1244041
[0071316H]

DOE/RL-2010-92
Revision 2

Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

RECEIVED
MAY 18 2017
EDMC

D-2-10, TS-2-6
Attached to: 1244040

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2010-92
Revision 2

Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2010-92
Revision 2

Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib

Date Published
April 2017

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
P.O. Box 550
Richland, Washington 99352

APPROVED
By Lana Perry at 6:58 am, Apr 12, 2017

Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Executive Summary

This document presents a revision to the 2011 groundwater monitoring plan[1] for the 216-A-37-1 Crib. This revised monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976*[2] (RCRA), and the implementing requirements in WAC 173-303-400,[3] which in turn specifies groundwater monitoring regulations under 40 CFR 265.[4]

The U.S. Department of Energy, Richland Operations Office is revising this groundwater monitoring plan due to the age of the plan and to ensure that the plan contains the most current Hanford Site groundwater monitoring information for the treatment, storage, and disposal (TSD) unit (revised well network and site-specific monitoring constituents). This indicator evaluation program groundwater monitoring plan is the principal controlling document for conducting groundwater monitoring at the 216-A-37-1 Crib.

Currently, the 216-A-37-1 Crib is an inactive interim status TSD unit, in the 200-EA-1 Soil Operable Unit (OU), which is located above the underlying 200-PO-1 Groundwater OU. The 216-A-37-1 Crib is located southeast of the 200 East Area perimeter fence and was used for percolation to the soil column of evaporator process condensate from the 242-A Evaporator. The 216-A-37-1 Crib began operation in March 1977 and received spent halogenated and non-halogenated solvents and ammonia. Discharge of the evaporator process condensate to the 216-A-37-1 Crib continued through April 1989 when the crib was removed from service.

In 1994, the bottom of the diversion box was filled with grout to physically preclude inadvertent discharges to the crib. In July of 2000, vent risers from the crib were sealed to prevent potential passive radioactive emissions. In April 2007, the remaining space in the

---

[1] DOE/RL-2010-92, 2011, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1106271470.

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

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

[4] 40 CFR 265, "Interim Status Standards for Owners and operators of hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=24aad4966ac52acbeba416c2c1114889&mc=true&node=pt40.26.265&rgn=div5.

diversion box was filled with gravel to eliminate any hazard associated with a subsurface void. Subsequently, no additional interim stabilization measures were required.

A groundwater quality assessment program in accordance with 40 CFR 265 was implemented in 1997. The groundwater quality assessment plan[5] combined the 216-A-10, 216-A-36B, and 216-A-37-1 Cribs based on their proximity, similarities in construction, waste history, and hydrogeologic regime. In 2010, a separate site-specific groundwater monitoring plan was developed for the 216-A-37-1 Crib[6] to monitor under the indicator evaluation program. Since monitoring for indicator parameters was initiated in 2010, statistical analyses of the parameters used as indicators of groundwater contamination have not shown an exceedance that resulted in the site entering into a groundwater quality assessment program. Thus, dangerous wastes from the 216-A-37-1 Crib subject to WAC 173-303-040[7] are not considered to have contaminated the groundwater beneath the 216-A-37-1 Crib. Therefore, the site remains under the indicator evaluation program described in 40 CFR 265.92.

This revised groundwater monitoring plan continues with the same detection monitoring requirements for indicator parameters and water quality constituents of the uppermost aquifer beneath the 216-A-37-1 Crib as the previous plan. This plan addresses the following:

- Number, locations, and depths of wells in the 216-A-37-1 Crib groundwater monitoring network
- Sampling and analytical methods of parameters required for groundwater contamination detection monitoring waste constituents
- Methods for evaluating groundwater quality information
- Schedule for groundwater monitoring at the 216-A-37-1 Crib

---

[5] PNNL-11523, 1997, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1662256.

[6] DOE/RL-2010-92, 2010, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1106170793.

[7] WAC 173-303-040, "Dangerous Waste Regulations," "Definitions," *Washington Administrative Code,* Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-040.

This revised plan uses the existing groundwater monitoring well network, as identified in the previous groundwater monitoring plan (DOE/RL-2010-92, Rev. 1), with the addition of a second upgradient monitoring well and an additional downgradient well. Groundwater flow direction determinations indicate that a southeast flow direction exists beneath the 216-A-37-1 Crib. Groundwater in the 216-A-37-1 Crib monitoring wells will be sampled and analyzed semiannually for the parameters used as indicators of groundwater contamination (pH, specific conductance, total organic carbon, and total organic halogen) and annually for parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) in accordance with 40 CFR 265.92(b)(2)&(3) and (d). For the two wells added to the monitoring network in this plan, sampling for indicator parameters, groundwater quality parameters, and drinking water suitability parameters included in Appendix III to 40 CFR 265 will be performed quarterly for 1 year.

Additional site-specific constituents will be sampled annually. These include nitrate, which is a degradation product of waste previously discharged to the crib, and supporting constituents (anions and metals) that will be used to support the evaluation of upgradient and downgradient water chemistry variations and identify any corrosion of well casings. Water-level measurements will be taken each time a sample is collected to satisfy 40 CFR 265.92(e).

This page intentionally left blank.

Contents

1 Introduction 1-1

2 Background 2-1

2.1 Facility Description and Operational History 2-1
2.2 Regulatory Basis 2-4
2.3 Waste Characteristics 2-5
2.4 Geology and Hydrogeology 2-7
2.4.1 Stratigraphy 2-7
2.4.2 Hydrogeology 2-13
2.4.3 Groundwater Flow Interpretation 2-13
2.5 Summary of Previous Groundwater Monitoring 2-16
2.6 Conceptual Site Model 2-26
2.7 Monitoring Objectives 2-29

3 Groundwater Monitoring Program 3-1

3.1 Constituents List and Sampling Frequency 3-1
3.1.1 Sample Schedule Impacts from Well Maintenance and Sampling Logistics 3-1
3.1.2 Well Biofouling and TOC Results 3-5
3.2 Monitoring Well Network 3-5
3.3 Differences between This Plan and Previous Plan 3-9
3.4 Sampling and Analysis Protocol 3-10

4 Data Evaluation and Reporting 4-1

4.1 Data Review 4-1
4.2 Statistical Evaluation 4-1
4.3 Interpretation 4-1
4.4 Annual Determination of Monitoring Network 4-2
4.5 Reporting and Notification 4-2

5 Outline for Groundwater Quality Assessment Plan 5-1

6 References 6-1

Appendices

A Quality Assurance Project Plan ..... A-i

B Sampling Protocals ..... B-i

C Well Construction ..... C-i

Figures

Figure 1-1. Location Map for the 216-A-37-1 Crib 1-3
Figure 2-1. Site Map for the 216-A-37-1 Crib and Surrounding Facilities 2-2
Figure 2-2. Construction Diagram for the 216-A-37-1 Crib 2-3
Figure 2-3. General Stratigraphy at the Hanford Site 2-9
Figure 2-4. Northwest-Southeast Geologic Cross Section Showing the Stratigraphy Below the 216-A-37-1 Crib 2-10
Figure 2-5. North-South Geologic Cross Section Showing the Stratigraphy Below the 216-A-37-1 Crib 2-11
Figure 2-6. Southwest-Northeast Geologic Cross Section Showing the Stratigraphy Underlying the 216-A-37-1 Crib 2-12
Figure 2-7. Average 2015 Water Table Surface, 200 East Area 2-14
Figure 2-8. 2014 Local Groundwater Flow Directions for the 200 East Area 2-15
Figure 2-9. Estimated Local Flow Direction and Monitoring Networks near the 216-A-37-1 Crib 2-17
Figure 2-10. Generalized Representation of High Hydraulic Conductivity Zone Associated With Hanford and Cold Creek Paleochannel Deposits 2-18
Figure 2-11. Distribution of Nitrate for 2014 in the Vicinity of the 216-A-37-1 Crib 2-21
Figure 2-12. Time Series Plot Showing Changes in Nitrate Concentrations in Upgradient and Downgradient Monitoring Wells 2-22
Figure 2-13. Time Series Plot Showing Changes in Sulfate Concentrations in Upgradient and Downgradient Monitoring Wells 2-23
Figure 2-14. Distribution of Sulfate for 2014 in the Vicinity of 216-A-37-1 Crib 2-24
Figure 2-15. Time Series Plot Showing Increasing Specific Conductance Values in Upgradient and Downgradient Monitoring Wells 2-25
Figure 2-16. General Representation of Hydrogeologic Characteristics Underlying the 216-A-37-1 Crib and Southeastern Portion of the 200 East Area 2-28
Figure 3-1. 216-A-37-1 Crib Monitoring Well Network 3-7

Tables

Table 2-1. Dangerous Waste Constituents Derived from the Hanford Facility RCRA Permit Application Part A Form Waste Codes for the 216-A-37-1 Crib 2-6
Table 2-2. Summary of Groundwater Monitoring Plans for the 216-A-37-1 Crib 2-19
Table 2-3. Pertinent Interim Status Facility Groundwater Monitoring Requirements 2-29
Table 2-4. Additional Monitoring Objectives 2-33
Table 3-1. Monitoring Well Network for the 216-A-37-1 Crib 3-2
Table 3-2. Constituents and Sampling Frequency for 1 Year of Monitoring at Wells Added to the 216-A-37-1 Crib Network 3-4
Table 3-3. Attributes for Wells in the 216-A-37-1 Crib Groundwater Monitoring Network 3-8
Table 3-4. Main Differences Between this Monitoring Plan and Previous Monitoring Plan 3-9
Table 5-1. Suggested Groundwater Quality Assessment Plan Outline 5-2

Terms

AEA	*Atomic Energy Act of 1954*
bgs	below ground surface
CCU	Cold Creek Unit
CCUg	Cold Creek Unit gravel
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CSM	conceptual site model
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
DST	double-shell tank
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FWS	Field Work Supervisor
HSU	hydrostratigraphic unit
NAD83	*North American Datum of 1983*
NAVD88	*North American Vertical Datum of 1988*
OU	operable unit
PUREX	Plutonium Uranium Extraction
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
TEDF	Treated Effluent Disposal Facility
TOC	total organic carbon
TOX	total organic halogen
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a)
TSD	treatment, storage, and disposal
VOC	volatile organic compound

This page intentionally left blank.

1 Introduction

This document presents a revised (Rev. 2) groundwater monitoring plan for the 216-A-37-1 Crib and supersedes the previous plan (DOE/RL-2010-92, Rev. 1, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*). The U.S. Department of Energy (DOE), Richland Operations Office (DOE-RL), is revising this groundwater monitoring plan due to the age of the plan and to ensure that the plan contains the most current Hanford Site groundwater monitoring information for the treatment, storage, and disposal (TSD) unit (revised well network and site-specific monitoring constituents). This groundwater monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA), with regulations promulgated by the Washington State Department of Ecology (Ecology) in the *Washington Administrative Code*, and the *Code of Federal Regulations* by reference (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"; 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring"). This plan is used to monitor the indicator parameters in groundwater samples that are used to determine whether dangerous waste or dangerous waste constituents have entered the groundwater. This plan is also used for monitoring the parameters used to establish groundwater quality.

The 216-A-37-1 Crib is an inactive interim status TSD unit designated as a landfill, as defined in WAC 173-303-040, "Definitions." In accordance with Section I.A of WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (hereafter referred to as the Hanford Facility RCRA Permit), the 216-A-37-1 Crib will continue to be considered an interim status unit until is it incorporated into Part III, V, and/or VI of the Hanford Facility RCRA Permit, or until interim status is terminated. Therefore, groundwater monitoring for 216-A-37-1 Crib continues under interim status requirements. This TSD unit received small quantities of spent halogenated and non-halogenated solvents as well as ammonia. For regulatory purposes, the TSD unit boundary of the 216-A-37-1 Crib is identified on the current Hanford Facility RCRA Permit Part A Form.

The 216-A-37-1 Crib is located in the 200-EA-1 Soil Operable Unit (OU), southeast of the 200 East Area perimeter fence (Figure 1-1). The crib is located above the underlying 200-PO-1 Groundwater OU. The crib was installed for percolation of 242-A Evaporator process condensate to the soil column. Operating records indicate that the 216-A-37-1 Crib began receiving process condensate from the 242-A Evaporator in March 1977. Discharge of the evaporator process condensate to the crib continued through April 1989, when the crib was removed from service.

The purpose of this groundwater monitoring plan is to present an updated groundwater monitoring program for the parameters used as indicators of groundwater contamination and groundwater quality from the 216-A-37-1 Crib, commonly referred to as an indicator evaluation program under interim status. This plan is required by 40 CFR 265.90(a) and (b), "Applicability," and is intended to satisfy groundwater monitoring requirements applicable to interim status TSD units that are not impacting groundwater, as required by WAC 173-303-400(3) and 40 CFR 265, Subpart F. This monitoring plan is the principal controlling document for conducting groundwater monitoring at the 216-A-37-1 Crib.

The previous 216-A-37-1 monitoring network consisted of one upgradient and three downgradient wells. In this revised plan, an additional upgradient monitoring well is added to the network. Two upgradient wells are needed to monitor the current spatial variability in upgradient constituent concentrations impacting the TSD unit. A fourth downgradient well is added to provide better coverage downgradient of the TSD unit. The indicator evaluation program detailed in this revised plan requires semiannual sampling for parameters used as indicators of groundwater contamination, as well as annual sampling for

parameters establishing groundwater quality for the two upgradient and four downgradient wells. Additional site-specific constituents will be collected annually, as well as supporting constituents including anions and metals that will be used to support the evaluation of upgradient and downgradient water chemistry variations. Water-level measurements are also required each time that a sample is collected to satisfy 40 CFR 265.92(e), "Sampling and Analysis."

This groundwater monitoring plan addresses the operational history, current hydrogeology, and conceptual site model (CSM) for the 216-A-37-1 Crib and incorporates knowledge about the potential for contamination originating from the crib and includes the following chapters and appendices;

- Chapter 2 summarizes background information and references other documents that contain more detailed information. It also describes the 216-A-37-1 Crib and the regulatory basis, types of waste present, the pertinent geology and hydrogeology beneath the 216-A-37-1 Crib, and it presents a brief history of groundwater monitoring. This information is summarized as a CSM to aid in development of the groundwater monitoring program.
- Chapter 3 describes the groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols.
- Chapter 4 describes data evaluation and reporting.
- Chapter 5 provides an updated outline for a groundwater quality assessment plan.
- Chapter 6 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.

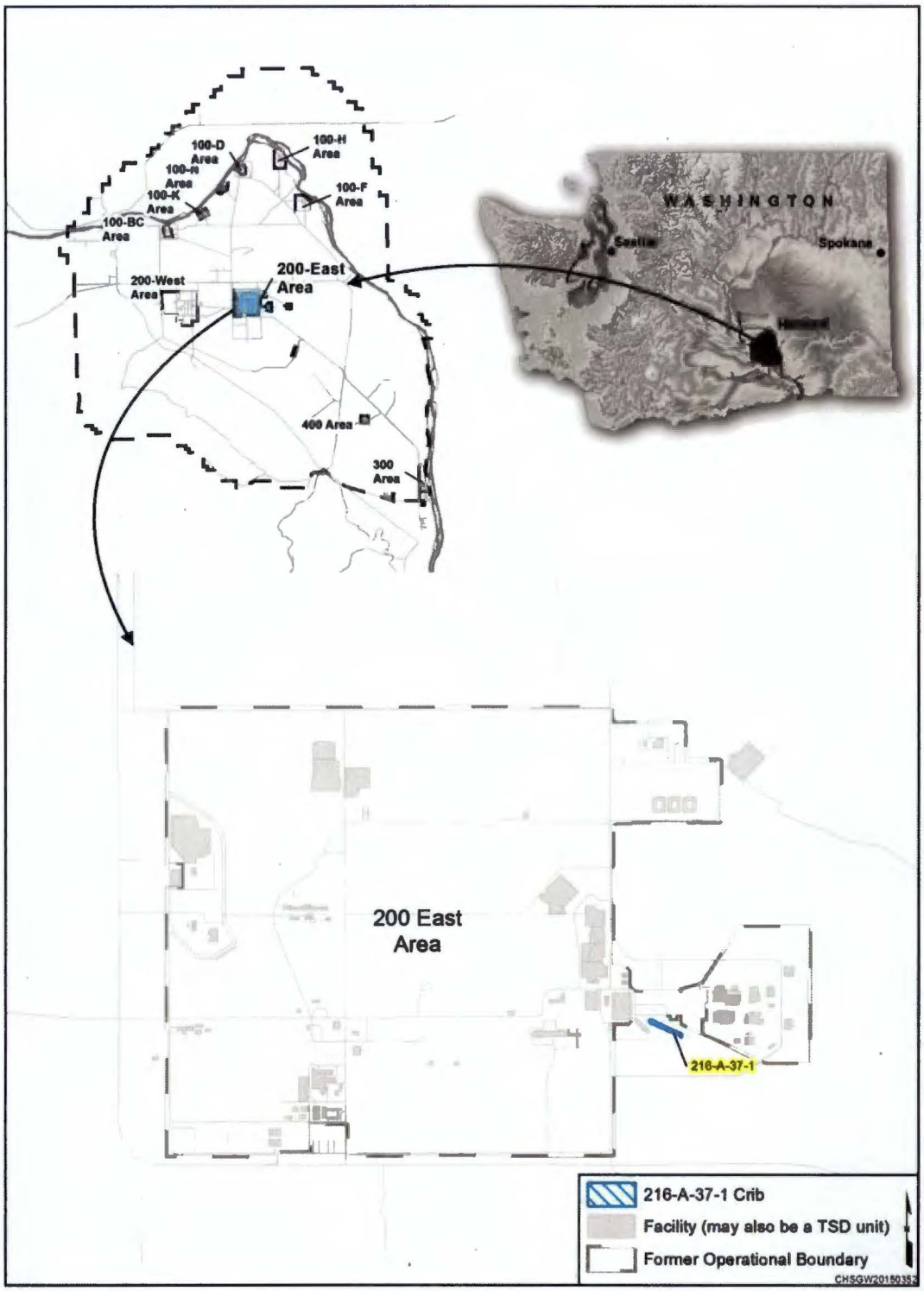


Figure 1-1. Location Map for the 216-A-37-1 Crib

This page intentionally left blank.

2 Background

This chapter describes the 216-A-37-1 Crib and its operating history, regulatory basis, wastes and waste characteristics associated with the 216-A-37-1 Crib, local subsurface geology and hydrogeology, a summary of previous groundwater monitoring, and the CSM for the 216-A-37-1 Crib.

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

- DOE/RL-93-88, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*
- DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*
- DOE/RL-2009-85, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*
- DOE/RL-2010-92, Rev. 0, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*
- DOE/RL-2010-92, Rev. 1, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*
- DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014*
- PNNL-11523, Rev. 0, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*
- PNNL-11523, Rev. 1, *Interim-Status RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- WHC-EP-0342, Addendum 15, *242-A Evaporator Process Condensate Stream-Specific Report*
- WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units*

2.1 Facility Description and Operational History

Constructed in 1976, the 216-A-37-1 Crib is located southeast of the 200 East Area perimeter fence (Figure 2-1). When actively receiving effluent, the crib was about 2.4 to 4.3 m (8 to 14 ft) deep. A 25.4 cm (10 in.) diameter perforated, galvanized steel distribution pipe was placed 2 m (7 ft) below grade, near the top of the coarse gravel fill along the centerline of the crib. Waste was pumped to the crib through waste transfer piping to the diversion box located outside of the south end of the crib, and then to the crib for disposal. At the crib, the transfer piping connected to the perforated distributor pipe that evenly distributed effluent waste over the length of the crib within a 1.5 m (5 ft) thick bed of course gravel. The piping inlet to the crib was at its southeast end, which is at a lower elevation than the northwest end. This configuration favored infiltration at the southeastern end of the crib (Figure 2-2).

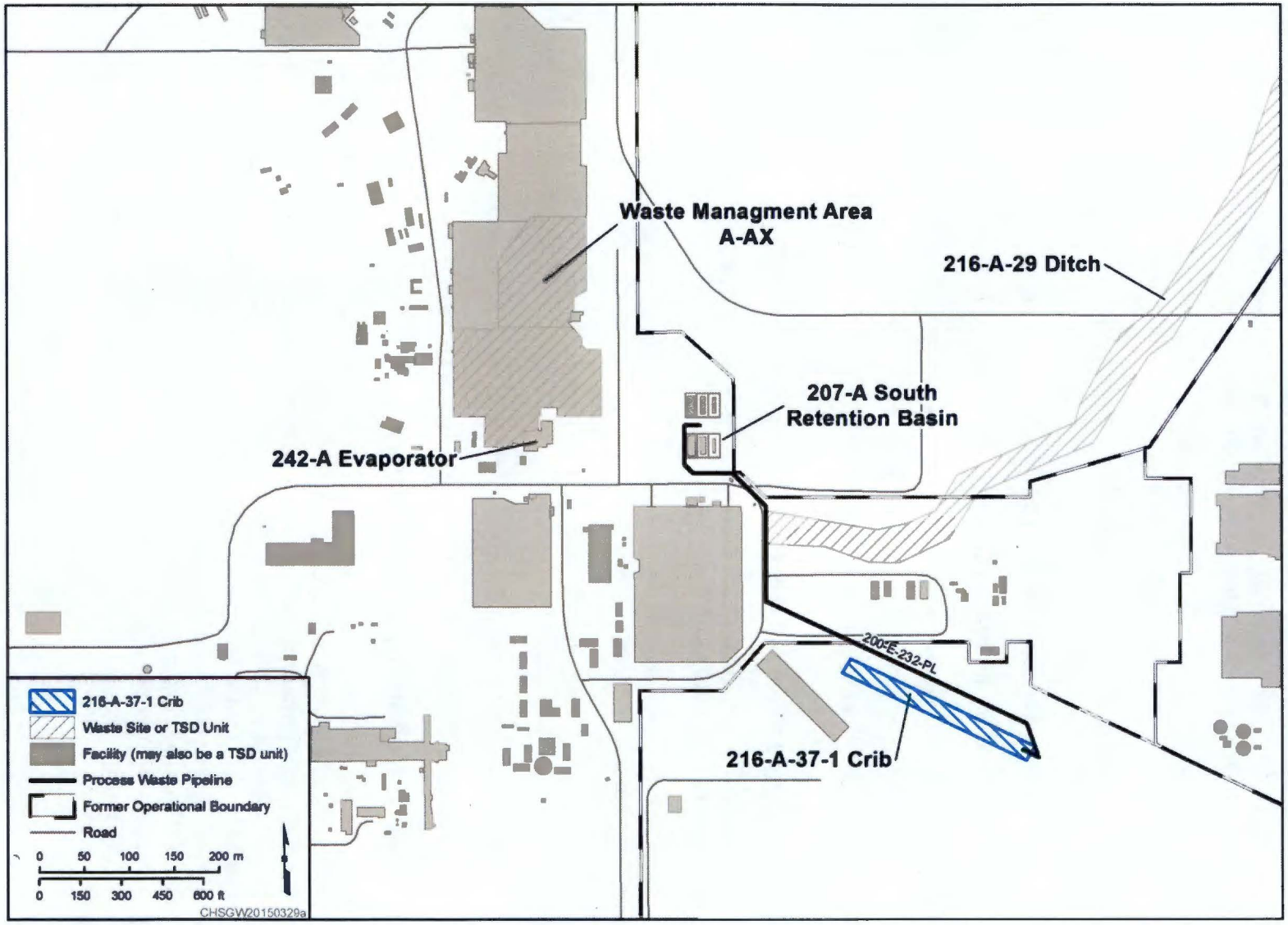


Figure 2-1. Site Map for the 216-A-37-1 Crib and Surrounding Facilities

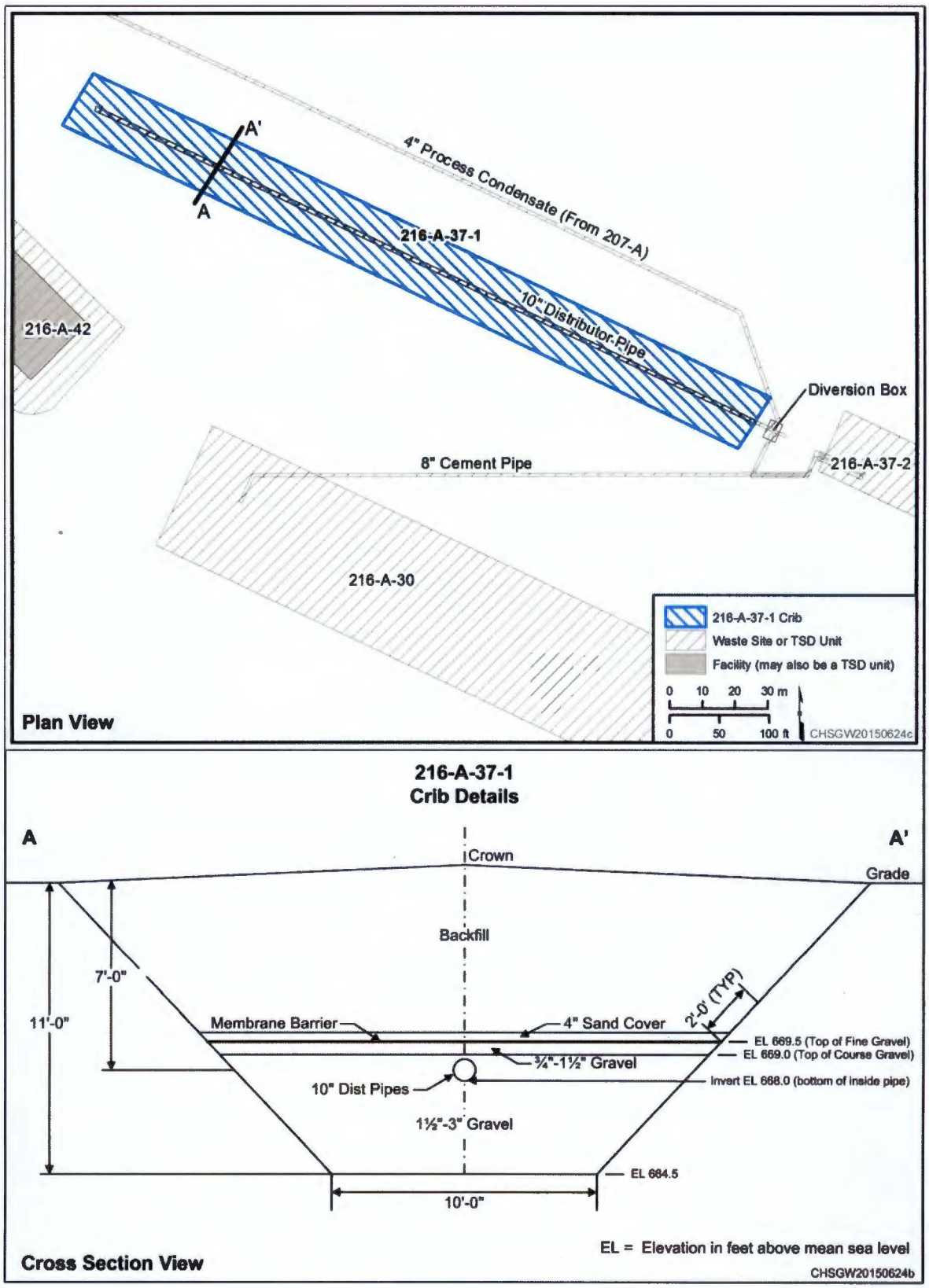


Figure 2-2. Construction Diagram for the 216-A-37-1 Crib

The 216-A-37-1 Crib began operation in March 1977 and was used for percolation of 242-A Evaporator process condensate to the soil column. All waste contributions to the 216-A-37-1 Crib originated from the 242-A Evaporator via the 207-A South Retention Basin. No waste treatment occurred at this TSD unit. The crib received waste water containing spent halogenated and non-halogenated solvents and ammonia.
The design capacity of the crib was estimated at 327,000 L/day (86,400 gal/day), based on the daily output of the evaporator. Discharge of the evaporator process condensate to the crib continued through April 1989, when the 216-A-37-1 Crib was removed from service. The diversion box was filled with grout to physically preclude inadvertent discharges to the 216-A-37-1 Crib. During its operational life, the 216-A-37-1 Crib received 380 million L (98 million gal) of process condensate from the 242-A Evaporator (DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*).

2.2 Regulatory Basis

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

In May 1989, DOE, the U.S. Environmental Protection Agency (EPA), and Ecology signed the Ecology et al., 1989a, *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 the 216-A-37-1 Crib. Groundwater monitoring is conducted at the 216-A-37-1 Crib in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F), which requires monitoring to determine whether the dangerous waste constituents from the TSD unit have entered the groundwater in the uppermost aquifer underlying the TSD unit.

Dangerous waste is regulated under RCW 70.105, "Hazardous Waste Management," and its 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). AEA states that these radionuclide materials are regulated at DOE facilities, exclusively by the DOE, acting pursuant to its AEA authority. Radionuclide materials are not hazardous/dangerous wastes and, therefore, are not subject to regulation by the state of Washington under RCRA or RCW 70.105.

The 216-A-37-1 Crib was monitored from July 1983 to June 1997 under the AEA (DOE/RL-2010-92, Rev. 1). The 216-A-37-1 Crib was one of several liquid effluent discharge sites that were initially excluded from the list of RCRA sites in the Tri-Party Agreement (Ecology et al., 1989). Under Tri-Party Agreement Milestones M-17-00A and M-17-00B, the excluded sites were the subject of a liquid effluent study to determine their environmental impact. As a result, the 216-A-37-1 Crib was monitored along with the non-RCRA active effluent discharge sites by the Operational Monitoring Program (DOE-RL-93-88). Some wells near the crib were also monitored as part of the 216-A-29 Ditch (Figure 2-1) RCRA groundwater assessment monitoring program. Listed wastes were identified in the effluent stream to the 216-A-37-1 Crib, as the result of effluent stream sampling performed between August 1985 and March 1989. The sampling results and waste designations were documented in 1990 in WHC-EP-0342, Addendum 15 (Appendix B and Chapter 5, respectively), thereby obligating the operator to monitor the site under RCRA regulations (Section 2.3 identifies wastes discharged to the 216-A-37-1 Crib).

Discharge to the crib was terminated in April 1989, and a RCRA Permit Application Part A Form was submitted for the site in February 1990. Subsequent investigations indicated the potential presence of chlorinated hydrocarbon solvents from facility operations, and a revised Part A Form was submitted in May 1993. The groundwater monitoring program for the 216-A-37-1 Crib, which included the 216-A-10 and 216-A-36B Cribs, was initiated in 1997 (PNNL-11523, Rev. 0), based on the interim status groundwater quality assessment monitoring requirements of 40 CFR 265(d)(3) and (d)(4) and WAC 173-303-400. The 1997 plan was designed as a groundwater quality assessment program due to elevated measurements of specific conductance in well 299-E17-9 at the 216-A-36B Crib. This combined monitoring approach was based on the proximity, similarities in construction, waste history, and hydrogeologic regime of the three cribs. The combined groundwater monitoring plan was revised in 2005 (PNNL-11523, Rev. 1). Radionuclides were removed from the plan because radionuclides are not monitored under RCRA (PNNL-11523, Rev. 1, Sections 1.1 and 1.2). Far-field wells were removed from the 216-A-37-1 monitoring network because they were primarily being used to monitor within and immediately outside of the tritium plume (PNNL-11523, Rev. 0, Table 5.1). These wells extended southeast from the 200 East Area to the Columbia River and were monitored under the 200-PO-1 OU *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) sampling and analysis plan DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*

In 2010, the 216-A-37-1 Crib was separated from the Plutonium Uranium Extraction (PUREX) Cribs combined groundwater monitoring plan and entered into an indicator parameter evaluation program in accordance with WAC 173-303-400(3), "Interim Status Facility Standards" (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 uppermost aquifer underlying the TSD unit. The 216-A-37-1 Crib returned to indicator parameter monitoring because specific conductance exceedances under the combined plan were attributed solely to the 216-A-36B Crib groundwater monitoring well (299-E17-9). In 2010, it was determined that 216-A-10 did not receive mixed waste after the effective date of the mixed waste rule in Washington State (August 19, 1987) and was no longer subject to regulation as a dangerous waste management unit. It was also determined that the distance between the 216-A-36B and 216-A-37-1 Cribs was great enough that different monitoring networks were appropriate for these two cribs. Therefore, a site specific groundwater monitoring plan (DOE/RL-2010-92, Rev. 0) was developed for the 216-A-37-1 Crib. The site-specific groundwater monitoring plan was updated in 2011 (DOE/RL-2010-92, Rev. 1) to include a section outlining the constituent list and sampling frequency for the first year of monitoring for well 299-E25-47. First year monitoring was performed to meet upgradient monitoring requirements not previously established.

2.3 Waste Characteristics

Discharges received from the 242-A Evaporator process condensate (Figure 2-1) consisted of waste water potentially contaminated with spent halogenated and non-halogenated solvents (waste codes F001 through F005) and ammonia (state only toxicity waste code WT02), as described in the Hanford Facility RCRA Permit Application Part A Form (WA7890009867) for the 216-A-37-1 Crib. Listed waste constituents of concern related to waste codes F001, F002, F003, F004, and F005 are described in WHC-MR-0517 and listed in Table 2-1.

Table 2-1. Dangerous Waste Constituents Derived from the Hanford Facility RCRA Permit Application Part A Form Waste Codes for the 216-A-37-1 Crib

Listed Constituent	CAS No.	Listed Waste Code*
Acetone	67-64-1	F003 (State Only)
Cresol–m	108-39-4	F004
Cresol–o	95-48-7	F004
Cresol–p	106-44-5	F004
Methylene Chloride	75-09-2	F002
Methyl Ethyl Ketone	78-93-3	F005
Methyl Isobutyl Ketone	108-10-1	F003 (State Only)
1,1,1-Trichloroethane	71-55-6	F001

Source: WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units.*
Note: Does not include state only toxicity waste codes (WT02/ammonia).
* Dangerous waste source codes are from WAC 173-303-9904, "Dangerous Sources List."
CAS = Chemical Abstracts Service

All waste contributions to the 216-A-37-1 Crib originated from the 242-A Evaporator. Prior to discharge to the crib, the waste passed through the 207-A South Retention Basin. Waste processed by the 242-A Evaporator is a mixed waste, as defined in WAC 173-303-040, that was received from the double-shell tank (DST) system. DST mixed waste is an aqueous solution containing dissolved cations and anions, sodium, potassium, aluminum, hydroxides, nitrates, nitrites, and a radioactive component. Slurry and process condensate are the two mixed waste streams generated at the 242-A Evaporator. The slurry is returned to the DST system. The process condensate is condensed vapor from the evaporation process. During crib operations, this condensate was transferred to the 207-A South Retention Basin for interim storage before it was disposed at the 216-A-37-1 Crib. The process design capacity of 327,000 L (86,400 gal) per day was based on the potential daily output of the 242-A Evaporator process condensate discharged to the crib via the 207-A South Retention Basin. Approximately 380 million L (98 million gal) of 242-A Evaporator process condensate containing trace quantities of chemicals and radionuclides are estimated to have been discharged to this crib (DOE/RL-98-28). The process condensate was mostly water containing small quantities of ammonia and inorganic constituents and trace quantities of volatile organics and radionuclides (WHC-EP-0342). Offgas from the process was routed through a de-entrainment unit, a pre-filter, and high-efficiency particulate air filters before being discharged to the environment. Constituents with vapor pressures substantially lower than water were likely not removed during the evaporation process and were returned as part of the concentrated slurry to the process system. Constituents with vapor pressures close to or higher than water were likely removed during the evaporation process and directed to the condensate filters and retention basin. The vapor pressure of water is 23.76 mm of mercury at 25°C (77°F) and the vapor pressures of cresol-m, -o, and -p are substantially lower than water. Therefore, these constituents were generally returned to the process system as part of the concentrated solution remaining after evaporation. The other constituents listed in Table 2-1 have vapor pressure near to or higher than water and were likely removed as an offgas during evaporation and treated by a de-entrainment unit and filters prior to being routed to the crib.

2.4 Geology and Hydrogeology

The geology and hydrogeology of the 200 East Area, including the region of the 216-A-37-1 Crib, are described in detail in the following documents:

- CP-57037, *Model Package Report Plateau to River Groundwater Transport Model Version 7.1*
- DOE/RL-2009-85, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*
- DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010* (Chapter 2, "Overview of Hanford Hydrogeology and Geochemistry")
- DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014*
- ECF-Hanford-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- SGW-54165, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*

2.4.1 Stratigraphy

The general stratigraphy at the Hanford Site is presented in Figure 2-3. Stratigraphic units underlying the 200 East Area within the vicinity of the 216-A-37-1 Crib include the following (listed in order from youngest to oldest) (Section 3.4 in DOE/RL-2009-85):

- A discontinuous veneer of Holocene eolian silty sand or backfill mixtures of sand and gravel.
- Hanford formation – cataclysmic flood deposits equivalent to hydrostratigraphic unit (HSU) 1. The Hanford formation consists of three facies subunits (silt-dominated, sand-dominated, and gravel-dominated) that grade into one another both vertically and laterally (Figure 2-3). On the central plateau, the Hanford formation is sometimes further delineated into H1, H2, and H3 lithostratigraphic sequences. The H1 and H3 gravel sequences are not differentiated in those areas where the intervening sandy H2 sequence is absent. Units H1 and H3 consist of coarse-grained, basalt-rich, sandy gravels with varying amounts of silt/clay. These gravel units may also contain interbedded sand and or silt/clay lenses. The H2 sequence is dominated by sand to gravelly sand, with minor sandy gravel or silt/clay interbeds. Both the sand-dominated H2 and gravel-dominated H3 sequences are present near the 216-A-37-1 Crib.
- Cold Creek unit (CCU) – equivalent to HSUs 2 and 3. The CCU is often undifferentiated but has been subdivided regionally into three subunits which include the Cold Creek unit Z (Early Palouse Soil) and unit C (caliche), both of which are primarily located in 200 West Area, and unit G (pre-Missoula gravels), which is primarily located beneath 200 East Area and vicinity. In much of the 200 East Area, the CCU is characterized as a quartzo-feldspathic sandy gravel (unit G) above the Ringold Formation and below the more basaltic Hanford formation (PNNL-16407, *Geology of the Waste Treatment Plant Seismic Boreholes*; Sections 3.4 and 5.4 in RPP-23748, *Geology, Hydrogeology, and Mineralogy Data Package for the Single-Shell Tank Farm Waste Management Area at Hanford*; Section 3.4 in DOE/RL-2009-85; Section 2.2.6 in RPP-14430, *Subsurface Conditions Description of the C and A-AX Waste Management Area*; Section 2.4.1 in DOE/RL-2015-49, *Interim Status Groundwater Quality Assessment Plan for the Single Shell Waste Management Area A-AX*).

The Cold Creek unit Z is associated with fluvial overbank to eolian deposits, which can have variable thickness (PNNL-19277, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*; Section 3.1 in PNNL-16407).

- Ringold Formation unit E – equivalent to HSU 5. Fluvial deposits with thick layers of silty sandy gravel (conglomerate), intercalated with thinner beds of overbank silts and fine-grained paleosols. In the 200 East Area, HSU 5 is present only in the southern portion because, to the north, it has been removed by erosion or was not deposited.

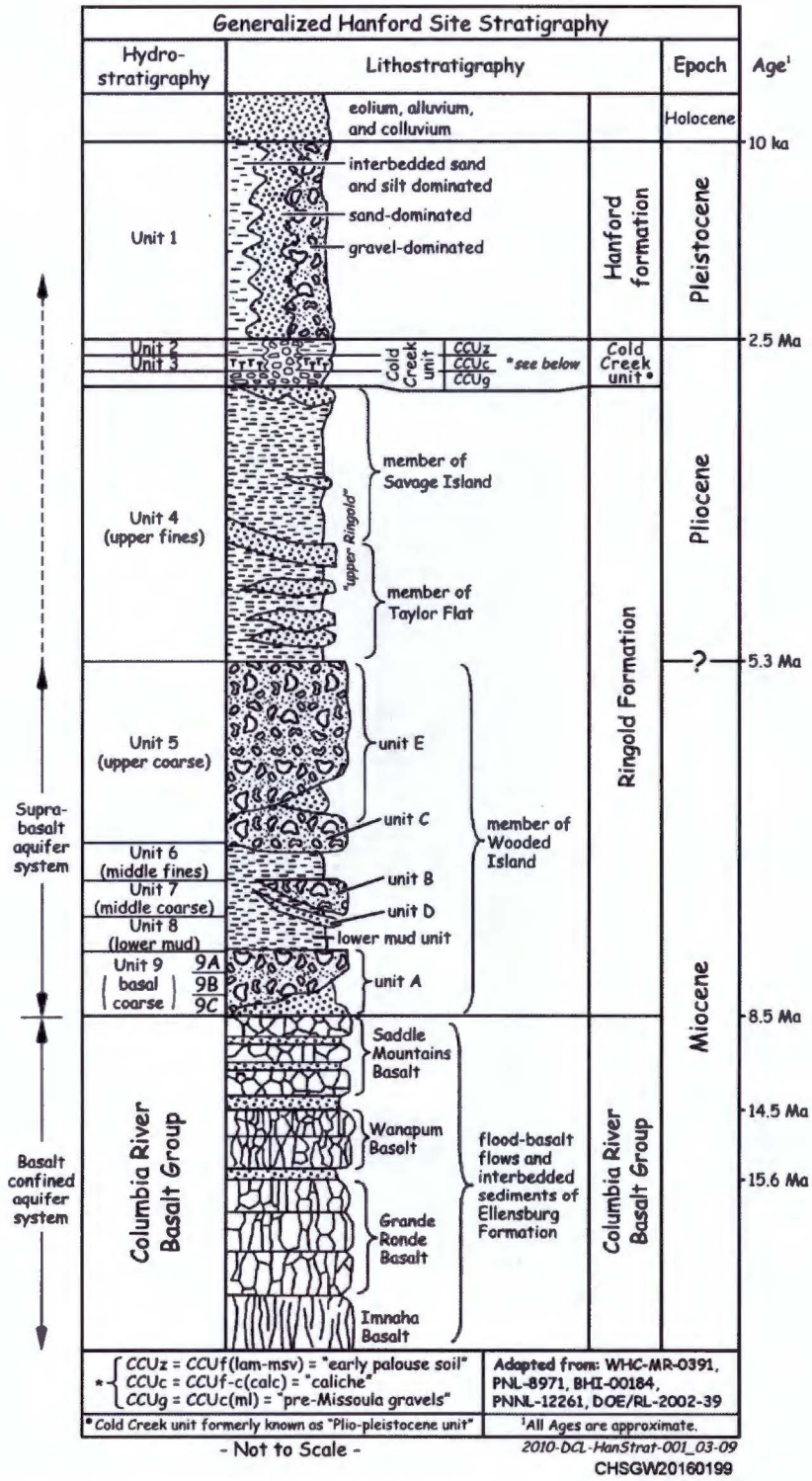
- Ringold Formation, lower mud unit – equivalent to HSU 8. This unit is composed of a sequence of fluvial overbank, paleosol, and lacustrine silt and clay, with minor sand and gravel. This unit may locally create confining conditions, and isolate the Ringold Formation unit E from the underlying Ringold Formation unit A when all units are present and laterally continuous. Based on available geologic data (Figures 2-4, 2-5, and 2-6), the Ringold Formation lower mud does not create confining conditions directly underlying the 216-A-37-1 Crib.

- Ringold Formation unit A – equivalent to HSU 9. Unit 9 can be further subdivided into three hydrostratigraphic units based on markedly different lithologies and hydraulic properties. The primary subunit is characterized as a silt to clay-rich confining zone with lower permeability, classified as unit 9B. Subunits 9A and 9C have much higher permeabliities and lower clay content and consist of consolidated silty sandy gravel deposits.

- Bedrock consisting of Columbia River Basalt flows dip gently to the south toward the axis of the Cold Creek syncline. The two uppermost flows are within the Elephant Mountain Member of the Saddle Mountains Basalt.

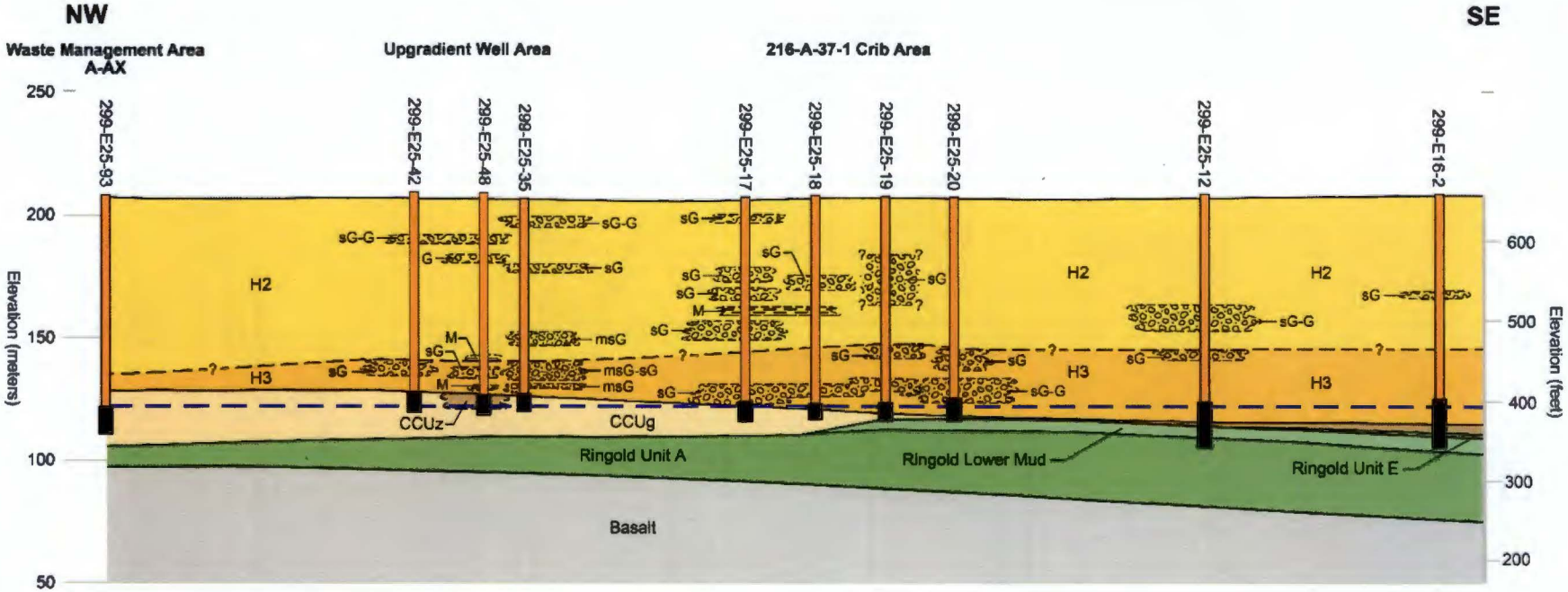
Geologic cross sections which include selected wells in the southern portion of the 200 East Area present the approximate stratigraphy underlying and adjacent to the 216-A-37-1 Crib (Figures 2-4, 2-5, and 2-6). Geologic contacts associated with the wells presented in the cross-sections are based on the contacts defined in Table A-2 of Attachment A within ECF-Hanford-13-0029. Definition of the stratigraphic units and contacts shown in each cross-section is consistent with the most current, integrated understanding of the subsurface geologic framework beneath the 200 East Area. In some cases, geologic contacts and stratigraphy from adjacent areas where data is available is projected to surrounding areas where data is less complete, utilizing the Leapfrog Hydro® geologic three-dimensional software (ECF-Hanford-13-0029). The resulting geologic representation of the subsurface can be examined using the cross-section generation tool provided in the web-based version of DOE/RL-2015-07. As indicated in each figure legend, geologic information associated with a well is projected to the cross-section within a buffer zone extending 75 m (246 ft) from either side of the cross-section line, resulting in approximate depths for stratigraphic contacts.

® Leapfrog Hydro is a registered trademark of ARANZ Geo Limited, Christchurch, New Zealand.



Note: Complete reference citations are provided in Chapter 6.

Figure 2-3. General Stratigraphy at the Hanford Site



Legend

- Hanford Sand-Dominated Sequence (H2) – Sand to Gravelly Sand
- Hanford Gravel-Dominated Sequence (H3) – Sandy Gravel to Gravel
- Cold Creek Unit Silt (CCUz)
- Cold Creek Unit Gravel (CCUg)
- Ringold Unit E
- Ringold Lower Mud
- Ringold Unit A
- Basalt
- Well
- Well Screen Interval
- 2014 Water Table (120.8 m AMSL)

Localized Lithology

- Silt (M)
- Slightly Silty Sandy Gravel (msG) or Silty Sandy Gravel to Sandy Gravel (msG-sG)
- Sandy Gravel (sG) or Sandy Gravel to Gravel (sG-G)

Notes: 10x vertical exaggeration.

AMSL = Above Mean Sea Level

CHSGW20150341 v11

Map Legend

- Well Location
- 216-A-37-1 Crib
- Waste Site or TSD Unit
- Facility (may also be a TSD unit)
- Cross Section Line
- Cross Section Line Buffer (75 m) *
- Roads

* Wells projected to cross-section within 75 m on either side of line

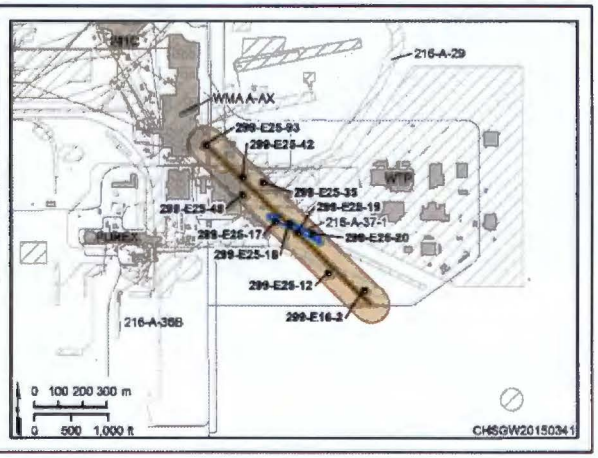


Figure 2-4. Northwest-Southeast Geologic Cross Section Showing the Stratigraphy Below the 216-A-37-1 Crib

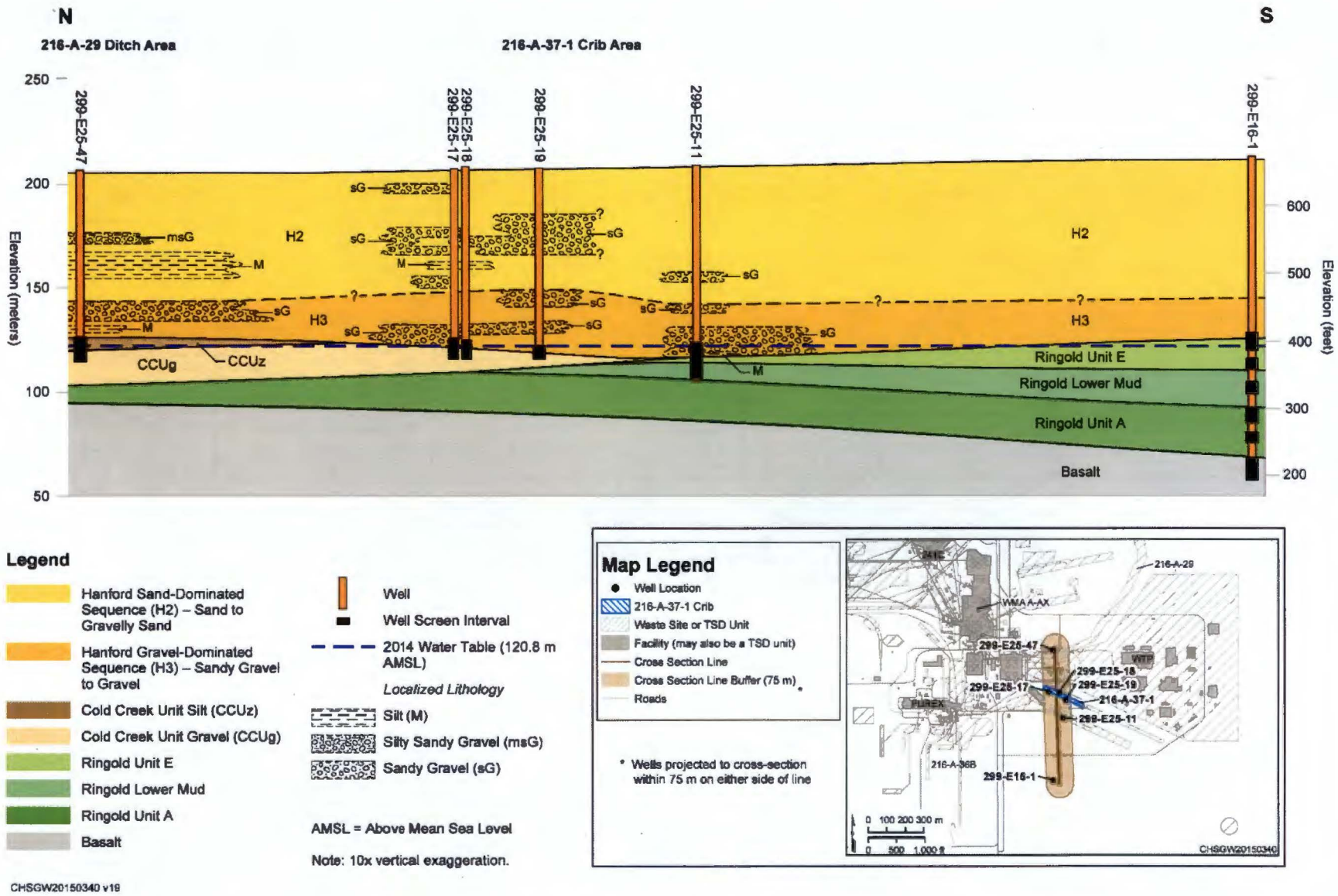


Figure 2-5. North-South Geologic Cross Section Showing the Stratigraphy Below the 216-A-37-1 Crib

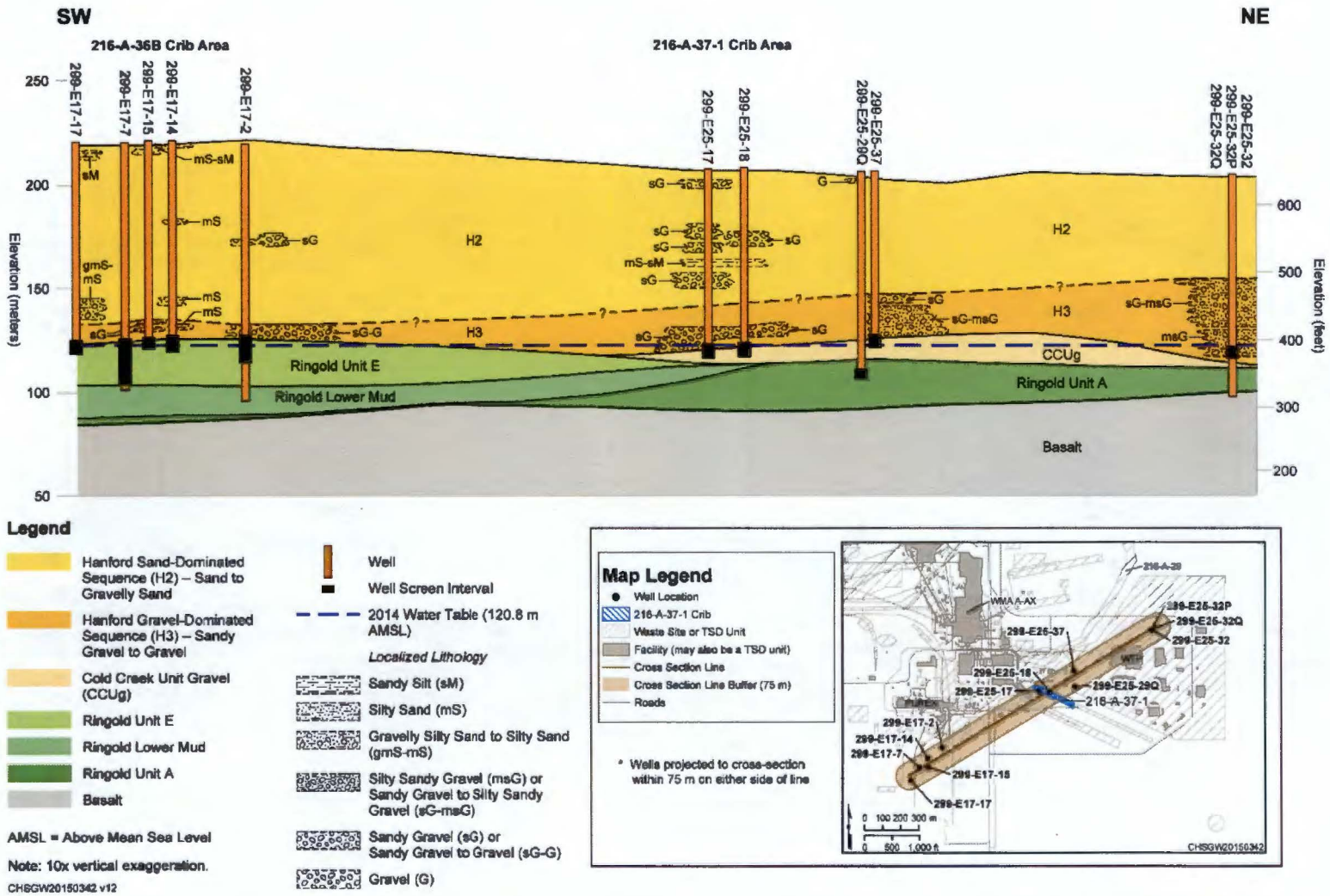


Figure 2-6. Southwest-Northeast Geologic Cross Section Showing the Stratigraphy Underlying the 216-A-37-1 Crib

2.4.2 Hydrogeology

The water table occurs within the lower Hanford formation gravel sequence (H3) or Cold Creek unit gravel (CCUg) underlying the crib. The uppermost aquifer underlying the 216-A-37-1 Crib extends from the water table surface within the Hanford formation H3 gravel sequence or Cold Creek Unit (depending on the specific location), through the Ringold Unit A (where no Ringold lower mud is present) to the top of the basalt surface (Figures 2-4, 2-5, and 2-6). The thickness of the unconfined aquifer below the 216-A-37-1 Crib ranges from 25 to 31 m (82 to 102 ft). The 216-A-37-1 Crib overlies a sequence of Hanford formation and CCU sediments that locally incised and removed the Ringold Formation unit E (HSU 5) and the Ringold Formation lower mud (HSU 8) (Figures 2-3 through 2-6). As a result, the overlying CCU lies unconformably on the Ringold Formation unit A (HSU 9) or the Ringold Formation lower mud (HSU 8) near the crib. Sediments comprising the Hanford formation and CCU have a relatively high hydraulic conductivity compared to the underlying Ringold Formation. Based on recent groundwater flow and transport modelling iterations for the 200-PO-1 OU, the calibrated average hydraulic conductivity for the Hanford formation gravel-dominated facies (H3) and CCU, where channelized flow occurs, is estimated to be approximately 17,000 m/day (55,777 ft/day) and 2.27 to 109 m/day (7.45 to 357.6 ft/day) in those areas without channelized flow where older sediment occurs (CP-57037). The calibrated average hydraulic conductivity for the Ringold Unit A is estimated to be approximately 5 m/d (16.4 ft/d) (DOE/RL-2009-85-ADD1, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit Addendum 1*, Table 3-3; CP-57037, Table 3-1). Additional information on hydraulic conductivities for geologic units in the 200 East Area is provided in Section 3.1 and Table 3.1 of PNNL-12261, Table 3-3 in DOE/RL-2009-85-ADD1, and Table 3-1 in CP-57037). Hydraulic conductivity of the sand and gravel-dominated sequence in Hanford formation and the pre-Missoula gravel deposits (i.e. CCU) generally ranges from 1 to 1,000,000 m/d and is much higher than any of the other units that compose the unconfined aquifer. Flow velocities in the uppermost aquifer below the 216-A-37-1 Crib have been estimated to range from 0.0036 to 0.6 m/d (0.012 to 1.97 ft/d) (DOE/RL-2015-07, Table B-1). Due to high hydraulic conductivity, the water table in the area where the crib is located is flat with an extremely low gradient (Figure 2-7) (SGW-54165, Section 2.2 and SGW-58828, *Water Table Maps for the Hanford Site 200 East Area, 2013 and 2014*, Section 2.2). The current water table elevation is 121.80 m (399.6 ft) above mean sea level (Figure 2-7) and occurs within the Hanford formation or CCU in the vicinity of the 216-A-37-1 Crib (Figures 2-4, 2-5, and 2-6).

2.4.3 Groundwater Flow Interpretation

Historically, water levels in the unconfined aquifer increased as much as 5.5 m (18 ft) above the pre-Hanford natural water table level near the PUREX Cribs (i.e., 216-A-10, 216-A-36B, and 216-A-37-1). This increase was the result of artificial recharge from liquid waste disposal operations (e.g., PUREX Cribs and B Pond) between the mid-1940s and 1997. The pre-Hanford groundwater flow was to the east and southeast in the southeastern portion of the 200 East Area. While the 216-B-3 Pond (B Pond consisting of 216-B-3-1, 216-B-3, 216-B-3A, 216-B-3B, and 216-B-3C) was in operation, artificial recharge created a significant groundwater mound, resulting in a radial flow pattern around B Pond that impeded flow towards the east and redirecting it to the southwest. As discharges to B Pond ceased, the mound at B Pond subsided, and groundwater flow directions in the southeastern portion of the 200 East Area and vicinity of the 216-A-37-1 Crib began to change. Currently, the unconfined aquifer in the 200 East Area has a very low hydraulic gradient, making it difficult to determine groundwater flow direction. The hydraulic gradient of the water table in the area around the 216-A-37-1 Crib is calculated to be 2.0×10^{-5} meters per meter (DOE/RL-2015-07) (Figure 2-7). Estimated flow directions in different portions of the 200 East Area have been determined through statistical analysis of water levels obtained from wells comprising the low gradient monitoring well network in conjunction with tracking contaminant plume movements (Figure 2-8).

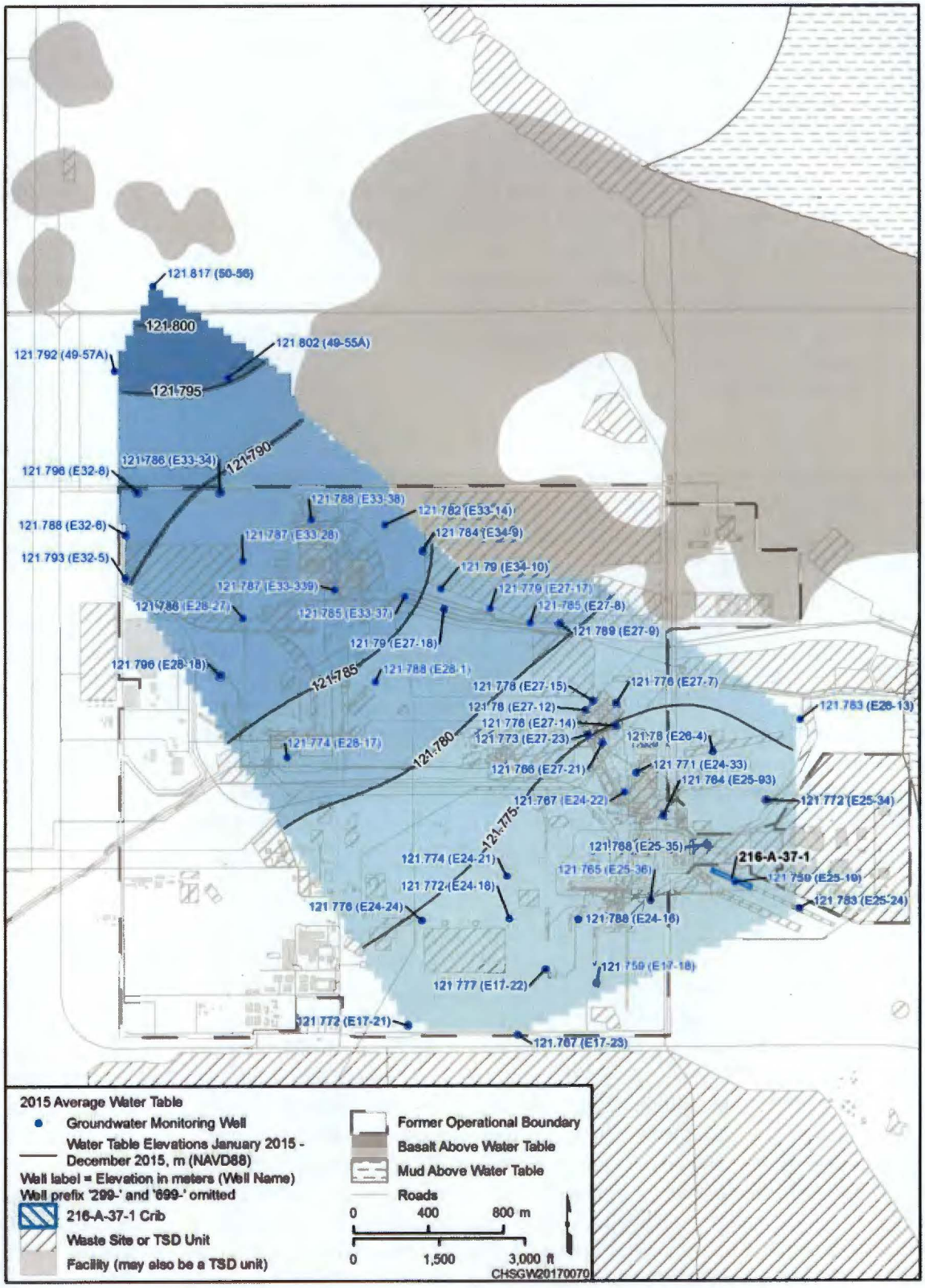
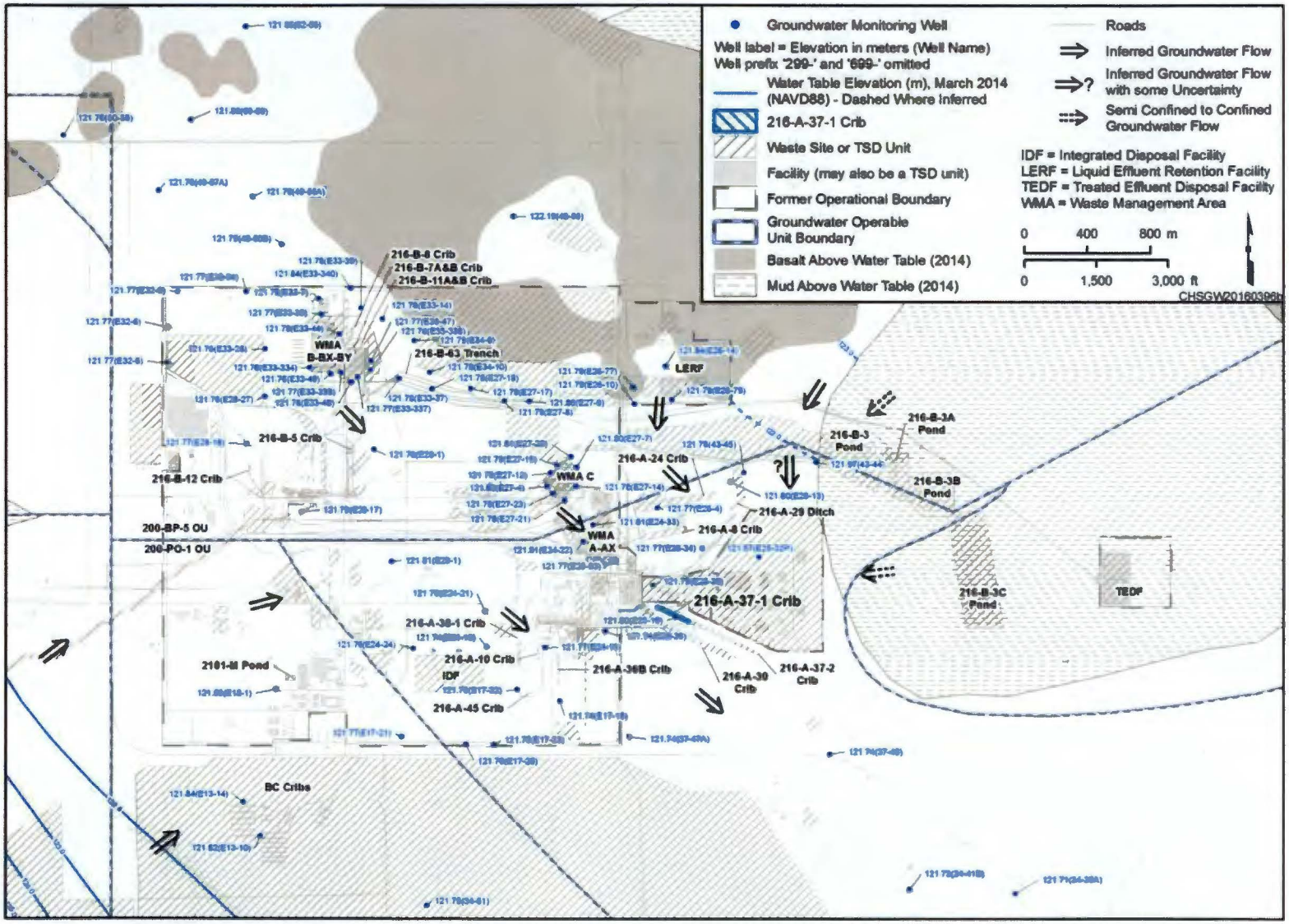


Figure 2-7. Average 2015 Water Table Surface, 200 East Area



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

Figure 2-8. 2014 Local Groundwater Flow Directions for the 200 East Area

In 2015, the local groundwater flow direction near the 216-A-37-1 Crib was interpreted to be southeast, based on measurements from the adjacent 216-A-29 low gradient monitoring network (Figure 2-9). Water table elevations and local flow directions occasionally show temporary changes due to discharges from the 200 East Area Treated Effluent Disposal Facility (TEDF) and possibly from elevated Columbia River water level (SGW-54165, Section 2.2 and SGW-58828, Section 2.2). The configuration of the 200 East Area water table at any given time results from the interaction of the river stage and stressors related to discharges to the TEDF, located east of 200 East Area. Discharges to TEDF are variable. The water table in 200 East Area responds to Columbia River stage changes via the high-transmissivity paleochannel that originates to the north, near 100-BC Area and extends through the eastern portion of the 200 East Area (Figure 2-10). Since 2011, discharges to the TEDF have not been substantial enough to cause a change in groundwater flow direction in 200 East, and flow has continued toward the southeast. The main effect of the TEDF discharges is to reduce the hydraulic gradient toward the southeast.

2.5 Summary of Previous Groundwater Monitoring

Groundwater monitoring was initiated at the 216-A-37-1 Crib in 1983 under AEA. The 216-A-37-1 Crib was monitored from July 1983 to June 1997 under the Hanford operational groundwater monitoring and the Hanford surveillance monitoring programs. Monitoring specification associated with the site have evolved since 1983 in response to implementation of RCRA monitoring requirements, recognition of changing groundwater flow directions, and evaluation of groundwater monitoring results.

Elevated concentrations of groundwater contaminants resulting in high specific conductance discovered during Hanford operational groundwater monitoring programs at the PUREX Cribs (well 299-E17-9 located at the 216-A-36B Crib) provided the basis for requiring groundwater quality assessment monitoring (WAC 173-303-400 and, by reference, 40 CFR 265.93(d)(3) and (d)(4), "Preparation, Evaluation, and Response"). In 1997, monitoring of the 216-A-37-1 Crib was initiated in conjunction with the 216-A-36B and 216-A-10 Cribs through an 11 well near-field monitoring network designated as part of groundwater quality assessment monitoring program (PNNL-11523, Rev. 0). The 216-A-37-1 Crib monitoring network included one upgradient (299-E25-31) and three downgradient wells (299-E25-17, 299-E25-19, and 699-37-47A) in the vicinity of the TSD unit (PNNL-11523, Rev. 0) (Figure 2-9). Wells designated as part of the 1997 monitoring network were retained in a revision to the PNNL-11523 (Rev. 0) monitoring plan published in 2005 (PNNL-11523, Rev. 1).

Based on sampling results collected under the 2005 groundwater monitoring plan, the 216-A-37-1 Crib was determined to be responsible for nitrate groundwater contamination and associated elevated specific conductance. Nitrate is not a dangerous waste constituent listed in Appendix 5 of WAC 173-303-080, "Dangerous Waste Lists," and 173-303-100, "Dangerous Waste Criteria" (Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*). Therefore, an indicator evaluation program (WAC 173-303-400(3), incorporating 40 CFR 265.92 through 265.93(b)(3)), was determined to be the appropriate program for the 216-A-37-1 Crib. In 2010, PNNL-11523 (Rev. 1) was replaced by DOE/RL-2010-92 (Rev. 0), which was a site-specific monitoring plan for the 216-A-37-1 Crib. At that time, two separate monitoring well networks were considered appropriate for the remaining cribs (216-A-36B and 216-A-37-1). In 2011, DOE/RL-2010-92 (Rev. 0) was revised to include the sampling frequency and constituent list for the first year of monitoring. The well network remained unchanged in DOE/RL-2010-92 (Rev. 1). Table 2-2 provides a summary of groundwater monitoring plans of the 216-A-37-1 Crib.

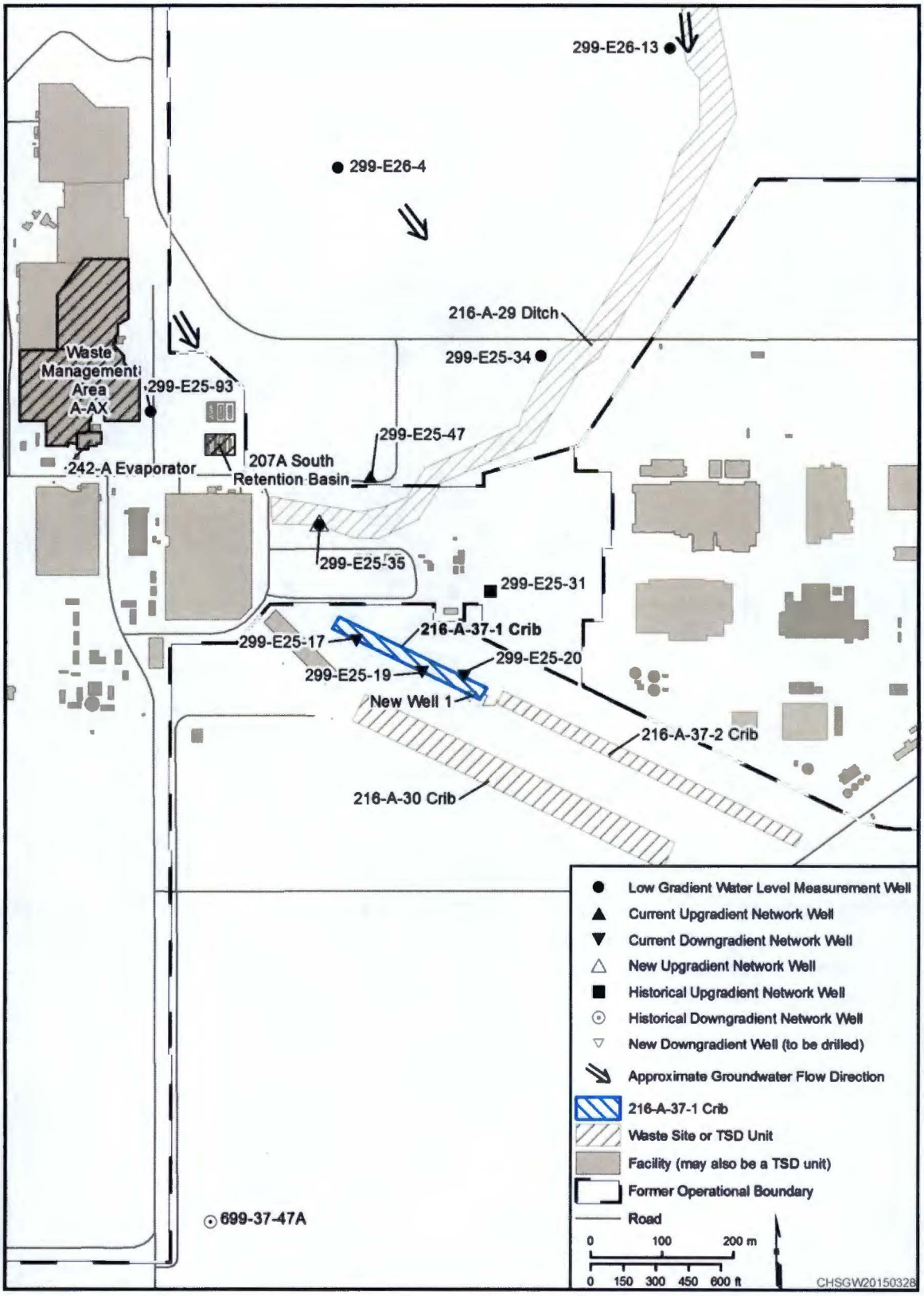


Figure 2-9. Estimated Local Flow Direction and Monitoring Networks near the 216-A-37-1 Crib

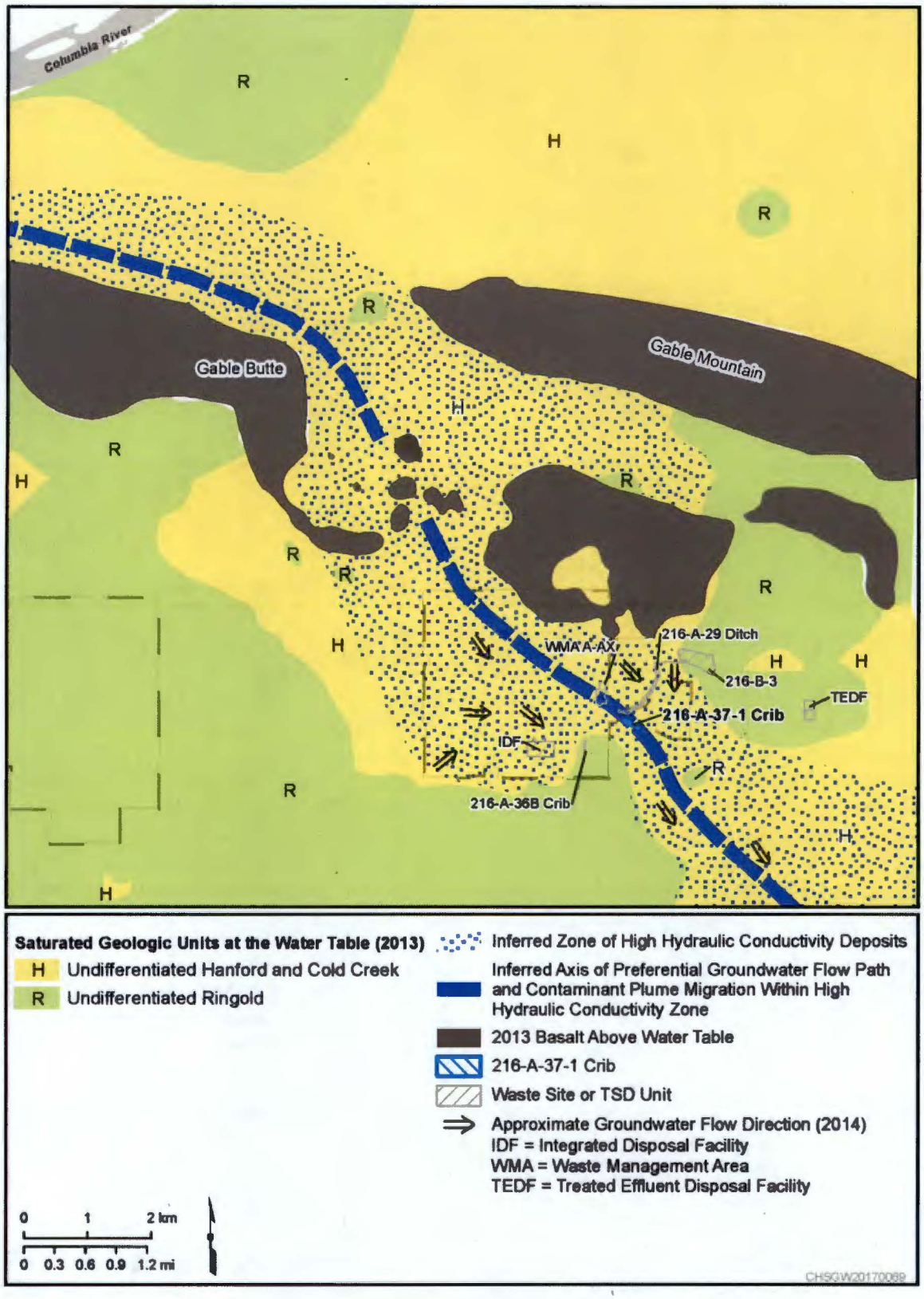


Figure 2-10. Generalized Representation of High Hydraulic Conductivity Zone Associated With Hanford and Cold Creek Paleochannel Deposits

Table 2-2. Summary of Groundwater Monitoring Plans for the 216-A-37-1 Crib

Document	Date Issued	Monitoring Program*	Summary
PNNL-11523, Rev. 0	June 1997	Groundwater Quality Assessment	Groundwater quality assessment program was developed due to elevated specific conductance in a well monitoring the 216-A-36B Crib. Monitoring for the 216 A 10, 216-A-36B, and 216-A-37-1 Cribs was combined into one groundwater assessment plan.
PNNL-11523, Rev. 1	July 2005	Groundwater Quality Assessment	Updated the monitoring well network and site-specific constituents.
DOE/RL-2010-92, Rev. 0	October 2010	Indicator Evaluation Program	Site-specific indicator evaluation program was initiated for the 216-A-37-1 Crib.
DOE/RL-2010-92, Rev. 1	June 2011	Indicator Evaluation Program	Updated the constituent list and sampling frequency for monitoring during the first year.

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

While the 216-B-3 Pond (B Pond) was in operation, the groundwater flow direction was in a radial pattern from the pond. Cessation of wastewater discharge to B Pond led to changes to the local groundwater flow direction in the vicinity of the 216-A-37-1 Crib, from west to south. From 1997 until 2005, well 299-E25-31, located northeast of the crib, monitored upgradient conditions when flow was toward the west (Figure 2-9). The location of well 299-E25-31 was appropriate as an upgradient well for the 216-A-37-1 Crib at that time because it was located between the pond and the crib.

Prior to 1997, AEA monitoring conducted for the PUREX Cribs detected ammonia (ammonium ion). Ammonium ion (more recently ammonia) was analyzed in groundwater samples through 2006, but analyses for this constituent were discontinued due to infrequent detections. Detected results ranged from the method detection limit (approximately 7 µg/L) to 850 µg/L. Similarly, volatile organic compounds (VOCs) were analyzed in groundwater samples collected from 1987 to 1994 for the PUREX Cribs (216-A-10, 216-A-37-1, and 216-A-36B) but were discontinued because VOCs were not detected. Throughout much of that time period, however, the method detection limit was 5 µg/L. Since that period, lower detection limits (e.g., 1 µg/L) were utilized for analysis of VOCs.

Since 1996, other constituents have been detected (e.g., zinc, chromium, arsenic, and vanadium). Detections for zinc and chromium occur intermittently; zinc has shown low concentration level trending, and chromium levels have been below the drinking water standard (DWS). Arsenic concentrations have been at background levels (the 95 percent confidence level is 11.8 µg/L [DOE/RL-96-61]).

In 2005, in response to changing flow directions, well 299-E25-31 was no longer considered suitable as an upgradient well for the monitoring network and was replaced by well 299-E25-47 (which is compliant with WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells").

Well 299-E25-47 is north of the 216-A-37-1 Crib and provided better representation of upgradient groundwater (Figure 2-9). This well is located near the 216-A-29 Ditch and has been sampled since 1992 in conjunction with the CERCLA monitoring program. Another well change occurred in 2010 as part of the monitoring network revisions presented in DOE/RL-2010-92 (Rev. 0); well 699-37-47A was removed as a downgradient well, and existing well 299-E25-20, which had been sampled since 1980, was added to provide coverage for the southeastern end of the crib (Figure 2-9). In 1987, sampling for metals, anions, VOCs, semivolatile organic compounds, total organic carbon (TOC), and total organic halogen (TOX) began at well 299-E25-20.

Monitoring conducted between 1995 and 2014 identified a continued presence of nitrate below the 216-A-37-1 Crib at concentrations exceeding the 10 mg/L DWS for nitrogen in nitrate (equivalent to 45 mg/L nitrate). Currently, a nitrate plume occurs beneath the southeastern portion of the crib (Figure 2-11). Plume delineation underlying the waste site is based on a nitrate concentration above the DWS. Nitrate concentrations have gradually been increasing, with the highest levels generally being associated with well 299-E25-20, located at the southeastern end of the crib (Figures 2-9 and 2-12). Concentrations above the DWS have not historically been observed in upgradient wells. The ongoing presence of a nitrate at the 216-A-37-1 Crib indicates that the crib is a probable source of nitrate contamination. West of the 216-A-37-1 Crib, a more extensive nitrate plume across the western portion of the 200 East Area in the vicinity of the 216-A-10 and 216-A-36B Cribs (Figure 2-11), extends into the 200-BP-5 Groundwater OU, located north of the 200-PO-1 Groundwater OU. Nitrate plumes in the 200 East area are monitored under CERCLA by the well networks associated with the 200-PO-1 and 200-BP-5 Groundwater OUs (Figure 2-11).

Increasing sulfate concentrations have been noted in the downgradient network wells since 1996. Downgradient well 299-E25-17 has shown the greatest rate of increase and the highest sulfate concentrations (Figures 2-9 and 2-13). The increasing sulfate values observed in the network wells are consistent with recent mapping of sulfate levels in the 200 East Area (Figure 2-14). Encroachment of the sulfate plume is also shown by rising specific conductance values observed in upgradient well 299-E25-35 (Figure 2-15). This well will be utilized in the revised monitoring network presented in this plan (see Chapter 3) to reflect upgradient conditions impacting the 216-A-37-1 Crib. Some of the higher concentration regions of the sulfate plume are migrating toward the 216-A-37-1 Crib, as seen in the rising specific conductance values measured in well 299-E25-17 (Figure 2-15). Specific conductance has also been increasing in upgradient wells 299-E25-47 and 299-E25-35, as it has for other wells along the 216-A-29 Ditch and 216-A-37-1 Crib. Increasing concentration trending of nitrate and sulfate correlates with the increasing specific conductance values measured in network wells.

Based on results from the groundwater quality assessment, an indicator evaluation monitoring program (as described in 40 CFR 265.92) was reinstated at the 216-A-37-1 Crib per 40 CFR 264.93(d)(6) in 2010. During the first year of the indicator parameter monitoring program, the primary objective of monitoring was to establish initial background concentrations in accordance with 40 CFR 265.92(c)(1) and (2) for well 299-E25-47. Well 299-E25-47 (upgradient) was sampled quarterly for the indicator parameters (pH, specific conductance, total organic carbon, and total organic halogen) and groundwater quality parameters (chloride, iron, manganese, phenols, sodium, and sulfate), and semiannually for VOCs, because it did not have sufficient data for indicator parameter monitoring and had little background data. In the established downgradient wells, indicator parameters and VOCs were analyzed semiannually, and groundwater quality parameters and alkalinity were analyzed annually. The field parameters (temperature, turbidity, and water level) were collected every time the wells were sampled.

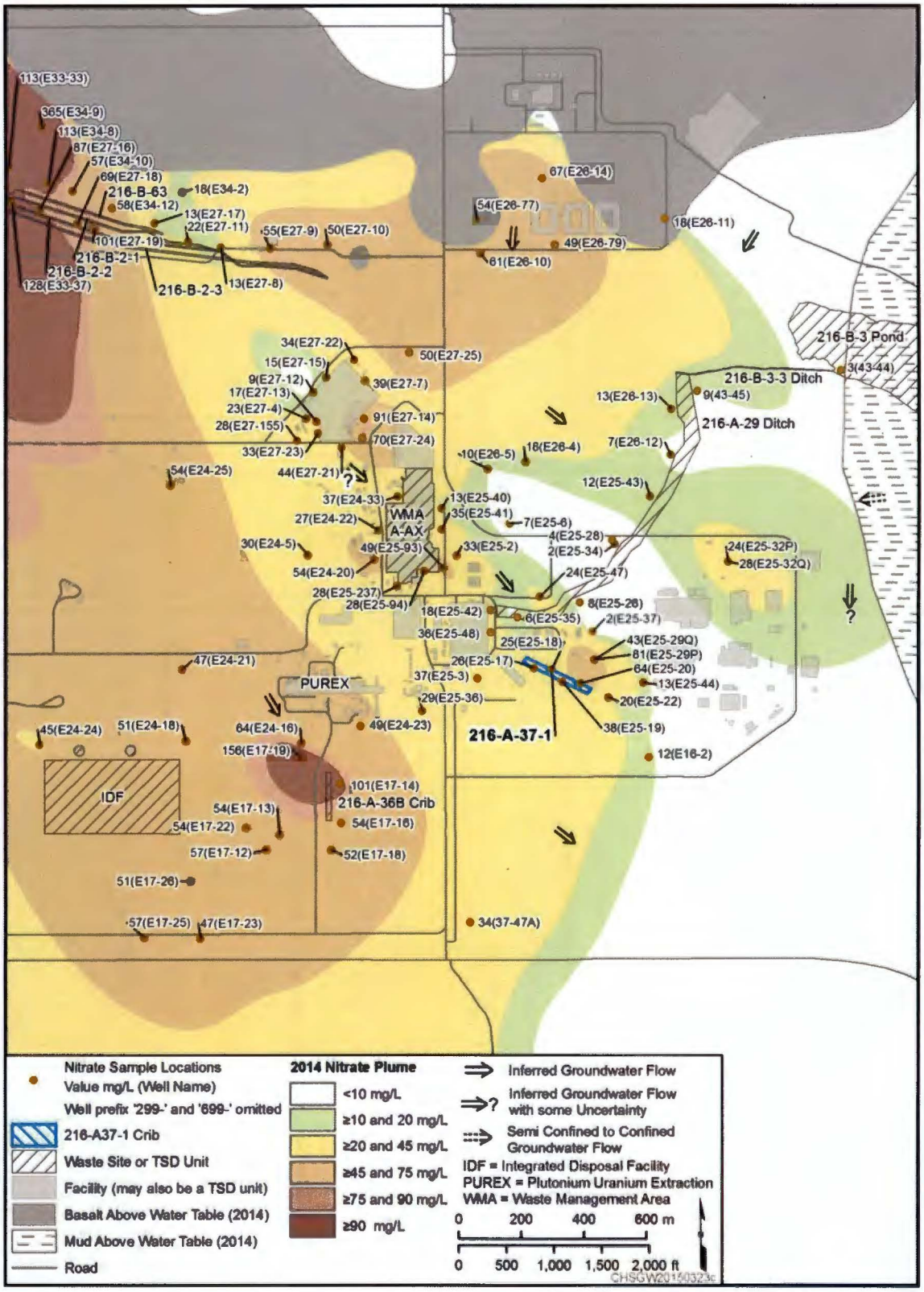


Figure 2-11. Distribution of Nitrate for 2014 in the Vicinity of the 216-A-37-1 Crib

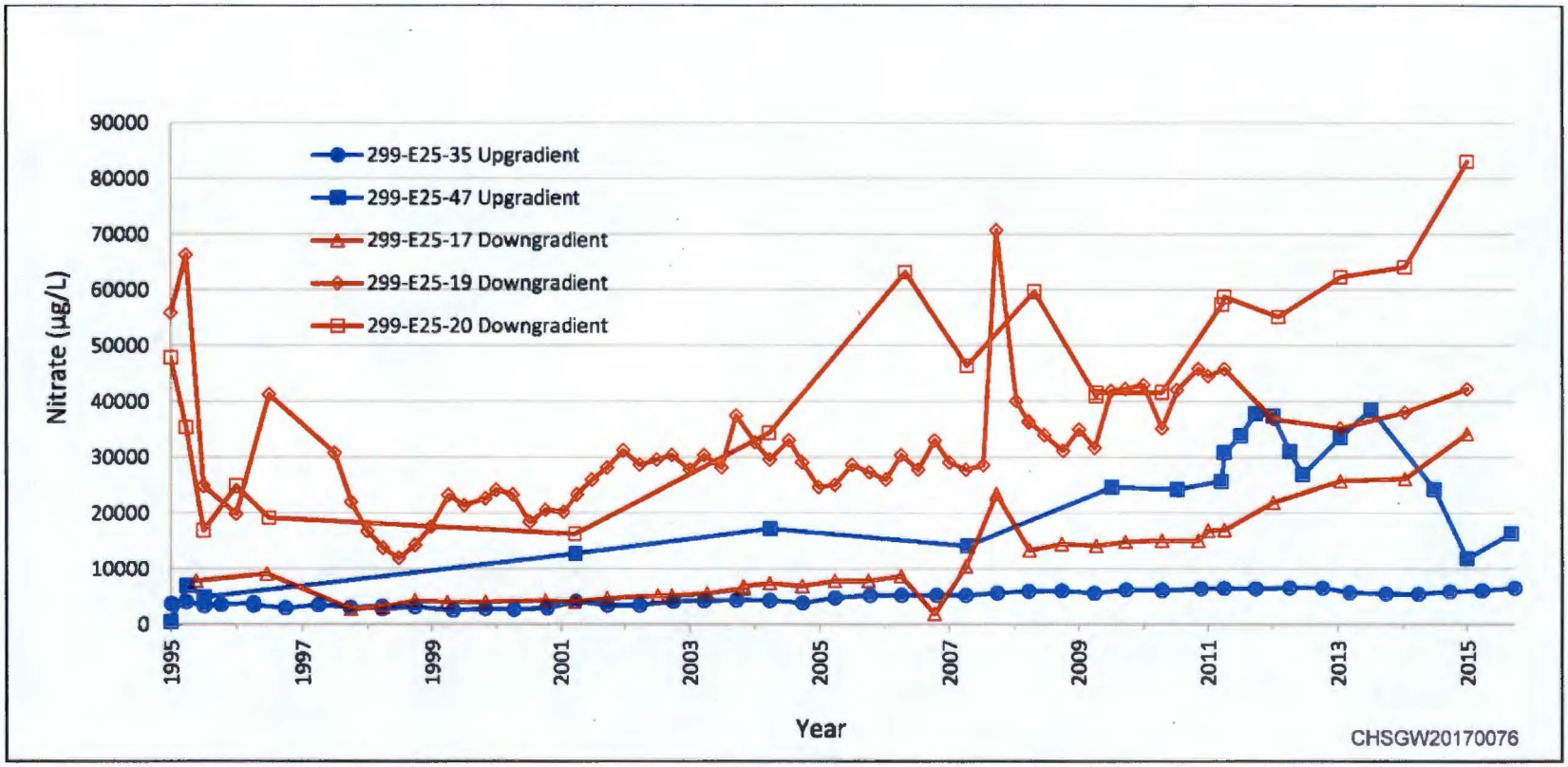


Figure 2-12. Time Series Plot Showing Changes in Nitrate Concentrations in Upgradient and Downgradient Monitoring Wells

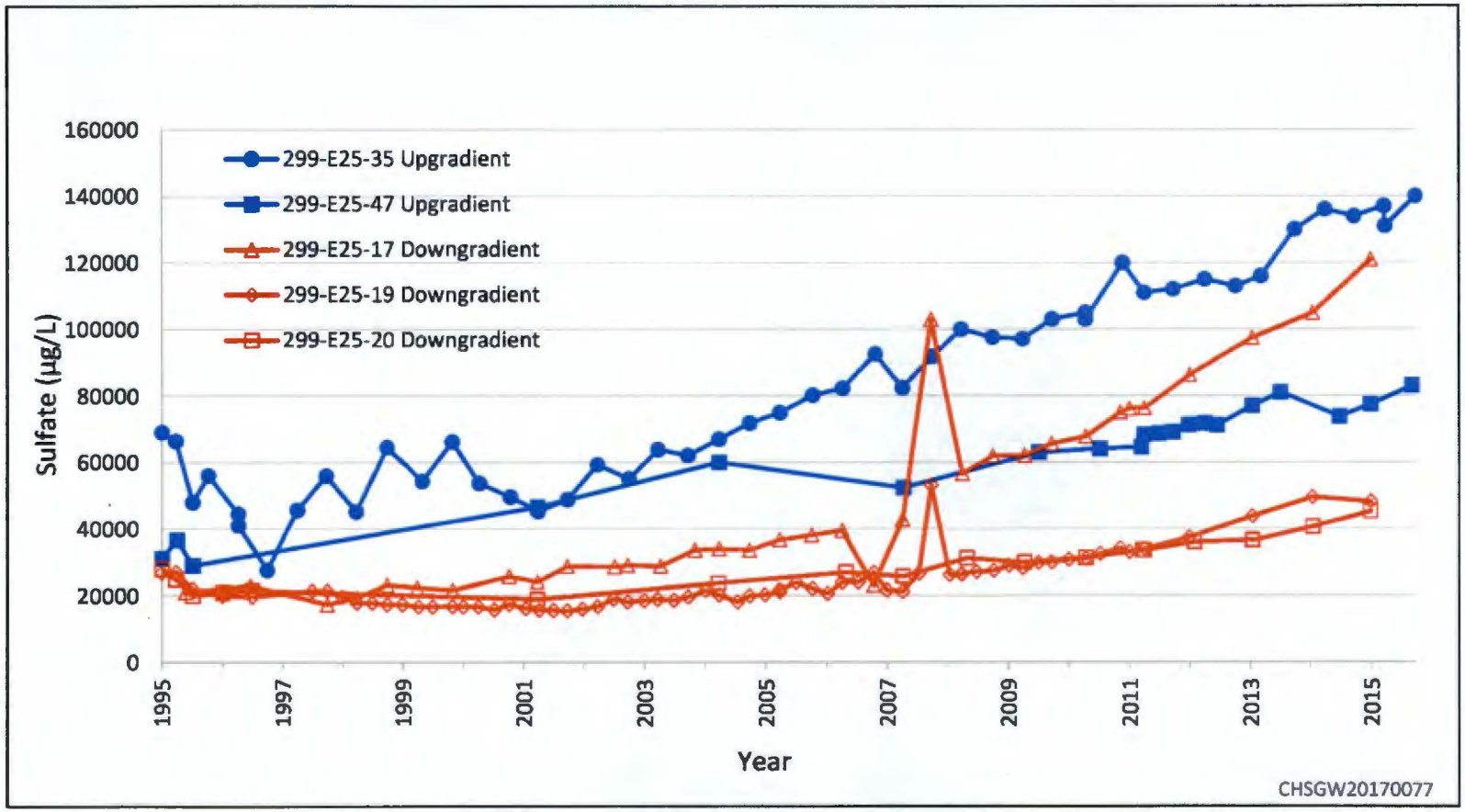


Figure 2-13. Time Series Plot Showing Changes in Sulfate Concentrations in Upgradient and Downgradient Monitoring Wells

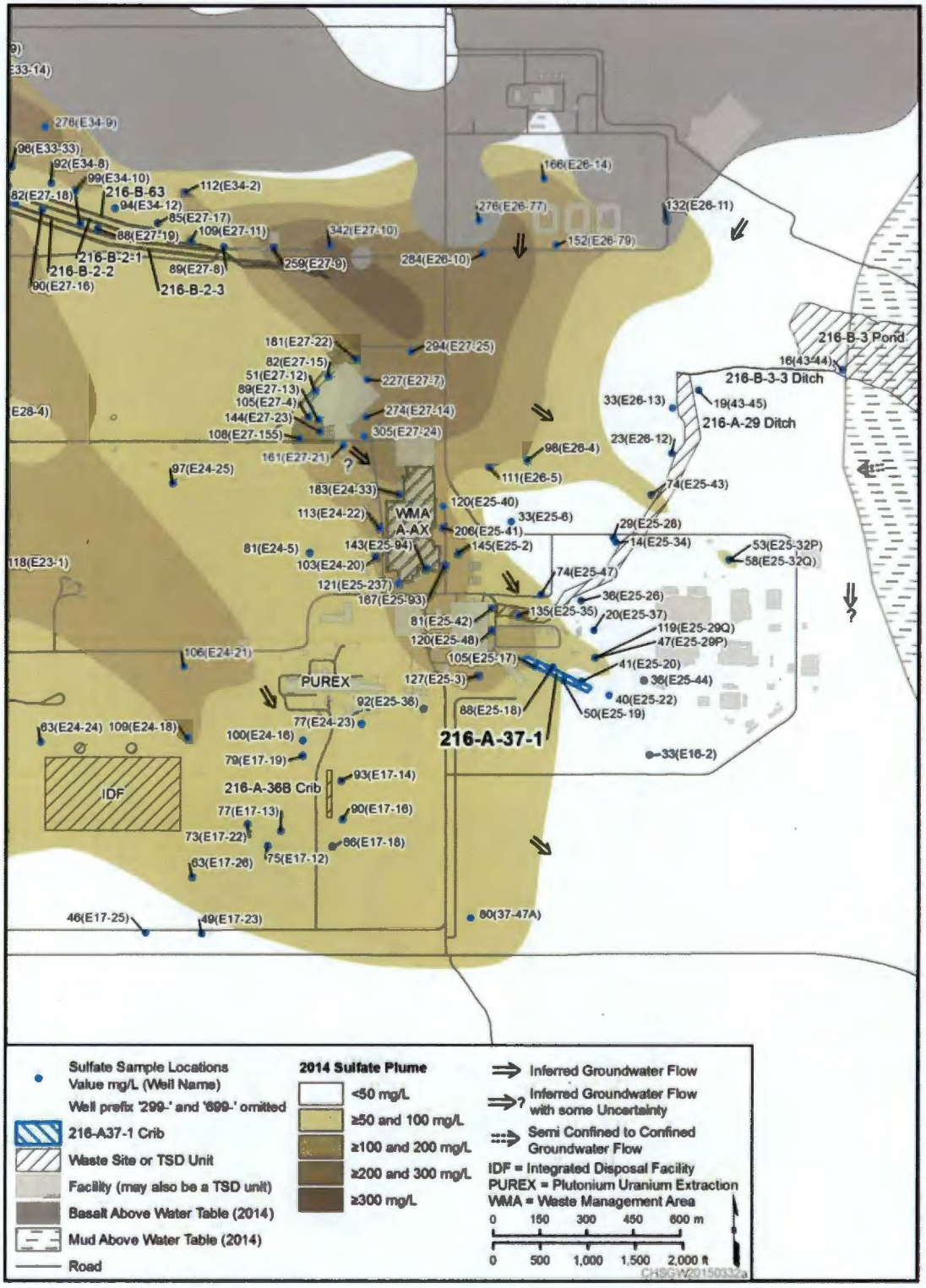


Figure 2-14. Distribution of Sulfate for 2014 in the Vicinity of 216-A-37-1 Crib

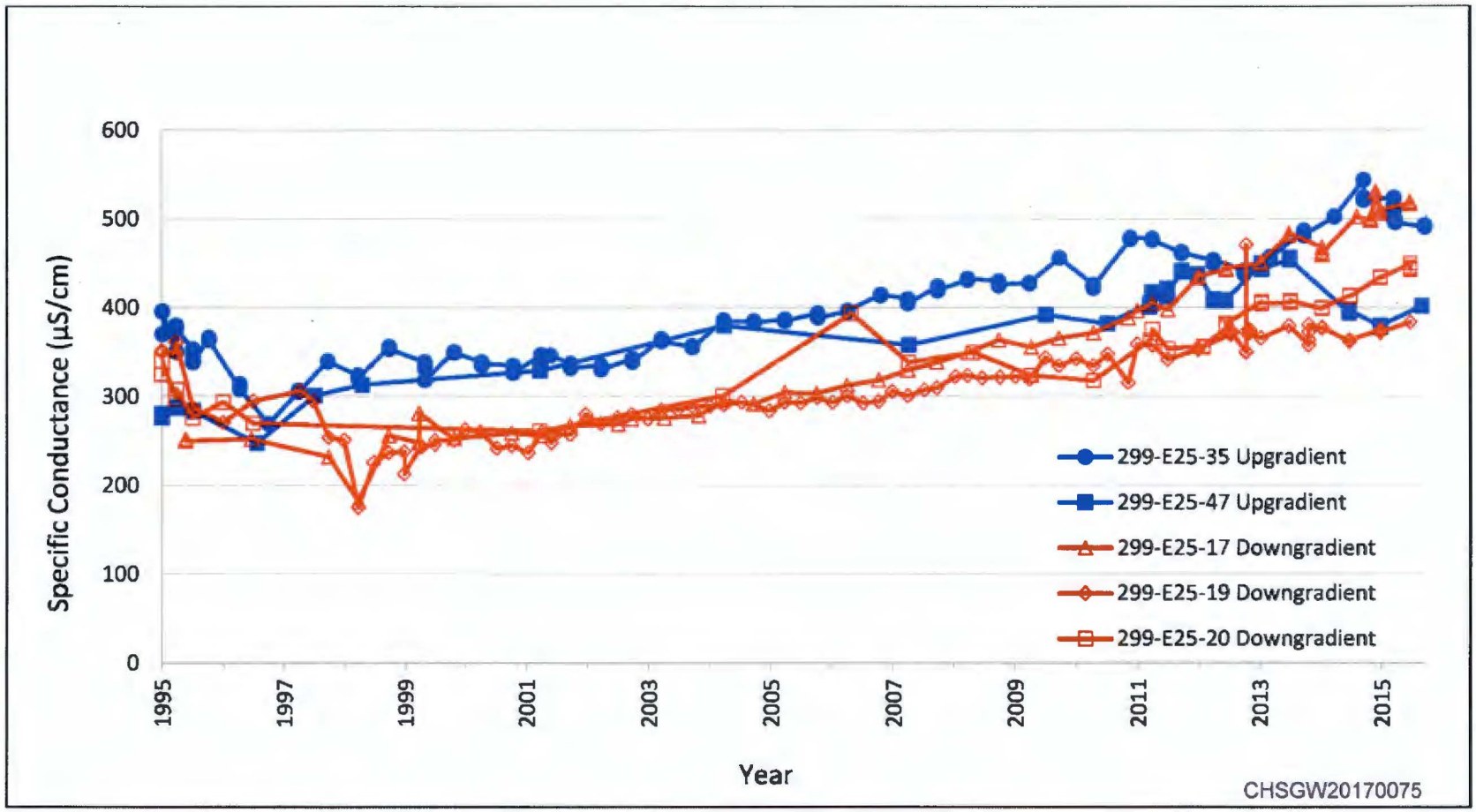


Figure 2-15. Time Series Plot Showing Increasing Specific Conductance Values in Upgradient and Downgradient Monitoring Wells

Per DOE/RL-2010-92 (Rev. 0), if VOCs were detected in downgradient wells (and not upgradient wells), analysis for the detected constituents would continue. Following completion of the first year monitoring requirements outlined in DOE/RL-2010-92 (Rev. 1), sampling frequency for all wells was established as semiannual for indicator parameters and field parameters, and annual for groundwater quality parameters.

The 216-A-37-1 Crib has remained under an interim status indicator evaluation monitoring program (as described in 40 CFR 265.92) since 2010. Statistical analyses of the parameters used as indicators of groundwater contamination have not shown an exceedance since implementation of DOE/RL-2010-92 (Rev. 0). Thus, dangerous wastes subject to WAC 173-303 are not considered to have contaminated the groundwater beneath the 216-A-37-1 Crib.

Groundwater monitoring activities at the 216-A-37-1 Crib under this groundwater monitoring plan (DOE/RL-2010-92, Rev. 2) sample from a network of 6 wells. Samples are analyzed semiannually for parameters used as indicators of groundwater contamination and annually for parameters establishing groundwater quality. VOCs were not detected during the previous monitoring and will no longer be monitored. Site-specific constituents will be monitored annually, except for field parameters to be monitored during each sampling event. Water-level measurements are collected each time that a sample is obtained from a network well. Site-specific constituents are also sampled annually. The network wells are included in the annual comprehensive March water-level measurement campaign (SGW-38815, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*). Groundwater monitoring results are summarized for the 216-A-37-1 Crib in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2016-12, *Hanford Site Groundwater Monitoring Report for 2015*).

2.6 Conceptual Site Model

Groundwater flow and potential contaminant transport strongly influence the groundwater monitoring strategy. Therefore, having a CSM of hydrogeologic and potential contaminant conditions is necessary for development a practical groundwater monitoring plan. A groundwater CSM is an evolving hypothesis that identifies important features, actual and possible events, and processes that control groundwater and contaminant movement. This CSM is based on the results of previous geological and hydrogeological studies, and groundwater monitoring results (Section 4 in PNNL-11523 [Rev. 1], Section 4 in PNNL-12261, Sections 3.4 and 3.6 in DOE/RL-2009-85, and annual groundwater monitoring reports).

The generalized hydrogeologic characteristics below the 216-A-37-1 Crib are shown in Figure 2-16. The CSM includes the following site characteristics and assumptions:

- Liquid wastes are released in the crib and migrate through the vadose zone and into the groundwater.
- As the mobile constituents in the vadose zone intercept and mix with groundwater in the unconfined aquifer, the constituents move laterally with groundwater flow.
- The persistence of an isolated nitrate plume below the 216-A-37-1 Crib suggests a continuing source of nitrate contamination in the vadose zone (Figure 2-11). Increasing nitrate levels in surrounding wells upgradient of the crib indicates there is additional nitrate contribution from a diffuse nitrate mass migrating through the area.
- Groundwater contamination, if any, tends to be higher in concentration near the water table; thus, wells are most often screened (or casings perforated) near the water table (PNL-2724, *Vertical Contamination in the Unconfined Groundwater at the Hanford Site, Washington*).

- Groundwater flow in more recent years has reverted toward the flow pattern that existed before large discharges to B Pond. A southeast flow direction near the 216-A-37-1 Crib is indicated based on contaminant plume migration in the area and measurements obtained from adjacent wells comprising low gradient water table measurement network (Figures 2-8 and 2-9). The water table elevation in the 200 East Area has declined significantly since discharges to B Pond completely ceased in 1997. The rate of decline has decreased during the last 5 years. Wells in the area have shown a decrease in the water table elevation of only 0.07 to 0.15 m (0.2 to 0.5 ft) between 2010 and 2015.

- Near the 216-A-37-1 Crib, a large region of channel deposits comprised of Hanford formation and older CCU sediments extends across the southeastern portion of 200 East Area (Figure 2-10). Channel sediments fill an erosional scour that has removed a portion of the older Ringold Formation sediment (i.e., unit E and the Ringold lower mud unit north and northeast of the site (Figures 2-4, 2-5, and 2-6). Where the Ringold lower mud is present, it acts as a confining or semiconfining layer above the Ringold Formation unit A. North and northeast of the crib, the Cold Creek directly overlays sand and gravel of the Ringold Formation unit A. The uppermost lithologic sequence underlying the crib consists of both the sand and gravel sequences within the Hanford formation (H2 and H3), underlain by gravels comprising the Cold Creek Unit (CCUg) (Figures 2-4, 2-5, and 2-6).

- Geologic contacts shown below wells presented in the cross-sections are based on interpolated geologic contacts using the Leapfrog geologic three-dimensional software (ECF-Hanford-13-0029) and the cross-section generation tool provided in the web-based version of DOE/RL-2015-07. As indicated in each cross-section figure legend, geologic information associated with a well is projected to the cross-section within a buffer zone extending 75 m (246 ft) from either side of the cross-section line, resulting in approximate depths for stratigraphic contacts. Definition of the stratigraphic units present is based on the most current, integrated understanding of the subsurface geologic framework beneath an area and in some cases utilizes projected geologic contacts and stratigraphy from adjacent areas where data is available, utilizing the Leapfrog geologic three-dimensional software. Projected lithologic contacts suggest that the Ringold lower mud may partially confine the Ringold Formation unit A south of the 216-A-37-1 Crib (Figure 2-5).

- As shown in Figures 2-4, 2-5, and 2-6, hydraulic communication can occur between the Hanford, CCU, and the unconfined or partially confined sediments comprising the Ringold Unit A. Directly west of the 216-A-37-1 Crib, where ancestral channel scour was not as pronounced, Ringold Unit E is present underlying the Hanford formation (Figure 2-6).

- Hydraulic conductivity of Hanford and Cold Creek sediments are generally higher than that of Ringold units A or E, although in some areas within 200 East, the hydraulic conductivity of the upper portion of the Ringold unit E appears similar to that of the Hanford and Cold Creek. Where these stratigraphic units are found laterally or vertically juxtaposed as the result of the depositional environment, contaminants may preferentially flow in the Hanford or Cold Creek versus Ringold units.

- Regionally, there is an upward hydraulic gradient within the confined Ringold aquifer. Groundwater flow may occur from the confined Ringold Formation unit A into the highly transmissive Hanford and Cold Creek channel-fill sediments in areas along the channel margins where these stratigraphic units are in contact (Figures 2-8 and 2-10).

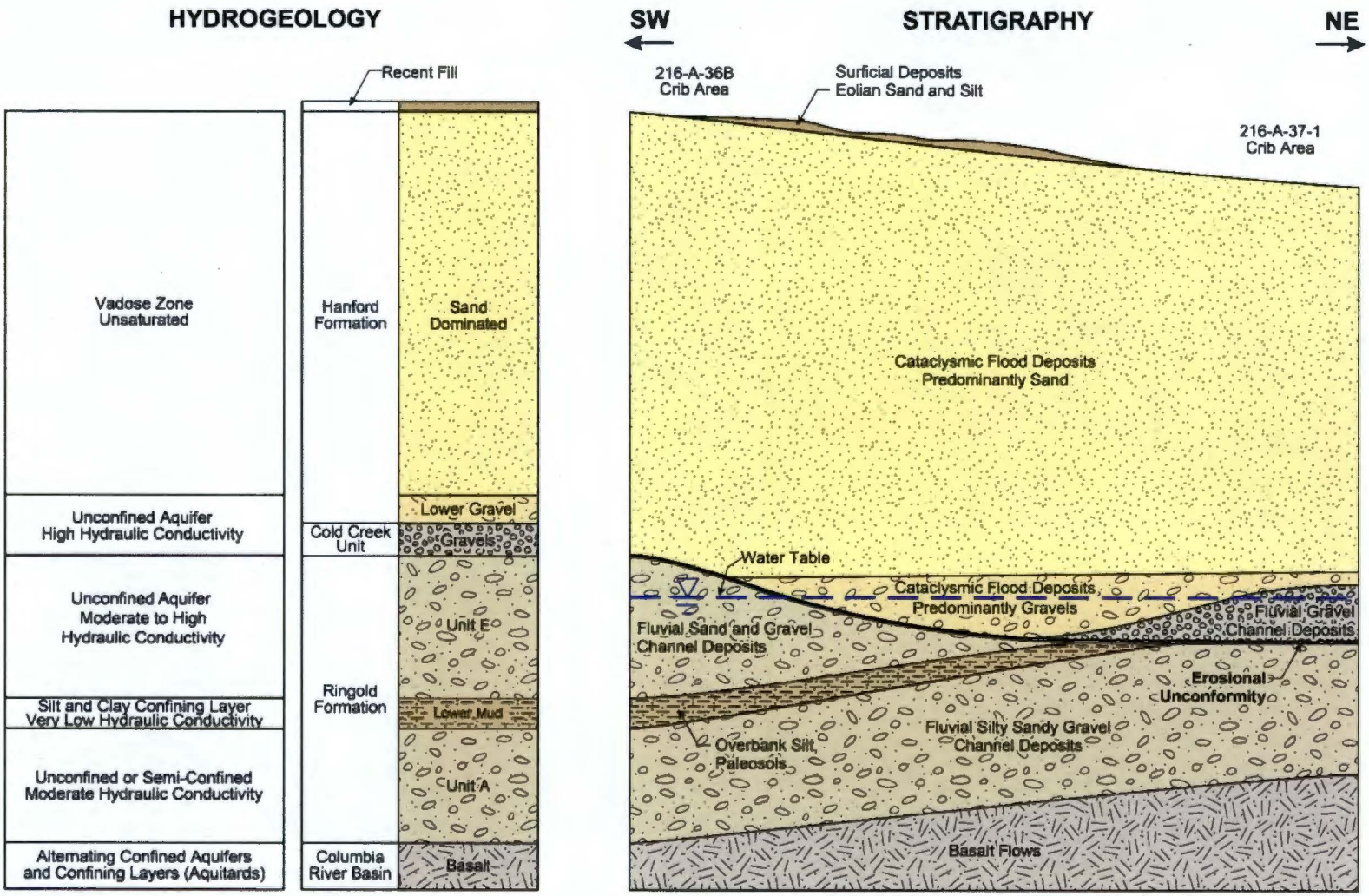


Figure 2-16. General Representation of Hydrogeologic Characteristics Underlying the 216-A-37-1 Crib and Southeastern Portion of the 200 East Area

2.7 Monitoring Objectives

The groundwater monitoring program at the 216-A-37-1 Crib is conducted with the objective of determining the facility's impact, if any, on the quality of the underlying groundwater. This groundwater monitoring plan addresses specifically those applicable dangerous waste requirements for interim status TSD units where no impact to groundwater has been identified. The regulatory requirements applicable to this groundwater monitoring plan are found in WAC 173-303-400(3) and 40 CFR 265.90 through 265.94, "Recordkeeping and Reporting." Table 2-3 identifies where each groundwater monitoring element of the pertinent regulations is addressed within this plan. Additional anions and cations (Table 2-4) will also be collected for general groundwater chemistry, which will support the evaluation of upgradient and downgradient water chemistry variations (e.g., data used for Stiff diagrams and charge balance determinations).

Table 2-3. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement*	Section Where Requirement Is Addressed in Monitoring Plan
Applicability	40 CFR 265.90, "Applicability" (a) Within one year after the effective date of these regulations, the owner or operator of a surface impoundment, landfill, or land treatment facility which is used to manage hazardous waste must implement a ground-water monitoring program capable of determining the facility's impact on the quality of ground water in the uppermost aquifer underlying the facility, except as §265.1 and paragraph (c) of this section provide otherwise. (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.	Chapter 1
Number and Location of Wells	40 CFR 265.91, "Ground-Water Monitoring System". (a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of: (1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are: (i) Representative of background ground-water quality in the uppermost aquifer near the facility; and (ii) Not affected by the facility; and (2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the waste management area to the uppermost aquifer.	Section 3.2

Table 2-3. Pertinent Interim Status Facility Groundwater 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 bore hole. 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 bore hole 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)(c)(v)(C), "Dangerous Waste Regulations," "Interim Status Facility Standards": Ground water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. Chapter 173-160 WAC may be used as guidance in the installation of wells.	Section 3.2 and Appendix C
Sample Protocols Analytical Methods	40 CFR 265.92: (a) The owner or operator must obtain and analyze samples from the installed ground-water monitoring system. The owner or operator must develop and follow a ground-water sampling and analysis plan. He must keep this plan at the facility. The plan must include procedures and techniques for: (1) Sample collection; (2) Sample preservation and shipment; (3) Analytical procedures; and (4) Chain of custody control.	Appendix A, Section A3 and Appendix B, Sections B2 through B5
Parameters to be sampled Frequency of sampling Water-level measurements	40 CFR 265.92, "Sampling and Analysis": (b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section: (1) Parameters characterizing the suitability of the ground water as a drinking water supply, as specified in Appendix III. (2) Parameters establishing ground-water quality: (i) Chloride (ii) Iron (iii) Manganese (iv) Phenols (v) Sodium (vi) Sulfate [Comment: These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under §265.93(d).] (3) Parameters used as indicators of ground-water contamination: (i) pH	Section 3.1 and Appendix B, Section B2.2

Table 2-3. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement*	Section Where Requirement Is Addressed in Monitoring Plan
	(ii) Specific conductance (iii) Total organic carbon (iv) Total organic halogen (c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this section. He must do this quarterly for one year. (2) For each of the indicator parameters specified in paragraph (b)(3) of this section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year. (d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies: (1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually. (2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semi-annually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	
Groundwater Quality Assessment Program Plan Outline	40 CFR 265.93, "Preparation, Evaluation, and Response": (a) Within one year after the effective date of these regulations, the owner or operator must prepare an outline of a ground-water quality assessment program. The outline must describe a more comprehensive ground-water monitoring program (than that described in §§265.91 and 265.92) capable of determining: (1) Whether hazardous waste or hazardous waste constituents have entered the ground water; (2) The rate and extent of migration of hazardous waste or hazardous waste constituents in the ground water; and (3) The concentrations of hazardous waste or hazardous waste constituents in the ground water.	Chapter 5
Methods used to evaluate the collected data and responses	40 CFR 265.93: (b) For each indicator parameter specified in §265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with §265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background.	Sections 4.1, 4.2, 4.3 and Appendix A

Table 2-3. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement*	Section Where Requirement Is Addressed in Monitoring Plan
	(c)(2) If the comparison for downgradient wells made under paragraph (b) of this section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error. (d)(1) If the analyses performed under paragraph (c)(2) of this section confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the department-within seven days of the date of such confirmation-that the facility may be affecting ground-water quality. (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.	
Recordkeeping and Reporting	40 CFR 265.93: (c)(1) If the comparisons for the *upgradient* wells made under paragraph (b) of this section show a significant increase or (pH decrease), the owner or operator must submit this information in accordance with §265.94(a)(2)(ii). 40 CFR 265.94, "Recordkeeping and Reporting": (a)(1) Keep records of the analyses required in §265.92(c) and (d), the associated ground-water surface elevations required in §265.92(e), and the evaluation required in §265.93(b) throughout the active life of the facility (a)(2) Report the following ground-water monitoring information to the department: (ii) Annually: Concentrations or values of the parameters listed in §265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under §265.93(b). The owner or operator must separately identify any significant differences from the initial background found in the upgradient wells, in accordance with §265.93(c)(1). (iii) No later than March 1 following each calendar year: Results of the evaluations of ground-water surface elevations under §265.93(f), and a description of the response to that evaluation, where applicable.	Section 4.5 Appendix A, Section A2.6 and A3.9

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

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

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

Table 2-3. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement*	Section Where Requirement Is Addressed in Monitoring Plan

Hanford Facility RCRA Permit, or until interim status is terminated. Therefore, groundwater monitoring continues under interim status requirements.

* Regulatory requirements for interim status TSD units where no impact to groundwater has been identified, are found in WAC 173-303-400(3) and 40 CFR 265.90, "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting," which are applicable to this groundwater monitoring plan.

RCRA = *Resource Conservation and Recovery Act of 1976*

TSD = treatment, storage, and disposal

Table 2-4. Additional Monitoring Objectives

Monitoring Objective	TSD Unit-Specific Constituents/ Field Measurements*
Site-specific - nitrate is a degradation product of waste previously discharged to the 216-A-37-1 Crib.	Nitrate
Alkalinity constituents – used in ion balance and to support water chemistry analysis.	Alkalinity, bicarbonate (from alkalinity), carbonate (from alkalinity), hydroxyl ion
Metals – additional metals used in ion balance and to support water chemistry analysis.	Calcium, magnesium, potassium
Metals – additional metals used to identify corrosion of well casing.	Chromium, hexavalent chromium, iron, manganese, and nickel
Anions – additional anions used in ion balance and to support water chemistry analysis.	Fluoride, nitrate, nitrite
Field parameters provide information on water properties at the time of sampling.	Temperature and turbidity

* Sampling for TSD unit-specific constituents/field measurements is not required by WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards" nor 40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground Water Monitoring."

TSD = treatment, storage, and disposal

This page intentionally left blank.

3 Groundwater Monitoring Program

This chapter describes the groundwater monitoring indicator evaluation program for the 216-A-37-1 Crib consisting of parameters used as indicators of groundwater contamination, parameters establishing groundwater quality, a monitoring well network, and sampling and analysis protocols. The monitoring program presented herein has been revised from that presented in the previous plan (DOE/RL-2010-92, Rev. 1) (revised well network and site-specific monitoring constituents), and supersedes the monitoring program of the previous plan.

3.1 Constituents List and Sampling Frequency

Table 3-1 presents the wells in the groundwater monitoring network, the parameters analyzed, and the sampling frequency for monitoring of the 216-A-37-1 Crib. Parameters used as indicators of groundwater contamination (pH, specific conductance, TOC, and TOX) will be sampled and analyzed semiannually (40 CFR 265.92(b)(3) and (d)(2)). Parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, sulfate) will be sampled and analyzed annually (40 CFR 265.92(b)(2) and (d)(1)). Water-level measurements at each monitoring well will be determined each time that a sample is obtained (40 CFR 265.92(e)). Though not required by regulation, site-specific constituents will be sampled annually and are identified in Table 2-4. These include nitrate, which is a degradation product of waste previously discharged to the crib and supporting constituents (anions and metals) to support analysis of general water chemistry in the upgradient and downgradient monitoring areas and comparative analysis of general groundwater characteristics in the monitoring area. Supporting constituents also include chromium, hexavalent chromium, iron, manganese, and nickel which are monitored to detect corrosion of well casings.

In this plan, upgradient well 299-E25-35 and downgradient New Well 1 are added to the 216-A-37-1 Crib monitoring network. Both of these wells will be sampled quarterly for 1 year for contamination indicator parameters and groundwater quality parameters in Table 3-1. In addition to the monitoring in Table 3-1, these wells will be sampled quarterly for 1 year for the drinking water suitability parameters included in Appendix III to 40 CFR 265 (Table 3-2). Monitoring for the Appendix III parameters in Table 3-2 will be performed concurrently with the monitoring required in Table 3-1.

3.1.1 Sample Schedule Impacts from Well Maintenance and Sampling Logistics

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

Table 3-1. Monitoring Well Network for the 216-A-37-1 Crib

Well Name	Purpose	WAC Compliant	RCRA Required Parameters[a]											Site-Specific Constituents				
				Contamination Indicator Parameters				Groundwater Quality Parameters						Supporting Constituents				
			Water Level	pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron (Filtered and Unfiltered)[b]	Manganese (Filtered and Unfiltered)[b]	Phenols	Sodium (Filtered and Unfiltered)[b]	Sulfate	Alkalinity[c]	Metals (Filtered and Unfiltered)[b,d]	Anions[e]	Field Parameters[f]	Site-Specific[g]
299-E25-35[h]	Upgradient	Y	Q	Q4	Q4	Q4	Q4	Q	Q	Q	Q	Q	Q	A	A	A	Q	A
299-E25-35[i]	Upgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S	A
299-E25-47	Upgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S	A
299-E25-17	Downgradient	N[j]	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S	A
299-E25-19	Downgradient	N[j]	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S	A
299-E25-20	Downgradient	N[j]	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S	A
New Well 1[h]	Downgradient	Y	Q	Q4	Q4	Q4	Q4	Q	Q	Q	Q	Q	Q	A	A	A	Q	A
New Well 1[i]	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S	A

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

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

c. Alkalinity includes analysis of bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity.

Table 3-1. Monitoring Well Network for the 216-A-37-1 Crib

			RCRA Required Parameters[a]											Site-Specific Constituents				
				Contamination Indicator Parameters				Groundwater Quality Parameters						Supporting Constituents				
Well Name	Purpose	WAC Compliant	Water Level	pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron (Filtered and Unfiltered)[b]	Manganese (Filtered and Unfiltered)[b]	Phenols	Sodium (Filtered and Unfiltered)[b]	Sulfate	Alkalinity[c]	Metals (Filtered and Unfiltered)[b,d]	Anions[e]	Field Parameters[f]	Site-Specific[g]

d. Includes analysis of calcium, magnesium, and potassium to support water chemistry analysis and chromium, hexavalent chromium, iron, manganese, and nickel to identify well casing corrosion.

e. Includes analysis of fluoride, nitrate, and nitrite.

f. Includes temperature and turbidity.

g. Nitrate will be monitored as a site-specific constituent because it is a degradation product of waste previously discharged to the 216-A-37-1 Crib.

h. Constituents and sampling frequency for 1 year of monitoring. During the 1 year monitoring period, additional analyses will be performed at this well as described in Table 3-2.

i. Constituents and sampling frequency after the 1 year of monitoring described in footnote.

j. Well identified for replacement consistent with sitewide cleanup priorities described in Milestone M-024-58 of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan.*

A = to be sampled annually

N = well is not constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")

Q = to be sampled quarterly

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

S = to be sampled semiannually

S4 = to be sampled semiannually, with quadruplicate samples collected during each event

RCRA = *Resource Conservation and Recovery Act of 1976*

WAC = *Washington Administrative Code*

Y = well is constructed as a resource protection well (WAC 173-160)

Table 3-2. Constituents and Sampling Frequency for 1 Year of Monitoring at Wells Added to the 216-A-37-1 Crib Network

Well Name	Water Level	40 CFR 265 Appendix III Parameters[a]																				
		Arsenic (Filtered and Unfiltered)[b]	Barium (Filtered and Unfiltered)[b]	Cadmium (Filtered and Unfiltered)[b]	Chromium (Filtered and Unfiltered)[b]	Fluoride	Lead (Filtered and Unfiltered)[b]	Mercury	Nitrate (as N)	Selenium (Filtered and Unfiltered)[b]	Silver (Filtered and Unfiltered)[b]	Endrin	Lindane	Methoxychlor	Toxaphene	2,4,-D	2,4,5-TP Silvex	Radium	Gross Alpha	Gross Beta	Coliform Bacteria	Turbidity
299-E25-35	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
New Well 1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q

Reference: 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix III, "EPA Interim Primary Drinking Water Standards."

a. Monitoring for the Appendix III parameters will be performed for 1 year and will be performed concurrently with monitoring required in Table 3-1.

b. 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.

Q = to be sampled quarterly

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

3.1.2 Well Biofouling and TOC Results

Biofouling of wells can result in collection of non-representative groundwater samples and produce non-representative analytical results for TOC. In Hanford Site wells, biofouling is often associated with iron and manganese-oxidizing bacteria. The bacterial growths are physically manifested as slime or as filamentous or flocculent accumulations. The accumulations frequently occur in the screened interval and exhibit discrete coloration (e.g., rusty orange in the case of iron-oxidizing bacteria or black in the case of manganese-oxidizing bacteria).

TOC is a non-specific analysis that is used as an indicator of the presence of organic compounds in groundwater. TOC represents organic compounds in the sample; this includes dissolved organic compounds as well as suspended organic particles that may be present in an unfiltered sample. Suspended organic materials in groundwater samples can include microbial biomass associated with well biofouling. TOC is used in detection monitoring as an indicator of the possible presence of regulated organic compounds, but the TOC measurement is non-specific. Furthermore, the TOC measurement is subject to positive interference if suspended organic material (e.g., microbial biomass) or dissolved naturally occurring organic compounds (e.g., humic and fulvic acids) are present in the sample.

If elevated concentrations of TOC are measured within a well (particularly, if a TOC concentration above the critical mean is encountered), then well maintenance activities to address accumulated microbiological growth in the well will be performed. Well maintenance activities are designed to reduce the impact of biomass transfer from the well and generation of a resultant high TOC value. Well maintenance will include cleaning/rehabilitation of the well to ensure that the groundwater samples collected are representative of ambient groundwater conditions and not the result of sampling of biomass material present within the well. Well cleaning will be completed per the contractor's standard operating procedures. A down-hole camera survey and well cleaning will be scheduled immediately following receipt of elevated TOC result where biofouling of the well is suspected. Subsequent to completing the cleaning activities, a well having an exceedance of the critical mean for TOC will be sampled for confirmational laboratory split samples as required under 40 CFR 265.93(c)(2).

3.2 Monitoring Well Network

Numerous groundwater wells exist in the vicinity of the 216-A-37-1 Crib. Not all wells meet WAC 173-160 construction standards. The following criteria were used to select wells for RCRA monitoring of the 216-A-37-1 Crib:

- Location of the downgradient wells with respect to the waste site boundary and groundwater flow path (wells closest to the waste site boundary were prioritized for use because they would provide the most immediate indication of a release)
- Well screen position with respect to the water table (wells constructed with screens positioned closest to the vadose zone/water table interface were preferred for indicating contaminant presence in groundwater resulting from a nearby waste site release)

- Suitable well construction such that the sampling data provided will be comparable with other network wells
- Compliance with WAC 173-160

The three existing downgradient wells (299-E25-17, 299-E25-19, and 299-E25-20) used for monitoring the 216-A-37-1 Crib are considered appropriate for the monitoring objectives, but are not compliant with WAC 173-160. Per agreement between DOE and Ecology, noncompliant wells are identified and placed on the prioritized drilling schedule for replacement consistent with site-wide cleanup priorities as described in Milestone M-024-58, which is contained in the Tri-Party Agreement Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*), as revised. The three downgradient wells have been included in this milestone for future replacement.

The previous 216-A-37-1 monitoring network consisted of one upgradient and three downgradient wells (Figure 2-9). One upgradient well located north of the crib (299-E25-47) is no longer considered suitable by itself for monitoring the southeast groundwater flow and upgradient constituent concentrations. Two upgradient wells are needed to monitor current spatial variability in upgradient constituent concentrations impacting the site. This upgradient well is being augmented with the addition of well 299-E25-35 (which is compliant with WAC 173-160). Well 299-E25-35 is an existing downgradient well within the monitoring network of the nearby 216-A-29 Ditch; however, it is newly added to the 216-A-37-1 monitoring well network as an upgradient well. Wells 299-E25-47 and 299-E25-35 are located north and north-northwest, respectively, of the 216-A-37-1 Crib and will provide better coverage and representation of the upgradient groundwater constituents migrating to the southeast that impact the site. Figure 3-1 presents the updated groundwater monitoring network to be utilized in this plan. Information on the wells comprising the updated network is summarized in Table 3-3.

Well 299-E25-35 is located south of the 216-A-29 Ditch and has been sampled since 1988. Specific conductance, nitrate, and sulfate levels have been consistently increasing in this well, as it has for other wells upgradient of the 216-A-37-1 Crib and the 216-A-29 Ditch since 1998 (Figure 2-15). Specific conductance levels in downgradient wells comprising the 216-A-37-1 well network (Figure 2-15) are related to the southeast migration of sulfate (Figures 2-13 and 2-14) and nitrate (Figures 2-11 and 2-12) plumes through the monitoring area and to nitrate levels associated with the crib (Figures 2-11 and 2-12).

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

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

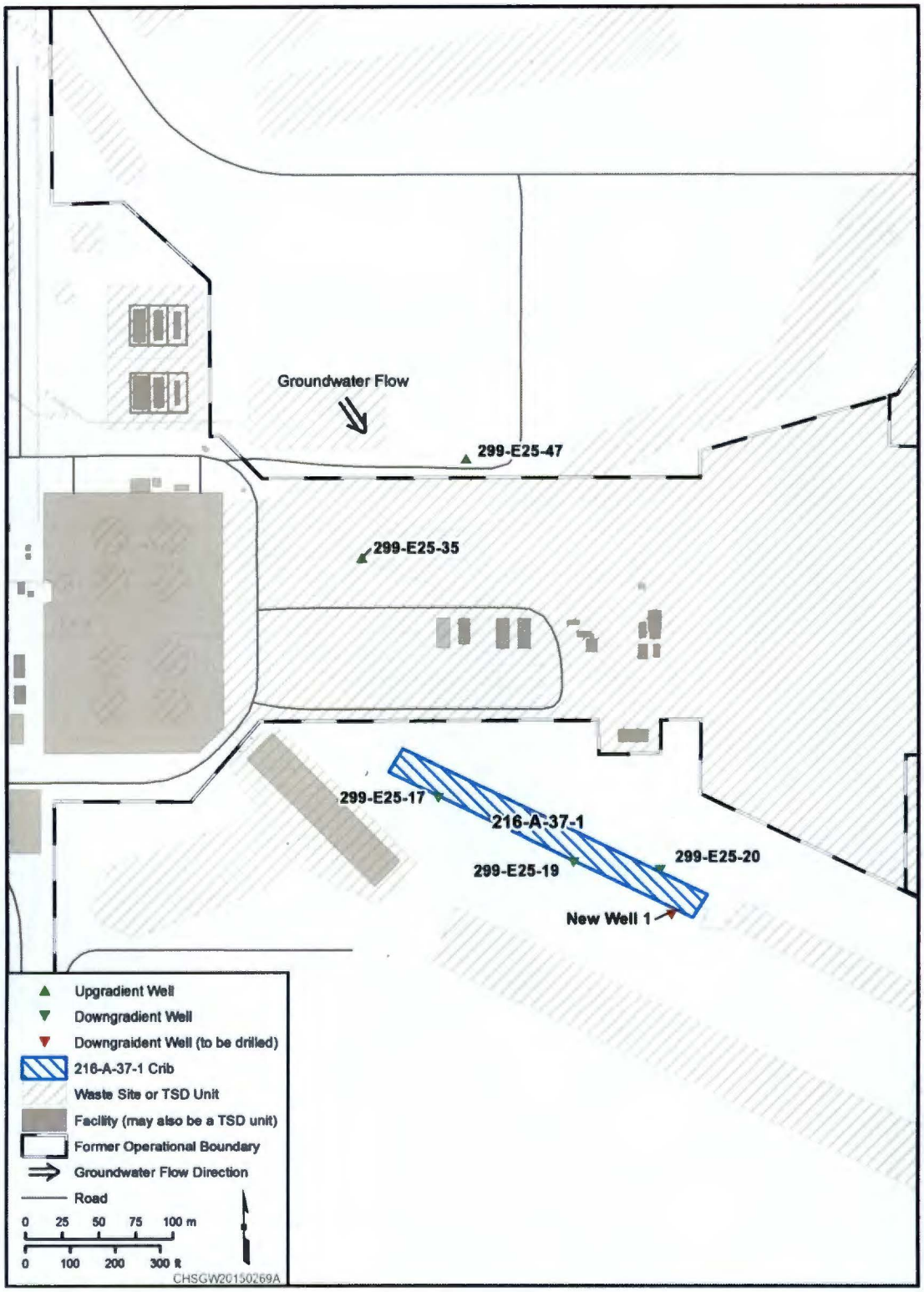


Figure 3-1. 216-A-37-1 Crib Monitoring Well Network

Table 3-3. Attributes for Wells in the 216-A-37-1 Crib Groundwater Monitoring Network

Well Name	Completion Date	Easting[a] (m)	Northing[a] (m)	Screen Top (m [ft] bgs) and Elevation (m [ft]) [b]	Screen bottom (m [ft] bgs) and Elevation (m [ft]) [b]	Water Depth (m [ft] bgs) and Elevation (m [ft])[b]	Remaining Water Column (m [ft])	Water Table Measurement Date
299-E25-35[c]	1988	575708.3	135864.7	94.2 (309.0) 111.4 (365.5)	100.6 (330.0) 105.0 (344.5)	83.6 (274.3) 122.04 (400.49)	17.0 (55.8)	7/24/2016
299-E25-47[c]	1992	575779.0	135931.5	80.2 (263.1) 125.2 (410.8)	86.3 (283.2) 119.1 (390.7)	83.7 (274.6) 121.71 (399.31)	2.7 (8.9)	7/10/2016
299-E25-17	1976	575760.2	135702.5	83.2 (273.0) 123.4 (404.9)	89.9 (295.0) 116.7 (382.9)	84.9 (278.5) 121.7 (399.28)	5.0 (16.4)	7/10/2016
299-E25-19	1976	575852.3	135659.0	82.3 (270.0) 124.6 (408.8)	89.9 (295.0) 117.0 (383.9)	85.3 (279.9) 121.65 (399.11)	4.7 (15.4)	7/10/2016
299-E25-20	1976	575910.9	135654.0	82.0 (269.0) 124.5 (408.5)	89.6 (294.0) 116.9 (383.5)	85.0 84.9(278.5) 121.61 (398.98)	4.7 (15.4)	7/10/2016
New Well 1	TBD	575916[d]	135628[d]	NA	NA	NA	NA	NA

a. Coordinates are in NAD83, *North American Datum of 1983.*

b. Elevations are in NAVD88, *North American Vertical Datum of 1988.*

c. Upgradient well

d. Planned coordinates for New Well 1.

bgs = below ground surface

NA = not applicable

TBD = to be determined

3.3 Differences between This Plan and Previous Plan

Table 3-4 identifies the main differences between this plan and the previous groundwater monitoring plan.

The previous plan included a single well (299-E25-47) for upgradient monitoring. This plan uses two existing wells (299-E25-35 and 299-E25-47) for upgradient monitoring, which will provide a better representation of groundwater conditions upgradient of the 216-A-37-1 Crib. The downgradient well network will be expanded to include an additional well (New Well 1). The additional downgradient well will provide better coverage of downgradient groundwater conditions associated with the crib. Wells 299-E25-35 and New Well 1 will be sampled quarterly for indicator parameters, groundwater quality parameters, and drinking water suitability parameters included in Appendix III to 40 CFR 265 for 1 year.

Monitoring for VOCs was completed in 2011 using the 216-A-37-1 downgradient wells. VOCs were not detected; therefore, the VOC sampling outlined in the previous plan is not included in this plan.

Table 3-4. Main Differences Between this Monitoring Plan and Previous Monitoring Plan

Type of Change	Previous Plan[a]	Current Plan	Justification Summary
Constituents	Indicator parameters, groundwater quality parameters, water chemistry constituents, site-specific constituents[b]	Indicator parameters, groundwater quality parameters, water chemistry constituents, site-specific constituents	Removal of VOC sampling from site-specific constituent list as it was completed under previous plan. Nitrate is identified as a site-specific constituent because it is a degradation product of waste that was previous discharged. Chromium, hexavalent chromium, iron, manganese, and nickel are added to monitor for corrosion of well casings.
Sampling Frequency	Indicator parameters (semiannual), Groundwater quality parameters (annual), Water level measurements (every sampling event), Additional constituents (annual), field parameters (semiannual)	Same, except wells 299-E25-35 and New Well 1 will be sampled quarterly for indicator parameters, groundwater quality parameters, and drinking water suitability parameters included in Appendix III to 40 CFR 265 for 1 year.	No change

Table 3-4. Main Differences Between this Monitoring Plan and Previous Monitoring Plan

Type of Change	Previous Plan[a]	Current Plan	Justification Summary
Well Network	One upgradient well, three downgradient wells Upgradient: 299-E25-47 Downgradient: 299-E25-17 299-E25-19 299-E25-20	Two upgradient wells, four downgradient wells Upgradient: 299-E25-35 299-E25-47 Downgradient: 299-E25-17 299-E25-19 299-E25-20 New Well 1	An additional upgradient monitoring well (299-E25-35) is added as two upgradient wells are needed to monitor current spatial variability in upgradient constituent concentrations impacting the site. An additional downgradient well is added to provide better coverage of downgradient groundwater conditions associated with the crib.
Groundwater Flow Direction	South to southeast	Same	No change
Type of Groundwater Monitoring Program	Indicator evaluation program	Same	No change
Background Arithmetic Mean Recalculated	Calculated annually using one upgradient well	Calculated annually using two upgradient wells	Two wells (299-E25-35 and 299-E25-47) are needed to capture spatial variability in upgradient conditions. Calculated annually using EPA 530/R-09-007, Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance.
Groundwater Quality Assessment Plan Outline	None[c]	Outline provided in Chapter 5	Updated outline to current norms

a. DOE/RL-2010-92, Rev. 1, Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib.

b. Specifically, VOCs were listed as a supporting constituent in the previous plan for first year analysis only. Monitoring was to continue for any detected VOCs.

c. Outline developed and accessible in project file.

VOC = volatile organic compound

3.4 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).

4 Data Evaluation and Reporting

This chapter discusses the evaluation and interpretation of data.

4.1 Data Review

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

4.2 Statistical Evaluation

The goal of the groundwater monitoring indicator evaluation program is to determine if the 216-A-37-1 Crib operations have affected groundwater quality beneath the TSD unit, which is determined based on the results of specified statistical tests. Under this plan, sampling activities and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference into WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general groundwater contamination indicator parameters (pH, specific conductance, TOC, and TOX) to background levels to test for potential impact to groundwater. Each time that a monitoring well is sampled, four replicate samples for TOC and TOX are collected, and four replicate field measurements are made for pH and specific conductance.

The basic procedure for statistical comparisons is as follows. Twice each year, monitoring data from downgradient wells are compared to the upgradient (background) results for each of the four indicator parameters. The arithmetic mean and variance must be calculated based on at least four replicate measurements on each sample, for each well monitored, and then compared with the background arithmetic mean obtained (40 CFR 265.92(c)(2)) and updated as discussed in Chapter 5 of EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. The comparison must consider each of the individual wells in the monitoring system and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (and decreases, in the case of pH) over background (40 CFR 265.93(b) and Appendix IV to 40 CFR 265). Implementation of the statistical test method at the Hanford Site, including at the 216-A-37-1 Crib, is generally consistent with EPA 530/R-09-007. The background statistical analysis is updated annually to establish comparative values for indicator parameters. A rolling mean is used because of changing upgradient concentrations and groundwater flow conditions. The practice of annually updating the background values is consistent with statistical evaluation methods for TSD units in final status under WAC 173-303-645(8)(h), "Releases from Regulated Units," "General Groundwater Monitoring Requirements."

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

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

4.3 Interpretation

Data are used to interpret groundwater conditions at the 216-A-37-1 Crib. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.

- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to 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.
- **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.

4.4 Annual Determination of Monitoring Network

Groundwater monitoring requirements include an annual evaluation of the network 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 (40 CFR 265.93(f)). 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 current groundwater monitoring network will continue to be re-evaluated to ensure that it is adequate to monitor the any changing hydrogeologic conditions beneath the unit. If flow changes are observed, the 216-A-37-1 Crib CSM and geochemical trends will be re-evaluated 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, and the data are presented in the annual Hanford Site RCRA groundwater monitoring reports (e.g., DOE/RL-2016-12).

4.5 Reporting and Notification

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

If an upgradient well comparison shows a significant increase (or pH decrease) relative to the statistical comparison value, that information is also reported (40 CFR 265.93(c)(1)) in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2016-12).

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

5 Outline for Groundwater Quality Assessment Plan

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

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

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

Table 5-1. Suggested Groundwater Quality Assessment Plan Outline

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

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

6 References

10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=24aad4966ac52acbeba416c2c1114889&mc=true&node=pt10.4.962&rgn=div5.

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

265.90, "Applicability."

265.91, "Ground-Water Monitoring System."

265.92, "Sampling and Analysis."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

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

Appendix IV, "Tests for Significance."

Atomic Energy Act of 1954, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: http://epw.senate.gov/atomic54.pdf.

BHI-00184, 1995, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0083482H.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

CP-57037, 2014, *Model Package Report, Plateau to River Groundwater Transport Model Version 7.1*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080149H.

DOE/RL-93-88, 1994, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D196094135.

DOE/RL-96-61, 1997, *Hanford Site Background: Part 3, Groundwater Background*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197226378.

DOE/RL-98-28, 1999, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199153696.

DOE/RL-2002-39, 2002, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0081471H.

DOE/RL-2003-04, 2003, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D3818675.

DOE/RL-2009-85, 2012, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0091415.

DOE/RL-2009-85-ADD1, 2015, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit Addendum 1*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080465H.

DOE/RL-2010-92, 2010, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1106170793.

DOE/RL-2010-92, 2011, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=1106271470.

DOE/RL-2011-01, 2011, *Hanford Site Groundwater Monitoring Report for 2010*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093693.

DOE/RL-2015-07, 2015, *Hanford Site Groundwater Monitoring Report for 2014*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080600H.

DOE/RL-2015-49, 2016, *Interim Status Groundwater Quality Assessment Plan for the Single Shell Waste Management Area A-AX*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0073187H.

DOE/RL-2016-12, 2016, *Hanford Site RCRA Groundwater Monitoring Report for 2015*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0077828H.

ECF-Hanford-13-0029, 2015, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080813H.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

Ecology Publication 97-407, 2014, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*, Hazardous Waste and Toxics Reduction Program, Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/97407.pdf.

EPA 530/R-09-007, 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.itrcweb.org/gsmc-1/Content/Resources/Unified_Guidance_2009.pdf.

NAD83, 1991, *North American Datum of 1983*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland, as revised. Available at: http://www.ngs.noaa.gov/.

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

PNL-2724, 1978, *Vertical Contamination in the Unconfined Groundwater at the Hanford Site, Washington*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196008014.

PNL-8971, 1993, *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1993 Status Report*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://www.osti.gov/scitech/servlets/purl/10116050.

PNNL-11523, 1997, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D1662256.

PNNL-11523, 2005, *Interim-Status RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=DA572902.

PNNL-12261, 2000, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0906180659.

PNNL-16407, 2007, *Geology of the Waste Treatment Plant Seismic Boreholes*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16407rev1.pdf.

PNNL-19277, 2010, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084238.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105&full=true.

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

RPP-14430, 2003, *Subsurface Conditions Description of the C and A-AX Waste Management Area*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0911240298.

RPP-23748, 2006, *Geology, Hydrogeology, and Mineralogy Data Package for the Single-Shell Tank Farm Waste Management Area at Hanford*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079752H.

SGW-38815, 2009, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*, Rev. 0, U.S. Department of Energy, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0082378H.

SGW-54165, 2014, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*, Rev. 0, U.S. Department of Energy, Richland, Washington, Available at: http://www.hanford.gov/files.cfm/SGW-54165_-_Rev_00.pdf.

SGW-58828, 2015, *Water Table Maps for the Hanford Site 200 East Area, 2013 and 2014*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079727H.

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

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

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

303-040, "Definitions."

303-080, "Dangerous Waste Lists."

303-100, "Dangerous Waste Criteria."

303-400, "Interim Status Facility Standards."

303-645, "Releases from Regulated Units."

303-9904, "Dangerous Sources List."

WHC-EP-0342, Addendum 15, 1990, *242-A Evaporator Process Condensate Stream-Specific Report*, Westinghouse Hanford Company, Richland, Washington, Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196021610.

WHC-MR-0391, 1992, *Field Trip Guide to the Hanford Site*, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D196136627.

WHC-MR-0517, 1996, *Listed Waste History at Hanford Facility TSD Units*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/30/040/30040521.pdf.

Appendix A

Quality Assurance Project Plan

This page intentionally left blank.

Contents

A1 Introduction **A-1**

A2 Project Management **A-1**

A2.1 Project/Task Organization A-1

A2.1.1 DOE-RL Manager A-1

A2.1.2 DOE-RL Project Lead A-1

A2.1.3 Soil and Groundwater Remediation Project Remedy Selection and Implementation Director A-2

A2.1.4 Project Delivery Manager for Groundwater Science A-2

A2.1.5 Sample Management and Reporting Group A-3

A2.1.6 Field Sampling Organization A-3

A2.1.7 Quality Assurance A-3

A2.1.8 Environmental Compliance Officer A-3

A2.1.9 Health and Safety A-4

A2.1.10 Waste Management A-4

A2.1.11 Analytical Laboratories A-4

A2.2 Problem Definition/Background A-4

A2.3 Project/Task Description A-4

A2.4 Quality Assurance Objectives and Criteria A-4

A2.5 Special Training/Certification A-8

A2.6 Documents and Records A-8

A3 Data Generation and Acquisition **A-11**

A3.1 Analytical Method Requirements A-11

A3.2 Field Analytical Methods A-13

A3.3 Quality Control A-14

A3.3.1 Field Quality Control Samples A-19

A3.3.2 Laboratory Quality Control Samples A-20

A3.4 Measurement Equipment A-22

A3.5 Instrument and Equipment Testing, Inspection, and Maintenance A-22

A3.6 Instrument/Equipment Calibration and Frequency A-22

A3.7 Inspection/Acceptance of Supplies and Consumables A-22

A3.8 Nondirect Measurements A-22

A3.9 Data Management A-22

A4 Assessment and Oversight **A-23**

A4.1 Assessments and Response Actions A-23

A4.2 Reports to Management A-23

A5 Data Review and Usability A-23

A5.1 Data Review and Verification A-24

A5.2 Data Validation A-24

A5.3 Reconciliation with User Requirements A-24

A6 References A-25

Tables

Table A-1. Data Quality Indicators A-5

Table A-2. Change Control for Monitoring Plans A-8

Table A-3. Analytical Requirements for Groundwater Analysis A-11

Table A-4. QC Samples A-14

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria A-15

Table A-6. Preservation and Holding Time Guidelines for Laboratory Analyses A-21

Figure

Figure A-1. Project Organization A-2

Terms

CAS	Chemical Abstracts Service
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQA	data quality assessment
DQI	data quality indicator
DUP	duplicate (laboratory)
EB	equipment blank
ECO	Environmental Compliance Officer
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FTB	full trip blank
FSO	Field Sample Operations
FWS	Field Work Supervisor
GC/MS	gas chromatography/mass spectrometry
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL-96-68)
HEIS	Hanford Environmental Information System
LCS	laboratory control sample
MB	method blank
MDC	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
PQL	practical quantitation limit
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control

RCRA	*Resource Conservation and Recovery Act of 1976*
RPD	relative percent difference
S&GRP	Soil and Groundwater Remediation Project
SAF	Sampling Authorization Form
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a)
Tri-Party Agreement Action Plan	*Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b)
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

A1 Introduction

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. It includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection requirements and controls based on the quality assurance (QA) elements found in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5) and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD). Sections 6.5 and 7.8 of the Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan* (Tri-Party Agreement Action Plan) require the QA, quality control (QC) and sampling and analysis activities to specify QA requirements for treatment, storage, and disposal (TSD) units, as well as for past practice processes. This QAPjP also describes the applicable requirements and controls based on guidance provided in Ecology Publication No. 04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*, and EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans* (EPA QA/G-5). This QAPjP is intended to supplement the contractor's environmental QA program plan.

This QAPjP is divided into the following five chapters, which describe the quality requirements and controls applicable to the 216-A-37-1 Crib groundwater monitoring activities:

- Chapter A2, Project Management
- Chapter A3, Data Generation and Acquisition
- Chapter A4, Assessment and Oversight
- Chapter A5, Data Review and Usability
- Chapter A6, References

A2 Project Management

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

A2.1 Project/Task Organization

Project organization (regarding routine groundwater monitoring) is described in the following subsections and illustrated in Figure A-1.

A2.1.1 DOE-RL Manager

Hanford Site cleanup is the responsibility of U.S. Department of Energy (DOE)-Richland Operations Office (RL). The DOE-RL 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., 1989a, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement).

A2.1.2 DOE-RL Project Lead

The DOE-RL 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 the DOE-RL management.

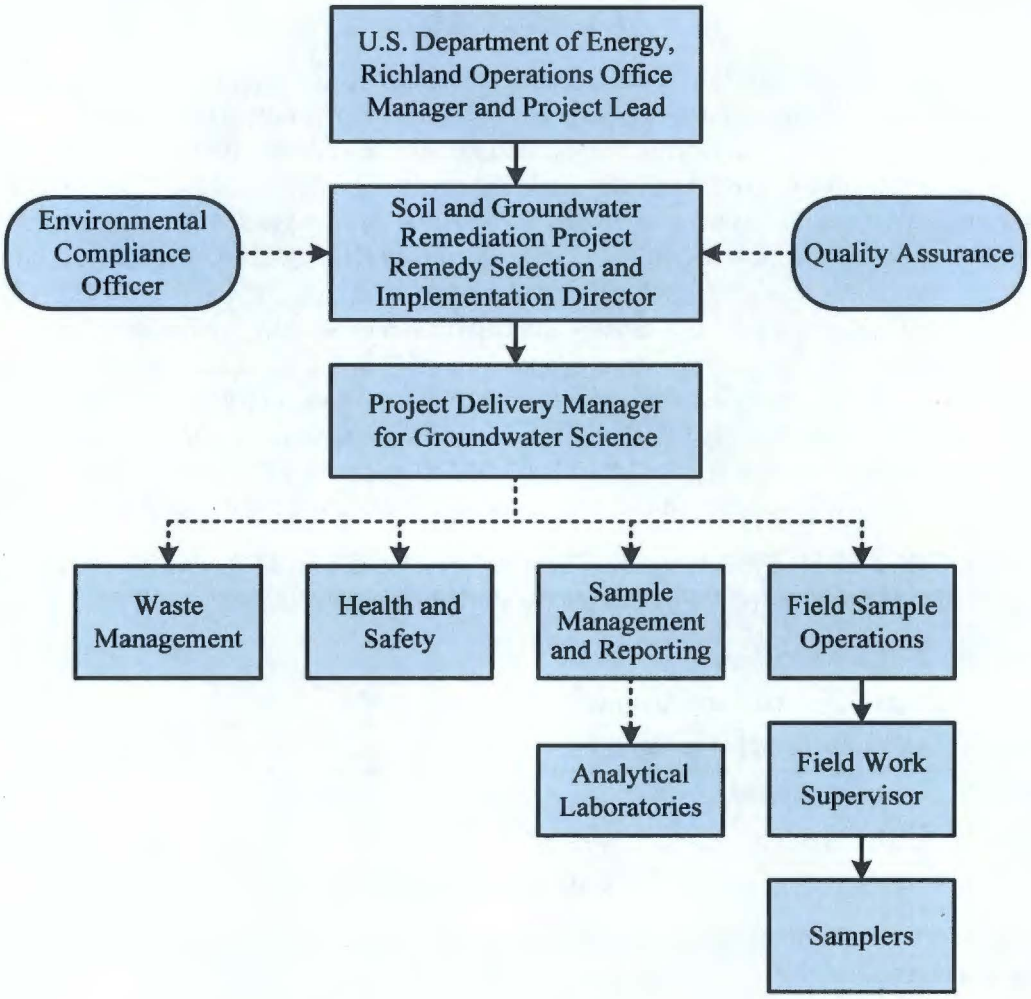


Figure A-1. Project Organization

A2.1.3 Soil and Groundwater Remediation Project Remedy Selection and Implementation Director

The Soil and Groundwater Remediation Project (S&GRP) Remedy Selection and Implementation Director provides oversight and coordinates with DOE-RL and primary contractor management in support of sampling and reporting activities. The Remedy Selection and Implementation Director also provides support to the Project Delivery Manager for Groundwater Science to ensure that work is performed safely and cost effectively.

A2.1.4 Project Delivery Manager for Groundwater Science

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

A2.1.5 Sample Management and Reporting Group

The SMR group oversees offsite analytical laboratories, coordinates laboratory analytical work to ensure that laboratories conform to the requirements of this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. The SMR group generates field sampling documents, labels, and instructions for field sampling personnel and develops the Sampling Authorization Form (SAF), which provides information and instruction to the analytical laboratories. The SMR group ensures that field sampling documents are revised to reflect approved changes. The SMR group receives analytical data from the laboratories, ensures it is appropriately reviewed, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation and recordkeeping. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with Field Sample Operations (FSO), laboratories, or other entities. The SMR group is responsible for informing the Project Delivery Manager for Groundwater Science of any issues reported by the analytical laboratories.

A2.1.6 Field Sampling Organization

FSO is responsible for planning and coordinating field sampling resources and provides the Field Work Supervisor (FWS) for routine groundwater sampling operations. The FWS directs the nuclear chemical operators (samplers), who collect groundwater samples in accordance with this groundwater monitoring plan and corresponding standard procedures and work packages. The FWS ensures that deviations from field sampling documents or issues encountered in the field are documented appropriately (e.g., in the field logbook). The FWS ensures that samplers are appropriately trained and available. Samplers collect samples in accordance with sampling documentation. Samplers also complete field logbooks, data forms, and chain-of-custody forms, including any shipping paperwork, and enable delivery of the samples to the analytical laboratory.

Pre-job briefings are conducted by FSO, in accordance with work management and work release requirements, to evaluate activities and associated hazards by considering the following factors:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required

A2.1.7 Quality Assurance

The QA point of contact provides independent oversight and is responsible for addressing QA issues on the project and overseeing implementation of the project QA requirements. Responsibilities include reviewing project documents, including the QAPjP, and participating in QA assessments on sample collection and analysis activities, as appropriate.

A2.1.8 Environmental Compliance Officer

The ECO provides technical oversight, direction, and acceptance of project and subcontracted environmental work and also develops appropriate mitigation measures with the goal of minimizing adverse environmental impacts.

A2.1.9 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulations or internal primary contractor work requirements.

A2.1.10 Waste Management

Waste Management is responsible for identifying waste management sampling/characterization requirements, to ensure regulatory compliance, and for interpreting data to determine waste designations and profiles. Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

A2.1.11 Analytical Laboratories

The analytical laboratories analyze samples, in accordance with established procedures and the requirements of this plan, and provide necessary data packages containing analytical and QC results. Laboratories provide explanations of results to support data review and in response to resolution of analytical issues. Statements of work flow down quality requirements consistent with the HASQARD (DOE/RL-96-68). The laboratories are evaluated under the DOE Consolidated Audit Program and must be accredited by the Washington State Department of Ecology (Ecology) for the analyses performed for S&GRP.

A2.2 Problem Definition/Background

The purpose to this groundwater monitoring plan is to satisfy *Washington Administrative Code* (WAC) and *Code of Federal Regulations* (CFR) requirements (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," and 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring,") for indicator evaluation program monitoring. More specific information on the activities to satisfy these requirements is provided in the main text of this monitoring plan in Chapter 1 and Sections 2.7, 3.1, 3.2, and 4.2. Background information on monitoring is also provided in the main text (Sections 2.2, 2.5, and 3.3).

A2.3 Project/Task Description

The focus of this plan is to monitor the parameters used as indicators of groundwater contamination and for parameters establishing groundwater quality in accordance with 40 CFR 265.92(b)(2)&(3) and (d), "Sampling and Analysis;" evaluate the well network; and interpret analytical results. The indicator parameters to be monitored, along with the monitoring wells and frequency of sampling, are provided in the main text (Chapter 3). Information on the collection and analyses of groundwater from the monitoring network is provided in this appendix and in Appendix B.

A2.4 Quality Assurance Objectives and Criteria

The QA objective of this plan is to ensure that the generation of analytical data of known and appropriate quality is acceptable and useful in order to meet the evaluation requirements stated in the monitoring plan. In support of this objective, data descriptors known as data quality indicators (DQIs) are used to help determine the acceptability and usefulness of the data to the user. Principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These DQIs are defined for the purposes of this document in Table A-1.

Table A-1. Data Quality Indicators

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

Table A-1. Data Quality Indicators

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

Table A-1. Data Quality Indicators

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

Source: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, as amended.

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

Data quality is defined by the degree of rigor in the acceptance criteria assigned to the DQIs. The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. DQIs are evaluated during the data quality assessment (DQA) process (Section A5.3).

A2.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility for collecting and transporting groundwater samples according to the dangerous waste training plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The FWS, in coordination with line management, will ensure that special training requirements for field personnel are met.

Training has been instituted by the contractor management team to meet training and qualification programs that satisfy multiple training drivers imposed by the applicable CFR and WAC requirements. Training records are maintained for each employee in an electronic training record database. The contractor's training organization maintains the training records system. Line management confirms that an employee's training is appropriate and up-to-date prior to performing any field work.

A2.6 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. Version control is maintained by the administrative document control process. 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 265.92 (e.g., water-level measurements will be collected each time a sample is obtained) cannot be changed.

Table A-2. Change Control for Monitoring Plans

Type of Change*	Action	Documentation
Temporary addition of wells or site-specific constituents, or increased sampling frequency that does not impact the requirements of 40 CFR 265.92.	Project Delivery Manager for Groundwater Science approves temporary change; provides informal notification to DOE-RL.	SMR group's integrated groundwater monitoring schedule
Unintentional impact to groundwater monitoring plan that impacts the indicator parameter 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 indicator parameters, or loss of samples in transit.	Project Delivery Manager for Groundwater Science provides electronic notification to DOE-RL. DOE-RL provides informal notification to Ecology as appropriate.	Annual Hanford Site RCRA groundwater monitoring report
Planned change to groundwater monitoring activities, including addition or deletion of supporting constituents, change of sampling frequency for supporting constituents, or changes to well network.	Project Delivery Manager for Groundwater Science obtains DOE-RL approval; revise monitoring plan as appropriate.	Annual Hanford Site RCRA groundwater monitoring report and revised groundwater monitoring plan as appropriate

Table A-2. Change Control for Monitoring Plans

Type of Change*	Action	Documentation
Anticipated unavoidable changes	Project Delivery Manager for Groundwater Science provides electronic notification to DOE-RL; revise monitoring plan as appropriate.	Annual Hanford Site RCRA groundwater monitoring report and revised groundwater monitoring plan as appropriate.

Note: 40 CFR 265.93, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," contains additional sampling and notification requirements should indicator parameter results demonstrate a significant increase (or pH decrease).

40 CFR 265, Subpart F, "Ground-Water Monitoring."

* "Site-specific constituents" are any constituents that may be included in this monitoring plan as additional analytes but are not required by 40 CFR 265.92, "Sampling and Analysis."

DOE-RL = U.S. Department of Energy, Richland Operations Office
Ecology = Washington State Department of Ecology
RCRA = *Resource Conservation and Recovery Act of 1976*
SMR = Sample Management and Reporting

Logbooks and data forms are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for the logbooks shall be identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes.

The FWS, SMR group, and any field crew supervisors are responsible for ensuring that field instructions are maintained and aligned with any revisions or approved changes to the groundwater monitoring plan. The SMR group will ensure that any deviations from the plan are reflected in revised field sampling documents for the samplers and analytical laboratory. The FWS or appropriate field crew supervisors will ensure that deviations from the plan or problems encountered in the field are documented appropriately (e.g., in the field logbook).

The Project Delivery Manager for Groundwater Science, FWS, or designee is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities. The Project Delivery Manager for Groundwater Science is also responsible for ensuring that project files are setup, as appropriate, and/or maintained. The project files will contain project records or references to their storage locations. Project files generally include, as appropriate, the following information:

- Operational records and logbooks
- Data forms
- Global positioning system data (a copy will be provided to the SMR group)
- Inspection or assessment reports and corrective action reports
- Field summary reports
- Interim progress reports
- Final reports

- Forms required by WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the master drilling contract

The following records are managed and maintained by SMR personnel:

- Completed field sampling logbooks
- Groundwater sample reports and field sample reports
- Completed chain-of-custody forms
- Sample receipt records
- Laboratory data packages
- Analytical data verification and validation reports
- Analytical data case file purges (i.e., raw data purged from laboratory files) provided by offsite analytical laboratories

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

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information
- Training records for employees, as they relate to analytical methods.
- Laboratory state accreditation records
- Laboratory audit records

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 hard copy format (e.g., DOE Records Holding Area). Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement (Ecology et al., 1989a) will be managed in accordance with the requirements therein. Records of analyses required by 40 CFR 265.92(c) and (d), as well as associated groundwater surface elevations required by 40 CFR 265.92(e) are to be maintained throughout the active life of a facility and post-closure care period.

Results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in the annual Hanford Site RCRA groundwater monitoring reports (e.g., DOE/RL-2016-12, *Hanford Site RCRA Groundwater Monitoring Report for 2015*).

A3 Data Generation and Acquisition

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

A3.1 Analytical Method Requirements

Analytical method requirements, for samples collected are presented in Table A-3. Updated U.S. Environmental Protection Agency (EPA) methods may be substituted for the analytical methods identified in Table A-3.

Table A-3. Analytical Requirements for Groundwater Analysis

Constituent	Analytical Method[a]	Highest Allowable Practical Quantitation Limit[b] (µg/L)
Drinking Water Suitability Parameters[c]		
Arsenic	SW-846 Method 6010B/C	10
Barium		100
Cadmium		5
Chromium		10
Fluoride[d]	EPA/600 Method 300.0	500
Lead	SW-846 Method 6010B/C	15
Mercury	SW-846 Method 7470	0.5
Nitrate (as N)[d]	EPA/600 Method 300.0	100
Selenium	SW-846 Method 6010B/C	50
Silver		10
Endrin	SW-846 Method 8081	0.1
Lindane		0.05
Methoxychlor		0.5
Toxaphene		2
2,4-D	SW-846 Method 8150	20
2,4,5-TP Silvex		1
Radium-226[e]	Lucas Cell or Gamma Energy Analysis	1 pCi/L
Radium-228[e]	Gamma Energy Analysis	3 pCi/L
Gross Alpha	Gas Proportional Counting	3 pCi/L
Gross Beta		4 pCi/L
Coliform Bacteria	Standard Method 9223	N/A

Table A-3. Analytical Requirements for Groundwater Analysis

Constituent	Analytical Method[a]	Highest Allowable Practical Quantitation Limit[b] (µg/L)
Turbidity	Field measurement Instrument/meter	N/A
Groundwater Quality Parameters (40 CFR 265.92(b)(2))		
Chloride[d]	EPA/600 Method 300.0	400
Sulfate[d]		550
Iron	SW-846 Method 6010B/C	100
Manganese		15
Sodium		1,000
Phenols	SW-846 Method 8270D	10[f]
Contamination Indicator Parameters (40 CFR 265.92(b)(3))		
pH	Field measurement Instrument/meter	N/A
Specific Conductance		N/A
Total Organic Carbon	SW-846 Method 9060	1,000
Total Organic Halogen	SW-846 Method 9020	10
Site-Specific Constituents[g]		
Alkalinity[h]	EPA/600 Method 310.1 or Standard Method 2320	5,000
Bicarbonate alkalinity		-[i]
Carbonate alkalinity		-[i]
Hydroxide alkalinity		-[i]
Fluoride[d]	EPA/600 Method 300.0	500
Nitrate[d]		250
Nitrite[d]		250
Calcium	SW-846 Method 6010B/C	1,000
Chromium		10
Iron		100
Magnesium		1,000
Manganese		15
Nickel		40
Potassium		5,000
Hexavalent chromium	SW-846 Method 7196	10

Table A-3. Analytical Requirements for Groundwater Analysis

Constituent	Analytical Method[a]	Highest Allowable Practical Quantitation Limit[b] (µg/L)
Temperature	Field Measurement Instrument/Meter	N/A
Turbidity		N/A

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

Appendix III, "EPA Interim Primary Drinking Water Standards"

Note: Analytical methods and highest allowable PQLs provided in this table do not represent EPA requirements but are intended solely as guidance.

a. For EPA Methods 300.0 and 310.1, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples.* For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V.* Equivalent methods may be substituted.

b. For purposes of this groundwater monitoring plan, the highest allowable PQL is interchangeable with the lower limit of quantitation, which is the lowest level that can be routinely quantified and reported by a laboratory. The highest allowable PQLs are not to be exceeded and are specified in contracts with analytical laboratories. Actual quantitation limits vary by laboratory and may be lower than required contractually. MDLs are three to five times lower than quantitation limits.

c. Parameters characterizing the suitability of groundwater as a drinking water supply as presented in Appendix III to 40 CFR 265 will be monitored for 1 year at the wells identified in Table 3-2 of the main text.

d. For general chemistry analyses, dilutions for certain ion chromatography constituents may be necessary, potentially raising the PQL above the limits established in this table. In circumstances where the PQL is critical to a project, the SMR group will negotiate with the project scientist regarding project-specific requirements.

e. Radium (total) determined by combining Radium-226 and Radium-228 concentrations.

f. PQL provided for phenol (CAS No. 108-95-2). Other PQL values may apply to other phenolic compounds.

g. Site-specific constituents/measurements are not required by RCRA but are used to support interpretation.

h. For general chemistry analyses, MDLs and PQLs are not strictly determinable. The highest allowable PQLs represent the lowest concentrations that laboratories should be able to measure given current analytical methods and instrumentation.

i. Constituent concentration is calculated from alkalinity and does not have an individual PQL.

CAS = Chemical Abstracts Service
EPA = U.S. Environmental Protection Agency
MDL = method detection limit
N/A = not applicable
PQL = practical quantitation limit
RCRA = Resource *Conservation and Recovery Act of 1976*
SMR = Sample Management and Reporting

A3.2 Field Analytical Methods

Field screening and survey data will be measured in accordance with HASQARD (DOE/RL-96-68) requirements (as applicable). Field analytical methods may also be performed in accordance with manufacturer manuals. Table A-3 provides the parameters (if any) identified for field measurements. Appendix B provides further discussion on field measurements.

A3.3 Quality Control

QC requirements specified in the plan must be followed in the field and analytical laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects of the analytical data. Field and laboratory QC samples 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 HEIS, as appropriate.

Table A-4. QC Samples

Sample Type	Frequency	Characteristics Evaluated
Field QC		
Field Duplicates	One in 20 well trips	Precision, including sampling and analytical variability
Field Splits	As needed When needed, the minimum is one for every analytical method, for analyses performed.	Precision, including sampling, analytical, and interlaboratory
Full Trip Blanks	One in 20 well trips	Cross-contamination from containers or transportation
Equipment Blanks	As needed If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment blank is not required; otherwise, one for every 20 samples[a]	Adequacy of sampling equipment decontamination and contamination from nondedicated equipment
Analytical QC[b]		
Laboratory Duplicates	One per analytical batch[c]	Laboratory reproducibility and precision
Matrix Spikes	One per analytical batch[c]	Matrix effect/laboratory accuracy
Matrix Spike Duplicates	One per analytical batch[c]	Laboratory accuracy and precision
Laboratory Control Samples	One per analytical batch[c]	Laboratory accuracy
Method Blanks	One per analytical batch[c]	Laboratory contamination
Surrogates	Added to each sample and QC sample[c]	Recovery/yield
Tracers	Added to each sample and quality control sample[c]	Recovery/yield

Note: The information in this table does not represent EPA requirements but is intended solely as guidance.

a. For portable pumps, equipment blanks are collected one for every 10 well trips. Whenever a new type of nondedicated equipment is used, an equipment blank will be collected every 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. Batching across projects is allowed for similar matrices (e.g., all Hanford groundwater).

c. Unless not required by, or different frequency is called out in, laboratory analysis methods.

EPA = U.S. Environmental Protection Agency

QC = quality control

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

Analysis	Quality Control	Acceptance Criteria	Corrective Action
General Chemistry			
Alkalinity (includes bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity)	MB	<MDL <5% Sample Concentration	Flag with "C"
	LCS	80 to 120% recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	75 to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Coliform	MB	Pass/Fail[d]	Review Data[a]
	LCS	Pass/Fail[d]	Review Data[a]
	DUP	Pass/Fail[d]	Review Data[a]
Total organic carbon	MB	<MDL <5% Sample Concentration	Flag with "C"
	LCS	80 to 120% recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	75 to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Total organic halogen	MB	<MDL <5% Sample Concentration	Flag with "C"
	LCS	80 to 120% recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	75 to125% recovery	Flag with "N"
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Anions			
Anions by ion chromatography (chloride, fluoride, nitrate, nitrite, and sulfate)	MB	<MDL <5% Sample Concentration	Flag with "C"
	LCS	80 to 120% recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	75 to 125% recovery	Flag with "N"

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

Analysis	Quality Control	Acceptance Criteria	Corrective Action
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Metals			
Inductively coupled plasma/atomic emission spectrometry metals (calcium, chromium, iron, magnesium, manganese, nickel, potassium, and sodium)	MB	<MDL <5% Sample Concentration	Flag with "C"
	LCS	80 to 120% recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	75 to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Mercury by cold-vapor atomic absorption	MB	<MDL <5% Sample Concentration	Flag with "C"
	LCS	80 to 120% recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	75 to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Hexavalent chromium	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80-120% recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	75 to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Semivolatile Organic Compounds			
Phenols by gas chromatography/mass spectrometry	MB	<MDL <5% Sample Concentration	Flag with "B"
	LCS	70 to 130% Recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Flag with "T"
	MS/MSD	% Recovery Statistically Derived[e]	Review Data[a]
	SUR	70 to 130% Recovery	Review Data[a]

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

Analysis	Quality Control	Acceptance Criteria	Corrective Action
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Herbicides by gas chromatography (2,4-D and 2,4,5,-TP silvex)	MB	<MDL <5% Sample Concentration	Flag with "B"
	LCS	70 to 130% Recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	% Recovery Statistically Derived[e]	Flag with "N"
	SUR	70 to 130% Recovery	Review Data[a]
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Pesticides by gas chromatography (endrin, lindane, methoxychlor, and toxaphene)	MB	<MDL <5% Sample Concentration	Flag with "B"
	LCS	70 to 130% Recovery	Review Data[a]
	DUP[b]/MSD[b]	≤20% RPD[c]	Review Data[a]
	MS/MSD	% Recovery Statistically Derived[e]	Flag with "N"
	SUR	70 to 130% Recovery	Review Data[a]
	EB, FTB	<MDL <5% Sample Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[c]	Review Data[a]
Radiological			
Gross alpha	MB	<MDC <5% Sample Activity Concentration	Flag with "B"
	LCS	80 to 120% Recovery	Review Data[a]
	DUP	≤20% RPD[f]	Review Data[a]
	EB, FTB	<MDC <5% Sample Activity Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[f]	Review Data[a]
Gross beta	MB	<MDC <5% Sample Activity Concentration	Flag with "B"
	LCS	80 to 120% Recovery	Review Data[a]
	DUP	≤20% RPD[f]	Review Data[a]
	EB, FTB	<MDC <5% Sample Activity Concentration	Flag with "Q"

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

Analysis	Quality Control	Acceptance Criteria	Corrective Action
	Field Duplicate/SPLIT	≤20% RPD[f]	Review Data[a]
Radium-226 by Lucas Cell or gamma energy analysis	MB	<MDC <5% Sample Activity Concentration	Flag with "B"
	LCS	80-120% Recovery	Review Data[a]
	DUP	≤20% RPD[c]	Review Data[a]
	Tracer[g]	30-105% Recovery	Review Data[a]
	EB, FTB	<MDC <5% Sample Activity Concentration	Flag with "Q"
	Field Duplicate	≤20% RPD[c]	Review Data[a]
Radium-228 by gamma energy analysis	MB	<MDC <5% Sample Activity Concentration	Flag with "B"
	LCS	80 to 120% Recovery	Review Data[a]
	DUP	≤20% RPD[f]	Review Data[a]
	EB, FTB	<MDC <5% Sample Activity Concentration	Flag with "Q"
	Field Duplicate/SPLIT	≤20% RPD[f]	Review Data[a]

Notes:

The information in this table does not represent EPA requirements but is intended solely as guidance. The table is consistent with SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*; and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document.*

This table only applies to laboratory analyses. Specific conductance, pH, temperature, and turbidity are not listed as they are measured in the field.

a. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data as suspect (Y flag), failed field QC (Q flag), or rejected (R flag).

b. Either a DUP or a MSD is to be analyzed to determine measurement precision.

c. Applies when at least one result is greater than the laboratory PQL (chemical analyses).

d. Passing QC; MB = no colonies detected, LCS = appropriate colonies detected, DUP = colonies detected/undetected are consistent with sample.

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

f. Applies only in cases where both results are greater than 5 times the MDC.

g. Where applicable, tracers are not used for all techniques (i.e., gamma energy analysis).

DUP = laboratory sample duplicate
EB = equipment blank
EPA = U.S. Environmental Protection Agency
FTB = full trip blank
LCS = laboratory control sample
MB = method blank
MDC = minimum detectable activity
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
PQL = practical quantitation limit
QC = quality control
RPD = relative percent difference
SPLIT = field split
SUR = surrogate

Data Flags

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

Analysis	Quality Control	Acceptance Criteria	Corrective Action

B, C = possible laboratory contamination: analyte was detected in the associated method blank.

N = result may be biased: associated matrix spike result was outside the acceptance limits (except gas chromatograph/mass spectrometry).

Q = problem with associated field QC blank: results were out of limits.

T = result may be biased: associated matrix spike result was outside the acceptance limits (gas chromatograph/mass spectrometry only).

A3.3.1 Field Quality Control Samples

Field QC samples are collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability and laboratory performance to help ensure that reliable data are obtained. Field QC samples include field duplicates, field split (SPLIT) samples, and two types of field blanks (full trip blanks [FTBs] and equipment blanks [EBs]). Field blanks are typically prepared using high-purity reagent water. QC sample definitions and their required frequency for collection are described below:

Field duplicates: independent samples collected as close as possible to the same time and same location as the scheduled sample, and intended to be identical. Field duplicates are placed in separate sample containers and analyzed independently. Field duplicates are used to determine precision for both sampling and laboratory measurements.

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

Full trip blanks (FTBs): bottles prepared by the sampling team before travel to the sampling site. The preserved bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. It is filled with high-purity reagent water[1], and the bottles are sealed and transported (unopened) to the field in the same storage containers used for samples collected that day. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event. FTBs are used to evaluate potential contamination of the samples attributable to the sample bottles, preservative, handling, storage, and transportation.

Equipment blanks (EBs): Reagent water passed through or poured over the decontaminated sampling equipment identical to the sample set collected and placed in sample containers, as identified on the SAF. EB sample bottles are placed in the same storage containers with samples from the associated sampling event. EB samples will be analyzed for the same constituents as samples from the associated sampling event. EBs are used to evaluate the effectiveness of the decontamination process and these samples are not required for disposable sampling equipment.

[1] High-purity water that is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques (DOE/RL-96-68).

A3.3.2 Laboratory Quality Control Samples

Internal QA/QC programs are maintained by laboratories used by the project. Laboratory QA includes a comprehensive QC program that includes the use of laboratory sample duplicates (DUPs), matrix spikes (MSs), matrix spike duplicates (MSDs), laboratory control samples (LCSs), method blanks (MBs), surrogates (SURs) and tracers. These QC analyses are required by EPA methods (e.g., those in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*), and will be run at the frequency specified in the respective references unless superseded by agreement. QC checks outside of control limits are documented in analytical laboratory reports during DQAs, if performed. Laboratory QC checks and their typical frequencies are listed in Table A-4. Acceptance criteria are shown in Table A-5. Descriptions of the various types of laboratory QC samples are as follows:

Laboratory sample duplicate (DUP): an intralaboratory replicate sample that is used to evaluate the precision of a method in a given sample matrix.

Matrix spike (MS): an aliquot of a sample spiked with a known concentration of target analyte(s). MS is used to assess the bias of a method in a given sample matrix. Spiking occurs prior to sample preparation and analysis.

Matrix spike duplicate (MSD): 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.

Laboratory control sample (LCS): 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.

Method blank (MB): 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 procedure and is used to quantify contamination resulting from the analytical process.

Surrogate (SUR): 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 measurement systems in a manner similar to the analytes of interest. Because SURs are added to every standard, sample, and QC sample, they are used to evaluate overall method performance in a given matrix. SURs are used only in organic analyses.

Tracer: a known quantity of radioactive isotope that is different from that of the isotope of interest but is expected to behave similarly and is added to an aliquot of sample. Sample results are generally corrected based on tracer recovery.

Laboratories are required to analyze samples within the holding time specified 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/ Parameter	Preservation*	Holding Time
Alkalinity (includes bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity)	Store ≤6°C	14 days
Coliform	Store ≤6°C, $Na_2S_2O_3$	6 hours
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 by ion chromatography (chloride, fluoride, nitrate, nitrite, and sulfate)	Store ≤6°C	48 hours
Herbicides by GC (2,4-D, 2,4,5-TP and silvex)	Store ≤6°C	7 days before extraction 40 days after extraction
Pesticides by GC (endrin, lindane, methoxychlor, and toxaphene)	Store ≤6°C	7 days before extraction 40 days after extraction
Hexavalent chromium	Store ≤6°C	24 hours
Inductively coupled plasma metals (calcium, iron, magnesium, manganese, potassium and sodium)	Adjust pH to <2 with nitric acid	6 months
Mercury by cold-vapor atomic absorption	Adjust pH to <2 with nitric acid	28 days
Phenols by GC/MS	Store ≤6°C	7 days before extraction 40 days after extraction
Gross alpha/beta by gas proportional counting	Adjust pH to <2 with nitric acid	6 months
Radium-226/Radium-228	Adjust pH to <2 with nitric acid	6 months

Notes:

The information in this table does not represent EPA requirements but is intended solely as guidance.

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

This table only applies to laboratory analyses. Specific conductance, pH, temperature, and turbidity are not listed as they are measured in the field.

* 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

GC/MS = gas chromatography/mass spectrometry

A3.4 Measurement Equipment

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

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

Collection, measurement, and testing equipment should meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or should have been evaluated as acceptable and valid in accordance with instrument-specific methods, requirements, and specifications. Software applications will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory will be subject to preventive maintenance measures to ensure minimization of downtime. Laboratories must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating protocols, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent applicable Hanford Site requirements.

A3.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Appendix B. Analytical laboratory instruments are calibrated in accordance with the laboratory's QA plan and applicable Hanford Site requirements.

A3.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with test methods in SW-846 and will be appropriate for their use. Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes. Responsibilities and interfaces necessary to ensure that items procured/acquired for the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

A3.8 Nondirect Measurements

Data obtained from sources, such as computer databases, programs, literature files, and historical databases, will be technically reviewed to the same extent as data generated as part of any sampling and analysis QA/QC effort. Data used in evaluations will be identified by source.

A3.9 Data Management

The SMR group, in coordination with the Project Delivery Manager for Groundwater Science, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements governing data management methods. Records of data analyses and groundwater surface elevations are maintained as required by 40 CFR 265.94(a)(1).

Electronic data access, when appropriate, will be through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the SMR group through an established process. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with applicable methods. This process is used to document analytical errors and establish their resolution with the Project Delivery Manager for Groundwater Science. The sample issue resolution forms become a permanent part of the analytical data package for future reference and records management.

A4 Assessment and Oversight

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

A4.1 Assessments and Response Actions

Random surveillances and assessments verify compliance with the requirements outlined in this plan, project field instructions, the QAPjP, methods, and regulatory requirements. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project line management chain coordinates the corrective actions/deficiency resolutions in accordance with the QA program, corrective action management program, and associated methods implementing these programs. When appropriate, corrective actions will be taken by the Project Delivery Manager for Groundwater Science.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with laboratory QA plans. The SMP group oversees offsite analytical laboratories and verifies that laboratories are qualified to perform Hanford Site analytical work.

A4.2 Reports to Management

Program and project management (as appropriate) will be made aware of deficiencies identified by self-assessments, corrective actions from ECOs, and findings from QA assessments and surveillances. Issues reported by the laboratories are communicated to the SMR group, which then initiates a sample issue resolution form. This process is used to document analytical or sample issues and establish resolution with the Project Delivery Manager for Groundwater Science.

These assessments are internal assessments and are not subject to RCRA regulation. If an assessment finding results in sampling issues that impact a regulatory requirement, DOE would be informed and the matter discussed with Ecology at the appropriate level and time.

A5 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.

A5.1 Data Review and Verification

Data review and verification are performed to confirm that 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 assess whether holding times, if any, have been met. Furthermore, a review of QC data is used to determine whether analyses have met the data quality requirements specified in this plan.

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, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Field QA/QC results also will be reviewed to ensure that they are usable.

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

A5.2 Data Validation

Data validation is performed at the discretion of the Project Delivery Manager for Groundwater Science and under the direction of the SMR group. It is based on the results of the QC samples for an individual network, discussions with the project scientist, and discussions with the laboratory services manager. If defined as appropriate, data validation (third party) will be performed at a minimum frequency of 5 percent and be based on EPA functional guidelines.

A5.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the DQA is to determine whether quantitative data are of the correct type and are of adequate quality and quantity to meet the project data quality needs. For routine groundwater monitoring performed through this groundwater monitoring plan, the DQA is captured in the DQA appendix associated with the annual Hanford Site RCRA groundwater report (e.g., DOE/RL-2016-12), which evaluates field and laboratory QC and the usability of data. Further DQAs will be performed at the discretion of the Project Delivery Manager for Groundwater Science and documented in a report overseen by the SMR group.

A6 References

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

265.92, "Sampling and Analysis."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

Atomic Energy Act of 1954, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: http://epw.senate.gov/atomic54.pdf.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE/RL-96-68, 2014, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), Rev. 4, *Volume 1, Administrative Requirements; Volume 2, Sampling Technical Requirements; Volume 3, Field Analytical Technical Requirements; and Volume 4, Laboratory Technical Requirements*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL4-04.pdf.

DOE/RL-2016-12, 2016, *Hanford Site RCRA Groundwater Monitoring Report for 2015*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0077828.

Ecology Publication No. 04-03-030, 2004, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*, Environmental Assessment Program, Washington State Department of Ecology, Olympia, Washington. Available at: https://fortress.wa.gov/ecy/publications/documents/0403030pdf.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf.

EPA/240/R-02/009, 2002, *Guidance for Quality Assurance Project Plans*, EPA QA/G-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf.

EPA/600/R-93/100, 1993, *Methods for the Determination of Inorganic Substances in Environmental Samples*, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30002U3P.TXT.

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

SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, 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.

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

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

303-330, "Personnel Training."

303-400, "Interim Status Facility Standards."

Appendix B

Sampling Protocol

This page intentionally left blank.

Contents

B1 Introduction **B-1**

B2 Sampling Methods **B-1**

B2.1 Decontamination of Sampling Equipment B-3

B2.2 Water Levels B-4

B3 Documentation of Field Activities **B-4**

B3.1 Corrective Actions and Deviations for Sampling Activities B-5

B4 Calibration of Field Equipment **B-5**

B5 Sample Handling **B-5**

B5.1 Containers B-6

B5.2 Container Labeling B-6

B5.3 Sample Custody B-6

B5.4 Sample Transportation B-7

B6 Management of Waste **B-7**

B7 Health and Safety **B-8**

B8 References **B-8**

This page intentionally left blank.

Terms

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

This page intentionally left blank.

B1 Introduction

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

This appendix provides more specific elements of the sampling protocols and techniques used for the groundwater monitoring plan. Chapter 3 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 216-A-37-1 Crib.

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

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

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

Field measurements (except for turbidity) are obtained using a flow-through cell. 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, and conductivity. Turbidity is measured by inserting a sample vial into a turbidimeter. The purgewater is then 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. The flow rate is reduced during sampling to minimize loss of volatiles (if any) and prevent over filling the bottles. Sample bottles are filled in a sequence designed to minimize loss of volatiles (if any). Filtered samples are collected after collection of the unfiltered samples. For some constituents (e.g., metals), both filtered and unfiltered samples are collected. If additional samples require filtration (e.g., at turbidity greater than 5 NTUs), an inline, disposable 0.45 μm filter is used.

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

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

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

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

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

Sample preservation and holding-time requirements are specified for groundwater samples in Appendix A, Table A-6. These requirements are in accordance with the analytical method specified in Appendix A, Table A-3. The 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 required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the constituent and are listed in analytical method compilations such as APHA/AWWA/WEF, 2012, *Standard Methods for the Examination of Water and Wastewater*; and SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition; Final Update V*. Recommended holding times are also provided in HASQARD (DOE/RL-96-68) and in applicable laboratory contracts.

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

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

B2.1 Decontamination of Sampling Equipment

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 performed using high-purity water[1] in each step. In general, three rinse cycles are performed to decontaminate sampling equipment: a detergent rinse, an acid rinse, and a water rinse. During the detergent rinse, the 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 1M 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 50°C (122°F) for items that are not metal or glass or at 100°C (212°F) for metal or glass. Once reaching temperature, equipment is baked for 20 minutes and then cooled. The equipment is then removed from the oven, and the equipment is enclosed in clean, unused aluminum foil using surgeon's gloves. The wrapped equipment is stored in a custody-locked, controlled-access area.

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. 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. The cleaning is documented on a tag that is affixed to the pump, and the tag will include the following information:

- Date pump cleaned
- Pump identification
- Comments
- Signature of person performing decontamination

---

[1] High-purity water that is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques (DOE/RL-96-68).

B2.2 Water Levels

Each time a sample is obtained, measurement of the ground water 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 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 or data forms are required for field activities and will be used in accordance with HASQARD (DOE/RL-96-68) requirements. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook, and only authorized persons may make entries in logbooks. Logbook entries will be reviewed by the sampling Field Work Supervisor (FWS), 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 may be used to collect field information; however, information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

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

- 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.
- Site activities in specific detail (e.g., maps and drawings) or the forms used to record such information (e.g., soil boring log or well completion log). Also, details of any field tests that were conducted; reference to any forms that were used, other data records, and methods followed in conducting the activity.
- Details of any field calibrations and surveys that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the calibrations and surveys.
- Details of any samples collected and the preparation (if any) of splits, duplicates, matrix spikes, or blanks. Reference the methods followed in sample collection or preparation; list location of sample collected, sample type, each label or tag numbers, sample identification, sample containers and volume, preservation method, packaging, chain-of-custody form number, and analytical request form number pertinent to each sample or sample set; and note the time and the name of the individual to whom custody of samples was transferred.
- 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.

- Any equipment failures or breakdowns that occurred, with a brief description of repairs or replacements.

B3.1 Corrective Actions and Deviations for Sampling Activities

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

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

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

B4 Calibration of Field Equipment

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

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

- Prior to initial use of a field analytical measurement system.
- 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 will be in accordance with established methods to 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 shall be collected, where and when appropriate, in break-resistant containers. The field sample collection record shall indicate the laboratory lot number of the bottles used in sample collection. When commercially pre-cleaned containers are used in the field, the name of the manufacturer, lot identification, and certification shall be retained for documentation.

Containers shall 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 shall 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 shall contain the sample identification number. The label shall identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis required, 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 will be maintained in accordance with existing protocols to ensure that sample integrity is maintained 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 field sampling team will make a copy of the signed record before sample shipment and transmit the copy to the SMR group.

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

- Project name
- Collectors' names
- Unique sample number
- Date and time of 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)

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

B5.4 Sample Transportation

Packaging and transportation instructions shall 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) as described in 49 CFR 171, "Transportation," "General Information, Regulations, and Definitions," through 49 CFR 177, "Carriage by Public Highway."[2] Carrier specific requirements, defined in the current edition of International Air Transport Association (IATA) *Dangerous Goods Regulations*, shall also be used when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents shall 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. Appropriate laboratory notifications will be made, if necessary, through the SMR project coordinator.

B6 Management of Waste

Waste materials are generated during sample collection, processing, and subsampling activities. Waste will be managed in accordance with DOE/RL-2004-18, *Waste Control Plan for the 200-PO-1 Groundwater Operable Unit*. For waste designation purposes, wells listed in Table 3-1 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 required.

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

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

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

---

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

B7 Health and Safety

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

B8 References

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.830&rgn=div5.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations.* Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=57ef404ac6f4734a67fd97302b2d7f7f&node=pt10.4.835&rgn=div5.

10 CFR 851, "Worker Safety and Health Program," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.851&rgn=div5.

29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," *Code of Federal Regulations*. Available at: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9765.

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=fc3e30d2a24de032666c2de7ddb46f1b&mc=true&node=se40.26.265_192&rgn=div8.

49 CFR, "Transportation," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?gp=&SID=4eee73b085f2533d72722864dbca949a&mc=true&tpl=/ecfrbrowse/Title49/49CIsubchapC.tpl.

49 CFR 171, "General Information, Regulations, and Definitions."

49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans."

49 CFR 173, "Shippers-General Requirements for Shipments and Packagings."

49 CFR 175, "Carriage by Aircraft."

49 CFR 177, "Carriage by Public Highway."

APHA/AWWA/WEF, 2012, *Standard Methods for the Examination of Water and Wastewater*, 22nd Edition, American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, D.C.

DOE/RL-96-68, 2014, *Hanford Analytical Services Quality Assurance Requirements Document*, Rev. 4, *Volume 1, Administrative Requirements; Volume 2, Sampling Technical Requirements; Volume 3, Field Analytical Technical Requirements; and Volume 4, Laboratory Technical Requirements*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL4-04.pdf.

DOE/RL-2004-18, 2008, *Waste Control Plan for the 200-PO-1 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0807010321.

DOE/RL-2009-80, 2009, *Investigation Derived Waste Purgewater Management Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0094946.

DOE/RL-2011-41, 2011, *Hanford Site Strategy for Management of Investigation Derived Waste*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093937.

IATA, *Dangerous Goods Regulations*, Current Edition, International Air Transport Association, Montreal, Quebec, Canada. Available at:
http://www.iata.org/publications/dgr/Pages/index.aspx.

Price-Anderson Amendments Act of 1988, Pub. L. 100-408, Aug. 20, 1988, 102 Stat. 1066, 42 USC 2010, et seq. Available at: http://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-Pg1066.pdf.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at:
http://www.epa.gov/epawaste/inforesources/online/index.htm.

SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, 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.

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

303-400, "Interim Status Facility Standards."

This page intentionally left blank.

Appendix C

Well Construction

This page intentionally left blank.

Contents

C1 Introduction **C-1**

Figures

Figure C-1. Well 299-E25-17 Construction and Completion Summary C-2
Figure C-2. Well 299-E25-19 Construction and Completion Summary C-4
Figure C-3. Well 299-E25-20 Construction and Completion Summary C-6
Figure C-4. Well 299-E25-35 Construction and Completion Summary C-8
Figure C-5. Well 299-E25-47 Construction and Completion Summary C-10

Tables

Table C-1. Hydrogeologic Monitoring Unit Classification Scheme C-1
Table C-2. Sampling Interval Information for Wells within the 216-A-37-1 Crib Network C-1

This page intentionally left blank.

C1 Introduction

This appendix provides the following information for the 216-A-37-1 Crib groundwater monitoring wells:

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

Figures C-1 through C-5 provide well construction and completion summaries for the 216-A-37-1 Crib monitoring 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 216-A-37-1 Crib Network

Well or Aquifer Tube Name	Hydrogeologic Unit Monitored	Elevation Top of Open Interval (m [ft] NAVD88)	Elevation Bottom of Open Interval (m [ft] NAVD88)	Open Interval Length (m [ft])
299-E25-17	TU	123.4 (404.9)	116.7 (382.9)	6.7 (22.0)
299-E25-19	TU	124.6 (408.8)	117.0 (383.9)	7.6 (24.9)
299-E25-20	TU	124.5 (408.5)	116.9 (383.5)	7.6 (24.9)
299-E25-35	TU	111.4 (365.5)	105.0 (344.5)	6.4 (21.0)
299-E25-47	TU	125.2 (410.8)	119.1 (390.7)	6.1 (20.0)

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

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

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

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: H. Baker
Drilling Company: Not documented
Date Started: 24May76

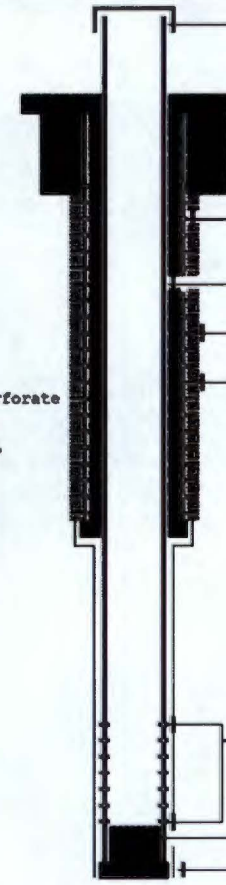
Sample Method: Drive barrel
Additives Used: Bentonite
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 21Jul76

WELL NUMBER: 299-E25-17
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 40,086 E/W W 46,570
State Coordinates: N 445,268 E 2,248,652
Start Card #: Not documented T R S
Elevation Ground surface: 688.1-ft Estimated

Depth to water: ~275 ft Jul76
(Ground surface) 271.4-ft Mar92

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: 90%f-cSAND, 10%fGRAVEL
5-20: 80%f-cSAND, 20%fGRAVEL
20-25: 70%f-cSAND, 30%fGRAVEL
25-30: vf-cSAND
30-50: 90%f-cSAND, 10%fGRAVEL
50-55: f-cSAND
55-65: 90%f-cSAND, 10%fGRAVEL
65-75: f-cSAND
75-85: 90%f-cSAND, 10%fGRAVEL
85-90: 80%f-cSAND, 20%fGRAVEL
90-95: 60%f-cSAND, 40%fGRAVEL
95-100: 80%f-cSAND, 20%fGRAVEL
100-120: 80%f-cSAND, 20%mGRAVEL
120-132: 70%m-cSAND, 30%fGRAVEL (2-in SILT @ 125-ft)
132-133: SILT & vfSAND
133-150: 80%f-cSAND, 20%fGRAVEL (Stopped drilling to perforate and grout)
150-160: 60%f-cSAND, 40%fGRAVEL
160-175: 60%m-cSAND, 40%f-mGRAVEL
175-180: 80%f-cSAND, 20%fGRAVEL
180-185: f-cSAND
185-190: 80%f-cSAND, 20%fGRAVEL
190-210: 70%m-cSAND, 30%fGRAVEL
210-220: 80%f-cSAND, 20%fGRAVEL
220-225: 60%f-cSAND, 20%GRAVEL, 20%COBBLES
225-245: Not documented
245-300: 60%m-cSAND, 40%fGRAVEL



Elevation of reference point: [690.00-ft] (top of casing)
Height of reference point above ground surface [1.9-ft]
Depth of surface seal [20.0-ft]
Type of surface seal: Cement grout between 8 and 16-in casings 0-20-ft, as 16-in assumed pulled back. 2-ft pad, depth indeterminate
8-in ID carbon steel casing, 0-150-ft
6-in ID carbon steel casing, +1.9-300-ft
Hole diameter, 9-in nominal 20-150-ft
Annular seal, Bentonite mud/cement
Perforated 20-127 ft, 4 cuts/rd/ft
Grouted w/bentonite drilling mud, filled casing with cement and drilled out. Cement grouted between 6 & 8-in casing.
6-in casing perforations, 273-295-ft, 4 cuts/rd/ft
Cement plug 295-300-ft
Borehole drilled depth: [300-ft]

Drawing By: RKL/2E25-17.ASB
Date : 07Sep93
Reference : HANFORD WELLS

Figure C-1. Well 299-E25-17 Construction and Completion Summary (page 1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-17

WELL DESIGNATION	:	299-E25-17
RCRA FACILITY	:	Not applicable
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 40,086 W 46,570
LAMBERT COORDINATES	:	N 445,268 E 2,248,652
DATE DRILLED	:	Jul76
DEPTH DRILLED (GS)	:	300-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	~275-ft, Jul76; 271.4-ft, 26Mar92
CASING DIAMETER	:	8-in, carbon steel, 0-150-ft; 6-in, carbon steel, +1.9-300-ft
ELEV TOP CASING	:	690.00-ft
ELEV GROUND SURFACE	:	688.1-ft, Estimated
PERFORATED INTERVAL	:	8-in casing, 20-127-ft; 6-in casing, 273-295-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 03Mar92, 6-in carbon steel casing. Capped and locked ~2-ft pad, no posts, no permanent identification. Not in radiation zone.
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Water levels measured 07Jan86-26Mar92,
CURRENT USER	:	PNL sitewide sampling 93
PUMP TYPE	:	None documented
MAINTENANCE	:	

Figure C-1. Well 299-E25-17 Construction and Completion Summary (page 2 of 2)

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Baker
Drilling Company: Not documented
Date Started: 22Jul76

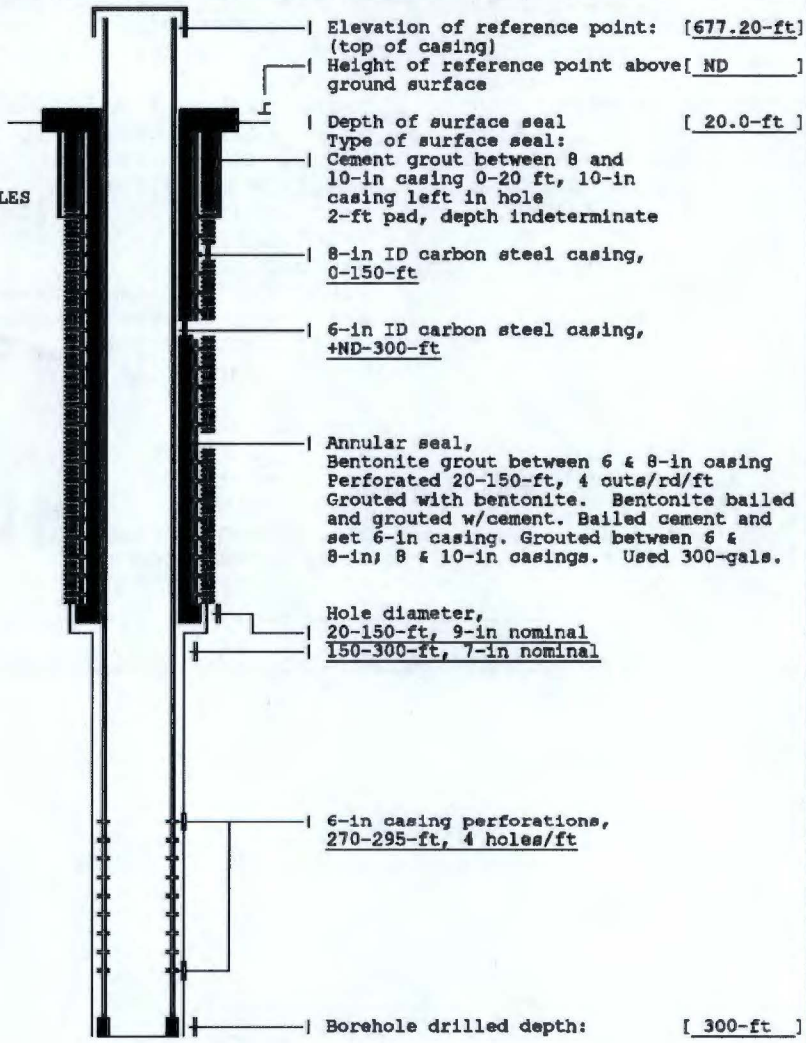
Sample Method: Hard tool (nom)
Additives Used: Bentonite
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 03Sep76

WELL NUMBER: 299-E25-19
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,935 E/W W 46,060
State Coordinates: N 445,119 E 2,249,163
Start Card #: Not documented T R S
Elevation Ground surface: Not documented

Depth to water: 272 ft Sep76
(Ground surface) -274-ft 17Jun93

GENERALIZED STRATIGRAPHY
Driller's Log

0-40: GRAVEL and SAND
40-65: SAND with GRAVEL
65-95: GRAVEL and SAND
95-125: SAND and GRAVEL, some COBBLES
125-130: SAND
130-145: SAND with GRAVEL
145-215: SAND and GRAVEL
215-220: SAND
220-255: SAND, GRAVEL and COBBLES
255-260: SAND
260-300: GRAVEL and SAND



Drawing By: RKL/2E25-19.ASB
Date : 07Sep93
Reference : HANFORD WELLS

Figure C-2. Well 299-E25-19 Construction and Completion Summary (page 1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-19

WELL DESIGNATION	:	299-E25-19
RCRA FACILITY	:	A-29 Ditch
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 39,935 W 46,060
LAMBERT COORDINATES	:	N 445,119 E 2,249,4163
DATE DRILLED	:	Sep76
DEPTH DRILLED (GS)	:	300-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	272-ft, Sep76; ~274-ft 17Jun93
CASING DIAMETER	:	10-in carbon steel, 0-10-ft; 8-in, carbon steel, 0-150-ft; 6-in, carbon steel, +ND-300-ft
ELEV TOP CASING	:	677.20-ft, [15May86]
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	8-in casing, 20-150; 6-in casing, 270-295-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 22Aug89, 6-in carbon steel casing. Capped and locked 2-ft pad, no posts, no permanent identification.
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	A29 Ditch Quarterly water level measurement, 09Dec86-17Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

Figure C-2. Well 299-E25-19 Construction and Completion Summary (page 2 of 2)

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Egan
Drilling Company: Not documented
Date Started: 20May76

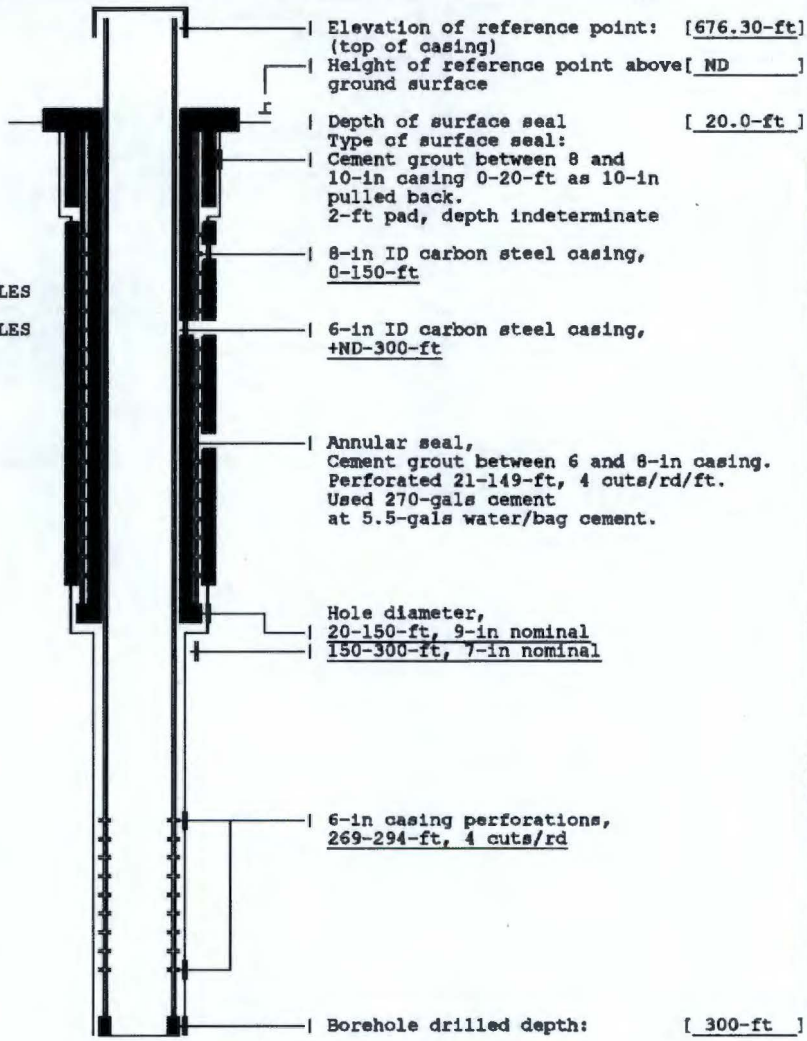
Sample Method: Hard tool (nom)
Additives Used: Bentonite
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 06Aug76

WELL NUMBER: 299-E25-20
TEMPORARY WELL NO: 4
Hanford Coordinates: N/S N 39,925 E/W W 45,875
State Coordinates: N 445,109 E 2,249,348
Start Card #: Not documented T ___ R ___ S ___
Elevation Ground surface: Not documented

Depth to water: 271-ft Aug76
(Ground surface) -273-ft 17Jun93

GENERALIZED STRATIGRAPHY — Driller's Log

0-160: SAND
160-175: Pebbly SAND
175-190: SAND
190-200: Pebbly SAND
200-210: SAND and PEBBLES
210-215: SAND
215-220: Pebbly SAND
220-225: SAND
225-245: SAND & PEBBLES, some COBBLES
245-260: SAND and COBBLES
260-270: SAND & PEBBLES, some COBBLES
270-280: SAND & PEBBLES
280-300: SAND, PEBBLES & COBBLES



Drawing By: RKL/2E25-20.ASB
Date : 07Sep93
Reference : HANFORD WELLS

Figure C-3. Well 299-E25-20 Construction and Completion Summary (page 1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-20

WELL DESIGNATION	:	299-E25-20
RCRA FACILITY	:	A-29 Ditch
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 39,925 W 45,875
LAMBERT COORDINATES	:	N 445,109 E 2,249,348
DATE DRILLED	:	Aug76
DEPTH DRILLED (GS)	:	300-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	271-ft, Aug76; ~273-ft, 17Jun93
CASING DIAMETER	:	8-in, carbon steel, 0-150-ft; 6-in, carbon steel, +ND-300-ft
ELEV TOP CASING	:	676.47-ft, [27Mar92-NGVD'29]
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	21-149 and 269-294-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 22Aug89, 6-in carbon steel casing. Capped and locked 2-ft pad, no posts, no permanent identification.
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	A29 Ditch Quarterly water level measurement, 01Jan87-17Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring, sampling and RCRA sampling; PNL sitewide sampling 93
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

Figure C-3. Well 299-E25-20 Construction and Completion Summary (page 2 of 2)

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water 200E Area
Driller's Name: Amos/Wamsley
Drilling Company: Kaiser Engineers
Date Started: 03May88

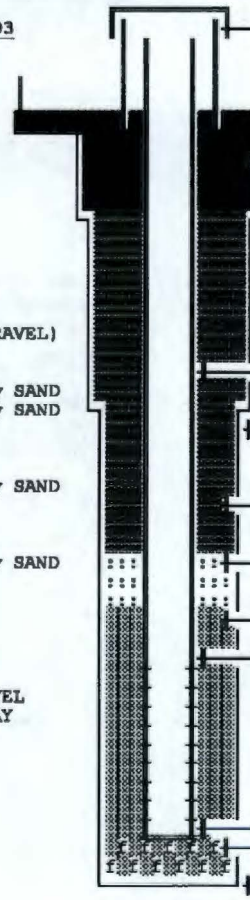
Sample Method: Not documented
Additives Used: Not documented
WA State Lic Nr: 1224 (Amos)
Company Location: Hanford
Date Complete: 27Aug88

WELL NUMBER: 299-E25-35
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 40,616.7 E/W W 46,538.5
State Coordinates: N 445,799 E 2,248,682
Start Card #: Not documented T R S
Elevation Ground surface: 670.98-ft (Brass cap)

Depth to water: 264.3-ft Aug88
(Ground surface) 268.9-ft 22Jun93

GENERALIZED STRATIGRAPHY Log — Geologist's Log

0-10: Slightly silty SAND
10-15 Silty SAND
15-20: Sandy GRAVEL
20-30: Silty sandy GRAVEL
30-55: SAND
55-60: Silty gravelly SAND
60-75: Gravelly SAND
75-85: Sandy GRAVEL
85-100: Slightly gravelly SAND
100-115: Gravelly SAND
115-120: SAND (Note: 116-119: GRAVEL)
120-125: Silty SAND
125-130: Gravelly SAND
130-135: Slightly gravelly silty SAND
135-160: Slightly silty gravelly SAND
160-165: Slightly silty SAND
165-170: Slightly silty slightly gravelly SAND
170-175: Slightly silty gravelly SAND
175-185: Silty sandy GRAVEL
185-190: Slightly silty slightly gravelly SAND
190-210: Slightly silty gravelly SAND
210-220: Silty sandy GRAVEL
220-235: Sandy GRAVEL
235-240: Slightly silty SAND
240-245: Silty sandy GRAVEL
245-250: Gravelly SAND
250-255: Silty sandy GRAVEL
255-260: Silty/clayey sandy GRAVEL
260-265: Gravelly sandy SILT/CLAY
265-270: CLAY/SILT
270-275: Slighlty gravelly slightly silty SAND
275-280: Slightly gravelly SAND
280-285: SAND



Elevation of reference point: [674.39-ft] (top of casing)
Height of reference point above ground surface [3.4-ft]
Depth of surface seal [3-19.5-ft]
Type of surface seal: Cement grout 3-19.5-ft 4x4-ft x 4-in concrete pad extends 3.0-ft into annulus
Hole diameter, 3.0-20.2-ft, 13-in nominal
20.2-145.3-ft, 11-in nominal
145.3-285-ft, 9-in nominal
4-in ID T304 stainless steel casing, +ND-260.5-ft
Bentonite crumbles, 19.5-250.9-ft
Bentonite pellets, 250.9-256.2-ft
Silica sand pack, 256.2--281.0-ft, 10-20-mesh
4-in stainless steel screen, 260.5-281.0-ft, #20-slot
Fill, ~281-285.0-ft
Borehole drilled depth: [285.0-ft]

Drawing By: RKL/2E25-35.ASB
Date : 08Sep93
Reference : HANFORD WELLS

Figure C-4. Well 299-E25-35 Construction and Completion Summary (page 1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-35

WELL DESIGNATION	:	299-E25-35
RCRA FACILITY	:	A-29 Ditch
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 40,616.7 W 46,538.5 [28Oct88-200E]
LAMBERT COORDINATES	:	N 445,799 E 2,248,682 [HANCONV]
DATE DRILLED	:	Aug88
DEPTH DRILLED (GS)	:	285-ft
MEASURED DEPTH (GS)	:	284.3-ft, 09Apr93
DEPTH TO WATER (GS)	:	264-ft, Aug88; 268.9-ft, 22Jun93
CASING DIAMETER	:	6-in, stainless steel, +3.4--0.5-ft; 4-in, stainless steel, +ND-260.5-ft
ELEV TOP CASING	:	674.39-ft, [28Oct88-200E]
ELEV GROUND SURFACE	:	670.98-ft, Brass cap [28Oct88-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	260.5-281.0-ft, 4-in stainless steel, #20-slot
COMMENTS	:	FIELD INSPECTION, 09Apr93; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone.
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	A29 Ditch monthly water level measurement, 18Oct88-22Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide w/l monitoring 93
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

Figure C-4. Well 299-E25-35 Construction and Completion Summary (page 2 of 2)

A4794 / 299-E25-47

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Backhoe/Air rotary
Drilling Fluid Used: None
Driller's Name: D. Mingo
Drilling Company: Jensen Drilling Co
Date Started: 14Jul92

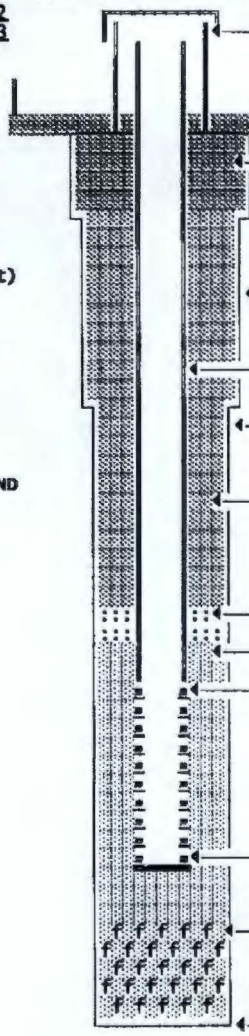
Downhole hammer
Sample Method: Continous
Air returns
Additives Used: None documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 06Aug92

WELL NUMBER: 299-E25-47
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 40,835.3 E/W W 46,306.1
State NAD83 N 135,931.0m 575,778.6m
Coordinates: N 446.018 E 2,248.914
Start Card #: Not documented T R S
Elevation Ground surface: 670.41-ft (Brass cap)

Depth to water: 266.7-ft 06Aug92
(Ground surface) 268.0-ft 22Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's

0-24: SAND
24-30: Sl gravelly (pebbly) SAND
30-100: SAND
(1-in SILT lens @ 90-ft)
100-115: Sl silty sandy (pebble) GRAVEL
115-130: SAND
130-162: SILT (SAND lens @ 144-ft)
162-175: SAND
175-180: Gravelly SAND
180-195: SAND
195-225: Gravelly (pebble) SAND
225-228: SILT
228-262: SAND
(HANFORD Fine/RINGOLD contact @ 262-ft)
262-266: SILT
266-280: SAND
280-295: Sl gravelly (pebbly) SAND
295-300: Gravelly (pebbly) SAND
300-301.4: SAND



Elevation of reference point: [673.77-ft] (top of casing)
Height of reference point above ground surface [3.36-ft]
Depth of surface seal [2.0-9.8-ft]
Type of surface seal: Cement grout, 2.0-9.8-ft 4x4-ft x 4-in concrete pad extends 2.0-ft into annulus
Hole diameter,
2.0-9.9-ft, 13-in nominal
9.9-162.3-ft, 11-in nominal
162.3-301.4-ft, 9-in nominal
4-in ID T304 stainless steel casing, +1.0-263.0-ft
Bentonite crumbles, 9.8-256.1-ft, 8-20-mesh
3/8-in bentonite pellets, 256.1-259.4-ft
Silica sand pack,
259.4-288.9-ft, 20-40-mesh
288.9-291.7-ft, 10-20-mesh
4-in T304 stainless steel screen, 263.0-283.2-ft, #10-slot w/cap
Fill, 291.7-301.4-ft
Borehole drilled depth: [301.4-ft]

Drawing By: RKL/2E25-47.ASB
Date : 08Sep93
Reference : WHC-SD-EN-DP-054

Figure C-5. Well 299-E25-47 Construction and Completion Summary (page 1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-47

WELL DESIGNATION	:	299-E25-47
RCRA FACILITY	:	Grout
CERCLA UNIT	:	Not applicable
HANFORD COORDINATES	:	N 40,835.4 W 46,306.1 [30Dec92-200E]
LAMBERT COORDINATES	:	N 446,018 E 2,248,914 [HANCONV];
		N 135,931.0m E 575,778.6m [NAD83-30Dec92]
DATE DRILLED	:	Aug92
DEPTH DRILLED (GS)	:	301.4-ft
MEASURED DEPTH (GS)	:	283.6-ft, 03Nov92
DEPTH TO WATER (GS)	:	266.7-ft, 06Aug92
		268.0-ft, 22Jun93
CASING DIAMETER	:	6-in, stainless steel, +3.4↔-0.5-ft;
		4-in, stainless steel, +1.0↔263.0-ft
ELEV TOP CASING	:	673.77-ft, [30Dec92-NGVD'29]
ELEV GROUND SURFACE	:	670.41-ft, Brass cap [30Dec92-NGVD'29]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	263.0↔283.2-ft, 4-in stainless steel, #10-slot
COMMENTS	:	FIELD INSPECTION, 03Nov92;
		4 and 6-in stainless steel casing.
		4-ft by 4-ft concrete pad, 4 posts, 1 removable.
		Capped and locked, brass cap in pad with well ID.
		Not in radiation zone.
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	A-29 Ditch monthly water level measurement, 14Dec92↔22Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling,
		PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar, @ 281.0-ft (GS)
MAINTENANCE	:	

Figure C-5. Well 299-E25-47 Construction and Completion Summary (page 2 of 2)

This page intentionally left blank.