RCRA-CN-01_DOE/RL-2009-76_R0

Interim Status Change Number 1: Interim Status Groundwater Monitoring Plan for the LLBG WMA-2

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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RCRA INTERIM STATUS GROUNDWATER MONITORING PLAN INTERIM CHANGE FORM

Change Number: *(Obtain Change Number From Interim Change Custodian)*		Date:
RCRA-CN-01_DOE/RL-2009-76_R0		04/30/2020
Document Number: DOE/RL-2009-76	Title: Interim Status Change Number 1: Interim Status Groundwater Monitoring Plan for the LLBG WMA-2	Rev: 0
Originator: Tessa Clark		Phone: 3605203189

Description of Change: This form is used only for RCRA interim status groundwater monitoring plans *(i.e., shall not be used for final status groundwater monitoring plans)*. Describe the interim changes made to the RCRA interim status groundwater monitoring plan; consider any previous interim changes made to the plan. Changes cannot be made to the plan that conflict with the requirements of 40 CFR 265, Subpart F.

-Previous Appendix A included the Quality Assurance Project Plan and Sampling Protocols in a single appendix. Replace Appendix A in its entirety with the most current version of the Quality Assurance Project Plan (Appendix A). Added Appendix B, Sampling Protocols, using the most current version.
-Change appendix references to Appendix A and/or Appendix B in Table of Contents, Chapter 1 on page 1-1, and Section 3.3 on page 3-1 of main text, as applicable.
-In Table 3-1, add superscript "e" to "Phenols" with footnote "e. The specific phenols to be analyzed as groundwater quality parameters are identified in Table 3-1a." Add additional site-specific metals to monitor for stainless steel corrosion (manganese and nickel) to Table 3-1 (footnote d).
-Add Table 3-1a, "Phenols Analyzed as Groundwater Quality Constituents" to pg. 3-4a and Table of Contents (Tables).

NOTE: For form use see CHPRC-03210, *Review of RCRA Groundwater Data and Management Plans.* Identify page(s), section(s), and table(s) that changed. Attach redline/strikeout of entire groundwater monitoring plan. Post interim change form(s) and redline/strikeout of entire groundwater monitoring plan on the S&GRP webpage as the current plan and place in Facility Operating Record.

Justification and Impacts of Change: State the reason and justification for the change(s) to the issued groundwater monitoring plans. Identify any impacts or actions that may result from this change.

-Appendix A is replaced in its entirety to separate the Quality Assurance Project Plan (Appendix A) and Sampling Protocols (Appendix B) due to multiple updates since issuance of the monitoring plan.
-Changes in the main text reflect the revised Appendix A and new Appendix B.
-Additional site-specific constituents (chromium, iron, manganese, molybdenum, and nickel) added to monitor for stainless steel corrosion.
-Table 3-1a added to clarify what phenols will be analyzed as groundwater quality constituents.

RCRA INTERIM STATUS GROUNDWATER MONITORING PLAN
INTERIM CHANGE FORM (Continued)

Approvals: Include "Other" approvals as appropriate *(e.g., Obtain SMR approvals on changes to "Field and Laboratory Quality Control Elements and Acceptance Criteria" table).*

Other:

Print First and Last Name	Signature	Date
K. M. Whitley	email approval attached	06/08/2020

S&GRP Environmental Compliance Officer:

Print First and Last Name	Signature	Date
S. M. Sexton	email approval attached	06/08/2020

CHPRC RCRA Groundwater Manager:

Print First and Last Name	Signature	Date
W. R. Faught	email approval attached	06/08/2020

DOE Subject Matter Expert:

Print First and Last Name	Signature	Date
R. D. Hildebrand	email approval attached	06/08/2020

From: PRC SharePoint
To: Clark, Tessa J
Cc: Clark, Tessa J
Subject: Electronic Approval has completed for document: RCRA-CN-01_DOE_RL-2009-76_R0.
Date: Monday, June 8, 2020 3:13:58 PM

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Electronic Approval for document: RCRA-CN-01_DOE_RL-2009-76_R0 has successfully COMPLETED.

Electronic Approval started by Clark, Tessa J on 6/8/2020 1:32 PM
Comment: To comply with CHPRC's electronic signature directive, we are resending the RCRA groundwater monitoring plan redlines for secondary approval. This is required to process the plans in clearance.

Approved by Whitley, Kelly M on 6/8/2020 1:49 PM
Comment:

Approved by Faught, William R on 6/8/2020 2:35 PM
Comment:

Approved by Sexton, Sean M on 6/8/2020 3:02 PM
Comment:

Approved by Hildebrand, R D (Doug) on 6/8/2020 3:13 PM
Comment:

Change History of Interim Status Monitoring Plan DOE/RL-2009-76, Rev. 0, for the LLBG WMA-2

Title	Document Number	Revision Number	Interim Change Number	Effective Date
Interim Status Groundwater Monitoring Plan for the LLBG WMA-2	DOE/RL-2009-76	0	N/A	6/21/2010
Interim Status Groundwater Monitoring Plan for the LLBG WMA-2	DOE/RL-2009-76	0	RCRA-CN-01_DOE/RL-2009-76_R0	4/30/2020

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Executive Summary

The Low-Level Waste Management Area (LLWMA) 2, which consists of the 218-E-12B Burial Ground, is regulated via Washington State's "Hazardous Waste Management Act"[1] and its implementing requirements in *Washington Administrative Code* (WAC) 173-303-400.[2] The Washington State Department of Ecology has been authorized by the U.S. Environmental Protection Agency[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976*.[4]

This document replaces PNNL-14859,[5] as well as the two subsequent interim change notices,[6,7] to incorporate changes that have occurred at LLWMA-2 since the previous plan was written.

This document presents the groundwater monitoring plan for LLWMA-2. The plan addresses the following: (1) adequacy and attributes of the wells monitoring the groundwater at LLWMA-2; (2) sampling requirements and schedule; (3) constituents, groundwater parameters, and analytical methods necessary to determine whether past releases from the LLWMA are affecting groundwater quality; (4) procedures for evaluating groundwater quality data; and (5) reporting requirements.

This groundwater monitoring plan is the principal controlling document for conducting groundwater monitoring at LLWMA-2.

1 RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*.

2 WAC 173-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*.

3 *Authorized State Hazardous Waste Programs*, 42 U.S.C. 6926, et seq.

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

5 PNNL-14859, 2004, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

6 PNNL-14859-ICN-1, 2006, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 1, Pacific Northwest National Laboratory, Richland, Washington.

7 PNNL-14859-ICN-2, 2007, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 2, Pacific Northwest National Laboratory, Richland, Washington.

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Terms

bgs	below ground surface
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FY	fiscal year
LLWMA	low-level waste management area
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
TOC	total organic carbon
TOX	total organic halides
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WAC	*Washington Administrative Code*

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1 Introduction

Low-Level Waste Management Area (LLWMA) 2 is located in the northeastern corner of the 200 East Area (Figure 1-1) of the Hanford Site and consists of the 218-E-12B Burial Ground, which contains 39 unlined trenches. The LLWMA-2 began receiving waste in 1967 and continues to receive U.S. Navy vessel reactor compartments in Trench 94. The other 38 trenches contain mainly unsegregated waste and low-level waste that have been covered with soil. The dangerous waste and dangerous waste constituents in the low-level mixed waste portions of LLWMA-2 are regulated under *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." A *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring program for LLWMA-2 was initiated in 1987 (WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*) based on the interim status monitoring requirements of 40 *Code of Federal Regulations* (CFR) 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring") and WAC 173-303-400 ("Interim Status Facilities"). The LLWMA-2 has remained under indicator evaluation monitoring since that time. The objectives for continued indicator evaluation monitoring at LLWMA-2, as required by 40 CFR 265.92(d) ("Sampling and Analysis") are to determine the following:

- Concentrations of specified groundwater quality parameters (annually)
- Concentrations of groundwater contamination indicator parameters (semiannually)
- Elevation of the water table

The scope of this groundwater monitoring plan is to obtain the necessary groundwater data to satisfy these objectives.

This document replaces the previous monitoring plan (PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*) and includes several activities that have occurred at LLWMA-2 since that plan was issued. Chapter 2 summarizes background information, with reference to other documents for more detailed information. Chapter 2 also describes LLWMA-2 and the types of waste present, provides a brief history of groundwater monitoring, and describes the geology and hydrology pertinent to the LLWMA. This information is summarized as a site conceptual model to aid in developing the groundwater monitoring program.

Chapter 3 describes the RCRA groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols. Chapter 4 describes data evaluation and reporting, and Chapter 5 contains references. The quality assurance project plan (QAPjP) is provided in Appendix A and sampling protocols are provided in Appendix B.

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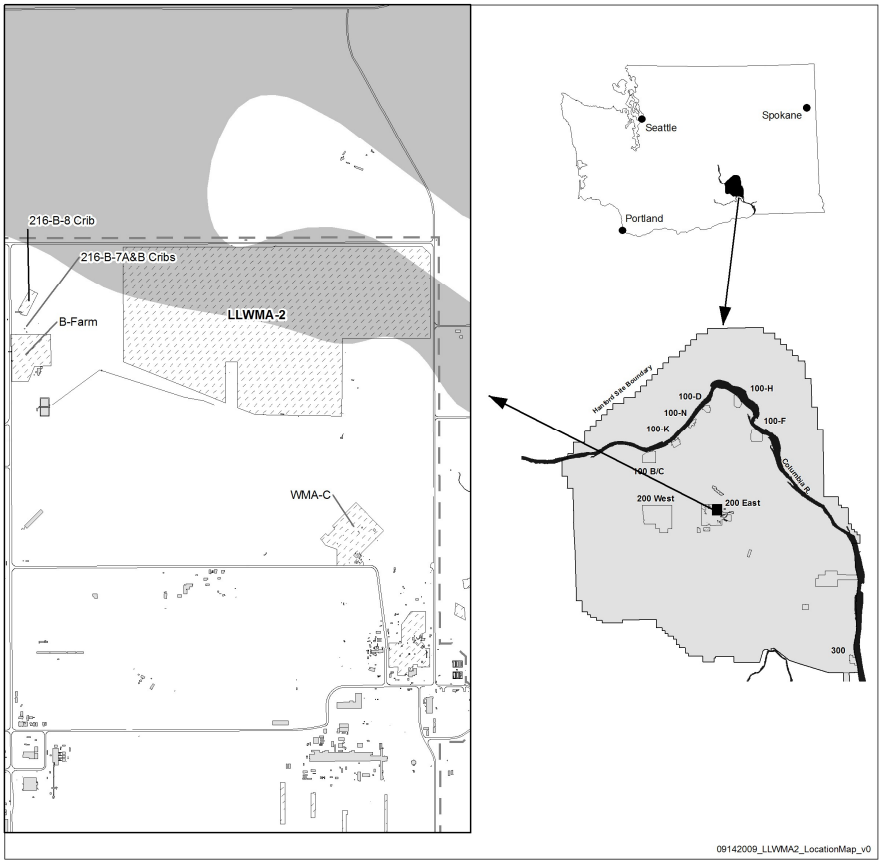

Figure 1-1. Low-Level Waste Management Area 2 in the 200 East Area

2 Background

This chapter presents the LLWMA-2 facility and its operating history, the waste and waste characteristics associated with the site, the local geology and hydrology, a summary of previous monitoring of the groundwater and vadose zone contamination, and the conceptual model for groundwater flow and contaminant migration. The discussion in this chapter is summarized from earlier characterization activities reported in the following documents:

- BHI-00178, *PUREX Plant Aggregate Area Management Study Technical Baseline Report*
- BHI-01177, *Borehole Summary Report for the 216-B-2-2 Ditch*
- BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report*
- DOE/RL-93-74, *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan*
- DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report*
- DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills Group and 200-SW-2 Radioactive Landfills Group Operable Units Remedial Investigation/Feasibility Study Work Plan*
- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report*
- PNNL-11470, *Hanford Site Groundwater Monitoring for Fiscal Year 1996*
- PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*
- PNNL-14187, *Hanford Site Groundwater Monitoring for Fiscal Year 2002*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford Washington*
- RHO-CD-673, *Handbook for 200 Area Waste Sites*
- WHC-MR-0204, *200E & 200W Areas Low Level Burial Grounds Borehole Summary Report*
- WHC-MR-0207, *Borehole Completion Data Package for the 216-B-63 Trench – 1990*
- WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*
- WHC-SD-EN-DP-044, *1991 Borehole Completion Data Package for the Low-Level Burial Grounds*
- WHC-SD-EN-DP-049, *1992 Borehole Completion Data Package for the Low-Level Burial Grounds*
- WHC-SD-WM-TI-260, *Water Inflow Investigation at the 218-E-12A and 218-E-12B Burial Grounds*
- WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds*

2.1 Facility Description and Operational History

The following summary was obtained from DOE/RL-2004-60, PNL-6820, WHC-SD-WM-TI-260, and the Waste Information Data System. The operational history discussed below also includes a brief description of adjacent sites.

The LLWMA-2 is located in the northeastern corner of the 200 East Area (Figure 1-1). The LLWMA-2 began service in 1967 and consists of the 218-E-12B Burial Ground (approximately 73.7 ha [182 ac]). The 218-E-12B Burial Ground was expanded from approximately 27 ha [66.7 ac] to contain 34 trenches and up to a potential for 138 trenches, 40 of which store waste (Figure 2-1). The landfill continues to receive U.S. Navy vessel reactor compartments in Trench 94. The other 39 trenches contain mainly unsegregated waste and low-level waste that have been covered with soil. Two trenches contain retrievably stored waste.

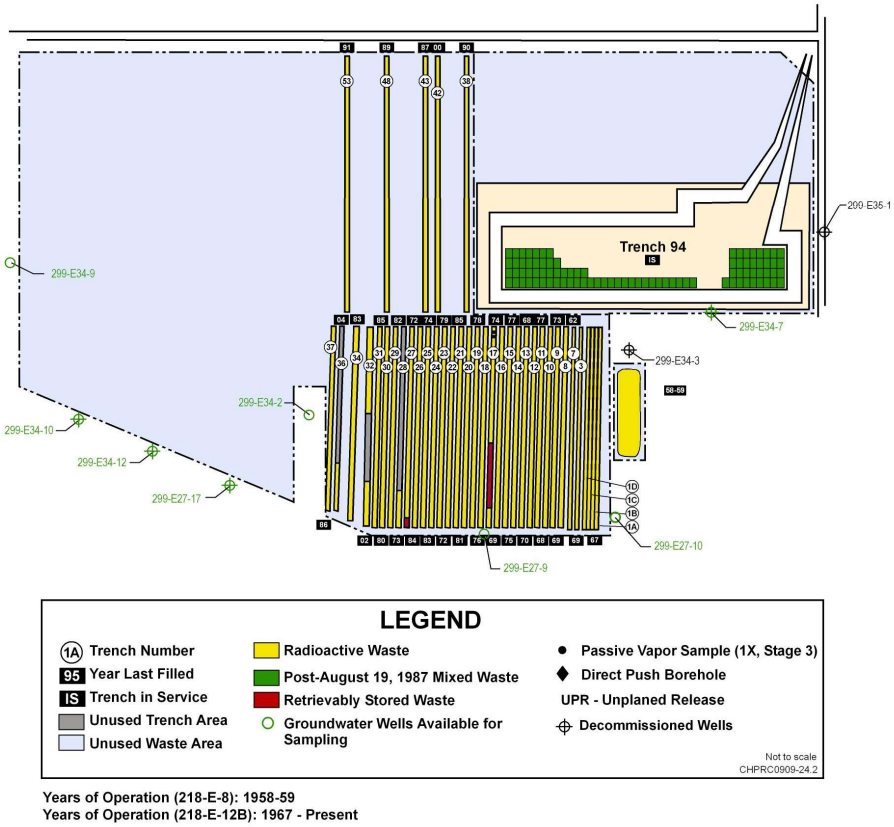

Figure 2-1. 218-E-10 Burial Ground at Low-Level Waste Management Area 2

The 40 used, unlined trenches vary in length from 288 to 381 m (944 to 1,250 ft). All of the trenches are in a north-south orientation, except Trench 94 (Figure 2-1). Thirty-four of the trenches are located in the southeastern portion of the burial ground. Trench 94 is located in the northeast portion of the burial ground, and five other trenches are located to the west of Trench 94. The western portion of the burial ground has not been used.

During the operational history of the 218-E-12B Burial Ground, one unplanned release of diesel fuel was reported in Trench 94 in 1995 (e.g. waste site 200-E-8). Analytical results confirmed that the spill was #2 diesel fuel. The impacted soil was excavated and disposed.

Hanford Site history has documented the following adjacent sites, which have impacted the environment: 216-B-2-1 Ditch, 216-B-2-2 Ditch, 216-B-2-3 Ditch, 200-E-53 contaminated zone, and the 200-E burn pit. The three unlined ditches associated with unplanned releases were located to the south of LLWMA-2. One of the unplanned releases in 1986 associated with the 216-B-2-3 unlined ditch caused cooling water to enter into Trench 37 of the 218-E-12B Burial Ground (WHC-SD-WM-TI-260). Information on the releases associated with these unlined ditches is provided in Section 2.3.

The 200-E-53 contaminated zone, located to the east of the southern portion of LLWMA-2 and north of the 216-B-2-1 through 216-B-2-3 Ditches, was first documented in 1987. The source of the contamination is unknown. Further information is provided in Section 2.3.

The 200-E burn pit, located to the east of southern portion of LLWMA-2, apparently began operations in 1950 and was associated with eliminating construction and office waste, as well as paint and chemical solvent waste. Further information is provided in Section 2.3.

2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, “Byproduct Material”) stating that the hazardous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these hazardous waste components within the State of Washington (51 FR 24504, “EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste”). In 1996, the Washington State Attorney General determined that the effective date of mixed waste in Washington State was August 19, 1987.

In May 1989, DOE, EPA, and Ecology signed the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site, which includes LLWMA-2. Groundwater monitoring is conducted at LLWMA-2 in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F), which requires monitoring to determine whether dangerous waste or dangerous waste constituents from the waste site have entered the groundwater. A RCRA groundwater monitoring program for LLWMA-2 was initiated in 1987 (WHC-SD-EN-AP-015) based on the interim status monitoring requirements of 40 CFR 265, Subpart F and WAC 173-303-400 and continues today.

2.3 Waste Characteristics

This section describes the waste disposed at 218-E-12B Burial Ground, unplanned releases adjacent to the burial ground, and contaminated zones adjacent the burial ground. The information was obtained from DOE/RL-2004-60, DOE/RL-2000-35, WHC-SD-WM-TI-260, BHI-00178, BHI-01177, RHO-CD-673, and the Waste Information Data System database.

The 218-E-12B Burial Ground contains solid unsegregated and low-level radiological waste. Examples of waste disposed in this burial ground include general trash, failed equipment, vent risers, filter boxes, liquid-level risers from the 216-B-14 Crib, and strontium-90-contaminated soil dredged from the 216-B-63 Ditch. The waste was generated primarily from the Plutonium-Uranium Extraction Plant, B Plant, and the 200 East Area tank farms (DOE/RL-2004-60).

Waste disposal at LLWMA-2 was generally dumped directly from trucks or was contained in cardboard cartons.[8] Historical documentation indicates that waste trenches were backfilled on a daily or weekly basis. No unplanned releases have been reported within the 218-E-12B Burial Ground. Herbicide application has been used to mitigate radioactive uptake by deep-rooted plant growth (DOE/RL-2004-60).

In 1986, water was observed in the 218-E-12B Burial Ground's Trench 36, which had not received any waste. It was determined that the water was from the unlined 216-B-2-3 Ditch. Seven investigation trenches and boreholes were used to determine the vertical and horizontal extent of released water. Based on the results of the investigation, only LLWMA-2 waste in the southern 19.8 m (65 ft) of Trench 37 (e.g., the westernmost trench in the southern portion of the 218-E-12B Burial Ground) had been contacted by the released water.

Two unplanned releases (UPR-200-E-32 and UPR-200-E-138) associated with the 216-B-2-1 and 216-B-2-2 Ditches were located to the south of LLWMA-2 and north of the 216-B-2-3 Ditch. Several inorganic chemicals are associated with the liquid disposed to these ditches, but the most prominent are sulfate and nitrate compounds (although chloride and carbonate compounds are also present) (DOE/RL-93-74).

The unplanned release at the 216-B-2-1 Ditch was associated with product via a storage tank coil leak in 1963. The total release volume, including decontamination flushing water, was approximately 4.9 million L (1.3 million gal). The extent of the contaminants is not known; however, a comparison of the release volume to the pore volume suggests that mobile contaminants have the potential to reach the groundwater.

The 216-B-2-2 Ditch received B Plant storage tank 8-1 condensate in 1970. The extent of the contamination is not known; however, a comparison of the release volume to the pore volume suggests that the effluent has the potential to reach the groundwater (DOE/RL-93-74). Subsequent remedial investigation results from the 216-B-2-2 Ditch indicated that elevated sulfate, nitrate, and chloride are present in the vadose zone soils. Sulfate had the highest reported maximum concentration (678 mg/kg), followed by nitrate with a maximum value of 330 mg/kg. The maximum concentration for chloride was 10.9 mg/kg (DOE/RL-2000-35). Four zones of increased moisture were also found at depths of 53 m, 54.9 m, 56.7 m, and 64.6 m (174 ft, 180 ft, 186 ft, and 212 ft) below ground surface (bgs). The first three zones correlate with probable thin silt horizons, and the fourth zone correlates with a potentially cemented sand interval (BHI-01177).

The 200-E-53 contaminated zone is located east of the southeast portion of the 218-E-12B Burial Ground and north of the 216-B-2 Ditches. No characterization sample results associated with this site were found.

The 200-E burn pit is a large depression with sparse vegetation located east of the southeast portion of LLWMA-2 and north of the 216-B-2 Ditches. The site received 1,500 m^3 (52,972 ft^3) of construction and office waste, paint wastes, and chemical solvents. This site was also used for a detonation event in 1984 for the disposal of unstable liquids. The chemicals detonated included: butoxyehtanol, dioxane,

[8] Information obtained from the Solid Waste Information and Tracking System database.

1,4-dioxane, hydrogen peroxide, isopropyl ether, methyl ethyl ketone, phosphoric acid, polyethylene glycol monoethyl ether, and sodium azide (BHI-00178).

2.4 Geology and Hydrogeology

The geology and hydrology of the 200 East Area, including the area of LLWMA-2, are described in detail in PNL-6820 and WHC-SD-EN-TI-290. Other reports providing significant information include PNNL-12261, WHC-MR-0204, WHC-MR-0207, WHC-SD-EN-AP-015, WHC-SD-EN-DP-044, and WHC-SD-EN-DP-049. The following discussion summarizes the information from these reports. This section also identifies the uppermost aquifer and the aquifers hydraulically interconnected beneath LLWMA-2.

In the past, LLWMA-2 underlying sediments, from the ground surface to the top of the basalt, were interpreted as Hanford formation sediments (PNL-6820). More recently, three Hanford units were defined beneath LLWMA-2 (Figure 2-2): the Hanford upper gravel unit (H1), the Hanford intermediate sand unit (H2), and the Hanford lower gravel unit (H3) (WHC-SD-EN-TI-290). Although these units were defined on the basis of the dominant lithology, significant subordinate lithologies are intercalcated in each unit. For example, the upper gravel unit, which thickens to the north and east, has silt-rich interbeds up to 1 m (3.3 ft) in thickness. These silt horizons are continuous to distances of several hundred meters and are capable of generating perched water conditions. This may have contributed to the northeastern migration of water from the 216-B-2-3 release (WHC-SD-WM-TI-260). The middle sand unit is the thickest in the southwestern portion of the 218-E-12B site and pinches out toward the east and north (Figure 2-2). The H2a (which is a transition zone between units H2 and H3) in Figure 2-2 represents a downward coursing of the Hanford sand unit where gravel horizons up to 6.1 m (20 ft) thick are present. The silt interbeds described in the Hanford upper gravels are also present in the lower gravels. The Hanford lower gravels extend into the unconfined aquifer and overly the Elephant Mountain Basalt.

The suprabasalt sediment beneath LLWMA-2 ranges from 54 m (177 ft) to more than 79.5 m (262 ft) thick. The water table as of June 2009 has ranged from 62.2 to 74.5 m (204 to 244.5 ft) bgs. Historically, the water table level was approximately 3.1 m (10 ft) higher in the late 1960s and 1980s due to peak production at the Hanford Site and associated artificial recharge. Initial transmissivity measurements from LLWMA-2 boreholes varied from 1,300 m^2/day (14,000 ft^2/day) in well 299-E34-3 to 7,900 m^2/day (85,000 ft^2/day) in well 299-E34-2. Due to the permeable nature of aquifer sediments, the groundwater gradient has historically been very small beneath LLWMA-2 (Figure 2-3). The groundwater flow direction beneath the LLWMA over the last 5 years has predominantly been reported as west-southwest in annual groundwater reports.

Underlying the suprabasalt sediments is the Elephant Mountain Member of the Saddle Mountains Basalt Formation. During the drilling of LLWMA-2 wells, some of the drilling extended into the upper portion of the Elephant Mountain Basalt. Examination of basalt drill cuttings found no vesicles in basalt chips from two wells (PNL-6820). Based on this information, it was concluded that past fluvial events removed part, to the entire, flow top from the Elephant Mountain Basalt in this area. This substantiates earlier conclusion that the Elephant Mountain Member acts hydrologically as an aquiclude, confining the underlying Rattlesnake Ridge aquifer.

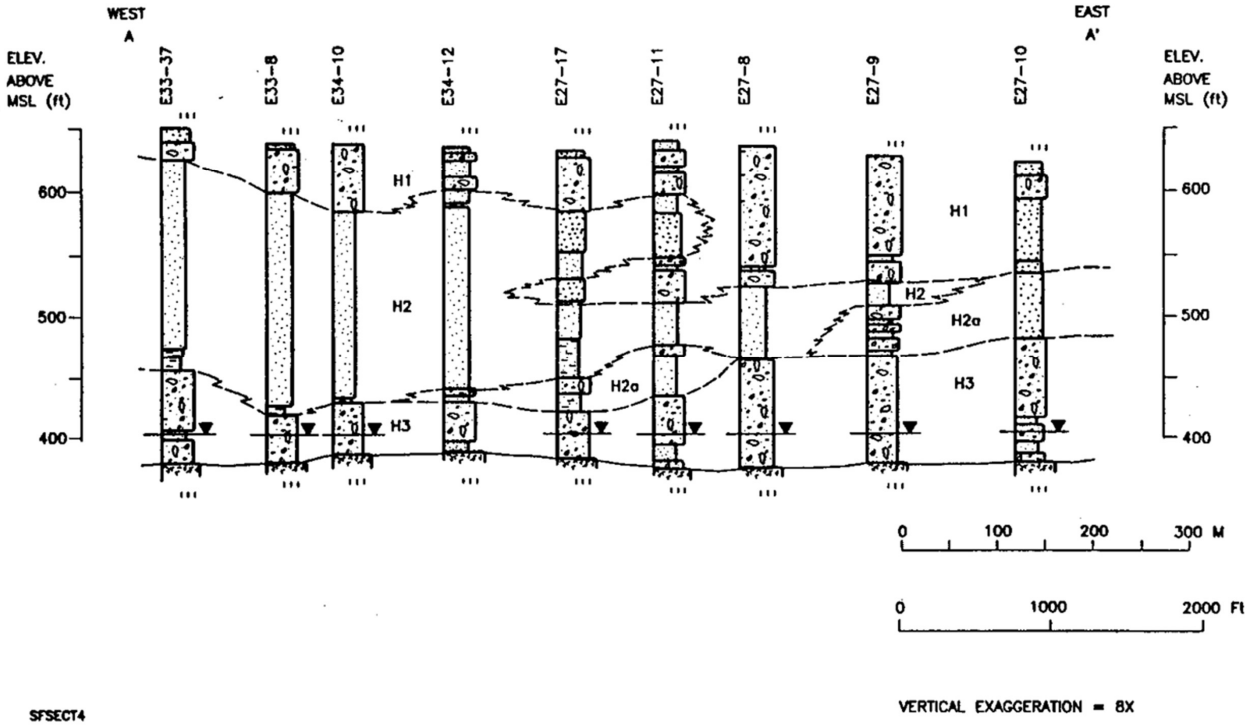

Figure 2-2. Geologic Cross-Section Along the Southern Boundary of Low-Level Waste Management Area 2

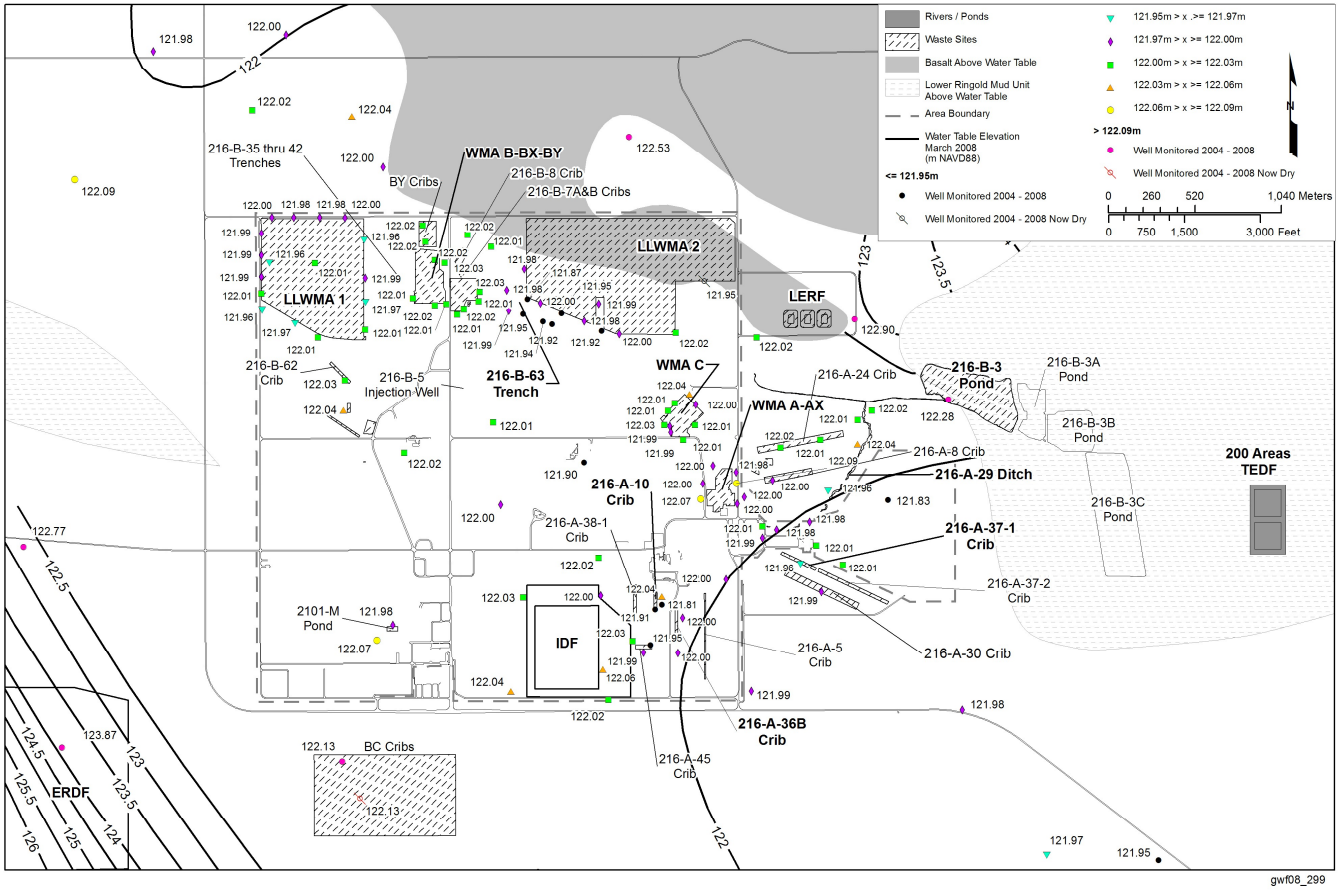

Figure 2-3. Water Table Map for the 200 East Area, March 2008

2.5 Summary of Previous Groundwater Monitoring

Groundwater monitoring was initiated at the LLWMA-2 in 1987 in accordance with WHC-SD-EN-AP-015. The groundwater beneath LLWMA-2 is sampled semiannually for indicator and groundwater quality parameters. Water levels are measured during each sampling event, as well as annually in March, as part of a comprehensive water-level measurement campaign. Groundwater monitoring results are summarized and presented in annual Hanford groundwater monitoring reports (i.e., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

The first eight RCRA-compliant monitoring wells were installed at LLWMA-2 in 1987. The initial network consisted of four upgradient wells and four downgradient wells. The initial flow direction was considered to the west and southwest. Additional wells were installed in 1989 (three wells), 1990 (one well), 1991 (three wells), and 1992 (two wells). The well screens extend from above the unconfined aquifer to various depths within the aquifer. All of the northern and eastern wells have gone dry over the past two decades for two reasons: (1) the basalt elevation is relatively high compared to the water table elevation beneath the northern and eastern portions of the burial ground, and (2) the water table level has continued to decline due to termination of Hanford Site production operations and effluent releases. The nine remaining active network monitoring wells are located along the southern and western boundary of the burial ground (Figure 2-1). The active wells monitor the upper portion of the aquifer and extend between 1.24 and 2.78 m (4.07 and 9.12 ft) into the aquifer.

Background monitoring at LLWMA-2 began in 1988, and initial background comparison values for indicator parameters (e.g., total organic carbon [TOC], total organic halides [TOX], pH, and specific conductivity) were established in 1989 using four quarters of data from upgradient wells 299-E27-10 and 299-E34-5 (PNNL-11470). Since September 1989, groundwater monitoring has been conducted primarily on a semiannual basis, except for the period between June 1990 and June 1991, when laboratory services were unavailable.

The local groundwater flow direction over the past 5 years has been reported to the west based on small differences within select wells along the southern boundary of LLWMA-2. However, over this same time period, other well groupings portray different groundwater flow directions. According to the *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project, Hanford Site* (SGW-38815), small measurement errors can have large effects on determining flow direction and velocity where the horizontal gradient is less than 0.001, as is the case for LLWMA-2. Therefore, the annual reports over this timeframe have added observations of mobile anion movement to depict flow direction. The nitrate- and sulfate-derived groundwater flow over the past 5 years has been reported to the southwest.

The derived background comparison value (i.e., critical mean) for all of the indicator parameters has been exceeded periodically throughout the history of detection monitoring. The downgradient wells that have exceeded the critical mean were explained by laboratory issues or sample collection errors. Upgradient wells (e.g., 299-E34-7) that exceeded the critical mean have been associated with either leaching or infiltration processes within the vadose zone (PNNL-14187). (Note that the source of infiltration has not been determined to date.) Well 299-E34-7, which is now dry, previously exceeded the critical mean for specific conductance, TOC, and TOX. The specific conductance was attributed mainly to sulfate, chloride, nitrate, and calcium. The TOC was consistent with subsequent oil/grease and total petroleum hydrocarbon results; however, later volatile and semivolatile analyses did not provide evidence for a specific contaminant. Likewise, no subsequent analytical contaminant result was able to be linked to the TOX results. Water level decline by 2005 caused well 299-E34-7 to be declared dry. Well 299-E27-10,

located to the southwest of well 299-E34-7, also exhibits some of the same characteristics described for well 299-E34-7.

The groundwater monitoring activities at LLWMA-2 currently consist of water-level monitoring and chemical constituent monitoring. The LLWMA-2 is sampled semiannually from a network of nine wells. Samples are analyzed semiannually for the indicator parameters, anions, and metals; samples are analyzed annually for alkalinity, mercury, lead, and phenols. Water-level measurements are collected each sampling event and in March for Hanford Sitewide monitoring. Regional water-level measurements have also been collected monthly since March 2008. Water levels will continue to be collected regionally on a monthly basis for an undetermined time period to resolve the groundwater gradient in the area with respect to high disposal discharges at the 200 Area Treated Effluent Disposal Facility, high Columbia River stages, and times when those influences are not present.

2.6 Conceptual Model

This section describes the LLWMA-2 conceptual model for potential contaminant transport to guide future groundwater monitoring. The conceptual model for contaminant release and transport is based on the following assumptions:

- Engineered barriers are not taken into account, so the model is applicable to unlined trenches.
- Average precipitation and net infiltration (5 to 10 cm/year [2 to 3.9 in./year]) prevail over the time period of interest.
- Net infiltration is assumed to occur under gravity drainage.
- Maximum vertical hydraulic conductivity in the vadose zone is assumed to be significantly larger than the net infiltration rate.
- The effective saturated porosity in the vadose zone is equal to the moisture content.
- Leaching of mobile contaminants from buried waste in unsealed containers, or contaminated soils in direct contact with the trench, is assumed to be the major potential source for contamination.
- There are no artificial sources of water (e.g., leaking potable or raw water lines, based on Hanford Site drawings).
- Extreme conditions or accidental releases are recognized as factors but would be addressed under emergency response/corrective actions.

2.6.1 Geochemical Considerations

The solubility and subsequent mobility of waste constituents in pore fluid depend on the container, chemical nature of the waste constituents, and natural subsurface geochemical conditions.

Pore fluid in the unsaturated and saturated zones beneath LLWMA-2 is slightly alkaline ($7 < pH < 8$), with appreciable amounts of bicarbonate and very little natural organic material. The lack of organic material indicates that conditions generally are oxidizing. Calcium carbonate is also abundant in vadose zone sediment. These general conditions favor sorption or retardation of many heavy metals and favor formation of anionic species, which enhances mobility for other metals (e.g., hexavalent chromium). Laboratory sorption studies have documented these effects and related mobility issues in Hanford Site media (e.g., PNNL-11800).

Based on the total beta, strontium-90, and gamma energy analysis samples collected beneath LLWMA-2 in 1986 (associated with the 216-B-2-3 release), significant contaminant migration from LLWMA-2 appears unlikely (Figure 2-4). The sediment results indicated a general decrease in concentration with depth from the trench bottoms; however, increased concentrations were reported in the deepest sample results. This appears consistent with the conclusion of WHC-SD-EN-TI-260 regarding the elevated gamma results being associated with water migration from the 216-B-2-3 Trench and not the 218-E-12B Burial Ground.

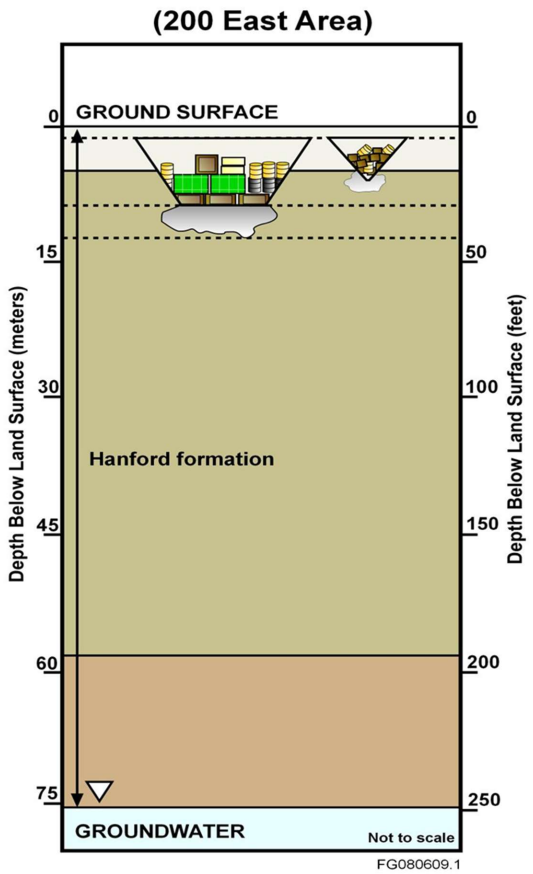

Figure 2-4. Conceptual Model for Low-Level Waste Management Area 2

2.6.2 Soil Moisture Factors

Direct precipitation is the primary driver for hypothetical leaching of waste constituents from the burial ground trenches and subsequent transport to groundwater. Contaminants in soil disposed to the trench or waste in degradable containers (e.g., cardboard boxes) subject to collapse are assumed to be leachable.

The amount of natural infiltration that can pass through the leachable buried waste and drain to the water table is controlled by the texture of the cover and backfill, as well as the degree of vegetative cover. Stratigraphic features in the soil column beneath the buried waste can also influence or retard downward migration by spreading the soil moisture laterally.

Most of the burial ground trenches are backfilled with the natural excavation materials (Hanford formation) consisting of coarse gravel, cobbles, and some interstitial sand. Some amounts of vegetation exist on the established backfilled areas and on the unused portions of LLWMA-2.

A coarse, sparse to moderately vegetated cover material allows a moderate to major fraction of the precipitation to infiltrate and potentially drain to the groundwater. It is estimated that recharge rates at the Hanford Site range from near 0 mm/year at highly vegetated sites to greater than 50 mm/year at gravel-covered nonvegetated sites (PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*).

2.6.3 Hydrogeologic Considerations

A discussion on hydrology is provided in Section 2.4. The vadose zone (e.g., ground surface to water table) beneath LLWMA-2 ranges from 54 m (177 ft) to more than 79.5 m (262 ft) bgs. The lithology of the vadose zone consists of the Hanford formation (e.g., upper gravel-dominated sequence, intermediate sand sequence, and a lower gravel sequence). Interbeds of sand and silt facies are present in each of the sequences and have the potential for generating perched aquifer (WHC-SD-EN-TI-290). These fine-grained facies also create conditions for retarding downward movement of contaminants. If the same northeast dip exists in these fine-grained sediments (which has been identified in many other sites in the 200 East Area), then lateral spreading within or on top of this unit may preferentially be toward the north-northeast.

If contaminants do breakthrough to groundwater beneath LLWMA-2, contaminants currently would move toward the southwest. This direction is based on the observed migration of nitrate and sulfate over the past 5 years and not on the subtle differences in water elevations along the southern boundary of LLWMA-2.

2.7 Data Quality Objectives

To define the required information for groundwater detection monitoring, the data quality objectives (DQO) process is used to ensure that data gathered are of appropriate quantity and quality to meet specific objectives. The DQO parameters, regulatory interim status requirements, and associated reports supporting regulatory requirements are outlined in Table 2-1.

Table 2-1. Data Quality Objectives at RCRA Sites Monitoring for Indicator Parameters

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Scope	RCRA interim status ground-water monitoring at sites where no impact to ground-water has been identified. Related requirements are found in WAC 173-303-400(3) and 40 CFR 265.90 through 265.94, as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).	
Number and location of wells Point(s) of compliance.	**40 CFR 265.91 Ground-Water Monitoring System.** (a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of: (1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are: (i) Representative of background ground-water quality in the uppermost aquifer near the facility; and (ii) Not affected by the facility; and (2) Monitoring wells (at least three) installed hydraulically downgradient (i.e. in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.	This plan, Section 3.2 PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* PNNL-14859-ICN-1 PNNL-14859-ICN-2
Well configuration (depth and length of screened interval; well construction)	**40 CFR 265.91 Ground-Water Monitoring System.** (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water. **Additional requirements for WAC 173-303-400 (3)(c)(v)(C).** Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells.	This plan, Section 3.2 PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* PNNL-14859-ICN-1 PNNL-14859-ICN-2

Table 2-1. Data Quality Objectives at RCRA Sites Monitoring for Indicator Parameters

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Frequency of sampling Types of analysis or measurement Method detection limits or accuracy and precision.	**40 CFR 265.92 Sampling and Analysis.** (b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section: (1) Parameters characterizing the suitability of the ground-water as a drinking water supply, as specified in Appendix III. *[Note: Have not listed these parameters because, in accordance with 40 CFR 265.92(c)(1) below, these analyses are conducted only during the first year. None of the RCRA sites is in its first year of monitoring.]* (2) Parameters establishing ground-water quality: (i) Chloride (ii) Iron (iii) Manganese (iv) Phenols (v) Sodium (vi) Sulfate *[Comment: These parameters are to be used as a basis for comparison in the event a groundwater quality assessment is required under 40 CFR 265.93(d).]* (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific conductance (iii) Total organic carbon (iv) Total organic halides (c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this section. The owner or operator must do this quarterly for one year. (2) For each of the indicator parameters specified in paragraph (b)(3) of this section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year.	This plan, Section 3.1 and Appendix A PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* PNNL-14859-ICN-1 PNNL-14859-ICN-2

Table 2-1. Data Quality Objectives at RCRA Sites Monitoring for Indicator Parameters

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
	40 CFR 265.92 Sampling and Analysis (cont'd). (d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies: (1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually. (2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semiannually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	
Methods used to evaluate the collected data	**40 CFR 265.93 Preparation, Evaluation, and Response.** (b) For each indicator parameter specified in 40 CFR 265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with 40 CFR 265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see Appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background.	This plan, Section 4.2 and Appendix A PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* PNNL-14859-ICN-1 PNNL-14859-ICN-2

Notes:

The references cited in this table are listed in the reference section (Chapter 5) of this plan.

CFR = *Code of Federal Regulations*

DQO = data quality objective

RCRA = *Resource Conservation and Recovery Act of 1976*

WAC = *Washington Administrative Code*

The assumptions regarding LLWMA-2 groundwater monitoring based on historical observations and the recent *Groundwater Monitoring Needs Assessment for Low-Level Burial Grounds Waste Management Areas* (SGW-40037) are as follows:

- The groundwater monitoring program described in PNNL-14859 (and interim change notices) does not meets the requirements of 40 CFR 265.90(b), "Applicability," based on a southwest flow direction because there is no true upgradient well.
- Elevated specific conductance and TOC in the southeast wells (e.g., 299-E27-9 and 299-E27-10) are driven primarily by sulfate, calcium, chloride, and nitrate from an unknown source.

- The western, unused portion of LLWMA-2 will be procedurally closed (Figure 2-1).
- Four new wells will be installed for the LLWMA (two wells along the eastern boundary as upgradient wells, and two wells along the western boundary as downgradient wells) (Figure 2-5).

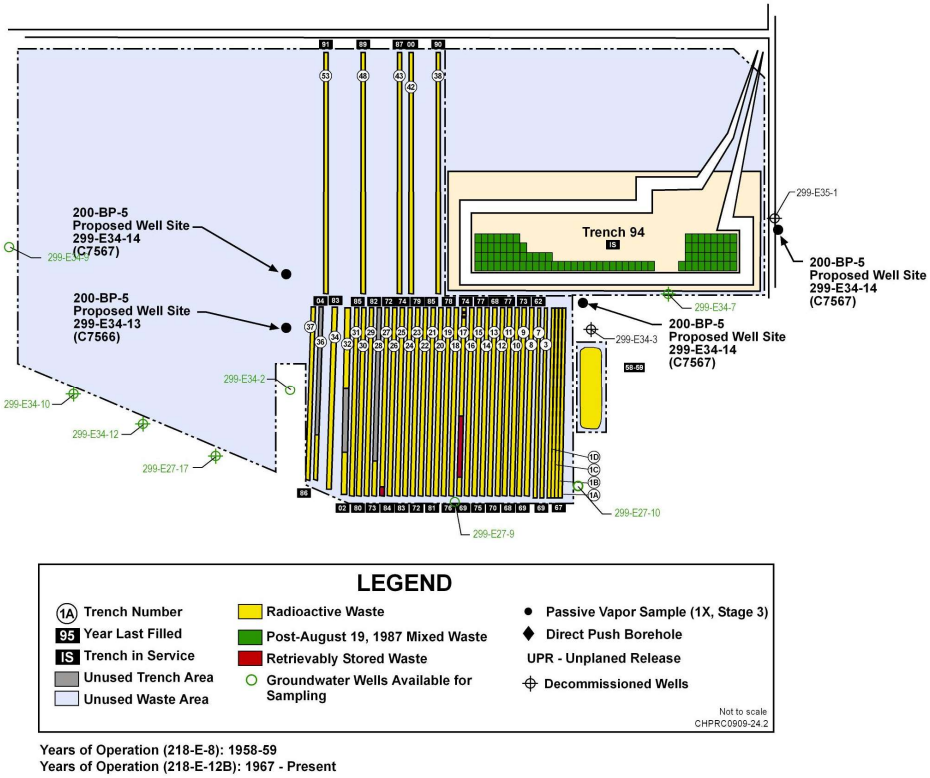

Figure 2-5. Four New Low-Level Waste Management Area 2 Network Monitoring Wells

Procedurally closing the western, unused portion and moving the western limit of the LLWMA to the west of Trenches 37 and 53 requires a revised monitoring network and plan. The recent monitoring needs assessment (SGW-40037) developed a three-tiered approach for changing the monitoring network. The first tier changes included the following:

- Adding four new monitoring wells. Two wells will be installed along the new western boundary point of compliance, just west of Trenches 37 and 53. One additional well will be installed east of Trench 94 as a replacement for well 299-E35-1 and an upgradient well for LLWMA-2. Finally, one well will be installed to the east of Trench 1a as a replacement well for well 299-E34-3 and an upgradient well for LLWMA-2. One well is planned to be completed in fiscal year (FY) 2010 and the other three wells are planned for completion in FY 2011.

- Retain the existing downgradient wells for the new monitoring network (299-E27-11, 299-E27-17, and 299-E34-2).
- Change the status of the six existing wells along the southern and western boundary of LLWMA-2 to supplemental and continue monitoring at these wells.

The second tier requirement is to perform modeling to identify the need for additional wells. The third tier requirements were to install the second tier monitoring wells.

Recommended changes to the conclusions of the monitoring needs assessment based on recent information and re-evaluation for refinement of the needs assessment logic are as follows:

- Retain wells 299-E27-8, 299-E27-9, 299-E27-10, 299-E27-11, 299-E27-17, 299-E34-2, and 299-E34-12 as part of the monitoring network. These wells provide downgradient groundwater data based on southwest flow direction, which seems more probable than a western flow direction.
- Change the groundwater gradient description of well 299-E27-10 from upgradient to cross-gradient. Additional future low-level groundwater monitoring information may require additional changes to this designation.
- Drill proposed well 299-E34-13 in FY 2010. Drill at least 1.5 m (5 ft) into the Elephant Mountain Basalt to investigate the basalt chips and complete the screen across the basalt to determine water availability. Use this information to determine whether to drill wells 299-E34-14 and 299-E34-15 in FY 2011. This decision will be based on previous basalt chip observations from two wells (299-E34-2 and 299-E34-4) in this area, which provided no evidence of flow top.
- If evidence of flow top is not present in well 299-E34-13 and water availability is not sufficient, then do not drill wells 299-E34-14 and 299-E34-15.

3 Groundwater Monitoring

This chapter lists the wells monitored, constituents analyzed, and sampling frequency. The quality assurance and quality control requirements are provided in the QAPjP in Appendix A.

3.1 Constituent List and Sampling Frequency

Table 3-1 lists the constituents to be analyzed and the frequency for the detection-level groundwater monitoring program at LLWMA-2. Note that wells 299-E34-13 through 299-E34-16 are new planned wells; one well will be drilled in FY 2010 and up to three wells will be drilled in FY 2011, depending on well production (as discussed in Section 2.7). Maintenance issues and sampling logistics can delay scheduled sampling events. If sampling of a well is delayed more than 3 months, that sampling event will be cancelled because it is nearly time for the next scheduled sampling event.

3.2 Well Network

Figure 3-1 shows the groundwater monitoring well network for LLWMA-2. Figure 2-5 shows the four new planned groundwater monitoring wells for LLWMA-2. Table 3-1 lists the wells in the groundwater monitoring network. Construction details and as-built diagrams for wells in LLWMA-2 monitoring network are described in PNL-6820, WHC-MR-0204, WHC-SD-EN-DP-044, and WHC-SD-EN-DP-049. The wells in the LLWMA-2 monitoring network may also be co-sampled as part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* sampling for the 200-BP-5 Operable Unit. Sampling for LLWMA-2 and the 200-BP-5 Operable Unit is coordinated to eliminate duplicate analyses and well trips.

Table 3-2 summarizes well attribute information, including the April 2009 depth to water in each well. All of the wells in the LLWMA-2 monitoring network are constructed to meet the requirements of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." These wells have stainless-steel casing and screen, sand pack in the screened interval, and full annular seal above. Given the current rate of water table decline (0.05 m/year [0.164 ft/year]), none of the wells in the LLWMA-2 monitoring network are expected to go dry for at least 20 years.

3.3 Sampling and Analysis Protocol

~~Groundwater monitoring at LLWMA-2 follows the conventions of the project and is described in the QAPjP (Appendix A).~~ The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status TSD units. The QAPjP outlining the project management structure, data generation and acquisition, analytical procedures, and quality control, is provided in Appendix A. Appendix B provides the sampling protocols (e.g., sampling methods, sample handling and custody, management of waste, and health and safety considerations).

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3.4 Differences Between This Plan and Previous Plan

Initially, the only difference between this groundwater monitoring plan and the previous plan (PNNL-14859-ICN-2) is the deletion of the analytes lead and mercury. Over the next 2 years, another difference will be the addition of up to four new wells (e.g. 299-E34-13 through 299-E34-16) to the monitoring network (Figure 2-5). After completion of the two new wells at the new western edge of the burial ground, the two existing western wells will no longer be sampled for indicator or groundwater quality parameters. After the two new wells have been completed and sampled once, second tier modeling will be conducted to determine if additional monitoring wells may be needed at LLWMA-2. If additional

wells are needed, a new monitoring plan will be completed. If some of the proposed wells are determined from the FY 2010 decision not to be drilled, then a revised groundwater monitoring plan will be developed to include any second tier proposed wells.

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Table 3-1. Sampling Schedule for Low-Level Waste Management Area 2

Well Name	Purpose	WAC Compliant	Water Level[c]	RCRA Required Constituents[a]														
				Contaminant Indicator Parameters				Groundwater Quality Parameters						Supporting Constituents[b]			
								Anions[d]			Metals, Unfiltered, Filtered[d]						
				pH[c]	Specific Conductance[c]	Total Organic Carbon	Total Organic Halides	Chloride	Sulfate	Phenols[d,e]	Iron	Manganese	Sodium	Alkalinity	Dissolved Oxygen[c]	Temperature[c]	Turbidity[c]
299-E27-8	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E27-9	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E27-10	Cross-gradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E27-11	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E27-17	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-2	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-9	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-10	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-12	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-13	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-14	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-15	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-16	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S

Table 3-1. Sampling Schedule for Low-Level Waste Management Area 2

Well Name	Purpose	WAC Compliant	Water Level[c]	RCRA Required Constituents[a]										Supporting Constituents[b]			
				Contaminant Indicator Parameters				Groundwater Quality Parameters									
								Anions[d]			Metals, Unfiltered, Filtered[d]						
				pH[c]	Specific Conductance[c]	Total Organic Carbon	Total Organic Halides	Chloride	Sulfate	Phenols[d,e]	Iron	Manganese	Sodium	Alkalinity	Dissolved Oxygen[c]	Temperature[c]	Turbidity[c]

Notes:

a. Constituents and parameters required by 40 CFR 265.92, "Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis."

b. Constituents not required by RCRA but needed to support interpretation.

c. Field measurement.

d. For anions, analytes include chloride, fluoride, nitrate, nitrite, and sulfate.

For metals, analytes include, but are not limited to, calcium, chromium, iron, manganese, molybdenum, nickel, potassium, and sodium.

e. The specific phenols to be analyzed as groundwater quality parameters are identified in Table 3-1a.

A = sampled annually
CFR = *Code of Federal Regulations*
LLWMA = low-level waste management area
RCRA = *Resource Conservation and Recovery Act of 1976*
S = sampled semiannually
S4 = sampled semiannually with quadruplicate samples taken
VOA = volatile organic analysis
WAC = *Washington Administrative Code*
Y = well is constructed to the resource protection well standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

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Commented [CTJ7]: RCRA-CN-01_DOE/RL-2009-76_R0

Table 3-1a. Phenols Analyzed as Groundwater Quality Constituents

Constituent	CAS Number
2-Chlorophenol	95-57-8
2-Methylphenol (o-Cresol)	95-48-7
2-Nitrophenol (o-Nitrophenol)	88-75-5
2,3,4,6-Tetrachlorophenol	58-90-2
2,4-Dichlorophenol	120-83-2
2,4-Dimethylphenol (2,4-Xylenol)	105-67-9
2,4-Dinitrophenol	51-28-5
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
2,6-Dichlorophenol	87-65-0
3-Methylphenol (m-Cresol)	108-39-4*
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7
4-Methylphenol (p-Cresol)	106-44-5*
4,6-Dinitro-O-cresol (4,6-Dinitro-2-methyl phenol)	534-52-1
Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	88-85-7
p-Nitrophenol (4-Nitrophenol)	100-02-7
Pentachlorophenol	87-86-5
Phenol	108-95-2

This table provides the specific phenols to be included for analysis as groundwater quality parameters under this monitoring plan.

*Analyzed and reported as 3 & 4 Methylphenol (CAS number 65794-96-9)

CAS = Chemical Abstracts Service

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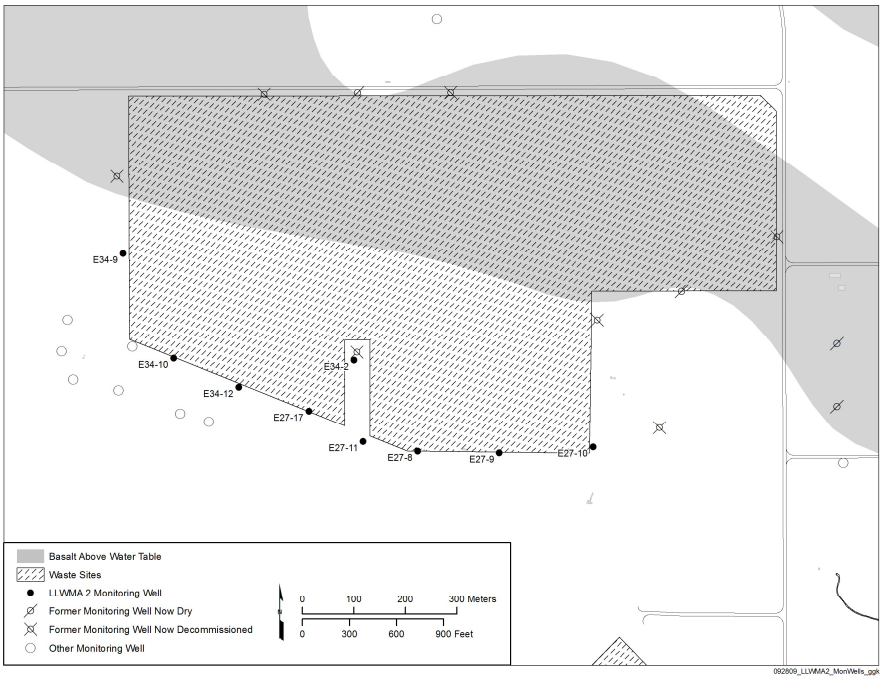

Figure 3-1. Map Showing Locations of Existing RCRA Monitoring Wells at Low-Level Waste Management Area 2

Table 3-2. Attributes for Wells in the Low-Level Waste Management Area 2 Groundwater Monitoring Network

Well Name	Completion Date	Easting (m)	Northing (m)	Brass Survey Marker Elevation (m NAVD88)	Water Table Elevation (m amsl)	Screened Interval (m) NAVD88	Water Remaining, (m) (April 2009)
299-E27-8	9/30/87	137044.178	574759.08	No value	121.972	225.5 - 245.5	2.23
299-E27-9	08/31/87	137040.904	574917.649	*No value*	121.987	219.8 - 239.1	2.5
299-E27-10	08/19/87	137052.481	575100.298	*190.81*	121.933	212.1 - 232.4	1.99
299-E27-11	10/18/89	137062.736	574652.93	196.264	121.909	230.4 – 251.4	2.26
299-E27-17	11/11/91	137122.01	574547.31	No value	121.929	223.2 - 224.2	2.78
299-E34-2	09/30/87	137220.694	574634.81	No value	121.919	230.2 - 240.4	2.39
299-E34-9	11/05/91	137429.82	574186.02	No value	121.984	212.63 - 233.4	1.24
299-E34-10	10/29/91	137224.57	574284.4	No value	122.032	225.29 - 246.0	1.73
299-E34-12	04/15/92	137168.544	574411.004	194.823	121.921	223.9 - 244.21	1.45
299-E34-13	TBD	TBD	TBD	TBD	TBD	TBD	TBD
299-E34-14	TBD	TBD	TBD	TBD	TBD	TBD	TBD
299-E34-15	TBD	TBD	TBD	TBD	TBD	TBD	TBD
299-E34-16	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Notes:

All wells are constructed to the standards of resource protection wells in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." Stainless-steel casing and screen, sand pack around screen or "channel pack" screen, and annular seal around casing.

Shaded rows show the anticipated network monitoring wells after the four new wells (299-E34-13 through 299-E34-16) are installed and sampled once.

Bold/italic print indicates upgradient wells for a southwest flow direction.

Water levels measured in April 2009.

amsl = above mean sea level

NAVD88 = North American Vertical Datum of 1988

TBD = to be determined

WAC = *Washington Administrative Code*

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4 Data Evaluation and Reporting

This chapter discusses the data evaluation and reporting for LLWMA-2.

4.1 Data Review

Data review, validation, and verification are discussed in the QAPjP in Appendix A.

4.2 Statistical Evaluation

The goal of RCRA detection monitoring is to determine if LLWMA-2 has affected groundwater quality beneath the site. For most RCRA treatment, storage, and disposal units at the Hanford Site, this is determined based on the results of specified statistical tests. The sampling procedures and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference in WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general contamination indicator parameters (e.g., TOC, TOX, pH, and specific conductance) in downgradient wells to background levels obtained from upgradient wells.

There is one current cross-gradient well at LLWMA-2 (Table 3-1) that was previously used for deriving a statistical comparisons value. Each year, a new calculation is generally completed to derive the background comparison value of significance because of the variability of upgradient groundwater. Since there is no current upgradient well, the current values will remain in place until a new upgradient well is in place and sampled quarterly for one year. Thus, the current upgradient indicator parameter derived in January 2009 will be compared with each downgradient well indicator parameter result to determine if a significant increase has occurred. In addition, groundwater quality results are used to verify ion balance and relative change associated with specific conductance measurements. If questions arise from the ion balance, the laboratory results are reviewed for errors (as discussed in Appendix A). Also, phenol analyses are ran for further evaluation of potentially elevated TOC or TOX indicator parameters.

4.3 Interpretation

After the data are validated and verified, acceptable data are used to interpret groundwater conditions at LLWMA-2. Interpretive techniques include the following:

- Hydrographs: Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- Water table maps: Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential on the maps.
- Trend plots: Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.
- Plume maps: Mapped distributions of chemical constituent concentrations in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement and groundwater flow direction.
- Contaminant ratios: Can sometimes be used to distinguish among different sources of contamination.

4.4 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the groundwater monitoring network to determine if it remains adequate to monitor the LLWMA. The network must include upgradient and downgradient wells in the uppermost aquifer. The groundwater flow direction beneath LLWMA-2 has been predominantly reported to the southwest since 2002 based on nitrate and sulfate movement.

Water-level measurements will be collected before each sampling event. A more comprehensive set of water-level measurements has been made for the northeastern portion of the 200 East Area each month since April 2009. The measurements are corrected, if needed, to account for borehole deviation from vertical, and the resulting data are plotted on a map. The data will be presented in the annual groundwater monitoring report.

Any new RCRA wells needed as a result of the second tier modeling at LLWMA-2 will be negotiated and prioritized by Ecology, DOE, and EPA and approved under Tri-Party Agreement Milestone M-24-00.

4.5 Reporting and Notification

Results of detection monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66). Notifications will be made as outlined in Table 4-1.

If comparisons for the upgradient well show a statistically significant increase (and/or pH decrease), the information is reported in the annual groundwater report. If the comparisons for a downgradient well show a significant increase (and/or pH decrease), then one or both of the following actions are taken: (1) the well is resampled and split samples are sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error, and/or (2) the original samples may be re-analyzed if laboratory error is suspected.

If the exceedance of the statistical comparison value is confirmed by resampling, then written notice is provided to the regulatory agency within 7 days that the monitored facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program will be developed and submitted (40 CFR 265.93[d], "Preparation, Evaluation, and Response"). In some instances, it is possible to determine immediately that the statistical finding is not the result of contamination from the facility. In that case, the regulatory agency is notified but an assessment program is not instituted.

Table 4-1. Reports Required for Compliance with 40 CFR 265, Subpart F for Groundwater Monitoring

Submittal	Submittal Period	Reporting Vehicle	Regulatory Requirement
First year of sampling: concentrations of interim primary drinking water constituents, identifying those that exceed limits	Quarterly	Complete[a]	40 CFR 265.94(a)(2)(i)
Concentration and statistical analyses of groundwater contamination indicator parameters, noting significant differences in upgradient wells	Annually (by March 1 of following year)	Annual Hanford Site groundwater monitoring report	40 CFR 265.94(a)(2)(ii)
Results of groundwater surface elevation evaluation and description of response, if appropriate	Annually (by March 1 of following year)	Annual Hanford Site groundwater monitoring report	40 CFR 265.94(a)(2)(iii)
Outline for groundwater quality assessment program	Within one year after effective date of regulations	S&GRP document or letter	40 CFR 265.93(a)
Notification of statistical exceedance[b]	Within 7 days of verification	Letter to Ecology	40 CFR 265.93(c)
Assessment plan[b]	Within 15 days of notification	S&GRP document or letter	40 CFR 265.93(d)
Determinations under assessment program[b]	As soon as technically feasible; annually thereafter	S&GRP document, letter, or annual Hanford Site groundwater monitoring report	40 CFR 265.93(d)(5) and 40 CFR 265.94(b)

Notes:

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities."

a. Requirement was fulfilled during first year of sampling via published reports. Quarterly submittal of data continues via the Hanford Environmental Information System database.

b. Required if exceedance occurs and is verified.

CFR = *Code of Federal Regulations*

Ecology = Washington State Department of Ecology

S&GRP = Soil and Groundwater Remediation Project

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Appendix A

Quality Assurance Project Plan

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Figure A-1. Project Organization A-2

Terms

DOE	U.S. Department of Energy
DQI	data quality indicator
DUP	duplicate (laboratory)
DWMU	dangerous waste management unit
EB	equipment blank
ECO	Environmental Compliance Officer
EPA	U.S. Environmental Protection Agency
FSO	Field Sample Operations
FTB	full trip blank
FWS	Field Work Supervisor
HEIS	Hanford Environmental Information System
LCS	laboratory control sample
MB	method blank
MS	matrix spike
MSD	matrix spike duplicate
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate

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A1 Introduction

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. This QAPjP includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection quality assurance (QA) elements for this groundwater monitoring plan. This QAPjP is intended to supplement the contractor's environmental QA program plan.

This QAPjP is divided into the following four chapters that describe the quality requirements and controls applicable to the dangerous waste management unit (DWMU) groundwater monitoring activities:

- Chapter A2, Project Management
- Chapter A3, Data Generation and Acquisition
- Chapter A4, Data Review and Usability
- Chapter A5, References

A2 Project Management

This chapter addresses the management approaches planned, project goals, and planned documentation.

A2.1 Project/Task Organization

Project organization (regarding groundwater monitoring) is described in the following sections and illustrated in Figure A-1. Titles used in the project organization are for the purposes of discussing the role of the individual in the performance of the work scope. Individuals with different titles but similar/equivalent positions may fulfill these roles.

A2.1.1 U.S. Department of Energy Manager

Hanford Site operation is the responsibility of the U.S. Department of Energy (DOE). The DOE Manager is responsible for authorizing the contractor to perform activities at the Hanford Site under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; *Resource Conservation and Recovery Act of 1976* (RCRA); *Atomic Energy Act of 1954*; and Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*.

A2.1.2 U.S. Department of Energy Project Lead

The DOE Project Lead is responsible for providing day-to-day oversight of the contractor's performance of the work scope, working with the contractor to identify and work through issues, and providing technical input to DOE management.

A2.1.3 U.S. Department of Energy Primary Contractor Management for Groundwater Science

The DOE Primary Contractor Management for Groundwater Science provides oversight and coordinates with DOE in support of sampling and reporting activities. The DOE Primary Contractor Management for Groundwater Science also provides support to the Project Delivery Manager for Groundwater Science to ensure that work is performed safely and cost effectively.

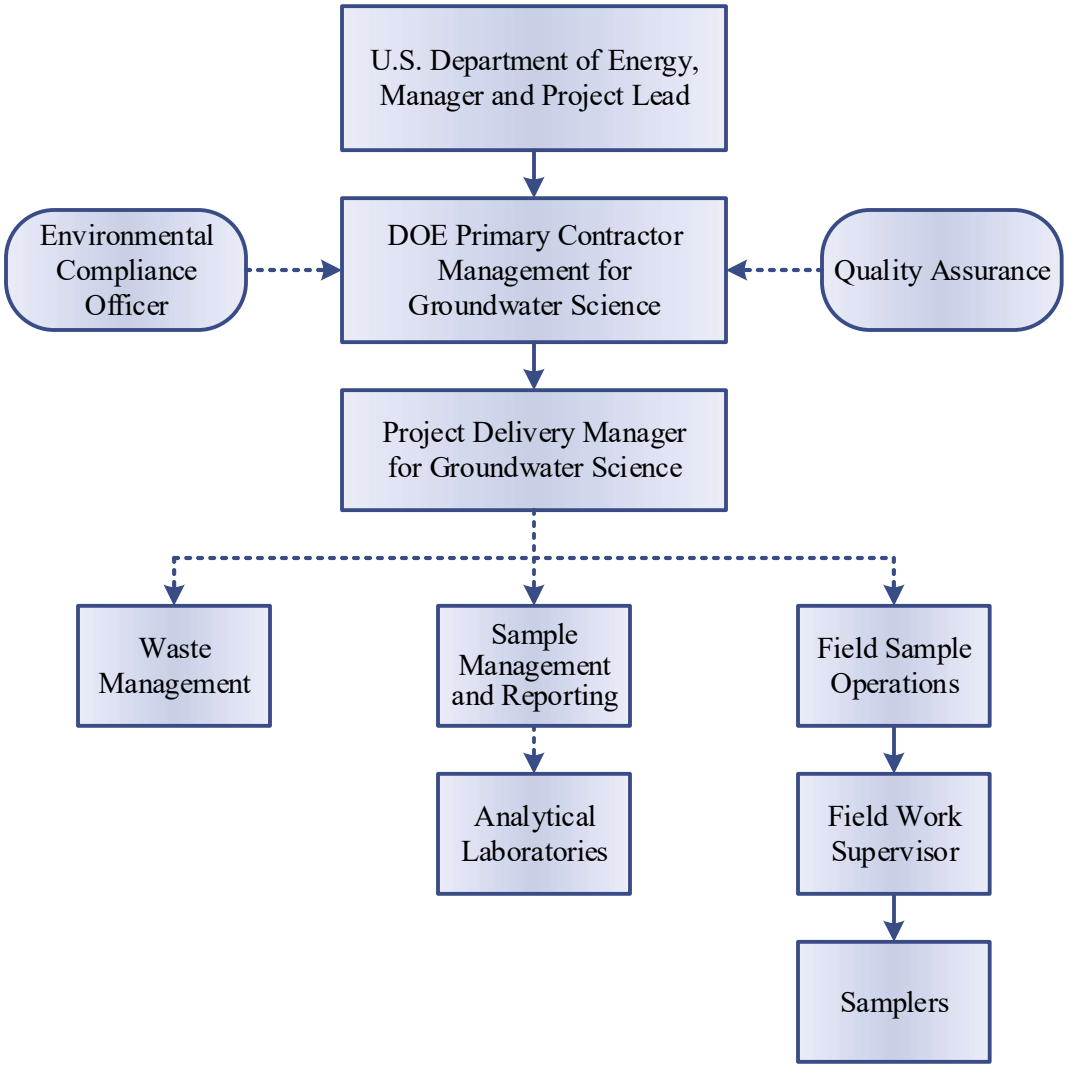

Figure A-1. Project Organization

A2.1.4 Project Delivery Manager for Groundwater Science

The Project Delivery Manager for Groundwater Science is responsible for direct management of activities performed to meet DWMU groundwater monitoring requirements. The Project Delivery Manager for Groundwater Science coordinates with, and reports to, DOE and DOE Primary Contractor Management for Groundwater Science regarding DWMU groundwater monitoring requirements. The Project Delivery Manager for Groundwater Science (or designee) works closely with the Environmental Compliance Officer (ECO), QA, and Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope. The Project Delivery Manager for Groundwater Science assigns staff to provide technical expertise.

A2.1.5 Sample Management and Reporting Group

The SMR group oversees offsite analytical laboratories, coordinates laboratory analytical work with this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. They generate field sampling documents, labels, and instructions for field sampling personnel and develop sample authorization forms, which provide information and instruction to the analytical laboratories. The SMR group revises field sampling documents to reflect approved changes. This group's

responsibilities include receiving analytical data from the laboratories, performing data entry into the Hanford Environmental Information System (HEIS) database, arranging for data validation and recordkeeping. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with Field Sample Operations (FSO), laboratories, or other entities. They are responsible for informing the Project Delivery Manager for Groundwater Science (or designee) of any issues reported by the analytical laboratories.

A2.1.6 Field Sample Operations

FSO is responsible for planning and coordinating field sampling resources and provides the Field Work Supervisor (FWS) for routine groundwater sampling operations. The FWS directs the samplers who collect groundwater samples for this groundwater monitoring plan. Samplers collect samples, complete field logbooks, data forms, and chain-of-custody forms, including any shipping paperwork, and assist sample delivery to the analytical laboratory.

A2.1.7 Quality Assurance

The QA point of contact provides independent oversight, is responsible for addressing QA issues on the project, and overseeing implementation of the project QA program.

A2.1.8 Environmental Compliance Officer

ECOs provide technical oversight, direction, and acceptance of project and subcontracted environmental work, with the goal of minimizing adverse environmental impacts.

A2.1.9 Waste Management

Waste Management identifies waste management sampling/characterization activities for regulatory compliance and is responsible for data interpretation to determine waste designations and profiles. Waste Management communicates policies and practices for project compliance for waste storage, transportation, disposal, and tracking in a safe and cost-effective manner.

A2.1.10 Analytical Laboratories

The laboratories maintain custody and analyze samples in accordance with established quality systems and provide data packages containing sample and quality control (QC) results. Laboratories provide explanations of results to support data review and resolve analytical issues.

A2.2 Problem Definition/Background

The purpose of this groundwater monitoring plan is to satisfy *Washington Administrative Code* and *Code of Federal Regulations* requirements (WAC 173-303-400, “Dangerous Waste Regulations,” “Interim Status Facility Standards,” and 40 CFR 265, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” Subpart F, “Ground-Water Monitoring”) for indicator parameter evaluation. Additional information on the activities to satisfy these requirements and background information on monitoring is provided in the main text of this monitoring plan.

A2.3 Project/Task Description

The focus of this plan is to monitor the parameters used as indicators of groundwater contamination and for parameters establishing groundwater quality in accordance with 40 CFR 265.92, “Sampling and Analysis;” evaluate the well network; and interpret analytical results. The indicator parameters to be monitored, along with the monitoring wells and frequency of sampling, are provided in the main text (Chapter 3). Information on the collection and analyses of groundwater from the monitoring network is provided in this appendix and in Appendix B.

A2.4 Quality Assurance Objectives and Criteria

The QA objective of this plan is the generation of analytical data of known and appropriate quality. In support of this objective, the process to assess data usability may include data verification, data validation, or a data quality indicator (DQI) evaluation. Principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These DQIs are defined for the purposes of this document in Table A-1.

The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. The process to assess data usability is further discussed in Section A4.

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Possible Corrective Actions
Precision (field duplicates, laboratory sample duplicates, and matrix spike duplicates)	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference.	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity). • Request reanalysis or remeasurement. • Qualify the data before use.
Accuracy (laboratory control samples, matrix spikes, and surrogates)	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include laboratory control samples, spiked samples, and surrogates.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample).	If recovery does not meet objective: • Qualify the data before use. • Request reanalysis or remeasurement. • Determine if follow-up evaluation is needed. • Evaluate instrumentation and re-calibrate, if necessary
Representativeness (field duplicates)	Sample representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring that the approved plans were followed during sampling and analysis.	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	If results are not representative of the system sampled: • Identify the reason for results not being representative. • Flag for further review. • Review data for usability. • If data are usable, qualify the data for limited use and define the portion of the system that the data represent. • If data are not usable, flag as appropriate. • Redefine sampling and measurement requirements and protocols. • Resample and reanalyze, as appropriate.

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Possible Corrective Actions
Comparability (field duplicate, field splits, laboratory control samples, matrix spikes, and matrix spike duplicates)	Comparability expresses the degree of confidence with which one dataset can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and quality assurance protocols.	If data are not comparable to other datasets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.
Completeness (no QC element; addressed in data usability assessment)	Completeness is a measure of the amount of valid data collected compared to the amount of data planned. Measurements are considered valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/acceptance criteria).	If dataset does not meet the completeness objective: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future completeness.
Bias (equipment blanks, full trip blanks, laboratory control samples, matrix spikes, and method blanks)	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: • Properly select and use sampling tools. • Institute correct sampling and subsampling processes to limit preferential selection or loss of sample media. • Use sample handling processes, including proper sample preservation, that limit the loss or gain of constituents to the sample media. • Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. • Laboratories that are known to generate biased data for a specific analyte are asked to correct

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Possible Corrective Actions
			their methods to remove the bias as practicable. Otherwise, samples are sent to other laboratories for analysis.
Sensitivity (method detection limit, practical quantitation limit, and relative percent difference)	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation[b] is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: • Request reanalysis or remeasurement using methods or analytical conditions that will meet required detection or limit of quantitation. • Qualify/reject the data before use.

Based on SW-846 Compendium (July 2014). Available at: https://www.epa.gov/hw-sw846/sw-846-compendium.

a. Acceptance criteria for QC elements are provided in Table A-5.

b. For purposes of this groundwater monitoring plan, the lower limit of quantitation is interchangeable with the practical quantitation limit.

QC = quality control

A2.5 Documents and Records

The Project Delivery Manager for Groundwater Science (or designee) is responsible for ensuring that the current version of the groundwater monitoring plan is used and providing any updates to field personnel. Table A-2 defines the types of changes that may impact the groundwater monitoring plan and the associated approvals, notifications, and documentation requirements. Elements of the monitoring plan that are required by 40 CFR 265 Subpart F cannot be changed.

Table A-2. Change Control for Monitoring Plans

Type of Change	Action	Documentation
Unintentional impact to groundwater monitoring plan that impacts the groundwater quality assessment program requirements of 40 CFR 265, Subpart F, including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of groundwater constituents or parameters, or loss of samples in transit.	Project Delivery Manager for Groundwater Science provides informal notification to DOE-RL. DOE-RL provides informal notification to Ecology as appropriate.	Copy of informal notification to Ecology is placed in the facility operating record. Annual Hanford Site RCRA groundwater monitoring report.
Planned change to groundwater monitoring activities, including addition or deletion of constituents analyzed for, change of sampling frequency, or changes to well network.	Project Delivery Manager for Groundwater Science obtains DOE-RL approval; revise monitoring plan as appropriate.	Annual Hanford Site RCRA groundwater monitoring report and revised groundwater monitoring plan as appropriate.

40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring."

DOE-RL = U.S. Department of Energy, Richland Operations Office

Ecology = Washington State Department of Ecology

RCRA = *Resource Conservation and Recovery Act of 1976*

Logbooks and data forms are used to document field activities. The logbooks are identified with a unique project name and number. Individuals responsible for the logbooks are identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled documents. Data forms are also identified with a unique project name and number, may be used to record the same field information as logbooks, and are referenced in the logbooks.

The FWS, SMR group, and field crew supervisors are responsible for alignment of field instructions with the groundwater monitoring plan.

Convenience copies of laboratory analytical results are maintained in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hardcopy format (e.g., DOE Records Holding Area). Records of analyses required by 40 CFR 265.94, "Recordkeeping and Reporting," are to be maintained throughout the active life of a facility and post-closure care period (if any).

By March 1, groundwater monitoring results are reported in the Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2018-65, *Hanford Site RCRA Groundwater Monitoring Report for 2018*).

A3 Data Generation and Acquisition

This chapter addresses data generation and acquisition so that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented. Instrument calibration and maintenance, supply inspections, and data management are also discussed.

A3.1 Analytical Method Requirements

Sample analytical methods are presented in Table A-3. Equivalent (e.g., U.S. Environmental Protection Agency [EPA] Method 300 and SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods,* Method 9056) or updated (e.g., updates to SW-846 methods) Washington State Department of Ecology-accredited methods may be substituted for the methods identified in Table A-3.

Table A-3. Analytical Methods for the DWMU

CAS Number	Waste Constituent (Alternate Name)	Analytical Method[a]	Practical Quantitation Limit (µg/L)
General Chemistry			
ALKALINITY	Alkalinity, total as CaCO3	310.1, Standard Method 2320, Standard Method 4500	5250
TOC	Total organic carbon	415.1, 9060	1050
59473-04-0	Total organic halogen	9020	31.5
Anions[b]			
16887-00-6	Chloride	300, 9056	400
16984-48-8	Fluoride	300, 9056	525
14797-55-8	Nitrate, as NO3	300, 9056	525
14797-65-0	Nitrite, as NO2	300, 9056	250
14808-79-8	Sulfate	300, 9056	1050
Field Measurements			
--	pH	150.1, 9040, Standard Method 4500 H+	N/A
--	Specific conductance	120.1, 9050, Standard Method 2520 B -97	N/A
--	Temperature	170.1	N/A
--	Turbidity	180.1, Standard Method 2130 B	N/A
Metals			
7440-70-2	Calcium	6010	1050
7440-47-3	Chromium	6020	10.5

Table A-3. Analytical Methods for the DWMU

CAS Number	Waste Constituent (Alternate Name)	Analytical Method[a]	Practical Quantitation Limit (µg/L)
7439-89-6	Iron	6010	105
7439-96-5	Manganese	6020	5.25
7439-98-7	Molybdenum	6020	5.25
7440-02-0	Nickel	6020	21
7440-09-7	Potassium	6010	5250
7440-23-5	Sodium	6010	1050
Semivolatile Organic Compounds			
95-57-8	2-Chlorophenol	8270	10.5
95-48-7	2-Methylphenol (o-Cresol)	8270	10.5
88-75-5	2-Nitrophenol (o-Nitrophenol)	8270	10.5
58-90-2	2,3,4,6-Tetrachlorophenol	8270	52.5
120-83-2	2,4-Dichlorophenol	8270	10.5
105-67-9	2,4-Dimethylphenol (2,4-Xylenol)	8270	10.5
51-28-5	2,4-Dinitrophenol	8270	50
95-95-4	2,4,5-Trichlorophenol	8270	10.5
88-06-2	2,4,6-Trichlorophenol	8270	10.5
87-65-0	2,6-Dichlorophenol	8270	10.5
108-39-4[c]	3-Methylphenol (m-Cresol)	8270	--
59-50-7	4-Chloro-3-methylphenol (p-Chloro-m-cresol)	8270	10.5
106-44-5[c]	4-Methylphenol (p-Cresol)	8270	--
534-52-1	4,6-Dinitro-O-cresol (4,6-Dinitro-2-methyl phenol)	8270	52.5
88-85-7	Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	8270	21
100-02-7	p-Nitrophenol (4-Nitrophenol)	8270	21
87-86-5	Pentachlorophenol	8270	52.5
108-95-2	Phenol	8270	10.5

Note: Analytical methods and practical quantitation limits provided in this table do not represent EPA nor Washington State Department of Ecology requirements but are intended solely as guidance.

Table A-3. Analytical Methods for the DWMU

CAS Number	Waste Constituent (Alternate Name)	Analytical Method[a]	Practical Quantitation Limit (µg/L)

a. For EPA Methods 180.1 and 300, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples.* For EPA Methods 120.1, 150.1, 170.1, 310.1, 376.1 and 415.1, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For four-digit EPA methods, see the SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Compendium*. For Standard Methods, see APHA/AWWA/WEF, 2017, *Standard Methods for the Examination of Water and Wastewater*.

b. Dilutions for certain ion chromatography constituents may be necessary, potentially raising the practical quantitation limit above the limits provided.

c. Analyzed and reported as 3 & 4 Methylphenol (CAS number 65794-96-9). The PQL for 3 & 4 Methylphenol is 20 µg/L.

CAS = Chemical Abstracts Service
DWMU = dangerous waste management unit
Ecology = Washington State Department of Ecology
EPA = U.S. Environmental Protection Agency
N/A = not applicable
PQL = practical quantitation limit

A3.2 Field Analytical Methods

Field screening and survey data will be measured in accordance with applicable work practices. Field analytical methods may also be performed in accordance with manufacturer manuals. Appendix B provides further discussion on field measurements.

A3.3 Quality Control

Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects on the analytical data. Field and laboratory QC samples, and their typical frequencies, are summarized in Table A-4. Acceptance criteria for field and laboratory QC are shown in Table A-5. Data will be qualified and flagged in the HEIS database, as appropriate.

Table A-4. QC Samples

Sample Type	Frequency	Characteristics Evaluated
Field QC		
Equipment blanks	1 in 20 samples when nondedicated equipment is used[a]	Contamination from nondedicated sampling equipment
Field duplicates	1 in 20 well trips[b]	Reproducibility/sampling precision
Field splits	As needed	Interlaboratory comparability
Full trip blanks	1 in 20 well trips[b]	Contamination from containers preservative reagents, storage, or transportation

Table A-4. QC Samples

Sample Type	Frequency	Characteristics Evaluated
Analytical QC[c]		
Laboratory control samples	One per analytical batch[d]	Method accuracy
Laboratory sample duplicates	One per analytical batch[d]	Laboratory reproducibility and precision
Matrix spikes	One per analytical batch[d]	Matrix effect/laboratory accuracy
Matrix spike duplicates	One per analytical batch[d]	Laboratory reproducibility, and method accuracy and precision
Method blanks	One per analytical batch[d]	Laboratory contamination
Surrogates	Added to each sample and QC sample	Recovery/yield for organic compounds

Note: The information in this table does not create U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

a. For portable pumps, equipment blanks are collected (1 for every 20 well trips). Whenever a new type of nondedicated equipment is used, an equipment blank will be collected each time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination methods for the nondedicated equipment.

b. For groundwater, a sample is collected any time a well is accessed for sampling; this is also known as a well trip. Field duplicates and full trip blanks are run at a frequency of 1 in 20 well trips (i.e., 5% of the well trips) for all groundwater monitoring wells sampled within any given month and drilling campaign (for all groundwater monitoring programs).

c. A batch is a group of up to 20 samples that behave similarly with respect to the sampling or testing procedures being employed and which are processed as a unit. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

d. Unless not required by, or different frequency is called out, in laboratory analysis method.

QC = quality control

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemistry			
Alkalinity	MB	<MDL <5% sample concentration	Flag with “C”
	LCS	80% to 120% recovery	Flag with “o”[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with “N”
	EB, FTB	<MDL <5% sample concentration	Flag with “Q”
	Field duplicate[c]	≤20% RPD	Review data[e]
Total organic carbon	MB	<MDL <5% sample concentration	Flag with “C”

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Total organic halogen	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Anions			
Anions by ion chromatography	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Metals			
Metals by inductively coupled plasma/atomic emission spectrometry	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Metals by inductively coupled plasma/mass spectrometry	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Semivolatile Organic Compounds			
Phenols gas chromatography/mass spectrometry	MB	<MDL <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	% recovery statistically derived[g]	Flag with "T"
	SUR	% recovery statistically derived[g]	Review data[e]
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]

Notes: The information in this table does not create U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, temperature, and turbidity) are not listed because they are measured in the field.

a. See Table A-3 for constituent list and analytical methods.
b. The reporting laboratory will apply the "o" flag with SMR group concurrence.
c. Applies when at least one result is greater than the laboratory PQL.
d. Either a DUP or an MS/MSD is to be analyzed to determine measurement precision (if there is insufficient sample volume, a laboratory control sample duplicate is analyzed with the acceptance criteria defaulting to the ≤20% RPD criteria).
e. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data.
f. Laboratory-determined, statistically derived control limits based on historical data are used here. Control limits are reported with the data.

DUP = laboratory sample duplicate
EB = equipment blank
FTB = full trip blank
LCS = laboratory control sample
MB = method blank
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
PQL = practical quantitation limit
QC = quality control
RPD = relative percent difference
SMR = Sample Management and Reporting
SUR = surrogate

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action

Data Flags

B, C	=	possible laboratory contamination: analyte was detected in the associated method blank – laboratory applied. The B flag is used for organic analytes. The C flag is used for general chemical and inorganic analytes.
N	=	result may be biased: associated matrix spike result was outside the acceptance limits (except gas chromatograph/mass spectrometry) – laboratory applied.
o	=	result may be biased: associated laboratory control sample result was outside the acceptance limits – laboratory applied.
Q	=	problem with associated field QC blank: results were out of limits – SMR review.
T	=	result may be biased: associated matrix spike result was outside the acceptance limits (gas chromatograph/mass spectrometry only) – laboratory applied.

A3.3.1 Field Quality Control Samples

Field QC samples are used to monitor the integrity of field samples during sample collection, transportation, storage, and laboratory analysis. Field QC samples are submitted to the analyzing laboratories as field samples. Field QC samples are analyzed for the same set of analytes as their corresponding field samples. Field QC samples include field duplicates, field split (SPLIT) samples, and field blanks (equipment blanks [EBs], and full trip blanks [FTBs]). Field blanks are typically prepared to match the sample matrix as closely as possible using high-purity water[1]. The following describe the QC samples in more detail:

- **Equipment blanks:** EBs are used to monitor the effectiveness of the decontamination process for reusable sampling equipment. They are samples of high-purity water contacted with the sampling surfaces of equipment used to collect samples prior to using that equipment for field sampling. EBs are collected from each type of reusable sampling equipment to ensure that the decontamination procedures are effective for the specific equipment types. EBs will be analyzed for the same analytes as samples collected using that equipment. EB samples are not required for disposable sampling equipment.

- **Field duplicates:** Field duplicates provide information regarding the homogeneity of the sample matrix and the precision of the sampling and analysis processes. Field duplicates are two samples that are intended to be identical and are collected as close as possible in time and location. Each sample in the sample-duplicate pair receives its own unique sample number.

- **Field splits:** SPLITs are two samples that are intended to be identical and are collected as close as possible in time and location. SPLITs will be stored in separate containers and analyzed by different laboratories for the same analytes. SPLITs are interlaboratory comparison samples used to evaluate comparability between laboratories.

- **Full trip blanks:** FTBs are used to monitor for potential sample contamination from the sampling container, preservation reagents, or storage conditions. FTBs are prepared high-purity water and sealed prior to traveling to the sampling site, transported to the sampling site (not opened in the field), and then shipped as part of the sample set to the laboratory. The bottle set is either for volatile organic

[1] High-purity water is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques.

analysis only or identical to the set that will be collected in the field. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event.

A3.3.2 Laboratory Quality Control Samples

Internal QA/QC programs are maintained by laboratories used by the project and include the use of laboratory control samples (LCSs), laboratory sample duplicates (DUPs), matrix spikes (MSs), matrix spike duplicates (MSDs), method blanks (MBs), and surrogates (SURs). These QC analyses follow EPA methods (e.g., those in the SW-846 Compendium). QC checks outside of control limits are documented in analytical laboratory reports and during a DQI evaluation. Descriptions of the various types of laboratory QC samples are as follows:

- **Laboratory control sample:** A control matrix (e.g., reagent water) spiked with analytes representative of the target analytes or a certified reference material that is used to evaluate laboratory accuracy.
- **Laboratory sample duplicate:** A second aliquot of a sample that is taken through the entire sample preparation and analytical process. DUPs are used to evaluate the precision of a method in a given sample matrix.
- **Matrix spike:** An aliquot of a sample spiked with a known concentration of target analyte(s) that is then taken through the entire sample preparation and analytical process. An MS is used to assess the bias of a method in a given sample matrix. Thus, MS results are an indicator of the effect the sample matrix has on the accuracy of measurement of the target analytes.
- **Matrix spike duplicate:** A replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. MSD results are used to determine the bias and precision of a method in a given sample matrix.
- **Method blank:** An analyte-free matrix to which the same reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the complete sample preparations and analytical process. The MB is used to quantify contamination resulting from the sample preparation and analysis.
- **Surrogate:** Used only in organic analyses, a compound added to every sample in the analysis batch (field samples and QC samples) prior to preparation. SURs are typically similar in chemical composition to the analyte being determined, but they are not normally encountered. SURs are expected to respond to the preparation and analytical process in a manner similar to the analytes of interest. Because SURs are added to every sample and QC sample, they are used to evaluate overall method performance in a given matrix.

Samples are analyzed within the holding time guidelines provided in Table A-6. In some instances, constituents in the samples not analyzed within the holding times may be compromised by volatilization, decomposition, or other chemical changes. Data from samples analyzed outside of the holding times are flagged in the HEIS database with an “H.”

Table A-6. Preservation and Holding Time Guidelines for Laboratory Analyses

Constituent[a]	Preservation[b]	Holding Time
General Chemistry		
Alkalinity	Store ≤6°C	14 days
Total organic carbon	Store <6°C, adjust pH to <2 with sulfuric acid or hydrochloric acid	28 days
Total organic halogen	Store <6°C, adjust pH to <2 with sulfuric acid	28 days
Anions		
Chloride, Fluoride, Sulfate	Store ≤6°C	28 days
Nitrate, Nitrite	Store ≤6°C	48 hours
Metals		
Metals by inductively coupled plasma-atomic emission spectrometry	Adjust pH to <2 with nitric acid	6 months
Metals by inductively coupled plasma/mass spectrometry	Adjust pH to <2 with nitric acid	6 months
Semivolatile Organic Compounds		
Phenols by gas chromatography/mass spectrometry	Store ≤6°C	7 days before extraction 40 days after extraction

Notes: Holding times and preservation methods are dependent on the constituent and are consistent with EPA guidance and approved analytical methods. Information in this table does not create EPA or Washington State Department of Ecologyrequirements but is intended solely as guidance.

The container type for a sample is available on the chain-of-custody documentation.

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, dissolved oxygen [if applicable], temperature, and turbidity) are not listed because they are measured in the field.

a. See Table A-3 for constituent list and analytical methods.

b. For preservation identified as stored at ≤6°C, the sample should be protected against freezing unless it is known that freezing will not impact the sample integrity.

EPA = U.S. Environmental Protection Agency

A3.4 Measurement Equipment

Each measuring equipment user will ensure that equipment is functioning as expected, properly handled, and properly calibrated per methods governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded according to approved methods. Field screening instruments will be used, maintained, and calibrated as provided in manufacturer specifications and other approved methods.

A3.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment will meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or have been evaluated as acceptable and valid according to instrument-specific methods and specifications. Software applications will be acceptance tested prior to use in the field. Measurement and testing equipment used in the field will be subject to preventive maintenance measures to minimize downtime.

A3.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Appendix B.

A3.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed per test methods in the SW-846 Compendium and EPA/600 Method series (e.g., EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*) and will be appropriate for their use. Supplies and consumables used in sampling and analysis activities are procured under internal work processes. Supplies and consumables are checked and accepted by users prior to use.

A3.8 Nondirect Measurements

Data obtained from sources such as computer databases, programs, literature files, and historical records will be evaluated by the staff member assigned by the Project Delivery Manager for Groundwater Science. Data used in evaluations will be identified by source. Historical data obtained from the HEIS database are usable for comparison to data collected by this groundwater monitoring plan.

A3.9 Data Management

Records of data analyses and groundwater surface elevations are maintained as required by 40 CFR 265.94.

Electronic data access will be through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided.

A4 Data Review and Usability

This chapter addresses QA activities that occur after data collection. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives.

A4.1 Data Review and Verification

Data review and verification are performed to confirm that field and field QC sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, and reviewing sample collection dates and sample preparation and analysis dates to determine if holding times were met.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, and the correct application of conversion factors. Data verification is typically conducted on a portion of multi-media samples collected across projects.

The staff member, assigned by the Project Delivery Manager for Groundwater Science, will also perform a data review to determine if observed changes reflect improved/degraded groundwater quality or potential data errors, which may result in a request for data review on questionable data. The laboratory may be asked to check calculations, reanalyze samples, or the well may be resampled. Results of the request for data review process are used to flag data in the HEIS database and to add comments.

A4.2 Data Validation

Data validation is performed at the discretion of the Project Delivery Manager for Groundwater Science, under the direction of the SMR group. The decision to perform validation is based on the results of QC

samples for individual well networks and discussions with the staff member assigned by the Project Delivery Manager for Groundwater Science. If conducted, data validation (third-party) will be performed at a minimum frequency of 5% per method. Data validation evaluates the analytical quality of data from samples specifically collected for this plan.

A4.3 Reconciliation with User Requirements

The purpose of reconciliation with user requirements is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. For routine groundwater monitoring undertaken by projects, DQIs such as precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity for the specific datasets (individual data packages) will typically be evaluated on an annual basis. A DQI evaluation specific to data quality requirements specified in this plan may be performed at the discretion of the Project Delivery Manager for Groundwater Science. Results of the DQI evaluation(s) will be used by the Project Delivery Manager for Groundwater Science to interpret the data and determine if the data quality objectives for this activity have been met.

A5 References

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5.

265.92, "Sampling and Analysis."

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Appendix B

Sampling Protocol

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Terms

DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
IATA	International Air Transport Association
QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*

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B1 Introduction

Groundwater monitoring at the Hanford Site, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA) and implemented in WAC 173-303, "Dangerous Waste Regulations," has been conducted since the mid-1980s. Hanford Site groundwater sampling methods contain sampling precautions to be taken; identify equipment and its use; cleaning and decontamination practices; records and documentation; and sample collection, management, and control activities. Together, Appendices A and B discuss the sampling and analysis elements for the groundwater monitoring plan: sample collection, sample preservation and holding times, chain–of-custody control, analytical methods, and field and laboratory quality assurance (QA)/quality control (QC).

This appendix provides elements of the sampling protocols and techniques used for the groundwater monitoring plan. The main text of the groundwater monitoring plan identifies the monitoring wells that will be sampled, constituents to be analyzed, and sampling frequency for the groundwater monitoring at the dangerous waste management unit.

B2 Sampling Methods

Sampling may include, but is not limited to, the following methods:

- Field screening measurements
- Groundwater sampling
- Water-level measurements

Groundwater samples will be collected according to the current revision of applicable operating methods. Groundwater samples are collected after field measurements of purged groundwater have stabilized:

- **pH** – two consecutive measurements agree within 0.2 pH units
- **Temperature** – two consecutive measurements agree within 0.2°C (0.36°F)
- **Conductivity** – two consecutive measurements agree within 10% of each other
- **Turbidity** – less than 5 nephelometric turbidity units prior to sampling (or the staff assigned by the Project Delivery Manager for Groundwater Science's recommendation at the time of collection)

Dissolved oxygen, if included in the main text of the groundwater monitoring plan, will also be measured in the field. Dissolved oxygen is not required to be stable prior to sample collection.

Unless special directions are provided by the staff assigned by the Project Delivery Manager for Groundwater Science at the time of sample collection, wells are typically purged at a flow rate not to exceed 7.6 L/min (2 gal/min). Purging will continue until stable readings of selected field water quality parameters are achieved (as described above).

Field measurements (except for turbidity) are typically obtained using an instrumented flow-through cell located at the well head. Groundwater is pumped directly from the well to the flow-through cell. At the beginning of the sample event, field crews attach a clean stainless steel sampling manifold to the riser discharge. The manifold has two valves and two ports: one port is used only for purgewater, and the other port is used to supply water to the flow-through cell. Probes are inserted into the flow-through cell to measure pH, temperature, specific conductance, and dissolved oxygen, if required by the main text. Turbidity is measured by collecting an aliquot of water from the purgewater valve and inserting the

sample vial into a turbidimeter. Purgewater, including the water passing through the flow-through cell, is then discharged to a tank on the purgewater truck.

Collection of the field measurement data will commence when a volume of water equal to the volume of the pump riser pipe has been extracted and discharged to the purgewater truck. Once field measurements have stabilized, the hose supplying water to the flow-through cell is disconnected and a clean stainless steel drop leg is attached for sampling collection. The flow rate does not exceed 7.6 L/min (2 gal/min) during sampling to minimize loss of volatiles (if any) and prevent overfilling the bottles. Sample bottles are filled in a sequence designed to minimize loss of volatiles (if any). If both filtered and unfiltered samples are required (see Table 3-1 in main text), filtered samples are collected after collection of the unfiltered samples.

Samples may be filtered in the field using a 0.45 µm filter as noted on the chain-of-custody form. Unfiltered samples are collected in conjunction with filtered samples for select analysis to determine if metal constituents being monitored (excluding hexavalent chromium, if one of the monitored constituents) occur as both suspended and dissolved phases, or in only one state. The evaluation of suspended and dissolved metals provide supporting information for groundwater geochemical characteristics, as well as indication of well integrity such as the presence of dislodged well encrustation, well corrosion products, or failure of the well screen filter pack.

Environmental-grade electric submersible pumps will typically be used for well purging and sample collection. In the event a well exhibits insufficient productivity to support purging and sampling using the electric submersible pumps, adjustable-rate bladder pumps with typical flow rates of 0.1 to 0.5 L/min (0.26 to 0.13 gal/min) may be employed. The same purge protocol described above will be used for these pumps.

For certain types of samples, preservatives are required. Preservatives, based on the analytical methods used, are generally added to the collection bottles before their use in the field. Sample preservation and holding times for groundwater samples are provided in Appendix A (Table A-6) and are based on the analytical method identified in Appendix A (Table A-3). Container types, preservatives, and volumes will be identified on the chain-of-custody form. This groundwater monitoring plan defines a sample as a filled sample bottle for purposes of starting the clock for holding time restrictions.

Holding time is the maximum allowable period between sample collection and analysis. Exceeding holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Holding times depend on the constituent and are listed in analytical method compilations such as APHA/AWWA/WEF, 2017, *Standard Methods for the Examination of Water and Wastewater*; SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*; and the EPA/600 Method series (e.g., EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*).

B2.1 Decontamination of Drilling and Sampling Equipment

Drilling of wells is not addressed by this groundwater monitoring plan. Therefore, a discussion of the decontamination of drilling equipment is not included.

Sampling equipment will be decontaminated in accordance with sampling equipment decontamination methods. To prevent potential contamination of the samples, care should be taken to use decontaminated equipment for each specific sampling activity.

Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample 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 events

Decontamination of sampling equipment and pumps is typically performed using high-purity water[1] in each step. In general, three rinse cycles are performed to decontaminate sampling equipment: detergent rinse, acid rinse, and water rinse. During the detergent rinse, equipment is washed in a phosphate-free detergent solution, followed by rinsing with water in three sequential containers. After the third water rinse, equipment that is stainless steel or glass is rinsed in a 1 M nitric acid solution (pH less than 2). Equipment is then rinsed with water in three sequential containers (the water rinses following the acid rinse are conducted in separate water containers that are not used for detergent rinse). Following the final water rinse, equipment is rinsed in hexane and then placed on a rack to dry. Dry equipment is loaded into a drying oven. The oven is set at approximately 50°C (122°F) for items that are not metal or glass or at approximately 100°C (212°F) for metal or glass. Once reaching temperature, equipment is baked for approximately 20 minutes and then cooled. Equipment is then removed from the oven and enclosed in clean, unused aluminum foil using surgical gloves. The wrapped equipment is stored in a custody locked, controlled access area. Water-level measurement tapes (portion that came in contact with groundwater) are decontaminated using a high-purity water rinse and dried with disposable towels.

To decontaminate sampling pumps that are not permanently installed, the pump cowling is first removed, washed (if needed) in phosphate-free detergent solution, and then reinstalled on the pump. Typically, the pump is then submerged in phosphate-free detergent solution, and 11.4 L (3 gal) of solution is pumped through the unit and disposed. Detergent solution is then circulated through the submerged pump for 5 minutes. The pump is removed from solution and rinsed with water. The pump is submerged in water, and 30.3 L (8 gal) of water is pumped through the unit and disposed. The pump is removed from the water, and the intake and housing are covered with plastic sleeving. Cleaning is documented on a tag that is affixed to the pump with the following information:

- Date of pump cleaning
- Pump identification
- Comments (if any)
- Signature of person performing decontamination

B2.2 Water Levels

Each time a sample is obtained, measurement of the groundwater surface elevation at each monitoring well is required by 40 CFR 265.92(e), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." Using a calibrated depth measurement tape, the depth to water is recorded in each well prior to sampling. When two consecutive measurements are taken that agree within 6 mm (0.24 in.), the final determined measurement is recorded, along with the date and time for the specific event. The depth to groundwater is subtracted from the

[1] High-purity water that is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques.

elevation of a reference point (usually the top of the casing) to obtain the water-level elevation. The top of the casing is a known elevation reference point because it has been surveyed to local reference data.

B3 Documentation of Field Activities

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

Data forms for field activities are also identified with a unique project name and number. Data forms may be used to collect field information; information recorded on data forms is the same as for logbooks. The data forms are referenced in the logbooks.

The following information is recorded in logbooks or on data forms:

- Day and date; time task started; weather conditions; and names, titles, and organizations of personnel performing the task
- Purpose of visit to the task area
- Details of field tests that were conducted, and references to forms that were used and methods followed in conducting the activity
- Details of field calibrations and surveys that were conducted, and references to forms that were used, other data records, and methods followed in conducting the calibrations and surveys
- Details of samples collected and the preparation (if any) of splits, duplicates, or blanks
- Time, equipment type, serial or identification number, and methods followed for decontaminations and equipment maintenance performed (reference the page number[s] of any logbook where detailed information is recorded)
- Equipment failures or breakdowns that occurred, with a brief description of replacements

B4 Calibration of Field Equipment

Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work processes, and/or field instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. Calibration records will include the raw calibration data, identification of the standards used, associated reports, date of analysis, and analyst's name or initials. Results from instrument calibration activities are recorded.

Field instrumentation calibration and QA checks will be performed as follows:

- Prior to initial use of a field analytical measurement system
- At a minimum, at the frequency recommended by the manufacturer or methods, or as required by regulations

- Upon failure to meet specified QC criteria
- Daily calibration checks will be performed and documented for each instrument used (these checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data; analysis times will be sufficient to establish detection efficiency and resolution)
- Using standards for calibration that are traceable to a nationally recognized standard agency source or measurement system (manufacturer's recommendations for storage and handling of standards, if any, will be followed)

B5 Sample Handling

Sample handling and transfer methods preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date.

A sampling and analytical database is used to track samples from the point of collection through the laboratory analysis process.

B5.1 Containers

Samples will be collected, where and when appropriate, in break-resistant containers. The field sample collection record will indicate the lot number of the bottles used in sample collection. When commercially precleaned containers are used in the field, the name of the manufacturer, lot identification, and certification will be retained for documentation.

Containers will be capped and stored in an environment that minimizes the possibility of sample container contamination. If contamination of the stored sample containers occurs, corrective actions will be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified on the chain-of-custody form.

B5.2 Container Labeling

Each sample is identified by affixing a standardized label or tag to the container. This label or tag will contain the sample identification number. The label will identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis requested, and collector's name or initials. Sample labels may be either preprinted or handwritten in indelible or waterproof ink.

B5.3 Sample Custody

Sample custody protocols maintain sample integrity throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility for custody of the sample changes, new and previous custodians will sign the record and note the date and time.

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

- Project name
- Collectors' names
- Unique sample number
- Date, time, and location (or traceable reference thereto) of sample collection
- Matrix
- Preservatives
- Chain-of-possession information (i.e., signatures and printed names of each individual involved in the transfer of sample custody and storage locations, and dates/times of receipt and relinquishment)
- Requested analyses (or reference thereto)
- Shipped to information (i.e., analytical laboratory performing the analysis)

B5.4 Sample Transportation

Packaging and transportation instructions will comply with applicable transportation regulations and U.S. Department of Energy (DOE) requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT). Carrier specific requirements, defined in the current edition of International Air Transport Association (IATA) *Dangerous Goods Regulations*, will also be considered when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents will be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be classified, described, packaged, marked, labeled, and shipped according to the specific instructions for that material.

B6 Management of Waste

Waste materials generated during sample activities, including purgewater and decontamination fluids, will be collected and managed in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* as authorized under Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order Action Plan* Milestone M-024.

For waste designation purposes, wells listed in the main text of the monitoring plan may be surveyed in the Hanford Environmental Information System, and the maximum concentration for each analyte within the most recent 5 years will be evaluated for use in creating a waste profile, if necessary.

Packaging and labeling during waste storage and transportation will meet WAC 173-303, DOE, and DOT requirements, as appropriate.

Offsite analytical laboratories are responsible for the disposal of unused sample quantities and wastes generated during analytical processes.

B7 References

40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5.

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