

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

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



P.O. Box 550
Richland, Washington 99352

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Release Approval

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**RCRA INTERIM STATUS GROUNDWATER MONITORING PLAN
 INTERIM CHANGE FORM**

Change Number: <i>(Obtain Change Number From Interim Change Custodian)</i> RCRA-CN-01_DOE_RL-2009-75_R1		Date: 04/30/2020
Document Number: DOE/RL-2009-75	Title: Interim Status Change Number 1: Interim Status Groundwater Monitoring Plan for the LLBG WMA-1	Rev: 1
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.

- Add discussion of the monitoring network change that includes removal of existing wells 299-E28-26 and 299-E28-28, and the downgradient well that had been proposed in DOE/RL-2009-75, Rev. 1, from the network (Executive Summary, pp. x and xi). Remove statement regarding sampling of the new downgradient well on p. xi. The revised network is based on results of recent contaminant particle-tracking calculations that are subject to an annual assessment. Add additional references to Chapter 6.
- Remove well 299-E28-26, well 299-E28-28, and proposed well from Figure 1-2 and Figure 3-1.
- In the Introduction on pg. 1-4: change number of downgradient wells from "six" to "three;" delete sentence "One of the six downgradient wells will be a new well installed to monitor the southeast corner of LLWMA and will be sampled quarterly for one year;" change number of existing groundwater wells from "seven" to "five;" and delete "and proposes a new well be added to the well network for the total of eight wells."
- Delete "with the exception of the southeast corner between wells 299-E28-26 and 299-E28-27. Chapter 3 discusses the resolution of this deficiency" from Section 2.4.2 on pg. 2-15.
- Change the number of network wells from "eight" to "five" in Section 2.5 on pg. 2-20.
- In Section 2.6.3 on pg. 2-23: Remove discussion of "2014 and early to mid-2015 groundwater flow determinations and particle migration simulations." Add discussion and references to the contaminant particle-tracking calculations and the annual assessment that demonstrate the three downgradient wells (299-E28-27, 299-E33-28, and 299-E33-29) would detect possible contaminant releases from LLWMA-1.
- Change section reference from "A2.6" to "A2.5" in Table 2-2, page 2-27, and delete "For this TSD unit, the Appendix III parameters are included for monitoring at well(s) specified in Section 3.1 as a best practice activity to obtain additional scientific and technical information" from Table 2-2, footnote b, on pg. 2-28.
- Add site-specific metals to monitor for stainless steel corrosion (chromium, iron, manganese, molybdenum, and nickel) to Table 2-3, Section 3.1, Table 3-1 (footnote c.), and Table 3-4 (Constituents row).
- Delete paragraph "The newly installed well... provided in Table 3-1." from Section 3.1 on pg. 3-1.
- Delete well 299-E28-26, well 299-E28-28, and Proposed Well from Table 3-1 and Table 3-3.
- In Table 3-1, add superscript "f" to "Phenols" with footnote "f. The specific phenols to be analyzed as groundwater quality parameters are identified in Table 3-1a."
- Add Table 3-1a, "Phenols Analyzed as Groundwater Quality Constituents" to pg. 3-3a and Table of Contents (Tables).
- Delete Table 3-2, and remove reference to Table 3-2 in Table of Contents (Tables).
- Edit text in Section 3.2 and Section 3.3 to remove the proposed downgradient well from the well network. Additional changes to designate groundwater flow direction to "east-southeast" with reference to the 2019 RCRA groundwater monitoring report.
- Remove well 299-E28-26, well 299-E28-28, and proposed well from the Current Plan/Well Network cell, and change groundwater flow direction from "South-southeast" to "East-southeast" in Current Plan/Groundwater Flow Direction cell in Table 3-4.

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

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-Replace Appendix A in its entirety with an updated version of Quality Assurance Project Plan.

-Remove "The field sampling team will make a copy of the signed record before sample shipment and transmit the copy to the SMR group" from Section B5.3 in Appendix B.

-Delete wells 299-E28-26 and 299-E28-28 from Table of Contents (Figures) and Table C-2, and delete Figures C-3 and C-4, in Appendix C.

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.

-Due to changes in groundwater flow direction from south-southeast to east-southeast, the previously-designated downgradient wells 299-E28-26 and 299-E28-28, and the proposed downgradient well, are no longer applicable to the monitoring network and are removed from this groundwater plan. The monitoring well network changes from eight total wells to five (two upgradient and three downgradient). All text, tables, and figures are revised to reflect this change in the groundwater flow direction and monitoring well network.

-Reference in Table 2-2 changed to Section A2.5 to reference the applicable section in the updated Appendix A.

-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.

-Appendix A (Quality Assurance Project Plan) is replaced in its entirety due to multiple updates since issuance of the monitoring plan.

-Sentence removed from Section B5.3 is not applicable to the monitoring plan.

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:

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

S&GRP Environmental Compliance Officer:

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

CHPRC RCRA Groundwater Manager:

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

DOE Subject Matter Expert:

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

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Electronic Approval started by Clark, Tessa J on 6/8/2020 1:41 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 1:52 PM

Comment:

Approved by Faught, William R on 6/8/2020 2:37 PM

Comment:

Approved by Sexton, Sean M on 6/8/2020 3:03 PM

Comment:

Approved by Hildebrand, R D (Doug) on 6/8/2020 3:25 PM

Comment:

DOE/RL-2009-75, REV. 1
RCRA-CN-01_DOE/RL-2009-75_R1

Change History of Interim Status Monitoring Plan DOE/RL-2009-75, Rev. 1, for the LLBG WMA-1

Title	Document Number	Revision Number	Interim Change Number	Effective Date
Interim Status Groundwater Monitoring Plan for the LLBG WMA-1	DOE/RL-2009-75	1	N/A	8/8/2016
Interim Status Groundwater Monitoring Plan for the LLBG WMA-1	DOE/RL-2009-75	1	RCRA-CN-01_DOE/RL-2009-75_R1	4/30/2020

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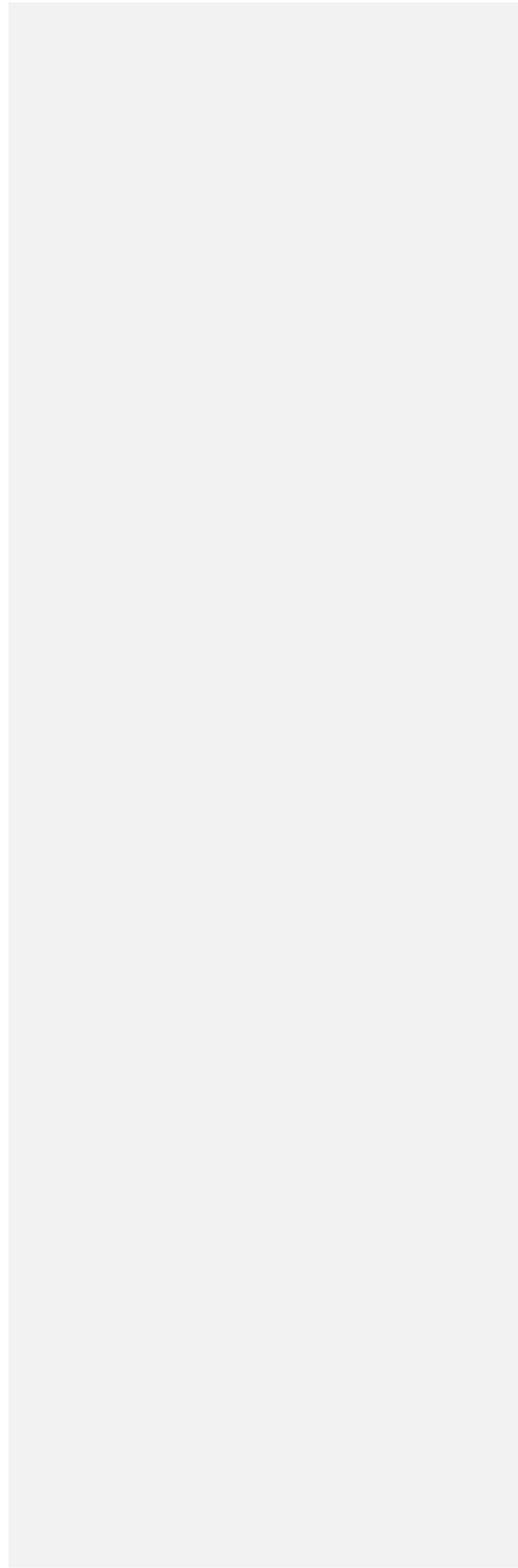
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Executive Summary

This document presents a revision to the Low Level Waste Management Area 1 (LLWMA-1) groundwater monitoring plan¹ previously published in 2009. This revised monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976*² (RCRA) and the implementing requirements in WAC 173-303-400,³ which in turn, specifies groundwater monitoring regulations under 40 CFR 265.⁴ The U.S. Department of Energy (DOE), Richland Operations Office (DOE-RL), is revising this groundwater monitoring plan due to the age of the plan and to ensure that the plan contains the most current Hanford Site groundwater monitoring information for the treatment, storage, and disposal (TSD) unit (e.g., changes in groundwater flow direction and changes to the monitoring network). This indicator evaluation program groundwater monitoring plan is the principal controlling document for conducting groundwater monitoring at LLWMA-1.

The LLWMA-1 is an inactive interim status TSD unit in the 200-SW-2 Groundwater Operable Unit (OU). LLWMA-1 is located in the northwestern corner of the 200 East Area (Figure ES-1). LLWMA-1 consists of the 218-E-10 Burial Ground, which contains 14 excavated trenches, one of which (Trench 9) received mixed waste regulated under RCRA consisting of di-octyl phthalate, and lead. From 1955 to 2000, the 218-E-10 Burial Ground received shipments of industrial waste from the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, T Plant, offsite (mainly Formerly Utilized Sites Remedial Action Program waste), and the 100 Areas (mainly N Reactor waste). Operating records indicate that mixed waste was disposed of only into portions of Trench 9 from 1987 to 1993.

¹ DOE/RL-2009-75, 2009, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1 Rev. 0*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084331>.

² *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: <http://www.epw.senate.gov/rcra.pdf>

³ WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*, Olympia, Washington, Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=173+303-400>.

⁴ 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."

265.93, "Preparation, Evaluation, and Response."

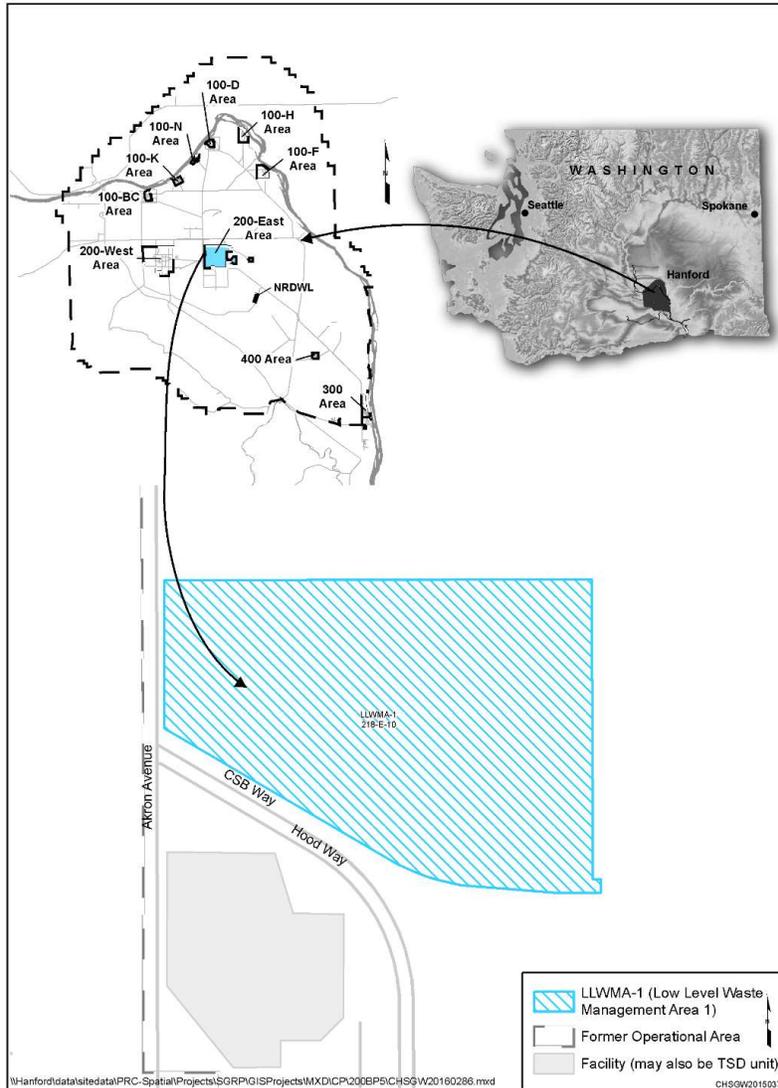


Figure ES-1. LLWMA-1 the 200 East Area

The mixed waste was from PUREX, B Plant, 225B Waste Encapsulation and Storage Facility, and 271B Support Building. The trenches were backfilled on a daily or weekly basis.

1 As LLWMA-1 received industrial waste contaminated with dangerous waste or dangerous
2 waste constituents, a groundwater monitoring program in accordance with 40 CFR 265
3 was implemented in 1986. Historically, three exceedances (1989, 1998, and 2012) of the
4 background indicator parameters within downgradient wells have been verified. In each
5 case, the groundwater quality assessment program concluded there was no dangerous
6 waste, or dangerous waste constituents, entering groundwater associated with LLWMA-1.
7 In 1989, statistical evaluation of specific conductance showed that concentrations in one
8 downgradient well were statistically greater than background levels. Verification
9 sampling confirmed the specific conductance exceedance. An interim status groundwater
10 quality assessment plan for LLWMA-1 was prepared and initiated in 1990.⁵ Indicator
11 evaluation monitoring was resumed in 1994 after results of the groundwater quality
12 assessment program concluded the initial estimate of groundwater flow was incorrect and
13 that the increased concentration of specific conductance was likely due to northward
14 migration of liquid waste from past practice waste sites to the south and not related to
15 releases of dangerous waste constituents from LLWMA-1.⁶

16 Concentrations of specific conductance were exceeded in 1998 for downgradient well
17 299-E33-34. A notification letter and an assessment report⁷ were submitted to the
18 Washington State Department of Ecology in March 1999; the notification letter reported
19 that the elevated specific conductance was associated with nitrate contamination from the
20 area of the BY Cribs.

21 In early 2012, total organic carbon was verified as exceeding background levels.

22 A groundwater quality assessment program plan⁸ was submitted to the Regional
23 Administrator in 2012. The plan was implemented in July 2012, and a subsequent first

⁵ WHC-SD-EN-AP-021, 1990, *Interim-Status Groundwater Quality Assessment Plan for Waste Management Area 1 of the 200 Areas Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0006975>.

⁶ WHC-SD-EN-EV-025, 1994, *Results of Groundwater Quality Assessment Program at Low-Level Waste Management Area 1 of the Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196097452>.

⁷ Furman, M.J., 1999, "Notification of Specific Conductance Exceedance at Low-Level Waste Management Area 1 (218-E-10)" (letter to S. Leja, Acting Perimeter Areas Manager, Nuclear Waste Program, State of Washington Department of Ecology, from M.J. Furman), U.S. Department of Energy, Richland Operations Office, Richland, Washington, March 18. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199152613>.

⁸ DOE/RL-2012-35, 2012, *First Determination RCRA Groundwater Quality Assessment Plan for Low-Level Burial Grounds Low-Level Waste Management Area-1*, Rev. 0, U.S. Department of Energy, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091456>.

1 determination report⁹ concluded there was no dangerous waste, or dangerous waste
2 constituents entering groundwater associated with LLWMA-1. The indicator evaluation
3 program was reinstated based on 40 CFR 265.93(d)(6).

4 This revised groundwater monitoring plan presents an updated indicator evaluation
5 program for detection monitoring of the uppermost aquifer beneath LLWMA-1. This plan
6 addresses the following:

- 7 • Number, locations, and depths of wells in the LLWMA-1 groundwater monitoring
8 network
- 9 • Sampling and analytical methods of parameters required for groundwater
10 contamination detection monitoring
- 11 • Methods for evaluating groundwater quality information
- 12 • Schedule for groundwater monitoring at LLWMA-1

13 This revised plan updates the existing groundwater monitoring well network as identified
14 in the previous groundwater monitoring plan (DOE/RL-2009-75, Rev. 0, *Interim Status*
15 *Groundwater Monitoring Plan for the LLBG WMA-1*) and addresses the well network
16 changes needed to accommodate the 2011 groundwater flow reversal. From mid-2011 to
17 mid-2015, groundwater flow direction determinations continue to indicate a southward
18 groundwater flow direction beneath LLWMA-1. As a result, DOE/RL-2009-75, Rev. 1,
19 included an eight well network ~~has been devised~~ to evaluate groundwater quality,
20 including a new downgradient well that will monitor the southeast corner of LLWMA. In
21 Change Notice 1 of this plan, the monitoring network is revised to align with
22 SGW-60590, Engineering Evaluation Report for Low-Level Burial Grounds Waste
23 Management Area-1 Green Islands Groundwater Monitoring¹⁰. This report utilized
24 contaminant particle-tracking calculations to evaluate the interim status well network and
25 propose a well network for monitoring under final status permit conditions. The
26 monitoring network proposed in SGW-60590 is evaluated annually and, based on the

⁹ DOE/RL-2013-25, 2013, *First Determination RCRA Groundwater Quality Assessment Report for Low-Level Burial Grounds Low-Level Waste Management Area-1*, Rev. 0, U.S. Department of Energy, Richland, Washington. Available at: <http://pdw.hanford.gov/arpit/index.cfm/viewDoc?accession=0088747>.

¹⁰ SGW-60590, *Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-1 Green Islands Groundwater Monitoring, Rev. 0*, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: <https://pdw.hanford.gov/document/AR-03212>.

1 ~~groundwater flow direction, no network changes have been recommended (Section 7.7.2.2~~
2 ~~in ECF 200E 19-0003, *Groundwater Flow and Migration Calculations for Annual*~~
3 ~~*Assessment of the Final Status Monitoring Networks for the 200 East Area Dangerous*~~
4 ~~*Waste Management Units*)¹¹. Therefore, wells 299-E28-26 and 299-E28-28, and the~~
5 ~~proposed downgradient well that were included in DOE/RL-2009-75, Rev. 1, are no~~
6 ~~longer included in the monitoring network.~~

Future groundwater flow changes are possible
7 as a result of the 200-BP-5 treatability test (DOE/RL-2010-74, *Treatability Test Plan for*
8 *the 200-BP-5 Groundwater Operable Unit*)¹². The 200-BP-5 treatability test will be
9 completed at a well located east of LLWMA-1 and will use varying groundwater
10 extraction rates to determine hydraulic parameters and existence of nearby hydrogeologic
11 boundary conditions.

12 Groundwater in LLWMA-1 monitoring wells will be sampled and analyzed semiannually
13 for the parameters used as indicators of groundwater contamination (pH, specific
14 conductance, total organic carbon, and total organic halogen) and annually for parameters
15 establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and
16 sulfate) in accordance with 40 CFR 265.92(b)(2)&(3) and (d). ~~The newly installed well~~
17 ~~will be sampled quarterly as a best practice activity to provide additional scientific and~~
18 ~~technical information.~~ Additional site-specific constituents (calcium, magnesium,
19 potassium, fluoride, nitrate, and nitrite) and field measurements (dissolved oxygen,
20 temperature, and turbidity) will also be collected for general groundwater chemistry to
21 support the evaluation of upgradient and downgradient water chemistry variations.

22 Water-level measurements will be taken each time that a sample is collected to satisfy the
23 requirements of 40 CFR 265.92(e).

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¹¹ ECF-200E-19-0003, 2020, *Groundwater Flow and Migration Calculations for Annual Assessment of the Final Status Monitoring Networks for the 200 East Area Dangerous Waste Management Units, Rev. 0*, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: <https://pdw.hanford.gov/document/AR-03697>.

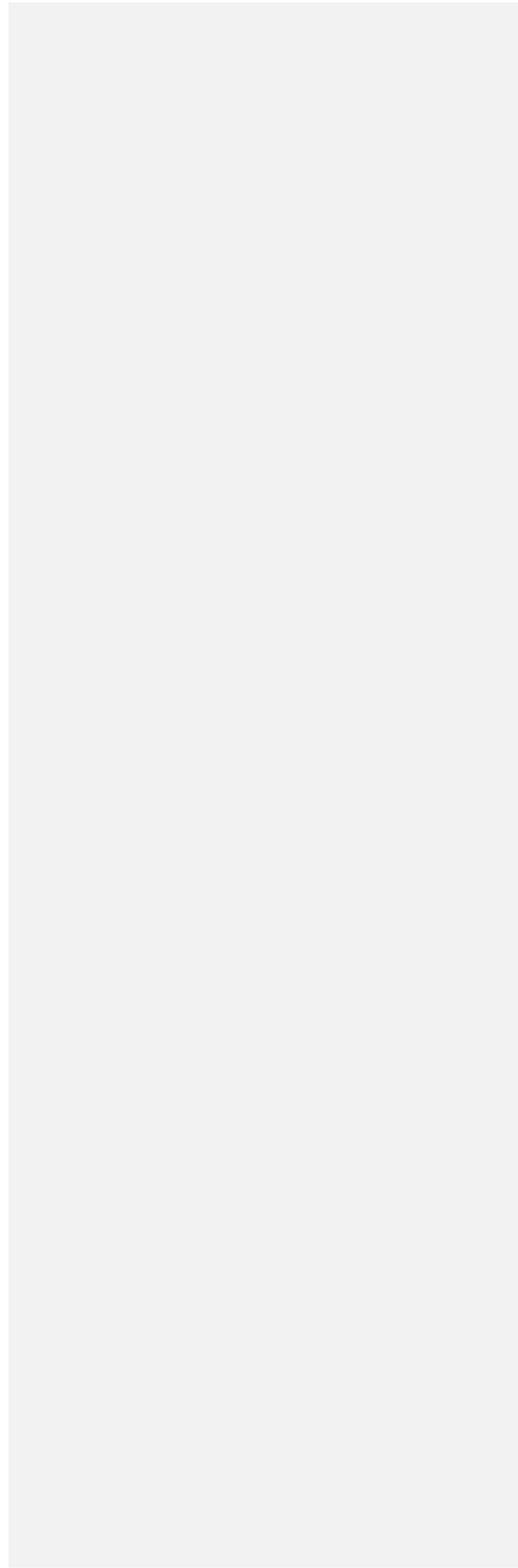
¹² DOE/RL-2010-74, 2015, *Treatability Test Plan for the 200-BP-5 Groundwater Operable Unit, Rev. 2*, U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081243H>.

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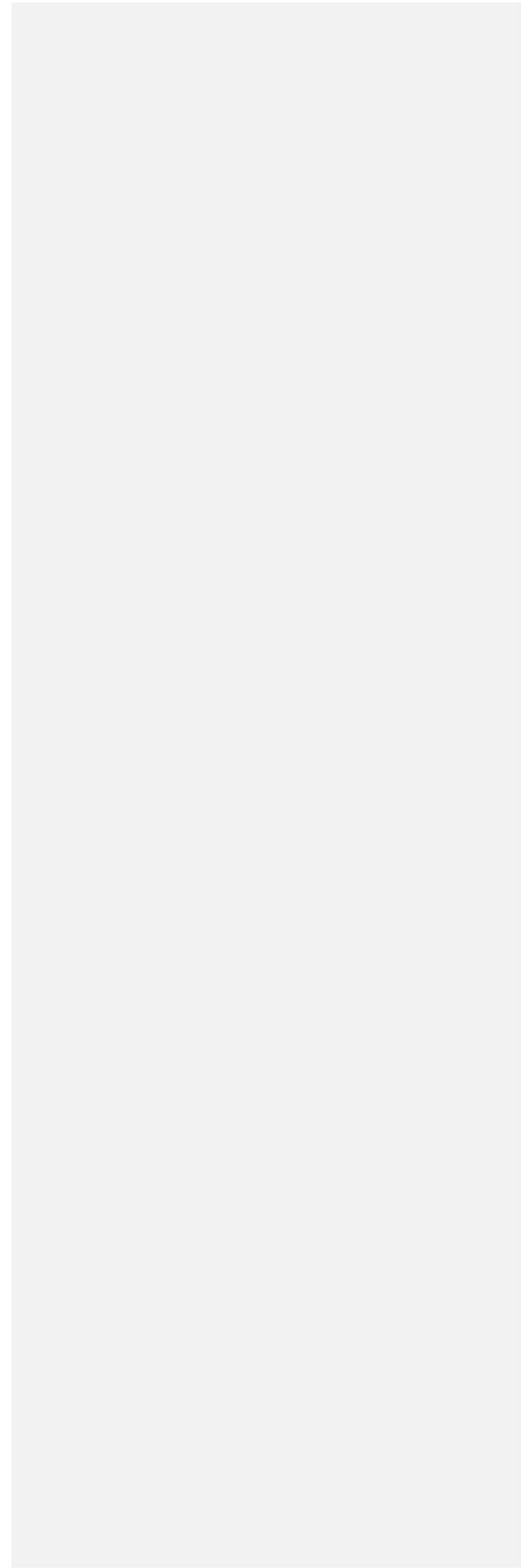
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Terms

AEA	<i>Atomic Energy Act of 1954</i>
CCU	Cold Creek Unit
CCU _r (lam-msv)	CCU fine-grained, laminated to massive; (the early Palouse soil)
CCU _g	CCU – gravel dominated
CCU _z	CCU – silt dominated
CSM	conceptual site model
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
Ecology	Washington State Department of Ecology
EMM	Elephant Mountain Member
EPA	U.S. Environmental Protection Agency
FWS	Field Work Supervisor
H1	Hanford formation unit 1
H2	Hanford formation unit 2
HEPA	high-efficiency particulate arrestance
LLWMA	Low-Level Waste Management Area
NAD83	<i>North American Datum of 1983</i>
NAVD88	<i>North American Vertical Datum of 1988</i>
OU	operable unit
PUREX	Plutonium-Uranium Extraction
QAPjP	quality assurance project plan
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
TBD	to be determined
TEDF	Treated Effluent Disposal Facility
TOC	total organic carbon
TOX	total organic halogen
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i> (Ecology et al., 1989a)
TRU	transuranic

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TSD treatment, storage, and disposal
UPR unplanned release
WMA waste management area



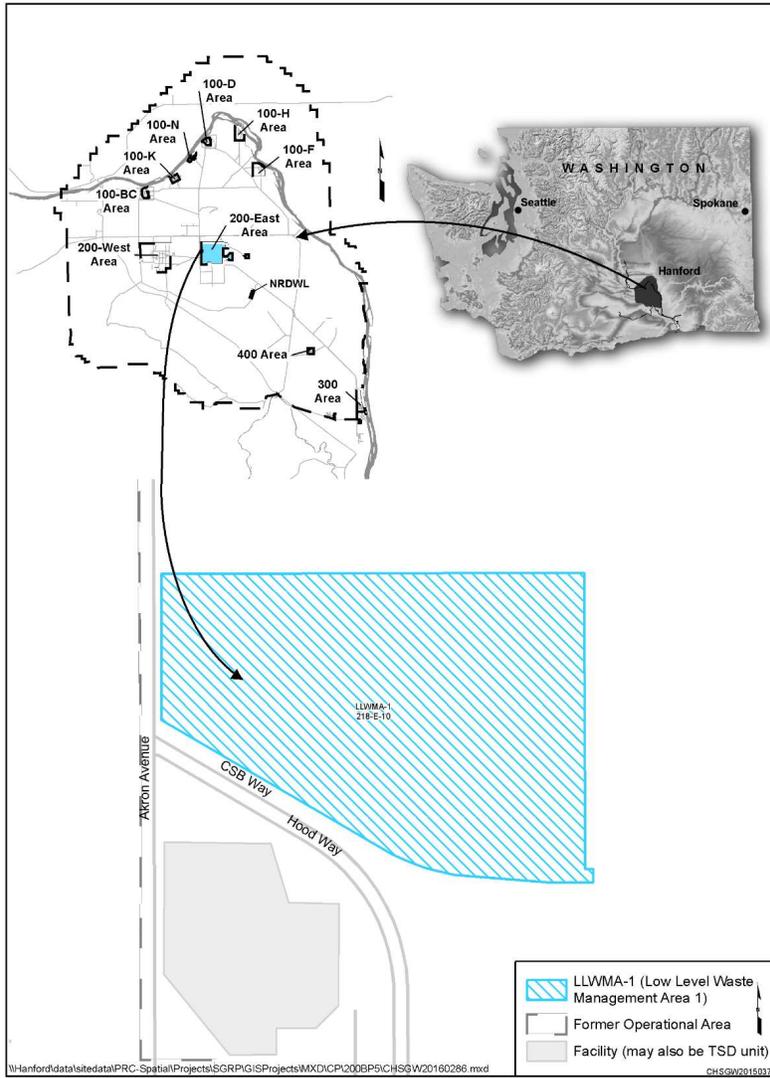
1 Introduction

This document presents the revised groundwater monitoring plan for the Low-Level Waste Management Area 1 (LLWMA-1) and supersedes the previous plan (DOE/RL-2009-75, Rev. 0, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*) (Figure 1-1). The U.S. Department of Energy (DOE), Richland Operations Office (DOE-RL), is revising this groundwater monitoring plan due to the age of the plan and to ensure that the plan contains the most current Hanford Site groundwater monitoring information for the treatment, storage, and disposal (TSD) unit (changes in groundwater flow direction and changes to the monitoring network). This groundwater monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA), with regulations promulgated by the Washington State Department of Ecology (Ecology) in the *Washington Administrative Code*, and the *Code of Federal Regulations* by reference (WAC 173-303-400, “Dangerous Waste Regulations,” “Interim Status Facility Standards;” 40 CFR 265, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” Subpart F, “Ground-Water Monitoring”). This plan is used to monitor the indicator parameters in groundwater samples that are used to determine whether dangerous waste or dangerous waste constituents have entered the groundwater. This plan is also used for monitoring the parameters used to establish groundwater quality.

LLWMA-1 is an inactive interim status TSD unit regulated as a landfill, as defined in WAC 173-303-040, “Definitions.” In accordance with Section I.A of WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (hereafter referred to as the Hanford Facility RCRA Permit), LLWMA-1 will continue to be considered an interim status unit until is it incorporated into Part III, V, and/or VI of the Hanford Facility RCRA Permit, or until interim status is terminated. Therefore, groundwater monitoring for LLWMA-1 continues under interim status requirements. For regulatory purposes, the TSD unit boundary of the LLWMA-1 is identified on the current Hanford Facility RCRA Permit Part A Form.

LLWMA-1 is located at the northwestern corner of the 200 East Area within the 200-SW-2 OU (Figure 1-1). LLWMA-1 consists of the 218-E-10 Burial Ground, originally planned for 19 trenches; however, only 14 trenches were excavated for waste disposal (Figure 1-2). Operating records indicate that LLWMA-1 received industrial waste from 1955 to 2000 and mixed waste from 1987 to 1993. The industrial waste shipments were from the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, T Plant, offsite (mainly Formerly Utilized Sites Remedial Action Program waste), and the 100 Areas (mainly N Reactor waste). Only portions of Trench 9 received mixed waste regulated under RCRA (Figure 1-2). The regulated RCRA mixed waste consists of di-octyl phthalate¹³ and lead.

¹³ Chemical Abstract Service number 117-84-0.



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Figure 1-1. LLWMA-1 in the 200 East Area

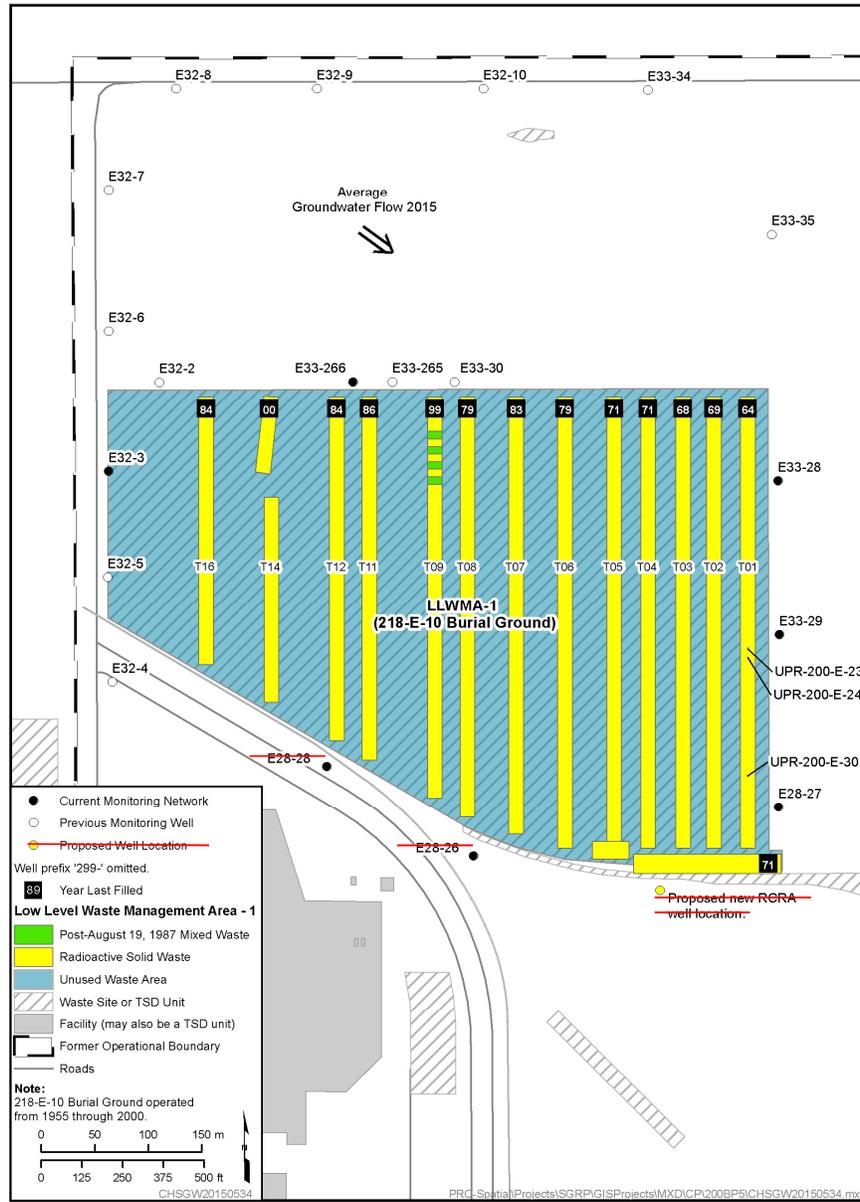


Figure 1-2. 218-E-10 Burial Ground at LLWMA-1

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1 The purpose of this groundwater monitoring plan is to present an updated groundwater monitoring
2 program for the parameters used as indicators of groundwater contamination and groundwater quality
3 from LLWMA-1, commonly referred to as an indicator evaluation program under interim status.
4 This plan is required by 40 CFR 265.90(a) and (b) and is intended specifically to satisfy monitoring
5 requirements for interim status TSD units, as required by WAC 173-303-400(3) and 40 CFR 265.92,
6 “Sampling and Analysis.” This monitoring plan is the principal controlling document for conducting
7 groundwater monitoring at the LLWMA-1. The indicator evaluation program detailed in this plan requires
8 semiannual sampling for parameters used as indicators of groundwater contamination, as well as and
9 annual sampling for parameters establishing groundwater quality for the two upgradient and ~~six three~~
10 downgradient wells. ~~One of the six downgradient wells will be a new well installed to monitor the~~
11 ~~southeast corner of LLWMA and will be sampled quarterly for one year.~~ Water level measurements are
12 also required each time a sample is collected in accordance with 40 CFR 265.92(e).

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13 This revised plan uses ~~seven five~~ existing groundwater monitoring wells from the previous monitoring
14 network ~~and proposes a new well be added to the well network for the total of eight wells~~ to address the
15 groundwater flow direction change. Future groundwater flow changes are possible as a result of the
16 200-BP-5 treatability test (DOE/RL-2010-74, *Treatability Test Plan for the 200-BP-5 Groundwater*
17 *Operable Unit*). The 200-BP-5 treatability test will be completed at a well located east of LLWMA-1 and
18 will use varying groundwater extraction rates to determine hydraulic parameters and existence of nearby
19 hydrogeologic boundary conditions.

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20 This groundwater monitoring plan addresses the operational history, current hydrogeology, and
21 conceptual site model (CSM) for the TSD unit and incorporates knowledge about the potential for
22 contamination originating from the LLWMA-1 and includes the following chapters and appendices:

- 23 • Chapter 2 summarizes background information and references other documents that contain more
24 detailed or additional information. It also describes LLWMA-1 and the regulatory basis, types of
25 waste present, the pertinent geology and hydrogeology beneath LLWMA-1; and it presents a brief
26 history of groundwater monitoring. This information is summarized as a CSM to aid in development
27 of the groundwater monitoring program.
- 28 • Chapter 3 describes the groundwater monitoring program, including the wells in the monitoring
29 network, constituents analyzed, sampling frequency, and sampling protocols.
- 30 • Chapter 4 describes data evaluation and reporting.
- 31 • Chapter 5 provides an updated outline for a groundwater quality assessment plan.
- 32 • Chapter 6 contains the references cited in this plan.
- 33 • Appendix A provides the quality assurance project plan (QAPjP).
- 34 • Appendix B contains sampling protocols.
- 35 • Appendix C provides information for the wells within the groundwater monitoring network.

2 Background

This chapter describes LLWMA-1 and its operating history, regulatory basis, waste and waste characteristics associated with LLWMA-1, local subsurface geology and hydrogeology, a summary of previous groundwater monitoring, and the CSM for LLWMA-1.

The information contained in this chapter was obtained from several sources including previous groundwater monitoring plans listed in Section 2.5, documents listed in Section 2.4, and the following documents:

- Furman, 1999, "Notification of Specific Conductance Exceedance at Low-Level Waste Management Area 1 (218-E-10)"
- DOE/RL-2004-60, *200-SW-2 Radioactive Landfills Group Operable Unit RCRA Facility Investigation/Corrective Measures Study/Remedial Investigation/Feasibility Study Work Plan*
- DOE/RL-2012-35, *First Determination RCRA Groundwater Quality Assessment Plan for Low-Level Burial Grounds Low-Level Waste Management Area-1*
- DOE/RL-2013-25, *First Determination RCRA Groundwater Quality Assessment Report for Low-Level Burial Grounds Low-Level Waste Management Area-1*
- DOE/RL-2014-43, *Mixed Waste Disposed of in the Low-Level Burial Grounds*
- PNNL-13404, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*

2.1 Facility Description and Operational History

Most of the information conveyed in this section is from DOE/RL-2004-60, which provides details regarding the beginning of disposal, site dimensions, types of waste disposed of, and disposal operating procedures. These are summarized as follows.

LLWMA-1 consists of the 218-E-10 Burial Ground and covers approximately 36.5 ha (90.2 ac), including a northern annexed portion. The 14 unlined trenches vary in length from 165 to 433 m (541 to 1,421 ft), as shown in Figure 1-2. The trenches are located in the southern portion of LLWMA-1, occupying approximately 23 ha (57 ac). All trenches are 4.6 m (15 ft) deep except Trench 1, which is 7.3 m (24 ft) deep (DOE/RL-2004-60). The northern annexed portion of LLWMA-1 was not used for disposal of waste (DOE/RL-2004-60 and SGW-48278, *Investigation of Unused Landfill Areas: 218-W-4C, 218-W-6, 218-E-10 and 218-E-12B*). The existing trenches received approximately 26,900 m³ (950,000 ft³) of waste. Based on the waste disposal depths, there is 73.4 to 82.8 m (241 to 272 ft) of vadose zone between the base of the trenches and groundwater. Solid waste received at the 218-E-10 Burial Ground was generally from the 200 East Area but also included 100 and 300 Areas material. A detailed listing of wastes disposed of to the 218-E-10 Burial Ground is provided in Appendix D of DOE/RL-2004-60. Most of the low-level waste appeared to have been associated with used 200 Area separation plant equipment (scrubbers, connectors, resin tanks, filters, pumps, tube bundles, columns, and centrifuges) but also included building demolition waste and debris. The building demolition waste and debris included concrete, roofing material, insulation, wood and other associated building items. Asphalt also was listed as part of the waste. Metals identified included aluminum, lead, stainless steel, and steel. Other miscellaneous materials included soil, dewatered sludge, and absorbent materials. Trench 9 (shown as T09 in Figure 1-2) is the only trench identified with mixed waste disposed after the effective date of mixed waste regulations. Based on the research conveyed in DOE/RL-2014-43 (Appendix G),

1 di-octyl phthalate and lead are the only dangerous waste constituents associated with waste storage at
2 LLWMA-1.

3 Packaging requirements were designed to prevent the spread of contamination to the environment, and are
4 discussed as follows. Initial disposal procedures were directed by HW-25457, *Manual of Radiation*
5 *Protection Standards*. The manual specifically provided packaging, handling, transport, and burial
6 procedures in order to minimize personnel exposure and prevent the spread of radioactivity to the
7 environment. These waste disposal procedures were more detailed and restrictive than earlier procedures
8 because of the increasing concern for contaminant releases to groundwater. By 1970, ARH-1842,
9 *Specification and Standards for the Burial of ARHCO Solid Wastes*, was implemented, which required the
10 segregation of transuranic (TRU) waste from non-TRU waste for retrieval within 20 years. Other notable
11 preventative packaging requirements included the following (DOE/RL-2004-60):

- 12 • Solid wastes were to be dry
- 13 • Damp wastes were to be packaged in an inner waterproof container
- 14 • Wood, cardboard, and fiberboard containers were to be banded for TRU waste
- 15 • Containers of waste containing easily airborne contaminants were to have an inner container such as
16 sheet plastic.

17 In 1977, two barriers for waste packages were imposed by RHO-CD-138, *Containment Barrier Criteria*.
18 TRU packaging was further refined in 1980 under the requirements of RHO-MA-222, *Hanford*
19 *Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, which required no loss of
20 containment for 25 years instead of the 20 years required by ARH-1842. Packing requirements continued
21 to increase throughout the years for protection of human health and the environment as discussed further
22 in DOE/RL-2004-60.

23 Liquid waste disposal at LLWMA burial grounds was considered minimal because bulk liquids could be
24 disposed to cribs, trenches, and underground storage tanks until 1973 (DOE/RL-2004-60). Damp wastes
25 were packaged in an inner waterproof container that was typically packaged with absorbent material
26 (DOE/RL-2004-60).

27 Because the nature of the material disposed was predominantly dry or sorbed onto media to reduce
28 mobility, the likelihood of contaminant migration below the trenches is expected to be low. Consideration
29 of the low annual precipitation and recharge rates further reduces the likelihood for contaminant
30 migration because infiltration is the driving mechanism (DOE/RL-2004-60).

31 Two unplanned releases (UPRs) occurred in the early 1960s (UPR-200-E-23 and UPR-200-E-30) in
32 Trench 1 (shown as T01 in Figure 1-2). The UPRs occurred due to the collapse of two wooden burial
33 boxes releasing high-level contamination. Dose levels were reported in supporting release documents
34 (HW-65935, *Chemical Processing Department Monthly Report For June, 1960*, page K-2, HW-84619,
35 *Summary of Environmental Contamination Incidents At Hanford, 1958-1964*, page 6, HW-69443,
36 *Chemical Processing Department Monthly Report April, 1961* pages B-3 and E-2) with maximum dose
37 readings of 60 and 500 mrem/hr, respectively. When UPR-200-E-23 was identified, the contamination
38 was fixed by spraying water or road oil over the affected area (UPR-200-E-24). One document
39 (HW-65935, page E-2) indicated that a conventional agricultural sprinkler system consisting of 366 m
40 (1,200 ft) of 10.3 cm (4 in.) irrigation pipe was installed in an effort to stabilize the ground contamination.
41 Rye seed was inferred to have been sown to form a root mat for preventing wind erosion. UPR-200-E-30
42 occurred during soil coverage, which was used to mitigate airborne contamination.

2.2 Regulatory Basis

In May 1987, DOE issued a final rule (10 CFR 962, “Byproduct Material”) stating that the hazardous waste components of mixed waste are subject to RCRA regulations. The hazardous waste components of mixed waste were determined to be subject to Ecology authority to regulate these waste since August 19, 1987.

In May 1989, DOE, the U.S. Environmental Protection Agency (EPA), and Ecology signed the Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site, which includes LLWMA-1. Groundwater monitoring is conducted at LLWMA-1 in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F), which requires monitoring to determine whether the dangerous waste constituents from the TSD unit have entered the groundwater in the uppermost aquifer underlying the TSD unit.

Dangerous waste is regulated under RCW 70.105, “Hazardous Waste Management,” and its implementing requirements in the Washington State dangerous waste regulations (WAC 173-303-400). Radionuclides in mixed waste may include source, special nuclear, and byproduct materials as defined in the *Atomic Energy Act of 1954* (AEA). AEA states that these radionuclide materials are regulated at DOE facilities, exclusively by the DOE, acting pursuant to its AEA authority. Radionuclide materials are not hazardous/dangerous wastes and, therefore, are not subject to regulation by the state of Washington under RCRA or RCW 70.105.

Groundwater monitoring at LLWMA-1 was initiated in 1986 (PNL-6772, *A Detection-Level Hazardous Waste Ground-Water Monitoring Compliance Plan for the 200 Areas Low-Level Burial Grounds and Retrieval Storage Units*) based on the interim status indicator evaluation program requirements of 40 CFR 265, Subpart F, and WAC 173-303-400. The groundwater monitoring plan was revised in 1989 (WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*), in 2004 (PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*), and again in 2009 (DOE/RL-2009-75, Rev. 0). A summary of the monitoring history is provided in Section 2.5 of this report, which explains the details behind the various monitoring performed over the past three decades. An indicator evaluation program that monitors parameters required for groundwater contamination detection continues to this day.

2.3 Waste Characteristics

The LLWMA-1 trenches began receiving shipments of industrial waste in 1955. The waste included low-level radiological waste, mixed low-level waste, and unsegregated remote-handled waste from PUREX, B Plant, T Plant, offsite (mainly Formerly Utilized Sites Remedial Action Program waste), and the 100 Areas (mainly N Reactor waste). The trenches received large items, often packaged in drag-off boxes (DOE/RL-2004-60). Radiological waste is not regulated under RCRA and is discussed herein for informational purposes only. The mixed industrial waste regulated under RCRA was disposed of into portions of Trench 9 from 1987 to 1993. Burial records for the mixed waste include approximately 13 kg (30 lbs) of di-octyl phthalate impregnated high-efficiency particulate arrestance (HEPA) filters and approximately 550 kg (1,200 lbs) of lead (DOE/RL-2014-43). The mixed waste was contained in either concrete or plastic and fiberboard burial boxes. The plastic and fiberboard burial boxes were grouted. The trenches were backfilled on a daily or weekly basis, and LLWMA-1 stopped receiving waste in 2000.

2.4 Geology and Hydrogeology

The geology and hydrogeology of the 200 East Area, including the region of LLWMA-1, are described in detail in the following documents:

- DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*
- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds-An Interim Report*
- PNL-8889, *Solid-Waste Leach Characteristics and Contaminant-Sediment Interactions*
- PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- PNNL-19277, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*
- PNNL-19702, *Hydrogeologic Model for the Gable Gap Area, Hanford Site*
- RHO-BW-SA-318 P, *Paleodrainage of the Columbia River System on the Columbia Plateau of Washington State: A Summary*
- RHO-BWI-ST-4, *Geologic Studies of the Columbia Plateau, A Status Report*
- WHC-MR-0204, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report*
- WHC-MR-0205, *Borehole Completion Data Package for the Low-Level Burial Gounds-1990*
- 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-EN-EV-024, *Site Characterization Report for the Liquid Effluent Retention Facility*
- WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*

2.4.1 Stratigraphy

The suprabasalt sediment of the northwest corner of the 200 East Area, specifically the area of LLWMA-1, was initially investigated and reported in detail in PNL-6820 and supporting documents WHC-MR-0204, WHC-MR-0205, WHC-SD-EN-DP-044, and WHC-SD-EN-DP-049. Since the time of these reports, the stratigraphic terminology for the suprabasalt sediments has evolved, including a new lithologic unit, the Cold Creek Unit (CCU) as described in Section 2.4.1.3. The following subsections describe the stratigraphic units present beneath LLWMA-1, from deepest to shallowest.

2.4.1.1 Elephant Mountain Member Basalt

The Columbia Plateau is recognized as the Earth's youngest flood-basalt province, formed between 6 and 16.5 million years ago (RHO-BW-SA-318P). Several individual flows occurred over the 10 plus million

1 years, and the uppermost flow in the area of LLWMA-1 is the Elephant Mountain Member (EMM) of the
2 Saddle Mountains Basalt units. The EMM has been characterized as consisting of two flows that erupted
3 approximately 10.5 million years ago. In the region near LLWMA-1, the younger EMM flow is not
4 present (RHO-BWI-ST-4); however, the oldest EMM flow (Elephant Mountain I) is continuous
5 throughout the area.

6 Regionally, Elephant Mountain I has been reported to range in thickness from approximately 12 m (39 ft),
7 where partially eroded, to greater than 35.1 m (115 ft) north of the eastern part of the 200 East Area
8 (WHC-SD-EN-EV-024). Closer to LLWMA-1, four wells (299-E33-12, 299-E33-40, 299-E33-50, and
9 299-E33-340) have extended through Elephant Mountain I with an average thickness of 15.3 m (50 ft).
10 The reason Elephant Mountain I was eroded in this area is the meandering nature of the ancestral
11 Columbia River across the Pasco Basin, including the southern flank of the Gable Butte/Gable Mountain
12 anticlinal first-order fold. Beneath the 218-E-10 Burial Ground, the basalt dips predominantly to the
13 southwest as shown in Figure 2-1.

14 **2.4.1.2 Ringold Formation**

15 The Ringold Formation beneath LLWMA-1 comprises only the relict basal Ringold fluvial sediments,
16 unit A. PNNL-12261 refined the hydrostratigraphic conceptual model for the 200 East Area Ringold
17 Formation through visual depictions and definition of three Ringold unit A subunits. Only the oldest
18 subunit, 9C, has been defined near LLWMA-1 (PNNL-12261). Younger Ringold Formation units were
19 also deposited at LLWMA-1; however, a Columbia River course change in the Columbia River Gorge
20 about 2 to 3.4 million years ago began a headward erosion of the Ringold Formation
21 (RHO-BW-SA-318-P), leaving only a thin remnant of the low hydraulic conductive Ringold unit 9C in
22 the southwest portion of the LLWMA-1 network (Figure 2-1).

23 The primary characteristic used to differentiate Ringold Formation basal gravel from the overlying Cold
24 Creek gravel-dominated facies is its significantly lower hydraulic conductivity and slower drilling rate
25 when hard tooling with a cable tool drill rig. The consolidated condition of the Ringold Formation gravels
26 stems from the millions of years of in situ weathering and groundwater contact (PNNL-19702). As a
27 result, granitic and gneissic clasts, which are friable in such environments, can be transformed into low to
28 moderate binding cements through diagenesis.

29 Geologist observations and hydraulic data confirm Ringold Formation gravels only in the lower portions
30 of the southwestern wells (PNNL-6820 and PNNL-12261). Because of the elevation and location of these
31 sediments, they do not play a role in groundwater monitoring at LLWMA-1. This is shown in Figure 2-1,
32 where the Ringold Formation sediments are located within the deeper part of the aquifer and below the
33 well screens in this area.

34 **2.4.1.3 Cold Creek Unit**

35 The suprabasalt CCU sediments disconformably overlie both Ringold unit 9C and the Elephant Mountain
36 basalt and contain two facies: the lower gravel-dominated and upper silt-dominated units. These
37 sediments were formerly referred to as the "Plio-Pleistocene unit" and "pre-Missoula Gravels," as well as
38 the "early Palouse soil." The nomenclature was derived in order to define sediments generally confined to
39 the boundaries of the Cold Creek syncline (DOE/RL-2002-39). The lower gravel unit extends generally
40 from the basalt interface to 10 or more meters above the water table. The exception is in the southwest
41 corner, where the Ringold unit 9C gravels exist.

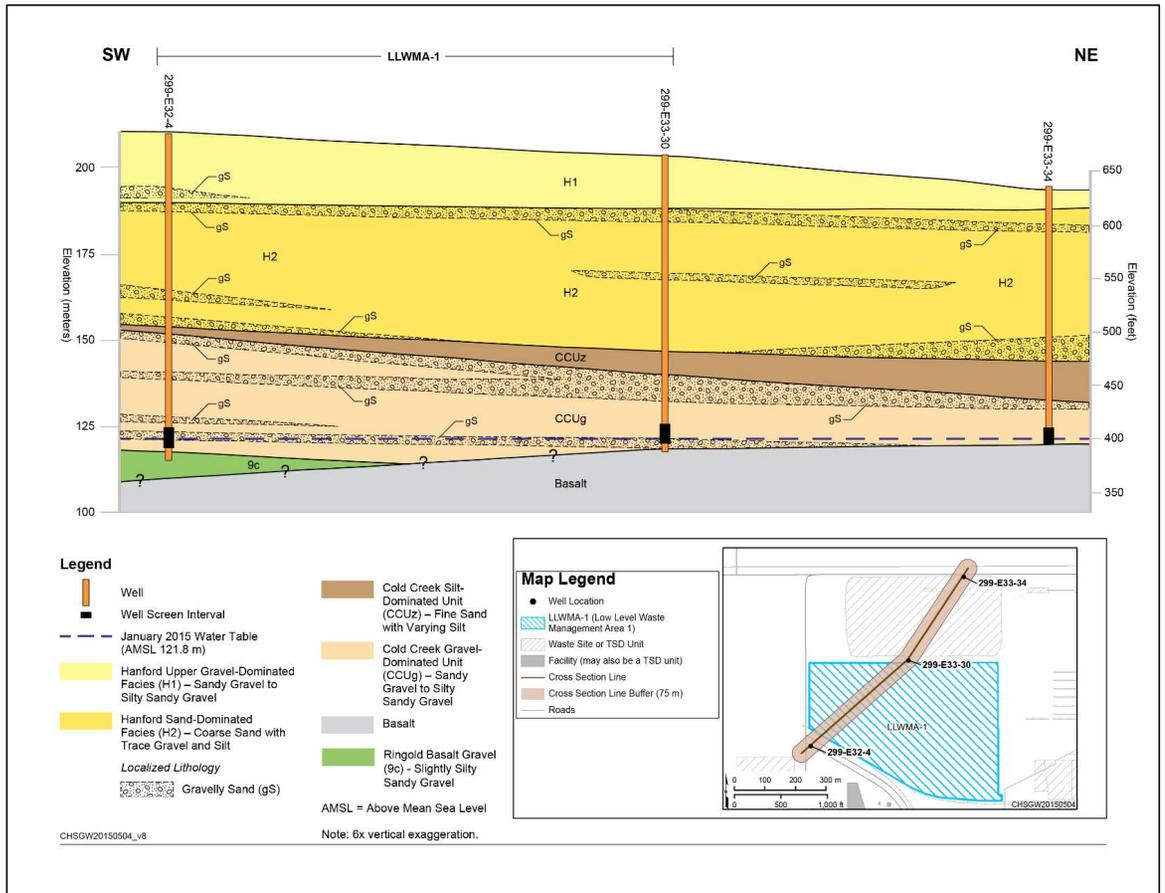
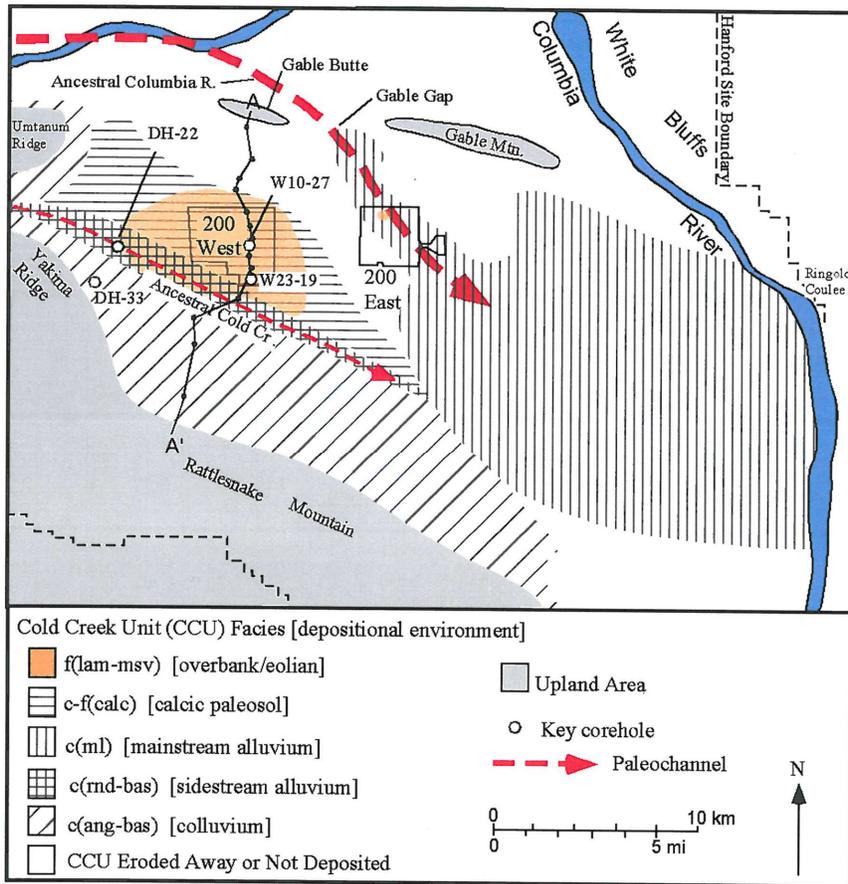


Figure 2-1. Geologic Cross-Section of Suprabasalt Sediments and Underlying EMM Extending from the Northeast to the Southwest Corner of LLWMA-1

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1 **2.4.1.3.1 Cold Creek Unit - Gravel Dominated**

2 The CCU - gravel-dominated (CCU_g) deposition began between 2 and 3.4 million years ago, as the
 3 ancestral Columbia River neared the basal incision depth through possibly 200 m (600 ft) of Ringold
 4 Formation sediments in the central portion of the Pasco Basin. Near and beneath the 218-E-10 Burial
 5 Ground, a gravel train of Cold Creek sediments marks one interpreted ancestral Columbia River pathway
 6 through the Gable Butte/Gable Mountain Gap and into the 200 East Area (Figure 2-2).
 7



8
 9 **Figure 2-2. 2002 Interpretation of Cold Creek Depositional Extent**
 10

1 The Cold Creek gravels are best distinguished from the underlying Ringold unit 9C sediments by the
2 significantly higher hydraulic conductivity and higher drilling rate. In addition, the CCU_g generally lacks
3 significant weathering and consolidation, due to its younger age.

4 The Cold Creek gravels beneath LLWMA-1 range from silty sand to sandy gravel and increase in
5 thickness to the west (Figures 2-3 through 2-5). The facies' upper boundary was based primarily on the
6 sieve analysis completed during drilling of the initial eight monitoring wells. Sieve analyses were not
7 performed as thoroughly during drilling of the more recent monitoring wells, and when comparing
8 geologist observations to the sieve analysis, there is usually a 5 to 10 percent difference in the sediment
9 composition. There are a various number of fining-upward sequences within the CCU_g, ranging from
10 three to seven identifiable layers, based on sieve analyses.

11 Wells to the west have gravel content ranging from 40 to 70 percent, while wells to the east have gravel
12 content ranging from nearly zero to 30 percent. Thus, it appears that dispersive effects within the
13 groundwater will be greater along the east side of LLWMA-1 than along the west side.

14 **2.4.1.3.2 Cold Creek Unit - Silt-Dominated**

15 The CCU - silt-dominated (CCU_z) facies is continuous beneath the 218-E-10 Burial Ground and is known
16 to extend to the east beneath WMA B-BX-BY. DOE/RL-2002-39 indicates that this unit can grade from
17 fluvial to alluvial overbank and eolian deposits laterally (e.g., CCU_f [lam-msv] CCU_z [early Palouse
18 soil]). The structure of the sediments during this gradation is described as transitioning from laminated to
19 massive.

20 The CCU_z facies beneath the 218-E-10 Burial Ground ranges from a fine-grained sand to sandy silt based
21 on sieve analyses. The unit thickness is consistent across the site but increases in elevation to the west
22 (Figures 2-3 through 2-5). The silt content generally ranges from 2.4 to 17 percent; however, the silt range
23 at wells 299-E28-26 and 299-E33-30 is up to 47.6 and 65.8 percent, respectively. The highest silt content
24 is found in the base of the unit, and sediment size increases with elevation. The sand content ranges from
25 75 to 97 percent, except where the higher silt content is observed. Calcium carbonate content ranges from
26 none to a few percent. Where higher calcium carbonate content is found, clumps of silt and sand were
27 generally reported.

28 **2.4.1.4 Hanford Formation**

29 The Hanford formation is the informal name for the glacio-fluvial deposits from cataclysmic Ice Age
30 floods. Sources for floodwaters included Glacial Lake Missoula, pluvial Lake Bonneville, and ice-margin
31 lakes that formed around the margins of the Columbia Plateau (Baker et al., 1991, "Quaternary Geology
32 of the Columbia Plateau"). The last Ice Age floods occurred about 15,000 years ago; the earliest may
33 have been 1 to 2 million years ago (Bjornstad, 2006, *On the Trail of the Ice Age Floods: A Geological
34 Field Guide to the Mid-Columbia Basin*). The Hanford formation consists of mostly unconsolidated
35 sediments that cover a wide range in grain size, from pebble to boulder-size gravel, fine- to
36 coarse-grained sand, silty sand, and silt. The Hanford formation is subdivided further into gravel and
37 sand-dominated facies, which transition into one another laterally with distance from the main,
38 high-energy flood currents (PNNL-19277).

39

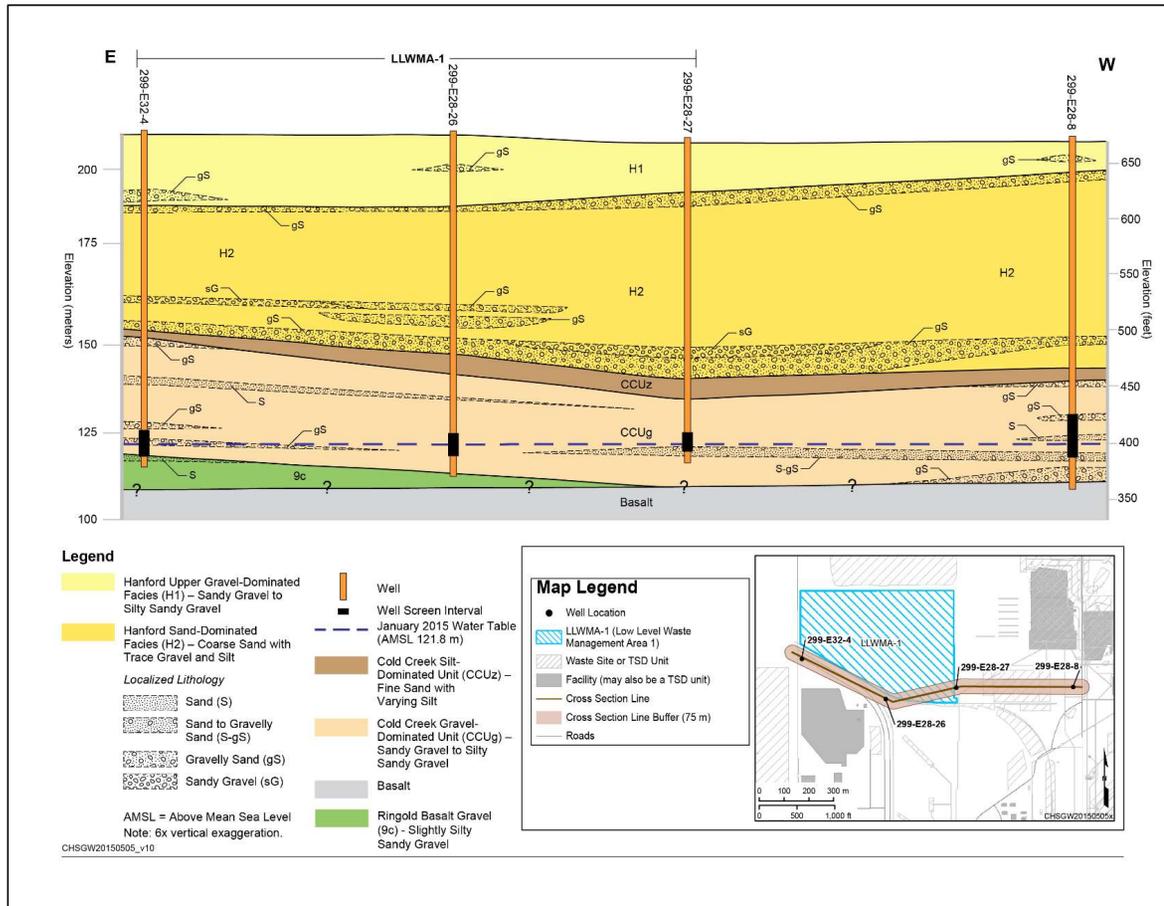


Figure 2-3. Geologic Cross-Section of Suprabasalt Sediments and Underlying EMM Extending from West to East along the LLWMA-1 Southern Boundary

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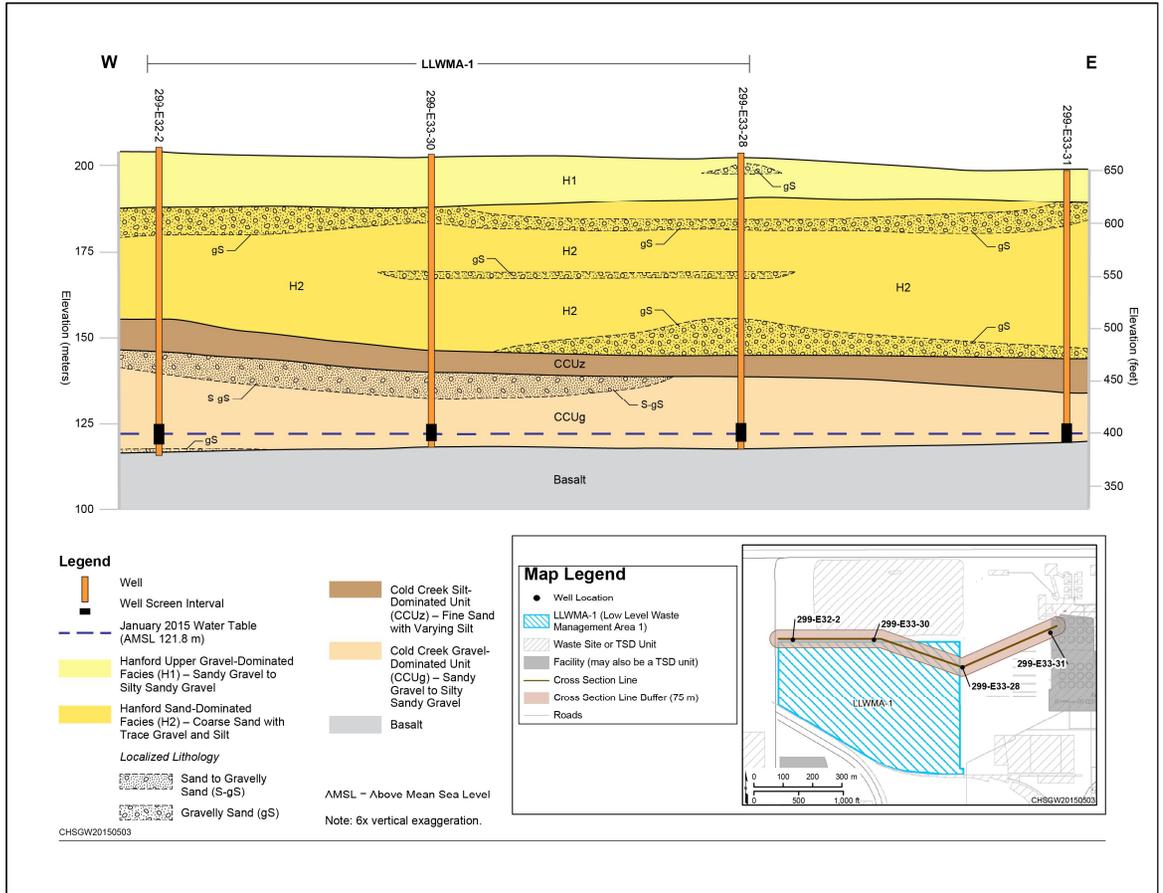


Figure 2-4. Geologic Cross-Section of Suprabasalt Sediments and Underlying EMM Extending from West to East within the Central Portion of LLWMA-1

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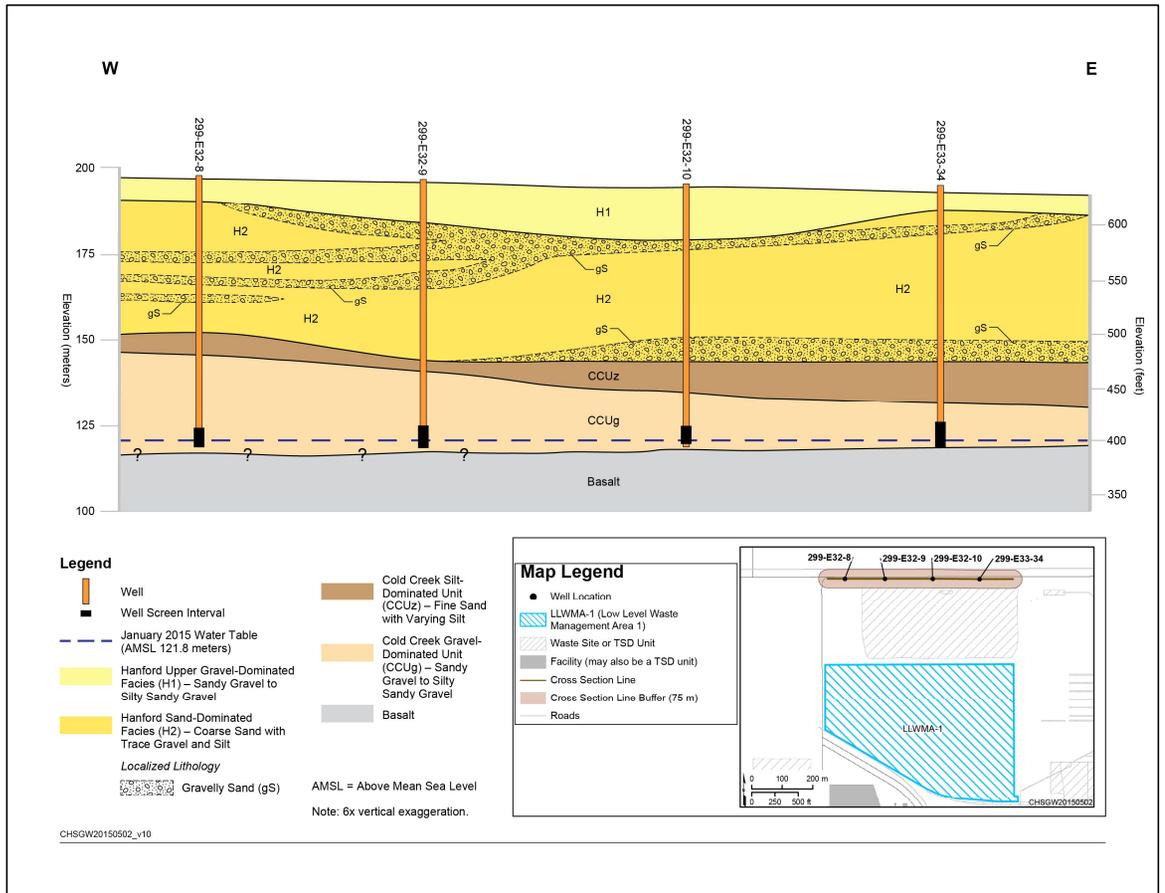


Figure 2-5. Geologic Cross-Section of Suprabasalt Sediments and Underlying EMM Extending from West to East along the LLWMA-1 Northern Boundary

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1 **2.4.1.4.1 Hanford Formation Sand-Dominated Unit**

2 The Hanford formation unit 2 (H2) sand-dominated sequence deposition is considered the result of
3 slowing flood currents south of Gable Gap (PNNL-19702). The buildup of the sand facies beneath the
4 218-E-10 Burial Ground was associated conceptually with aggregation of a significant suspended
5 sediment load within the flood currents that exceeded the preflood river banks. As the sediment-loaded
6 floodwaters diverged from the primary channel, the flow slowed, resulting in vertical accretion.
7 Figure 2-6 shows the relationship of the various flood channels, the deposition of gravel-dominated main
8 channel flood deposits, and the areas of sand-dominated aggregation. Figure 2-7 provides the extent of the
9 sand-dominated facies in relation to the 200 East Area, including LLWMA-1.

10 The H2 sand-dominated sequence overlies the CCU₂ at LLWMA-1. Silty sand or silt is occasionally
11 observed near the top of the graded sand to gravelly sand sequences. Cementation is minor or absent in
12 the H2, and total calcium carbonate content is generally a few weight percent or less.

13 The H2 sand-dominated facies under the 218-E-10 Burial Ground thickens slightly from west to east,
14 ranging from 35 to 47 m (115 to 155 ft), respectively. Locally fine-grained lenses are apparent; however,
15 based on sieve analysis, the lenses do not appear to be continuous beneath the site.

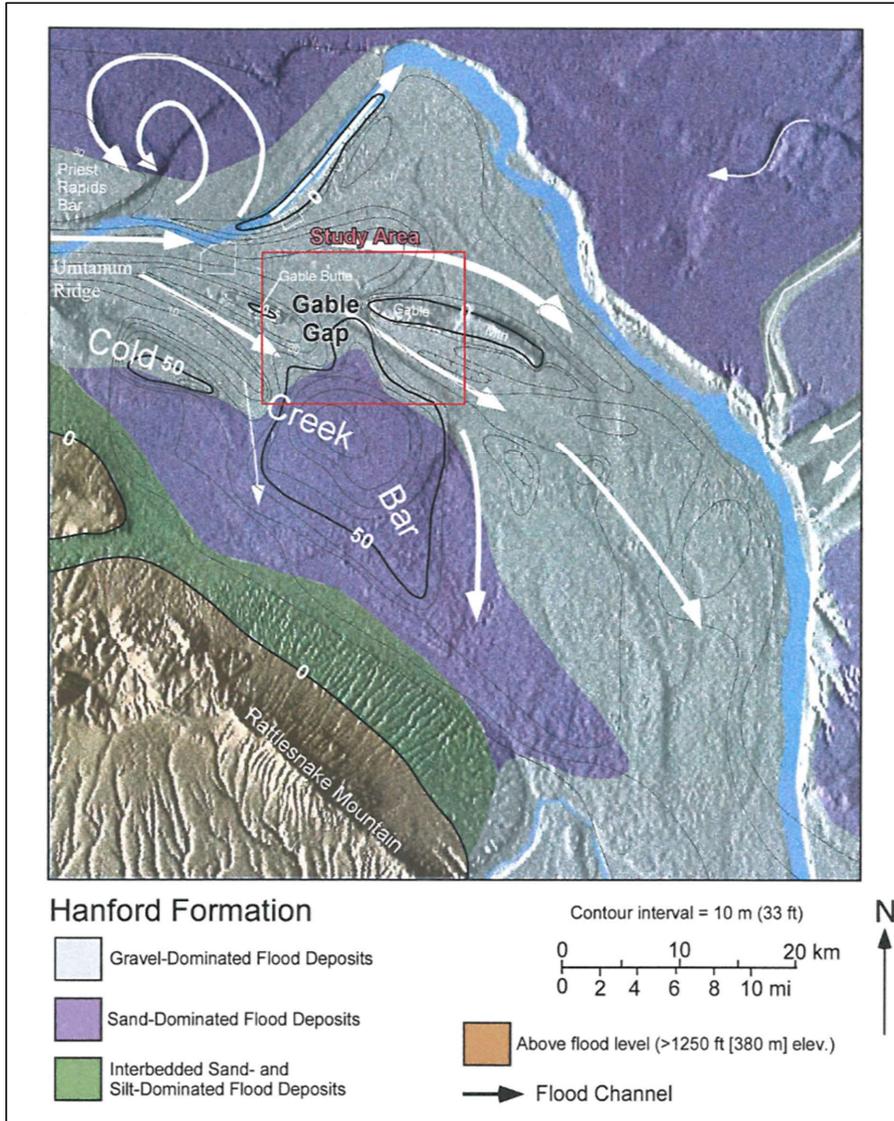
16 Regionally, PNNL-19277 defined the mean bulk density, porosity, and effective porosity of the H2
17 sand-dominated facies as 1.77 g/cm³, 0.2515 cm³/cm³, and 0.2207 cm³/cm³, respectively. The field
18 capacity result provided in PNNL-19277 was 0.0842 cm³/cm³. The longitudinal and transverse
19 dispersivity was also provided, and the ratio was 0.1.

20 **2.4.1.4.2 Hanford Formation Gravel-Dominated Unit**

21 The Hanford formation unit 1 (H1) gravel-dominated sequence overlies the H2 sand-dominated sequence.
22 The H1 gravel-dominated sequence consists of the high-energy gravels with subordinate lenticular and
23 discontinuous layers of the sand and silt. The maximum thickness of the H1 reflects a northeast-
24 southwest-trending trough (i.e., channel) through LLWMA-1 (Figures 2-3 through 2-5). The maximum
25 thickness of the H1 in this trough is about 23 m (75 ft) (Figure 2-4). Regionally, PNNL-19277 defined the
26 mean bulk density, porosity, and effective porosity of this unit as 2.07 g/cm³, 0.1207 cm³/cm³, and
27 0.1027 cm³/cm³, respectively. Field capacity and longitudinal to transverse dispersivity was also provided
28 in PNNL-19277 at 0.0741 cm³/cm³, with a ratio of 0.1.

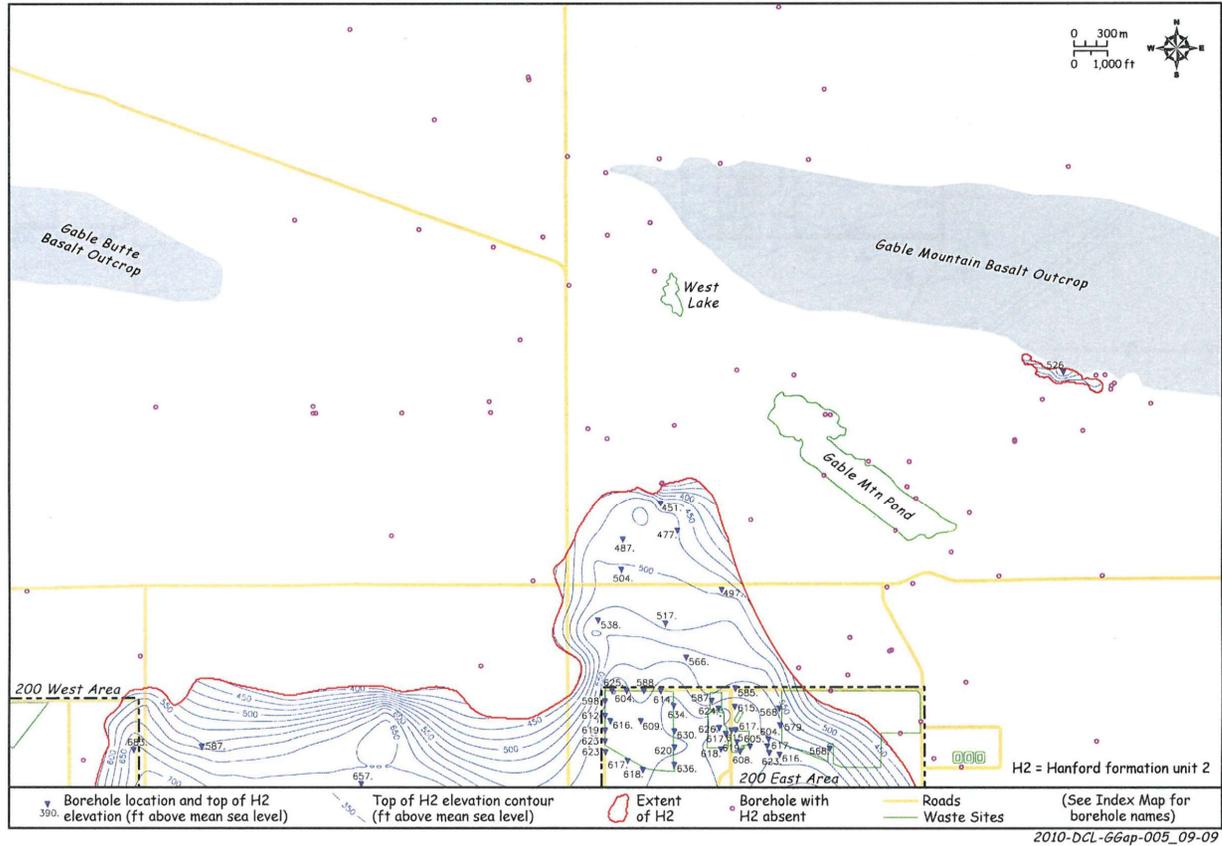
29 **2.4.2 Hydrogeology**

30 The vadose zone beneath LLWMA-1 consists of Hanford formation and Cold Creek suprabasalt
31 sediments. The Hanford formation consists of the upper gravel-dominated (H1) and lower
32 sand-dominated (H2) facies (Section 2.4.1). Neither of these facies appears to contain sufficient silt layers
33 to establish a perched water horizon beneath LLWMA-1. However, underlying the H2 sand-dominated
34 facies is the CCU₂, which is associated with a perched water horizon to the east of LLWMA-1. As
35 discussed in Section 2.4.1, the CCU₂ facies beneath LLWMA-1 dips from west to east and, at the base of
36 the unit, is a continuous silty sand to sandy silt layer. The silt content at the base of the unit, according to
37 sieve analysis, ranges from 10 to more than 50 percent silt or finer sediments. The highest measured silt
38 percentage was at wells 299-E28-26 and 299-E33-30, with 48 and 64 percent, respectively. Perched water
39 conditions were not seen during drilling of the boreholes used to set the LLWMA-1 monitoring well
40 network. Historical review of the area indicates that waste disposal was dry. Even if a large number of
41 208 L (55 gal) drums (e.g., 48) storing liquid waste were stored in a 9.3 m² (100 ft²) area of one of the
42 trenches and all the content were released to the underlying soils, the total liquid released would be less
43 than 1 percent of the effective porosity to the basal silt unit of the CCU₂. Thus, it appears that a perched
44 water horizon should not develop beneath this site.



Source: PNNL-19702, *Hydrogeologic Model for the Gable Gap Area, Hanford Site*.

1
 2
 3
 4 **Figure 2-6. Distribution of Cataclysmic Hanford Formation Flood Deposits within the Central Pasco Basin**



Source: PNNL-19702, *Hydrogeologic Model for the Gable Gap Area, Hanford Site*.
 Note: Contour intervals = 25 ft (7.6 m)

Figure 2-7. Top of the (Sand-Dominated) H2 Unit

1 The unconfined aquifer directly beneath LLWMA-1 ranges in thickness from 1.7 m (5.6 ft) at the
2 northeast corner to an estimated 15 m (49.2 ft) at the southwest corner (Figure 2-1). The water table was
3 approximately 3 m (10 ft) higher in elevation in 1988 than in January 2015 but did not reach the bottom
4 of the CCU_z. Thus, residual moisture from previous elevated anthropogenic groundwater mounds only
5 affected the CCU_g.

6 The unconfined aquifer is primarily contained within the CCU_g as discussed in Section 2.4.1.
7 The sediments are transmissive, as determined from previous hydraulic testing, in which the hydraulic
8 conductivity ranged from greater than 400 m/day (1,300 ft/d) (PNL-6820).

9 The general groundwater chemistry beneath LLWMA-1 displays calcium bicarbonate-dominated
10 composition. However, the chemical composition varies where past plumes from the south and east have
11 migrated beneath LLWMA-1. The most affected wells, 299-E32-5 to the southeast and 299-E32-10,
12 299-E33-34, and 299-E33-35 to the northwest, display a calcium bicarbonate-sulfate chemical
13 composition. The sulfate signature dissipates with distance from these wells. This chemical signature
14 indicates that all the wells are hydraulically connected, and that the dispersive effects of migrating plumes
15 are laterally sufficient to be observed in neighboring wells. Based on these observations it appears the
16 monitoring network is sufficient to detect contaminant infiltration into the aquifer beneath LLWMA-1;
17 ~~with the exception of the southeast corner between wells 299-E28-26 and 299-E28-27. Chapter 3~~
18 ~~discusses the resolution of this deficiency.~~

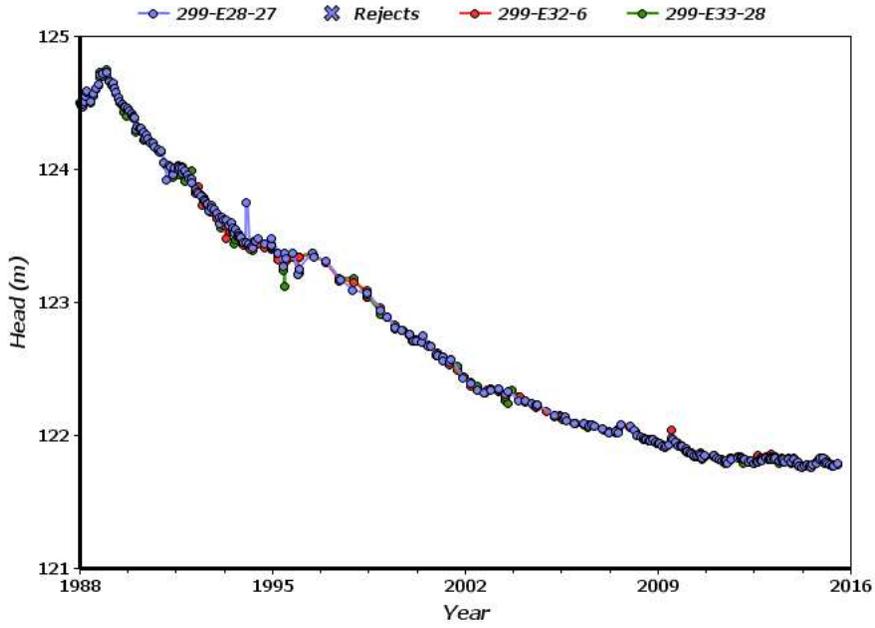
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19 2.4.3 Groundwater Flow Interpretation

20 In the northwest corner of the 200 East Area, including the area of LLWMA-1, the direction of
21 groundwater flow has varied due to changes in liquid waste discharges. During the operational period of
22 the Hanford Site, recharge mounds from Gable Mountain Pond and B Pond caused groundwater to flow
23 to the northwest. The mounds began to dissipate in the late 1980s, when Hanford Site actions were
24 curtailed, and cooling water discharges to Gable Mountain Pond ceased. As discharges to B Pond were
25 also curtailed and eventually terminated, the groundwater mound within the 200 East Area dissipated in
26 elevation, as shown in Figure 2-8, for LLWMA-1 wells 299-E28-27, 299-E32-6, and 299-E33-28.
27 Initially, groundwater levels dropped rapidly, and contaminant plumes within the 200 East Area migrated
28 northwest toward the northwest corner of the 200 East Area and into the Gable Gap and beyond. As the
29 water table in the 200 East Area continued to decline, the groundwater gradient and direction became
30 increasingly difficult to determine. Between 2008 and 2011, the determination of groundwater flow
31 direction and magnitude was generally uncertain. Occasionally, the propagation of Columbia River spring
32 runoff was transmitted through the permeable Cold Creek gravel train (Section 2.4.1), extending into the
33 200 East Area through the Gable Gap, causing a statistically significant gradient and flow direction to the
34 south. From mid-2011 to early 2015, a perpetual southward flow direction has been maintained. Even in
35 2014, when five separate months of significant discharges ($>10^8$ L/month) of cooling water at the Treated
36 Effluent Disposal Facility (TEDF) (located southeast of the 200 East Area) occurred, a statistically
37 significant southward flow direction was maintained (Figure 2-9). The average groundwater flow
38 direction in 2014 at LLWMA-1 was to the southeast, with an azimuth from north of 159°. Further details
39 of the calculation of flow direction are provided in ECF-200E-12-0086, *Calculations in Support of the*
40 *Low Hydraulic Gradient Evaluation Study for the 200 East Area Unconfined Aquifer*. Although the water
41 table has declined significantly in the past, from January 2012 to January 2015, the water table has not
42 shown a significant decline at LLWMA-1 wells 299-E28-27, 299-E32-6, and 299-E33-28 (Figure 2-8).

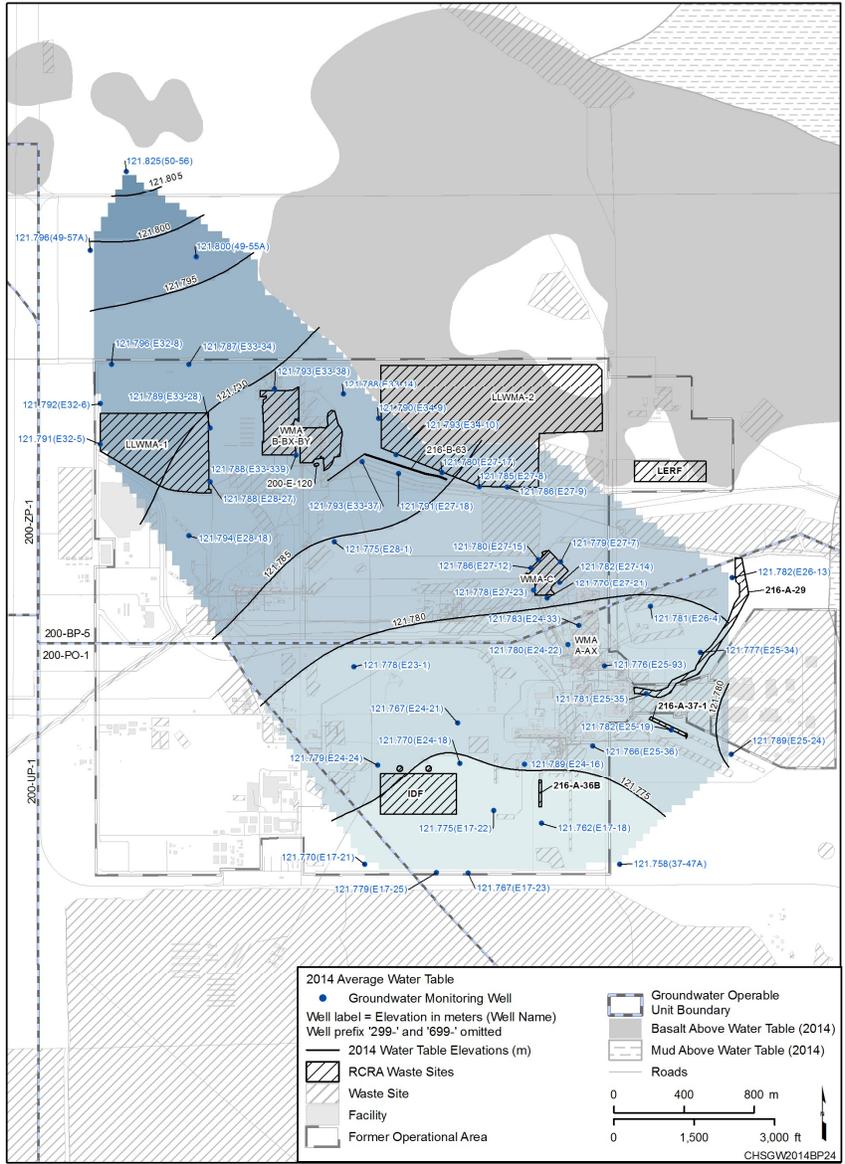
43

Triple Head Plot



1
2
3

Figure 2-8. Water Table Elevations at LLWMA-1 Wells 299-E28-27, 299-E32-6, and 299-E33-28



1
 2 **Figure 2-9. 2014 Annual Average 200 East Water Table Elevations and Interpreted Water Table Isoleths**

1 **2.5 Summary of Previous Groundwater Monitoring**

2 Table 2-1 lists the previous groundwater monitoring plans implemented at LLWMA-1.

Table 2-1. Previous Monitoring Plans

Document	Date Issued	Monitoring Program ^a
PNL-6772, <i>A Detection-Level Hazardous Waste Ground-Water Monitoring Compliance Plan for the 200 Areas Low-Level Burial Grounds and Retrievable Storage Units</i>	February 1987	Indicator Evaluation Program
WHC-SD-EN-AP-015, <i>Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds</i>	August 1989	Indicator Evaluation Program
WHC-SD-EN-AP-021, <i>Interim-Status Ground-Water Quality Assessment Program Plan for Waste Management Area 1 of the 200 Areas Low-Level Burial Grounds</i>	January 1990	Interim-Status Groundwater Quality Assessment Program
DOE/RL-2009-75, <i>Interim Status Groundwater Monitoring Plan for the LLBG WMA-1</i>	December 2009	Indicator Evaluation Program
DOE/RL-2012-35, Rev. 0, <i>First Determination RCRA Groundwater Quality Assessment Plan for Low-Level Burial Grounds Low-Level Waste Management Area-1</i>	September 2012	First Determination Plan implementing Groundwater Quality Assessment Program
DOE/RL-2009-75, Rev. 0, <i>Interim Status Groundwater Monitoring Plan for the LLBG WMA-1</i>	Reinstated in 2013 ^b	Indicator Evaluation Program

a. The Indicator Evaluation Program satisfies the requirements of 40 CFR 265.92(b)(2), (b)(3), (d)(1), (d)(2), and (c), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." The groundwater quality assessment program's first determination satisfies the requirements of 40 CFR 265.93(d)(4) and (d)(6), "Preparation, Evaluation, and Response."

b. DOE/RL-2009-75, Rev. 0, reinstated in 2013 when LLWMA-1 returned to an indicator evaluation program as reported in DOE/RL-2013-25, *First Determination RCRA Groundwater Quality Assessment Report for Low-Level Burial Grounds Low-Level Waste Management Area-1*.

LLWMA = Low-Level Waste Management Area

3
 4 A detection-level groundwater monitoring well construction plan was initiated at LLWMA-1 in 1986 in
 5 accordance with PNL-6772 (WHC-SD-EN-AP-015). PNL-6772 established the construction criteria of
 6 eight initial monitoring wells at LLWMA-1. The well configuration was initially designed to reflect
 7 long-term groundwater flow directions (e.g., east to west or east to northwest) (PNL-6772 and
 8 WHC-SD-EN-EV-AP-015). The well screens for LLWMA-1 were designed to monitor the top portion of
 9 the uppermost aquifer (WHC-SD-EN-AP-015), extending from above the unconfined aquifer to 2 to 3 m
 10 (7 to 10 ft) into the unconfined aquifer. All eight of the wells that were in place at the 1987 time period
 11 were constructed in compliance with WAC 173-160, "Minimum Standards for Construction and
 12 Maintenance of Wells."

13 Detection monitoring for initial background indicator parameters (e.g., total organic carbon, total organic
 14 halides, pH, and specific conductivity) began at the initial eight wells in September/October 1988

1 (WHC-SD-EN-AP-021). The delay between well completion and background sampling was because of
2 mechanical problems with pump installation and personnel limitations (PNL-6675, *Ground-Water*
3 *Monitoring Compliance Projects for Hanford Site Facilities: Progress Report for the Period April 1 to*
4 *June 30, 1988*). From September/October 1988 to September/October 1989, quarterly background
5 groundwater quality and indicator parameter samples were collected. The year of background indicator
6 parameter results was used to develop a 0.01 level of significance, critical mean, for each indicator
7 parameter from the upgradient monitoring wells (299-E28-27, 299-E33-28, and 299-E33-29), as directed
8 by 40 CFR 265.93(b), "Preparation, Evaluation, and Response."

9 An indicator evaluation monitoring plan, WHC-SD-EN-AP-015, was developed in 1989 to provide
10 direction for commencement of detection monitoring and improvement of the spatial coverage of the
11 groundwater monitoring network. Four additional wells were defined to improve the spatial coverage at
12 LLWMA-1: one well in 1989 and three wells in 1990 (WHC-SD-EN-EV-AP-015). Two of the four wells
13 were located along the boundary of a north expansion area for future disposal. However, the north
14 expansion area was never used.

15 The derived background comparison value, critical mean, for specific conductance was exceeded in well
16 299-E28-26 (located along the south boundary of LLWMA-1) in September 1989. Verification sampling
17 confirmed the exceedance, and an interim status groundwater quality assessment program was initiated as
18 outlined in WHC-SD-EN-AP-021. The quarterly assessment monitoring extended until April 1994,
19 except between June 1990 and June 1991, when laboratory services were unavailable. Quarterly
20 assessment sampling results provided evidence that LLWMA-1 did not contribute to the elevated specific
21 conductance (WHC-SD-EN-EV-025, *Results of Groundwater Quality Assessment Program at Low-Level*
22 *Waste Management Area 1 of the Low-Level Burial Grounds*); rather, liquid waste disposal facilities to
23 the south were identified as the most probable sources. The sampling frequency changed to semiannual in
24 1994 and remained semiannual until 2000.

25 Five additional wells were added to the network: four wells in 1991 and one well in 1992. The additional
26 wells installed in 1991 and 1992 were designed to encompass the LLWMA-1 boundary, which included
27 the northern expansion area, and to provide sufficient coverage for potential groundwater flow direction
28 changes. Another specific conductance exceedance was found; encountered in the northeast well
29 299-E33-34 in December 1998. A notification letter and an assessment report were submitted to Ecology
30 in March 1999 (Furman, 1999). The letter report determined the exceeded specific conductance critical
31 mean was associated with migration of increased nitrate concentrations from the BY Cribs source. Based
32 on the determination, no further actions were required per 40 CFR 265.93(d). The determination was also
33 reported in the annual report (PNNL-13404).

34 Two additional monitoring wells (299-E33-265 and 299-E33-266) were added in 2010 to provide
35 downgradient detection monitoring for the northern portion of Trench 9 (Figure 1-2).

36 The most recent indicator parameter exceedance was total organic carbon at well 299-E33-265 from a
37 January 25, 2012, semiannual detection monitoring sample. Split verification samples were collected on
38 April 5, 2012, to determine if a laboratory error may have occurred. Upon confirmation of the
39 exceedance, DOE transmitted DOE/RL-2012-35 to Ecology in May 2012. DOE and Ecology agreed on
40 the plan in June 2012, and DOE began assessment sampling in July 2012 for well 299-E33-265 and two
41 neighboring wells (299-E33-30 and 299-E33-266). In October 2012 the entire LLWMA-1 monitoring
42 network was sampled to complete the assessment. After evaluation of the assessment results, a
43 determination was made that no dangerous waste or dangerous waste constituents were associated with
44 LLWMA-1. The determination was reported in DOE/RL-2013-25. As a result, the site returned to
45 indicator detection monitoring in January 2013.

1 The groundwater monitoring activities at LLWMA-1 under this groundwater monitoring plan currently
2 sample from a network of ~~eight-five~~ wells. Samples are analyzed semiannually for parameters used as
3 indicators of groundwater contamination and annually for parameters establishing groundwater quality.
4 Water-level measurements are collected each time that a sample is obtained from a network well.
5 The network wells are also included in the annual comprehensive March water-level measurement
6 campaign (SGW-38815, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater*
7 *Remediation Project*). Groundwater monitoring results are summarized for the LLWMA-1 in the annual
8 Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2016-12, *Hanford Site RCRA*
9 *Groundwater Monitoring Report for 2015*).

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10 2.6 Conceptual Site Model

11 This section describes the LLWMA-1 CSM for potential contaminant transport to guide future
12 groundwater monitoring. The CSM is shown in Figure 2-10. The CSM describes the current
13 understanding of the contaminant release and transport and includes the following assumptions
14 (DOE/RL-2009-75, Rev. 0):

- 15 • Engineering barriers are not taken into account, so the model is applicable to unlined trenches.
- 16 • Average precipitation and net infiltration (5 to 10 cm/yr [2 to 3.9 in./yr]) prevail over the timeframe
17 of interest.
- 18 • Net infiltration is assumed to occur under gravity drainage.
- 19 • Maximum vertical hydraulic conductivity in the vadose zone is assumed to be significantly larger
20 than the net infiltration rate.
- 21 • Leaching of mobile contaminants from buried waste in unsealed containers, or contaminated soils in
22 direct contact with the trench, are assumed to be the major potential sources for contamination.
- 23 • There are no artificial sources of water (e.g., leaking potable or raw water lines based on Hanford Site
24 drawings).

25 As of the writing of this plan no groundwater dangerous wastes or dangerous waste constituents have
26 been attributed to releases associated with the 218-E-10 Burial Ground even though groundwater quality
27 has been affected. Direct precipitation is the primary driver for hypothetical leaching of waste
28 constituents from the burial ground trenches and subsequent transport to groundwater. Contaminants from
29 degradable containers (e.g., cardboard boxes) subject to collapse are assumed to be leachable.
30 Conservative calculations suggest recharge rates for LLWMA-1 could be as high as 10 cm/year
31 (4 in./year) at gravel-covered nonvegetated sites (WHC-SD-WM-TI-730). However, solid waste leaching
32 tests associated with Hanford formation sediments and natural waters found most metals are not mobile
33 when contacted by natural waters (PNL-8889). Tests also found that oxidizing and calcium carbonate
34 present in vadose zone sediments promotes sorption or retardation of many heavy metals (PNL-8889).
35 The amount of natural infiltration that can pass through the leachable buried waste and drain to the water
36 table is controlled by the texture of deposited sediments within the vadose zone. Stratigraphic features in
37 the soil column, such as the CCU_z can retard downward migration by capillary retentive forces. Based on
38 the information, provided in the following subsections, it appears unlikely that leached wastes could
39 migrate to the groundwater in the near future. Current conservative calculations suggest that leached
40 waste from the 218-E-10 Burial Ground is probably still within the trench or the adjacent sediments
41 beneath the burial trench.

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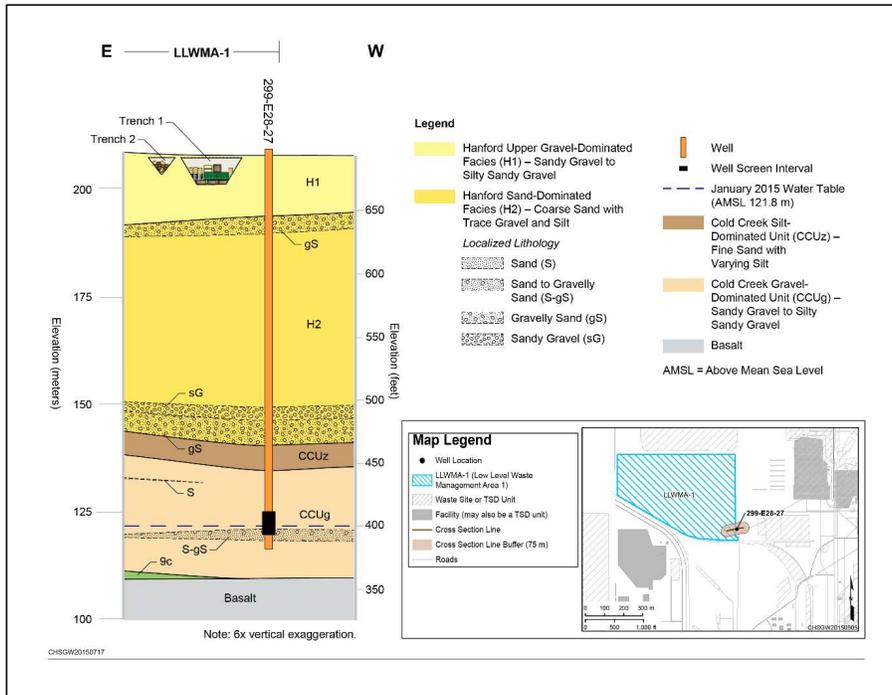


Figure 2-10. General Representation of Hydrogeologic Characteristics Underlying the LLWMA-1

2.6.1 Geochemical Considerations

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

Pore fluid in the unsaturated and saturated zones beneath LLWMA-1 is slightly alkaline ($7 < \text{pH} < 8$), with appreciable amounts of bicarbonate and very little natural organic material. The lack of organic matter indicates that conditions generally are oxidizing. Calcium carbonate is also present in vadose zone sediment. These general conditions favor sorption or retardation of many heavy metals and favor the mobilization of anionic species. Laboratory sorption studies have documented these effects and related mobility issues in Hanford Site media (e.g., PNNL-11800).

Based on the general geochemical conditions in the vadose zone and nonradiological waste constituents disposed at LLWMA-1, significant contaminant migration appears unlikely (Figure 2-10). It is possible that large volumes of water were applied to the region of a UPR (e.g., UPR-200-E-23), but gross-gamma logging results from 1987 at proximal wells 299-E28-27 and 299-E33-29 (approximately 87 and 118 m [285 and 387 ft], respectively) showed no elevated sign of gamma. Cesium-137, which would be the most logical gamma emitter detected in gross-gamma logging, was not detected. Because cesium-137 has mobility similar to lead, as defined in PNNL-11800, it is a good surrogate for the mobility of lead. Note that neither lead nor cesium-137 are very mobile in Hanford formation sediments. For example, cesium-137 is mainly found directly beneath cribs that have released significant quantities (>1 million L

[264,172 gal]) of liquid waste. Cesium-137 is generally not detected beyond 15.2 m (50 ft) below the base of the crib because of the absorptive attraction to Hanford Site vadose zone sediments. Thus, with 73.4 to 82.8 m (241 to 272 ft) of vadose zone, migration of lead to groundwater is considered unlikely.

Ecological information on di-octyl phthalate indicates this constituent binds to soils and sediments. In addition, disposal records indicate this constituent was initially absorbed to HEPA filters. It is also expected to biodegrade in aerobic conditions with a photochemical estimated half-life of 18 hours. Thus, it appears that this constituent should not migrate much farther than the bottom of the trench in which it was disposed. Figure 2-10 provides a generalized visual depiction of the expected state of dangerous waste contaminant migration from the bottom of Burial Trench 9 (note Figure 2-10 identifies Trenches 1 and 2 as surrogates for cesium-137 migration as discussed earlier in this section, but also is used for the conceptual migration of Trench 9 for dangerous waste components, lead and di-octyl phthalate).

2.6.2 Soil Moisture Factors

Except for waste in sealed metal or concrete containers (e.g., retrievable waste), direct precipitation is the primary driver for hypothetical leaching of waste constituents from the burial trenches and the subsequent transport to groundwater. Contaminants in soil disposed to the trench or waste in degradable containers (e.g., cardboard boxes or wooden boxes) subject to collapse are 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 and the degree of vegetative cover. Most of the burial ground trenches are backfilled with 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 unused portions of LLWMA-1. Therefore, the coarse, sparsely vegetated cover material allows a fraction of the precipitation to infiltrate and potentially drain to the groundwater.

Two different documented studies of pore water migration within Hanford Site sediments are used to provide a conceptual model of the expected vertical transport of gravity drained precipitation within the vadose zone. PNNL-8889 used moisture retention and saturated hydraulic conductivity of the Hanford Site sediments to calculate the vadose zone hydraulic conductivity versus natural pore water content. Using a 4 to 7 percent moisture content, the rate of vertical transport of pore water was calculated at 0.3 to 3 cm/yr (0.1 to 1 in./yr). Alternatively, WHC-SD-WM-TI-730 determined the maximum infiltration rate for unvegetated coarse-grained soils ranged between 5 and 10 cm/yr (2 and 4 in./yr). Using the more conservative infiltration rate (5 cm/yr [2 in./yr]) and ignoring less permeable silt-dominated horizons such as the CCUs, a conceptual model of pore water vertical transport is provided in the next paragraph below. Note the use of 5 cm/yr (2 in./yr) converges with the rate of recharge condition developed for DOE/EIS-0391, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.

Using the more conservative precipitation infiltration rate estimate (e.g., 5 cm/yr [2 in./yr]) and a minimum depth to groundwater of 73.4 m (241 ft), model results suggest a range between 115 and 129 years are required for gravity-drained, precipitation-driven pore water to first reach groundwater from the bottom of the burial trench (DOE/EIS-0391, Table N-2 and WHC-SD-WM-TI-730, Figure 4-19). The migration of leached contaminant pore water in the model result is based on fixed boundary conditions of the site to groundwater, constant infiltration rate (precipitation), and three hydraulic conductivity values for three vadose zone layers as a function of moisture content. Using an average moisture content of 0.087 yields travel time similar to the 129 year travel time result by the model for the arrival of the peak concentration at the groundwater (WHC-SD-WM-TI-730, Figure 4-19). Considering that the initial buried waste has currently been in contact with natural pore water for up to 60 years,

1 possibility of additional moisture added to the site, and variability of geologic sediments, uninhibited
2 contaminant migration may reach groundwater sooner than expected.

3 2.6.3 Hydrogeologic Considerations

4 The hydrogeology beneath LLWMA-1 is discussed in Section 2.4.2. The vadose zone (e.g., ground
5 surface to water table) beneath the trench bottoms of LLWMA-1 ranges from 73.4 to 82.8 m
6 (234 to 272 ft) below ground surface. The lithology of the vadose zone consists of the Hanford formation
7 (i.e., H1 upper gravel-dominated sequence and, H2 lower sand-dominated sequence) and CCUs
8 (i.e., upper CCU_z facies and CCU_g facies). The continuous silty sand to sandy silt layer of the CCU_z facies
9 beneath the 218-E-10 Burial Ground, based on sieve analyses, ranges from 10 to 65.8 percent and is likely
10 to retard downward movement of moisture and contaminants because of the finer textured sediment
11 (Figures 2-1 and 2-3 through 2-5).

12 If contaminants break through to the groundwater beneath LLWMA-1, contaminants would move toward
13 the southeast. Based on the results of contaminant particle-track calculations (Section 7.4 in SGW-60590,
14 Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-1 Green Islands
15 Groundwater Monitoring and Section 7.7.2.2 in ECF-200E-19-0003, Groundwater Flow and Migration
16 Calculations for Annual Assessment of the Final Status Monitoring Networks for the 200 East Area
17 Dangerous Waste Management Units), based on 2014 and early to mid-2015 groundwater flow
18 determinations, the five three downgradient wells 299-E28-26, 299-E28-27, 299-E28-28, 299-E33-28,
19 and 299-E33-29 would detect possible LLWMA-1 releases while groundwater flows to the southeast,
20 with the exception of the section between wells 299-E28-26 and 299-E28-27. However, installation of a
21 new monitoring well is proposed in this area through Tri-Party Agreement (Ecology et al., 1989)
22 Milestone M-24.

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23 2.7 Monitoring Objectives

24 The groundwater monitoring program at LLWMA-1 is conducted with the objective of determining the
25 facility's impact, if any, on the quality of the underlying groundwater. This groundwater monitoring plan
26 addresses specifically those applicable dangerous waste requirements for interim status TSD units where
27 no impact to groundwater has been identified. The regulatory requirements applicable to this groundwater
28 monitoring plan are found in WAC 173-303-400(3) and 40 CFR 265.90, "Applicability," through 265.94,
29 "Recordkeeping and Reporting." Table 2-2 identifies where each groundwater monitoring element of the
30 pertinent regulations is addressed within this plan. Site-specific constituents are not required by
31 40 CFR 265.92, but used to support interpretation, are included in Table 2-3.

Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement^a	Section Where Requirement is Addressed in Monitoring Plan
Applicability	<p>40 CFR 265.90, “Applicability”</p> <p>(a) Within one year after the effective date of these regulations, the owner or operator of a surface impoundment, landfill, or land treatment facility which is used to manage hazardous waste must implement a ground-water monitoring program capable of determining the facility’s impact on the quality of ground water in the uppermost aquifer underlying the facility, except as §265.1 and paragraph (c) of this section provide otherwise.</p> <p>(b) Except as paragraphs (c) and (d) of this section provide otherwise, the owner or operator must install, operate, and maintain a ground-water monitoring system which meets the requirements of §265.91, and must comply with §§265.92 through 265.94. This ground-water monitoring program must be carried out during the active life of the facility, and for disposal facilities, during the post-closure care period as well.</p>	Chapter 1
Number and Location of Wells	<p>40 CFR 265.91, “Ground-Water Monitoring System”:</p> <p>(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:</p> <p>(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:</p> <p>(i) Representative of background ground-water quality in the uppermost aquifer near the facility; and</p> <p>(ii) Not affected by the facility; and</p> <p>(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 numbers, locations, and depths must ensure that they immediately detect any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the waste management area to the uppermost aquifer.</p>	Section 3.2
Well Configuration	<p>40 CFR 265.91:</p> <p>(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.</p> <p>Additional requirements from WAC 173-303-400(3)(c)(v)(C), “Dangerous Waste Regulations,” “Interim Status Facility Standards”:</p>	Section 3.2 and Appendix C

Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement^a	Section Where Requirement is Addressed in Monitoring Plan
	Ground water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. Chapter 173-160 WAC may be used as guidance in the installation of wells.	
Sample Protocols Analytical Methods	40 CFR 265.92: (a) The owner or operator must obtain and analyze samples from the installed ground-water monitoring system. The owner or operator must develop and follow a ground-water sampling and analysis plan. He must keep this plan at the facility. The plan must include procedures and techniques for: (1) Sample collection; (2) Sample preservation and shipment; (3) Analytical procedures; and (4) Chain of custody control.	Appendix A, Section A3 and Appendix B, Sections B2 through B5
Parameters to be Sampled Frequency of Sampling Water-Level Measurements	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 ^b . (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 ground-water quality assessment is required under §265.93(d).] (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific conductance (iii) Total organic carbon (iv) Total organic halogen (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. He 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	Section 3.1 and Appendix B, Section B2.2

Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement^a	Section Where Requirement is Addressed in Monitoring Plan
	<p>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.</p> <p>(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:</p> <p>(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.</p> <p>(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 semi-annually.</p> <p>(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.</p>	
Groundwater Quality Assessment Program Plan Outline	<p>40 CFR 265.93, "Preparation, Evaluation, and Response":</p> <p>(a) Within one year after the effective date of these regulations, the owner or operator must prepare an outline of a ground-water quality assessment program. The outline must describe a more comprehensive ground-water monitoring program (than that described in §§265.91 and 265.92) capable of determining:</p> <p>(1) Whether hazardous waste or hazardous waste constituents have entered the ground water;</p> <p>(2) The rate and extent of migration of hazardous waste or hazardous waste constituents in the ground water; and</p> <p>(3) The concentrations of hazardous waste or hazardous waste constituents in the ground water.</p>	Chapter 5
Methods Used to Evaluate the Collected Data and Responses	<p>40 CFR 265.93:</p> <p>(b) For each indicator parameter specified in §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 §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.(c)(2) If the comparison for downgradient wells made under paragraph (b) of this section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error.</p> <p>(d)(1) If the analyses performed under paragraph (c)(2) of this section confirm the significant increase (or pH decrease), the owner or operator</p>	Section 4.1, 4.2, 4.3 and Appendix A

Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement ^a	Section Where Requirement is Addressed in Monitoring Plan
	<p>must provide written notice to the department-within seven days of the date of such confirmation-that the facility may be affecting ground-water quality.</p> <p>(d)(2) Within 15 days after the notification under paragraph (d)(1) of this section, the owner or operator must develop a specific plan, based on the outline required under paragraph (a) of this section and certified by a qualified geologist or geotechnical engineer, for a ground-water quality assessment at the facility.</p>	
Recordkeeping and Reporting	<p>40 CFR 265.93:</p> <p>(c)(1) If the comparisons for the <i>upgradient</i> wells made under paragraph (b) of this section show a significant increase or (pH decrease), the owner or operator must submit this information in accordance with §265.94(a)(2)(ii).</p> <p>40 CFR 265.94, “Recordkeeping and Reporting”:</p> <p>(a)(1) Keep records of the analyses required in §265.92(c) and (d), the associated ground-water surface elevations required in §265.92(e), and the evaluation required in §265.93(b) throughout the active life of the facility.</p> <p>(a)(2) Report the following ground-water monitoring information to the department:</p> <p>(ii) Annually: Concentrations or values of the parameters listed in §265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under §265.93(b). The owner or operator must separately identify any significant differences from the initial background found in the upgradient wells, in accordance with §265.93(e)(1).</p> <p>(iii) No later than March 1 following each calendar year: Results of the evaluations of ground-water surface elevations under §265.93(f), and a description of the response to that evaluation, where applicable.</p>	<p>Section 4.5</p> <p>Appendix A, Sections <u>A2.6</u> <u>A2.5</u> and A3.9</p>

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Notes: The references cited in this table are listed in the reference section (Chapter 6) of this plan.

In accordance with WAC 173-303-400(3)(b), “Dangerous Waste Regulations,” “Interim Status Facility Standards”, for the purposes of applying the interim status standards of 40 CFR 265, Subpart F, the federal terms “Regional Administrator” means the “Department” and “Hazardous” means “Dangerous”.

In accordance with Section I.A of the WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (Hanford Facility RCRA Permit), this unit will continue to be considered an interim status unit until it is incorporated into Part III, V, and/or VI of the Hanford Facility RCRA Permit, or until interim status is terminated. Therefore, groundwater monitoring continues under interim status requirements.

Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement ^a	Section Where Requirement is Addressed in Monitoring Plan
	a. Regulatory requirements for interim status TSD units, where no impact to groundwater has been identified, are found in WAC 173-303-400(3) and 40 CFR 265.90, "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting," which are applicable to this groundwater monitoring plan.	
	b. The parameters characterizing the suitability of the groundwater as a drinking water supply, as specified in 40 CFR 265, Appendix III, "EPA Interim Primary Drinking Water Standards," are conducted only during the first year of monitoring in accordance with 40 CFR 265.92(c)(1), "Sampling and Analysis". <u>For this TSD unit, the Appendix III parameters are included for monitoring at well(s) specified in Section 3.1 as a best practice activity to obtain additional scientific and technical information.</u>	
	RCRA = Resource Conservation and Recovery Act of 1976	
	TSD = treatment, storage, and disposal	

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Table 2-3. Additional Monitoring Objectives

Monitoring Objective	TSD Unit-Specific Constituent/Field Measurements*
Metals-additional metals used in ion balance and to support water chemistry analysis	Calcium, magnesium, and potassium
<u>Metals-additional metals used to determine corrosion of stainless steel</u>	<u>Chromium, iron, manganese, molybdenum, and nickel</u>
Anions-additional anions used in ion balance and to support water chemistry analysis	Fluoride, nitrate, and nitrite,
Field measurements provided information on water properties at the time of sampling.	Dissolved oxygen, temperature, and turbidity
* Sampling for TSD unit-specific constituents/field measurements is not required by WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards" nor 40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground Water Monitoring."	
TSD = treatment, storage, and disposal	

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3

3 Groundwater Monitoring Program

This chapter describes the groundwater monitoring indicator evaluation program for LLWMA-1 consisting of parameters used as indicators of groundwater contamination, parameters establishing groundwater quality, a monitoring well network, and sampling and analysis protocols. The monitoring program presented herein has been revised from that presented in the previous plan (DOE/RL-2009-75, Rev. 0), and supersedes the monitoring program of the previous plan.

3.1 Constituents List and Sampling Frequency

Table 3-1 presents the wells in the groundwater monitoring network, parameters analyzed, and sampling frequency for monitoring of LLWMA-1. Parameters used as indicators of groundwater contamination (pH, specific conductance, total organic carbon (TOC), and total organic halogen (TOX)) will be sampled and analyzed semiannually (40 CFR 265.92(b)(3) and (d)(2)). Parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) will be sampled and analyzed annually (40 CFR 265.92(b)(2) and (d)(1)). Water-level measurements at each monitoring well will be determined each time that a sample is obtained (40 CFR 265.92). Site-specific constituents (calcium, chromium, iron, magnesium, manganese, molybdenum, nickel, potassium, fluoride, nitrate, nitrite, dissolved oxygen, temperature, and turbidity) not required by 40 CFR 265.92, but used to support interpretation, are included in Table 3-1.

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~~The newly installed well will be sampled quarterly during the first year of monitoring as a best practice activity to provide additional scientific and technical information. The quarterly monitoring will include the parameters used for indicators of groundwater contamination and parameters establishing groundwater quality (Table 3-2). In addition, the new well will be sampled quarterly for one year for the drinking water suitability parameters included in Appendix III to 40 CFR 265 (Table 3-2). At the end of the first year, monitoring will thereafter be conducted along the same frequency as other established wells and as provided in Table 3-1.~~

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Maintenance problems and sampling logistics resulting from multiple factors including environmental (i.e., inclement weather) and access restrictions (i.e., heightened fire danger, area access restriction due to work by other Hanford contractors such as in the tank farms) sometimes delay scheduled sampling events. Sampling events are scheduled by month. The Field Work Supervisor (FWS) determines the specific times within a given month that a well will be sampled. If a well cannot be sampled at the times determined by the FWS, then the FWS and Sampling Management and Reporting group, along with the project scientist, will consult on how to best recover or reschedule the sampling event as close to the original sampling date as possible. If it is observed during the pre-sampling walkdown that one or more network wells cannot be sampled, then sampling of the well network will not begin and management will be notified. Depending on the situation, the network sampling will be rescheduled within a short time frame (such as 3 to 4 weeks). In some cases, it may not be obvious that sampling cannot be performed until a well is accessed (e.g., an issue with a pump).

Missed sampling events that are not rescheduled within the same month are given top priority when rescheduling sampling for the following month. In the event that a sampling delay has occurred and the representativeness of the samples is in question, DOE-RL and Ecology may agree to resampling wells. DOE-RL will provide informal notification to Ecology if sampling of the network is expected to be delayed for longer than 4 weeks. Ecology may provide input in a timely fashion to DOE-RL on how to proceed. Missed or cancelled sampling events are reported to DOE-RL and are documented in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2016-12).

Table 3-1. Monitoring Well Network for LLWMA-1

Well Name	Purpose	WAC Compliant	RCRA-Required Parameters ^a										Site-Specific Constituents			
			Water Level	Contamination Indicator Parameters				Groundwater Quality Parameters						Metals (Filtered and Unfiltered) ^{b,c}	Anions ^d	Field Measurements ^e
				pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron (Filtered and Unfiltered) ^b	Manganese (Filtered and Unfiltered) ^b	Phenols ^f	Sodium	Sulfate			
299-E28-26	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S
299-E28-27	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S
299-E28-28	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S
299-E32-3	Upgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S
299-E33-28	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S
299-E33-29	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S
299-E33-266	Upgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S
Proposed Well	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S

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Table 3-1. Monitoring Well Network for LLWMA-1

- a. Parameters are required by 40 CFR 265.92, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” “Sampling and Analysis.”
- b. Unfiltered samples will be collected in conjunction with filtered samples for select analyses to determine if metal constituents being monitored 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.
- c. Includes analysis of calcium, magnesium, and potassium **for water chemistry analysis and chromium, iron, manganese, molybdenum, and nickel to monitor for stainless steel corrosion.**
- d. Includes analysis of fluoride, nitrate, and nitrite.
- e. Includes measurement of dissolved oxygen, temperature, and turbidity.

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

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A	=	to be sampled annually
CFR	=	<i>Code of Federal Regulations</i>
LLWMA	=	Low-Level Waste Management Area
N	=	well is not constructed as a resource protection well (WAC 173-160)
RCRA	=	<i>Resource Conservation and Recovery Act of 1976</i>
S	=	to be sampled semiannually
S4	=	to be sampled semiannually, with quadruplicate samples collected during each event
WAC	=	<i>Washington Administrative Code</i>
Y	=	well is constructed as a resource protection well (WAC 173-160)

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

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

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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

Table 3-2. Constituents and Sampling Frequency for Proposed Well during Initial Year after Implementation of Groundwater Monitoring Plan

Well Name	Parameters ^a																														
	40 CFR 265 Appendix III Parameters																			Groundwater Contamination Indicator Parameters		Groundwater Quality Parameters									
	Water Level	Arsenic (Filtered and Unfiltered) ^b	Barium (Filtered and Unfiltered) ^b	Cadmium (Filtered and Unfiltered) ^b	Chromium (Filtered and Unfiltered) ^b	Fluoride	Lead (Filtered and Unfiltered) ^b	Mercury	Nitrate (as N)	Selenium (Filtered and Unfiltered) ^b	Silver (Filtered and Unfiltered) ^b	Endrin	Lindane	Methoxychlor	Toxaphene	2,4-D	2,4,5-TP Silvex	Radium	Gross Alpha	Gross Beta	Coliform Bacteria	Turbidity	pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron (Filtered and Unfiltered) ^b	Manganese (Filtered and Unfiltered) ^b	Phenols	Sodium (Filtered and Unfiltered) ^b
Proposed Well	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q4	Q4	Q4	Q4	Q	Q	Q	Q	Q	Q

Reference: 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis,"

Appendix III, "EPA Interim Primary Drinking Water Standards."

a. Sampling for the Appendix III drinking water parameters (40 CFR 265.92(b)(1)) for one year at wells added to the groundwater monitoring network after the initial year of interim status monitoring at the treatment, storage, and disposal unit is not required by the regulations. Such monitoring is performed as a best practice activity to provide additional scientific and technical information.

b. Unfiltered samples will be collected in conjunction with filtered samples for select analyses to determine if metal constituents being monitored 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.

CFR = Code of Federal Regulations

Q = to be sampled quarterly

Q4 = to be sampled quarterly, with quadruplicate samples collected during each event

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1 3.2 Monitoring Well Network

2 The current LLWMA-1 monitoring network consists of two upgradient and ~~five three~~ downgradient
3 wells, as shown in Table 3-1. ~~An additional downgradient well is proposed at the northing and easting~~
4 ~~coordinates, 136992 and 573116, respectively.~~ Figure 3-1 shows the groundwater monitoring network,
5 ~~including the proposed new well,~~ and information for the wells is summarized in Table 3-3. ~~The proposed~~
6 ~~well location is based on the current flow direction with respect to Trench 9, as shown in Figure 1 2. This~~
7 ~~location also provides sufficient coverage for the flow direction variability over the past 4 years, since the~~
8 ~~flow direction change.~~ Past indicator parameter results from the two upgradient wells (299-E32-3 and
9 299-E33-266) will be used to establish background levels for the revised LLWMA-1 groundwater
10 monitoring program. The two upgradient wells are considered hydraulically upgradient based on ~~the~~
11 groundwater flow ~~direction toward the east-southeast (Section 2.8 in DOE/RL-2019-65, Hanford Site~~
12 ~~RCRA Groundwater Monitoring Report for 2019) determinations from July 2011 to mid 2015.~~ The ~~five~~
13 ~~three~~ wells to the south and east of LLWMA-1 will be used to monitor whether a 0.01 level of significant
14 increase (and decrease, in the case of pH) over background is observed. ~~One additional downgradient well~~
15 ~~is required to monitor the southeast corner of LLWMA-1 to ensure that a statistically significant increase~~
16 ~~can be observed.~~

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17 If a well is within approximately 2 years of going dry, a replacement well will be proposed; such wells are
18 negotiated annually by Ecology, DOE, and EPA under Tri-Party Agreement (Ecology et. al., 1989a)
19 Milestone M-24-00.

20 Construction details and pertinent information for the wells are provided in Appendix C.

21 3.3 Differences Between This Plan and Previous Plan

22 Table 3-4 identifies the main differences between this plan and the previous groundwater monitoring
23 plan. Monitoring well network changes from the previous plan include number and location of upgradient
24 wells, ~~and number and location of downgradient wells, and addition of one new downgradient well.~~
25 Changes to the number and location of network wells was based on a groundwater flow change. The flow
26 direction was previously north-northwest. However, groundwater mounding in the 200 East Area has
27 dissipated since the 1980s, and since mid-2011, groundwater elevations to the north have been higher,
28 causing the groundwater to flow to the ~~south-east-southeast.~~ The current arrangement of the two
29 upgradient wells provides a sufficient spatial relationship for incorporating spatial variability of
30 background parameters. ~~The addition of the new downgradient well provides a more uniform distance~~
31 ~~between downgradient wells.~~

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32 3.4 Sampling and Analysis Protocol

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

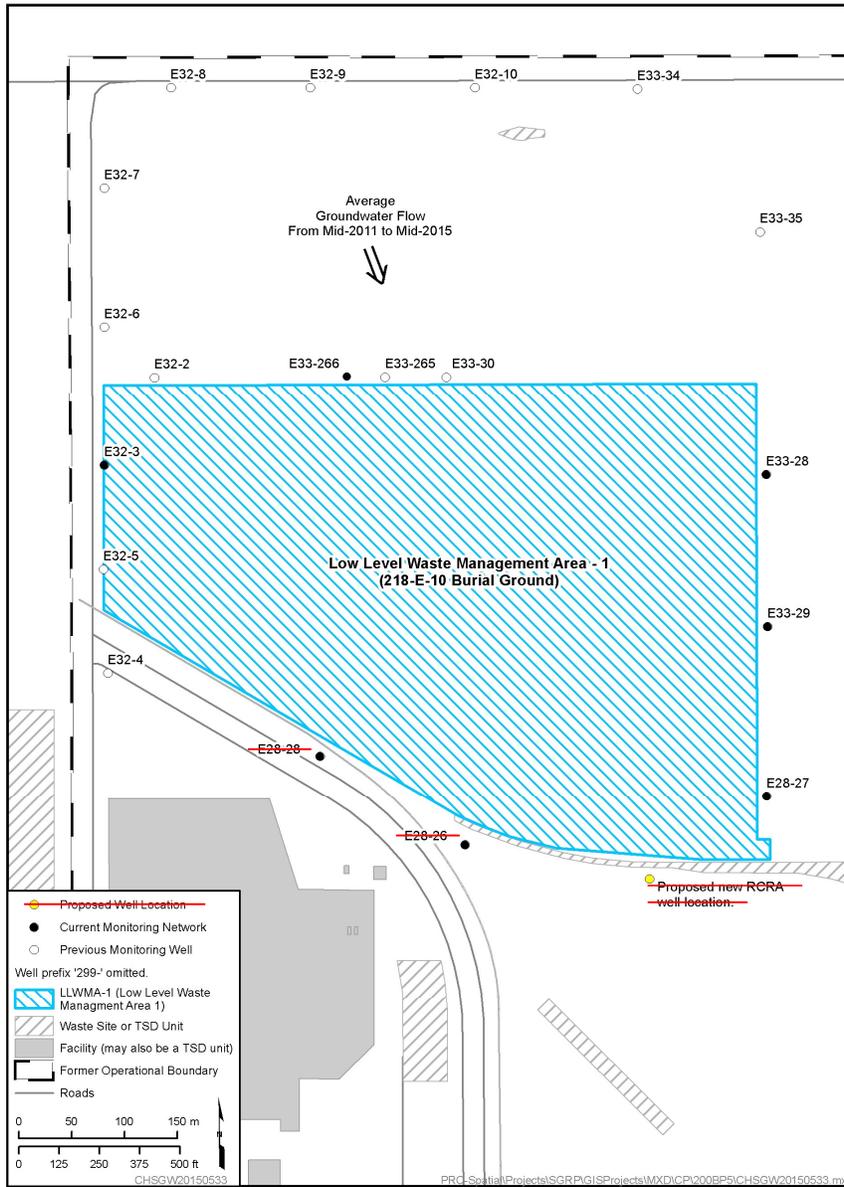


Figure 3-1. Groundwater Monitoring Well Network at LLWMA-1

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Table 3-3. Attributes for Wells in the LLWMA-1 Groundwater Monitoring Network

Well Name	Completion Date	Easting ^a (m)	Northing ^a (m)	Groundwater Elevation ^b (m [ft])	Groundwater Thickness across Screen Interval (m [ft])	Measured Groundwater Level Date
299-E28-26	11/06/1987	572941.553	137024.016	121.8 (399.6)	3.0 (9.96)	January 2015
299-E28-27	09/29/1987	573226.784	137070.063	121.8 (399.6)	2.3 (7.7)	January 2015
299-E28-28	04/17/1990	572804.351	137108.259	121.8 (399.6)	2.3 (7.5)	January 2015
299-E32-3	09/30/1987	572600.614	137383.996	121.8 (399.6)	2.1 (6.9)	January 2015
299-E33-28	10/15/1987	573226.365	137375.019	121.8 (399.6)	2.8 (9.1)	January 2015
299-E33-29	09/30/1987	573227.858	137231.193	121.8 (399.6)	2.2 (7.4)	January 2015
299-E33-266	10/06/2010	57282.95	137467.95	121.8 (399.6)	4.5 (14.8)	January 2015
Proposed Well	TBD	573116	136992	TBD	TBD	N/A

a. Coordinates are in NAD83, *North American Datum of 1983*.
 b. Elevations are in NAVD88, *North American Vertical Datum of 1988*.
 N/A = not applicable
 TBD = to be determined

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Table 3-4. Main Differences between This Plan and Previous Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
Constituents	40 CFR 265.92(b)(2) and (b)(3) and alkalinity, dissolved oxygen, temperature, and turbidity as a site-specific constituent	Alkalinity discontinued Stainless steel corrosion constituents (chromium, iron, manganese, molybdenum, and nickel) added	Alkalinity is not required per 40 CFR 265.92(b)(2) and (b)(3). Cation balances can be completed using specific conductance instead of against anions. Stainless steel constituents are sampled to monitor for well corrosion
Sampling Frequency	Annual sampling frequency for phenols Semiannual sampling frequency for indicator parameters, dissolved oxygen, temperature, and turbidity. Semiannual sampling frequency for iron, manganese, sodium, chloride, and sulfate	Annual sampling frequency for phenols Semiannual sampling frequency for, indicator parameters, dissolved oxygen, temperature, and turbidity Reduced sampling frequency to annual iron, manganese, sodium, chloride, and sulfate	Historical data indicates only annual sampling, consistent with 40 CFR 265.92 requirements, is necessary to determine well quality.
Well Network	Downgradient wells 299-E32-2 through 299-E32-10, 299-E33-34, 299-E33-265, and 299-E33-266 Upgradient wells 299-E28-26, 299-E28-27, 299-E28-28, 299-E33-28, 299-E33-29, and 299-E33-35	Downgradient wells 299-E28-26, 299-E28-27, 299-E28-28, 299-E33-28, 299-E33-29, and proposed well Upgradient wells 299-E32-3 and 299-E33-266	Both upgradient and downgradient wells were changed based on groundwater flow direction changes.
Groundwater Flow Direction	Northwest	South-southeast East-southeast	Decline of 200 East Area groundwater mounds has created a continuing south east -southeast flow direction.
Type of Groundwater Monitoring Program	Indicator Evaluation Program	Indicator Evaluation Program	No change
Background Arithmetic Mean, a concentration derived from	Calculated approximately yearly for changing	Calculate yearly to ensure representative background	Calculated annually using EPA 530/R-09-007, <i>Statistical Analysis of Groundwater</i>

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Table 3-4. Main Differences between This Plan and Previous Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
upgradient wells at the 0.01 level of significance per 40 CFR 265.93 for comparison with downgradient indicator concentrations, is recalculated approximately every year to ensure representativeness of upgradient comparison values.	groundwater conditions.	groundwater quality as required in 40 CFR 265.91 and recommended in the unified guidance.	<i>Monitoring Data at RCRA Facilities Unified Guidance.</i>
Groundwater Quality Assessment Plan Outline	Not applicable as groundwater quality assessment plan outline was provided in WHC-SD-EN-AP-015, Table 4.1	Chapter 5	Update outline to current norms.

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

265.91, "Ground-Water Monitoring System."

265.92, "Sampling and Analysis."

265.93, "Preparation, Evaluation, and Response."

WHC-SD-EN-AP-015, *Interim-Status Ground-Water Quality Assessment Plan for Waste Management Area 1 of the 200 Areas Low-Level Burial Grounds.*

* DOE/RL-2009-75, Rev. 0, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1.*

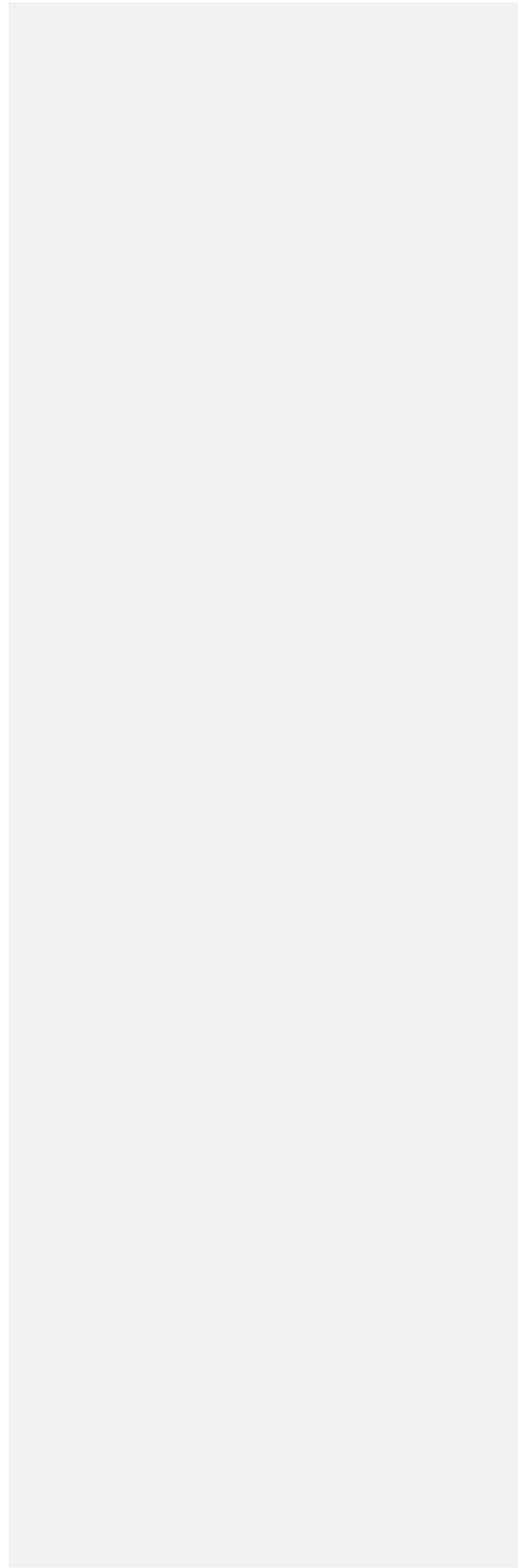
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4 Data Evaluation and Reporting

This chapter discusses the evaluation and interpretation of data.

4.1 Data Review

The data review and verification tasks are discussed in the QAPjP (Appendix A).

4.2 Statistical Evaluation

The goal of the groundwater monitoring indicator evaluation program is to determine if LLWMA-1 operations have affected groundwater quality beneath the TSD unit, which is determined based on the results of specified statistical tests. Under this plan, sampling activities and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference into WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general groundwater contamination indicator parameters (pH, specific conductance, TOC, and TOX) to background levels to test for potential impact to groundwater. Each time that a monitoring well is sampled, four replicate samples for TOC and TOX are collected, and four replicate field measurements are made for pH and specific conductance.

The basic procedure for statistical comparisons is as follows. Twice each year, monitoring data from downgradient wells are compared to the upgradient (background) results for each of the four indicator parameters. The arithmetic mean and variance must be calculated based on at least four replicate measurements on each sample, for each well monitored, and then compared with the background arithmetic mean obtained (40 CFR 265.92(c)(2)) and updated as discussed in Chapter 5 of EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. The comparison must consider each of the individual wells in the monitoring system and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (and decreases, in the case of pH) over background (40 CFR 265.93(b) and Appendix IV to 40 CFR 265). Implementation of the statistical test method at the Hanford Site, including at LLWMA-1, is generally consistent with EPA 530/R-09-007. The background statistical analysis is updated annually to establish comparative values for indicator parameters. A rolling mean is used because of changing upgradient concentrations and groundwater flow conditions.

If a downgradient well comparison shows a significant increase (or pH decrease), then the well is resampled. For TOC and TOX, split samples are sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error.

If the exceedance of the statistical comparison value is confirmed by resampling, then written notifications are made as detailed in Section 4.5 and in accordance with 40 CFR 265.93(d)(1).

4.3 Interpretation

Data are used to interpret groundwater conditions at LLWMA-1. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases and increases and seasonal or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and estimate flow directions. Groundwater flow is assumed to be perpendicular to the equal potential lines on the maps.

- 1 • **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and
2 fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if
3 concentrations relate to changes in water level or groundwater flow directions.
- 4 • **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine the
5 extent of contamination. Changes in plume distribution over time assist in determining plume
6 movement and direction of groundwater flow.
- 7 • **Contaminant ratios:** Illustrate the relative abundances of contaminants from previously
8 characterized Hanford Site-related processes and sources. Comparison of these ratios in groundwater
9 can sometimes be used to distinguish among different sources of contamination (e.g., a specific
10 process and its associated facility). Ratios may provide evidence of continuing source contamination,
11 thereby linking contamination with a specific facility under monitoring. Evaluation of contaminant
12 ratios in concentration trends may be used to demonstrate when facility-specific contamination no
13 longer affects underlying groundwater.

14 **4.4 Annual Determination of Monitoring Network**

15 Groundwater monitoring requirements include an annual evaluation of the network to determine if it
16 remains adequate to monitor the facility's impact on the quality of the groundwater in the uppermost
17 aquifer underlying the facility (40 CFR 265.93(f)). The network must include at least one upgradient and
18 at least three downgradient wells in the uppermost aquifer (40 CFR 265.91(a)(1) and (2)).

19 The current groundwater monitoring network will continue to be re-evaluated to ensure that it is adequate
20 to monitor any changing hydrogeologic conditions beneath the unit. If flow changes are observed, the
21 LLWMA-1 CSM and groundwater constituents will be re-evaluated to determine network efficiency and
22 any necessary modifications required for the network.

23 Water-level measurements will continue to be collected during each sampling event. An additional and
24 more comprehensive set of water-level measurements is made annually for selected wells on the Hanford
25 Site, and the data are presented in the annual Hanford Site RCRA groundwater monitoring reports
26 (e.g., DOE/RL-2016-12).

27 **4.5 Reporting and Notification**

28 Groundwater monitoring and evaluation of groundwater surface elevation results are reported annually in
29 accordance with the requirements of 40 CFR 265.94(a)(2). Reporting will be made in the annual Hanford
30 Site RCRA groundwater monitoring reports (e.g., DOE/RL-2016-12).

31 If a comparison for an upgradient well shows a significant increase (or pH decrease) relative to the
32 statistical comparison value, that information is also reported in the annual Hanford Site RCRA
33 groundwater monitoring report (e.g., DOE/RL-2016-12).

34 If the exceedance of the statistical comparison value is confirmed, written notice is then provided to
35 Ecology within 7 days (40 CFR 265.93(d)(1)) stating that the facility may be affecting groundwater
36 quality. Within 15 days after the notification, a groundwater quality assessment program must be
37 developed and placed in the facility operating record (40 CFR 265.93(d)(2)). This plan must be submitted
38 to Ecology (WAC 173-303-400(3)(c)(v)D)).

5 Outline for Groundwater Quality Assessment Plan

If a groundwater contamination indicator parameter at a downgradient well significantly exceeds the background value or if pH decreases and is confirmed by verification sampling, a groundwater quality assessment plan will be prepared and submitted to Ecology and the facility monitoring will be elevated to assessment monitoring status. The assessment program must be capable of determining whether dangerous waste or dangerous waste constituents from the facility have entered the groundwater, their rate and extent of migration and their concentration. This chapter presents a revision of the groundwater quality assessment monitoring plan outline required by 40 CFR 265.93(a). A crosswalk to information that is still pertinent (e.g., the facility description, geology and hydrogeology, or sampling protocols) within the indicator parameter program groundwater monitoring plan that precedes the groundwater quality assessment plan may be included. An outline for the assessment plan is presented in Table 5-1. Changes may be made to this outline based on the information identified on the crosswalk, if used. The groundwater quality assessment program may include the following elements:

- Description of the hydrogeologic conditions and identification of potential contaminant pathways
- Description of the investigative approach for making first determination to decide if dangerous waste or dangerous waste constituents from the facility have entered the groundwater or if the exceedance was caused by other sources (false-positive rationale)
- Description of the approach to fully characterize rate and extent of contaminant migration
- Number, locations, and depths of wells in the monitoring network
- Sampling and analytical methods used
- Data evaluation methods
- An implementation schedule

The results of assessment determinations will be made as soon as technically feasible and a report of the findings will be sent to Ecology. The results of the groundwater quality assessment program will then be reported annually as required by 40 CFR 265.94(b).

Table 5-1. Suggested Groundwater Quality Assessment Plan Outline

Introduction
Background
Facility Description and Operational History
Regulatory Basis
Waste Characteristics
Geology and Hydrogeology
Summary of Previous Groundwater Monitoring and Results
Conceptual Site Model
Monitoring Objectives
Groundwater Monitoring
Constituent List and Sampling Frequency
Well Network
Sampling and Analysis Protocol
Data Evaluation and Reporting
Data Evaluation
Interpretation
Annual Determination of Monitoring Network
Reporting and Notification
Implementation Schedule
References
Appendix A – Quality Assurance Project Plan
Appendix B –As-Built Drawings of Wells in Well Network

Note: A crosswalk to information that is still pertinent (e.g., the facility description, geology and hydrogeology, or sampling protocols) within the indicator parameter program groundwater monitoring plan that precedes the groundwater quality assessment plan may be included. Changes may be made to this outline based on the information identified on the crosswalk, if used.

6 References

- 1
2 10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at:
3 [http://www.ecfr.gov/cgi-bin/text-](http://www.ecfr.gov/cgi-bin/text-idx?SID=24aad4966ac52acbeba416c2c1114889&mc=true&node=pt10.4.962&rgn=div5)
4 [idx?SID=24aad4966ac52acbeba416c2c1114889&mc=true&node=pt10.4.962&rgn=div5](http://www.ecfr.gov/cgi-bin/text-idx?SID=24aad4966ac52acbeba416c2c1114889&mc=true&node=pt10.4.962&rgn=div5).
- 5 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment,
6 Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at:
7 [http://www.ecfr.gov/cgi-bin/text-](http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5)
8 [idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5](http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5).
- 9 265.90, "Applicability."
10 265.91, "Ground-Water Monitoring System."
11 265.92, "Sampling and Analysis."
12 265.93, "Preparation, Evaluation, and Response."
13 265.94, "Recordkeeping and Reporting."
14 Subpart F, "Ground-Water Monitoring."
15 Appendix III, "EPA Interim Primary Drinking Water Standards."
- 16 ARH-1842, 1970, *Specification and Standards for the Burial of ARHCO Solid Wastes*, Atlantic Richfield
17 Hanford Company, Richland, Washington. Available at:
18 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082006H>.
- 19 *Atomic Energy Act of 1954*, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at:
20 <http://epw.senate.gov/atomic54.pdf>.
- 21 Baker, V.R., B.N. Bjornstad, A.J. Busacca, K.R. Fecht, E.P. Kiver, J.G. Moody, J.G. Rigby, D.F.
22 Stradling, and A.M. Tallman, 1991, "Quaternary Geology of the Columbia Plateau,"
23 *Quaternary Non-glacial Geology: Conterminous U.S.*, The Geology of North America
24 Volume K-2, R.B. Morrison (ed.), Geological Society of America, Boulder, Colorado, pp.
25 215-250. Available at: <http://pbadupws.nrc.gov/docs/ML0037/ML003756793.pdf>.
- 26 Bjornstad, B.N., 2006, *On the Trail of the Ice Age Floods: A Geological Field Guide to the*
27 *Mid-Columbia Basin*, Keokee Books, Sandpoint, Idaho.

- 1 DOE/EIS-0391, 2009, *Draft Tank Closure and Waste Management Environmental Impact Statement for*
2 *the Hanford Site, Richland, Washington*, U.S. Department of Energy, Richland, Washington.
3 Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180376>.
4 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180377>.
5 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180378>.
6 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180379>.
7 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180380>.
8 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180381>.
9 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180382>.
10 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180383>.
11 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180384>.
12 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180385>.
13 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180386>.
14 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180387>.
15 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180388>.
16 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180389>.
17 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180390>.
18 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180391>.
19 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180392>.
20 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180393>.
21 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180394>.
22 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180395>.
23 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180396>.
24 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180397>.
25 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0912180398>.
- 26 DOE/RL-2002-39, 2002, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation*
27 *Sediments Within the Central Pasco Basin*, Rev. 0, U.S. Department of Energy, Richland
28 Operations Office, Richland, Washington. Available at:
29 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081471H>.
- 30 DOE/RL-2004-60, 2015, *200-SW-2 Radioactive Landfills Group Operable Unit RCRA Facility*
31 *Investigation/Corrective Action Measures Study/Remedial Investigation/Feasibility Study*
32 *Work Plan*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland,
33 Washington. Available at:
34 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081616H>.
- 35 DOE/RL-2009-75, 2009, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*, Rev. 0,
36 U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
37 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084331>.
- 38 DOE/RL-2010-74, 2015, *Treatability Test Plan for the 200-BP-5 Groundwater Operable Unit*, Rev. 2,
39 U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at:
40 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081243H>.
- 41 DOE/RL-2012-35, 2012, *First Determination RCRA Groundwater Quality Assessment Plan for*
42 *Low-Level Burial Grounds Low-Level Waste Management Area-1*, Rev. 0, U.S. Department of
43 Energy, Richland Operations Office, Richland, Washington. Available at:
44 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091456>.

- 1 DOE/RL-2013-25, 2013, *First Determination RCRA Groundwater Quality Assessment Report for*
2 *Low-Level Burial Grounds Low-Level Waste Management Area-1*, Rev. 0, U.S. Department of
3 Energy, Richland Operations Office, Richland, Washington. Available at:
4 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0088747>.
- 5 DOE/RL-2014-43, 2014, *Mixed Waste Disposed of in the Low-Level Burial Grounds*, Rev. 0, U.S.
6 Department of Energy, Richland Operations Office, Richland, Washington. Available at:
7 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081637H>.
- 8 DOE/RL-2016-12, 2016, *Hanford Site RCRA Groundwater Monitoring Report for 2015*, Rev. 0,
9 U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
10 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0077828H>.
- 11 [DOE/RL-2019-65, 2020, Hanford Site RCRA Groundwater Monitoring Report for 2019, Rev. 0,](https://pdw.hanford.gov/document/AR-03577)
12 [U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:](https://pdw.hanford.gov/document/AR-03577)
13 <https://pdw.hanford.gov/document/AR-03577>.
- 14 ECF-200E-12-0086, 2013, *Calculations in Support of the Low Hydraulic Gradient Evaluation Study for*
15 *the 200 East Area Unconfined Aquifer*, Rev. 0, U.S. Department of Energy, Richland
16 Operations Office, Richland, Washington. Available at:
17 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087794>.
- 18 [ECF-200E-19-0003, 2020, Groundwater Flow and Migration Calculations for Annual Assessment of the](https://pdw.hanford.gov/document/AR-03697)
19 [Final Status Monitoring Networks for the 200 East Area Dangerous Waste Management](https://pdw.hanford.gov/document/AR-03697)
20 [Units, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.](https://pdw.hanford.gov/document/AR-03697)
21 [Available at: https://pdw.hanford.gov/document/AR-03697](https://pdw.hanford.gov/document/AR-03697).
- 22 Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols.,
23 as amended, Washington State Department of Ecology, U.S. Environmental Protection
24 Agency, and U.S. Department of Energy, Olympia, Washington. Available at:
25 <http://www.hanford.gov/?page=81>.
- 26 EPA 530/R-09-007, 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*
27 *Unified Guidance*, Office of Resource Conservation and Recovery, U.S. Environmental
28 Protection Agency, Washington, D.C. Available at: [http://www.itreweb.org/gsmc-](http://www.itreweb.org/gsmc-1/Content/Resources/Unified_Guidance_2009.pdf)
29 [1/Content/Resources/Unified_Guidance_2009.pdf](http://www.itreweb.org/gsmc-1/Content/Resources/Unified_Guidance_2009.pdf).
- 30 Furman, M.J., 1999, "Notification of Specific Conductance Exceedance at Low-Level Waste
31 Management Area 1 (218-E-10)," (Letter to S. Leja, Acting Perimeter Areas Manager,
32 Nuclear Waste Program, State of Washington Department of Ecology, from M.J. Furman),
33 U.S. Department of Energy, Richland Operations Office, Richland, Washington, March 18.
34 Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199152613>.
- 35 HW-25457, 1960, *Manual of Radiation Protection Standards*, Rev. 2, Hanford Atomic Products
36 Operation, Richland, Washington. Available at:
37 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081989H>.
- 38 HW-65935, 1960, *Chemical Processing Department Monthly Report For June, 1960*, Hanford Atomic
39 Products Operation, Richland, Washington. Available at:
40 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080180H>.

Commented [CTJ38]: RCRA-CN-01_DOE/RL-2009-75_R1

Commented [CTJ39]: RCRA-CN-01_DOE/RL-2009-75_R1

- 1 HW-69443, 1961, *Chemical Processing Department Monthly Report April, 1961*, Hanford Atomic
2 Products Operations, Richland, Washington. Available at:
3 <http://www.osti.gov/scitech/servlets/purl/10183794>
- 4 HW-84619, *Summary of Environmental Contamination Incidents At Hanford, 1958-1964*, Hanford
5 Atomic Products Operations, Richland, Washington. Available at:
6 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080181H>.
- 7 NAD83, 1991, *North American Datum of 1983*, National Geodetic Survey, Federal Geodetic Control
8 Committee, Silver Spring, Maryland, as revised. Available at: <http://www.ngs.noaa.gov/>.
- 9 NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic
10 Control Committee, Silver Spring, Maryland. Available at: <http://www.ngs.noaa.gov/>.
- 11 PNL-6675, 1988, *Ground-Water Monitoring Compliance Projects for Hanford Site Facilities: Progress*
12 *Report for the Period April 1 to June 30, 1988*, Pacific Northwest Laboratory, Richland,
13 Washington. Available at:
14 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196104716>.
15 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196105356>.
- 16 PNL-6772, 1987, *A Detection-Level Hazardous Waste Ground-Water Monitoring Compliance Plan for*
17 *the 200 Areas Low-Level Burial Grounds and Retrievable Storage Units*, Pacific Northwest
18 Laboratory, Richland, Washington. Available at:
19 <http://www.osti.gov/scitech/servlets/purl/6201649>.
- 20 PNL-6820, 1989, *Hydrogeology of the 200 Areas Low-Level Burial Grounds-An Interim Report*, Vols. 1
21 and 2, Rev. 0, Pacific Northwest Laboratory, Richland, Washington. Available at:
22 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195066506>.
23 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195066592>.
24 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195066599>.
- 25 PNL-8889, 1993, *Solid-Waste Leach Characteristics and Contaminant-Sediment Interactions*, Vol.1,
26 Pacific Northwest Laboratory, Richland, Washington. Available at:
27 <http://www.osti.gov/scitech/servlets/purl/10193544-NZAgRx/native/>.
- 28 PNNL-11800, 1998, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the*
29 *Hanford Site*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.
30 Available at: <http://www.osti.gov/scitech/servlets/purl/594543>.
- 31 PNNL-12261, 2000, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and*
32 *Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland,
33 Washington. Available at:
34 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0906180659>.
- 35 PNNL-13404, 2001, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*, Pacific Northwest
36 National Laboratory, Richland, Washington. Available at:
37 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2743868>.
38 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2786917>.
- 39 PNNL-14859, 2004, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management*
40 *Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Rev. 0, Pacific Northwest National
41 Laboratory, Richland, Washington. Available at:
42 http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14859.pdf.

- 1 PNNL-19277, 2010, *Conceptual Models for Migration of Key Groundwater Contaminants Through the*
2 *Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*, Pacific Northwest
3 National Laboratory, Richland, Washington. Available at:
4 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084238>.
- 5 PNNL-19702, 2010, *Hydrogeologic Model for the Gable Gap Area, Hanford Site*, Pacific Northwest
6 National Laboratory, Richland, Washington. Available at:
7 http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19702.pdf.
- 8 RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington.
9 Available at: <http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105&full=true>.
- 10 *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at:
11 <http://www.epw.senate.gov/rcra.pdf>.
- 12 RHO-BW-SA-318P, 1986, *Paleodrainage of the Columbia River System on the Columbia Plateau of*
13 *Washington State: A Summary*, Rockwell Hanford Operations, Richland, Washington.
14 Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196044988>.
- 15 RHO-BWI-ST-4, 1979, *Geologic Studies of the Columbia Plateau, A Status Report*, Rockwell Hanford
16 Operations, Richland, Washington. Available at:
17 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196002105>.
18 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000171>.
19 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000172>.
20 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000173>.
21 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000174>.
22 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000175>.
23 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000176>.
24 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000177>.
25 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000178>.
26 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000179>.
27 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196000180>.
- 28 RHO-CD-138, 1977, *Containment Barrier Criteria*, Rockwell Hanford Operations, Richland
29 Washington. Available at:
30 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080182H>.
- 31 RHO-MA-222, 1987, *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*,
32 Rev. 4, Rockwell Hanford Operations, Richland, Washington. Available at:
33 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081554H>.
- 34 SGW-38815, 2009, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater*
35 *Remediation Project*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland,
36 Washington. Available at:
37 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082378H>.
- 38 SGW-48278, 2011, *Investigation of Unused Landfill Areas: 218-W-4C, 218-W-6, 218-E-10 and*
39 *218-E-12B*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.
40 Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093366>.

1 SGW-60590, Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-1
2 Green Islands Groundwater Monitoring, Rev. 0, CH2M HILL Plateau Remediation Company,
3 Richland, Washington. Available at: <https://pdw.hanford.gov/document/AR-03212>.

Commented [CTJ40]: RCRA-CN-01_DOE/RL-2009-75_R1

4 WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous*
5 *Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as
6 amended, Washington State Department of Ecology. Available at:
7 <http://www.ecy.wa.gov/programs/nwp/permitting/hdwp/rev/8c/index.html>.

8 WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington*
9 *Administrative Code*, Olympia, Washington. Available at:
10 <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160>.

11 WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia,
12 Washington. Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303>.

13 303-040, "Definitions."

14 303-400, "Interim Status Facility Standards."

15 WHC-MR-0204, 1990, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary*
16 *Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
17 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196038070>.

18 WHC-MR-0205, 1990, *Borehole Completion Data Package for the Low-Level Burial Grounds-1990*,
19 Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
20 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196035268>.

21 WHC-SD-EN-AP-015, 1989, *Revised Groundwater Monitoring Plan for the 200 Areas Low-Level Burial*
22 *Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
23 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195063349>.

24 WHC-SD-EN-AP-021, 1990, *Interim-Status Ground-Water Quality Assessment Plan for Waste*
25 *Management Area 1 of the 200 Areas Low-Level Burial Grounds*, Rev. 0, Westinghouse
26 Hanford Company, Richland, Washington. Available at:
27 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0006975>.

28 WHC-SD-EN-DP-044, 1993, *1991 Borehole Completion Data Package for the Low-Level Burial*
29 *Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
30 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196137037>,
31 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196137214>,
32 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196137229>.

33 WHC-SD-EN-DP-049, 1993, *1992 Borehole Completion Data Package for the Low-Level Burial*
34 *Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
35 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196126247>.

36 WHC-SD-EN-EV-024, 1994, *Site Characterization Report for the Liquid Effluent Retention Facility*,
37 Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
38 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196090383>.

DOE/RL-2009-75, REV. 1
RCRA-CN-01_DOE/RL-2009-75_R1

1 WHC-SD-EN-EV-025, 1994, *Results of Groundwater Quality Assessment Program at Low-Level Waste*
2 *Management Area 1 of the Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford
3 Company, Richland, Washington. Available at:
4 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196097452>.

5 WHC-SD-WM-TI-730, 1996, *Performance Assessment for the Disposal of Low-Level Waste in the 200*
6 *East Area Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
7 Available at: <http://www.osti.gov/scitech/servlets/purl/657436-k3bzG9/webviewable/>.

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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	<i>Resource Conservation and Recovery Act of 1976</i>
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate
VOC	volatile organic compound

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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.

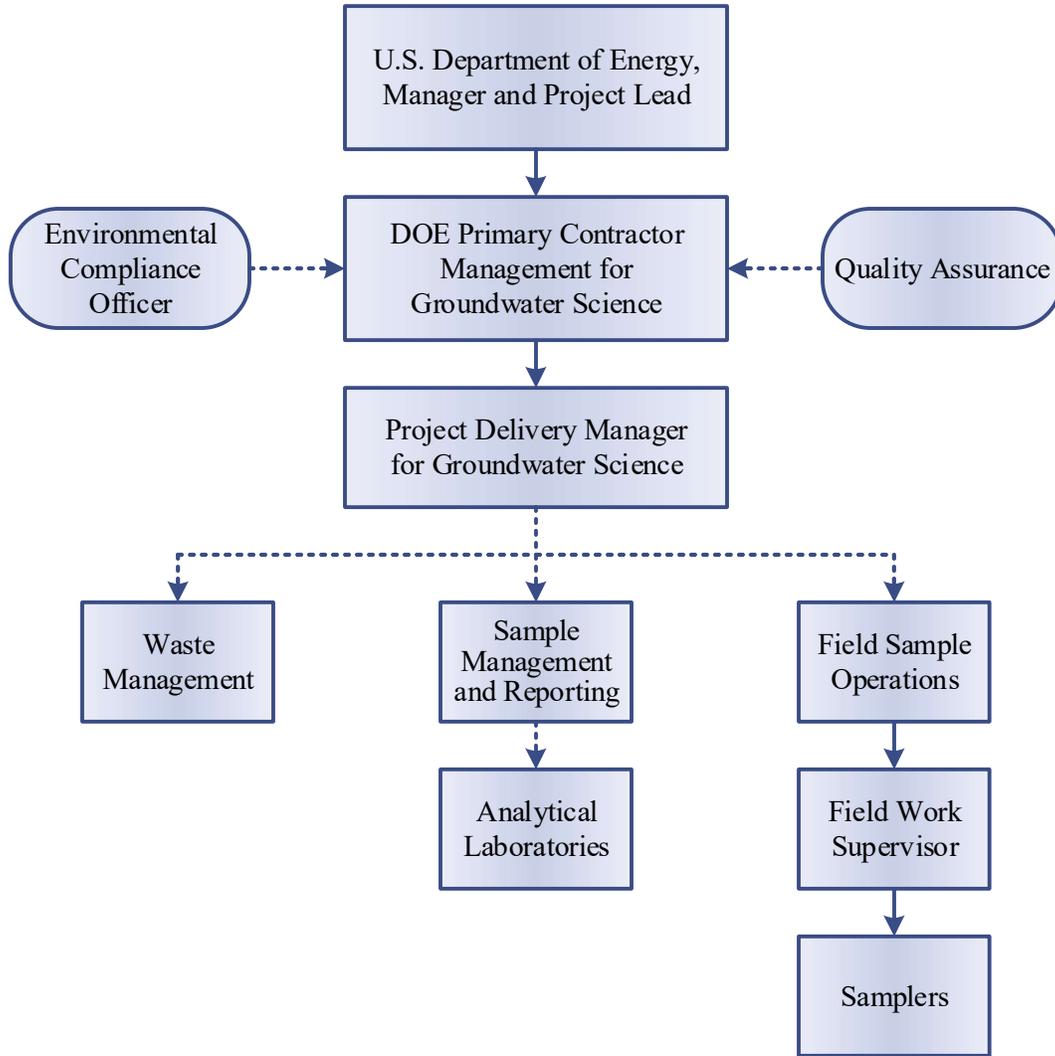


Figure A-1. Project Organization

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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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-2019-65, *Hanford Site RCRA Groundwater Monitoring Report for 201*).

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			
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 NO ₃	300, 9056	250
14797-65-0	Nitrite, as NO ₂	300, 9056	250
14808-79-8	Sulfate	300, 9056	1050
Field Measurements			
--	pH	150.1, 9040, Standard Method 4500 H+	N/A
--	Dissolved oxygen	360.1, Standard Method 4500 O	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
7439-95-4	Magnesium	6010	1050
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

Table A-3. Analytical Methods for the DWMU

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

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

VOC = volatile organic compound

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

Analyte ^a	QC Element	Acceptance Criteria	Corrective Action
General Chemistry			
Total organic carbon	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 ^c
	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 ^c
Total organic halogen	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
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
	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			

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

Analyte ^a	QC Element	Acceptance Criteria	Corrective Action
Phenols gas chromatography/mass spectrometry	MB	<MDL <5% sample concentration	Flag with “B”
	LCS	70% to 130% recovery or % recovery statistically derived ^f	Flag with “o” ^b
	DUP ^c or MS/MSD ^d	≤20% RPD	Review data ^e
	MS/MSD ^d	% recovery statistically derived ^f	Flag with “T”
	SUR	% recovery statistically derived ^f	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., dissolved oxygen, 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 | MSD = matrix spike duplicate |
| EB = equipment blank | PQL = practical quantitation limit |
| FTB = full trip blank | QC = quality control |
| LCS = laboratory control sample | RPD = relative percent difference |
| MB = method blank | SMR = Sample Management and Reporting |
| MDL = method detection limit | SUR = surrogate |
| MS = matrix spike | |

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 water¹. 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 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.

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.

- **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		
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

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

Constituent ^a	Preservation ^b	Holding Time
--------------------------	---------------------------	--------------

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 Ecology requirements 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., dissolved oxygen, 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. For preservation identified as stored at $\leq 6^{\circ}\text{C}$, 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.”
- 265.93, “Preparation, Evaluation, and Response.”
- 265.94, “Recordkeeping and Reporting.”
- Subpart F, “Ground-Water Monitoring.”
- APHA/AWWA/WEF, 2017, *Standard Methods for the Examination of Water and Wastewater*, 23rd Edition, American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, D.C.
- Atomic Energy Act of 1954*, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: <https://www.energy.gov/sites/prod/files/2017/10/f38/Atomic%20Energy%20Act%20of%201954%20%28AEA%29%20in%20U.S.C..pdf>.
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: <https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf>.
- DOE/RL-2019-65, 2020, *Hanford Site RCRA Groundwater Monitoring Report for 2019*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: <https://pdw.hanford.gov/document/AR-03577>.
- Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: <http://www.hanford.gov/?page=81>.
- EPA/600/4-79/020, 1983, *Methods for Chemical Analysis of Water and Wastes*, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196019611>.
- EPA/600/R-93/100, 1993, *Methods for the Determination of Inorganic Substances in Environmental Samples*, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. Available at: <https://nepis.epa.gov/Exe/ZyNET.exe/30002U3P.TXT?ZyActionD=ZyDocument&Client=EP A&Index=1991+Thru+1994&Docs=&Query=&Time=&EndTime=&SearchMethod=1&ToCRestrict=n&ToC=&ToCEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C91thru94%5CTxt%5C00000008%5C30002U3P.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL>.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at:
<https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf>.

SW-846, 2019, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: <https://www.epa.gov/hazardous-waste-test-methods-sw-846>.

SW-846 Compendium, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: <https://www.epa.gov/hw-sw846/sw-846-compendium>.

WAC 173-303, “Dangerous Waste Regulations,” *Washington Administrative Code*, Olympia, Washington. Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303>.

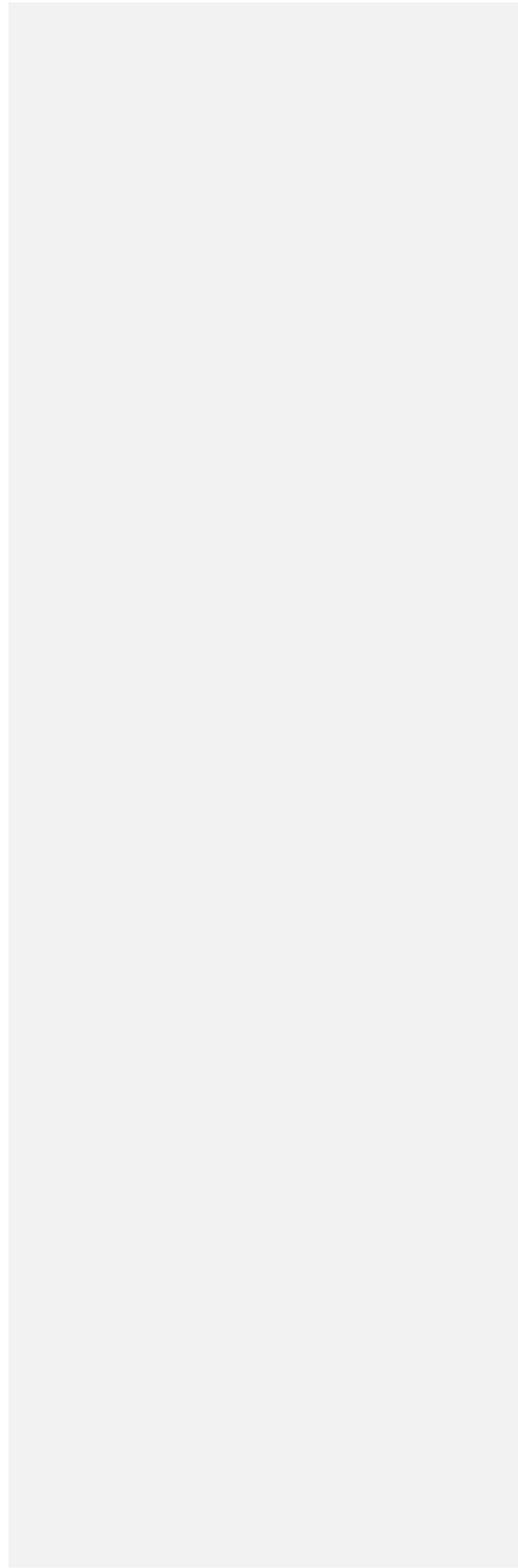
303-400, “Interim Status Facility Standards”

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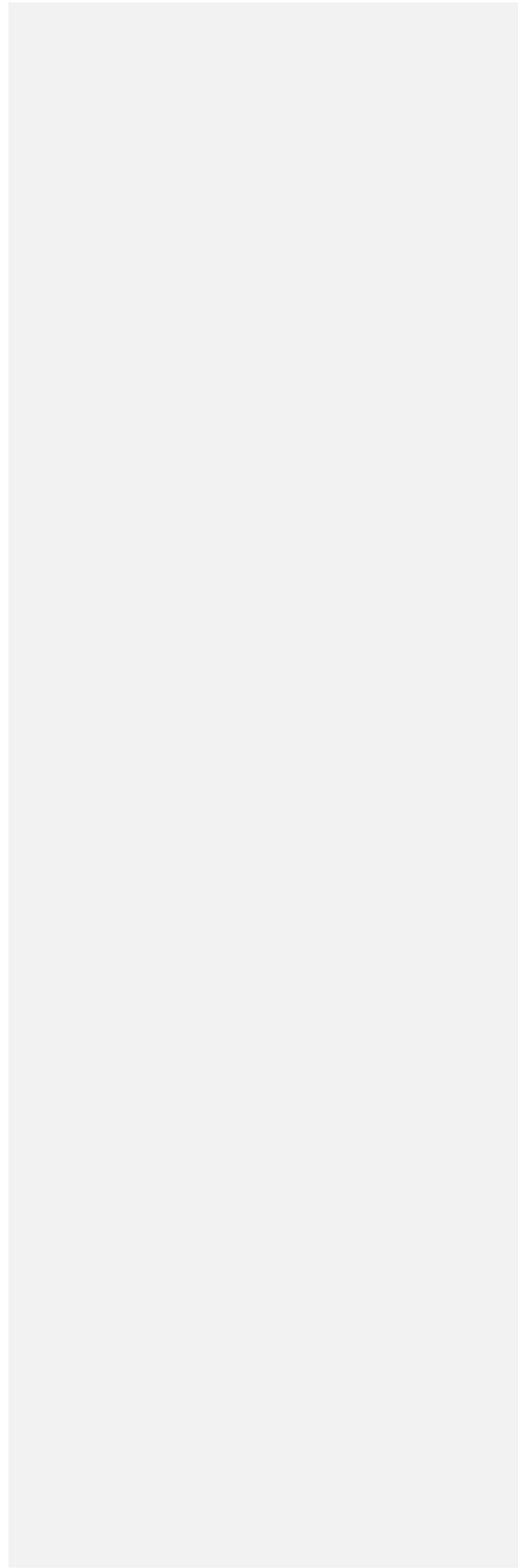
Appendix B

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Sampling Protocol



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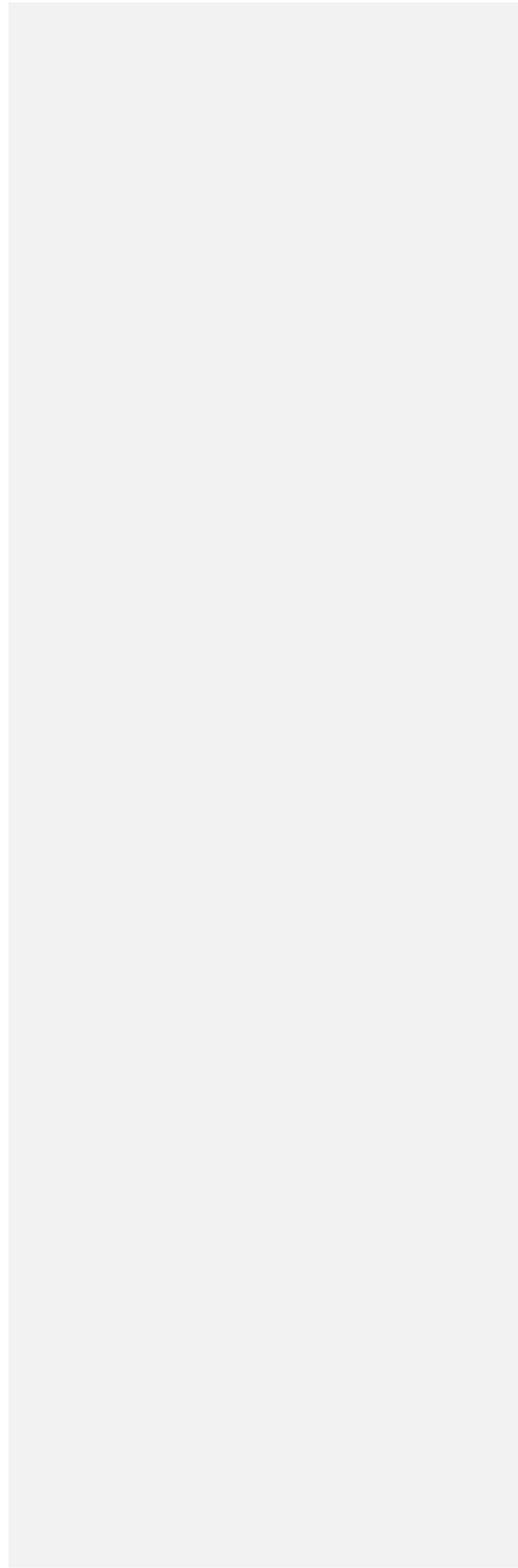
1		Contents	
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Terms

DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
FWS	Field Work Supervisor
gpm	gallons per minute
HASQARD	<i>Hanford Analytical Services Quality Assurance Requirements Document</i> (DOE/RL-96-68)
IATA	International Air Transport Association
LLWMA-1	Low-Level Waste Management Area 1
NTU	nephelometric turbidity unit
QA	quality assurance
QC	quality control
SMR	Sample Management and Reporting

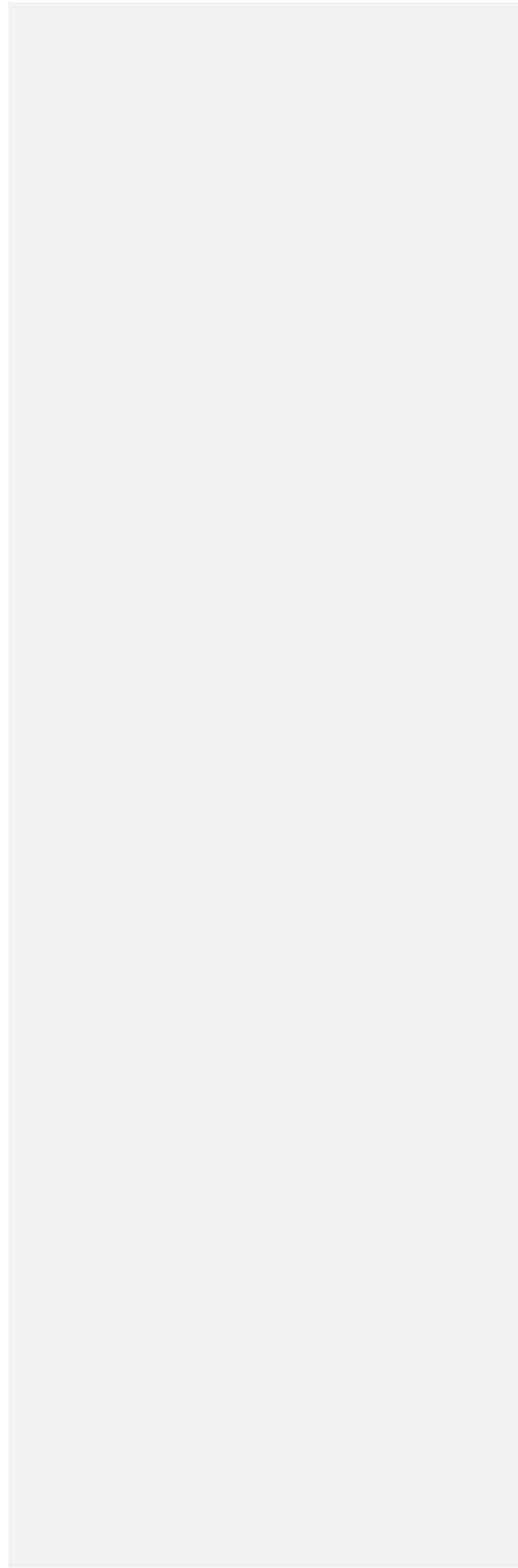
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B1 Introduction

2 Groundwater monitoring at the Hanford Site, as defined by the *Resource Conservation and Recovery Act*
3 *of 1976* and implemented in WAC 173-303-400, “Dangerous Waste Regulations,” “Interim Status
4 Facility Standards,” has been conducted since the mid-1980’s. Hanford Site groundwater sampling
5 methods contain extensive requirements for sampling precautions to be taken; equipment and its use;
6 cleaning and decontamination; records and documentation; and sample collection, management, and
7 control activities. Together, Appendices A and B, provide the sampling and analysis essentials necessary
8 for the groundwater monitoring plan: sample collection, sample holding times, chain-of-custody control,
9 analytical procedures, and field and laboratory quality assurance (QA)/quality control (QC).

10 This appendix provides more specific elements of the sampling protocols and techniques used for the
11 groundwater monitoring plan. Chapter 3 of the groundwater monitoring plan identifies the monitoring
12 wells that will be sampled, constituents to be analyzed, and sampling frequency for the groundwater
13 monitoring at the Low-Level Waste Management Area 1 (LLWMA-1).

14

B2 Sampling Methods

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

- 16 • Field screening measurements
- 17 • Groundwater sampling
- 18 • Water level measurements

19 Groundwater samples will be collected in accordance with the current revision of applicable operating
20 methods. Groundwater samples are collected after field measurements of purged groundwater have
21 stabilized:

- 22 • **pH** – two consecutive measurements agree within 0.2 pH units
- 23 • **Temperature** – two consecutive measurements agree within 0.2°C (32.3°F)
- 24 • **Conductivity** – two consecutive measurements agree within 10 percent of each other
- 25 • **Turbidity** – less than 5 nephelometric turbidity units (NTUs) prior to sampling (or project scientist’s
26 recommendation)

27 Dissolved oxygen will also be measured in the field in this groundwater monitoring plan. Dissolved
28 oxygen is not an indicator parameter nor a groundwater quality parameter and is not required to be stable
29 prior to sample collection.

30 Unless special requirements are requested from project scientists, wells are typically purged using the
31 equivalent volume as that of three borehole diameters multiplied by the length of the saturated portion of
32 the well screen. Stable field readings are also required as specified above. The default pumping rate is
33 7.6 to 45.4 L/min (2 to 12 gallons per minute [gpm]) depending on the pump, although this is not
34 practical at every well. On occasions when the purge volume is extraordinarily large, wells are purged for
35 a minimum of 1 hour and are then sampled once stable field readings are obtained.

1 Field measurements (except for turbidity) are obtained using a flow-through cell. Groundwater is pumped
2 directly from the well to the flow-through cell. At the beginning of the sample event, field crews attach a
3 clean, stainless-steel sampling manifold to the riser discharge. The manifold has two valves and two
4 ports; one port is used only for purgewater, and the other port is used to supply water to the flow-through
5 cell. Probes are inserted into the flow-through cell to measure pH, temperature, conductivity, and
6 dissolved oxygen. Turbidity is measured by inserting a sample vial into a turbidimeter. The purgewater is
7 then discharged to the purgewater truck.

8 Once field measurements have stabilized, the hose supplying water to the flow-through cell is
9 disconnected and a clean, stainless-steel drop leg is attached for sampling. The flow rate is reduced during
10 sampling to minimize loss of volatiles (if any) and prevent over filling the bottles. Sample bottles are filled
11 in a sequence designed to minimize loss of volatiles, if any. Filtered samples are collected after collection
12 of the unfiltered samples. For some constituents (e.g. metals) both filtered and unfiltered samples are
13 collected. If additional samples require filtration (e.g., at turbidity greater than 5 NTUs), an inline
14 disposable 0.45 µm filter is used.

15 Typically, three traditional types (i.e., Grundfos,¹ Hydrostar,² and submersible electrical pumps) of
16 environmental-grade sampling pumps are used for groundwater sampling at Hanford Site monitoring
17 wells. In addition, low-purge-volume, adjustable-rate bladder pumps may be used. Individual pumps are
18 selected based on the unique characteristics of the well and the sampling requirements.

19 A small number of wells will not support pumping of samples because of yield or the physical
20 characteristics of the well. In these cases, a grab sample may be obtained. In cases where there is not
21 sufficient yield, purgewater activities are not performed

22 Low-purge-volume sampling methodology for the collection of groundwater samples is also being
23 implemented at the Hanford Site. Low-flow purging and sampling uses a low-purge-volume,
24 adjustable-rate bladder pump with flow rates typically on the order of 0.1 to 0.5 L/min (0.26 to 0.13 gpm).
25 This methodology is intended to minimize excessive movement of water from the soil formation into the
26 well. The objective is to pump in a manner that minimizes stress (drawdown) to the system. Purge
27 volumes for wells using low purge bladder pumps are determined on a well-specific basis based on
28 drawdown, pumping rate, pump and sample line volume, and volume required to obtain stable field
29 conditions prior to collecting samples.

30 For certain types of samples, preservatives are required. Preservatives, based on analytical methods used,
31 are added to the collection bottles before their use in the field. Samples may require filtering in the field,
32 as noted on the chain-of-custody form.

33 To ensure sample and data usability, sampling associated with this groundwater monitoring plan will be
34 performed in accordance with the requirements of DOE/RL-96-68, *Hanford Analytical Services Quality*
35 *Assurance Requirements Document* (HASQARD), pertaining to sample collection, collection equipment,
36 and sample handling.

37 Sample holding time requirements are specified for groundwater samples in Appendix A, Table A-6.
38 These requirements are in accordance with the analytical methods specified in Appendix A, Table A-3.
39 The container types, preservatives, and volumes will be identified on the chain-of-custody form.
40 This groundwater monitoring plan defines a sample as a filled sample bottle for purposes of starting the
41 clock on holding time restrictions.

¹ Grundfos® is a registered trademark of Grundfos Holding A/S Corporation, Bjerringbro, Denmark.

² Hydrostar® is a registered trademark of KYB Corporation, Tokyo, Japan.

1
2 Holding time is the maximum allowable period between sample collection and analysis. Exceeding
3 required holding times could result in changes in constituent concentrations due to volatilization,
4 decomposition, or other chemical alterations. Required holding times depend on the constituent and are
5 listed in analytical method compilations such as APHA/AWWA/WEF, 2012, *Standard Methods for the*
6 *Examination of Water and Wastewater*; and SW-846, *Test Methods for Evaluating Solid Waste, Physical/*
7 *Chemical Methods, Third Edition; Final Update V*. Recommended holding times are also provided in
8 HASQARD (DOE/RL-96-68) and in applicable laboratory contracts.

9 **B2.1 Decontamination of Sampling Equipment**

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

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

- 15 • Improperly storing or transporting sampling equipment and sample containers
- 16 • Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near
17 potential contamination sources (e.g., uncovered ground)
- 18 • Handling bottles or equipment with dirty hands or gloves

19 Improperly decontaminating equipment before sampling or between sampling events-

20 Decontamination of sampling equipment and pumps is performed using high-purity water³ in each step.
21 In general, three rinse cycles are performed to decontaminate sampling equipment: a detergent rinse, an
22 acid rinse, and a water rinse. During the detergent rinse, the equipment is washed in a phosphate-free
23 detergent solution, followed by rinsing with water in three sequential containers. After the third water
24 rinse, equipment that is stainless-steel or glass is rinsed in a 1M nitric acid solution (pH less than 2).
25 Equipment is then rinsed with water in three sequential containers (the water rinses following the acid
26 rinse are conducted in separate water containers that are not used for detergent rinse). Following the final
27 water rinse, equipment is rinsed in hexane and then placed on a rack to dry. Dry equipment is loaded into
28 a drying oven. The oven is set at 50 degrees C (122 degrees Fahrenheit) for items that are not metal or
29 glass or at 100 degrees C (212 degrees Fahrenheit) for metal or glass. Once reaching temperature,
30 equipment is baked for 20 minutes and then cooled. The equipment is then removed from the oven, and
31 the equipment is enclosed in clean, unused aluminum foil using surgeon's gloves. The wrapped
32 equipment is stored in a custody-locked, controlled-access area.

33 To decontaminate sampling pumps that are not permanently installed, the pump cowling is first removed,
34 washed (if needed) in phosphate-free detergent solution, and then reinstalled on the pump. The pump is
35 then submerged in phosphate-free detergent solution, and 11.4 L (3 gal) of solution is pumped through the
36 unit and disposed. Detergent solution is then circulated through the submerged pump for 5 minutes.

37

³ 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 (DOE/RL-96-68).

1 The pump is removed from solution and rinsed with water. The pump is submerged in water and 30.3 L
2 (8 gal) of water is pumped through the unit and disposed. The pump is removed from the water and the
3 intake and housing are covered with plastic sleeving. The cleaning is documented on a tag that is affixed
4 to the pump, and the tag will include the following information:

- 5 • Date pump cleaned
- 6 • Pump identification
- 7 • Comments
- 8 • Signature of person performing decontamination

9 **B2.2 Water Levels**

10 Each time a sample is obtained, measurement of the ground water surface elevation at each monitoring
11 well is required by 40 CFR 265.92(e), "Interim Status Standards for Owners and Operators of Hazardous
12 Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." Using a calibrated depth
13 measurement tape, the depth to water is recorded in each well prior to sampling. When two consecutive
14 measurements are taken that agree within 6 mm (0.24 in.); the final determined measurement is recorded,
15 along with the date and time for the specific event. The depth to groundwater is subtracted from the
16 elevation of a reference point (usually the top of the casing) to obtain the water-level elevation. The top of
17 the casing is a known elevation reference point because it has been surveyed to local reference data.

18 **B3 Documentation of Field Activities**

19 Logbooks or data forms are required for field activities and will be used in accordance with HASQARD
20 (DOE/RL-96-68) requirements. A logbook must be identified with a unique project name and number.
21 The individual(s) responsible for logbooks will be identified in the front of the logbook, and only
22 authorized persons may make entries in logbooks. Logbook entries will be reviewed by the sampling
23 Field Work Supervisor (FWS), cognizant scientist/engineer, or other responsible manager; the review will
24 be documented with a signature and date. Logbooks will be permanently bound, waterproof, and ruled
25 with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will
26 be made in indelible ink. Corrections will be made by marking through the erroneous data with a single
27 line, entering the correct data, and initialing and dating the changes.

28 Data forms may be used to collect field information; however, information recorded on data forms must
29 follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

30 A summary of information to be recorded in logbooks or on data forms is as follows:

- 31 • Day and date; time task started; weather conditions; and names, titles, and organizations of personnel
32 performing the task.
- 33 • Purpose of visit to the task area.
- 34 • Site activities in specific detail (e.g., maps and drawings) or the forms used to record such
35 information (e.g., soil boring log or well completion log). Also, details of any field tests that were
36 conducted; reference to any forms that were used, other data records, and methods followed in
37 conducting the activity.
- 38 • Details of any field calibrations and surveys that were conducted. Reference any forms that were
39 used, other data records, and the methods followed in conducting the calibrations and surveys.

- 1 • Details of any samples collected and the preparation (if any) of splits, duplicates, matrix spikes, or
2 blanks. Reference the methods followed in sample collection or preparation; list location of sample
3 collected, sample type, each label or tag numbers, sample identification, sample containers and
4 volume, preservation method, packaging, chain-of-custody form number, and analytical request form
5 number pertinent to each sample or sample set; and note the time and the name of the individual to
6 whom custody of samples was transferred.
- 7 • Time, equipment type, serial or identification number, and methods followed for decontaminations
8 and equipment maintenance performed. Reference the page number(s) of any logbook where detailed
9 information is recorded.
- 10 • Any equipment failures or breakdowns that occurred, with a brief description of repairs or
11 replacements.

12 **B3.1 Corrective Actions and Deviations for Sampling Activities**

13 The Project Delivery Manager for Groundwater Science, FWS, appropriate field crew supervisors, and
14 Sample Management and Reporting (SMR) personnel must document deviations from protocols, issues
15 pertaining to sample collection, chain-of-custody forms, target analytes, contaminants, sample transport,
16 or noncompliant monitoring. Examples of deviations include samples not collected due to field
17 conditions.

18 As appropriate, such deviations or issues will be documented (e.g., in the field logbook) in accordance
19 with internal corrective action methods. The Project Delivery Manager for Groundwater Science, FWS,
20 field crew supervisors, or SMR personnel will be responsible for communicating field corrective action
21 requirements and ensuring that immediate corrective actions are applied to field activities.

22 Changes in sample activities that require notification, approval, and documentation will be performed as
23 specified in Appendix A, Table A-2.

24 **B4 Calibration of Field Equipment**

25 Onsite environmental instruments are calibrated in accordance with the manufacturer's operating
26 instructions, internal work requirements and processes, and/or field instructions that provide direction for
27 equipment calibration or verification of accuracy by analytical methods. Calibration records shall include
28 the raw calibration data, identification of the standards used, associated reports, date of analysis, and
29 analyst's name or initials. The results from all instrument calibration activities are recorded in accordance
30 with the HASQARD requirements (DOE/RL-96-68).

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

- 32 • Prior to initial use of a field analytical measurement system.
- 33 • At the frequency recommended by the manufacturer or methods, or as required by regulations.
- 34 • Upon failure to meet specified QC criteria.
- 35 • Daily calibration checks will be performed and documented for each instrument used. These checks
36 will be made on standard materials sufficiently like the matrix under consideration for direct
37 comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.

1 Using standards for calibration that are traceable to a nationally recognized standard agency source or
2 measurement system. Manufacturer's recommendations for storage and handling of standards (if any) will
3 be followed.

4 **B5 Sample Handling**

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

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

11 **B5.1 Containers**

12 Samples shall be collected, where and when appropriate, in break-resistant containers. The field sample
13 collection record shall indicate the laboratory lot number of the bottles used in sample collection.

14 When commercially pre-cleaned containers are used in the field, the name of the manufacturer, lot
15 identification, and certification shall be retained for documentation.

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

22 **B5.2 Container Labeling**

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

28 **B5.3 Sample Custody**

29 Sample custody will be maintained in accordance with existing protocols to ensure that sample integrity is
30 maintained throughout the analytical process. Chain-of-custody protocols will be followed throughout
31 sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained.

32 A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each
33 set of samples shipped to any laboratory.

34 Shipping requirements will determine how sample shipping containers are prepared for shipment.

35 The analyses requested for each sample will be indicated on the accompanying chain-of-custody form.

36 Each time the responsibility for custody of the sample changes, new and previous custodians will sign the
37 record and note the date and time. [The field sampling team will make a copy of the signed record before
38 sample shipment and transmit the copy to the SMR group.]

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

- 2 • Project name
- 3 • Collector's names
- 4 • Unique sample number
- 5 • Date and time of collection
- 6 • Matrix
- 7 • Preservatives
- 8 • Chain of possession information (i.e., signatures and printed names of each individual involved in the
9 transfer of sample custody and storage locations, and dates/times of receipt and relinquishment)
- 10 • Requested analyses (or reference thereto)
- 11 • Shipped-to information (i.e., analytical laboratory performing the analysis)

12 Samplers should note any anomalies with the samples. If anomalies are found, samplers should inform the
13 SMR group; so special direction for analysis can be provided to the laboratory if deemed necessary.

14 **B5.4 Sample Transportation**

15 Packaging and transportation instructions shall comply with applicable transportation regulations and
16 U.S. Department of Energy (DOE) requirements. Regulations for classifying, describing, packaging,
17 marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are
18 enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "Transportation,"
19 "General Information, Regulations, and Definitions," through 49 CFR 177, "Carriage by Public
20 Highway."⁴ Carrier-specific requirements, defined in the current edition of International Air Transport
21 Association (IATA) *Dangerous Goods Regulations*, shall also be used when preparing sample shipments
22 conveyed by air freight providers.

23 Samples containing hazardous constituents shall be considered hazardous material in transportation and
24 transported according to DOT/IATA requirements. If the sample material is known or can be identified,
25 then it will be classified, described, packaged, marked, labeled, and shipped according to the specific
26 instructions for that material. Appropriate laboratory notifications will be made, if necessary, through the
27 SMR project coordinator.

28 **B6 Management of Waste**

29 Waste materials are generated during sample collection, processing, and subsampling activities. Waste
30 will be managed in accordance with DOE/RL-2003-30, *Waste Control Plan for the 200-BP-5*
31 *Operable Unit*. For waste designation purposes, wells listed in Table 3-2 in the main text of the
32 monitoring plan may be surveyed in the Hanford Environmental Information System and the maximum
33 concentration for each analyte within the most recent 5 years will be evaluated for use in creating a waste
34 profile, if required.

⁴ Transportation regulations 49 CFR 174, "Carriage by Rail," and 49 CFR 176, "Carriage by Vessel," are not applicable, as these two transportation methods are not used.

1 Miscellaneous solid waste that has contacted suspect dangerous waste will be managed as dangerous
2 waste. Purgewater and decontamination fluids will be collected and managed in accordance with
3 DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste*; and
4 DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan*. Waste materials
5 requiring collection will be placed in containers appropriate for the material and the receiving facility in
6 accordance with the applicable waste management or waste control plan and applicable substantive
7 federal and/or state requirements.

8 Packaging and labeling during waste storage and transportation will meet WAC 173-303 and DOT
9 requirements, as appropriate. Packaging exceptions to DOT requirements may be used for onsite waste
10 shipments if documented as such and if the packaging provides an equivalent degree of safety during
11 transportation.

12 Offsite analytical laboratories are responsible for the disposal of unused sample quantities.

13 **B7 Health and Safety**

14 DOE established the hazardous waste operations safety and health program pursuant to the
15 *Price-Anderson Amendments Act of 1988* to ensure the safety and health of workers involved in
16 mixed-waste site activities. The program was developed to comply with the requirements of 10 CFR 851,
17 “Worker Safety and Health Program,” which incorporates the standards of 29 CFR 1910.120,
18 “Occupational Safety and Health Standards,” “Hazardous Waste Operations and Emergency Response”;
19 10 CFR 830, “Nuclear Safety Management”; and 10 CFR 835, “Occupational Radiation Protection.” The
20 health and safety program defines the chemical, radiological, and physical hazards and specifies the
21 controls and requirements for daily work activities on the overall Hanford Site. Personnel training; control
22 of industrial safety and radiological hazards; personal protective equipment; site control; and general
23 emergency response to spills, fire, accidents, injury, site visitors, and incident reporting are governed by
24 the health and safety program.

25 **B8 References**

- 26 10 CFR 830, “Nuclear Safety Management,” *Code of Federal Regulations*. Available at:
27 [http://www.ecfr.gov/cgi-bin/text-
28 idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.830&rgn=div5](http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.830&rgn=div5).
- 29 10 CFR 835, “Occupational Radiation Protection,” *Code of Federal Regulations*. Available at:
30 [http://www.ecfr.gov/cgi-bin/text-
31 idx?SID=57ef404ac6f4734a67fd97302b2d7f7f&node=pt10.4.835&rgn=div5](http://www.ecfr.gov/cgi-bin/text-idx?SID=57ef404ac6f4734a67fd97302b2d7f7f&node=pt10.4.835&rgn=div5).
- 32 10 CFR 851, “Worker Safety and Health Program,” *Code of Federal Regulations*. Available at:
33 [http://www.ecfr.gov/cgi-bin/text-
34 idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.851&rgn=div5](http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.851&rgn=div5).
- 35 29 CFR 1910.120, “Occupational Safety and Health Standards,” “Hazardous Waste Operations and
36 Emergency Response,” *Code of Federal Regulations*. Available at:
37 https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9765.
- 38 40 CFR 265.92, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment,
39 Storage, and Disposal Facilities,” “Sampling and Analysis,” *Code of Federal Regulations*.
40 Available at: [http://www.ecfr.gov/cgi-bin/text-
41 idx?SID=fc3e30d2a24de032666c2de7ddb46f1b&mc=true&node=se40.26.265_192&rgn=div8](http://www.ecfr.gov/cgi-bin/text-idx?SID=fc3e30d2a24de032666c2de7ddb46f1b&mc=true&node=se40.26.265_192&rgn=div8).

- 1 49 CFR, "Transportation," *Code of Federal Regulations*. Available at: <http://www.ecfr.gov/cgi-bin/text-idx?gp=&SID=4eee73b085f2533d72722864dbca949a&mc=true&tpl=/ecfrbrowse/Title49/49CISubchapC.tpl>.
- 2
- 3
- 4 49 CFR 171, "General Information, Regulations, and Definitions."
- 5 49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials
- 6 Communications, Emergency Response Information, Training Requirements, and Security
- 7 Plans."
- 8 49 CFR 173, "Shippers-General Requirements for Shipments and Packagings."
- 9 49 CFR 175, "Carriage by Aircraft."
- 10 49 CFR 177, "Carriage by Public Highway."
- 11 APHA/AWWA/WEF, 2012, *Standard Methods for the Examination of Water and Wastewater*,
- 12 22nd Edition, American Public Health Association, American Water Works Association, and
- 13 Water Environment Federation, Washington, D.C.
- 14 DOE/RL-96-68, 2014, *Hanford Analytical Services Quality Assurance Requirements Document*, Rev. 4,
- 15 *Volume 1, Administrative Requirements; Volume 2, Sampling Technical Requirements;*
- 16 *Volume 3, Field Analytical Technical Requirements; and Volume 4, Laboratory Technical*
- 17 *Requirements*, U.S. Department of Energy, Richland Operations Office, Richland,
- 18 Washington. Available at:
- 19 <http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf>.
- 20 <http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf>.
- 21 <http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf>.
- 22 <http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL4-04.pdf>.
- 23 DOE/RL-2003-30, 2007, *Waste Control Plan for the 200-BP-5 Operable Unit*, Rev. 3, U.S. Department
- 24 of Energy, Richland Operations Office, Richland, Washington. Available at:
- 25 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0089342>.
- 26 DOE/RL-2009-80, 2009, *Investigation Derived Waste Purgewater Management Work Plan*, Rev. 0,
- 27 U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
- 28 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0094946>.
- 29 DOE/RL-2011-41, 2011, *Hanford Site Strategy for Management of Investigation Derived Waste*, Rev. 0,
- 30 U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
- 31 <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093937>.
- 32 IATA, *Dangerous Goods Regulations*, Current Edition, International Air Transport Association,
- 33 Montreal, Quebec, Canada. Available at:
- 34 <http://www.iata.org/publications/dgr/Pages/index.aspx>.
- 35 *Price-Anderson Amendments Act of 1988*, Pub. L. 100-408, Aug. 20, 1988, 102 Stat. 1066, 42 USC 2010,
- 36 et seq. Available at: [http://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-](http://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-Pg1066.pdf)
- 37 [Pg1066.pdf](http://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-Pg1066.pdf).
- 38 *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at:
- 39 <http://www.epw.senate.gov/rcra.pdf>.

1 SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition;*
2 *Final Update V*, as amended, Office of Solid Waste and Emergency Response,
3 U.S. Environmental Protection Agency, Washington D.C. Available at:
4 <https://www.epa.gov/hazardous-waste-test-methods-sw-846>.

5 WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia,
6 Washington. Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303>.

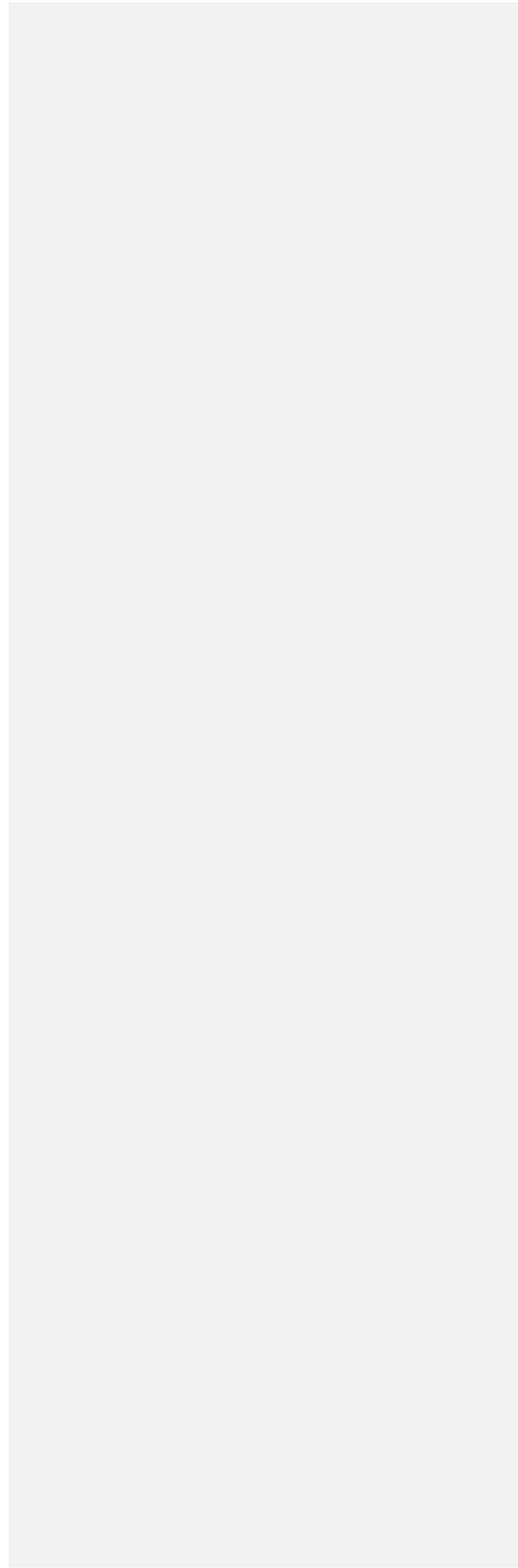
7 WAC 173-303-400, "Interim Status Facility Standards."
8

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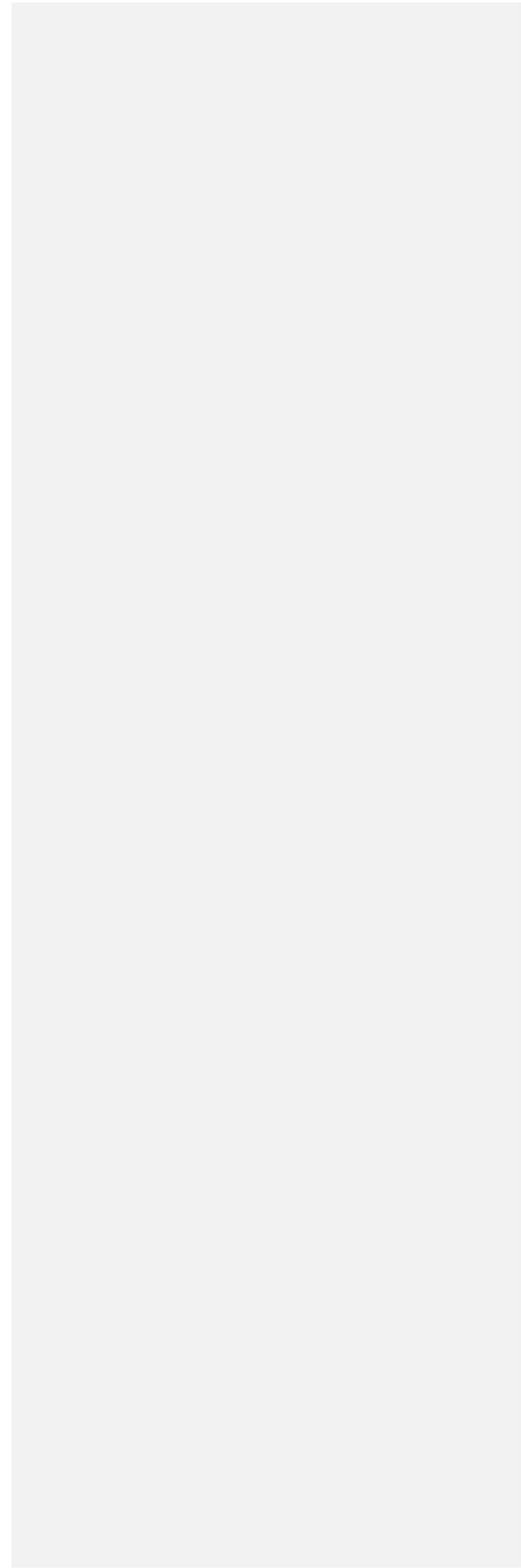
Appendix C

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Well Construction



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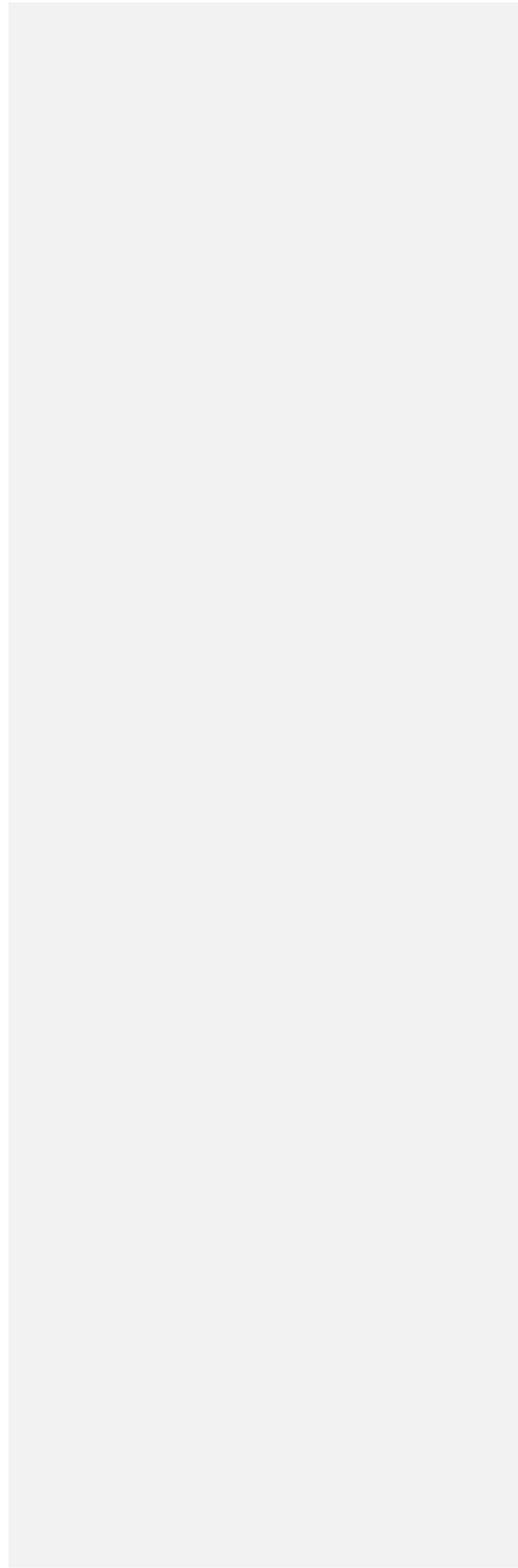
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C1 Introduction

This appendix provides the following information for the Low-Level Waste Management Area 1 (LLWMA-1) groundwater monitoring wells:

- Well name
- Hydrogeologic unit to be monitored (the portion of the aquifer that is located at the well screen or perforated casing) (Table C-1)
- The following sampling interval information, as shown in Table C-2:
 - Elevation at top of the screen or perforated interval
 - Elevation at the bottom of the screen or perforated interval
 - Open interval length (i.e., difference between elevations of top and bottom of the screen or perforated interval)

Figures C-1 through C-7 provide the well construction and completion summary for the LLWMA-1 monitoring network.

Table C-1. Hydrogeologic Monitoring Unit Classification Scheme

Unit	Description
TU	Top of Unconfined. Screened across the water table or the top of the open interval is within 1.5 m (5 ft) of the water table, and the bottom of the open interval is no more than 10.7 m (35 ft) below the water table.

Table C-2. Sampling Interval Information for Wells within the LLWMA-1 Network

Well or Aquifer Tube Name	Hydrogeologic Unit Monitored	Elevation Top of Open Interval (m [ft] NAVD88)	Elevation Bottom of Open Interval (m [ft] NAVD88)	Open Interval Length (m [ft])
299-E28-26	TU	125.1 (410.4)	118.8 (389.8)	6.1 (20.0)
299-E28-27	TU	125.6 (412.1)	119.5 (392)	6.1 (20.0)
299-E28-28	TU	125.6 (412.1)	119.5 (392)	6.2 (20.3)
299-E32-3	TU	125.8 (412.7)	119.7 (392.7)	6.1 (20.0)
299-E33-28	TU	125.1 (410.4)	119.0 (390.4)	6.1 (20.0)
299-E33-29	TU	125.7 (412.4)	119.6 (392.4)	6.1 (20.0)
299-E33-266	TU	123.4 (404.8)	117.3 (384.8)	6.1 (20.0)

Reference: NAVD88, *North American Vertical Datum of 1988*.

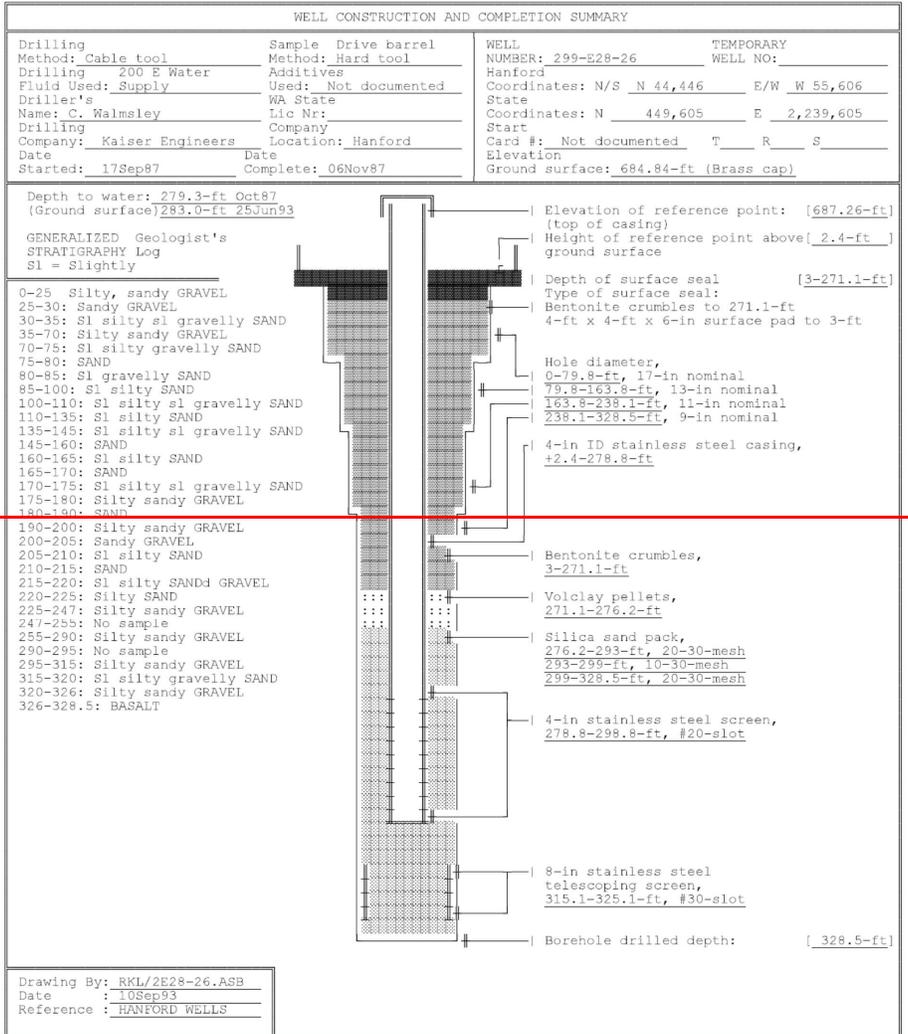
Note: See Table 3-3 in main text for depth of remaining water column.

TU = Top of Unconfined, as described in Table C-1

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Commented [CTJ3]: RCRA-CN-01_DOE/RL-2009-75_R1

DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1



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Figure C-1. Well 299-E28-26 Construction and Completion Summary

Commented [CTJ4]: RCRA-CN-01_DOE/RL-2009-75_R1

DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1

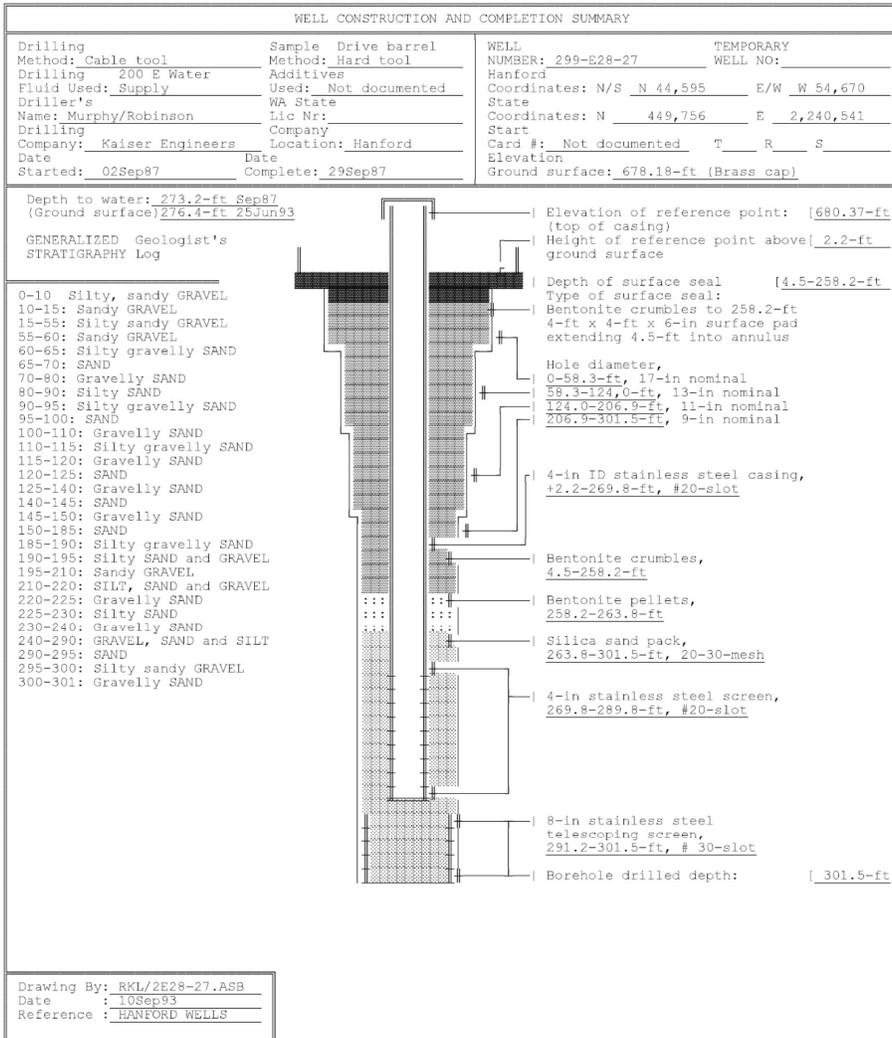
SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS	
RESOURCE PROTECTION WELL - 299-E28-26	
WELL DESIGNATION	: 299-E28-26
RCRA FACILITY	: Low Level WMA-1
CERCLA UNIT	: 200 Aggregate Area Management Study
HANFORD COORDINATES	: N 44,446 W 55,606
LAMBERT COORDINATES	: N 449,605 E 2,239,605 [HANCONV]
DATE DRILLED	: Nov87
DEPTH DRILLED (GS)	: 328.5-ft
MEASURED DEPTH (GS)	: 299.3-ft, 10Aug93
DEPTH TO WATER (GS)	: 280.5-ft, 20Oct87; 283.0-ft, 25Jun93
CASING DIAMETER	: 4-in, stainless steel, +2.4-278.8-ft.
ELEV TOP CASING	: 687.26-ft, [07Dec87-200E]
ELEV GROUND SURFACE	: 684.84-ft, Brass cap [07Dec87-200E]
PERFORATED INTERVAL	: Not applicable
SCREENED INTERVAL	: 278.8-299.0-ft, 4-in, stainless steel, #20-slot, 315.1-325.1-ft, 8-in, stainless steel, #30-slot,
COMMENTS	: FIELD INSPECTION, 10Aug93; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone.
AVAILABLE LOGS	: Geologist, Driller
TV SCAN COMMENTS	: Not applicable
DATE EVALUATED	: Not applicable
EVAL RECOMMENDATION	: Not applicable
LISTED USE	: LLBG-WMA-1 monthly water level measurement, 01Dec87-25Jun93;
CURRENT USER	: WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	: Hydrostar
MAINTENANCE	:

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Figure C-1. Well 299-E28-26 Construction and Completion Summary (continued)

Commented [CTJ5]: RCRA-CN-01_DOE/RL-2009-75_R1

DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1



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 2 **Figure C-2. Well 299-E28-27 Construction and Completion Summary**

DOE/RL-2009-75, REV. 1
RCRA-CN-01_DOE/RL-2009-75_R1

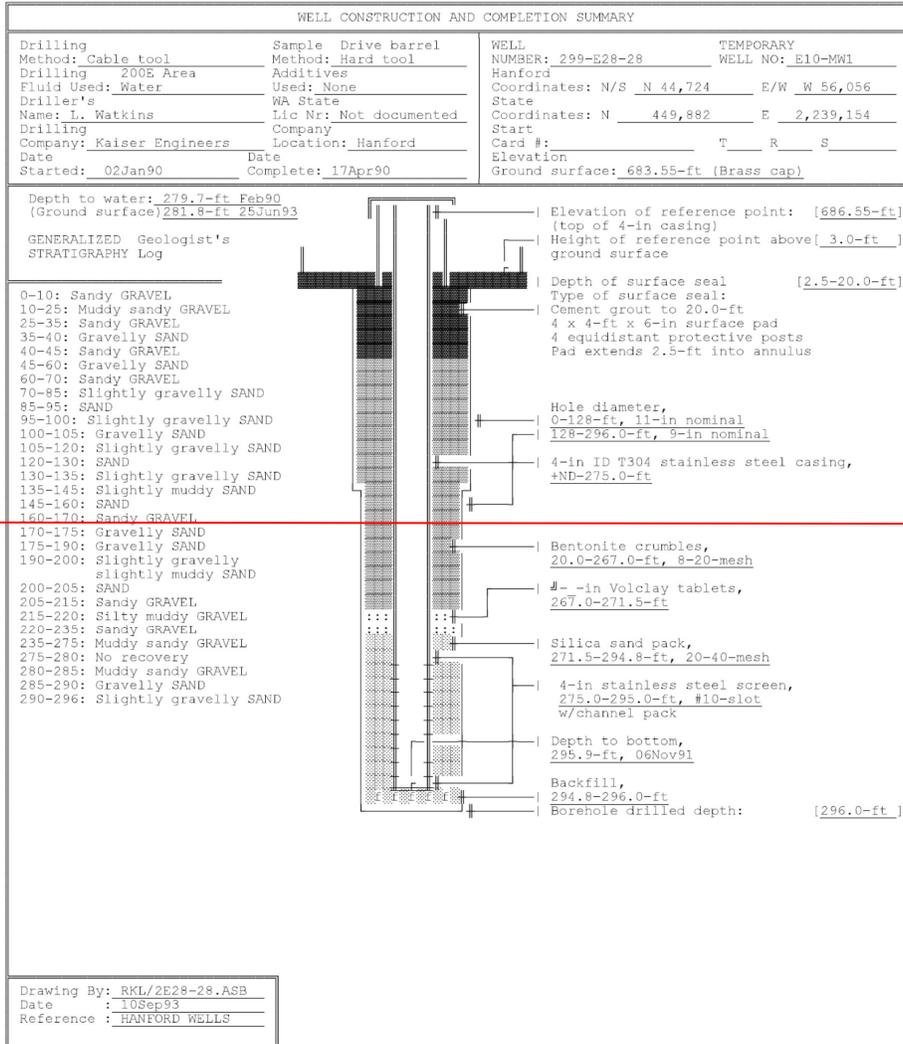
SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E28-27

WELL DESIGNATION : 299-E28-27
RCRA FACILITY : Low Level Burial Grounds, 218-E-10
CERCLA UNIT : 200 Aggregate Area Management Study
HANFORD COORDINATES : N 44,595 W 54,670 [07Dec87-200E]
LAMBERT COORDINATES : N 449,756 E 2,240,541 [HANCONV]
DATE DRILLED : Sep87
DEPTH DRILLED (GS) : 301.5-ft
MEASURED DEPTH (GS) : Not documented
DEPTH TO WATER (GS) : 273.2-ft, Sep87
276.4-ft, 25Jun93
CASING DIAMETER : 4-in, stainless steel, +2.2-289.9-ft.
ELEV TOP CASING : 680.37-ft [07Dec87-200E]
ELEV GROUND SURFACE : 678.18-ft, Brass cap [07Dec87-200E]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 4-in, 269.9-289.9-ft;
8-in, 291.2-301.5-ft
COMMENTS : FIELD INSPECTION, 06Feb90,
4-in stainless steel casing, no protective casing. Capped and locked.
4-ft by 4-ft concrete pad, 4 posts, brass marker with stamped ID.
OTHER;
AVAILABLE LOGS : Geologist, Driller
TV SCAN COMMENTS : Not applicable
DATE EVALUATED : Not applicable
EVAL RECOMMENDATION : Not applicable
LISTED USE : LBG monthly water level measurement, 01Dec87-25Jun93,
CURRENT USER : WHC ES&M w/1 monitoring and RCRA sampling,
PNL sitewide sampling and w/1 monitoring 93
PUMP TYPE : Hydrostar
MAINTENANCE :

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Figure C-2. Well 299-E28-27 Construction and Completion Summary (continued)

DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1



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Figure C-3. Well 299-E28-28 Construction and Completion Summary

Commented [CTJ6]: RCRA-CN-01_DOE/RL-2009-75_R1

DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1

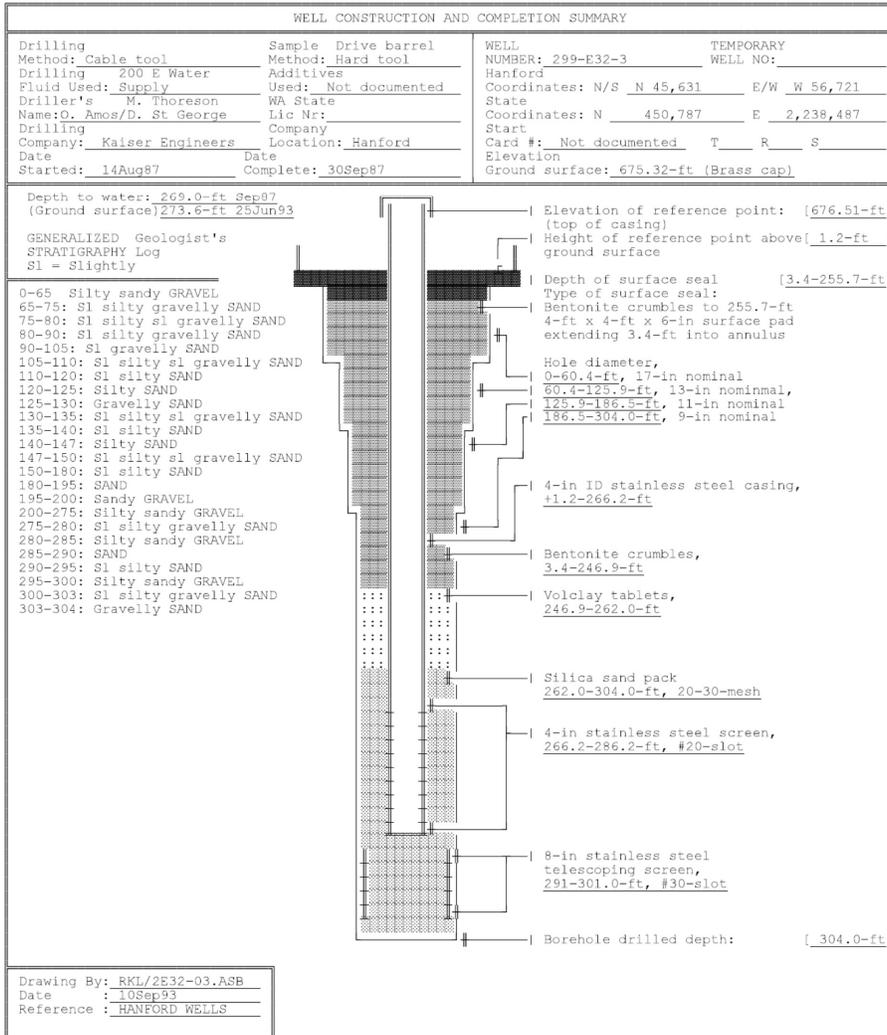
SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS	
RESOURCE PROTECTION WELL - 299-E28-28	
WELL DESIGNATION :	299-E28-28
RCRA FACILITY :	218-E10 LLWMA-1
CERCLA UNIT :	200 Aggregate Area Management Study
HANFORD COORDINATES :	N 44,724 W 56,056 [19Apr90-200E]
LAMBERT COORDINATES :	N 449,882 E 2,239,154 [HANCONV]
	N 137,108.51m E 572,804.49m [19Apr90-NAD83]
DATE DRILLED :	Jan-Apr90
DEPTH DRILLED (GS) :	296-ft
MEASURED DEPTH (GS) :	295.9-ft, Nov91
DEPTH TO WATER (GS) :	279.7-ft, Feb90;
	281.8-ft, 25Jun93
CASING DIAMETER :	4-in, stainless steel, ND-275.0-ft
	6-in stainless steel +3.0--0.5-ft
ELEV TOP CASING :	686.55-ft (19Apr90)
ELEV GROUND SURFACE :	683.55 (Brass cap)
PERFORATED INTERVAL :	Not applicable
SCREENED INTERVAL :	275.0-295.0-ft, 4-in stainless steel w/channel pack, #10-slot
COMMENTS :	Field Inspection, 06Nov91;
	6-in stainless steel outer casing. Capped and locked.
	4x4-ft concrete pad. 4 protective posts, 1 removable.
	Identification stamped on brass cap in pad. Not in radiation zone.
	OTHER;
AVAILABLE LOGS :	Drillers;
	Geologists
TV SCAN COMMENTS :	Not applicable
DATE EVALUATED :	Not applicable
EVAL RECOMMENDATION :	Not applicable
LISTED USE :	LLBG monthly water level measurement, 24Apr90-25Jun93,
CURRENT USER :	WHC ES&M w/l monitoring and RCRA sampling
PUMP TYPE :	Hydrostar, intake at 290.74-ft below top-of-casing
MAINTENANCE :	

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Figure C-3. Well 299-E28-28 Construction and Completion Summary (continued)

Commented [CTJ7]: RCRA-CN-01_DOE/RL-2009-75_R1

DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1



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Figure C-4. Well 299-E32-3 Construction and Completion Summary

DOE/RL-2009-75, REV. 1
RCRA-CN-01_DOE/RL-2009-75_R1

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS	
RESOURCE PROTECTION WELL - 299-E32-3	
WELL DESIGNATION :	299-E32-3
RCRA FACILITY :	Low Level Burial Grounds, WMA-1
CERCLA UNIT :	200 Aggregate Area Management Study
HANFORD COORDINATES :	N 45,631 W 56,721
LAMBERT COORDINATES :	N 450,787 E 2,238,487
DATE DRILLED :	Sep87
DEPTH DRILLED (GS) :	304.0-ft
MEASURED DEPTH (GS) :	Not documented
DEPTH TO WATER (GS) :	269.0-ft, 04Sep87; 273.6-ft, 25Jun93
CASING DIAMETER :	4-in, stainless steel, +1.2-266.2-ft.
ELEV TOP CASING :	676.51-ft
ELEV GROUND SURFACE :	675.32-ft (Brass cap)
PERFORATED INTERVAL :	Not applicable
SCREENED INTERVAL :	4-in, stainless steel, #20-slot, 266.2-286.2-ft; 8-in, stainless steel, #30-slot, 291.0-301.0-ft
COMMENTS :	FIELD INSPECTION, 07Feb90; 4-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable capped and locked, brass cap in pad with well ID. Not in radiation zone.
AVAILABLE LOGS :	Geologist, Driller
TV SCAN COMMENTS :	Not applicable
DATE EVALUATED :	Not applicable
EVAL RECOMMENDATION :	Not applicable
LISTED USE :	LLBG monthly water level measurement, 01Dec87-25Jun93;
CURRENT USER :	WHC ES&M w/l monitoring and RCRA sampling
PUMP TYPE :	Hydrostar
MAINTENANCE :	

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Figure C-4. Well 299-E32-3 Construction and Completion Summary (continued)

DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1

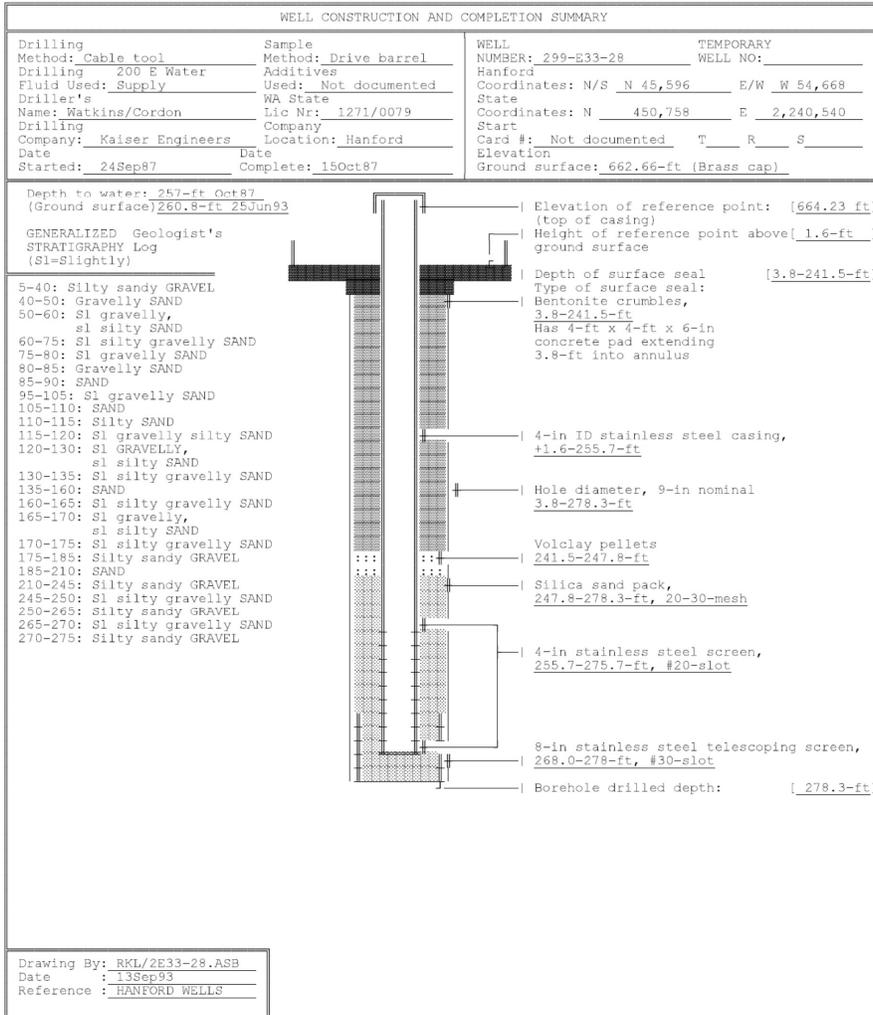


Figure C-5. Well 299-E33-28 Construction and Completion Summary

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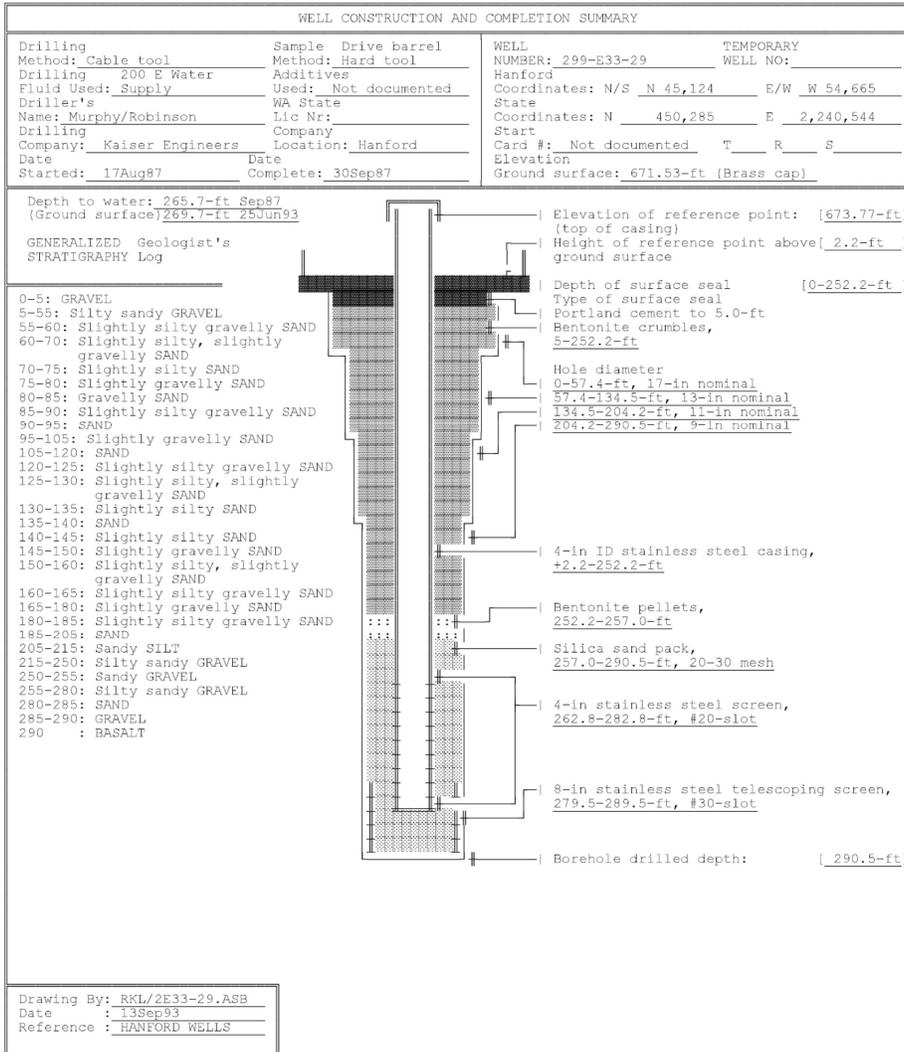
DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS RESOURCE PROTECTION WELL - 299-E33-28	
WELL DESIGNATION	: 299-E33-28
RCRA FACILITY	: Low Level Burial Grounds - WMA-1
CERCLA UNIT	: 200 Aggregate Area Management Study (200-BP-1)
HANFORD COORDINATES	: N 45,596 W 54,668 [07Dec87-200E]
LAMBERT COORDINATES	: N 450,758 E 2,240,540 [HANCONVI]
DATE DRILLED	: Nov87
DEPTH DRILLED (GS)	: 278-ft
MEASURED DEPTH (GS)	: 275-ft, Nov89 TV
DEPTH TO WATER (GS)	: 257-ft, Oct87; 260.9-ft, 25Jun93
CASING DIAMETER	: 4-in, stainless steel, +1.6-255.7-ft
ELEV TOP OF CASING	: 664.23-ft, [07Dec87-200E]
ELEV GROUND SURFACE	: 662.66, Brass cap [07Dec87-200E]
PERFORATED INTERVAL	: Not applicable
SCREENED INTERVAL	: 255.7-275.7-ft, 4-in, #20-slot stainless steel
COMMENTS	: FIELD INSPECTION, 06Feb90 4-in stainless steel casing, 4x4-ft concrete pad. 4 posts. Well identification stamped on brass cap in pad. Not in radiation zone. OTHER: Geologist
AVAILABLE LOGS	: Geologist
TV SCAN COMMENTS	: 19Nov89, depths referenced to ground surface; Depth to bottom: 275-ft Bottom of casing: 275-ft Depth to water: 259.9-ft Screen: 256-275-ft Clean, ready for sampling.
DATE EVALUATED	: 13Nov90
EVAL RECOMMENDATION	: 1. No remediation required. Surface seal is 3 3/4-ft, not >18-ft per WAC 173-160.
LISTED USE	: LDBG monthly water level measurement, 02Dec87-25Jun93;
CURRENT USER	: WHC ES&M w/1 monitoring and RCRA sampling, WHC ER monitoring
PUMP TYPE	: Hydrostar, intake at 274.9-ft, (top-of-casing).
MAINTENANCE	: 12Oct89; Removed hydrostar pump for camera survey. 19Oct89; TV camera survey. 02Nov89; TV camera survey. 28Nov89; Reinstalled hydrostar pump.

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Figure C-5. Well 299-E33-28 Construction and Completion Summary (continued)

DOE/RL-2009-75, REV. 1
 RCRA-CN-01_DOE/RL-2009-75_R1



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Figure C-6. Well 299-E33-29 Construction and Completion Summary

DOE/RL-2009-75, REV. 1
RCRA-CN-01_DOE/RL-2009-75_R1

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS RESOURCE PROTECTION WELL - 299-E33-29	
WELL DESIGNATION	: 299-E33-29
RCRA FACILITY	: Low Level Burial Grounds, 218-E-10
CERCLA UNIT	: 200 Aggregate Area Management Study (200-BP-5)
HANFORD COORDINATES	: N 45,124 W 54,665 [07Dec87]
LAMBERT COORDINATES	: N 450,285 E 2,240,544 [HANCONV]
DATE DRILLED	: Sep87
DEPTH DRILLED (GS)	: 290.0-ft
MEASURED DEPTH (GS)	: Not documented
DEPTH TO WATER (GS)	: 265.7-ft, Sep87, 269.7-ft, 25Jun93
CASING DIAMETER	: 4-in, stainless steel, +2.2-262.8-ft.
ELEV TOP CASING	: 673.77-ft, [07Dec87]
ELEV GROUND SURFACE	: 671.53-ft, Brass cap [07Dec87]
PERFORATED INTERVAL	: Not applicable
SCREENED INTERVAL	: 4-in, 262.8-282.8-ft; 8-in, 279.5-289.5-ft
COMMENTS	: FIELD INSPECTION, 02Jun90, 4-in stainless steel casing, no protective casing. Capped and locked. 4-ft by 4-ft concrete pad, 4 posts, brass marker with stamped ID. OTHER;
AVAILABLE LOGS	: Geologist, Driller
TV SCAN COMMENTS	: Not applicable
DATE EVALUATED	: Not applicable
EVAL RECOMMENDATION	: Not applicable
LISTED USE	: LLBG monthly water level measurement, 01Dec87-25Jun93;
CURRENT USER	: WHC ES&M w/l monitoring and RCRA sampling, WHC ER characterization
PUMP TYPE	: Hydrostar
MAINTENANCE	:

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Figure C-6. Well 299-E33-29 Construction and Completion Summary (continued)

WELL SUMMARY SHEET		Start Date: 4/9/10		Page 1 of 2	
Well ID: C7565		Well Name: 299-E33-266			
Location: 100 m W of 299-E33-30		Project: 5 M-24 RCRA Monitoring Wells			
Prepared By: Ryan W. Brauchla		Date: 4/28/10		Reviewed By: L. D. Walker	
Signature: <i>Ryan W. Brauchla</i>		Signature: <i>L. D. Walker</i>			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA			
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)	
Stainless Steel Protective Casing: 3.0 ft above ground surface		0		0-1 Gravel (G)	
Portland Cement Type I/II: 0 - 10.2 ft bgs		10.2		1-8 Gravelly Silt (gM) 8-12 Sandy Gravel (sG) 12-15 Silty Sandy Gravel (msG)	
4-in I.D. Stainless Steel Type 304, Permanent Blank Casing: + 2.06 - 263.05 ft bgs		263.05		15-48 Sandy Gravel (sG)	
Granular Bentonite Crumbles: 10.2 - 252.3 ft bgs		252.3		48-52 Sand (S)	
		52.3		52-59 Gravelly Sand (gS)	
		59.3		59-74 Sand (S)	
		74.3		74-79 Gravelly Sand (gS)	
		79.3		79-199 Sand (S)	
		100			
		120			
		140			
		160			
All temporary drill casing was removed from the ground.					
All depths are in feet below ground surface.					
Borehole drilled with 9-inch O.D. casing, 0.0 - 286.06 ft bgs					

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Figure C-7. Well 299-E33-266 Well Summary Sheet

WELL SUMMARY SHEET		Start Date: 4/9/10	Page 2 of 2
		Finish Date: 4/26/10	
Well ID: C7565		Well Name: 299-E33-266	
Location: 100 m W of 299-E33-30		Project: 5 M-24 RCRA Monitoring Wells	
Prepared By: Ryan W. Brauchla	Date: 4/28/10	Reviewed By: L.D. Walker	Date: 8-9-10
Signature: <i>[Signature]</i>		Signature: <i>[Signature]</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description/Groundwater Sample Depths (ft bgs)
Granular Bentonite Crumbles: 10.2 - 252.3 ft bgs		180	79-199 Sand (S)
4-in I.D. Stainless Steel Type 304, Permanent Blank Casing: + 2.06 - 263.05 ft bgs		200	199-203 Gravel (G) 203-209 Gravelly Sand (gS)
1/4-in Bentonite Pellets: 252.3 - 258.2 ft bgs		220	209-222 Sand (S)
Primary Filter Pack 10-20 Mesh Colorado Silica Sand: 258.2 - 286.06 ft bgs		240	222-233 Gravelly Sand (gS)
Static Water Level 267.72 ft bgs (4/26/10)		260	233-251 Sandy Gravel (sG)
4-in I.D. Stainless Steel Type 304, 20 Slot (0.020-in) Screen: 263.05 - 283.07 ft bgs		280	251-256 Silty Sandy Gravel (msG) 256-283 Gravel (G)
4-in, I.D. Stainless Steel Sump/End Cap: 283.07 - 286.06 ft bgs		300	283-286.06 Basalt
All temporary drill casing was removed from the ground.			Total Depth Drilled: 286.06 ft bgs (4/23/10)
All depths are in feet below ground surface.			
Borehole drilled with 9-inch O.D. casing. 0.0 - 286.06 ft bgs			

Figure C-7. Well 299-E33-266 Well Summary Sheet (continued)

1

C2 Reference

2 NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic
3 Control Committee, Silver Spring, Maryland. Available at: <http://www.ngs.noaa.gov/>.