

Interim Status Change Number 1: Interim Status Groundwater Quality Assessment Plan for the Low-Level Burial Grounds Waste Management Area-3

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



**P.O. Box 550
Richland, Washington 99352**

Interim Status Change Number 1: Interim Status Groundwater Quality Assessment Plan for the Low-Level Burial Grounds Waste Management Area-3

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



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Richland, Washington 99352

APPROVED

By Julia Raymer at 3:42 pm, Aug 17, 2020

Release Approval

Date

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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-2019-32_R0		Date: 07/29/2020
Document Number: DOE/RL-2019-32	Title: Interim Status Change Number 1: Interim Status Groundwater Quality Assessment Plan for the Low-Level Burial Grounds Waste Management Area-3	Rev: 0
Originator: Tessa Clark		Phone: 3605203189

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

- Add "In summary, the LLBG WMA-3 is located within the periphery of the regional 200-ZP-1 OU plumes and is additionally impacted by nearby former 200-ZP pump-and-treat and current 200 West Area pump-and-treat injection well networks. Evaluated wells indicate varying concentration trends with depth in wells near LLBG WMA-3. Available data for the wells is not sufficient to evaluate plume migration from a hypothetical release from LLBG WMA-3" to Section 1.1 on pg. 1-5.
- Delete Chrysene and CAS Number duplicate row from Table 2-1, pg. 2-5.
- Replace "88-85-7" with "Dinoseb (2-sec-Butyl-4,6-dinitrophenol)" in Table 2-1, pg. 2-5.
- Replace CAS number "37871-00-4" with "34465-46-8" in Table 2-1, pg. 2-6.
- Delete superscript "g" from CAS Number cell "55684-94-1" in Table 2-1, pg. 2-6.
- Change sample frequency from "Q" to "Q4" for Total Organic Carbon, Total Organic Halides, pH, and Specific Conductance, and add Q4 to footnotes in Table 2-2.
- Add molybdenum to corrosion constituents in Table 2-2 and Section 2.1.1.
- Replace analysis of bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity with "total alkalinity" in Table 2-2 (footnote c) and Table 2-4 in main file.
- Remove fluoride and nitrite from "Justification Summary" in Table 2-4.
- Format Section 3.2 to include methodology for evaluating dangerous waste constituent data, and add pages 3-1a through 3-1c.
- Add references included in revised text to Chapter 5.
- Replace Appendix A in its entirety with an updated version of Quality Assurance Project Plan.
- Replace Appendix B in its entirety with an updated version of the Sampling Protocol.

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.

- Text added to Section 1.1 discusses potential for regional plumes and/or pump-and-treat influence on the groundwater at LLBG WMA-3.
- Duplicate text and erroneous superscript deleted from Table 2-1. Incorrect CAS number for Hexachlorodibenzo-p-dioxins replaced with correct CAS number in Table 2-1.
- "Q4" added to Table 2-2 specifies that Total Organic Carbon, Total Organic Halides, pH, and Specific Conductance should be sampled quarterly with quadruplicate samples.
- Alkalinity analyses that are not required to calculate charge balance equations are removed from applicable tables.
- Molybdenum added as a well corrosion constituent.
- Fluoride and nitrite are not included with anion analysis at LLBG WMA-3.
- Data evaluation methodology added to Section 3.2 is required to determine if LLBG WMA-3 contributes dangerous waste constituents to the underlying groundwater.

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

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.

-References added to Chapter 5 support text revisions in monitoring plan.
 -Appendix A (Quality Assurance Project Plan) and Appendix B (Sampling Protocol) are replaced in their entirety due to multiple updates since issuance of 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 -	08/05/2020
<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 8/4/2020 3:23 PM

Comment: Please review the attached RCRA redline change to LLBG WMA-3: RCRA-CN-01_DOE/RL-2019-32_R0, Interim Status Change Number 1: Interim Status Groundwater Quality Assessment Plan for the Low-Level Burial Grounds Waste Management Area-3

Approved by Sexton, Sean M on 8/4/2020 3:58 PM

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Approved by Whitley, Kelly M on 8/5/2020 2:34 PM

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Comment:

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Title	Document Number	Revision Number	Interim Change Number	Effective Date
Interim Status Groundwater Monitoring Plan for the LLBG WMA-3	DOE/RL-2019-32	0	N/A	11/24/2019
Interim Status Groundwater Monitoring Plan for the LLBG WMA-3	DOE/RL-2019-32	0	RCRA-CN-01_DOE/RL-2019-32_R0	08/03/2020

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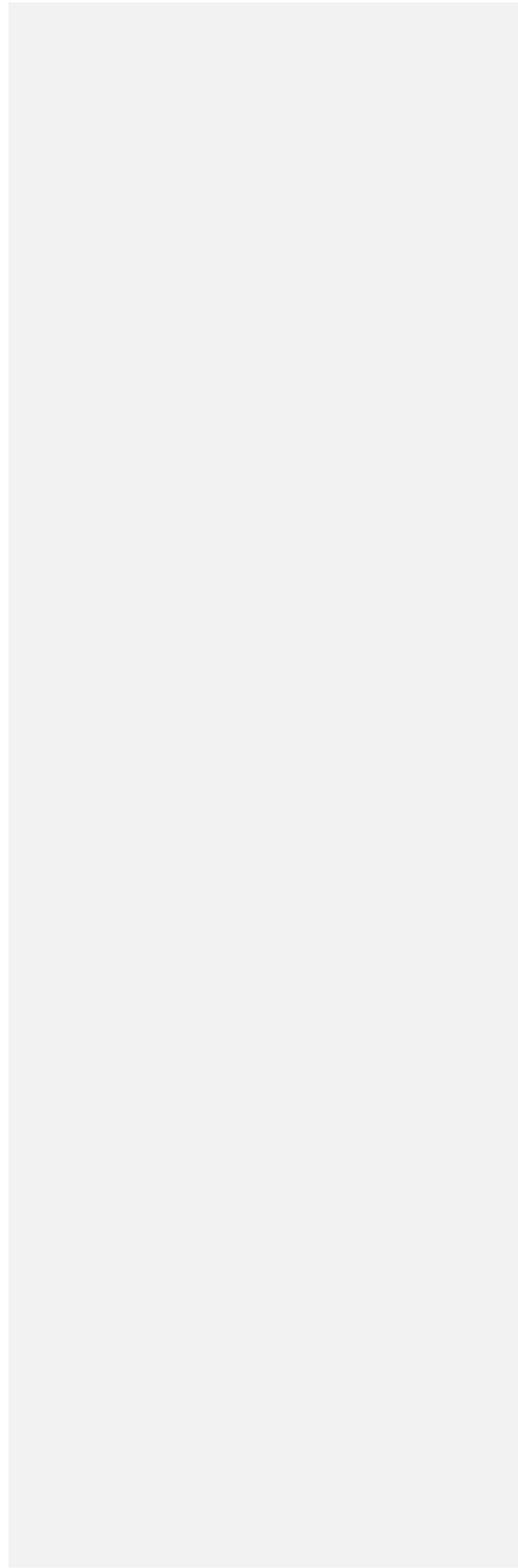
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Terms

AEA	<i>Atomic Energy Act of 1954</i>
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
Ecology	Washington State Department of Ecology
EER	engineering evaluation report
EPA	U.S. Environmental Protection Agency
LLBG	Low Level Burial Grounds
NAD83	<i>North American Datum of 1983</i>
NAVD88	<i>North American Vertical Datum of 1988</i>
OU	operable unit
QAPjP	quality assurance project plan
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
TOC	total organic carbon
TOX	total organic halides
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i> (Ecology et al., 1989)
TSD	treatment, storage, and disposal
WMA	waste management area

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1 Introduction

This document provides the groundwater quality assessment plan for Low Level Burial Grounds (LLBG) Waste Management Area 3 (WMA-3). LLBG WMA-3 is located in the 200 West Area of the Hanford Site in Washington State and overlies the 200-ZP-1 Groundwater Operable Unit (OU) (Figure 1-1). LLBG WMA-3 comprises four burial grounds: 218-W-3A, 218-W-3AE, 218-W-5, and 200-W-254 (Figure 1-1). The 200-W-254 Burial Ground was originally part of the 218-W-5 Burial Ground, but in 2014, it was created within the Hanford Site Waste Information Data System database to separately identify the operating portion of the LLBG (Trenches 31 and 34). LLBG WMA-3 received primarily nondangerous, low-level radiological waste; however, there are discrete areas within the LLBG, referred to as “Green Islands,” where regulated mixed waste (waste with both a radioactive and dangerous waste component) was disposed in unlined trenches.

This document replaces the previous indicator evaluation groundwater monitoring plan (DOE/RL-2009-68, Rev. 2, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*), and when issued into the operating record, becomes the principal controlling document for conducting groundwater monitoring under the dangerous waste regulations (WAC 173-303, “Dangerous Waste Regulations”) at LLBG WMA-3. The U.S. Department of Energy, Richland Operations Office (DOE-RL) is replacing the previous groundwater monitoring plan to respond to changes that have occurred in the groundwater at LLBG WMA-3 and to incorporate an updated quality assurance plan and sampling protocols. This groundwater 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, “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 intended to satisfy groundwater monitoring requirements applicable to interim status treatment, storage, and disposal (TSD) units that are in a groundwater quality assessment program. Information to determine the concentration of dangerous waste originating from LLBG WMA-3 in groundwater and to determine the rate and extent of migration is collected under this plan.

LLBG WMA-3 is placed into a groundwater quality assessment program in due to the recent exceedance of the critical mean by indicator parameters of specific conductance and total organic halides (TOX) (Chapter 7 in ECF-HANFORD-18-0079, *Calculation of Critical Means for Calendar Year 2019 RCRA Groundwater Monitoring*).

LLBG WMA-3 is an inactive burial ground TSD at the Hanford Site (Figure 1-1) with the exception of the 200-W-254 Burial Ground. 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* (hereinafter referred to as the Hanford Facility RCRA Permit), LLBG WMA-3 will continue to be considered under interim status until it is incorporated into Part III, V, and/or VI of the Hanford Facility RCRA Permit, the future Revision 9 of WA7890008967, *Hanford Facility Dangerous Waste Permit* (hereinafter referred to as the Hanford Site-Wide Permit), or until interim status is terminated. Therefore, groundwater monitoring for LLBG WMA-3 continues under interim status requirements.

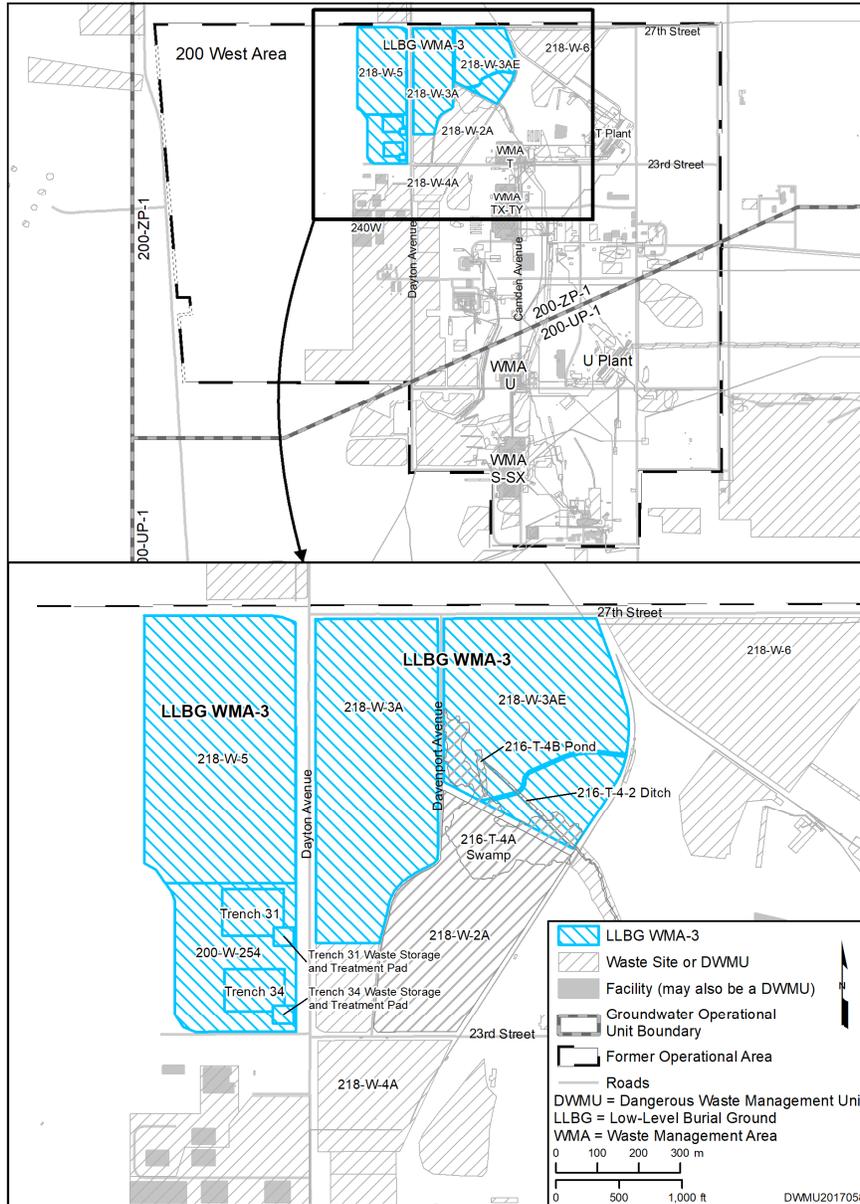


Figure 1-1. Location Map for LLBG WMA-3

SGW-60583, *Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-3 Green Islands Groundwater Monitoring*, is one of a suite of groundwater monitoring engineering evaluation reports (EERs) for regulated units located within the Hanford Site Central Plateau that were prepared to support Part B (final status) permit application material for the future Hanford Site-Wide Permit. While 16-NWP-143, "Groundwater Engineering Report and Final Status Groundwater Monitoring Plan Requirements for the Integrated Disposal Facility, Nonradioactive Dangerous Waste Landfill, Low Level Burial Grounds Trench 94, and Low Level Burial Grounds "Green Islands" Dangerous Waste Management Units," requested an EER for the "Green Islands" portion of LLBG WMA-3, Ecology and the U.S. Department of Energy (DOE) later agreed that the LLBG, less the 200-W-254 Burial Ground, would be the subject of the EER and subsequent final status permit application (Chapter 1 in SGW-60583). The 200-W-254 Burial Ground comprises LLBG Trenches 31 and 34 and the LLBG Trenches 31 and 34 Waste Storage and Treatment Pads. As the 200-W-254 Burial Ground will be separate from LLBG WMA-3 once it is incorporated into Revision 9 of the Hanford Facility Dangerous Waste Permit, an EER for LLBG Trenches 31 and 34 (SGW-59564, *Engineering Evaluation Report for Low-Level Burial Grounds Trenches 31 and 34 Groundwater Monitoring*) was prepared to support its final status permitting. The 200-W-254 Burial Ground (that comprises LLBG Trenches 31 and 34 and associated waste treatment and storage pads) is part of LLBG WMA-3 at the time of this report and is discussed as part of LLBG WMA-3.

The EERs do not create any groundwater monitoring requirements; however, they contain the most comprehensive background information to date for each regulated unit. Detailed area-wide and unit-specific groundwater modeling methods were used to evaluate the locations of existing wells, and propose locations for new wells, that would detect groundwater contamination that may occur from each regulated unit. For 200 West Area units, particle-tracking calculations, as well as an evaluation of vertical contaminant migration, were performed to evaluate the existing monitoring well networks and propose new well networks, as appropriate. Regular updates to the EERs are planned as new data become available and changes to groundwater conditions are identified. Because regular updates to the EERs will ensure that they remain the most updated source for unit-specific information (hydrogeologic conditions, contaminant migration conceptual models), the detailed information specific to LLBG WMA-3 provided in SGW-60583 (with pertinent LLBG Trenches 31 and 34 information from SGW-59564) is included only by reference in this interim status groundwater monitoring plan.

Table 1-1 identifies the locations where information that is pertinent to this groundwater monitoring plan is presented in SGW-60583 and SGW-59564.

This groundwater monitoring plan includes the following chapters and appendices:

- Chapter 2 describes the groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols.
- Chapter 3 describes data evaluation and reporting.
- Chapter 4 provides the schedule of implementation.
- Chapter 5 contains the references cited in this plan.
- Appendix A provides the quality assurance project plan (QAPjP).
- Appendix B contains sampling protocols.
- Appendix C provides information for the wells within the groundwater monitoring network.

Table 1-1. Locations of Pertinent Supporting/Background Information in Engineering Evaluation Reports

Section/ Subsection	<i>SGW-60583, Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-3 Green Islands Groundwater Monitoring</i>	<i>SGW 59564, Engineering Evaluation Report for Low-Level Burial Grounds Trenches 31 and 34 Groundwater Monitoring</i>
	Title/Topic	Title/Topic
2.1	Background	Background
2.1.1	218-W-3A Burial Ground	Trenches 31 and 34 Liner Systems
2.1.2	218-W-3AE Burial Ground	Trenches 31 and 34 Leachate Collection and Removal Systems
2.1.3	218-W-5 Burial Ground	LLBG Trenches 31 and 34 Waste Storage and Treatment Pads
2.2	Regulatory Basis	Regulatory Basis
2.3	Waste Characteristics	Waste Characteristics
2.4	Groundwater Monitoring and Sampling History	Groundwater Monitoring and Sampling History
3.1	Stratigraphy	Stratigraphy
3.2	Hydrogeology	Hydrogeology
3.3	Groundwater Flow	Groundwater Flow
4	Contaminant Migration Conceptual Model	Contaminant Migration Conceptual Model
4.1	Vadose Zone	Vadose Zone
4.2	Soil Moisture Factors	Soil Moisture Factors
4.3	Hydrogeologic Considerations	Hydrogeologic Considerations
4.4	Groundwater Chemistry	Groundwater Chemistry
4.5	Summary of Vertical Contaminant Distribution	Summary of Vertical Contaminant Distribution
5	Groundwater Flow Simulations	Groundwater Flow Simulations
6	Calculations	Calculations
7	Simulation Results and Conclusions	Simulation Results and Conclusions
9.3	Proposed Groundwater Monitoring Network	Proposed Groundwater Monitoring Network
9.3.1	Groundwater Monitoring Well 299-W9-2	Groundwater Monitoring Well 299-W9-2
9.3.2	Groundwater Monitoring Well 299-W10-31	Groundwater Monitoring Well 299-W10-29
9.3.3	--	Groundwater Monitoring Well 299-W10-30

1.1 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. Ecology gained regulatory authority over the hazardous waste components of mixed waste on August 19, 1987.

In May 1989, DOE, the U.S. Environmental Protection Agency (EPA), and Ecology signed 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 LLBG WMA-3. Groundwater monitoring is conducted at LLBG WMA-3 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 LLBG WMA-3.

Dangerous waste is regulated under RCW 70.105, "Hazardous Waste Management," and its Washington State implementing regulations (WAC 173-303). Radionuclides in mixed waste may include "source, special nuclear, and byproduct materials," as defined in the *Atomic Energy Act of 1954* (AEA). The AEA states that these radionuclide materials are regulated at DOE facilities, exclusively by 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. LLBG WMA-3 has an AEA component and is monitored for AEA under DOE/RL-2000-72, *Performance Assessment Monitoring Plan for the Hanford Site Low-Level Burial Grounds*.

Interim status groundwater monitoring at LLBG WMA-3 began in 1987 based on the indicator evaluation program requirements of 40 CFR 265, Subpart F. LLBG WMA-3 was monitored under an indicator evaluation program from 1987 to 1989, when it entered into assessment monitoring for an exceedance of the critical means for TOX and total organic carbon (TOC). In January 1994, a groundwater quality assessment report was issued and found that elevated TOX was not attributable to LLBG WMA-3, and elevated TOC results were due to laboratory error (Sections 1.2 and 3.2 in WHC-SD-EN-EV-026, *Results of Groundwater Quality Assessment Program at Low-Level Waste Management Area 3 of the Low-Level Burial Grounds*). Groundwater monitoring subsequently returned to an indicator evaluation program.

A revised indicator parameter monitoring plan was issued in 2010 (DOE/RL-2009-68, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*, Rev. 0) with another revision occurring in 2012 (DOE/RL-2009-68, Rev. 2).

In summary, the LLBG WMA-3 is located within the periphery of the regional 200-ZP-1 OU plumes and is additionally impacted by nearby former 200-ZP pump-and-treat and current 200 West Area pump-and-treat injection well networks. Evaluated wells indicate varying concentration trends with depth in wells near LLBG WMA-3. Available data for the wells is not sufficient to evaluate plume migration from a hypothetical release from LLBG WMA-3.

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1.2 Monitoring Objectives

The objective of the groundwater monitoring program at LLBG WMA-3 is to determine the groundwater concentration of dangerous waste originating from LLBG WMA-3 and to determine the rate and extent of migration. This groundwater monitoring plan addresses those applicable dangerous waste requirements for interim status TSD units where an impact to groundwater has been identified. The regulatory requirements applicable to this interim status groundwater monitoring plan are found in WAC 173-303-400(3) and 40 CFR 265.90, "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting." Table 1-2 identifies where each groundwater quality assessment monitoring element of the pertinent regulations is addressed within this plan.

Table 1-2. Pertinent Interim Status Facility Groundwater Quality Assessment Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement*	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 §265.91 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 number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.</p>	Section 2.2 and Tables 1-1 and 2-3

Table 1-2. Pertinent Interim Status Facility Groundwater Quality Assessment Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement*	Section Where Requirement is Addressed in Monitoring Plan
Well configuration	40 CFR 265.91: (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water. Additional requirements from WAC 173-303-400(3)(v)(C), "Dangerous Waste Regulations," "Interim Status Facility Standards": Groundwater 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.	Section 2.2 and Appendix C
Water-level measurements	40 CFR 265.92, "Sampling and Analysis": (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	Section 2.1
Constituents to be sampled Frequency of sampling Number, location, depth of wells	40 CFR 265.93, "Preparation, Evaluation, and Response": (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. This plan must be placed in the facility operating record and be maintained until closure of the facility. (d)(3) The plan to be submitted under §265.90(d)(1) or paragraph (d)(2) of this section must specify: (i) The number, location, and depth of wells; (ii) Sampling and analytical methods for those hazardous wastes or hazardous constituents in the facility; (iii) Evaluation procedures, including any use of previously-gathered groundwater quality information; and (iv) A schedule of implementation.	Sections 2.1, 2.2, 3.2, and 3.3, 3.5, Chapter 4, Appendix A, Table A-3, and Appendix B, Sections B2 through B5
Determination of contaminant concentration and migration	40 CFR 265.93: (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	Sections 3.2, 3.3, and 3.5

Table 1-2. Pertinent Interim Status Facility Groundwater Quality Assessment Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement*	Section Where Requirement is Addressed in Monitoring Plan
Recordkeeping and reporting	<p>40 CFR 265.93:</p> <p>(d)(5) The owner or operator must make his first determination under paragraph (d)(4) of this section, as soon as technically feasible, and prepare a report containing an assessment of groundwater quality. This report must be placed in the facility operating record and be maintained until closure of the facility.</p> <p>(d)(6) If the owner or operator determines, based on the results of the first determination under paragraph (d)(4) of this section, that no hazardous waste or hazardous waste constituents from the facility have entered the ground water, then he may reinstate the indicator evaluation program. If the owner or operator reinstates the indicator evaluation program, he must so notify the Regional Administrator in the report submitted under paragraph (d)(5) of this section.</p> <p>(d)(7) If the owner or operator determines, based on the first determination under paragraph (d)(4) of this section, that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then he:</p> <p>(i) Must continue to make the determinations required under paragraph (d)(4) of this section on a quarterly basis until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility</p> <p>Additional requirements from WAC 173-303-400(3)(c)(v)(E), "Dangerous Waste Regulations," "Interim Status Facility Standards":</p> <p>A copy of the report must be submitted to the department within 15 days.</p> <p>(e) Notwithstanding any other provision of this subpart, any groundwater quality assessment to satisfy the requirements of 265.93(d)(4) which is initiated prior to final closure of the facility must be completed and reported in accordance with 265.93(d)(5).</p> <p>40 CFR 265.94, "Recordkeeping and Reporting":</p> <p>(b) If the groundwater is monitored to satisfy the requirements of §265.93(d)(4), the owner or operator must:</p> <p>(1) Keep records of the analyses and elevations specified in the plan, which satisfies the requirements of §265.9(d)(3) throughout the active life of the facility, and, for disposal facilities throughout the post-closure care period was well; and</p> <p>(2) Annually, until final closure of the facility, submit to the Regional Administrator a report containing the results of his or her groundwater quality assessment program which includes, but is not limited to, the calculated (or measured) rate of migration of hazardous water or hazardous waste constituent in the groundwater during the reporting period. This information must be submitted no later than March 1 following each calendar year.</p>	<p>Section 3.5</p> <p>Appendix A, Sections A2.5 and A3.9</p>

Table 1-2. Pertinent Interim Status Facility Groundwater Quality Assessment Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement*	Section Where Requirement is Addressed in Monitoring Plan
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Notes: The references cited in this table are listed in Chapter 5 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, "Ground-Water Monitoring," the federal terms "Regional Administrator" means the "Department" and "Hazardous" means "Dangerous."

*RCRA regulatory requirements applicable to this groundwater monitoring plan are found in WAC 173-303-400(3), "Dangerous Waste Regulations," "Interim Status Facility Standards," and 40 CFR 265.90, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting."

RCRA = *Resource Conservation and Recovery Act of 1976*

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2 Groundwater Monitoring Program

This chapter describes the groundwater quality assessment monitoring program for LLBG WMA-3, including the dangerous waste constituents to be analyzed, sampling frequency, monitoring well network, and sampling and analysis protocols, and summarizes the differences between this plan and the previous groundwater monitoring plan (DOE/RL-2009-68, Rev. 2).

2.1 Constituent List and Sampling Frequency

Dangerous waste constituents that are to be sampled for this assessment are listed in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*, and presented in Table 2-1 in this document. These constituents will be analyzed on a quarterly basis to determine if dangerous waste constituents from LLBG WMA-3 have impacted the groundwater below the WMA.

Table 2-2 presents the wells in the groundwater monitoring network, constituents to be analyzed, and the sampling frequency for monitoring of LLBG WMA-3. In addition to the Table 2-1 constituents, other supporting constituents (metals major anions), alkalinity, and field parameters (pH, specific conductance, temperature, and turbidity) will be sampled on a quarterly basis in the network monitoring wells. These supporting constituents and field parameters provide information on general water chemistry and allow charge-balance computations to assess laboratory performance. TOC and TOX will be analyzed as supporting constituents for continuity with the indicator evaluation groundwater monitoring plan and to provide supporting information for the first determination evaluation. Where select constituents overlap between Tables 2-1 and 2-2, analysis will be completed once for each listed constituent during each event to eliminate unnecessary duplicate analysis.

Consistent with the requirements of 40 CFR 265.92(e), "Sampling and Analysis," water-level measurements at each monitoring well will be determined each time that a sample is obtained. The analytical methods associated with the routine sampling constituents are provided in Table A-3 in Appendix A.

Table 2-1. Dangerous Waste Constituents Included in LLBG WMA-3 Groundwater Quality Assessment

Constituent	CAS Number	Constituent	CAS Number
Appendix 5 of Ecology Publication No. 97-407 Dangerous Waste Constituents			
Anions			
Cyanide	57-12-5	Sulfide	18496-25-8
Metals			
Antimony	7440-36-0	Mercury	7439-97-6
Arsenic	7440-38-2	Nickel	7440-02-0
Barium	7440-39-3	Selenium	7782-49-2
Beryllium	7440-41-7	Silver	7440-22-4
Cadmium	7440-43-9	Thallium	7440-28-0
Chromium	7440-47-3	Tin	7440-31-5

Table 2-1. Dangerous Waste Constituents Included in LLBG WMA-3 Groundwater Quality Assessment

Constituent	CAS Number	Constituent	CAS Number
Cobalt	7440-48-4	Vanadium	7440-62-2
Copper	7440-50-8	Zinc	7440-66-6
Lead	7439-92-1		
Volatile Organic Compounds			
1,1-Dichloroethane	75-34-3	Carbon tetrachloride	56-23-5
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	Chlorobenzene	108-90-7
1,1,1-Trichloroethane	71-55-6	Chloroethane	75-00-3
1,1,1,2-Tetrachloroethane	630-20-6	Chloroform	67-66-3
1,1,2-Trichloroethane	79-00-5	Chloroprene	126-99-8
1,1,2,2-Tetrachloroethane	79-34-5	Dibromochloromethane	124-48-1
1,2-Dibromo-3-chloropropane	96-12-8	p-Dichlorobenzene (1,4-Dichlorobenzene)	106-46-7
1,2-Dibromoethane	106-93-4	Dichlorodifluoromethane	75-71-8
1,2-Dichloroethane	107-06-2	Ethylbenzene	100-41-4
1,2-Dichloropropane	78-87-5	Ethyl methacrylate	97-63-2
trans-1,2-Dichloroethylene	156-60-5	Isobutanol (isobutyl alcohol)	78-83-1
1,2,3-Trichloropropane	96-18-4	Methacrylonitrile	126-98-7
cis-1,3-Dichloropropene	10061-01-5	Methyl bromide (Bromomethane)	74-83-9
trans-1,3-Dichloropropene	10061-02-6	Methyl chloride (Chloromethane)	74-87-3
trans-1,4-Dichloro-2-butene	110-57-6	Methyl iodide (Iodomethane)	74-88-4
2-Butanone (Methyl ethyl ketone)	78-93-3	Methyl methacrylate	80-62-6
2-Propanone (Acetone)	67-64-1	Methylene bromide (Dibromomethane)	74-95-3
2-Hexanone	591-78-6	Methylene chloride	75-09-2
4-Methyl-2-pentanone	108-10-1	Propionitrile (Ethyl cyanide)	107-12-0
Acetonitrile; Methyl cyanide	75-05-8	Styrene	100-42-5
Acrolein	107-02-8	Tetrachloroethene (PCE)	127-18-4
Acrylonitrile	107-13-1	Toluene	108-88-3
Allyl chloride	107-05-1	Trichloroethene (TCE)	79-01-6

Table 2-1. Dangerous Waste Constituents Included in LLBG WMA-3 Groundwater Quality Assessment

Constituent	CAS Number	Constituent	CAS Number
Benzene	71-43-2	Trichlorofluoromethane	75-69-4
Bromodichloromethane	75-27-4	Vinyl acetate	108-05-4
Bromoform	75-25-2	Vinyl chloride (Chloroethene)	75-01-4
Carbon disulfide	75-15-0	Xylenes (Total)	1330-20-7
Semivolatile Organic Compounds			
1-Naphthylamine	134-32-7	O,O-Diethyl O-2-pyrazinyl phosphorothioate	297-97-2
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	p-(Dimethylamino)azobenzene	60-11-7
1,2,4-Trichlorobenzene	120-82-1	alpha, alpha-Dimethylphenethylamine	122-09-8
1,2,4,5-Tetrachlorobenzene	95-94-3	Dimethyl Phthalate	131-11-3
1,4-Dioxane	123-91-1	Di-n-butylphthalate	84-74-2
1,4-Naphthoquinone	130-15-4	m-Dinitrobenzene	99-65-0
2-Acetylaminofluorene	53-96-3	Di-n-octylphthalate	117-84-0
2-Chloronaphthalene	91-58-7	Diphenylamine	122-39-4
2-Chlorophenol	95-57-8	Ethyl methanesulfonate	62-50-0
2-Methylphenol (o-cresol)	95-48-7	Fluoranthene	206-44-0
2-Methylnaphthalene	91-57-6	9H-Fluorene (Fluorene)	86-73-7
2-Naphthylamine	91-59-8	Hexachlorobenzene	118-74-1
2-Nitrophenol (o-Nitrophenol)	88-75-5	Hexachlorobutadiene	87-68-3
2-Picoline	109-06-8	Hexachlorocyclopentadiene	77-47-4
2,3,4,6-Tetrachlorophenol	58-90-2	Hexachloroethane	67-72-1
2,4-Dichlorophenol	120-83-2	Hexachlorophene	70-30-4
2,4-Dimethylphenol	105-67-9	Hexachloropropene	1888-71-7
2,4-Dinitrophenol	51-28-5	Indeno(1,2,3-cd)pyrene	193-39-5
2,4-Dinitrotoluene	121-14-2	Isophorone	78-59-1
2,4,5-Trichlorophenol	95-95-4	Isosafrole	120-58-1
2,4,6-Trichlorophenol	88-06-2	Methapyrilene	91-80-5
2,6-Dichlorophenol	87-65-0	Methyl methanesulfonate	66-27-3
2,6-Dinitrotoluene	606-20-2	Naphthalene	91-20-3

Table 2-1. Dangerous Waste Constituents Included in LLBG WMA-3 Groundwater Quality Assessment

Constituent	CAS Number	Constituent	CAS Number
3-Methylcholanthrene	56-49-5	Nitrobenzene	98-95-3
3-Methylphenol (<i>m</i> -cresol)	108-39-4	<i>o</i> -Nitroaniline (2-Nitroaniline)	88-74-4
4-Methylphenol (<i>p</i> -cresol)	106-44-5	<i>m</i> -Nitroaniline (3-Nitroaniline)	99-09-2
3,3'-Dichlorobenzidine	91-94-1	<i>p</i> -Nitroaniline (4-Nitroaniline)	100-01-6
3,3'-Dimethylbenzidine	119-93-7	<i>p</i> -Nitrophenol (4-Nitrophenol)	100-02-7
4-Aminobiphenyl	92-67-1	<i>N</i> -Nitrosodi- <i>n</i> -butylamine	924-16-3
4-Bromophenyl phenyl ether	101-55-3	<i>N</i> -Nitrosodiethylamine	55-18-5
4-Chloro-3-methylphenol (<i>p</i> -Chloro- <i>m</i> -cresol)	59-50-7	<i>N</i> -Nitrosodimethylamine	62-75-9
4-Chlorophenyl phenyl ether	7005-72-3	<i>N</i> -Nitrosodiphenylamine	86-30-6
4-Nitroquinoline 1-oxide	56-57-5	<i>n</i> -Nitroso-di- <i>n</i> -dipropylamine (<i>N</i> -Nitrosodipropylamine; Di- <i>n</i> -propylnitrosamine)	621-64-7
4,6-Dinitro- <i>o</i> -cresol (4,6-Dinitro-2-methyl phenol)	534-52-1	<i>N</i> -Nitrosomethylethylamine	10595-95-6
5-Nitro- <i>o</i> -toluidine	99-55-8	<i>n</i> -Nitrosomorpholine	59-89-2
7,12-Dimethylbenz[<i>a</i>]anthracene	57-97-6	<i>N</i> -Nitrosopiperidine	100-75-4
Acenaphthene	83-32-9	<i>N</i> -Nitrosopyrrolidine	930-55-2
Acenaphthylene	208-96-8	Pentachlorobenzene	608-93-5
Acetophenone	98-86-2	Pentachloroethane	76-01-7
Aniline	62-53-3	Pentachloronitrobenzene	82-68-8
Anthracene	120-12-7	Pentachlorophenol	87-86-5
Aramite	140-57-8	Phenacetin	62-44-2
Benz[<i>a</i>]anthracene (Benzo[<i>a</i>]anthracene)	56-55-3	Phenanthrene	85-01-8
Benz[<i>e</i>]acephenanthrylene (Benzo[<i>b</i>]fluoranthene)	205-99-2	Phenol	108-95-2
Benzo[<i>k</i>]fluoranthene	207-08-9	<i>p</i> -Phenylenediamine	106-50-3
Benzo[<i>ghi</i>]perylene	191-24-2	Pyrene	129-00-0
Benzo[<i>a</i>]pyrene	50-32-8	Pyridine	110-86-1
Benzyl alcohol	100-51-6	Safrole	94-59-7
Bis(2-chloroethoxy)methane	111-91-1	Tetraethyl dithiopyrophosphate	3689-24-5

Table 2-1. Dangerous Waste Constituents Included in LLBG WMA-3 Groundwater Quality Assessment

Constituent	CAS Number	Constituent	CAS Number
Bis(2-chloroethyl)ether	111-44-4	o-Toluidine	95-53-4
Bis(2-chloro-1-methylethyl) ether (2,2'-Oxybis(1-chloropropane))	108-60-1	O,O,O-Triethyl phosphorothioate	126-68-1
Bis(2-ethylhexyl) phthalate	117-81-7	sym-Trinitrobenzene	99-35-4
Butylbenzylphthalate	85-68-7	Aroclor 1016	12674-11-2
p-Chloroaniline (4-Chloroaniline)	106-47-8	Aroclor 1221	11104-28-2
Chrysene	218-01-9	Aroclor 1232	11141-16-5
Chrysene	218-01-9	Aroclor 1242	53469-21-9
Dibenz[a,h]anthracene	53-70-3	Aroclor 1248	12672-29-6
Dibenzofuran	132-64-9	Aroclor 1254	11097-69-1
m-Dichlorobenzene (1,3-Dichlorobenzene)	541-73-1	Aroclor 1260	11096-82-5
Diethyl phthalate	84-66-2		
Herbicides			
2,4-D; 2,4-Dichlorophenoxyacetic acid; Dichlorophenoxyacetic acid	94-75-7	88-85-7 Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	88-85-7
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5	Pronamide	23950-58-5
Diallate	2303-16-4	Silvex; 2,4,5-TP	93-72-1
Pesticides			
4,4 '-DDD	72-54-8	Endosulfan II	33213-65-9
4,4 '-DDE	72-55-9	Endosulfan sulfate	1031-07-8
4,4 '-DDT	50-29-3	Endrin	72-20-8
Aldrin	309-00-2	Endrin aldehyde	7421-93-4
alpha-BHC	319-84-6	Famphur	52-85-7
beta-BHC	319-85-7	Heptachlor	76-44-8
delta-BHC	319-86-8	Heptachlor epoxide	1024-57-3
gamma-BHC (Lindane)	58-89-9	Isodrin	465-73-6
Chlordane	57-74-9	Kepone	143-50-0
Chlorobenzilate	510-15-6	Methoxychlor	72-43-5

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Table 2-1. Dangerous Waste Constituents Included in LLBG WMA-3 Groundwater Quality Assessment

Constituent	CAS Number	Constituent	CAS Number
Dieldrin	60-57-1	Methyl parathion (O,O-dimethyl O-P-nitrophenyl, phosphorothioate)	298-00-0
Dimethoate	60-51-5	Parathion	56-38-2
Disulfoton	298-04-4	Phorate (Phosphorodithioic Acid, O,O- Diethyl S-(Ethylthio) methyl ester)	298-02-2
Endosulfan I	959-98-8	Toxaphene	8001-35-2
Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans			
2,3,7,8-TCDD; 2,3,7,8- Tetrachlorodibenzo-p-dioxin	1746-01-6	Tetrachlorodibenzofurans	55722-27-5
Tetrachlorodibenzo-p-dioxins	41903-57-5	Pentachlorodibenzofurans	30402-15-4
Pentachlorodibenzo-p-dioxins	36088-22-9	Hexachlorodibenzofurans	55684-94-1
Hexachlorodibenzo-p-dioxins	37871-00-4 34465-46-8		

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Commented [CTJ5]: RCRA-CN-01_DOE/RL-2019-32_R0

Reference: Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100.*

CAS = Chemical Abstracts Service

N/A = not applicable

Table 2-2. Monitoring Network, Constituent List, and Sampling Frequency for LLBG WMA-3

Commented [CTJ6]: RCRA-CN-01_DOE/RL-2019-32_R0

Well Name	Purpose	WAC Compliant	Supporting Constituents ^a					Field Parameters					Dangerous Waste Constituents Table 2-1 ^{e,f}
			Alkalinity ^b	Anions ^c	Metals ^{d,e}	Total Organic Carbon	Total Organic Halides	pH	Specific Conductance	Temperature	Turbidity	Water Level	
299-W9-2	Upgradient	Y	Q	Q	Q	Q Q4	Q Q4	Q Q4	Q Q4	Q	Q	Q	Q
299-W10-29	Downgradient	Y	Q	Q	Q	Q Q4	Q Q4	Q Q4	Q Q4	Q	Q	Q	Q
299-W10-30	Downgradient	Y	Q	Q	Q	Q Q4	Q Q4	Q Q4	Q Q4	Q	Q	Q	Q
299-W10-31	Downgradient	Y	Q	Q	Q	Q Q4	Q Q4	Q Q4	Q Q4	Q	Q	Q	Q

Note: Wells are completed at the top of the unconfined aquifer.

a. Supporting constituents will not be used for groundwater quality assessment data evaluations (Section 3.2), but are used to support interpretation.

b. Alkalinity includes analysis of ~~total alkalinity, bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity.~~

c. Anions; analytes include chloride, nitrate, and sulfate.

d. Metals; analytes include calcium, magnesium, potassium, and sodium. Chromium, iron, manganese, ~~molybdenum~~, and nickel will also be analyzed to identify well casing corrosion. Corrosion constituent data are used to provide a better understanding of the potential condition of the network wells and are used for information only.

e. Unfiltered samples will be collected in conjunction with filtered samples for select analysis 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.

f. Metals identified in Table 2-1 will be collected as filtered and unfiltered.

Q = to be sampled quarterly

~~Q4~~ = to be sampled quarterly with quadruplicate

WAC = Washington Administrative Code

Y = well is constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")

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Missed sampling events that are not rescheduled within the same month are given top priority when scheduling 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 may decide to resample 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-2018-65, *Hanford Site RCRA Groundwater Monitoring Report for 2018*).

2.1.1 Well Casing Corrosion

Groundwater chemistry is routinely reviewed and evaluated. If the groundwater chemistry data for a well demonstrate a consistent upward trend over time for stainless steel corrosion constituents (chromium, iron, manganese, molybdenum, and nickel) in proportionate concentrations as found in stainless steel, it may be an indicator of corrosion. These data are used to provide a better understanding of the potential condition of the network wells and are used for information only.

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2.2 Monitoring Well Network

The groundwater well network identified for interim status monitoring of LLBG WMA-3 is the same as the most recent groundwater monitoring plan (DOE/RL-2009-68, Rev. 2). The network identified for interim status consists of one upgradient well (299-W9-2) and three downgradient wells (299-W10-29, 299-W10-30, 299-W10-31).

The groundwater flow direction at LLBG WMA-3 is to the east (Section 2.13 in DOE/RL-2016-66, *Hanford Site RCRA Groundwater Monitoring Report for 2016*). Specific details regarding each of the well locations are presented in Sections 9.3.1 and 9.3.2 of SGW-60583 and Sections 9.3.2 and 9.3.3 in SGW-59564. Figure 2-1 presents the groundwater monitoring network to be utilized in this plan. Information on the wells comprising the network is summarized in Table 2-3.

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

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

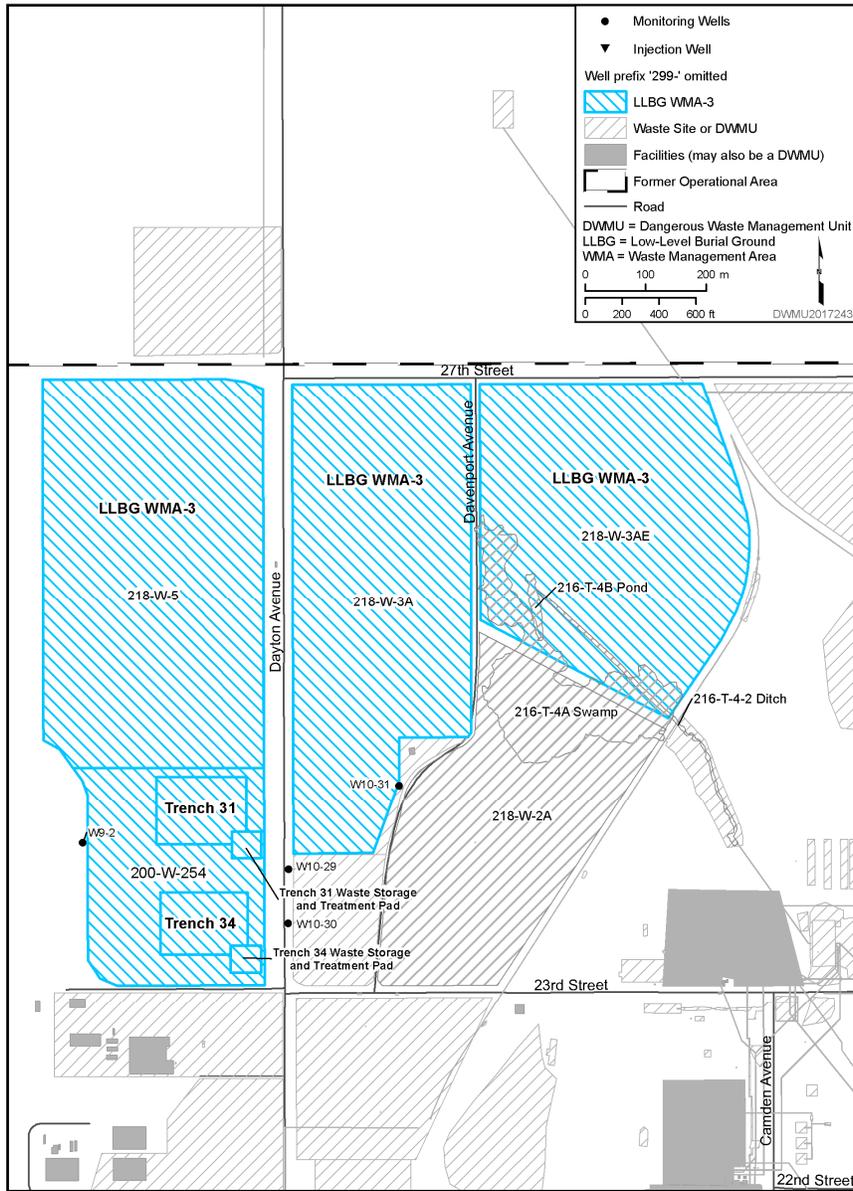


Figure 2-1. LLBG WMA-3 Monitoring Well Network

Table 2-3. Attributes for Wells in the LLBG WMA-3 Groundwater Monitoring Network

Well Name	Completion Date	Easting ^a (m)	Northing ^a (m)	Top of Casing Elevation (m [ft]) (NAVD88)	Water Table Elevation (m [ft]) (amsl)	Water Depth (m [ft] bgs)	Depth of Water in Screen (m [ft])	Water-Level Date
299-W9-2 ^b	9/22/2011	565742.21	136872.84	223.77 (734.15)	137.0 (449.5)	87.6 (287.4)	9.8 (32.2)	03/13/2015
299-W10-29	3/13/2006	566082.98	136828.74	212.37 (696.75)	136.8 (448.8)	75.6 (248.0)	9.8 (32.2)	03/13/2015
299-W10-30	4/3/2006	566082.78	136739.33	211.65 (694.39)	136.8 (448.8)	74.9 (245.6)	9.7 (31.8)	03/13/2015
299-W10-31	5/10/2006	136968.34	566266.44	210.38 (690.24)	135.93 (445.95)	73.74 (241.93)	10.13 (33.22)	9/13/2017

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

a. Coordinates are in Washington State Plane (south zone), NAD83, *North American Datum of 1983*; 1991 adjustment.

b. Upgradient well.

amsl = above mean sea level

bgs = below ground surface

2.3 Differences Between This Plan and Previous Plan

Table 2-4 identifies the main differences between this groundwater assessment plan and the previous indicator evaluation groundwater monitoring plan (DOE/RL-2009-68, Rev. 2).

Table 2-4. Main Differences Between this Monitoring Plan and Previous Monitoring Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
Constituents	40 CFR 265 Indicator parameters (pH, specific conductance, TOC, and TOX), groundwater quality parameters (chloride, iron, manganese, phenols, sodium, and sulfate), and water level	Not applicable	Indicator parameters and groundwater quality parameters are not required under a groundwater quality assessment program; however, some parameters are integrated into the current plan as supporting constituents or field parameters.
	Supporting constituents: alkalinity and field measurements (temperature, turbidity, dissolved oxygen, and oxidation-reduction potential)	Supporting constituents: alkalinity (bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity), anions (chloride, nitrate, and sulfate), metals (calcium, chromium, iron, magnesium, manganese, nickel, potassium, and sodium), TOC, and TOX	Retained alkalinity, and added <u>anions</u> (chloride, <u>fluoride</u> , nitrate, <u>nitrite</u> , and sulfate), metals (calcium, chromium, iron, magnesium, manganese, nickel, potassium, and sodium), TOC, and TOX to check water chemistry charge balance, track effects of soil gas on groundwater, and evaluate potential for well corrosion.
		Field parameters: pH, specific conductance, temperature, turbidity, and water level	Added pH and specific conductance as field parameters to provide continuous sampling data should indicator parameter monitoring program be reinstated. Dissolved oxygen and oxidation-reduction potential measurements not required under an assessment monitoring program.
	Not applicable	Dangerous waste constituents	Dangerous waste constituents from Appendix 5 of Ecology Publication 97-407 are included for groundwater assessment.
Sampling frequency	Indicator parameters – semiannually with quadruplicate samples taken Groundwater quality parameters – annually	Not applicable	Indicator parameters and groundwater quality parameters not required under a groundwater quality assessment program; however, some parameters are integrated into the current plan as supporting constituents or field parameters.

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Commented [CTJ8]: RCRA-CN-01_DOE/RL-2019-32_R0

Table 2-4. Main Differences Between this Monitoring Plan and Previous Monitoring Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
	Supporting constituents – semiannually (field measurements) and annually (alkalinity)	Supporting constituents – quarterly Field parameters (pH, specific conductance, temperature, turbidity, water level) – quarterly	Quarterly sampling is required for groundwater quality assessment monitoring.
	Not applicable	Dangerous waste constituents – quarterly	Quarterly sampling is required for groundwater quality assessment monitoring.
Well network	Upgradient: 299-W9-2 Downgradient: 299-W10-29 299-W10-30 299-W10-31	Upgradient: 299-W9-2 Downgradient: 299-W10-29 299-W10-30 299-W10-31	No change.
Groundwater flow direction	East-northeast	East	The groundwater flow direction beneath the area of the burial ground is now generally east as a result of groundwater extraction and injection for the 200 West P&T (SGW-60583, Section 4.3).
Type of groundwater monitoring program	Indicator Evaluation Program	Groundwater Quality Assessment program	Change to a groundwater quality assessment program was required due to exceedance of the specific conductance and TOX critical means.

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

Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*.

SGW-60583, *Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-3 Green Islands Groundwater Monitoring*.

*DOE/RL-2009-68, Rev. 2, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*.

P&T = pump and treat

TOC = total organic carbon

TOX = total organic halides

2.4 Sampling and Analysis Protocol

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

3 Data Evaluation and Reporting

This chapter discusses the evaluation and interpretation of data.

3.1 Data Review

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

3.2 Data Evaluation

Sample results will be evaluated as described in the following subsections (pages 3-1a through 3-1c) to determine the contribution from the unit of dangerous waste constituents, if any, to underlying groundwater and are subject to reporting requirements discussed in Section 3.5. If the unit has impacted the underlying groundwater, sample results will be used to determine the dangerous waste concentrations and the rate and extent of migration of applicable constituents from the unit. A detection is considered when dangerous waste concentration exceeds the practical quantitation limit (Table A-3 in Appendix A) for that constituent.

A groundwater flow rate and direction evaluation will be conducted using the Central Plateau Groundwater Model (CP-47631, Model Package Report: Central Plateau Groundwater Model, Version 8.4.5) as described in ECF-200W-17-0070, Groundwater Flow and Migration Calculations to Support Assessment of the Hanford Central Plateau 200 West Area Facilities Monitoring Network, for 200 West Area units. The flow rate and direction will be evaluated in the context of groundwater in the surrounding area (e.g., plume maps in DOE/RL-2017-66, Hanford Site Groundwater Monitoring Report for 2017). The outcome of this evaluation, along with contaminant concentrations from hydraulically upgradient and downgradient wells, provide context to the potential contribution from the unit.

Supporting constituents, corrosion constituents, and field measurements (Table 2-2) provide additional information for interpretation of dangerous waste constituent results. The evaluations required for the dangerous waste constituents are not applicable to supporting constituents, corrosion constituents, and field measurements. Some dangerous waste constituents (Table 2-1) are also included as the casing corrosion constituents (Table 2-2). In these cases, the constituents will be evaluated as required for dangerous waste constituents (Section 3.2.1).

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3.3 Interpretation

Data are used to interpret groundwater conditions at LLBG WMA-3. Interpretive techniques may include the following:

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

3.2 Data Evaluation

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The sampling results of the dangerous waste constituents listed in Table 2-1 from the wells identified in Table 2-2 will be evaluated and used to prepare a first determination report. In accordance with 40 CFR 265.93(d), the first determination report will include an assessment of groundwater quality and determine if dangerous waste from LLBG WMA-3 has entered the groundwater.

The dangerous wastes included for this assessment comprise the chemicals identified in Appendix 5 of Ecology Publication No. 97-407. Dangerous wastes that are detected in two or more sequential sample events, quantified above Hanford Site background values (inorganics only), and are not the result of contamination from another facility or source (e.g., detected in comparable concentrations in upgradient wells), will be considered attributable to a release from LLBG WMA-3.

Inorganic constituents that occur naturally in groundwater are included for the assessment. Some of these constituents will require statistical evaluation to determine if the concentration in groundwater is attributable to a release from LLBG WMA-3 or a different source (including natural background concentrations). It is anticipated that the statistical evaluation will require a minimum of eight sample results; therefore, evaluation of the dangerous waste will be performed after collection of eight samples.

Organic constituents that are included in the assessment are not naturally occurring. However, if detected, their presence in groundwater may be attributable to a source other than LLBG WMA-3.

3.2.1 Overview

Several steps are involved to evaluate sample results of the dangerous wastes in Table 2-1. Evaluations will be performed on sample results from both upgradient and downgradient wells.

The initial steps that follow describe identification of valid detections:

- Sample data will be reviewed to determine which constituents are detected (Section 3.2.2).
- Sample data identified as detected will be evaluated for analytical uncertainties associated with the results (Section 3.2.3).

The concentrations of valid detected sample results will be further evaluated. Inorganics that occur naturally in groundwater and organic constituents that are present from another source may require statistical evaluation of sample results to determine (1) the upgradient concentration for comparison to downgradient results, and/or (2) if a downgradient well concentration demonstrates a groundwater impact from LLBG WMA-3. Statistical evaluation of the results may be performed after a sufficient number of samples (eight) have been collected.

Further evaluation of valid detections may include the following, and may include other evaluations that are not specified herein:

- Comparison of downgradient concentrations to upgradient concentrations and/or Hanford Site background values (Section 3.2.4)
- Evaluation for stainless steel well casing corrosion (as applicable) (Section 3.2.5)

The preceding evaluations provide instruction for determining if a sample result represents a valid detection and is indicative of contamination from LLBG WMA-3. However, it is possible that a single detection may be a false-positive result. To avoid the possibility of attributing groundwater contamination

to the unit based on a single false-positive sample result, the next quarterly sample result will also be evaluated prior to making a determination. Therefore, valid detections of a dangerous waste constituent in two sequential sample results are needed prior to determining that the unit has contaminated groundwater.

3.2.2 Constituent Detection

A dangerous waste constituent (Table 2-1) is considered “detected” when its concentration exceeds its respective practical quantitation limit. Reported concentrations that are less than or equal to the practical quantitation limit of a constituent are not considered detected and are not further evaluated.

3.2.3 Analytical Uncertainties

For detected constituents, analytical results will be evaluated for data qualifiers or other information that may indicate a potential data use issue. Laboratory qualifiers identify issues associated with the analysis of the sample at the laboratory. Review qualifiers identify results with high uncertainty or data quality issues. Definitions of laboratory and review qualifiers applicable to data generated under this plan are available in HNF-38155, *HEIS Sample, Result, and Sampling Site Data Dictionary*. Data qualifiers will be reviewed to determine if the results are of sufficient quality for decision-making purposes. Sample results that are not of sufficient quality for decision-making purposes are not further evaluated.

3.2.4 Comparison to Upgradient Concentrations and/or Hanford Site Background Values

The concentration of any detected dangerous waste constituent in a downgradient well may be compared to the concentration in upgradient well(s), and for inorganics, the available Hanford Site groundwater background concentrations (90th percentile background threshold values in DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If the constituent concentration in a downgradient well is less than or equal to the upgradient concentration or less than or equal to the background value, the sample result is not further evaluated.

Further evaluation of detected dangerous waste constituents may be performed to identify other sources of a detected constituent, including any known contaminant plumes in the area of the monitoring network. Groundwater at LLBG WMA-3 is affected by operation of the 200 West Area pump-and-treat as injection wells are located within or near the WMA boundary. The injection wells introduce treated water that contain other constituents that are not associated with the remedial action.

Future changes to the pump-and-treat operations (e.g., a change in the volume of groundwater that is treated and thereby injected at wells affecting groundwater at LLBG WMA-3) may introduce new constituents to the groundwater or change the groundwater concentration of existing constituents that are evaluated in this assessment. If other sources of detected dangerous wastes are identified, evaluation and discussion of other source(s), known contaminant plumes, and/or the impact from the pump-and-treat operation will be provided in the first determination report.

3.2.5 Evaluation for Stainless Steel Well Casing Corrosion

As discussed in Section 2.1.1, groundwater is sampled for the products of stainless steel well casing corrosion, including chromium, iron, manganese, molybdenum, and nickel. Chromium and nickel are also dangerous wastes included for the assessment. Therefore, elevated concentrations of chromium and nickel measured as part of the assessment will also be evaluated in the context of stainless steel corrosion.

3.2.6 Outcomes

Evaluation of groundwater sample results will be performed after data from the first eight quarterly samples is available. If a dangerous waste constituent is detected in two sequential sample results and cannot be eliminated as attributable to LLBG WMA-3 based on the evaluations in Sections 3.2.4

and 3.2.5, or if statistical evaluation identifies that a constituent from the unit that is also naturally occurring has impacted groundwater, then the presence of that constituent in groundwater will be attributed to LLBG WMA-3. These findings will be reported in the first determination report, along with the rate and extent of contaminant migration and concentration of the constituents in groundwater.

3.2.7 Water-Level Measurements

Groundwater flow rate and direction evaluation will be conducted using the Central Plateau Groundwater Model (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.4.5*) as described in ECF-200W-17-0070, *Groundwater Flow and Migration Calculations to Support Assessment of the Hanford Central Plateau 200 West Area Facilities Monitoring Network*. The flow rate and direction will be evaluated in the context of groundwater in the surrounding area (e.g., plume maps in DOE/RL-2019-65, *Hanford Site RCRA Groundwater Monitoring Report for 2019*). The outcome of this evaluation, along with contaminant concentrations from hydraulically upgradient and downgradient wells, provide context to the potential contribution from the unit.

- **Contaminant ratios:** Illustrate the relative abundances of contaminants from previously characterized Hanford Site-related processes and sources. Comparison of these ratios in groundwater can sometimes be used to distinguish among different sources of contamination (e.g., a specific process and its associated facility). Ratios may provide evidence of continuing source contamination, thereby linking contamination with a specific facility under monitoring. Evaluation of contaminant ratios in concentration trends may be used to demonstrate when facility-specific contamination no longer affects underlying groundwater.

3.4 Annual Determination of Monitoring Network

Groundwater monitoring requirements include determining the rate and extent of migration of dangerous waste contamination, if any, in the groundwater underlying the unit (40 CFR 265.93(d)(4)(i)), Preparation, Evaluation, and Response.” An annual evaluation of the network is performed to determine if it remains adequate to monitor the facility’s impact on the quality of the groundwater in the uppermost aquifer underlying the facility. The network must include at least one upgradient and at least three downgradient wells in the uppermost aquifer (40 CFR 265.91(a)(1) and (2)).

The groundwater monitoring network in this plan will continue to be reevaluated to ensure that it is adequate to monitor any changing hydrogeologic conditions beneath the unit along with the rate and extent of migration of dangerous waste contamination, if any. If flow changes are observed, the LLBG WMA-3 contaminant migration conceptual model and geochemical trends will be reevaluated to determine network efficiency and any necessary modifications required for the network.

Water-level measurements will continue to be collected during each sampling event. An additional and more comprehensive set of water-level measurements is made annually for selected wells on the Hanford Site; these data may be found in the annual Hanford Site RCRA groundwater monitoring reports (e.g., DOE/RL-2018-65).

3.5 Recordkeeping, Reporting, and Notification

This plan and any subsequent determination reports will be placed in the facility operating record and be maintained in accordance with the requirements of 40 CFR 265.93(d)(2) and (5), and (e). Records of the analyses and evaluations specified in this plan will be kept in accordance with the requirements of 40 CFR 265.94(b)(1).

The results of groundwater quality assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94(b)(2). Reporting will be made in the annual Hanford Site RCRA groundwater monitoring reports (e.g., DOE/RL-2018-65) by March 1.

A first determination report containing an assessment of groundwater quality based on the results of this assessment plan (under 40 CFR 265.93(d)(4)) will be prepared as soon as technically feasible. This report will be submitted to Ecology with 15 days of issuance as required by 40 CFR 265.93(d)(5) and WAC 173-303-400(3)(c)(v)(E).

If, as a result of the assessment plan under 40 CFR 265.93(d)(4), it is determined that no dangerous waste or dangerous waste constituents from the facility have entered the groundwater, and an indicator evaluation groundwater monitoring program is reinstated, Ecology will be notified of this reinstatement in the first determination report as required by 40 CFR 265.93(d)(6) and WAC 173-303-400(3)(b)(i).

4 Implementation Schedule

The schedule for sampling is provided in Chapter 2 of this document. This groundwater quality assessment plan replaces the indicator evaluation groundwater monitoring program of DOE/RL-2009-68, Rev. 2, and will be implemented within 4 months of the document being placed in the operating record.

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Appendix A

Quality Assurance Project Plan

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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
FXR	field transfer blank
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

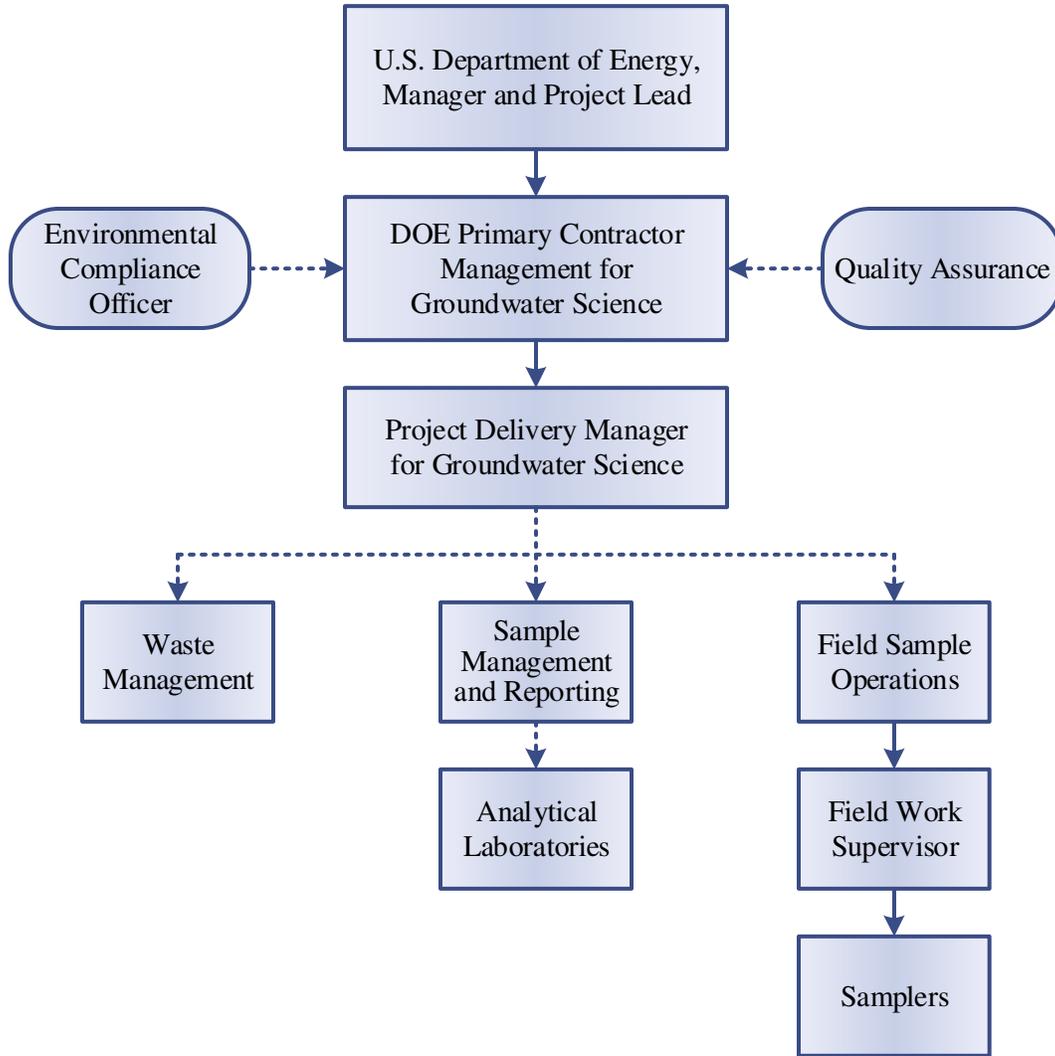
Hanford Site operation is the responsibility of the U.S. Department of Energy (DOE). The DOE Manager is responsible for authorizing the contractor to perform activities at the Hanford Site under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; *Resource Conservation 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 Prime Contractor Management for Groundwater Science

The DOE Prime Contractor Management for Groundwater Science provides oversight and coordinates with DOE in support of sampling and reporting activities. The DOE Prime 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.



1
2

Figure A-1. Project Organization

3 **A2.1.4 Project Delivery Manager for Groundwater Science**

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

12 **A2.1.5 Sample Management and Reporting Group**

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

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

7 **A2.1.6 Field Sample Operations**

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

13 **A2.1.7 Quality Assurance**

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

16 **A2.1.8 Environmental Compliance Officer**

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

19 **A2.1.9 Waste Management**

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

24 **A2.1.10 Analytical Laboratories**

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

28 **A2.2 Problem Definition/Background**

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

36 **A2.3 Project/Task Description**

37 The focus of this plan is to identify dangerous wastes or dangerous waste constituents from the DWMU
38 that have entered the groundwater; determine the groundwater concentration and rate and extent of
39 migration of any dangerous waste originating from the DWMU; evaluate the well network; interpret
40 analytical results; and report findings; each in accordance with 40 CFR 265.93, “Preparation, Evaluation,
41 and Response,” as promulgated by WAC 173-303-400(3)(b) and modified by (3)(c)(v) when indicated.

1 The constituents and parameters to be monitored, along with the monitoring wells and frequency of
2 sampling, are provided in the main text of this monitoring plan. Information on the collection and
3 analyses of groundwater from the monitoring network is provided in this appendix and in Appendix B.

4 **A2.4 Quality Assurance Objectives and Criteria**

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

10 The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are
11 dictated by the intended use of the data and the requirements of the analytical method. The process to
12 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
<p>Comparability (field duplicate, field splits, laboratory control samples, matrix spikes, and matrix spike duplicates)</p>	<p>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.</p>	<p>Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and quality assurance protocols.</p>	<p>If data are not comparable to other datasets:</p> <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.
<p>Completeness (no QC element; addressed in data usability assessment)</p>	<p>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.</p>	<p>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).</p>	<p>If dataset does not meet the completeness objective:</p> <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.
<p>Bias (equipment blanks, field transfer blanks, full trip blanks, laboratory control samples, matrix spikes, and method blanks)</p>	<p>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.</p>	<p>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).</p>	<p>For sampling bias:</p> <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. DOE 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 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 = U.S. Department of Energy

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 2019*).

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 LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method ^a	Practical Quantitation Limit (µg/L)
General Chemistry			
ALKALINITY	Alkalinity, total as CaCO ₃	310.1, Standard Method 2320, Standard Method 4500	5250
57-12-5	Cyanide (total)	335.4, 9012, 9014, Standard Method 4500	15.75
57-12-5 ^b	Cyanide (free)	9014	4
18496-25-8	Sulfide (total)	376.1, Standard Method 4500S	2100
TOC	Total organic carbon	9060	1050
59473-04-0	Total organic halogen	9020	31.5
Anions^c			
16887-00-6	Chloride	300, 9056	400
14797-55-8	Nitrate, as NO ₃	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

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method^a	Practical Quantitation Limit (µg/L)
--	Turbidity	180.1, Standard Method 2130 B	N/A
Metals			
7440-36-0	Antimony	6020	5.25
7440-38-2	Arsenic	6020	10.5
7440-39-3	Barium	6020	5.25
7440-41-7	Beryllium	6020	1.05
7440-43-9	Cadmium	6020	2.1
744-70-2	Calcium	6010	1050
7440-47-3	Chromium	6020	10.5
7440-48-4	Cobalt	6020	5.25
7440-50-8	Copper	6020	12.6
7439-89-6	Iron	6010	105
7439-92-1	Lead	6020	3.15
7439-95-4	Magnesium	6010	1050
7439-96-5	Manganese	6020	10.5
7439-97-6	Mercury	7470	0.5
7439-98-7	Molybdenum	6020	5.25
7440-02-0	Nickel	6020	21
7440-09-7	Potassium	6010	5250
7782-49-2	Selenium	6020	10.5
7440-22-4	Silver	6020	5.25
7440-23-5	Sodium	6010	1050
7440-28-0	Thallium	6020	2.1
7440-31-5	Tin	6020	10.5
7440-62-2	Vanadium	6010	52.5
7440-66-6	Zinc	6010	21
Volatile Organic Compounds			
75-34-3	1,1-Dichloroethane	8260	10
75-35-4	1,1-Dichloroethene (1,1-Dichloroethylene)	8260	10
71-55-6	1,1,1-Trichloroethane	8260	5
630-20-6	1,1,1,2-Tetrachloroethane	8260	2.1

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method^a	Practical Quantitation Limit (µg/L)
79-00-5	1,1,2-Trichloroethane	8260	5
79-34-5	1,1,2,2-Tetrachloroethane	8260	5
96-12-8	1,2-Dibromo-3-Chloropropane	8260	5.25
106-93-4	1,2-Dibromoethane (Ethylene dibromide [EDB])	8260	5
107-06-2	1,2-Dichloroethane	8260	5
78-87-5	1,2-Dichloropropane	8260	5
156-60-5	trans-1,2-Dichloroethylene	8260	5
96-18-4	1,2,3-Trichloropropane	8260	5
10061-01-5	cis-1,3-Dichloropropene	8260	5
10061-02-6	trans-1,3-Dichloropropene	8260	5
110-57-6	trans-1,4-Dichloro-2-butene	8260	50
78-93-3	2-Butanone (Methyl ethyl ketone [MEK])	8260	10.5
67-64-1	2-Propanone (Acetone)	8260	20
591-78-6	2-Hexanone (Methyl butyl ketone [MBK])	8260	20
108-10-1	4-Methyl-2-Pentanone (Methyl isobutyl ketone [MIBK])	8260	10.5
75-05-8	Acetonitrile (Methyl cyanide)	8260	100
107-02-8	Acrolein	8260	100
107-13-1	Acrylonitrile	8260	100
107-05-1	Allyl chloride	8260	10.5
71-43-2	Benzene	8260	5
75-27-4	Bromodichloromethane	8260	5
75-25-2	Bromoform	8260	5
75-15-0	Carbon disulfide	8260	5
56-23-5	Carbon tetrachloride	8260	3
108-90-7	Chlorobenzene	8260	5
75-00-3	Chloroethane	8260	10
67-66-3	Chloroform	8260	5

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method ^a	Practical Quantitation Limit (µg/L)
126-99-8	Chloroprene (Chloro-1,3-butadiene;2-)	8260	10
124-48-1	Dibromochloromethane	8260	5
106-46-7	p-Dichlorobenzene (1,4-Dichlorobenzene)	8260	4
75-71-8	Dichlorodifluoromethane	8260	10
100-41-4	Ethylbenzene	8260	4
97-63-2	Ethyl methacrylate	8260	10.5
78-83-1	Isobutanol (Isobutyl Alcohol)	8260	500
126-98-7	Methacrylonitrile (2-propenenitrile, 2-methyl-)	8260	10.5
74-83-9	Methyl bromide (Bromomethane)	8260	10
74-87-3	Methyl chloride (Chloromethane)	8260	10
74-88-4	Methyl iodide (Iodomethane)	8260	10.5
80-62-6	Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)	8260	10.5
74-95-3	Methylene bromide (Dibromomethane)	8260	10
75-09-2	Methylene chloride (Dichloromethane)	8260	5.25
107-12-0	Propionitrile (Ethyl cyanide)	8260	21
100-42-5	Styrene	8260	5
127-18-4	Tetrachloroethene (Tetrachloroethylene, Perchloroethylene)	8260	5
108-88-3	Toluene	8260	5
79-01-6	Trichloroethylene (Trichloroethene [TCE])	8260	2.1
75-69-4	Trichlorofluoromethane	8260	10
108-05-4	Vinyl acetate	8260	50
75-01-4	Vinyl chloride (Chloroethene, Chloroethylene)	8260	10

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method ^a	Practical Quantitation Limit (µg/L)
1330-20-7	Xylene (Total) (Mixed isomers)	8260	10
Semivolatile Organic Compounds			
134-32-7	1-Naphthylamine	8270	25
95-50-1	1,2-Dichlorobenzene (o-Dichlorobenzene)	8270	10.5
120-82-1	1,2,4-Trichlorobenzene	8270	13
95-94-3	1,2,4,5-Tetrachlorobenzene	8270	20
123-91-1	1,4-Dioxane (1,4-Diethylene dioxide)	8270	21
130-15-4	1,4-Naphthoquinone	8270	52.5
53-96-3	2-Acetylaminofluorene	8270	100
91-58-7	2-Chloronaphthalene (Beta-chloronaphthalene)	8270	10.5
95-57-8	2-Chlorophenol	8270	10.5
95-48-7	2-Methylphenol (o-Cresol)	8270	10.5
91-57-6	2-Methylnaphthalene	8270	10.5
91-59-8	2-Naphthylamine	8270	10.5
88-75-5	2-Nitrophenol (o-Nitrophenol)	8270	10.5
109-06-8	2-Picoline	8270	21
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
121-14-2	2,4-Dinitrotoluene	8270	10.5
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
606-20-2	2,6-Dinitrotoluene	8270	10.5
56-49-5	3-Methylcholanthrene	8270	21
108-39-4 ^d	3-Methylphenol (m-Cresol)	8270	--

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method ^a	Practical Quantitation Limit (µg/L)
106-44-5 ^d	4-Methylphenol (p-Cresol)	8270	--
91-94-1	3,3'-Dichlorobenzidine	8270	105
119-93-7	3,3'-Dimethylbenzidine	8270	50
92-67-1	4-Aminobiphenyl	8270	52.5
101-55-3	4-Bromophenyl phenyl ether	8270	10.5
59-50-7	4-Chloro-3-methylphenol (p-Chloro-m-cresol)	8270	10.5
7005-72-3	4-Chlorophenyl phenyl ether	8270	10.5
56-57-5	4-Nitroquinoline 1-oxide	8270	105
534-52-1	4,6-Dinitro-o-cresol (4,6-Dinitro-2-methyl phenol)	8270	52.5
99-55-8	5-Nitro-o-toluidine (Methyl-5-nitroaniline;2-)	8270	21
57-97-6	7,12-Dimethylbenz[a]anthracene	8270	21
83-32-9	Acenaphthene	8270	10.5
208-96-8	Acenaphthylene	8270	10.5
98-86-2	Acetophenone	8270	10.5
62-53-3	Aniline	8270	10.5
120-12-7	Anthracene	8270	10.5
140-57-8	Aramite	8270	20
56-55-3	Benz[a]anthracene (Benzo[a]anthracene)	8270	10.5
205-99-2	Benz[e]acephenanthrylene (Benzo[b]fluoranthene)	8270	10.5
207-08-9	Benzo[k]fluoranthene	8270	10.5
191-24-2	Benzo[ghi]perylene	8270	10.5
50-32-8	Benzo[a]pyrene	8270	10.5
100-51-6	Benzyl alcohol	8270	10.5
111-91-1	Bis(2-chloroethoxy)methane	8270	10.5
111-44-4	Bis(2-chloroethyl)ether	8270	10.5
108-60-1	Bis(2-chloro-1-methylethyl)ether (2,2'-Oxybis[1-chloropropane])	8270	10.5
117-81-7	Bis(2-ethylhexyl)phthalate	8270	15.7

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method^a	Practical Quantitation Limit (µg/L)
85-68-7	Butyl benzyl phthalate (Benzyl butyl phthalate)	8270	10.5
106-47-8	p-Chloroaniline (4-Chloroaniline)	8270	10.5
218-01-9	Chrysene	8270	10.5
53-70-3	Dibenz[a,h]anthracene (Dibenzanthracene, 1,2,5,6-)	8270	10.5
132-64-9	Dibenzofuran	8270	10.5
541-73-1	m-Dichlorobenzene (1,3-Dichlorobenzene)	8270	10.5
84-66-2	Diethyl phthalate	8270	10.5
297-97-2	O,O-Diethyl O-2-pyrazinyl phosphorothioate (Thionazin)	8270	52.5
60-11-7	p-(Dimethylamino)azobenzene	8270	21
122-09-8	alpha, alpha-Dimethylphenethylamine	8270	52.5
131-11-3	Dimethyl phthalate	8270	10.5
84-74-2	Di-n-butylphthalate (Dibutyl phthalate)	8270	10.5
99-65-0	m-Dinitrobenzene (1,3-Dinitrobenzene)	8270	10.5
117-84-0	Di-n-octylphthalate	8270	10.5
122-39-4	Diphenylamine	8270	10.5
62-50-0	Ethyl methanesulfonate	8270	10.5
206-44-0	Fluoranthene	8270	10.5
86-73-7	9H-Fluorene (Fluorene)	8270	10.5
118-74-1	Hexachlorobenzene	8270	10.5
87-68-3	Hexachlorobutadiene	8270	10.5
77-47-4	Hexachlorocyclopentadiene	8270	10.5
67-72-1	Hexachloroethane	8270	10.5
70-30-4	Hexachlorophene	8270	525
1888-71-7	Hexachloropropene	8270	105
193-39-5	Indeno(1,2,3-Cd)Pyrene	8270	10.5
78-59-1	Isophorone	8270	10.5

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method ^a	Practical Quantitation Limit (µg/L)
120-58-1	Isosafrole	8270	21
91-80-5	Methapyrilene	8270	52.5
66-27-3	Methyl methanesulfonate	8270	10.5
91-20-3	Naphthalene	8270	10.5
98-95-3	Nitrobenzene	8270	10.5
88-74-4	o-Nitroaniline (2-Nitroaniline)	8270	21
99-09-2	m-Nitroaniline (3-Nitroaniline)	8270	21
100-01-6	p-Nitroaniline (4-Nitroaniline)	8270	21
100-02-7	p-Nitrophenol (4-Nitrophenol)	8270	21
924-16-3	n-Nitrosodi-n-butylamine	8270	10.5
55-18-5	n-Nitrosodiethylamine	8270	10.5
62-75-9	n-Nitrosodimethylamine (Dimethyl nitrosamine)	8270	10.5
86-30-6 ^e	n-Nitrosodiphenylamine	8270	--
621-64-7	n-Nitroso-di-n-dipropylamine (n-Nitrosodipropylamine; Di-n-propylnitrosamine)	8270	10.5
10595-95-6	n-Nitrosomethylethalamine (Ethanamine, N-methyl-N-nitroso-)	8270	10.5
59-89-2	n-Nitrosomorpholine	8270	10.5
100-75-4	n-Nitrosopiperidine	8270	10.5
930-55-2	n-Nitrosopyrrolidine	8270	10.5
608-93-5	Pentachlorobenzene	8270	10.5
76-01-7	Pentachloroethane	8270	52.5
82-68-8	Pentachloronitrobenzene	8270	52.5
87-86-5	Pentachlorophenol	8270	52.5
62-44-2	Phenacetin	8270	21
85-01-8	Phenanthrene	8270	10.5
108-95-2	Phenol	8270	10.5
106-50-3	p-Phenylenediamine	8270	525
129-00-0	Pyrene	8270	10.5

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method ^a	Practical Quantitation Limit (µg/L)
110-86-1	Pyridine	8270	21
94-59-7	Safrole	8270	21
3689-24-5	Tetraethyl dithiopyrophosphate (Sulfotep)	8270	50
95-53-4	o-Toluidine (Methylaniline;2-)	8270	20
126-68-1	O,O,O-Triethyl phosphorothioate	8270	52.5
99-35-4	sym-Trinitrobenzene (Trinitrobenzene;1,3,5-)	8270	52.5
Polychlorinated Biphenyls			
12674-11-2	Aroclor 1016	8082	1.05
11104-28-2	Aroclor 1221	8082	2.1
11141-16-5	Aroclor 1232	8082	1.05
53469-21-9	Aroclor 1242	8082	1.05
12672-29-6	Aroclor 1248	8082	1.05
11097-69-1	Aroclor 1254	8082	1.05
11096-82-5	Aroclor 1260	8082	1.05
Herbicides			
94-75-7	2,4-D (2,4-Dichlorophenoxy acetic acid)	8151	20
93-76-5	2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	8151	1.05
2303-16-4	Diallate	8270	21
88-85-7	Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	8270	21
23950-58-5	Pronamide	8270	21
93-72-1	Silvex (2,4,5-TP)	8151	1.05
Pesticides			
72-54-8	4,4'-DDD	8081	0.1
72-55-9	4,4'-DDE	8081	0.1
50-29-3	4,4'-DDT	8081	0.1
309-00-2	Aldrin	8081	0.0525
319-84-6	alpha-BHC (hexachlorocyclohexane;alpha)	8081	0.0525

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method^a	Practical Quantitation Limit (µg/L)
319-85-7	beta-BHC (hexachlorocyclohexane;beta-)	8081	0.0525
319-86-8	delta-BHC (hexachlorocyclohexane;delta-)	8081	0.0525
58-89-9	gamma-BHC (Lindane; hexachlorocyclohexane)	8081	0.0525
57-74-9	Chlordane	8081	1.05
510-15-6	Chlorobenzilate	8270	10.5
60-57-1	Dieldrin	8081	0.0525
60-51-5	Dimethoate	8270	21
298-04-4	Disulfoton	8270	52.5
959-98-8	Endosulfan I	8081	0.0525
33213-65-9	Endosulfan II	8081	0.1
1031-07-8	Endosulfan sulfate	8081	0.1
72-20-8	Endrin	8081	0.1
7421-93-4	Endrin aldehyde	8081	0.1
52-85-7	Famphur	8270	105
76-44-8	Heptachlor	8081	0.0525
1024-57-3	Heptachlor epoxide	8081	0.0525
465-73-6	Isodrin	8270	10.5
143-50-0	Kepone	8270	100
72-43-5	Methoxychlor	8081	0.5
298-00-0	Methyl parathion (O,O-dimethyl O-P-nitrophenyl, phosphorothioate)	8270	10.5
56-38-2	Parathion	8270	52.5
298-02-2	Phorate (Phosphorodithioic acid, O,O-diethyl S-(ethylthio) methyl ester)	8270	52.5
8001-35-2	Toxaphene	8081	2.625
Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (Totals and Congeners)			
35822-46-9	1,2,3,4,6,7,8- Heptachlorodibenzodioxin	8290	5.25E-05
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	8290	5.25E-05
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	8290	5.25E-05

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method ^a	Practical Quantitation Limit (µg/L)
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	8290	5.25E-05
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	8290	5.25E-05
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	8290	5.25E-05
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	8290	5.25E-05
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	8290	5.25E-05
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	8290	5.25E-05
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	8290	5.25E-05
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	8290	5.25E-05
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	8290	5.25E-05
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	8290	5.25E-05
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	8290	1.05E-05
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	8290	1.05E-05
38998-75-3	Total Heptachlorodibenzofurans	8290	5.37E-05
37871-00-4	Total Heptachlorodibenzo-p-dioxins	8290	5.25E-05
55684-94-1	Total Hexachlorodibenzofurans	8290	5.25E-05
34465-46-8	Total Hexachlorodibenzo-p-dioxins	8290	1.05E-04
39001-02-0	Total Octachlorodibenzofurans	8290	1.05E-04
3268-87-9	Total Octachlorodibenzo-p-dioxins	8290	1.07E-04
30402-15-4	Total Pentachlorodibenzofurans	8290	5.25E-05
36088-22-9	Total Pentachlorodibenzo-p-dioxins	8290	5.25E-05
55722-27-5	Total Tetrachlorodibenzofurans	8290	1.05E-05

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.

This table identifies the dangerous waste constituents listed in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*. This appendix is incorporated at WAC 173-303-110(3)(c) and (7), "Dangerous Waste Regulations," "Sampling, Testing Methods, and Analytes."

- a. For EPA Methods 180.1, 300, and 335.4, 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, 360.1, and 376.1, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For four-digit EPA methods, see the SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Compendium*. For Standard Methods, see APHA/AWWA/WEF, 2017, *Standard Methods for the Examination of Water and Wastewater*.
- b. Analyzed and reported as free cyanide.
- c. Dilutions for certain ion chromatography constituents may be necessary, potentially raising the practical quantitation limit above the limits provided.
- d. Analyzed and reported as 3 & 4 Methylphenol (CAS number 65794-96-9). PQL for 3 & 4 Methylphenol is 20 µg/L.

Table A-3. Analytical Methods for LLBG WMA-3

CAS Number	Waste Constituent (Alternate Name)	Analytical Method ^a	Practical Quantitation Limit (µg/L)
e.	Analyzed and reported as Diphenylamine+N-Nitrosodiphenylamine. PQL for Diphenylamine+N-Nitrosodiphenylamine is 10.5 µg/L.		
CAS	=	Chemical Abstracts Service	
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
Field transfer blanks	One each day VOCs are sampled; additional field transfer blanks are collected if VOC samples are acquired on the same day for multiple laboratories	Contamination from sampling site
Full trip blanks	1 in 20 well trips ^b	Contamination from containers preservative reagents, storage, or transportation
Analytical QC^c		
Laboratory control samples	One per analytical batch ^d	Method accuracy

Table A-4. QC Samples

Sample Type	Frequency	Characteristics Evaluated
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			
Alkalinity	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o" ^b
	DUP ^c or MS/MSD ^d	≤20% RPD	Review data ^e
	MS/MSD ^d	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate ^c	≤20% RPD	Review data ^e
Cyanide (free and total)	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"

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

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

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

Analyte ^a	QC Element	Acceptance Criteria	Corrective Action
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
Mercury by cold-vapor atomic absorption	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
Volatile Organic Compounds			
Volatile organics by gas chromatography/mass spectrometry	MB	<MDL ^f <5% sample concentration	Flag with “B”
	LCS	70% to 130% recovery or % recovery statistically derived ^g	Flag with “o” ^b
	DUP ^c or MS/MSD ^d	≤20% RPD	Review data ^e
	MS/MSD ^d	70% to 130% recovery	Flag with “T”
	SUR	70% to 130% recovery	Review data ^e
	EB, FTB, FXR	<MDL ^f <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 by gas chromatography/mass spectrometry	MB	<MDL <5% sample concentration	Flag with “B”
	LCS	70% to 130% recovery or % recovery statistically derived ^g	Flag with “o” ^b
	DUP ^c or MS/MSD ^d	≤20% RPD	Review data ^e
	MS/MSD ^d	% recovery statistically derived ^g	Flag with “T”
	SUR	% recovery statistically derived ^g	Review data ^e
	EB, FTB	<MDL <5% sample concentration	Flag with “Q”
	Field duplicate ^c	≤20% RPD	Review data ^e
Semivolatiles by gas chromatography/mass spectrometry	MB	<MDL ^f <5% sample concentration	Flag with “B”
	LCS	70% to 130% recovery or % recovery statistically derived ^g	Flag with “o” ^b
	DUP ^c or MS/MSD ^d	≤20% RPD	Review data ^e
	MS/MSD ^d	% recovery statistically derived ^g	Flag with “T”
	SUR	% recovery statistically derived ^g	Review data ^e
	EB, FTB	<MDL ^f <5% sample concentration	Flag with “Q”
	Field duplicate ^c	≤20% RPD	Review data ^e
Polychlorinated Biphenyls			
Polychlorinated biphenyls by gas chromatography	MB	<MDL <5% sample concentration	Flag with “B”
	LCS	70% to 130% recovery or % recovery statistically derived ^g	Flag with “o” ^b
	DUP ^c or MS/MSD ^d	≤20% RPD	Review data ^e
	MS/MSD ^d	% recovery statistically derived ^g	Flag with “N”
	SUR	% recovery statistically derived ^g	Review data ^e
	EB, FTB	<MDL <5% sample concentration	Flag with “Q”
	Field duplicate ^c	≤20% RPD	Review data ^e
Herbicides			
Herbicides by gas chromatography	MB	<MDL <5% sample concentration	Flag with “B”
	LCS	70% to 130% recovery or % recovery statistically derived ^g	Flag with “o” ^b
	DUP ^c or MS/MSD ^d	≤20% RPD	Review data ^e
	MS/MSD ^d	% recovery statistically derived ^g	Flag with “N”

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

Analyte ^a	QC Element	Acceptance Criteria	Corrective Action
	SUR	% recovery statistically derived ^g	Review data ^e
	EB, FTB	<MDL <5% sample concentration	Flag with “Q”
	Field duplicate ^c	≤20% RPD	Review data ^e
Pesticides			
Pesticides by gas chromatography	MB	<MDL <5% sample concentration	Flag with “B”
	LCS	70% to 130% recovery or % recovery statistically derived ^g	Flag with “o” ^b
	DUP ^c or MS/MSD ^d	≤20% RPD	Review data ^e
	MS/MSD ^d	% recovery statistically derived ^g	Flag with “N”
	SUR	% recovery statistically derived ^g	Review data ^e
	EB, FTB	<MDL <5% sample concentration	Flag with “Q”
	Field duplicate ^c	≤20% RPD	Review data ^e
Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (Totals and Congeners)			
Dioxins/Furans by high-resolution gas chromatography/high-resolution mass spectrometry	MB	<PQL <5% sample concentration	Flag with “B”
	LCS	% recovery statistically derived ^g	Flag with “o” ^b
	DUP ^c	≤20% RPD	Review data ^e
	SUR	60%-140% recovery	Review data ^e
	EB, FTB	<PQL <5% sample concentration	Flag with “Q”
	Field duplicate ^c	<20% RPD	Review data ^e

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

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, dissolved oxygen, 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. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is <5 times the MDL.

g. Laboratory-determined, statistically derived control limits based on historical data are used here. Control limits are reported with the data.

DUP = laboratory sample duplicate

EB = equipment blank

FTB = full trip blank

MS = matrix spike

MSD = matrix spike duplicate

PQL = practical quantitation limit

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

Analyte ^a	QC Element	Acceptance Criteria	Corrective Action
FXR = field transfer 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	
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], field transfer blanks [FXRs], 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.
- **Field transfer blanks:** FXRs are used to document possible contamination during field acquisition of volatile organic compound (VOC) samples. FXRs are sample bottles (already containing any required

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.

sample preservative) filled at the sample collection site with high-purity water. The blank is sealed at the sampling site and becomes part of the sample set sent to the laboratory. FXRs are prepared daily for sites sampling for VOC analysis. Typically, one set of FXRs is prepared each day that VOC field samples are collected. If VOC samples are collected on the same day and shipped to multiple laboratories, a set of FXRs is collected for each analyzing laboratory.

- **Full trip blanks:** FTBs are used to monitor for potential sample contamination from the sampling container, preservation reagents, or storage conditions. FTBs are prepared with 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, laboratory sample duplicates (DUPs), matrix spikes (MSs), matrix spike duplicates (MSDs), method blanks (MBs), and surrogates (SURs). These QC analyses follow EPA methods (e.g., those in the SW-846 Compendium). QC checks outside of control limits are documented in analytical laboratory reports and during a DQI evaluation. Descriptions of the various types of laboratory QC samples are as follows:

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

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

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

Constituent^a	Preservation^b	Holding Time
General Chemistry		
Alkalinity	Store ≤6°C	14 days
Cyanide (free and total)	Store ≤6°C, adjust pH to >12 with 50% sodium hydroxide. If oxidizing agents present, add 5 mL 0.1 N sodium arsenite/L or 0.06 g ascorbic acid/L	14 days
Sulfide	Store ≤6°C, adjust pH to > 9 with zinc acetate and sodium hydroxide	7 days
Total organic carbon	Store <6°C, adjust pH to <2 with sulfuric acid or hydrochloric acid	28 days
Total organic halogen	Store <6°C, adjust pH to <2 with sulfuric acid	28 days
Anions		
Chloride, Sulfate	Store ≤6°C	28 days
Nitrate	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
Mercury by cold-vapor atomic absorption	Adjust pH to <2 with nitric acid	28 days
Volatile Organic Compounds		
Volatile organics by gas chromatography/mass spectrometry	Store ≤6°C, Adjust pH to <2 with sulfuric acid or hydrochloric acid	7 days unpreserved 14 days maximum preserved
Semivolatile Organic Compounds		
Phenols by gas chromatography/mass spectrometry	Store ≤6°C	7 days before extraction 40 days after extraction
Semivolatiles by gas chromatography/mass spectrometry	Store ≤6°C	7 days before extraction 40 days after extraction
Polychlorinated Biphenyls		
Polychlorinated biphenyls	Store <6°C	1 year before extraction 40 days after extraction
Herbicides		

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

Constituent ^a	Preservation ^b	Holding Time
Herbicides	Store <6°C	7 days before extraction 40 days after extraction
Pesticides		
Pesticides	Store <6°C	7 days before extraction 40 days after extraction
Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (totals and congeners)		
Dioxins/Furans by high-resolution gas chromatography/high-resolution mass spectrometry	Store <6°C	30 days before extraction 45 days after extraction

Notes: Holding times and preservation methods are dependent on the constituent and are consistent with EPA guidance and approved analytical methods. Information in this table does not create EPA or Washington State Department of 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., specific conductance, pH, dissolved oxygen, temperature, and turbidity) are not listed because they are measured in the field.

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

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

EPA = U.S. Environmental Protection Agency

A3.4 Measurement Equipment

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

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

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

A3.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Appendix B.

A3.7 Inspection/Acceptance of Supplies and Consumables

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

A3.8 Nondirect Measurements

Data obtained from sources such as computer databases, programs, literature files, and historical records will be evaluated by staff 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

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- 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.
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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>.

303-110, “Sampling, Testing Methods, and Analyses”

303-400, “Interim Status Facility Standards”

Appendix B

Sampling Protocol

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Terms

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

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B1 Introduction

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

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

B2 Sampling Methods

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

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

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

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

Dissolved oxygen will also be measured in the field. Dissolved oxygen is not required to be stable prior to sample collection.

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

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

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

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

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

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

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

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

B2.1 Decontamination of Drilling and Sampling Equipment

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

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

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

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

Decontamination of sampling equipment and pumps is typically performed using high-purity water¹ in each step. In general, three rinse cycles are performed to decontaminate sampling equipment: detergent rinse, acid rinse, and water rinse. During the detergent rinse, equipment is washed in a phosphate-free detergent solution, followed by rinsing with water in three sequential containers. After the third water rinse, equipment that is stainless steel or glass is rinsed in a 1 M nitric acid solution (pH less than 2). Equipment is then rinsed with water in three sequential containers (the water rinses following the acid rinse are conducted in separate water containers that are not used for detergent rinse). Following the final water rinse, equipment is rinsed in hexane and then placed on a rack to dry. Dry equipment is loaded into a drying oven. The oven is set at approximately 50°C (122°F) for items that are not metal or glass or at approximately 100°C (212°F) for metal or glass. Once reaching temperature, equipment is baked for approximately 20 minutes and then cooled. Equipment is then removed from the oven and enclosed in clean, unused aluminum foil using surgical gloves. The wrapped equipment is stored in a custody-locked, controlled access area. Water-level measurement tapes (portion that came in contact with groundwater) are decontaminated using a high-purity water rinse and dried with disposable towels.

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

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

B2.2 Water Levels

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

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

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

B3 Documentation of Field Activities

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

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

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

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

B4 Calibration of Field Equipment

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

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

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

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

B5 Sample Handling

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

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

B5.1 Containers

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

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

B5.2 Container Labeling

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

B5.3 Sample Custody

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

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

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

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

B5.4 Sample Transportation

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

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

B6 Management of Waste

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

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

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

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

B7 References

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

Well Construction

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C1 Introduction

This appendix provides the following information for the existing Low-Level Burial Grounds (LLBG) Waste Management Area (WMA)-3 groundwater monitoring wells:

- Well name
- Hydrogeologic unit monitored (the aquifer portion at the well screen perforation) (Table C-1)
- The following sampling interval information, as provided in Table C-2:
 - Elevation at the top of the screen or perforated interval
 - Elevation at the bottom of the screen or perforated interval
 - Open interval length (i.e., difference between the top and bottom screen perforation elevations)
 - Drilling method

Figures C-1 through C-4 provide construction and completion summaries for the existing network wells.

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 LLBG WMA-3 Network

Well 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])	Drilling Method
299-W9-2	TU	135.9 (445.87)	125.2 (410.76)	10.7 (35.0)	Auger/cable tool
299-W10-29	TU	136.8 (448.8)	126.2 (414.0)	10.6 (34.8)*	Becker hammer
299-W10-30	TU	136.9 (449.1)	126.2 (414.0)	10.7 (35.1)*	Becker hammer
299-W10-31	TU	136.5 (447.83)	125.8 (412.73)	10.7 (35.0)	Becker hammer

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

*Due to rounding and conversion of metric units, the computed open interval length based on the top and bottom elevations may differ slightly from the actual open interval length reported in Figures C-1 through C-4.

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

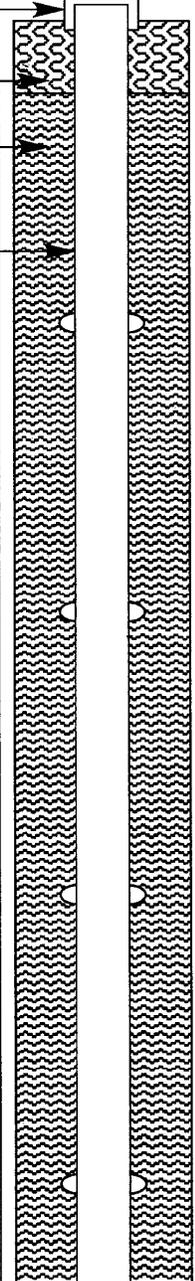
WELL SUMMARY SHEET		Start Date: 7/26/11	Page 1 of 2
		Finish Date: 9/22/11	
Well ID: C8201		Well Name: 299-W9-2	
Location: 350 meters NNW of WRAP Building		Project: 2 M-24 RCRA Groundwater Wells	
Prepared By: Patrick Cabbage	Date: 10/21/11	Reviewed By: <i>DC Weekes</i>	Date: <i>10/24/11</i>
Signature: <i>Patrick Cabbage</i>		Signature: <i>DC Weekes</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description/Groundwater Sample Depths (ft bgs)
Stainless Steel Protective Casing: 3.33 ft above ground surface		0	0-1 Gravel Drill Pad (G)
Type I/II Portland Cement Grout: 0 - 10.2 ft bgs			1-9 Sand (S)
#8 Granular Bentonite Crumbles: 10.2 - 277.1 ft bgs			9-20 Sandy Gravel (sG)
4-in I.D., Schedule 10, Type 304, Stainless Steel Permanent Casing: 2.35 ft ags - 284.69 ft bgs			20-33 Sand (S)
			33-50 Slightly Silty Sand ((m)S)
			50-62 Gravelly Sand (gS)
			62-65 Gravel (G)
			65-78 Silty Sandy Gravel (msG)
			78-85 Gravelly Sand (gS)
			85-120 Sand (S)
			120-130 Sand (S)
			130-140 Slightly Silty Gravelly Sand ((m)gS) with caliche
			140-152 Slightly Silty Sand ((m)S) with caliche
			152-164 Caliche
			164-183 Sand (S)
<p>All temporary drill casing was removed from the ground.</p> <p>All depths are in feet below ground surface.</p> <p>The borehole was drilled with 10 3/4-inch O.D. casing from 0.0 - 119.4 ft bgs and with 8 5/8-inch O.D. casing from 119.4 - 325.0 ft bgs.</p>			

Figure C-1. Well 299-W9-2 Construction and Completion Summary (1 of 2)

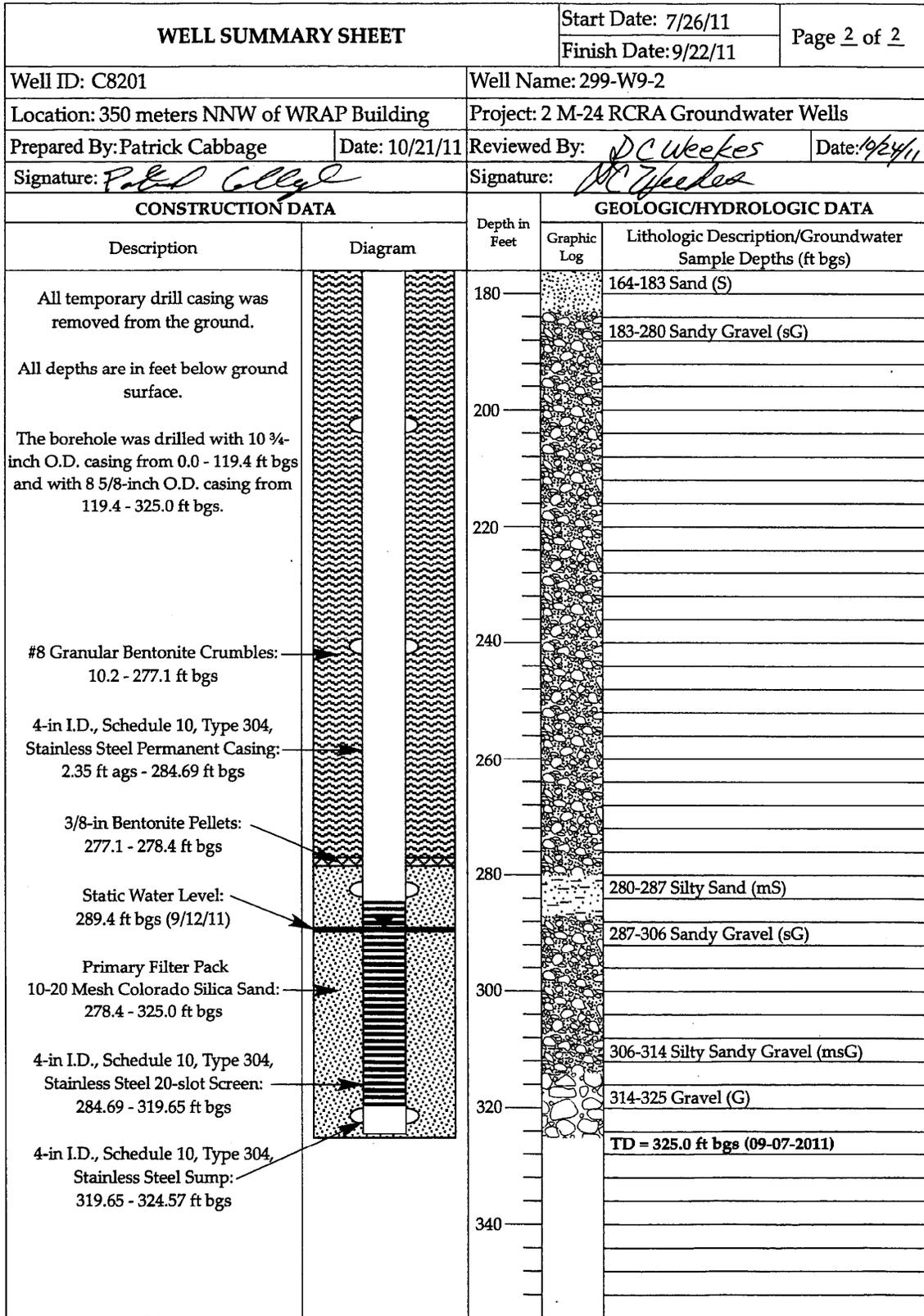


Figure C-1. Well 299-W9-2 Construction and Completion Summary (2 of 2)

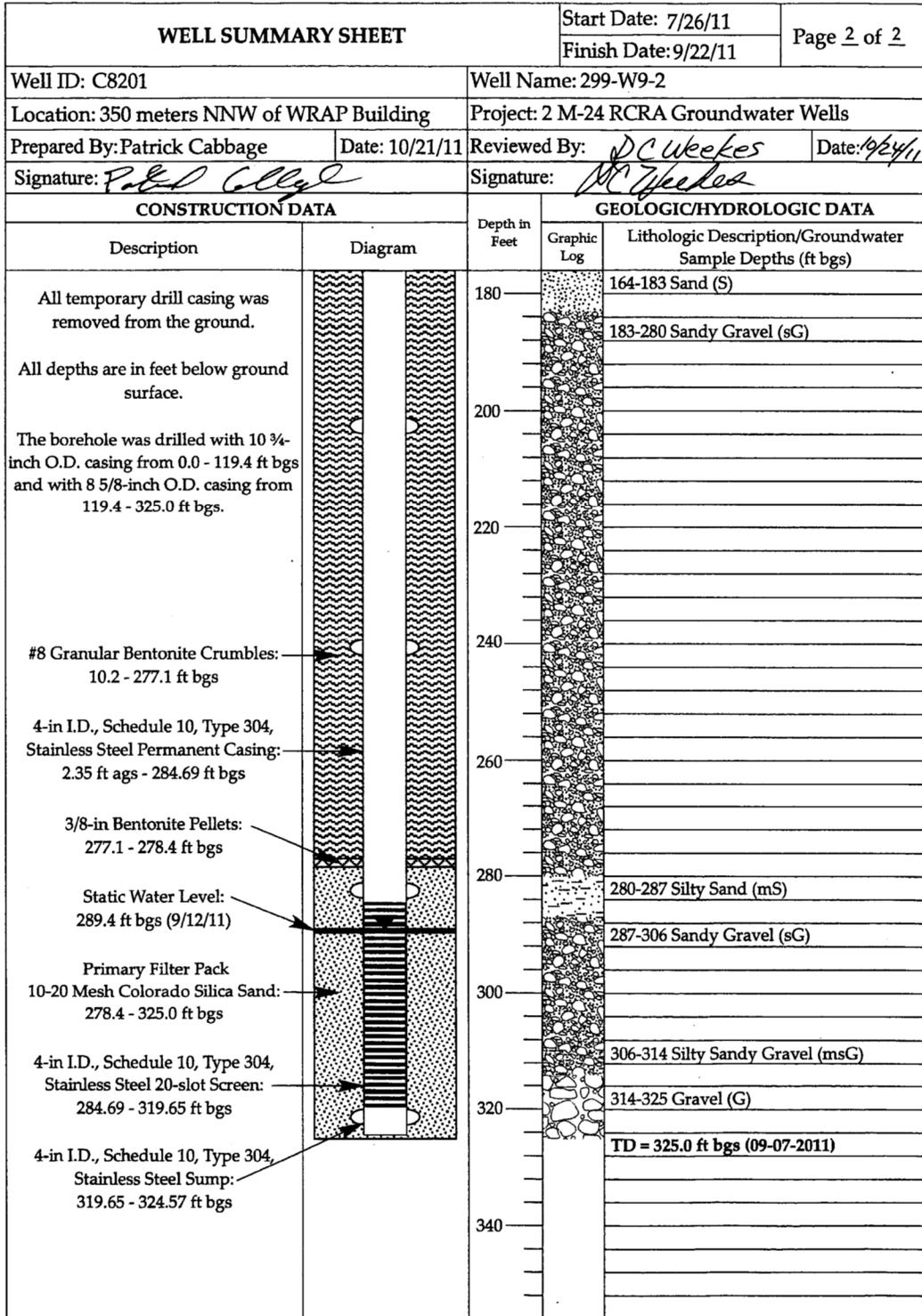


Figure C-2. Well 299-W10-29 Construction and Completion Summary (1 of 3)

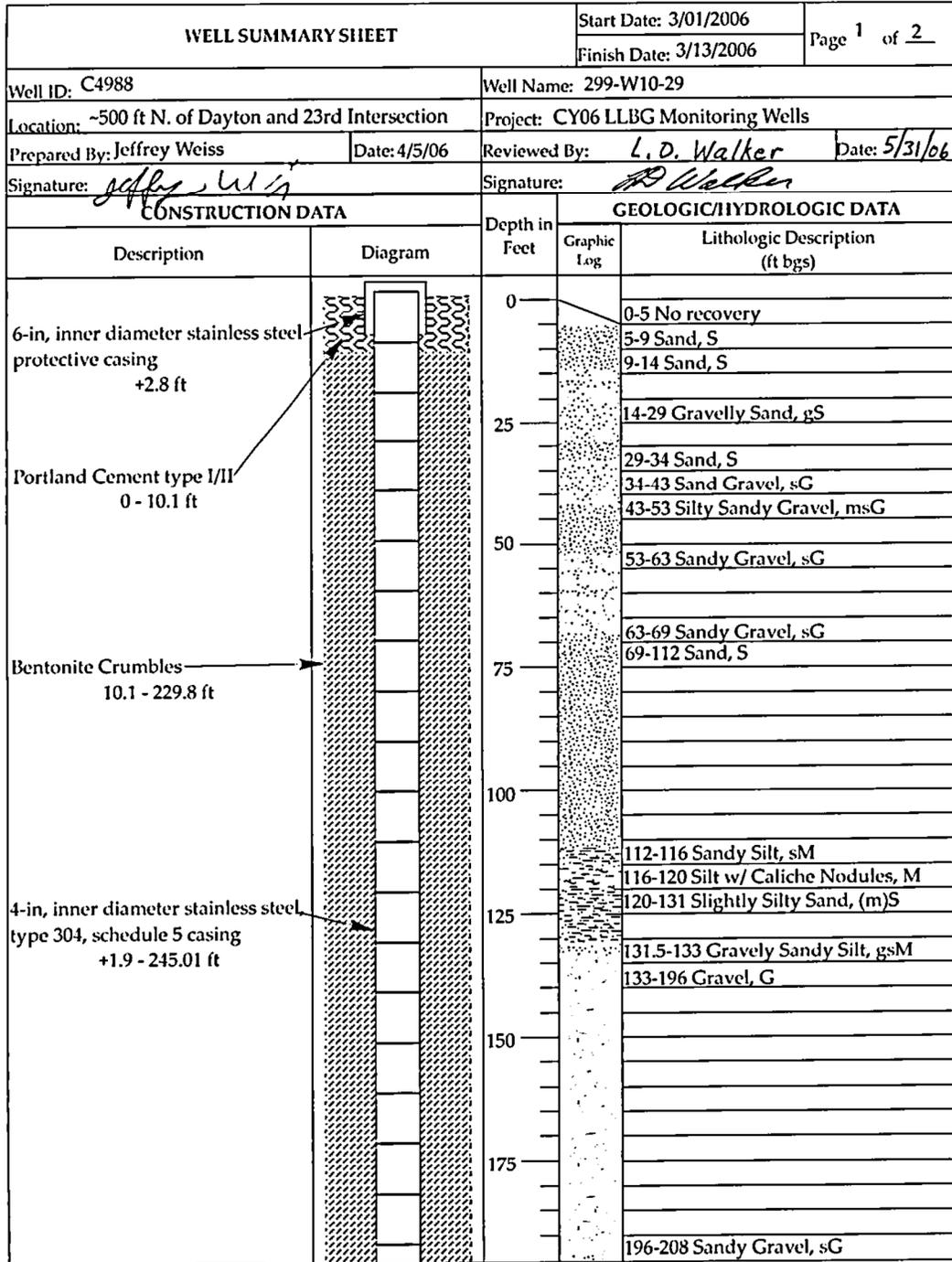


Figure C-2. Well 299-W10-29 Construction and Completion Summary (2 of 3)

WELL SUMMARY SHEET		Start Date: 3/01/2006		Page 2 of 2
		Finish Date: 3/13/2006		
Well ID: C4988		Well Name: 299-W10-29		
Location: ~500 N. of Dayton and 23rd Intersection		Project: CY06 LLBG Monitoring Wells		
Prepared By: Jeffrey Weiss	Date: 4/5/06	Reviewed By: L.D. Walker	Date: 5/31/06	
Signature: <i>Jeffrey Weiss</i>		Signature: <i>L.D. Walker</i>		
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
		200		196-208 Sandy Gravel, sG
				208-220 Gravel, G
		225		220-259 Sandy Gravel, sG
1/4-in coated bentonite pellets 229.8 - 234.9				
Static Water = 244.85 (3/9/06)				
		250		
10-20 mesh Colorado silica sand 234.9 - 287.2				
4-in, inner diameter stainless steel, type 304, 20 slot (0.02-in) screen 245.01 - 280.01				
		275		259-285 Gravelly Sand, gS
				285-287.2 Sand, S
		300		Total depth drilled = 287.2' bgs
		325		
		350		
		375		
All temporary casing removed from the ground				
All depths are in feet below ground				

Figure C-2. Well 299-W10-29 Construction and Completion Summary (3 of 3)

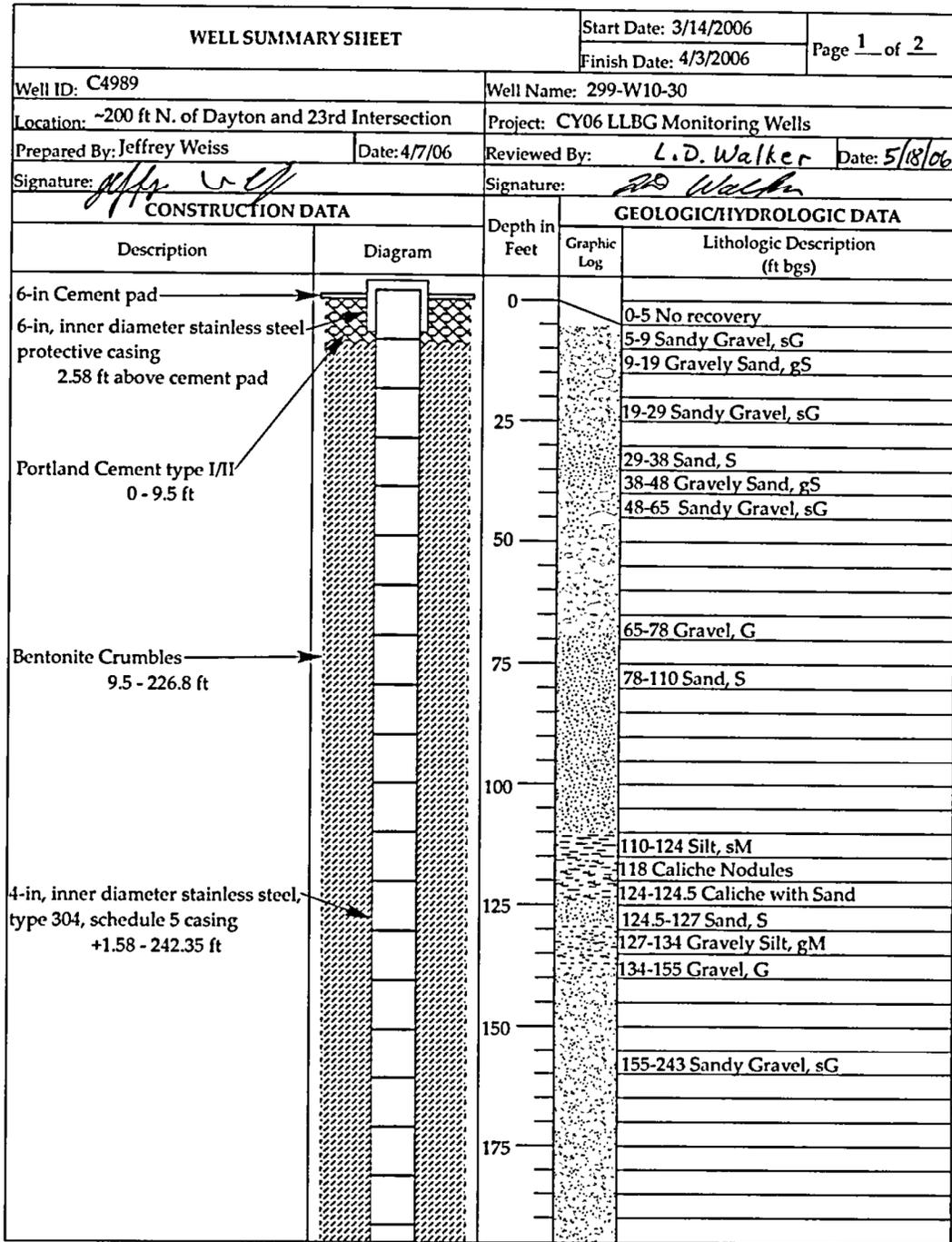


Figure C-3. Well 299-W10-30 Construction and Completion Summary (1 of 2)

WELL SUMMARY SHEET		Start Date: 3/14/2006	Page 2 of 2
Well ID: C4989		Well Name: 299-W10-30	
Location: ~200 N. of Dayton and 23rd Intersection		Project: CY06 LLBG Monitoring Wells	
Prepared By: Jeffrey Weiss	Date: 4/7/06	Reviewed By: L.D. Walker	Date: 5/18/06
Signature: <i>Jeffrey Weiss</i>		Signature: <i>L.D. Walker</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description (ft bgs)
1/4-in coated bentonite pellets 226.8-231.5		200	
Static Water = 243.02 (3/30/06)		225	
10-20 mesh Colorado silica sand 231.5 - 280.3		250	243-246 Gravelly Sand, gS 246-282 Sandy Gravel, sG
4-in, inner diameter stainless steel, type 304, 20 slot (0.02-in) screen 242.35 - 277.35		275	
4-in, inner diameter stainless steel, type 304, schedule 5 sump 277.35-280.34		300	282-283 Sand, S Total depth drilled = 283 ft
All temporary casing removed from the ground		325	
All depths are in feet below ground		350	
		375	

Figure C-3. Well 299-W10-30 Construction and Completion Summary (2 of 2)

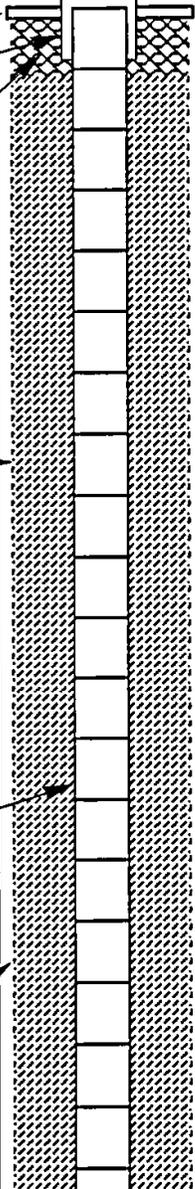
WELL SUMMARY SHEET		Start Date: 4/20/2006		Page <u>1</u> of <u>2</u>			
		Finish Date: 5/10/2006					
Well ID: C5194			Well Name: 299-W10-31				
Location: Approx. 560 ft E Dayton Ave., 790 N 23rd St.			Project: CY06 LLBG Monitoring Wells				
Prepared By: Jeffrey Weiss		Date: 5/10/06	Reviewed By: <i>L. D. Walker</i>		Date: <i>5/31/06</i>		
Signature: <i>John Houch for Jeff Weiss</i>			Signature: <i>L. D. Walker</i>				
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA					
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)			
6-in thick concrete pad		0		0-5 No Recovery			
6-in I.D. stainless steel protective casing - top of casing is 2.35 ft above pad				5-14 Gravely Sand, gS			
Concrete 0-3.0 ft					14-23 Sandy Gravel, sG		
Portland Cement 3.0 - 10.8 ft				25		23-35 Gravel, G	
						35-45 Sandy Gravel, sG	
				50		45-50 Gravel, G	
						50-72 Sandy Gravel, sG	
				75		72-80 Gravely Sand, gS	
Bentonite Crumbles 10.8 - 224.7 ft						80-95 Sand, S	
				100		95-105 Silty Sand, mS	
						101-103 Caliche	
						105-110 Gravely Sand, gS	
						110-121 Sand, S	
				125		121-130 Gravel, G	
4-in I.D. stainless steel, type 304, schedule 5 casing, flush threaded 1.45 ft above pad - 239.93 ft bgs						130-132 Gravely Sand, gS	
						132-133.5 Gravel, G, basalt boulder	
						133.5-142 Gravel, G	
						142-157 Sandy Gravel, sG	
				150		157-194 Gravel, G	
Nominal 9-in borehole diameter				175			

Figure C-4. Well 299-W10-31 Construction and Completion Summary (1 of 2)

WELL SUMMARY SHEET		Start Date: 4/20/2006	Page 2 of 2
Well ID: C5194		Finish Date: 5/10/2006	
Location: Approx. 560 ft E Dayton Ave., 790 N 23rd St.		Project: CY06 LLBG Monitoring Wells	
Prepared By: Jeffrey Weiss	Date: 5/10/06	Reviewed By: L.D. Walker	Date: 5/31/06
Signature: <i>John Houch for Jeff Weiss</i>		Signature: <i>L.D. Walker</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description (ft bgs)
		200	194-195 Boulder 195-273 Sandy Gravel, sG
1/4-in coated bentonite pellets 224.7 - 228.7		225	
Static water level = 239.95 (5/02/06)		250	
10-20 mesh Colorado silica sand 228.7 - 281.3 ^{LU 5-31-06} 279.8		275	273-279.8 (TD) Sandy GRAVEL, sG to Gravelly SAND, gS
4-in I.D. stainless steel, type 304, 20 slot (0.02-in) screen 239.93 - 275.01			Total depth drilled = 279.8 ft
4-in I.D. stainless steel, type 304, schedule 5 sump w/ plate bottom 275.01 - 278.01		300	
		325	
		350	
All temporary casing removed from the ground		375	
All depths are feet below ground surface			

Figure C-4. Well 299-W10-31 Construction and Completion Summary (2 of 2)

C2 Reference

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

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