
64	299-W22-47	566909	134076	206.3	136.6	125.9	1/19/05	131.2
65	299-W22-48	566997	134425	207.9	138.9	134.4	11/8/99	136.7
66	299-W22-50	566904	134140	205.0	138.6	134.0	1/28/00	136.3
67	299-W22-72	567237	134207	208.0	135.8	125.1	2/22/06	130.5
68	299-W22-86	567187	134041	206.4	135.9	125.2	3/10/06	130.5
69	299-W22-87	567542	134540	212.0	135.7	125.1	12/14/05	130.4
70	299-W22-88	568046	134391	213.9	134.3	123.7	2/6/08	129.0
71	299-W23-4	566628	134392	203.0	148.1	111.6	6/18/57	129.9
72	299-W23-9	566642	134275	203.7	153.7	133.6	8/11/72	142.7
73	299-W26-13	566424	133294	199.8	138.2	127.5	12/28/99	132.8
74	299-W27-2	566908	133670	207.4	83.6	80.5	12/18/92	82.1
75	299-W6-10	567413	137453	218.2	141.7	135.5	2/13/92	138.6
76	299-W6-3	567118	137299	214.4	89.5	86.4	10/15/91	88.0
77	299-W6-6	567319	137639	217.5	89.9	86.6	10/24/91	88.3
78	299-W7-3	566292	137639	207.2	70.3	61.9	11/23/87	66.1
79	299-W7-4	566409	137308	205.8	144.0	134.8	11/19/87	139.4
80	299-W7-5	566476	137636	206.2	143.1	136.8	11/19/87	140.0
81	699-32-72A	567943	133363	204.7	76.7	56.8	7/31/57	66.7
82	699-33-75	566908	133662	207.4	135.7	125.1	1/8/08	130.4
83	699-35-70	568566	133988	212.3	141.3	135.2	9/8/48	138.3
84	699-35-78A	566064	134271	202.4	147.5	117.3	8/17/50	132.0
85	699-36-70A	568467	134309	216.0	137.6	128.4	12/10/94	132.2
86	699-36-70B	568428	134626	215.2	134.7	124.1	6/9/04	129.4
87	699-38-65	570090	135040	230.7	163.7	72.2	12/31/59	117.9
88	699-38-70B	568469	135331	222.6	98.6	94.0	2/3/04	96.3
89	699-38-70C	569084	135326	226.7	106.1	101.5	2/17/04	103.8

Table E3-2. 200-ZP-1 Groundwater OU Contaminant Monitoring Well Network (Full)

Well No.	Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Bottom (m)	Depth to Screen Top (m)	Date Drilled	Mid-Screen Elevation* (m)
90	699-40-65	570057	135881	231.0	130.2	119.5	2/3/04	124.1
91	699-43-69	568967	136488	227.4	105.4	94.7	12/11/07	100.1
92	699-44-64	570391	136897	222.2	125.9	87.5	1/31/60	106.7
93	699-45-69A	568729	137183	222.1	138.6	110.6	6/22/48	124.6
94	699-45-69C	568947	137234	222.6	110.7	106.1	7/13/07	108.4
95	699-48-71	568388	138057	210.9	138.0	118.8	9/26/56	128.4
96	699-50-74	567360	138647	201.4	133.3	122.7	7/12/05	128.0
97	299-W10-27	566844	136442	205.6	138.3	127.6	3/23/01	132.9
98	299-W11-33	567185	136844	217.2	142.8	126.1	9/9/94	134.4
99	299-W18-11	566440	135266	209.5	151.6	142.4	1/4/69	147.0
100	299-W19-18	567361	135012	214.0	146.9	104.9	12/12/85	125.9
101	299-W19-34B	567663	135011	215.5	90.0	87.1	NA	87.6
102	299-W19-4	567950	135351	219.0	141.3	56.0	2/15/60	98.3
103	299-W19-47	566895	135162	206.3	137.1	126.4	6/1/04	131.7
104	299-W19-6	567133	134694	210.3	94.5	85.1	12/13/68	89.8
105	299-W22-24P	567648	134411	212.2	48.6	39.4	9/8/60	44.0
106	299-W22-24Q	567648	134411	212.2	67.4	60.7	9/8/60	64.1
107	299-W22-24R	567648	134411	212.2	86.7	79.0	9/8/60	82.8
108	299-W22-24S	567648	134411	212.2	104.9	97.3	9/8/60	101.1
109	299-W22-24T	567648	134411	212.2	123.2	115.6	9/8/60	119.4
110	299-W22-44	566956	134484	207.8	145.2	134.0	11/26/91	139.6
111	299-W22-9	567740	134043	207.5	140.5	116.4	5/4/56	128.4
112	299-W23-19	566759	134167	202.5	139.5	136.4	11/17/99	137.9
113	299-W6-11	567163	137635	215.2	138.8	132.7	5/21/92	135.7
114	699-30-66	569991	132739	210.5	93.1	90.1	10/13/04	91.6
115	699-32-62	571010	133216	216.6	132.7	64.2	4/6/60	98.5
116	699-34-61	571396	133810	221.8	129.4	123.3	11/29/93	126.3
117	699-35-66A	569858	134099	222.5	143.2	124.3	6/13/57	133.8
118	699-36-61A	571395	134557	229.0	128.4	110.5	8/12/48	119.5
119	699-36-66B	569731	134469	221.3	131.7	121.0	12/20/07	126.4

Table E3-2. 200-ZP-1 Groundwater OU Contaminant Monitoring Well Network (Full)

Well No.	Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Bottom (m)	Depth to Screen Top (m)	Date Drilled	Mid-Screen Elevation* (m)
120	699-37-66	569730	134797	222.0	131.3	120.6	11/28/07	126.0
121	699-38-61	571219	134997	228.2	126.3	120.2	11/16/93	123.3
122	699-38-68A	569180	134932	218.9	137.3	128.2	6/21/94	132.0
123	699-40-62	571164	135764	228.9	126.8	115.0	1/17/49	120.9
124	699-47-60	571474	137969	199.6	123.4	115.1	7/20/48	118.5
125	699-51-63	570664	139148	175.3	127.4	119.5	11/6/56	123.5

Notes:

* Mid-screen elevations were obtained from the 2008 carbon tetrachloride plume shell data set and are included in this table because the top and bottom screen elevation were not available. Top and bottom screen elevations are not available from the Hanford Environmental Information System database but are likely available from other data sources and/or databases because they were available to construct the plume shell data set.

NA = not available

Table E3-3. 200-ZP-1 Groundwater OU Contaminant Monitoring Well Network (Reduced)

Well No.	Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Bottom (m)	Depth to Screen Top (m)	Date Drilled	Mid-Screen Elevation* (m)
1	299-W10-22	566833	136883	209.0	143.3	134.1	10/02/94	138.7
2	299-W10-27	566844	136442	205.6	138.3	127.6	03/23/01	132.9
3	299-W10-33	566773	136610	206.0	87.1	81.0	06/15/07	84.1
4	299-W10-4	566735	136578	205.5	147.6	130.8	11/10/52	139.0
5	299-W11-12	566898	136597	208.2	147.2	132.0	12/21/53	139.6
6	299-W11-37	567606	137011	221.6	142.3	132.8	07/07/94	136.6
7	299-W11-43	567241	136964	217.5	88.1	83.5	05/23/05	85.8
8	299-W11-45	566993	136776	213.6	127.9	123.4	09/02/05	125.7
9	299-W11-46	566886	136766	210.9	130.7	124.6	07/26/05	127.6
10	299-W11-47	566934	136681	210.4	126.8	117.5	01/06/06	122.2
11	299-W11-48	566882	136846	209.7	125.1	97.7	11/29/06	111.4
12	299-W11-7	567261	136675	217.1	142.4	128.7	09/17/51	135.6
13	299-W11-87	568113	136602	223.6	107.3	102.7	03/01/07	105.0
14	299-W11-88	567875	137113	221.9	86.2	74.0	10/03/07	80.1
15	299-W13-1	568149	136049	223.5	104.4	93.7	02/10/04	99.1
16	299-W14-11	566902	136288	205.1	125.3	122.3	04/26/05	123.1
17	299-W14-13	566873	136275	205.1	138.7	128.7	08/31/98	133.7
18	299-W14-71	567733	135568	219.4	94.2	89.7	07/27/06	92.0
19	299-W15-33	566405	135960	206.8	142.4	127.9	12/31/95	135.2
20	299-W15-38	566784	135666	203.7	141.2	135.1	05/17/96	137.3
21	299-W15-46	566752	135587	204.2	140.4	116.0	10/03/03	128.2
22	299-W15-50	566794	135791	203.2	129.0	118.4	02/28/05	123.7
23	299-W15-7	566676	135920	204.2	148.8	97.6	03/30/66	123.2
24	299-W18-1	566422	135465	209.1	149.6	79.5	01/12/59	113.8
25	299-W18-15	566351	134727	202.2	142.8	118.7	04/25/80	130.7
26	299-W18-16	566605	135426	208.6	137.1	126.4	10/20/04	131.8
27	299-W19-105	567536	134739	213.0	135.2	124.5	12/13/05	129.8
28	299-W19-18	567332	135005	214.0	146.9	104.9	12/12/85	125.9
29	299-W19-36	567606	135010	215.4	140.8	127.1	09/01/95	133.9
30	299-W19-48	567823	134926	212.9	133.0	122.3	10/05/04	127.6

Table E3-3. 200-ZP-1 Groundwater OU Contaminant Monitoring Well Network (Reduced)

Well No.	Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Bottom (m)	Depth to Screen Top (m)	Date Drilled	Mid-Screen Elevation* (m)
31	299-W19-49	567539	134888	214.2	135.1	124.5	08/30/05	129.8
32	299-W21-2	568096	134567	214.9	135.6	124.9	11/22/04	130.2
33	299-W22-20	567564	133872	207.1	144.6	116.0	06/19/57	130.3
34	299-W22-44	566927	134478	207.8	145.2	134.0	11/26/91	139.6
35	299-W22-47	566909	134076	206.3	136.6	125.9	01/19/05	131.2
36	299-W22-50	566875	134133	205.0	138.6	134.0	01/28/00	136.3
37	299-W22-72	567210	134201	208.0	135.8	125.1	02/22/06	130.5
38	299-W22-86	567159	134035	206.4	135.9	125.2	03/10/06	130.5
39	299-W23-19	566730	134160	202.5	139.5	136.4	11/17/99	137.9
40	299-W23-4	566599	134385	203.0	148.1	111.6	06/18/57	129.9
41	299-W23-9	566613	134268	203.7	153.7	133.6	08/11/72	142.7
42	699-30-66	569991	132739	210.5	93.1	90.1	10/13/04	91.6
43	699-32-62	570981	133209	216.6	132.7	64.2	04/06/60	98.5
44	699-32-72A	567914	133356	204.7	76.7	56.8	07/31/57	66.7
45	699-34-61	571396	133810	221.8	129.4	123.3	11/29/93	126.3
46	699-35-66A	569829	134092	222.5	143.2	124.3	06/13/57	133.8
47	699-35-70	568538	133981	212.3	141.3	135.2	09/08/48	138.3
48	699-36-61A	571366	134550	229.0	128.4	110.5	08/12/48	119.5
49	699-36-66B	569731	134469	221.3	131.7	121.0	12/20/07	126.4
50	699-36-70A	568438	134302	216.0	137.6	128.4	12/10/94	132.2
51	699-36-70B	568399	134619	215.2	134.7	124.1	06/09/04	129.4
52	699-37-66	569730	134797	222.0	131.3	120.6	11/28/07	126.0
53	699-38-61	571219	134997	228.2	126.3	120.2	11/16/93	123.3
54	699-38-65	570090	135040	230.7	163.7	72.2	12/31/59	117.9
55	699-38-68A	569151	134925	218.9	137.3	128.2	06/21/94	132.0
56	699-38-70B	568469	135331	222.6	98.6	94.0	02/03/04	96.3
57	699-38-70C	569084	135326	226.7	106.1	101.5	02/17/04	103.8
58	699-40-62	571164	135764	228.9	126.8	115.0	01/17/49	120.9
59	699-40-65	570057	135881	231.0	130.2	119.5	02/03/04	124.1
60	699-43-69	568967	136488	227.4	105.4	94.7	12/11/07	100.1
61	699-44-64	570391	136897	222.2	125.9	87.5	01/31/60	106.7

Table E3-3. 200-ZP-1 Groundwater OU Contaminant Monitoring Well Network (Reduced)

Well No.	Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Bottom (m)	Depth to Screen Top (m)	Date Drilled	Mid-Screen Elevation* (m)
62	699-45-69A	568729	137183	222.1	138.6	110.6	06/22/48	124.6
63	699-45-69C	568947	137234	222.6	110.7	106.1	07/13/07	108.4
64	699-47-60	571474	137969	199.6	123.4	115.1	07/20/48	118.5
65	699-48-71	568388	138057	210.9	138.0	118.8	09/26/56	128.4
66	699-50-74	567360	138647	201.4	133.3	122.7	07/12/05	128.0
67	699-51-63	570664	139148	175.3	127.4	119.5	11/06/56	123.5

Notes:

* Mid-screen elevations were obtained from the 2008 carbon tetrachloride plume shell data set and are included in this table because the top and bottom screen elevation were not available. Top and bottom screen elevations are not available from the Hanford Environmental Information System database but are likely available from other data sources and/or databases because they were available to construct the plume shell data set.

N/A = not available

E3.5.2 Groundwater Extraction Well Pumping Rates

Extraction well instantaneous pumping rates and total flow are measured by inline flow meters and the data saved to an onsite and remote server. The data servers can be queried as needed to obtain daily, weekly or monthly average flow rates, and total monthly flows.

E3.5.3 Groundwater Quality Sampling

Groundwater sampling will initially be performed on an annual basis from a full or reduced list of monitor wells. The full list of monitor wells (Figure E3-2 and Table E3-1) will be sampled beginning in 2011. The reduced list of monitor wells (Figure E3-3 and Table E3-1) will be sampled beginning in 2012. This full and reduced list of monitor wells will likely be revised following evaluation of the early operations data.

E3.6 Sampling Methods

Water level measurements shall be performed using an electronic meter, and the date, time and measurement depth recorded on the water level measurement form, or in the logbook as described in Section E3.2.

Groundwater samples shall be collected by first purging the each well using procedure GRP-FS-04-G-028, *Field Characterization and Treatment Monitoring Activities Groundwater Sampling.* During the purging process water quality parameters (pH, temperature, specific conductance, dissolved oxygen and redox potential) shall be periodically measured in a flow-through chamber using field instrumentation and the results recorded on the data form or in the field logbook. Samples are collected after field parameters have stabilized in accordance with the criteria described in the procedure.

Following the purging step, samples for VOC and TOC analysis will be collected first using a bottom emptying disposable bailer equipped with a VOC draw tube. Samples for inorganic and general water quality parameters may be collected from the pump discharge (if dedicated purge tubing is being used) or from the bailer. Samples for dissolved metals analysis will be collected by field-filtering though an inline 0.45 micron filter installed on the pump discharge tubing.

Preliminary sample container bottle and preservation types are shown in Table E3-4. The Laboratory Letter of Instruction will specify the final container types, sample volume and preservation requirements. The total estimated number of samples to be collected, including field QA samples is shown on Table E3-5. Additional sample volume requirements (MS/MSD) will be specified in the Laboratory Letter of Instruction.

E3.6.1 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with GRP-FS-04-G-037, *Field Decontamination of Sampling Equipment*. To prevent contamination of the samples, care will be taken to use clean or dedicated equipment for each sampling activity. Special care will be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers.
- Contaminating the equipment or sample container by setting the equipment/sample container on or near potential contamination sources (e.g., uncovered ground).
- Handling bottles or equipment with dirty hands or gloves.

Table E3-4. Sample Preservation, Container, and Holding Times for Groundwater Samples[a]

Analytes[b]	Container Number	Container Type	Volume[c]	Chemical Preservation	Packing Requirements	Holding Time
VOCs (carbon tetrachloride, chloroform, dibromomethane, chloromethane, TCE, cis 1-2-dichloroethene, vinyl chloride)	4	Glass VOA, septum lined lid	40 ml	HCL pH < 2	Cool 4 °C	14 days
TOC	4	Glass VOA, septum lined lid	40 ml	HCL pH < 2	Cool 4 °C	14 days
Total Metals (chromium, iron, manganese)	1	Plastic	500 ml	HNO3 pH < 2	Cool 4 °C	28 days
Dissolved Metals (chromium, iron, manganese)	1	Plastic	500 ml	HNO3 pH < 2	Cool 4 °C	28 days
Hexavalent chromium	1	Plastic	500 ml	4 °C	Cool 4 °C	24 hrs
I-129	1	Plastic	TBD	HNO3 pH < 2	None	N/A
Tc-99	1	Plastic	TBD	None	None	N/A
Tritium	1	Plastic	TBD	None	None	N/A
Nitrate	1	Plastic	500 ml	None	Cool 4 °C	48 hrs
Nitrite	1	Plastic	500 ml	None	Cool 4 °C	48 hrs
Alkalinity	1	Plastic	500 ml	None	Cool 4 °C	14 days
Sulfate	1	Plastic	500 ml	None	Cool 4 °C	28 Days
Sulfide	1	Plastic	TBD	4 drops 2N zinc acetate/100 mL sample; NaOH to pH>9; Minimize aeration; Store headspace free at ≤6 °C	Cool 4 °C	7 days
Chloride	1	Plastic	500 ml	None	Cool 4 °C	28 Days
Total dissolved solids	1	Plastic	500 ml	None	Cool 4 °C	7 days
Uranium	1	Glass	500 ml	None	Cool 4 °C	14 days

Notes:

a. Refer to Section E2 for specific constituents requiring analyses for each media and specified Analytical Methods.

b. For 4-digit methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A.*

c. Minimum sample size and preservation requirements will be defined on the Sampling Authorization Form.

ICP = inductively coupled plasma

N/A = not applicable

TAL = target analyte list

TBD = to be determined

Table E3-5. Sample Locations, Frequencies and Sampling Methods

Sampling Event	Sample Matrix	Sample Locations	Number of Samples & Depth	Number of QA Samples*	Sampling Procedure	Sampling Frequency
Full Monitor Well List	Groundwater	Fig E3-2 and Table E3-2	125	7–DUP 7-EB TB – one per day when VOC samples collected	GRP-FS-04-G-028	Biennial
Reduced Monitor Well List	Groundwater	Fig E3-3 and Table E3-3	67	4-DUP 4-EB TB – one per day when VOC samples collected	GRP-FS-04-G-028	Biennial

Notes:

* Final QA sample types and numbers will be specified in the Sample Authorization Form.

- Improperly decontaminating equipment before sampling or between sampling events. Field decontamination (e.g., field washing methods) are not rigorous enough or do not use the appropriate equipment (stiff brushes or pressure washer) for the sampling equipment being used.

E3.6.2 Preshipment Sample Screening

A representative portion of each sample, retained from leftover media, will be shipped to the Waste Sampling and Characterization Facility or other suitable onsite laboratory for total-activity analysis. Total radiological activities or other analysis as required will be used for sample-shipping characterization. Samples that slightly exceed the offsite laboratory criterion may be reduced in volume to reduce total activity and allow offsite shipment. Onsite and offsite laboratories will be identified before field activities are initiated and will be mutually acceptable to the CHPRC Sample and Data Management Organization and the Field Work Supervisor.

E3.7 Sample Handling

Level I EPA pre cleaned sample containers will be used for samples collected for chemical analysis. Container sizes may very depending on laboratory-specific volumes/requirements for meeting analytical detection limits. The radiological engineering organization will measure both the contamination levels and dose rates associated with the sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. If the dose rate on the outside of a sample jar or the curie content exceeds levels acceptable by an offsite laboratory, the Field Work Supervisor in consultation with Sample Management and Reporting, can send smaller volumes to the laboratory. Preliminary container types and volumes are identified in Table E3-2.

E3.7.1 Container Labeling

The sample location, depth, and corresponding HEIS numbers are documented in the sampler's field logbook. Each sample container will be labeled with the following information on firmly affixed, water resistant labels:

- Sampling Authorization Form
- HEIS number
- Sample collection date/time
- Analysis required
- Preservation method (if applicable)

In addition to the above information, sample records must include:

- Analysis required
- Source of sample
- Matrix (water, soil, etc.)
- Field data (pH, radiological readings)

E3.7.2 Sample Custody

Sample custody will be maintained in accordance with existing Hanford Site protocols to ensure the maintenance of sample integrity throughout the analytical process. The custody of samples will be maintained from the time the samples are collected until the ultimate disposal of the samples, as appropriate. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to indicate potential tampering. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory. The following information is required on a completed chain-of-custody form:

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer
- Requested analyses or reference thereto

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Chain-of-custody will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time the responsibility changes for the custody of the sample the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to Sample and Data Management within 48 hours of shipping.

Custody tape (i.e., evidence seals) will be affixed to the lids of each sample jar. The container tape will be inscribed with the sampler's initials and the date. For VOA sample vials, the custody tape is not to be applied directly over the septa because of a potential for affecting analytical results. The tape may be applied in any manner that does not affect analysis. For examples, the custody tape may be placed in a single layer directly around the neck of the vial (use caution as too much tape applied around the neck of vial will cause difficulties in with analytical equipment) or the VOA vials can be placed inside a plastic bag and the custody seal and any other required labels/documentation can be fixed to exterior of the bag.

E3.7.3 Sample Transportation

Sample transportation will be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste that are mandated by the U.S. Department of Transportation (49 CFR 171-177, Chapter 1, "Research and Special Programs Administration, Department of Transportation," Part 171, "General Information, Regulations, and Definitions," through Part 177, "Carriage By Public Highway") in association with the International Air Transportation Authority, DOE requirements, and applicable program-specific implementing procedures.

E3.8 Investigation Derived Waste-Management Sampling

All IDW sample and analysis will be performed in accordance with the Waste Management Plan included as Appendix B to the O&M Plan.

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E4 Health and Safety

All field operations will be performed in accordance with existing 200-ZP-1 groundwater OU and Hanford Site health and safety procedures. In addition, documentation will be prepared that will further control site operations. This documentation will consist of an activity hazard analysis, a site-specific health and safety plan, and applicable work permits. Work will be performed in accordance with these site-specific health and safety plans and applicable work permits. The sampling procedures and associated activities will take into consideration exposure-reduction and contamination-control techniques that will minimize the sampling team's exposure.

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E5 Management of Investigation-Derived Waste

The IDW generated by characterization activities will be managed in accordance with the Waste Management Plan included as Appendix B to the O&M Plan.

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E6 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_09/10cfr835_09.html.

ANSI/ASQC E4-1994, 1994, *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs*, American National Standards Institute/American Society for Quality, New York, New York.

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