DOE/RL-2010-72
Revision 1

Sampling Analysis Plan for Eighteen Remediation Wells in the 200-ZP-1 Operable Unit

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

**Approved for Public Release;
Further Dissemination Unlimited**

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Terms

AEA	alpha energy analysis
ALARA	as low as reasonably achievable
bgs	below ground surface
CAS	Chemical Abstract Services
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
COC	contaminant of concern
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EW	extraction well
FS	feasibility study
FY	fiscal year
GEA	gamma energy analysis
GM	Geiger-Müller
GPC	gas proportional counting
gpm	gallons per minute
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
IW	injection well
LSC	liquid scintillation counting
MCL	maximum contaminant level
MNA	monitored natural attenuation
N/A	not applicable
NA	not available
NP	not present

NTU	nephelometric turbidity unit
OU	operable unit
P&T	pump-and-treat
PAM	portable alpha meter
PCB	polychlorinated biphenyl
ppm	parts per million
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCT	radiological control technician
RDL	required detection limit
RD/RAWP	remedial design/remedial action work plan
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
RPD	relative percent difference
S&GRP	Soil and Groundwater Remediation Project
SAP	sampling and analysis plan
TC	toxicity characteristic
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbon
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
VOC	volatile organic compound

1 Introduction

This sampling and analysis plan (SAP) supports implementation of the 200-ZP-1 Operable Unit (OU) preferred cleanup alternative, as described in the *Record of Decision, Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008). The 200-ZP-1 Groundwater OU underlies the northern portion of the 200 West Area of the Hanford Site. The *Feasibility Study Report for the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2007-28) concluded that without remedial action, contaminants in 200-ZP-1 groundwater would exceed risk threshold values for future industrial workers and residents that might use the groundwater as a drinking water supply. The existing contaminant concentrations also exceed federal and state maximum contaminant levels (MCLs) and state groundwater cleanup standards for use of the groundwater as a drinking water source.

The Record of Decision (ROD) presents the remedial action for restoring the aquifer as well as the cleanup levels (EPA et al., 2008). The preferred alternative for the 200-ZP-1 OU consists of pump-and-treat (P&T), monitored natural attenuation (MNA), flow-path control, and institutional controls. The remedial design/remedial action work plan (RD/RAWP) describes how the design and implementation of the remedial action process required by the ROD will be executed (DOE/RL-2008-78, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan*). This SAP addresses the drilling of five extraction and 13 injection wells in support of this final remedy. The components of the remedial action are as follows:

- **Groundwater extraction and treatment ("pump-and-treat") component:** Groundwater P&T technology will be used to capture and treat the contaminated groundwater, with a design objective of reducing the mass of carbon tetrachloride (which is the predominant contaminant in the groundwater) by 95 percent within a time frame of 25 years or less. The carbon tetrachloride concentration in the groundwater greater than 100 μg/L (0.100 parts per million [ppm]) corresponds to approximately 95 percent of the mass of carbon tetrachloride currently residing in the aquifer. Following extraction, the groundwater contaminants of concern (COCs) will be treated to ensure that contaminant levels in the injected water are below drinking water standards. Except for nitrate, the 200-ZP-1 groundwater COCs reside within the boundaries of the carbon tetrachloride contamination and will be addressed concurrently with the P&T component designed for the 200-ZP-1 OU.

- **Flow-path control component:** The extraction and injection of treated water will be coordinated to produce groundwater flow paths that (1) contain the contamination within the Central Plateau geographic area, (2) provide sufficient time to remove the contaminants from the groundwater, and (3) delay the migration of groundwater in order to maximize natural attenuation processes. The fate and transport analysis conducted during the 200-ZP-1 OU feasibility study (FS) (DOE/RL-2007-28) indicates that residual contaminant mass will remain within the Central Plateau geographic area until it attenuates through MNA to the desired cleanup levels.

- **MNA component:** For the remaining portion of carbon tetrachloride not captured by the P&T component (i.e., the remaining 5 percent of the mass), natural attenuation processes will be used to reduce concentrations to levels below the cleanup level. The process of MNA will also be used to reduce tritium concentrations in the aquifer to acceptable levels. Natural attenuation processes that are part of this component include abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring will be used to evaluate the effectiveness of the natural attenuation processes, as well as to optimize performance of the P&T component. Fate and transport analyses conducted as part of the FS indicated that the time frame necessary to reduce the remaining carbon tetrachloride concentrations to acceptable levels through MNA will be approximately 100 years.

- **Institutional controls component:** Institutional controls would be required as long as contamination remains above the cleanup levels. Institutional controls would, therefore, be in place to control access to the groundwater while cleanup is underway. Once the cleanup levels are met and the groundwater has been restored to achieve beneficial-use, institutional controls would no longer be necessary.

The RD/RAWP (DOE/RL-2008-78), issued July 30, 2009, includes as many as 16 injection and 20 extraction wells to support the final remedy (Figure 1-1). The 18 wells covered by this SAP are scheduled to be installed in fiscal years (FYs) 2011, 2012, 2013, and 2014 in partial fulfillment of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) preferred alternative (Figure 1-2, drilling sequence 3). Two previous SAPs (DOE/RL-2008-57, *Sampling and Analysis Plan for the First Set of Remedial Action Wells in the 200-ZP-1 Groundwater Operable Unit*; and DOE/RL-2009-95, *Sampling Analysis Plan for Eleven ARRA Wells to Support the 200 West Groundwater Treatment System in Fiscal Year 2010*) were issued to address the drilling and sampling of the first 9 wells (drilling sequence 1) and the second 11 wells (drilling sequence 2), respectively.

The five extraction and 13 injection wells shown as drilling sequence 3 in Figure 1-2 are included in this SAP. The well locations selected for drilling sequences 1, 2, and 3 were based on maximum mass reduction.

Figure 1-3 presents the two-dimensional distribution of carbon tetrachloride. This distribution was calculated as an average of an ensemble of stochastic estimates produced using the program "SGSIM" (*GSLIB: Geostatistical Software Library and User's Guide* [Deutsch and Journel, 1992]) as part of a recent update of the carbon tetrachloride inventory analysis completed by Pacific Northwest National Laboratory and the planned extraction and injection well network. Figure 1-4 presents a two-dimensional depiction of the current distribution of carbon tetrachloride calculated by combining the series of maps presented in the 200-ZP-1 OU FS report (DOE/RL-2007-28) and the planned sequencing of the well locations.

It is expected that the full network of P&T wells (Figure 1-1) will be installed over several years in accordance with the RD/RAWP. The 200-ZP-1 OU FS report (DOE/RL-2007-28) contains a summary of the geology and hydrogeology of the 200 West Area, as well as a summary of the major groundwater contamination sources. Table 1-1 presents key hydrogeologic units and anticipated depths at each well proposed in drilling sequence 3.

This SAP closely follows the format of the SAPs developed for drilling sequence 1 (DOE/RL-2008-57) and drilling sequence 2 (DOE/RL-2009-95) and includes five chapters:

- **Chapter 1:** Includes the data quality objective (DQO) process and data needs.
- **Chapter 2:** Provides the quality assurance project plan (QAPjP).
- **Chapter 3:** Contains the field sampling plan.
- **Chapter 4:** Provides the health and safety plan.
- **Chapter 5:** Provides the list of the references cited in this SAP.

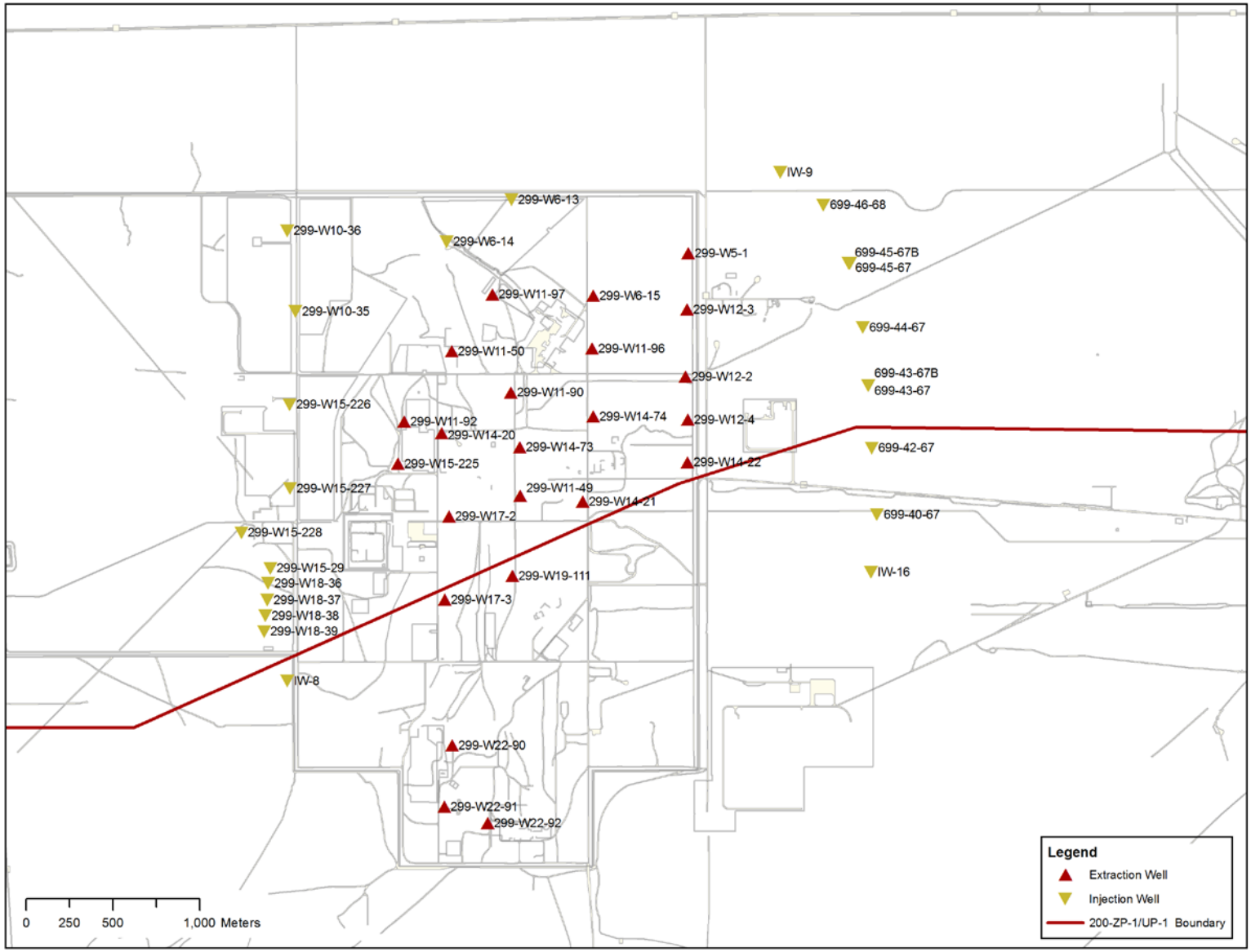

Figure 1-1. Approximate Location of Groundwater Extraction and Injection Wells

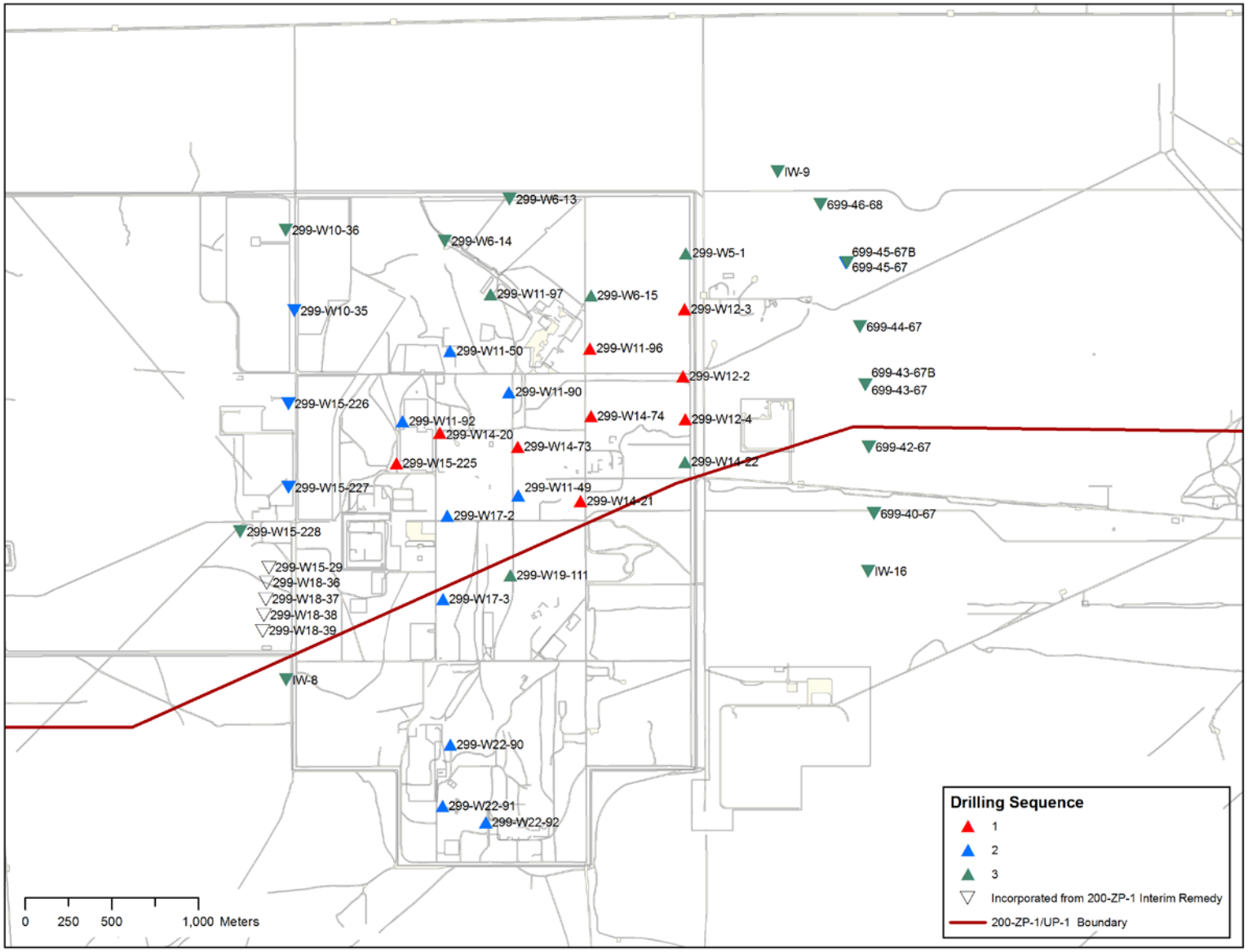

Figure 1-2. Approximate Location of Proposed Wells by Drilling Sequence

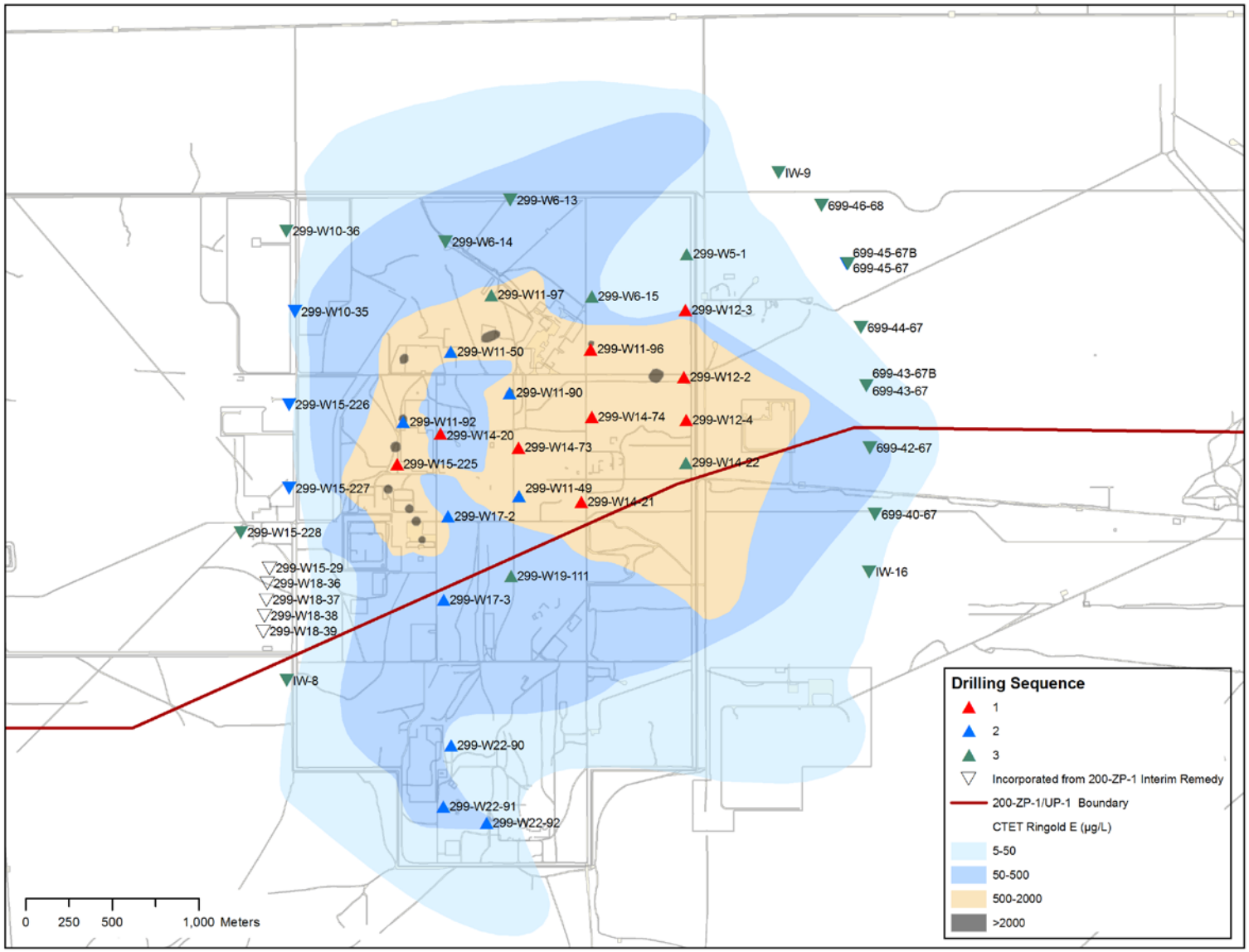

Figure 1-3. Two-Dimensional Distribution of Carbon Tetrachloride

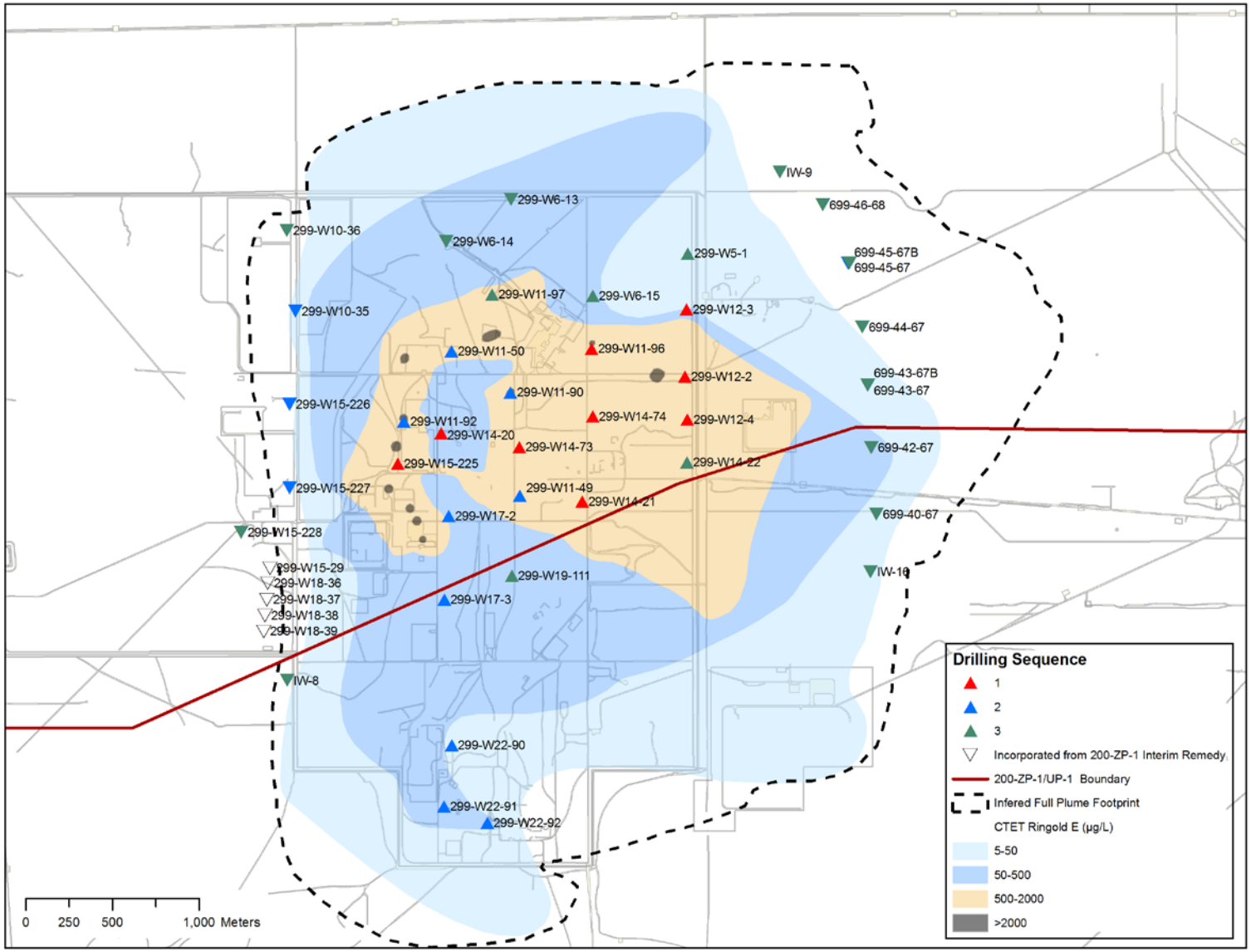

Figure 1-4. Two-Dimensional Distribution of Carbon Tetrachloride

Table 1-1. Estimated Depth of Each Proposed Extraction and Injection Well

Well Name	Extraction/ Injection Well	Estimated Depth to Water (ft bgs)	Estimated Depth to Upper Caliche (ft bgs)	Estimated Depth to Upper Ringold Unit (ft bgs)	Estimated Depth to Ringold Unit E (ft bgs)	Estimated Depth to Ringold Lower Mud (ft bgs)	Estimated Depth to Basalt (ft bgs)
299-W6-13	IW-1	266	56	69	108	416	450
299-W6-14	IW-2	250	59	NA	95	404	463
299-W10-36	IW-3	242	98	105	131	433	505
299-W15-228	IW-7	232	160	NA	164	456	561
NA	IW-8	225	145	NP	150	446	571
NA	IW-9	250	10?	NP	50?	NP	381
699-46-68	IW-10	291	NA	148*	195	302	413
699-44-67	IW-12	312	105	NP	220	335	485
699-42-67	IW-14	321	120	270	280	415	508
699-40-67	IW-15	321	120	270	280	428	518
NA	IW-16	305	200?	NA	266	400	545
699-43-67B	IW-17	320	118	NP	210	351	476
699-45-67B	IW-23	301	61	NP	193	320	442
299-W19-111	EW-11	262	125	138	140	437	549
299-W11-97	EW-13	270	96	NA	117?	NP	491
299-W6-15	EW-14	290	110	NA	157?	NP	491
299-W5-1	EW-17	295	100*	NA	159?	NP	474
299-W14-22	EW-20	300	150	NP	180	428*	530

Sources:

PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*, was used to estimate Ringold Unit E outside of the 200 West Area (Plate 7), Ringold lower mud (Plate 5), and top of basalt (Plate 2).

Water levels are estimated from Figure 2.8-2 of DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*; March 2008 data.

WHC-SD-EN-TI-014, *Hydrogeologic Model of the 200 West Groundwater Aggregate Area*, was used to estimate the top of the caliche (Figure 2-12), top of upper Ringold (Figure 2-10), and Ringold Unit E (Figure 2-8) in the 200 West Area.

* May not be present.

bgs = below ground surface
EW = extraction well
IW = injection well
NA = not available
NP = not present
? = questionable selection

1.1 Contaminants of Concern

The list of the COCs for the 200-ZP-1 OU presented in Table 1-2 was taken from the ROD (EPA et al., 2008) and was derived from review of the documents identified in Table 1-3. The 200-ZP-1 OU FS report (DOE/RL-2007-28) outlines the statistical measures used for determining the COCs. In addition to the COCs presented in the ROD, other parameters or constituents may be analyzed (including chloroform) to support future MNA monitoring. Standardized reporting lists for certain broad-spectrum U.S. Environmental Protection Agency (EPA) methods (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*; Methods 8260, 200.8, and 300.0) are provided in Appendix A of this SAP. The tables in Appendix A define the standard compound lists for statements of work when developing laboratory contracts for this project using a method-based analysis approach. The results for the analytes listed in these tables will be reported in the Hanford Environmental Information System (HEIS) database in addition to the COCs presented in Table 1-2. If analysis indicates tentatively identified compounds beyond those listed in Table 1-2 or Appendix A, these will also be reported in the HEIS database and will have a "J" (estimated value) qualifier (which identifies it as a tentatively identified compound).

Table 1-2. Final List of Contaminants of Concern in Groundwater

COC	CAS Number
Nonradiological Constituents[a]	
Carbon tetrachloride	56-23-5
Chloroform[b]	67-66-3
Trichloroethene	79-01-6
Chromium, total	7440-47-3
Chromium, hexavalent	18540-29-9
Nitrate	14797-55-8
Radiological Constituents	
Iodine-129	15046-84-1
Technetium-99	14133-76-7
Tritium	10028-17-8
Uranium[a]	7440-61-1

a. Uranium (total) will also be analyzed as a target constituent. While not a COC specified in the *Record of Decision, Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008), it is a COC for the 200-UP-1 Operable Unit to the south.

b. Degradation product of carbon tetrachloride; not a COC specified in the 200-ZP-1 Operable Unit Record of Decision (EPA et al., 2008).

CAS = Chemical Abstract Services

COC = contaminant of concern

Table 1-3. Existing References

Reference	Summary
DOE/RL-2000-40, *Waste Management Plan for the Expedited Response Action for 200 West Area Carbon Tetrachloride Plume and the 200-ZP-1 and 200-PW-1 Operable Units*	Provides the plan for managing and disposing waste associated with the groundwater and vapor treatment systems. Identifies listed waste codes for waste that comes into contact with contaminated groundwater associated with the 200-ZP-1 OU. Waste codes "F001" through "F005" are identified for groundwater-contacted 200-ZP-1 OU wastes.
DOE/RL-2003-55, *Remedial Investigation/Feasibility Study Work Plan for the 200-ZP-1 Groundwater Operable Unit*	Summarizes the details of the remedial investigation/feasibility study data quality objective summary report.
DOE/RL-2006-19, *Sampling and Analysis Plan for Characterizing Groundwater in 200-West Area in Vicinity of Old Laundry Facility and T Plant*	Provides the SAP for five groundwater wells targeting the unconfined aquifer on the east side of the 200 West Area, near the Old Laundry Facility and just west of T Plant.
DOE/RL-2006-24, *Remedial Investigation Report for 200-ZP-1 Groundwater Operable Unit*	Includes a summary of data for the 200-ZP-1 OU, including individual well information and a summary of the logic for screening contaminants based on available data.
DOE/RL-2007-28, *Feasibility Study Report for the 200-ZP-1 Groundwater Operable Unit*	Establishes a basis for remedial action in the 200-ZP-1 OU, formulates preliminary objectives for conducting the remedial action, and develops and evaluates alternatives for remediation of the groundwater in the 200-ZP-1 OU. A baseline risk assessment is also presented.
DOE/RL-2007-33, *Proposed Plan for Remediation of the 200-ZP-1 Groundwater Operable Unit*	Issued by DOE and EPA for public and Tribal Nations comment, and Ecology has concurred with the preferred alternative. The plan identifies the preferred approach for remediation of 200-ZP-1 OU groundwater and explains the reasons for this preference. The plan facilitates public and Tribal Nations review by summarizing the findings of the remedial investigation report, feasibility study report, and baseline risk assessment contained in the feasibility study report.
DOE/RL-2008-57, *Sampling and Analysis Plan for the First Set of Remedial Action Wells in the 200-ZP-1 Groundwater Operable Unit*	Provides the SAP for nine extraction wells in support of the preferred cleanup alternative in the 200-ZP-1 Groundwater OU.
DOE/RL-2008-78, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan*	Includes the plan and schedule for implementing all of the tasks to design, install, and operate the remedy set forth in the 200-ZP-1 OU ROD.
DOE/RL-2009-95, *Sampling Analysis Plan for Eleven ARRA Wells to Support the 200 West Groundwater Treatment System in Fiscal Year 2010*	Provides the SAP for six extraction wells and five injection wells in support of the preferred cleanup alternative in the 200-ZP-1 Groundwater OU.
DOE/RL-2009-115, *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action*	Provides guidance for collection of groundwater monitoring data associated with implementation of the 200-ZP-1 OU remedial action.

Table 1-3. Existing References

Reference	Summary
Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington (EPA et al., 2008)	Presents the selected remedy for the 200-ZP-1 Groundwater OU, which is part of the Hanford Site 200 Areas.
WMP-28389, *T-Area Technetium-99 Data Quality Objectives Summary Report*	Provides the data quality objective summary report to support decision-making activities pertaining to evaluation of technetium-99 in the unconfined aquifer in the Hanford Site's T Area.

Note: The references cited in this table are included in the reference list (Chapter 5).

DOE = U.S. Department of Energy
Ecology = Washington State Department of Ecology
EPA = U.S. Environmental Protection Agency
OU = operable unit
ROD = Record of Decision
SAP = sampling and analysis plan

1.2 Data Quality Objectives

The DQO process is a strategic planning approach for defining the criteria that a data collection design should satisfy. This process is used to ensure that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application. The DQO process was used to support the sample design presented in this SAP.

This SAP supports implementation of the 200-ZP-1 OU preferred cleanup alternative, as provided in the ROD (EPA et al., 2008). The DQO process for this SAP was supported by the existence of a well-defined conceptual site model and groundwater modeling efforts conducted as part of the FS process leading to issuance of the ROD. Samples collected as part of this SAP will be used to support decisions related to well construction and to validate groundwater modeling parameters. Sample analysis is limited to the COCs in the 200-ZP-1 OU (as provided in the ROD), along with chloroform and uranium, and also data to assist in the implementation of the preferred cleanup alternative. This section presents the results of the key outputs of the DQO process.

1.3 Statement of the Problem

Carbon tetrachloride, trichloroethene, total and hexavalent chromium, nitrate, technetium-99, iodine-129, and tritium are present in groundwater within the 200-ZP-1 OU at concentrations exceeding the MCLs. These eight COCs in the groundwater exceed MCLs based on 5 years (2001 through 2005) of groundwater data obtained from 107 wells within the 200-ZP-1 OU. The current distribution of contaminants is the result of historical industrial practices on the Central Plateau, as presented in the ROD (EPA et al., 2008). Data collected in support of this DQO process will supplement groundwater modeling to better define the distribution of the contaminants at depth, which will assist in validating the current conceptual site model and selecting appropriate screen intervals.

1.4 Decision Statements and Decision Rules

The decision statements (DSs) consolidate potential questions and alternative actions. Decision rules (DRs) are generated from the DSs. A DR is an "IF…THEN…" statement incorporating the parameter of interest, unit of decision making, action level, and action(s) resulting from resolution of the decision. Tables 1-4 and 1-5 present the DSs and DRs, respectively, as identified during the DQO process.

Table 1-4. Decision Statements

DS #	Decision Statement
Extraction Wells	
1	Determine whether, during the drilling of the five proposed extraction wells, there are one or more intervals within the aquifer that exceed 100 µg/L (0.100 ppm) carbon tetrachloride, requiring the wells to be completed as an extraction well and screen the interval showing the highest concentration of carbon tetrachloride; otherwise, complete the well as a monitoring well, screening the interval showing the highest carbon tetrachloride concentration.
2	Determine whether new data collected during the drilling of the five proposed extraction wells requires updating the groundwater model and contaminant transport model; otherwise, no action is required.
3	Determine the appropriate screen slot size and filter pack for the five proposed extraction wells using sieve analysis, and complete the wells using this data to optimize performance.
Injection Wells	
4	Determine whether, during the drilling of the 13 proposed injection wells, there are one or more intervals within the aquifer that exceed 100 µg/L (0.100 ppm) carbon tetrachloride, requiring the well to be completed as an extraction well, and screen the interval showing the highest concentration of carbon tetrachloride; otherwise, complete the well as an injection well.
5	Determine whether new data collected during the drilling of the 13 proposed injection wells requires updating the groundwater model and contaminant transport model; otherwise, no action is required.
6	Determine the appropriate screen slot size and filter pack for the 13 proposed injection wells using sieve analysis, and complete the well using this data to optimize performance.

DR = decision rule
DS = decision statement
ppm = parts per million

Table 1-5. Decision Rules

DS #	DR #	Decision Rule
Extraction Wells		
1	1	If the maximum concentration of carbon tetrachloride collected from systematic depths throughout the unconfined aquifer (during the drilling of the five proposed extraction wells) shows one or more intervals within the aquifer that exceed 100 µg/L (0.100 ppm) carbon tetrachloride, complete as an extraction well screening the interval showing the highest concentration of carbon tetrachloride; otherwise, complete as a monitoring well screening the interval showing the highest carbon tetrachloride concentration.

Table 1-5. Decision Rules

DS #	DR #	Decision Rule
2	2	If the new data collected from systematic depths throughout the unconfined aquifer (during the drilling of the five proposed extraction wells) show contaminant concentrations significantly different from that calculated by the groundwater model and contaminant transport model, update the models as needed; otherwise, no action is required.
3	3	Use sieve analysis data collected during well drilling to determine the appropriate screen slot size and filter pack for the five proposed extraction wells to optimize performance.
Injection Wells		
4	4	If the maximum concentration of carbon tetrachloride collected from systematic depths throughout the unconfined aquifer (during the drilling of the 13 proposed injection wells) does not show one or more intervals within the aquifer that exceed 100 µg/L (0.100 ppm) carbon tetrachloride, complete as an injection well; otherwise, complete as an extraction well, screening the interval showing the highest concentration of carbon tetrachloride.
5	5	If the new data collected from systematic depths throughout the unconfined aquifer (during the drilling of the 13 proposed injection wells) show contaminant concentrations significantly different from that calculated by the groundwater model and contaminant transport model, update the models as needed; otherwise, no action is required.
6	6	Use sieve analysis data collected during well drilling to determine the appropriate screen slot size and filter pack for the 13 proposed injection wells to optimize performance.

DR = decision rule
DS = decision statement
ppm = parts per million

A numerical groundwater model has been developed to support the pre-conceptual design for the 200-ZP-1 OU preferred alternative. This model provides the number, locations, and anticipated rates of extraction and injection wells, as well as the influent concentrations at individual extraction wells for the entire system for carbon tetrachloride and technetium-99. The results from recent aquifer tests performed in well C7017 were used to support selection of the final spacing between extraction and injection wells.

1.5 Sampling Designs

This section presents the supplementary data identified as needed to address the decisions. The supplemental data gathered from the installation of five extraction and 13 injection wells in the 200-ZP-1 OU will allow the required analytical data to be collected in order to address the DSs identified in Table 1-4.

The map provided in Figure 1-2 shows the locations of the five extraction and 13 injection wells in drilling sequence 3. Table 1-6 summarizes the data required to resolve each DS, the estimated number of depth-discrete samples to be collected from each well, and the analyses to be performed on individual water samples. Table 1-7 presents the selected analytical method to meet the required detection limits (RDLs) and the analytical performance requirements. The RDLs will meet the DQO requirements.

Table 1-6. Information Required to Resolve the Decision Statements

DS #	Number of New Wells to Be Installed	Number of Samples/Measurements	Survey/Analytical Methods
1, 2, 3, 4, 5, and 6	Five new extraction wells and 13 new injection wells (Figure 1-2, drilling sequence 3)	Depth-discrete vadose zone and aquifer samples will be collected, as outlined in Table 3-1. Sample numbers will vary.	Sampling intervals from each borehole shall be analyzed using the analytical methods identified in Table 1-7, as appropriate.

DS = decision statement

Table 1-7. Water Sample Analytical Performance Requirements

DS #	COC	Survey/Analytical Method[a]	RDL	Precision Requirement[b,c]	Accuracy Requirement[b,c]
1, 2, 4, and 5	COCs listed in Table 1-2	SW-846, Method 8260, carbon tetrachloride	2 µg/L	≤20%	80-120%
		Trichloroethene	2 µg/L	≤20%	80-120%
		Chloroform	5 µg/L	≤20%	80-120%
		Method 6010 or 200.8, chromium	10 µg/L	≤20%	80-120%
		Method 7196, chromium (hexavalent)	10 µg/L	≤20%	80-120%
		SW-846, Method 9056 or 300.0, nitrate	250 µg/L	≤20%	80-120%
		SW-846, Method 6010 or 200.8, uranium (total)	1 µg/L	≤20%	80-120%
		Low-energy photon spectroscopy, iodine-129	1 pCi/L	≤20%	80-120%
		Liquid scintillation, tritium	400 pCi/L	≤20%	80-120%
		Technetium-99	15 pCi/L	≤20%	80-120%
N/A	N/A	Field screening parameters,[d] temperature (Hach HQ40d or equivalent)	0.0 to 80.0°C	N/A	±0.3°C
		pH (Hach HQ40d or equivalent)	0.0 to 14.0	N/A	±0.1 of the buffer solution
		Dissolved oxygen (Hach HQ40d or equivalent)	0.1 to 20.0 mg/L (ppm) or 1% to 200% saturation	N/A	±0.1 mg/L for 0.1 to 8 mg/L or ±0.2 mg/L for >8.0 mg/L

Table 1-7. Water Sample Analytical Performance Requirements

DS #	COC	Survey/Analytical Method[a]	RDL	Precision Requirement[b,c]	Accuracy Requirement[b,c]
		NTU (Hach 2100P Turbidimeter HQ40d or equivalent)	0 to 1,000 NTUs	N/A	±2% from 0 to 499 NTUs or 3% from 500 to 1,000 NTUs
		Specific conductance (Hach HQ40d or equivalent)	0.01 µS/cm to 200.0 mS/cm	N/A	±0.5% of reading

Notes: Hach® is a registered trademark of the Hach Company, Loveland, Colorado.

a. Equivalent methods may be substituted in future sampling and analysis instructions or other documents. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes.* For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

b. Precision and accuracy requirements are identified and defined in referenced EPA procedures.

c. Accuracy criteria are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional analyte-specific evaluations also performed for matrix spikes and surrogates as appropriate to the method. Precision criteria for batch laboratory replicate matrix spike analyses.

d. Field hydrological parameters to be collected in accordance with DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD), Vol. 3.

COC = contaminant of concern
DS = decision statement
EPA = U.S. Environmental Protection Agency
N/A = not applicable
NTU = nephelometric turbidity unit
ppm = parts per million
RDL = required detection limit

2 Quality Assurance Project Plan

This chapter identifies the individuals or organizations that are participating in the project, discusses specific roles and responsibilities, and establishes the quality requirements for environmental data collection, including field measurements. The quality objectives for measurement data and the special training requirements for staff performing the work are also documented. This SAP complies with the following requirements:

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

This chapter describes the applicable quality requirements and controls.

2.1 Project Management and Organization

The following subsections address the basic areas of project management and will ensure that the project has a defined goal, the participants understand the goal and the approach to be used, and the planned outputs are appropriately documented. The project organization is shown in Figure 2-1. CH2M HILL Plateau Remediation Company (CHPRC), or its approved subcontractor, will be responsible for collecting, packaging, and shipping samples to the appropriate laboratory.

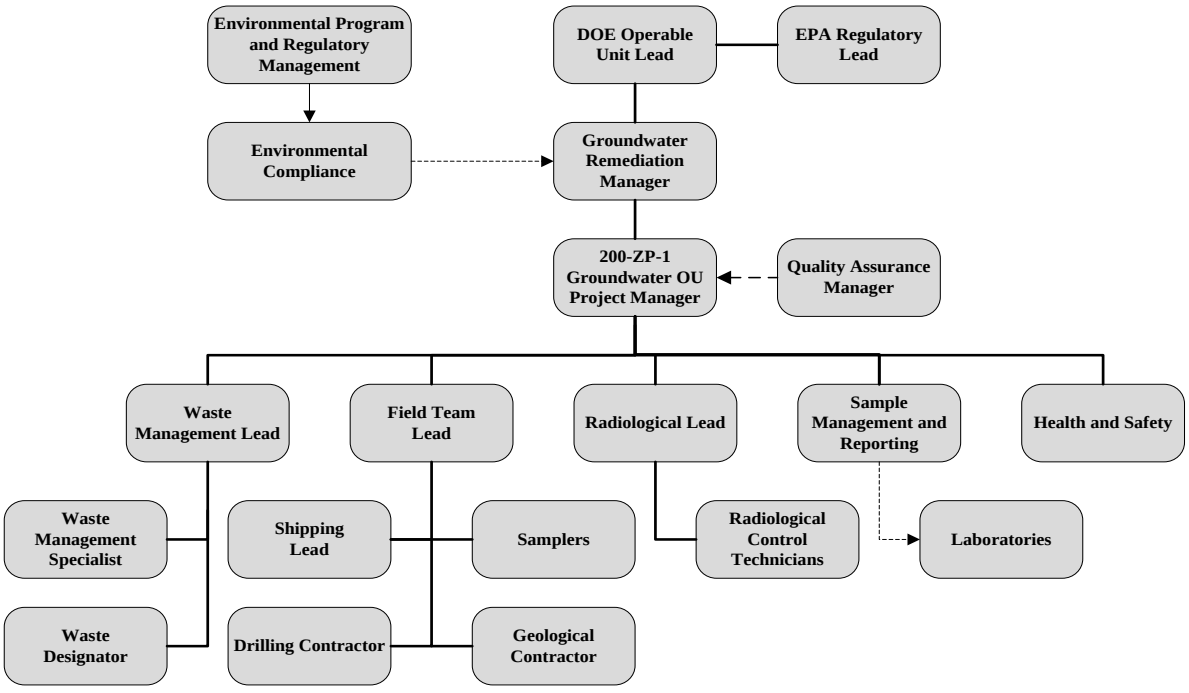

Figure 2-1. Project Organization

2.1.1 Management Responsibilities

Management responsibilities and inter-relationships are described in the following subsections.

2.1.1.1 Environmental Compliance

The environmental compliance officers work under the Environmental Program and Regulatory Management group. The environmental compliance officers provide oversight in dealing with environmental management assessments and compliance assessments, defining any potential environmental impacts, and identifying corrective actions (if needed) for each of the Hanford Site activities.

2.1.1.2 Groundwater Remediation Manager

The groundwater remediation manager provides oversight for activities and coordinates with the U.S. Department of Energy (DOE), Richland Operations Office (RL); EPA; and CHPRC management. In addition, support is provided to the 200-ZP-1 OU project manager to ensure that work is performed safely and cost effectively.

2.1.1.3 200-ZP-1 Operable Unit Project Manager

The 200-ZP-1 OU project manager is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The project manager ensures that the field team lead and others responsible for implementation of this SAP and QAPjP are provided with current copies of this document and revisions thereto. For each sampling event, the 200-ZP-1 OU project manager establishes the COCs, directs the field team lead (i.e., sample coordinator), and works closely with the Quality Assurance (QA) and the Health and Safety organizations to integrate these and other lead disciplines in planning and implementing the workscope. The 200-ZP-1 OU project manager coordinates with and reports to RL and CHPRC management on sampling activities.

2.1.1.4 Quality Assurance Engineer

The QA engineer is matrixed to the 200-ZP-1 OU project manager and is responsible for QA issues on the project. Responsibilities include overseeing implementation of project QA requirements, reviewing project documents (including SAPs and the QAPjP), and participating in QA assessments.

2.1.1.5 Waste Management Lead (Waste Coordinator)

The waste management lead communicates policies and procedures and also ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. Other responsibilities include receiving data from the field team lead to initiate waste designations, profiles, and other documents to confirm compliance with waste acceptance criteria.

2.1.1.6 Field Team Lead

The field team lead has overall responsibility for the planning, coordination, and execution of field activities. Specific responsibilities include converting the sampling design requirements into field task instructions to provide specific direction for field activities, as well as directing training, mock-ups, and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The field team lead will also communicate with the 200-ZP-1 OU project manager to identify field constraints affecting sampling design, direct the procurement and installation of materials and equipment needed to support fieldwork, and prepare data packages based on instructions from the 200-ZP-1 OU project manager and information contained in this SAP. The shipping lead will report to the field team lead for shipment authorization. No sample material may be transported on or off

of the Hanford Site without permission from the Soil and Groundwater Remediation Project (S&GRP) authorized shipper.

2.1.1.7 Radiological Engineering

Radiological Engineering is responsible for the radiological engineering and health physics support for the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for work planning. In addition, radiological hazards are identified and appropriate controls are implemented to maintain worker exposures to hazards at ALARA levels. Radiological Engineering interfaces with the project Health and Safety representative, and other appropriate personnel as needed, to plan and direct radiological control technician (RCT) support for activities.

2.1.1.8 Sample Management and Reporting

The Sample Management and Reporting organization is responsible for managing the analyses and resulting analytical data for samples collected for this SAP. The Sample Management and Reporting organization selects laboratories to perform the required analyses and ensures that the laboratories conform to the HASQARD (DOE/RL-96-68) QA requirements (or their equivalent), as approved by RL, EPA, and the Washington State Department of Ecology (Ecology). After the selected laboratories have completed the analyses, Sample Management and Reporting receives the analytical data from the selected laboratories, performs data entry into the HEIS database, and arranges for data interpretation. After analytical data interpretation is completed, Sample Management and Reporting provides the analytical data to the waste management lead (i.e., waste coordinator). The Sample Management and Reporting organization also interfaces with the field team lead (i.e., sample coordinator) regarding sampling information (e.g., sampling activities, sample and associated data tracking, and distributing analytical data).

2.1.1.9 Health and Safety

The Health and Safety organization's responsibilities include 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 regulations or by internal CHPRC work requirements. In addition, assistance is provided to project personnel in complying with applicable health and safety standards and requirements. Personal protective equipment requirements are coordinated with Radiological Engineering.

2.1.2 Quality Objectives and Criteria for Measurement Data

Regarding analytical methods, the detection limits and the precision and accuracy requirements for each analysis to be performed are summarized in Table 1-7. Procedures from CHPRC (or its approved subcontractor) will be used for sampling.

The QA objective of this SAP is to develop implementation guidance providing data of known and appropriate quality. Data quality for this SAP may be assessed by five criteria: representativeness, comparability, accuracy, precision, and completeness. The applicable quality control (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 methods. The applicable QC guidelines and level of effort are addressed below.

2.1.2.1 Representativeness

Representativeness is a measure of how closely analytical results reflect the actual concentration and distribution of the constituents in the matrix sampled. Sampling plan design, sampling techniques, and

sample-handling protocols (e.g., storage, preservation, and transportation) are discussed in subsequent sections of this SAP. The required documentation will establish the protocols to be followed and will ensure appropriate sample identification and integrity.

2.1.2.2 Accuracy

Accuracy is an assessment of the closeness of the measured value to the true value. Radionuclide measurements requiring chemical separations use this technique to measure method performance. For radionuclide measurements analyzed by gamma spectroscopy, laboratories typically compare the results of blind-audit samples against known standards to establish accuracy. The validity of calibrations is evaluated by comparing results from the measurement of a standard to known values and/or by generation of in-house statistical limits based on three standard deviations (±3 standard deviations). Table 1-7 lists the laboratory accuracy parameters for this SAP.

2.1.2.3 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained by using standard procedures, uniform methods, and consistent units.

2.1.2.4 Completeness

For waste designation purposes, a complete analytical data set will include the analytes listed in Table 1-2 for each of the wells addressed by this SAP. The analytes are repeated in Table 1-7 where laboratory performance parameters are included. Technetium-99 and carbon tetrachloride are the most important analytes for the technical evaluation. The analytical data set for this SAP will be considered incomplete if technetium-99 and carbon tetrachloride are not included. If one or more of the other analytical parameters in Table 1-7 are not reported, the 200-ZP-1 OU project manager will determine whether the data set is complete for this SAP.

2.1.2.5 Precision

Precision is a measure of the data spread when there is more than one measurement of the same sample. Precision can be expressed as the relative percent difference (RPD) for duplicate measurements or relative standard deviation for triplicates. Analytical precision for laboratory analyses is included in Table 1-7.

2.1.3 Special Training Requirements and Certification

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 (as required)
- Hanford Site General Employee Radiation Training
- Radiological Worker Training

A graded approach is used to ensure that workers receive a level of training commensurate with their responsibilities and that complies with applicable DOE orders and government regulations. Specialized employee training includes pre-job briefings, on-the-job training, emergency preparedness, plan-of-the-day meetings, and facility/work site orientations.

2.1.4 Documentation and Records

Field sampling and laboratory analytical documentation will be in accordance with CHPRC procedures and standard industry practices. Work products resulting from the sampling and analysis that may be included as documents and records include the following:

- Forms required by WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the master drilling contract
- Borehole summary reports
- Laboratory data packages
- Verification and validation report
- Modeling letter report to evaluate the data generated from the SAP and to determine adequacy and consistency (comparability) with existing information used to generate the groundwater model

Field documentation shall be kept in the form of chain-of-custody/sample analysis request forms, data forms, and logbook entries.

2.1.5 Problem Definition/Background

Eight COCs were identified within the 200-ZP-1 OU groundwater at concentrations exceeding the MCLs:

- Carbon tetrachloride
- Trichloroethene
- Total chromium
- Hexavalent chromium
- Nitrate
- Technetium-99
- Iodine-129
- Tritium

The current distribution of contaminants is the result of historical industrial practices on the Central Plateau, as presented in the ROD (EPA et al., 2008). Groundwater contamination is present from the top to the base of the unconfined aquifer, which is approximately 61 m (200 ft) thick.

The primary component of the 200-ZP-1 OU remedy presented in the ROD is the installation of a P&T system to contain and capture a large fraction of the mass of contamination (i.e., 95 percent of the dissolved mass of carbon tetrachloride) early in the remedy's lifecycle (i.e., 25 years). Twenty extraction wells and 16 injection wells, strategically placed, will be drilled to control the direction and rate of groundwater flow throughout the 200-ZP-1 OU. Following extraction, groundwater will be treated in the 200 West Area P&T system to achieve cleanup levels (Table 11 in the ROD) and returned to the aquifer through the injection wells. Data collected in support of the DQO process will supplement groundwater modeling to better define the distribution of contaminants at depth, which will assist in validating the current conceptual site model and selecting appropriate screen intervals. The DSs and DRs are identified in Table 1-4 and Table 1-5, respectively, in this SAP.

Samples collected as part of this SAP will be used to support decisions related to well construction and to validate groundwater modeling parameters. Sample analysis is limited to COCs in the 200-ZP-1 OU (as provided in the ROD), chloroform and uranium, and field parameters. This SAP addresses samples

taken at the time of drilling five extraction and 13 injection wells (Figure 1-2, drilling sequence 3) for analyses of contaminants. Table 3-1 lists the location and depth to be sampled during the drilling of each well.

2.1.6 Project/Task Description

This SAP covers wells scheduled to be drilled in FYs 2011, 2012, 2013, and 2014. The field sampling plan (Chapter 3 of this SAP) identifies the location of the new groundwater wells to be installed. Figure 1-2 illustrates the approximate location of the 18 proposed new groundwater wells in drilling sequence 3. The field sampling plan defines the sampling and analysis requirements for samples and the measurements to be collected from each well. Groundwater samples will be analyzed for the eight COCs identified in the ROD, along with uranium and other constituents (including additional volatile organic compounds [VOCs]), and their concentrations will influence the treatment process. Table 1-7 identifies the list of analytes. Groundwater samples will be collected as outlined in Table 3-1. Approximately 10 groundwater samples will be collected per well at 6.1 m (20 ft) intervals from the water table to the base of the well. The sampling data results will be entered into the HEIS database and will be used to aid in the construction design of the wells, as well as used to update groundwater modeling parameters.

2.2 Data/Measurement and Acquisition

The following subsections present the requirements for sampling methods, sample handling and custody, analytical methods, and field and laboratory QC. The requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed.

2.2.1 Sampling Methods Requirements

The procedures to be implemented in the field should be in accordance with those presented in Section 3.5 of this SAP. In the event of failure to accomplish sampling activities in accordance with this SAP, failures observed by the field construction manager will be documented in the field logbook and may result in changes to the SAP. The field construction manager is responsible for addressing immediate field issues.

2.2.2 Sampling Identification

A sample and data tracking database will be used to track the samples from the point of collection through the laboratory analysis process. The HEIS database is the repository for laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project, and the numbers are to be carried through the laboratory data-tracking system.

2.2.3 Sample Preservation, Containers, and Holding Times

Sample preservation, containers, and holding-time requirements will be prepared for specific sample events, as specified on the sampling authorization and chain-of-custody forms in accordance with the requirements specified for the applicable analytical method.

2.2.4 Sample Handling, Shipping, and Custody Requirements

The procedures to be implemented for sample handling, shipping, and custody requirements should be in accordance with those presented in Section 3.5 of this SAP.

2.2.5 Laboratory Sample Custody

Sample custody during laboratory analysis will be addressed in the applicable laboratory's standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process.

2.2.6 Analytical Methods Requirements

Analytical parameters and methods are presented in Table 1-7. 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.

Analytical errors reported by the laboratories are reported to the Sample Management and Reporting organization's project coordinator, who initiates a sample disposition record in accordance with CHPRC procedures. This process is used to document analytical errors and to establish resolution with the 200-ZP-1 OU project manager. In addition, the CHPRC QA engineer receives quarterly reports providing summaries and summary statistics of the analytical errors.

2.2.7 Quality Control Requirements

Field QC samples will be collected to evaluate the potential for cross-contamination and laboratory performance to ensure that reliable data are obtained. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling event

Laboratory QC sample requirements will be specified in the applicable laboratory's statement of work.

2.2.7.1 Laboratory Quality Control

Laboratory duplicates will be analyzed for the waste designation samples. Laboratory method blanks and laboratory control samples/blank spikes are defined in Chapter 1 of EPA SW-846 and will be run as specified in Chapter 1 of SW-846.

2.2.7.2 Field Replicates

Field replicates will be collected at a frequency of 1 in 20 samples or at least one per well. Field replicates are used to evaluate laboratory consistency and the precision of field sampling methods.

2.2.7.3 Equipment Rinsates or Blanks

Equipment blanks are collected from reusable sampling devices in a frequency of 1 in 20 samples. The field team lead may request that additional equipment blanks be taken. Equipment blanks will consist of silica sand or reagent water poured over the decontaminated sampling equipment and placed in containers, as identified on the project sample authorization form. Because volatiles are the key COCs, equipment blanks will only be analyzed for VOCs. Equipment blanks are not needed for disposable sampling equipment.

2.2.7.4 Trip Blanks

Trip blanks are samples prepared by the sampling team before traveling to the sampling site. The preserved bottle set is filled with reagent water, as appropriate to the primary sample media. The bottles

are sealed and transported, unopened, to the field in the same storage container used for samples collected the same day. Trip blanks shall be analyzed for VOCs only.

2.2.7.5 Field Transfer Blanks

Field transfer blanks are preserved volatile organic analysis sample containers filled at the sample collection site with reagent water transported to the field. The samples are prepared during the sampling to evaluate potential contamination caused by conditions in the field. After collection, field transfer blank bottles are sealed and placed in the same storage container with the samples from the associated sampling event. Field transfer blank samples are analyzed for VOCs only.

A minimum of one field transfer blank will be collected at each well where the samples will undergo volatile organic analysis. The field transfer blank will consist of reagent water or silica sand (as appropriate to the primary sample media) added to clean sample containers at the location where the VOC sample was collected. The field transfer blank will be batched with samples for which volatile organic analysis is being requested.

2.2.8 Instrument/Equipment Testing, Inspection, and Maintenance

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 minimize measurement system downtime. Laboratories and onsite measurement organizations must also maintain and calibrate their equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance shall be recorded in a bound logbook (see Section 3.5.3). Tags will be attached to field screening and onsite analytical instruments, noting the date when the instrument was last calibrated and the calibration expiration date. Maintenance requirements (e.g., parts lists and documentation of routine maintenance) will be included in the individual laboratory's and onsite organization's QA plan and/or operating procedures.

2.2.8.1 Instrument/Equipment Calibration and Frequency

Calibration shall be conducted using certified equipment and/or standards with a known, valid relationship to nationally recognized standards. If no such standard exists, the basis for the calibration shall be documented. Calibration of laboratory instruments will be performed in a manner consistent with EPA SW-846 or with auditable DOE Hanford Site and contractual requirements. Calibration of radiological field instruments will be performed by Pacific Northwest National Laboratory instrument technicians.

2.2.8.2 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with EPA's current SW-846 requirements and will be appropriate for their use. Potential contamination is monitored by QC samples and laboratory blanks. The lot number from the manufacturer-certified, pre-cleaned sample containers shall be recorded in the sampler's logbook.

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 for the contractor meet the specific technical and quality requirements must be in place. 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.

2.2.9 Data Management

Data resulting from the implementation of this SAP will be stored in the HEIS database. Reports and supporting analytical data packages will be subject to final technical review by qualified reviewers before submittal to the regulatory agencies or inclusion in reports or technical memoranda. Electronic data access, when appropriate, shall be through computerized database (e.g., HEIS). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989).

2.3 Assessment/Oversight

Routine evaluation of data quality described for this project will be documented and filed with the data in the project file. The 200-ZP-1 OU project manager and/or the field team lead will monitor field activities for this SAP. The 200-ZP-1 OU project manager retains overall responsibility for sampling but may delegate specific responsibilities to the field team lead or other appropriate CHPRC staff. The Sample Management and Reporting organization will select a laboratory to perform the soil and groundwater analyses for this SAP. The Sample Management and Reporting organization will also assess and verify that analytical data are reported by the laboratory and will then enter the verified data into the HEIS database.

2.3.1 Assessments and Response Action

Random surveillance and assessments may be conducted to verify compliance with the requirements outlined in this SAP, project work packages, the QAPjP, procedures, and regulatory requirements. Deficiencies identified by these assessments will be reported. The project's QA organization coordinates the corrective actions/deficiencies in accordance with CHPRC's QA program. When appropriate, corrective actions will be taken by the 200-ZP-1 OU project manager.

2.3.2 Reports to Management

Management will be made aware of deficiencies identified by self-assessments.

2.4 Data Review, Verification, Validation, and Usability Requirements

Samples taken for quick-turnaround analysis during drilling are intended to support selection of screened intervals and the verification of the groundwater modeling assumptions. Verification and validation are not planned for these samples.

Samples taken for standard turnaround analysis during drilling will be received from the laboratory, loaded into a database (e.g., HEIS), verified (Section 2.4.1), 5 percent of the data will be validated (Section 2.4.2), and data assessment will then be performed (Section 2.4.3). At the direction of the 200-ZP-1 OU project manager, analytical data packages will be subject to final technical review by qualified personnel before submittal to the regulatory agencies or inclusion in reports. Electronic data access, when appropriate, will be via a database (e.g., HEIS). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the Tri-Party Agreement (Ecology et al., 1989).

2.4.1 Data Verification and Usability Methods

Data review and verification may be performed by the laboratory to confirm that sampling and chain-of-custody documentation are complete. Verification is typically performed by the Sample Management and Reporting organization. This review shall include tying sample numbers to specific sampling location, reviewing sample collection dates and sample preparation/analysis dates to assess

whether holding times have been met, and reviewing QC data to determine whether analyses have met the data quality requirements specified in this SAP.

2.4.2 Data Validation

Data validation may be performed either by an independent third party not involved in sampling, analysis, or assessment, or by S&GRP. *Data Validation Procedure for Chemical Analyses* (HNF-20433) will be used to perform validation for chemical methods, and *Data Validation Procedures for Radiochemical Analyses* (HNF-20434) will be used to perform validation for radiochemical methods. Of the results, 5 percent will undergo Level C validation, as defined by these validation procedures.

The RPDs between the pair of field duplicates/replicates will be calculated to determine whether the precision requirements of the project (RPD less than or equal to 20 percent) were met for the COCs. Following the validation rules in HNF-20433 and HNF-20434, the RPDs will be calculated only when results for the duplicate and the corresponding primary sample are more than five times the required detection limit or reporting limit. When at least one result is a detect, and one or both results are less than five times the detection limit, the results are compared by difference using the reporting value for nondetects. A difference of up to two times the detection limit is considered satisfactory for samples. Where both results are nondetects, an RPD is not calculated.

2.4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field activities to those proposed in corresponding documents and provides an evaluation of the resulting data. The purpose of the data assessment is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs. The data quality assessment will be consistent with EPA guidelines for the data quality assessment process (i.e., EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide*; and EPA/240/B-06/003, *Data Quality Assessment: Statistical Tools for Practitioners*).

Method blanks and any field/equipment blanks will be compared to the data to assess contamination. The comparison will evaluate whether any analyte present in the trip/equipment or laboratory blank exceeds the regulatory limits (i.e., universal treatment standards and toxicity characteristics).

3 Field Sampling Plan

Additional details regarding field-specific collection requirements are provided in this chapter.

3.1 Sampling Objectives

The objective of the field sampling plan is to clearly identify project sampling and analysis activities. The field sampling plan uses the sampling design identified during the DQO process and presents the design to identify sampling locations, total number of samples to be collected, sampling procedures to be implemented and analyses to be performed, and sample bottle requirements.

The extraction and injection wells to be installed will support the groundwater P&T remedy. The relative drilling schedule will be defined by the drilling manager.

3.2 Sampling Locations and Frequencies

The purpose of this section is to identify the location of the new groundwater wells to be installed and to define the sampling and analysis requirements for the samples and measurements to be collected from each of the wells. The map provided in Figure 1-2 shows the approximate location of the 18 proposed new groundwater wells in drilling sequence 3. The actual locations of the wells will be determined based on a field walkdown of current site conditions to avoid Hanford Site National Historic restrictions, roads, waste sites, and other obstructions. After installation of the well screens, the wells may be hydraulically tested as part of an aquifer test plan, which is outside the scope of this document. Geophysical logging may be conducted based on direction from the drilling manager. The wells may become part of the monitoring network until the P&T system is operational. Table 3-1 lists the location and depth to be sampled at each well during drilling, and Table 3-2 lists the field QC requirements.

Figure 1-2 depicts five extraction well locations and 13 injection well locations in drilling sequence 3. It is anticipated that once installed and operational, extraction wells will be capable of recovering approximately 378.5 L/min (100 gallons per minute [gpm]) on a sustainable basis, while the injection wells will be capable of injecting approximately 567.8 L/min (150 gpm) sustainably. The rationale for selecting the well drilling locations is described below.

The well locations were selected based upon the following:

- Maps depicting the extent of contamination of the primary COC, which is carbon tetrachloride, as presented in the 200-ZP-1 OU FS report (DOE/RL-2007-28) and in *Spatial Analysis of Contaminants in 200 West Area Groundwater in Support of the 200-ZP-1 Operable Unit Pre-Conceptual Remedy Design* (PNNL-18100)
- The results of groundwater flow and particle-tracking simulations completed using the 200-ZP-1 OU model (further described below)
- Relatively simple analytical calculations made to verify conclusions drawn on the basis of the flow modeling and particle tracking

Table 3-1. Well Sample/Measurement Locations and Depth

Sampling Location	Vadose Zone Sampling Depth, Frequency, and Analysis (ft bgs)	Aquifer Sampling Depth, Frequency, and Analysis (ft bgs)	
		Water Samples	Soil Samples (Sediment) Below Water Table[a]
EW-11, EW-13, EW-14, EW-17, EW-20, IW-1, IW-2, IW-3, IW-7, IW-8, IW-9, IW-10, IW-12, IW-14, IW-15, IW-16, IW-17, and IW-23	**Ground surface to water table at each of the 18 wells:** During drilling, archive grab samples for geological purposes will be collected every 5 ft and where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.	During drilling, water samples to be collected (in accordance with Section 3.5.6) at 20 ft intervals throughout aquifer, unless visual observation in aquifer material change by the field geologist calls for 10 ft intervals for further clarification: • Carbon tetrachloride, technetium-99, and nitrate quick-turnaround samples[b] • Table 1-2 constituents at standard turnaround time (in accordance with Table 1-7) • Field screening parameters (temperature, pH, dissolved oxygen, specific conductance, and NTU)	During drilling, soil samples to be collected: • Every 5 ft, grab archive samples will be collected and where lithology changes occur in one-pint jar and a chip tray from the drill cuttings. • Every 20 ft, in correlation with aquifer water samples, grab two composite soil samples in pint jars from drill cuttings over the 20 ft interval for field screening grain-size (sieve) analysis

a. If field screening instruments indicate radiological contamination above background at a given interval, grab two additional pint jar samples. Send one pint jar for 24-hour turnaround gamma-energy analysis and one additional jar for testing based on the gamma-energy analysis results (as determined by the groundwater remediation manager).

b. If samples have elevated organic concentrations, an "E" flag may be applied to the data due to a lack of time for dilutions and re-runs on a quick-turnaround time. The standard turnaround time sample will account for dilutions and re-runs, as applicable.

c. Samples not used should be disposed in accordance with Section 3.6.

bgs = below ground surface
EW = extraction wells
IW = injection wells
NTU = nephelometric turbidity unit

Table 3-2. Field QC Requirements

Sample Type	Frequency	Purpose
Field replicate	One sample in 20, or at least one per well	To check the precision of field sampling and laboratory analyses
Equipment rinsates or blanks	One sample in 20	To check the effectiveness of the decontamination process; VOC analysis only
Trip blank	One sample in 20, or at least one per well	Assess contamination from containers or transportation; VOC analysis only
Field transfer blank	One per day when volatile organics are sampled	Assess contamination from sampling site; VOC analysis only

VOC = volatile organic compound

The well locations and alignment were developed for consistency with the objectives outlined in the ROD:

> *Groundwater pump-and-treat technology will be used to capture and treat the contaminated groundwater with a design requirement of reducing the mass of carbon tetrachloride, the predominant contaminant in the groundwater, by 95 percent*… (EPA et al., 2008).

The extraction well locations selected for drilling are expected to exhibit concentrations at any depth above 100 µg/L (0.100 ppm) carbon tetrachloride based on groundwater modeling efforts conducted as part of the FS process leading to issuance of the ROD. As such, the extraction well locations are positioned near the center of mass of the dissolved carbon tetrachloride contamination, providing additional support for the existing fifteen extraction wells. Maps depicting the extent of carbon tetrachloride contamination in the groundwater suggest that the center of mass is oriented east-northeast from suspected source areas 216-Z-1A, 216-Z-18, and 216-Z-9, to Route 3. This orientation is also consistent with previous interpretations of likely historic groundwater flow and contaminant migration directions (e.g., DOE/RL-2007-28).

The spacing of the extraction well locations along the carbon tetrachloride contamination plume (i.e., in the direction of groundwater flow) were developed based on the following:

- Particle tracking completed using the groundwater model of the area encompassing the 200-ZP-1 OU
- Relatively simple analytical calculations made to verify conclusions drawn on the basis of the flow modeling and particle tracking
- Location of right-of-ways and other accessibility restrictions

Well spacing may be revised based on new data collected during well installation and aquifer testing. The first well installed was extraction well EW-1, located near the presumed source areas and the existing interim remedial treatment system. Installation of this well enabled the completion of rigorous well development and aquifer testing activities, as water recovered from the well could be treated at the existing treatment facility. The results of this aquifer test provided estimates of aquifer properties and influent concentrations for the COCs that were used to validate and update the groundwater model and update estimates of the ideal recovery well spacing. A similar approach of rigorous well development and

aquifer testing activities may be used on other extraction wells as they are installed. The approach of installing and testing wells, and updating the remedy well configuration model, will be adopted throughout development and installation of the final remedy in order to reflect the most up-to-date information available.

Well development and aquifer testing should follow the same approach as described in *Description of Work for Aquifer Testing at Well 299-W15-225* (SGW-40266) unless it is determined that other well development methods are more appropriate. The description of work describes the approach, the procedures to be used, management structure, and benefits of each of the aquifer tests. Not all of the aquifer testing described in SGW-40266 may be conducted at each well, but it is anticipated that each well may either undergo the more extensive well development procedures described in the description of work or will use other current well development methods described in the *200 West Area Groundwater Pump-and-Treat Facility Extraction and Injection Well Maintenance Plan* (DOE/RL-2010-78) to improve the efficiency of each well. The 200-ZP-1 OU project manager will decide which, if any, aquifer tests (i.e., slug test characterization during or following drilling, electromagnetic borehole flow meter surveys, and constant-rate pump tests) may be applied at each of the individual wells.

3.3 Well Depth and Screen Placement

The wells will be drilled to the Ringold lower mud unit or basalt, whichever is first, based on quick-turnaround results collected during drilling (as specified in Table 3-1). Screen placement varies between extraction and injection well installations.

3.3.1 Extraction Wells

Extraction well screens will be installed and centered on the interval showing the highest carbon tetrachloride concentration to capture as much of the greater than 100 µg/L (0.100 ppm) concentration plume as possible. A decision will be made in the field regarding the well screen interval length based on depth-discrete groundwater sample analytical results for carbon tetrachloride, technetium-99, and nitrate collected during the well drilling process, contaminant concentrations in nearby monitoring wells, and the extraction well's location in the carbon tetrachloride plume. The minimum screened interval of the extraction well will be based on the groundwater sample analytical results, with the well screen sufficiently long enough to encompass carbon tetrachloride concentrations greater than 100 µg/L (0.100 ppm). This minimum screened interval of the extraction well may be increased based on the concentrations of the other COCs identified during drilling and/or concentrations of carbon tetrachloride and other COCs in other wells and borings upgradient from the extraction well locations. Figure 3-1 depicts an extraction well screen design. Blank sections may be used in areas of low permeability or low contaminant concentration to optimize performance.

The well yield is dependent on the length of the screen, aquifer thickness, and aquifer hydraulic properties. The current assumption for well yield is 12.4 L/min/m (1 gpm/ft) of well screen. An extraction well with at least 30.5 m (100 ft) of well screen is expected to be capable of producing 378.5 L/min (100 gpm). Given the heterogeneity known to be present (particularly the mixed sedimentary sequences and the variability of cementing in the Ringold Formation), it is not possible to guarantee that each individual well will produce 378.5 L/min (100 gpm), and some wells may produce greater than 378.5 L/min (100 gpm). Sieve analyses will be used to size the filter pack and in turn for well screen slot size selection.

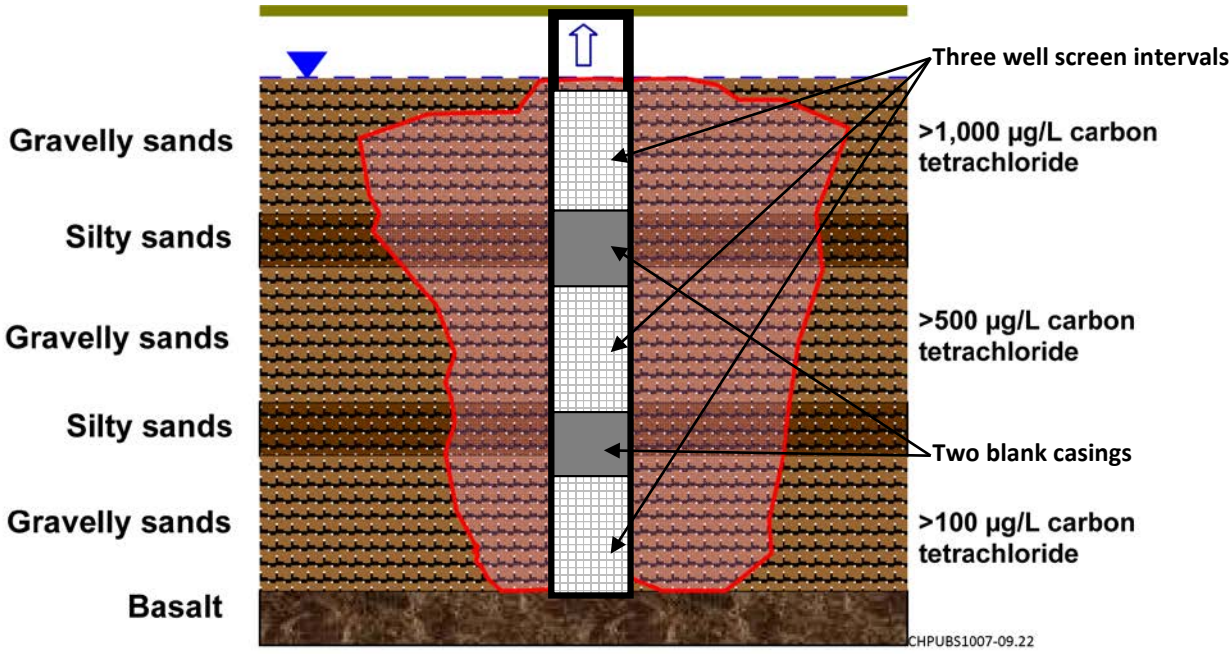

Figure 3-1. Conceptual Illustration of Extraction Well Screen Design

3.3.2 Injection Wells

Injection well consumption also depends on the length of the screen, aquifer thickness, and aquifer hydraulic properties. Injection well screens will be installed generally at a depth of approximately 82.3 m (270 ft) and have a screen length of approximately 30.5 m (100 ft), as illustrated in Figure 3-2. The current assumption for well consumption is 18.6 L/min/m (1.5 gpm/ft) of well screen. An injection well with at least 30.5 m (100 ft) of well screen is expected to be capable of injecting 567.8 L/min (150 gpm). Given the heterogeneity known to be present (particularly the mixed sedimentary sequences and the variability of cementing in the Ringold Formation), it is not possible to guarantee that each well will receive 567.8 L/min (150 gpm), and some wells may consume greater than 567.8 L/min (150 gpm). Sieve analyses will be used to size the filter pack and for well screen slot size selection.

3.4 Well Drilling and Completion Procedures

Well drilling will be performed in accordance with WAC 173-160 for resource protection wells. The wells will be constructed using 20.3 cm (8 in.) diameter casing. The method of drilling will most likely be an air circulation technique; however, the final drilling method will be determined based on negotiation of the drilling contract.

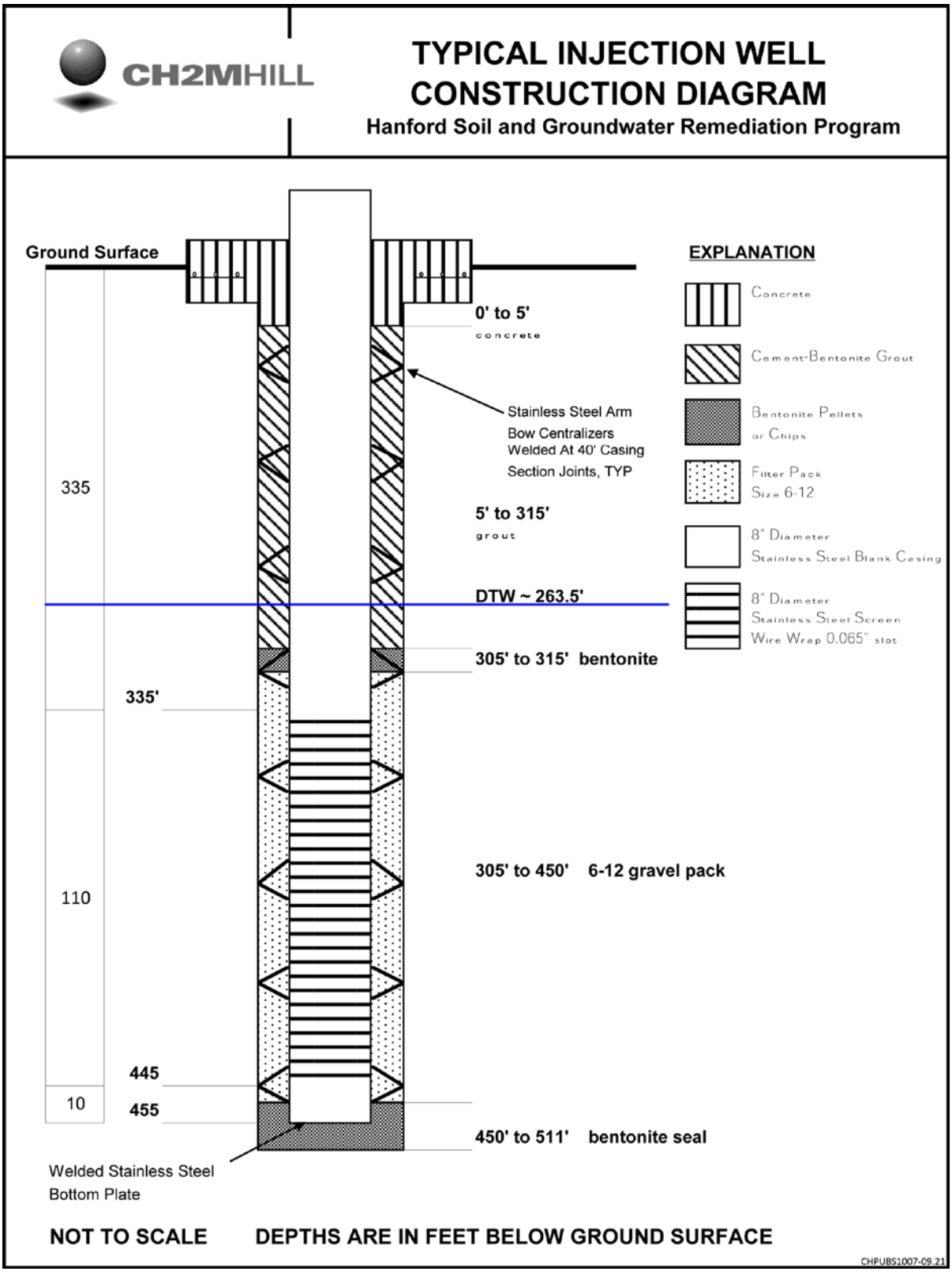

Figure 3-2. Conceptual Illustration of Injection Well Screen Design

The wells will be constructed with Schedule 10, Type 304 or 316, stainless-steel, V-slot continuous wire-wrap screen, atop approximately a 1.5 to 3 m (5 to 10 ft)-long, stainless-steel sump with end cap. A Schedule 10 stainless-steel riser will be used to extend the permanent well into the vadose zone, with Schedule 10 stainless-steel casing through the vadose zone to ground surface. Screen slot size and sand-pack grain size will be determined after evaluation of sample data collected and composited every 6.1 m (20 ft) in correlation with aquifer water samples from drill cuttings for field screening grain-size (sieve) analysis in accordance with Table 3-1. Colorado silica sand or an equivalent quality material will be used for the sand pack. Sodium bentonite pellets and/or natural sodium bentonite chunks, crumbles, or powdered bentonite will be used for bentonite sealing material. Type I/II Portland cement shall be used for cement grout. A bentonite seal will be emplaced between the well screen sections, as required by the design. Bentonite slurry or cement shall not be poured down the long annulus, but will be placed by tremie tube.

Surface construction consisting of protective casing, protective guard posts, and cement pad must be in place prior to job completion. The protective casing shall be a minimum 5.1 cm (2 in.) larger in diameter than the permanent casing. Protective casing shall rise approximately 0.9 m (3 ft) above ground surface. Permanent casing shall rise to approximately 0.3 m (1 ft) below the top of the protective casing. Protective casing shall have a lockable well cap that extends approximately 38.1 cm (15 in.) above the top of the protective casing. If the proposed completion based on the conceptual model and numerical flow and transport modeling is different than WAC 173-160 requirements, variances will be obtained from Ecology.

3.4.1 Extraction Wells

The extraction wells may have a long screen, possibly greater than 30.5 m (100 ft) in length, potentially from the water table all the way down to the 100 µg/L (0.100 ppm) carbon tetrachloride concentration level. In addition, one or more blank sections of casing may separate screen intervals within the same aquifer based on grain size and contaminant concentration; however, this will be a single-casing well completion. The blank sections are part of the well screen installation and are only to facilitate efficient operation of the well pump. Figure 3-1 provides a conceptual illustration of well screen design for the extraction wells. This design will enable extraction of groundwater from the entire contaminated aquifer thickness if needed and will allow the wells to preferentially extract more highly contaminated water to maximize attainment of remedy goals with the current treatment system capacity.

3.4.2 Injection Wells

Injection wells will have a long screen, approximately 30.5 m (100 ft) in length, as a single casing well. Based on the observed hydraulic conductivity of the aquifer, the 30.5 m (100 ft) length should accommodate up to 567.8 L/min (150 gpm) on a sustained basis. Figure 3-2 provides a conceptual illustration of injection well design. This design will enable injection of groundwater from the P&T system and will allow the wells to inject a sufficient quantity of water to meet the injection needs of the treatment system.

3.4.3 Well Maintenance

Extraction or injection wells that do not meet performance expectations or have diminishing performance over time may be rehabilitated using methods described in DOE/RL-2010-78. DOE/RL-2010-78 discusses the programs and procedures in place for preventative, routine, and corrective (non-routine) well maintenance after the system is fully operational. The plan also outlines how monitoring will be conducted and results reported for well performance.

3.5 Field-Specific Collection Requirements

The field-specific collection requirements for sampling are outlined in the following subsections.

3.5.1 Sample Location and Depth

The sample number, well identification number, and depth shall be documented. Each bottle and chain-of-custody form must be identified by sample number and sample authorization form number.

3.5.2 Sample Identification

A sample data-tracking database will be used to track the samples through collection and the laboratory analysis process. The HEIS database is the repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project. The radiological and physical properties of each sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook. Each sample container will be labeled with the following information, using a waterproof marker on firmly affixed, water-resistant labels:

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

3.5.3 Field Sample Logbook

Information pertinent to sampling and analysis will be recorded in field checklists and bound logbooks in accordance with existing sample collection protocols (DOE/RL-96-68). The sampling team is responsible for recording relevant sampling information. Logbook entries will be dated and signed by the individual making the entry. Program requirements for managing the generation, identification, transfer, protection, storage, retention, retrieval, and disposition of records will be followed. At a minimum, the information noted in Section 3.5.1 will be documented.

3.5.4 Sample Custody

Sample custody will be maintained in accordance with existing Hanford Site protocols. The custody of samples will be maintained from the time that samples are collected until ultimate disposal of the samples, as appropriate. 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 the laboratory. Sample shipping procedures will be followed throughout sample shipping. Each chain-of-custody form will include the sample identification number, associated well identification number, and remediation system designation. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Chain-of-custody procedures will be followed throughout sample collection, storage, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time the responsibility for the custody of the sample changes, the new and previous custodians will sign the record and note the date and time. 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. Except for volatile organic analysis samples, a custody seal will be affixed to the lid of each sample container, and the custody seal will be inscribed with the sampler's initials and the date. Custody seals are not applied directly to volatile organic analysis bottles collected because of a potential for affecting analytical results and/or fouling of laboratory equipment. Custody seals and any other required labels/documentation can be fixed to the exterior of

a plastic bag holding volatile organic analysis vials in such a manner to detect potential tampering. Sample custody during laboratory analysis will be addressed in the applicable laboratory's standard operating procedures.

3.5.5 Sample Containers, Preservatives, and Holding Times

Appropriate sample containers will be used for soil and groundwater samples collected for radiological and chemical analysis. Container sizes may vary, depending on the laboratory-specific volumes needed to meet analytical detection limits. If, however, the dose rate on the outside of a sample jar or the curie content within the sample exceeds levels acceptable to an offsite laboratory, the sample coordinator may send smaller volumes to the laboratory after consultation with Sample Management and Reporting to determine acceptable volumes. The final container type and volumes will be provided on the sample authorization form and the chain-of-custody form. This SAP defines a "sample" as a filled sample bottle for the purpose of starting the clock for holding-time restrictions.

3.5.6 Sampling Procedure

Depth-discrete soil samples from drill cuttings will be collected within the vadose zone and unconfined aquifer. This will enable sieve analyses to be completed to design both the filter pack and the slot size for the screen in the unconfined aquifer.

Most groundwater samples will be pumped from selected intervals, although collecting samples from groundwater brought to the surface with a bailer is acceptable (e.g., near the water table where insufficient head may not be available for a sample pump, or where groundwater turbidity is high enough to interfere with pumping). Samples will be collected with a submersible pump. Prior to sample capture, the pump will be operated for a period of time sufficient to provide stabilized field readings.

Samples collected as the boring is advanced will assist in validating the conceptual model for the distribution of the COCs and might lead to changes in the open-screen interval.

3.5.7 Sample Shipping

Samples may not be transported without authorization from the S&GRP authorized shipper. If the proposed wells have a medium or high risk of encountering radiological material, RCT surveys will be required. If radiological materials are not anticipated, RCT surveys may not be required if the RCT field readings show no activity above background. As applicable, the RCT will measure the contamination levels on the outside of each sample jar and the dose rates on each sample jar. As applicable, the RCT will also measure the radiological activity on the outside of the sample container (through the container) and will document the highest contact radiological reading in millirem per hour (mrem/hr). This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations (49 CFR, "Transportation") and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. The sampler will send copies of the shipping documentation to Sample Management and Reporting within 48 hours of shipping.

As a general guideline, samples with activities less than 5 µSv/hr (0.5 mrem/hr) can be shipped to an appropriate offsite laboratory (e.g., DOE contract laboratory, or a laboratory with a U.S. Nuclear Regulatory Commission or state license for specific radionuclides). Samples with activities between 5 µSv/hr (0.5 mrem/hr) and 100 µSv/hr (10 mrem/hr) may be shipped to an offsite laboratory, although samples with dose rates within this range will be evaluated on a case-by-case basis by Sample Management and Reporting. Samples with activities greater than 100 µSv/hr (10 mrem/hr) may be sent to an onsite laboratory, as arranged by Sample Management and Reporting.

3.5.8 Radiological Field Data

The scope of work for this SAP consists of vadose zone and aquifer sampling. Alpha and beta/gamma data collection in the field will be used as needed to support sampling and analysis efforts. The following information will be disseminated to personnel performing work in support of this SAP:

- Instructions to RCTs on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the Geiger-Müller (GM) portable instrument, to include a physical description of the GM, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. The GM instrument is a beta/gamma instrument commonly used on the Hanford Site to obtain removable surface contamination measurements and direct measurements of the total surface contamination.
- Information regarding the portable alpha meter (PAM), to include a physical description of the PAM, the radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. The PAM is an alpha instrument commonly used on the Hanford Site to obtain removable surface contamination measurements 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 includes 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 instrument commonly used on the Hanford Site to obtain removable surface contamination measurements and direct measurements of total surface contamination.

3.6 Management of Waste

Waste generated by drilling and sampling activities (e.g., personal protective clothing and equipment) will be managed in accordance with the "Waste Management Plan for the 200-ZP-1 Operable Unit Remedial Action" (Appendix B of DOE/RL-2009-124, *200 West Area Pump-and-Treat Facility Operations and Maintenance Plan*, Rev. 1). The waste management plan establishes the requirements for the management and disposal of waste associated with groundwater wells used to monitor the 200-ZP-1 OU, as required by the ROD (EPA et al., 2008). Remediation-derived waste from these sampling activities is handled in accordance with CERCLA. The characterization of wastes generated by drilling and the sampling of the wells identified in this SAP vary by location, depth, and time of each well's installation.

- Saturated zone soils and related miscellaneous solid waste will be designated for disposal on the basis of an existing waste profile developed using data previously obtained from numerous other 200-ZP-1 wells.
- Vadose zone soils and related waste generated or planned prior to the release of Rev. 1 of this SAP were characterized in accordance with internal plans developed using an abbreviated DQO process. This process indicated that vadose zone contamination at the location of these wells was unlikely, and field readings conducted to date have confirmed this assumption; therefore, no additional sampling has been performed. Wells characterized in this manner include the following:
  - 299-W6-13
  - 299-W6-14
  - 299-W10-36

  - 699-46-68
  - 699-44-67
  - 699-42-67
  - 699-40-67
  - 699-43-67B
  - 399-W14-22

- Vadose zone soils and related waste at the following wells are expected to be uncontaminated because no waste disposal sites or unplanned releases are identified within 100 m (328.1 ft) of these wells; therefore, no additional sampling is planned:

  - 299-W15-228
  - 699-45-67B
  - 299-W6-15
  - 299-W5-1

- Vadose zone soils and related waste at well 299-W19-111 are also expected to be uncontaminated because the nearest waste sites are removed and not expected to pose a subsurface migration risk. These waste sites include a pipeline (200-W-105-PL) that is more than 85 m (278.9 ft) away at its closest point to the proposed drilling location, and two surficial contamination sites more than 40 m (131.2 ft) away. These include UPR-200-W-48 (an area of surface contamination along railroad tracks that is no longer marked or posted) and UPR-200-W-86 (a small, 3 m by 3 m [9.8 ft by 9.8 ft] area around a light pole with no obvious source, but likely came from biological transport such as coyotes or tumbleweeds).

- Vadose zone soils at injection wells IW-8, IW-9, and IW-16 will be addressed in a later revision of this SAP, after their locations have been more narrowly defined.

- Well 299-W11-97 is located approximately 100 m (328.1 ft) from the 218-W-1A Burial Ground; however, the nature of the waste disposed at this site (e.g., failed equipment and industrial waste) poses little risk of significant lateral migration. Two liquid waste disposal cribs, less than 30 m (98.4 ft) from the proposed drilling location are more significant. These cribs, 216-T-34 and 216-T-35, were used to dispose approximately 22.7 million L (6 million gal) of process effluent from the 340 Facility in the 300 Area. The 216-T-34 and 216-T-35 Cribs are currently managed as part of the 200-WA-1 OU; however, they were previously assigned to the 200-LW-1 OU, which underwent a DQO process that identified the contaminants of potential concern listed in Table 3-3.

Table 3-3. Vadose-Zone Contaminants of Potential Concern at Well 299-W11-97

Radionuclides		
Americium-241	Europium-152/154/155	Radium-226/228
Antimony-125	Hydrogen-3 (tritium)	Strontium-90
Carbon-14	Neptunium-237	Technetium-99
Cesium-134/137	Nickel-63	Thorium-232
Cobalt-60	Plutonium-238/239/240	Uranium-233/234/235/236/238

Table 3-3. Vadose-Zone Contaminants of Potential Concern at Well 299-W11-97

Inorganics – Metals		
Antimony	Boron	Lead
Arsenic	Cadmium	Mercury
Barium	Chromium	Nickel
Beryllium	Chromium (VI) (hexavalent)	Selenium
Bismuth	Copper	Silver
Inorganics – Other		
Ammonia/ammonium	Cyanide	
Organics – Volatiles		
1,1-Dichloroethane	Butanol	Ethylene glycol
1,2-Dichloroethane	n-Butyl benzene	Methyl ethyl ketone (MEK)
cis-1,2-Dichloroethylene	Carbon tetrachloride	Methyl isobutyl ketone (MIBK)
trans-1,2-Dichloroethylene	Chlorobenzene	Tetrachloroethylene
1,1,1-Trichloroethane (TCA)	Chloroform (trichloromethane)	Toluene
Acetone	Dichloromethane (methylene chloride)	Trichloroethene
Benzene	Ethylbenzene	Xylene
Organics – Semivolatiles		
AMSCO*	Normal paraffin hydrocarbon (kerosene)	PCBs
Dodecane	Phenol	Tributyl phosphate
Greases		

* Analyzed as kerosene by nonhalogenated volatile organic analysis via method 8015 (SW-846), total petroleum hydrocarbon (TPH) - diesel range or TPG-gasoline range

PCB = polychlorinated biphenyl

Of the contaminants of potential concern listed in Table 3-3, a few can be excluded, as follows:

- Radium-226 and -228 are naturally occurring products of uranium decay that have not been found in Hanford Site soils in significant concentrations and can be estimated from uranium results.
- Hexavalent chromium will be included with total chromium.
- Ethylene glycol will be present at the 10 percent concentration required to trigger a Washington State toxic waste code and does not require any other waste codes.

- Ammonia/ammonium, bismuth, and greases are not characteristic waste, are not Washington State toxic or persistent, and are not considered underlying hazardous constituents.

It is assumed that one sample, located with a conservative bias, will be sufficient to characterize well 299-W11-97 vadose zone drill cuttings and related waste. If field readings (organic or radioactive) are positive during drilling, the sample will be collected from the depth with the highest field readings. If no field readings are detected above background levels, the sample will be collected from the depth of the first (nearest to ground surface) sand/silt interface. Additional samples for QA/QC purposes are assumed to be unnecessary for waste characterization; however, standard and best management practices will be employed for sampling and analysis. The sample will be analyzed for the constituents identified in Tables 3-4 and 3-5.

Table 3-4. Radiological Analytical Performance Requirements for Waste

COCs	CAS #	Name/Analytical Technology	Target Required Quantitation Limits (pCi/g)	Precision Soil	Accuracy Soil
Radionuclides					
Am-241	14596-10-2	Americium-241 – GEA	1	≤30%	70–130%
Sb-125	14234-35-6	Antimony-125 – GEA	0.3	≤30%	70–130%
C-14	14762-75-5	Carbon-14 – LSC	1	≤30%	70–130%
Cs-134	13967-70-9	Cesium-134 – GEA	0.1	≤30%	70–130%
Cs-137	10045-97-3	Cesium-137 – GEA	0.1	≤30%	70–130%
Co-60	10198-40-0	Cobalt-60 – GEA	0.05	≤30%	70–130%
Eu-152	14683-23-9	Europium-152 – GEA	0.1	≤30%	70–130%
Eu-154	15585-10-1	Europium-154 – GEA	0.1	≤30%	70–130%
Eu-155	14391-16-3	Europium-155 – GEA	0.1	≤30%	70–130%
Np-237	13994-20-2	Neptunium-237 - GEA	1	≤30%	70–130%
Ni-63	13981-37-8	Nickel-63 – LSC	30	≤30%	70–130%
Pu-238	13981-16-3	Isotopic Pu – AEA	1	≤30%	70–130%
Pu-239/240	PU239/240	Isotopic Pu – AEA	1	≤30%	70–130%
Sr-90	10098-97-2	Strontium-90 – GPC	1	≤30%	70–130%
Tc-99	14133-76-7	Technetium-99 – LSC	15	≤30%	70–130%

Table 3-4. Radiological Analytical Performance Requirements for Waste

COCs	CAS #	Name/Analytical Technology	Target Required Quantitation Limits (pCi/g)	Precision Soil	Accuracy Soil
Th-232	7440-29-1	Isotopic Th – AEA	1	≤30%	70–130%
U-233/234	U233/234	Isotopic U – AEA	1	≤30%	70–130%
U-235/236	15117-96-1	Isotopic U – AEA	1	≤30%	70–130%
U-238	U238	Isotopic U – AEA	1	≤30%	70–130%

AEA = alpha energy analysis
CAS = Chemical Abstract Services
COC = contaminant of concern
GEA = gamma energy analysis
GPC = gas proportional counting
LSC = liquid scintillation counting

Table 3-5. Nonradiological Analytical Performance Requirements for Waste

COCs	CAS #	Preliminary Action Level			Name/Analytical Technology[d]	Target Required Quantitation Limits	Precision Soil[f]	Accuracy Soil[f]
		Target Method B[a] (mg/kg)	TC Dangerous Waste Threshold (mg/kg)[b]	Universal Treatment Standard[c] (mg/kg)		Soil – Other Low Conc. (mg/kg)		
Inorganics								
Antimony	7440-36-0	32	N/A	1.15[e]	EPA Method 6010	6	≤30%	70–130%
Arsenic	7440-38-2	0.0667	100	5[e]	EPA Method 6010	10	≤30%	70–130%
Barium	7440-39-3	16,000	2,000	21[e]	EPA Method 6010	2	≤30%	70–130%
Beryllium	7440-41-7	160	N/A	1.22[e]	EPA Method 6010	0.5	≤30%	70–130%
Boron	7440-42-8	16,000	N/A	N/A	EPA Method 6010	2	≤30%	70–130%
Cadmium	7440-43-9	80	20	0.11[e]	EPA Method 6010	0.5	≤30%	70–130%
Chromium	7440-47-3	120,000	100	0.60[e]	EPA Method 6010	1	≤30%	70–130%
Copper	7440-50-8	3,200	N/A	N/A	EPA Method 6010	1	≤30%	70–130%
Cyanide	57-12-5	1600	N/A	12	EPA Method 335.2	500	≤30%	70–130%
Lead	7439-92-1	250	100	0.75[e]	EPA Method 6010	5	≤30%	70–130%
Mercury	7439-97-6	24	4	0.5	EPA Method 7471	0.2	≤30%	70–130%
Nickel	7440-02-0	1,600	N/A	11[e]	EPA Method 6010	4	≤30%	70–130%
Selenium	7782-49-2	400	20	5.7[e]	EPA Method 6010	10	≤30%	70–130%
Silver	7440-22-4	400	100	0.14[e]	EPA Method 6010	1	≤30%	70–130%

Table 3-5. Nonradiological Analytical Performance Requirements for Waste

COCs	CAS #	Preliminary Action Level			Name/Analytical Technology[d]	Target Required Quantitation Limits	Precision Soil[f]	Accuracy Soil[f]
		Target Method B[a] (mg/kg)	TC Dangerous Waste Threshold (mg/kg)[b]	Universal Treatment Standard[c] (mg/kg)		Soil – Other Low Conc. (mg/kg)		
Vanadium	7440-62-2	560	N/A	1.6[e]	EPA Method 6010	2.5	≤30%	70–130%
Volatile Organic Analytes								
1,1-Dichloroethane	75-34-3	8,000	N/A	6	EPA Method 8260	0.010 (0.001)	≤30%	70–130%
1,1,1-Trichloroethane	71-55-6	165,000	N/A	6	EPA Method 8260	0.005	≤30%	70–130%
1,2-Dichloroethane	107-06-2	10.9	N/A	6	EPA Method 8260	0.005 (0.0015)	≤30%	70–130%
2-Butanone (MEK)	78-93-3	48,000	4,000	36	EPA Method 8260	0.010	≤30%	70–130%
4-Methyl-2-pentanone (MIBK)	108-10-1	6,400	N/A	33	EPA Method 8260	0.010	≤30%	70–130%
Acetone	67-64-1	72,000	N/A	160	EPA Method 8260	0.020	≤30%	70–130%
Benzene	71-43-2	10	10	10	EPA Method 8260	0.005	≤30%	70–130%
1-Butanol	71-36-3	8,000	N/A	2.6	EPA Method 8260	0.1	≤30%	70–130%
Carbon tetrachloride	56-23-5	7.69	10	6	EPA Method 8260	0.005	≤30%	70–130%
Chlorobenzene	108-90-7	1,600	2,000	6	EPA Method 8260	0.005	≤30%	70–130%
Chloroform	67-66-3	163.9	120	6	EPA Method 8260	0.005	≤30%	70–130%
cis-1,2-Dicholoroethylene	156-59-2	800	N/A	N/A	EPA Method 8260	0.005	≤30%	70–130%

Table 3-5. Nonradiological Analytical Performance Requirements for Waste

COCs	CAS #	Preliminary Action Level			Name/Analytical Technology[d]	Target Required Quantitation Limits	Precision Soil[f]	Accuracy Soil[f]
		Target Method B[a] (mg/kg)	TC Dangerous Waste Threshold (mg/kg)[b]	Universal Treatment Standard[c] (mg/kg)		Soil – Other Low Conc. (mg/kg)		
Ethyl benzene	100-41-4	8,000	N/A	10	EPA Method 8260	0.005	≤30%	70–130%
n-Butyl benzene	104-51-8	3,200	N/A	N/A	EPA Method 8260	0.005	≤30%	70–130%
Methylene chloride	75-09-2	133	N/A	30	EPA Method 8260	0.005	≤30%	70–130%
Tetrachloroethene	127-18-4	1.85	14	6	EPA Method 8260	0.005	≤30%	70–130%
Toluene	108-88-3	6,400	N/A	10	EPA Method 8260	0.005	≤30%	70–130%
trans-1,2-Dicholoroethylene	156-60-5	1,600	N/A	30	EPA Method 8260	0.005	≤30%	70–130%
Trichloroethene	79-01-6	11.2	10	6	EPA Method 8260	0.005	≤30%	70–130%
Xylenes (total)	1330-20-7	16,000	N/A	30	EPA Method 8260	0.010	≤30%	70–130%
Semivolatile Organic Analytes and Other Organics								
Dodecane	112-40-3	N/A	N/A	N/A	EPA Method 8270	0.33	≤30%	70–130%
PCBs	1336-36-3	0.5	N/A	10	EPA Method 8080/8082	0.02	≤30%	70–130%
Phenol	108-95-2	24,000	N/A	6.2	EPA Method 8270	0.33	≤30%	70–130%
TPH–kerosene range	N/A	N/A	N/A	N/A	WTPH Kerosene	5	≤30%	70–130%
TPH-diesel range	N/A	N/A	N/A	N/A	WTPH Diesel	5	≤30%	70–130%

Table 3-5. Nonradiological Analytical Performance Requirements for Waste

COCs	CAS #	Preliminary Action Level			Name/Analytical Technology[d]	Target Required Quantitation Limits	Precision Soil[f]	Accuracy Soil[f]
		Target Method B[a] (mg/kg)	TC Dangerous Waste Threshold (mg/kg)[b]	Universal Treatment Standard[c] (mg/kg)		Soil – Other Low Conc. (mg/kg)		
Tributyl phosphate	126-73-8	185	N/A	N/A	EPA Method 8270	3.3	≤30%	70–130%

a. WAC 173-340-740 ("Unrestricted Land Use Soil Cleanup Standards"), Method B soil cleanup levels. This is the concentration specified for unrestricted land use.

b. Waste disposition for this project will comply with the "Toxicity Characteristic," 40 CFR 268.40, "Land Disposal Restrictions," "Applicability of Treatment Standards." This value applies to the maximum concentration of contaminants for designation as a dangerous waste under the toxicity characteristic. This value is 20 times the TCLP value. The EPA allows the use of 20 times the TCLP values to determine the total action levels because of the "20 times" dilution used in the TCLP process.

c. Value reflects the Universal Treatment Standard as an underlying hazardous constituent in accordance with 40 CFR 268.48, "Land Disposal Restrictions," "Universal Treatment Standards." The unit value is in mg/kg^3.

d. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

e. Precision and accuracy requirements are identified and defined in the referenced EPA methods.

f. Accuracy criteria are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional analyte-specific evaluations also performed for matrix spikes and surrogates, as appropriate to the method. Precision criteria for batch laboratory replicate matrix spike analyses.

CAS = Chemical Abstract Services
COC = contaminant of concern
EPA = U.S. Environmental Protection Agency
N/A = not applicable
PCB = polychlorinated biphenyl
TC = toxicity characteristic
TCLP = toxicity characteristic leaching procedure
TPH = total petroleum hydrocarbon

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4 Health and Safety

Field operations will be performed in accordance with health and safety requirements and appropriate S&GRP requirements. Additionally, work control documents will be prepared to further control 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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5 References

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Appendix A

Waste Sampling and Characterization Facility Standard Compound List

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Table A-1. EPA SW-846, Method 8260

CAS Number	Constituent	Water RDL (µg/L)	Soil RDL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
100-41-4	Ethylbenzene	5	5	≤20%/≤30%	80-120%/70-130%
100-42-5	Styrene	5	5	≤20%/≤30%	80-120%/70-130%
10061-01-5	cis-1,3-Dichloropropene	5	5	≤20%/≤30%	80-120%/70-130%
10061-02-6	trans-1,3-Dichloropropene	5	5	≤20%/≤30%	80-120%/70-130%
107-06-2	1,2-Dichloroethane	5 (1.5)	5 (1.5)	≤20%/≤30%	80-120%/70-130%
108-10-1	4-Methyl-2-pentanone	10	10	≤20%/≤30%	80-120%/70-130%
108-88-3	Toluene	5	5	≤20%/≤30%	80-120%/70-130%
108-90-7	Chlorobenzene	5	5	≤20%/≤30%	80-120%/70-130%
124-48-1	Dibromochloromethane	5	5	≤20%/≤30%	80-120%/70-130%
127-18-4	Tetrachloroethene	5	5	≤20%/≤30%	80-120%/70-130%
1330-20-7	Xylenes (total)	10	10	≤20%/≤30%	80-120%/70-130%
540-59-0	1,2-Dichloroethene (total)	10	10	≤20%/≤30%	80-120%/70-130%
591-78-6	2-Hexanone	20	20	≤20%/≤30%	80-120%/70-130%
67-64-1	Acetone	20	20	≤20%/≤30%	80-120%/70-130%
71-43-2	Benzene	5 (1.5)	5 (1.5)	≤20%/≤30%	80-120%/70-130%
71-55-6	1,1,1-Trichloroethane	5	5	≤20%/≤30%	80-120%/70-130%
74-83-9	Bromomethane	10	10	≤20%/≤30%	80-120%/70-130%
74-87-3	Chloromethane	10	10	≤20%/≤30%	80-120%/70-130%
75-00-3	Chloroethane	10	10	≤20%/≤30%	80-120%/70-130%
75-01-4	Vinyl chloride	10 (5)	10 (5)	≤20%/≤30%	80-120%/70-130%
75-09-2	Methylene chloride	5	5	≤20%/≤30%	80-120%/70-130%
75-15-0	Carbon disulfide	5	5	≤20%/≤30%	80-120%/70-130%
75-25-2	Bromoform	5	5	≤20%/≤30%	80-120%/70-130%
75-27-4	Bromodichloromethane	5	5	≤20%/≤30%	80-120%/70-130%
75-34-3	1,1-Dichloroethane	10 (1)	10 (1)	≤20%/≤30%	80-120%/70-130%
75-35-4	1,1-Dichloroethene	10 (2)	10 (2)	≤20%/≤30%	80-120%/70-130%
78-87-5	1,2-Dichloropropane	5 (1.5)	5 (1.5)	≤20%/≤30%	80-120%/70-130%
78-93-3	2-Butanone	10	10	≤20%/≤30%	80-120%/70-130%

Table A-1. EPA SW-846, Method 8260

CAS Number	Constituent	Water RDL (µg/L)	Soil RDL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
79-00-5	1,1,2-Trichloroethane	5 (2)	5 (2)	≤20%/≤30%	80-120%/70-130%
79-34-5	1,1,2,2-Tetrachloroethane	5	5	≤20%/≤30%	80-120%/70-130%
56-23-5	Carbon tetrachloride	2	2	≤20%/≤30%	80-120%/70-130%
79-01-6	Trichloroethene	2	2	≤20%/≤30%	80-120%/70-130%
67-66-3	Chloroform	5	5	≤20%/≤30%	80-120%/70-130%

CAS = Chemical Abstract Services
RDL = required detection limit

Table A-2. EPA Method 200.8

CAS Number	Constituent	Water RDL (µg/L)	Soil RDL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
7429-90-5	Aluminum	50	5,000	≤20%/≤30%	80-120%/70-130%
7440-38-2	Arsenic	100	10,000	≤20%/≤30%	80-120%/70-130%
7440-39-3	Barium	20	2,000	≤20%/≤30%	80-120%/70-130%
7440-43-9	Cadmium	5	500	≤20%/≤30%	80-120%/70-130%
7440-47-3	Chromium	10	1,000	≤20%/≤30%	80-120%/70-130%
7440-48-4	Cobalt	20	2,000	≤20%/≤30%	80-120%/70-130%
7440-50-8	Copper	10	1,000	≤20%/≤30%	80-120%/70-130%
7439-92-1	Lead	50	5,000	≤20%/≤30%	80-120%/70-130%
7439-96-5	Manganese	5	5,000	≤20%/≤30%	80-120%/70-130%
7440-02-0	Nickel	40	4,000	≤20%/≤30%	80-120%/70-130%
7440-24-6	Strontium	10	1,000	≤20%/≤30%	80-120%/70-130%
7440-61-1	Uranium	1	1,000	≤20%/≤30%	80-120%/70-130%
7440-66-6	Vanadium	10	1,000	≤20%/≤30%	80-120%/70-130%

CAS = Chemical Abstract Services
RDL = required detection limit

Table A-3. EPA Method 300.0

CAS Number	Constituent	Water RDL (µg/L)	Soil RDL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
24959-67-9	Bromide	250	2,500	≤20%/≤30%	80-120%/70-130%
16887-00-6	Chloride	200	2,000	≤20%/≤30%	80-120%/70-130%
16984-48-8	Fluoride	500	5,000	≤20%/≤30%	80-120%/70-130%
14797-55-8	Nitrate	250	2,500	≤20%/≤30%	80-120%/70-130%
NO3-N	Nitrogen in nitrate	75	750	≤20%/≤30%	80-120%/70-130%
NO2-N	Nitrogen in nitrite	75	750	≤20%/≤30%	80-120%/70-130%
14265-44-2	Phosphate	500	5,000	≤20%/≤30%	80-120%/70-130%
14808-79-8	Sulfate	500	5,000	≤20%/≤30%	80-120%/70-130%

CAS = Chemical Abstract Services
RDL = required detection limit

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Distribution

	MS	Quantity
U.S. Department of Energy, Richland Operations Office		
B.L. Charboneau	A6-33	1
J.G. Morse	A5-11	5
N.M. Bland	A5-11	1
DOE Public Reading Room	H2-53	1
CH2M HILL Plateau Remediation Company – Electronic Distribution		
N.A. Bowles	R3-60	
M.E. Byrnes	R3-50	
S.F. Conley	R3-60	
D.E. Dooley	R3-50	
R.T. Evans	R3-50	
S.L. Huggins	R3-21	
R.W. Oldham	R3-60	
A.J. Rossi	R3-50	
S.A. Simmons	R3-50	
C. Sutton	R3-50	
L.C. Swanson	R3-60	
D. Todak	R3-50	
Administrative Record	H6-08	1
Document Clearance	H6-08	1

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