DOE/RL-2010-92
Revision 1

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

D-210

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June 2011

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Release Approval 6/21/2011
Date

Executive Summary

The 216-A-37-1 Crib is a non-operating treatment, storage, and disposal unit regulated under RCW 70.105 ("Hazardous Waste Management") and its implementing requirements in Washington State's dangerous waste regulations (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"). The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*, to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA), including the requirements in 40 CFR 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"). The 216-A-37-1 Crib is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989), with Ecology identified as the lead regulatory agency for the unit.

Groundwater monitoring for the 216-A-10, 216-A-36B, and 216-A-37-1 Cribs was combined as one plan in 1997 (PNNL-11523, Rev. 0, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*) based on their proximity, similarities in construction, waste history, and hydrogeologic regime. The combined plan was designed as a groundwater quality assessment program due to elevated specific conductance and the recognition that the cribs had contributed to groundwater contamination. The groundwater monitoring plan was revised in 2005 (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*).

Groundwater monitoring under RCRA is no longer required for the 216-A-10 Crib because the crib has been removed from Part A of the Hanford Facility Dangerous Waste Permit (WA7890008967). Because of the distance between the 216-A-36B and 216-A-37-1 Cribs, different monitoring well networks are appropriate for these cribs; therefore, monitoring for these cribs is being described in two separate groundwater monitoring plans.

The groundwater monitoring plan for 216-A-37-1 Crib is described in this document. This plan is also updated to include information from previous routine quarterly groundwater monitoring at the Plutonium-Uranium Extraction (PUREX) Cribs, and it also updates the groundwater monitoring project management organization.

This plan describes the operating history, waste characteristics, hydrogeology, previous monitoring, groundwater and vadose zone contamination, and the conceptual model for the 216-A-37-1 Crib. The plan addresses the following:

- Adequacy of the wells monitoring groundwater at the 216-A-37-1 Crib
- Sampling requirements and schedule
- Analytes, groundwater parameters, and analytical methods
- Procedures for evaluating groundwater quality data
- Reporting requirements

This plan is the principal controlling document for conducting RCRA groundwater monitoring at the 216-A-37-1 Crib.

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Terms

AEA	*Atomic Energy Act of 1954*
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE	U.S. Department of Energy
DQO	data quality objective
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ICP	inductively coupled plasma
OU	operable unit
PUREX	Plutonium-Uranium Extraction (Plant)
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
VOC	volatile organic compound
WMA	waste management area

1 Introduction

Three cribs (216-A-10, 216-A-36B, and 216-A-37-1) (Figure 1-1) that received wastewater generated by the Plutonium-Uranium Extraction (PUREX) Plant were regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA), including the requirements of WAC 173-303-400 ("Dangerous Waste Regulations," "Interim Status Facility Standards") and, by reference, 40 CFR 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"). The 216-A-10 Crib no longer requires regulation under the above rules, however, the 216-A-36B and 216-A-37-1 Cribs remain subject to these rules. This groundwater monitoring plan addresses the requirements for only the 216-A-37-1 Crib; a separate groundwater monitoring plan addresses the requirements for the 216-A-36B Crib (DOE/RL-2010-93, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*).

The 216-A-37-1 Crib is within the 200-PO-1 Groundwater Operable Unit (OU), managed under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Information generated through the CERCLA process (DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*) is considered when evaluating data obtained through the RCRA groundwater monitoring program. Information gathered for the CERCLA process is also used to fulfill sitewide surveillance monitoring requirements under the *Atomic Energy Act of 1954* (AEA), as implemented under DOE O 450.1A, *Environmental Protection Program*. The 216-A-37-1 Crib is also regulated in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989), with the Washington Department of Ecology (Ecology) identified as the lead regulatory agency. The 216-A-37-1 Crib is managed as a non-operating treatment, storage, and disposal (TSD) unit under RCRA.

This document provides a revised groundwater monitoring plan for 216-A-37-1 Crib that supersedes the previous RCRA groundwater monitoring plan (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*). This revised groundwater monitoring plan is designed to bring the groundwater monitoring plan up to date with current protocols and incorporates the data quality objectives (DQO) process. Three important updates include the change in the eastern upgradient well in the groundwater monitoring network, the addition of well 299-E25-20 to the monitoring network, and the return to an indicator parameters evaluation program. Cessation of wastewater discharge to the 216-B-3 Pond (B Pond) led to changes to groundwater flow direction in the vicinity of the 216-A-37-1 Crib, from west to south. An alternate upgradient well was selected to more accurately represent groundwater in the current upgradient direction. Well 299-E25-20 was added to the network to provide coverage for the eastern end of the crib. The 216-A-37-1 Crib was returned to an indicator parameters evaluation program because the groundwater constituents detected in higher concentrations in downgradient wells (as compared to concentrations in the upgradient well) were not dangerous waste constituents (listed in Appendix 5 of WAC 173-303-080, "Dangerous Waste Lists," and WAC 173-303-100, "Dangerous Waste Criteria") (Ecology Publication 97-407, *Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*) (more detail is provided in Section 2.5.1). Only the dangerous chemical waste is regulated by RCRA; the radioactive waste is regulated under the AEA.

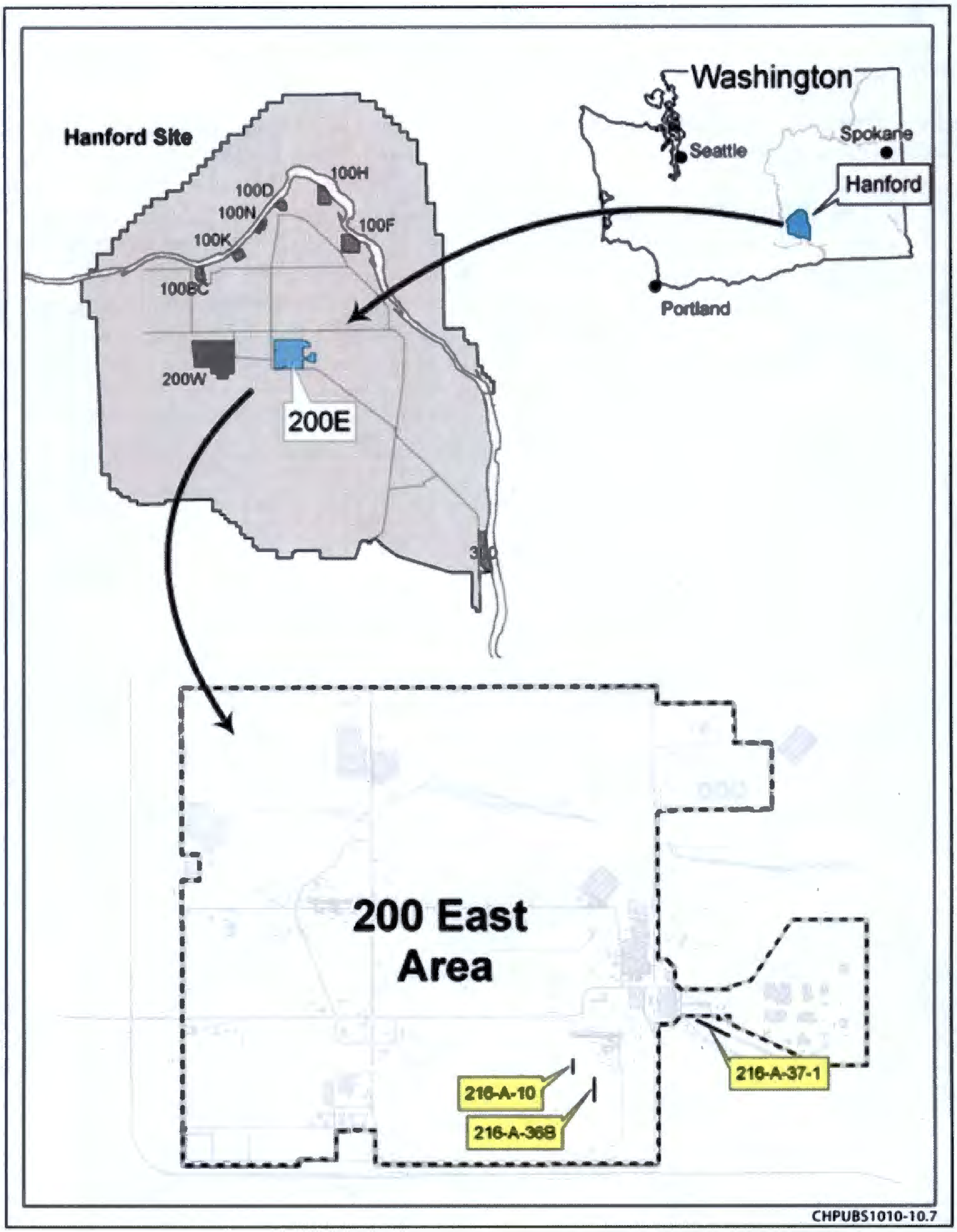

Figure 1-1. Location of 216-A-37-1 and Other Significant PUREX Cribs

The specific objective of this revised groundwater monitoring plan is to fulfill the requirements specified in WAC 173-303-400(3), incorporating 40 CFR 265.92 ("Sampling and Analysis") through 265.93(b) ("Preparation, Evaluation, and Response") by reference, to determine whether the 216-A-37-1 Crib has impacted groundwater quality (indicator parameters evaluation). To meet this objective, this monitoring plan defines the network of groundwater monitoring wells; specifies the sampling frequency; and lists the indicator parameters, dangerous constituents, and supporting constituents to be monitored in the groundwater.

Chapter 2 summarizes background information, including a description of the waste management area (WMA) and the types of waste present; provides a brief history of the groundwater monitoring program; and includes a description of the geology and hydrogeology of the area. This information is incorporated into the site conceptual model to aid in developing the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, the wells monitored, the sampling frequency and protocols, and the constituents analyzed. Chapter 4 describes data evaluation, interpretation, and reporting. A list of the references cited in this document is found in Chapter 5. Appendix A includes the quality assurance project plan (QAPjP), and Appendix B provides construction details for wells 299-E25-47 and 299-E25-20, which have been added to the monitoring network.

2 Background

This chapter provides information on the operating history, waste characteristics, hydrogeology, conceptual model of contaminant migration for the area, applicable regulations, and DQOs that provide the basis for this groundwater monitoring plan.

2.1 Facility Description and Operational History

The 216-A-37-1 Crib is located east of the 200 East Area boundary (Figure 2-1). Constructed in 1976, the crib is 5.2 m (17 ft) deep, 213 m (700 ft) long, and 3 m (10 ft) wide at the base, and the sides slope at 1:1. An 8-in. diameter perforated distributor pipe runs the length of the crib, located approximately 3.7 m (12 ft) below grade within a 1.5 m (5 ft) thick bed of 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.

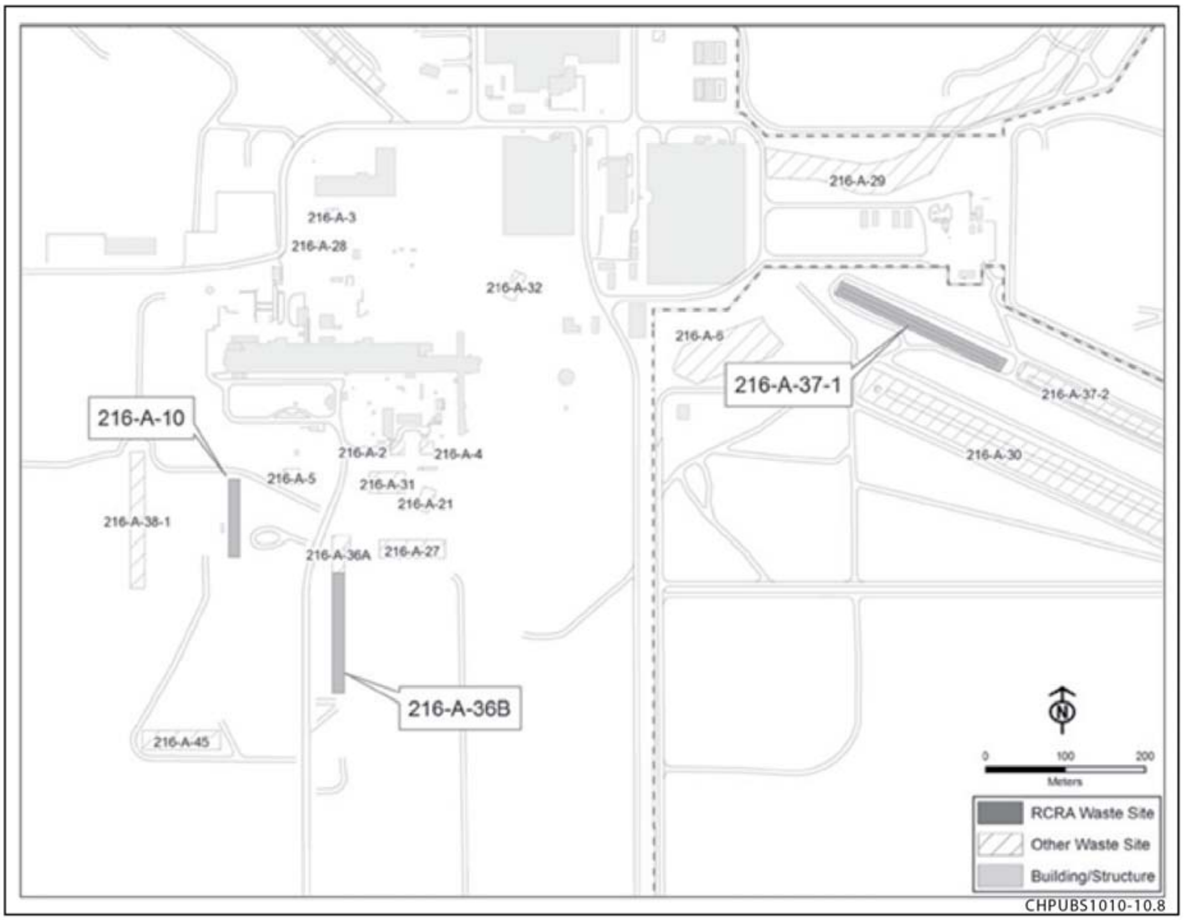

Figure 2-1. Site Map for 216-A-37-1 and Other PUREX Cribs

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. The crib received spent halogenated and non-halogenated solvents and ammonia. The crib's design capacity is 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. However, subsequent site visitors reported hearing water flowing through the distribution box that diverted effluent to the crib. In 1994, the distribution box was filled with grout to physically preclude the potential for inadvertent discharges to the 216-A-37-1 Crib. During its operational life, the 216-A-37-1 Crib received 3.7×10^8 L (9.8×10^7 gal) of process condensate from the 242-A evaporator.

Additional details on the history of the PUREX Cribs and their waste streams are provided in *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-3-37-1 PUREX Cribs* (PNNL-11523, Rev. 0) and *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan Includes: 200-PW-2 and 200-PW-4 Operable Units* (DOE/RL-2000-60).

2.2 Regulatory Basis

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

Before the PUREX Cribs were combined into one RCRA monitoring plan in June 1997 (PNNL-11523, Rev. 0), the 216-A-10 and 216-A-36B Cribs were monitored under separate interim status RCRA programs. The 216-A-37-1 Crib was not monitored under RCRA but was monitored from July 1983 to June 1997 under the AEA.

In 1996, in was determined that the 216-A-37-1 Crib should be added to the list of cribs requiring groundwater monitoring under RCRA. Subsequently, the three cribs were combined into a single WMA for groundwater monitoring. A groundwater quality assessment program was initiated (40 CFR 265.93[d]) because it was determined the cribs had contributed contamination to the groundwater. However, the main non-radioactive groundwater contaminant was nitrate, which is not on the Washington State dangerous waste list (Appendix 5 of WAC 173-303-080, and WAC 173-303-100) (Ecology Publication 97-407). Therefore, monitoring for the 216-A-37-1 Crib is being continued under detection monitoring regulations (WAC 173-303-645[9], "Releases from Regulated Units") and, by reference, 40 CFR 265.92 through 265.93. (See Section 2.5.1 for more information on dangerous waste constituents detected in the 216-A-37-1 Crib monitoring network.)

2.3 Waste Characteristics

Process condensate discharged from the 242-A evaporator to the 216-A-37-1 Crib contained small quantities of spent halogenated and non-halogenated solvents (waste codes "F001" through "F005"), as well as ammonia (state-only toxicity waste code "WT02"), as described in the Dangerous Waste Permit Application Part A Form for the 216-A-37-1 Crib (WA7890009867). Listed waste constituents of concern related to waste numbers "F001," "F002," "F003," "F004," and "F005" are described in *Listed Waste History at Hanford Facility TSD Units* (WHC-MR-0517). The constituents are listed in Table 2-1.

Table 2-1. Dangerous Waste Constituents in the Dangerous Waste Permit Application Part A for the 216-A-37-1 Crib

Listed Constituent	CAS No.	Listed Waste Number
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

CAS = Chemical Abstract Service

Two waste stream left the 242-A evaporator following the treatment process. The first stream, the concentrated slurry (approximately 40 to 60 percent of the water is removed during evaporation, as well as a portion of the volatile organics), was pumped back into the process system. The second waste stream, process condensate (containing a portion of the volatile organics removed from the mixed waste during the evaporation process), was routed through condensate filters before release to a retention basin (Liquid Effluent Retention Facility). Off-gas 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 (RCRA Dangerous Waste Permit Application Part A for the 216-A-37-1 Crib). Those 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 (the first waste stream mentioned previously) to the process system. Those constituents with vapor pressures close to or higher than that of water were likely removed during the evaporation process and directed to the condensate filters and the retention basin. Off-gas went through the de-entrainment unit and filters and was then directed to the crib.

The vapor pressure of water is 23.76 mm of mercury at 25°C (77°F). Vapor pressures of cresol-m, -o, and -p are less than 1 at 25°C (77° F) (substantially lower vapor pressure than water). 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 off-gas during evaporation and treated by a de-entrainment unit and filters prior to being routed to the crib.

Although the 242-A evaporator was designed to remove the dangerous waste constituents from the waste streams, it is likely that the system was not 100 percent efficient. Small quantities of the dangerous waste components likely made it to the 216-A-37-1 Crib. A precise estimate of the amount of these wastes that actually entered the crib is unknown. Groundwater monitoring efforts (Section 2.5.1) and analyses of soils from vadose zone boring (Section 2.5.2) suggest that very few waste constituents were discharged in significant quantities. Nitrate was the major contaminant detected in groundwater and in soil borings; only aluminum, manganese, nitrate, and thallium exceeded screening limits.

2.4 Geology and Hydrology

This section summarizes the geology and hydrology in the vicinity of the 216-A-37-1 Crib. Detailed information on the geology and groundwater hydrology of the 200-PO-1 OU and the 200 East Area is provided in *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington* (PNNL-12261) and *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit* (DOE/RL-2009-85).

The 216-A-37-1 Crib is located on the eastern side of a large Pleistocene-age flood bar known as the 200 Areas Plateau, also commonly referred to as the Central Plateau. The ground surface is relatively flat but slopes gently to the north. Elevation of the ground surface is approximately 210 m (690 ft) near the 216-A-37-1 Crib.

The general stratigraphy in the vicinity of the PUREX Cribs includes the following stratigraphic units (listed in order from upper to lower) (DOE/RL-2009-85):

- A discontinuous veneer of Holocene eolian silty sand or backfill mixtures of sand and gravel.
- Pleistocene cataclysmic flood deposits of the Hanford formation (HSU 1) consisting of a middle sandy unit (H2) with lower (H3 unit) and upper (H1 unit) portions of sandy gravel and gravelly sand.
- Undifferentiated Cold Creek unit (HSU 3) (pre-Missoula gravel) composed of clast-supported sandy gravel and the underlying (Miocene- to Pliocene-aged) fluvial Ringold Formation Unit E (HSU 9), with thick layers of river gravel, intercalated with thinner beds of overbank silts and fine-grained paleosols. The Ringold Formation may be missing at this location.
- Bedrock consisting of Columbia River Basalt flows that 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.

The 216-A-37-1 Crib lies over a northwest-southeast-trending paleochannel of Pleistocene age that incised into and removed the Ringold Unit E (HSU 5) and the Ringold lower mud unit (Unit 8 or HSU 8). As a result, the overlying Hanford formation and Cold Creek unit lie unconformably on the Ringold Unit E (HSU 9) in the area of the crib. The sediments deposited within the paleochannel have a relatively high hydraulic conductivity compared to the underlying Ringold Formation. The hydraulic conductivity is estimated at 18 to 3,000 m/day (59 to 9,842 ft/day), with an average flow rate of 0.0011 to 0.54 m/day (0.0036 to 1.77 ft/day) (DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009*, Appendix C). Due to high hydraulic conductivity, the water table in the area where the paleochannel is located is very flat with an extremely low gradient. The current water table elevation is approximately 122 m (400 ft) above mean sea level and is most likely within the Cold Creek unit, near the 216-A-37-1 Crib.

Historically, water levels in the unconfined aquifer increased as much as 13.5 m (44.3 ft) above the pre-Hanford natural water table level near the PUREX Cribs. 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 1995. The pre-Hanford groundwater flow was to the east in the southeastern portion of the 200 East Area. Artificial recharge from B Pond created a significant groundwater mound, impeding flow to the east and redirecting flow 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. The current groundwater flow in the unconfined aquifer beneath the 216-A-37-1 Crib is difficult to interpret from water table maps because of the very low gradient (2 x 10^5) of the water table; however, the direction is interpreted to be south to southeast (Figure 2-2) based on the geometry of the major groundwater contaminant plumes flowing from the 200 East Area. Water table elevations occasionally show a temporary increase due to discharges from the 200 East Area Treated Effluent Disposal Facility and possibly from elevated Columbia River stage (PNNL-SA-49780, *The 2002-2003 Fluctuation of the Water-Table Elevation in the 200 East Area and Vicinity: Evaluation of Potential Causes*).

2.5 Summary of Previous Groundwater Monitoring

Elevated concentrations of groundwater contaminants (e.g., nitrate) discovered in earlier groundwater monitoring programs at the PUREX Cribs provided the basis for requiring RCRA groundwater quality assessment monitoring (WAC 173-303-400 and, by reference, 40 CFR 265.93[d][3] and [d][4]). Although the 216-A-37-1 Crib was responsible for tritium and nitrate groundwater contamination, neither are dangerous waste constituents regulated under RCRA. Tritium is a radioactive element regulated under the AEA, and nitrate is not a dangerous waste constituent listed in Appendix 5 of WAC 173-303-080 and -100 (Ecology Publication 97-407). Therefore, indicator parameters evaluation (WAC 173-303-400[3], incorporating 40 CFR 265.92 through 265.93[b][3]) is the appropriate program for this site. The vadose zone contamination is also important because any residual vadose zone contamination is a potential source for future groundwater contamination. The detection monitoring program described in this plan is designed to detect contaminant migration from the vadose zone into the uppermost aquifer.

2.5.1 Groundwater Contamination

Monitoring conducted prior to 1997 identified nitrate at concentrations exceeding the drinking water standard (DWS) (Section 2.2) and ammonia (ammonium ion) present but not exceeding the DWS. Since that time, other constituents (e.g., arsenic, chromium, vanadium, and zinc) have been detected but not with significant regularity or concentration. Arsenic concentrations have decreased to background levels (the 95 percent confidence level is 11.8 µg/L [DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*]).

Two nitrate plumes are found in the vicinity of the PUREX Cribs (Figure 2-2). One plume is under the 216-A-37-1 Crib (Figure 2-2), where the concentration of nitrate is greater than that detected in upgradient wells but is below the 10 mg/L DWS (nitrogen in nitrate; equivalent to 45 mg/L nitrate). The second plume trends southeast across the southern portion of the 200 East Area in the vicinity of the 216-A-10 and 216-A-36B Cribs. The increased concentration of nitrate near the 216-A-37-1 Crib indicates that it is a source of nitrate contamination. The nitrate plumes coalesce near the southeast corner of the 200 East Area and spread east and southeast into the 600 Area. The combined nitrate plume in the 600 Area between the 200 East Area and the Columbia River is monitored by the 200-PO-1 OU under CERCLA.

Ammonium ion (more recently "ammonia") was analyzed in PUREX Cribs groundwater samples through 2006 but was 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 PUREX Cribs groundwater samples from 1987 to 1994 but were discontinued because the VOCs were not detected. However, throughout much of that time period, the method detection limit was 5 µg/L.

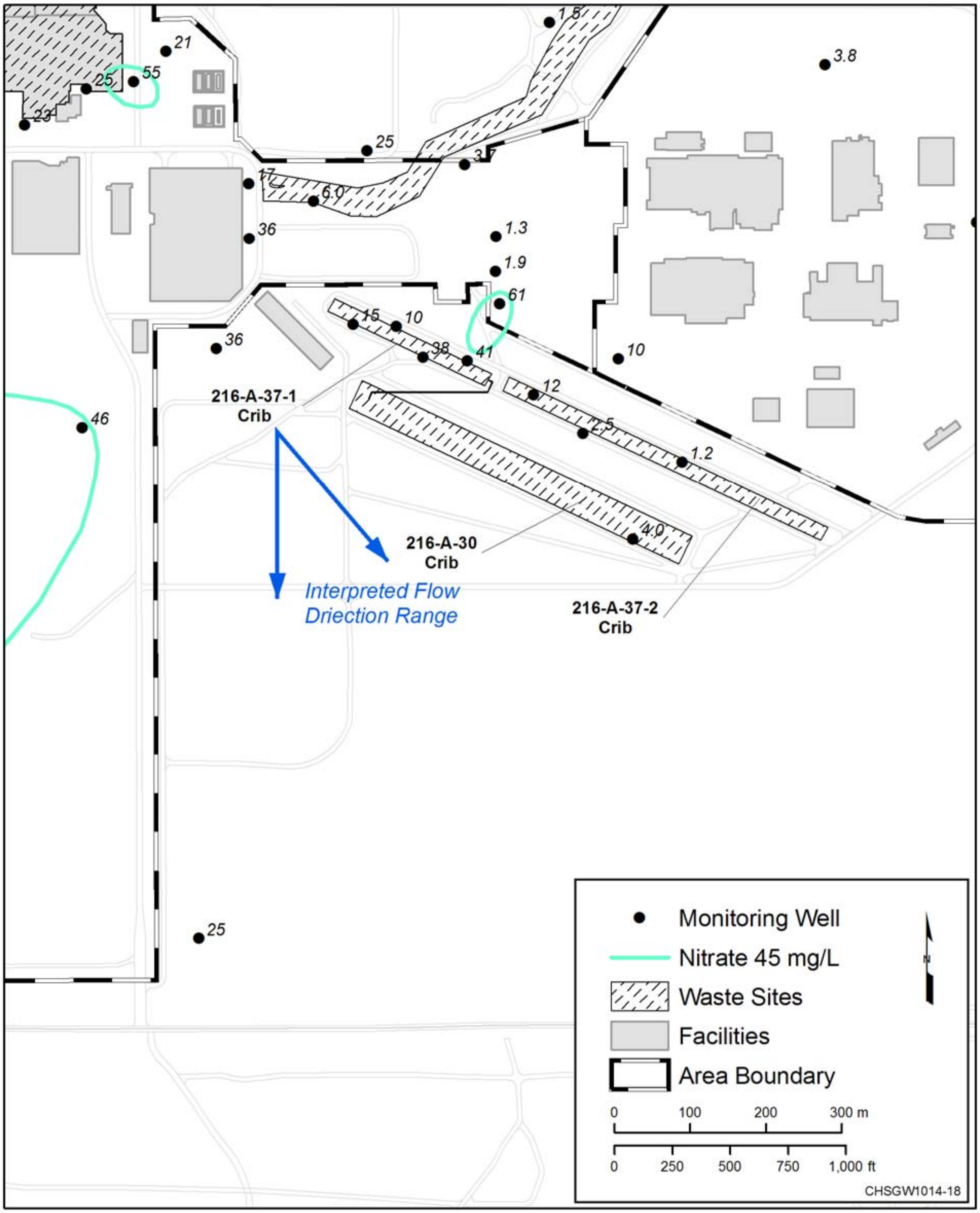

Figure 2-2. Nitrate Concentrations in the Unconfined Aquifer (2009) near the 216-A-37-1 Crib

Because this plan proposes to move the 216-A-37-1 Crib groundwater monitoring program from groundwater quality assessment to indicator parameters evaluation, data were reviewed to ensure that dangerous constituents are not present in groundwater that may have a source from the crib. A systematic check was made of all groundwater constituents detected in 299-A-37-1 Crib wells during the last 5 years (2006 through 2010) to determine whether dangerous waste constituents (Appendix 5 list) were among those detected. Four criteria were considered during the review:

- Were the detections persistent or only anomalous or incorrect high values (false positives)?
- Were detected concentrations above Hanford Site background levels (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*)?
- Were concentrations of the detected constituents higher in downgradient wells than in upgradient wells?
- Are the detected constituents on the dangerous waste constituent list (Appendix 5 of Ecology Publication 97-407, *Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-90 and -100*)?

The results concluded there were no detected constituents that met all four of the above criteria. Therefore, the appropriate RCRA groundwater monitoring program for the 216-A-37-1 Crib is indicator parameters evaluation (WAC 173-303-400(3), incorporating 40 CFR 265.92 through 265.93(b) by reference).

2.5.2 Vadose Zone Contamination

In 2004, a soil boring (C4106) was drilled through the eastern end of the 216-A-37-1 Crib to a total depth of 84.8 m (278.2 ft) as part of the CERCLA site characterization process (PNNL-15070, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*, Section 3.1.1.3). The depth to groundwater at that time was approximately 85 m (279 ft), and the bottom of the crib was found at 3.8 m (12.5 ft). Eleven samples were collected during the drilling process and analyzed for ammonia, anions, hexavalent chromium, cyanide, metals, oil, grease, pesticides, herbicides, polychlorinated biphenyls, semivolatile organics, total petroleum hydrocarbons, and VOCs. The results showed that three metals and one anion exceeded the screening limits. The maximum concentrations of these analytes and the depths of these maximum concentrations are shown in Table 2-2. It was concluded that the concentrations and depths of these metals and the one anion did not constitute a significant threat to the groundwater (PNNL-15070, Section 3.1.1.3).

Table 2-2. Concentrations for Selected Constituents in Vadose Zone Samples from the 216-A-37-1 Crib

Constituent	Maximum Concentration (mg/kg)	Depth of Concentration (m)
Aluminum	15,000	22
Manganese	652	15.2
Nitrate (as N)	385	3.8
Thallium	1.54	29.5

2.6 Conceptual Model

Groundwater flow and contaminant transport strongly influence groundwater monitoring strategy. Therefore, developing a realistic conceptualization (conceptual model) of groundwater flow and transport is necessary for developing a practical groundwater monitoring plan. A groundwater conceptual model is an evolving hypothesis that identifies the important features, events, and processes that control groundwater and contaminant movement. This model is based on the results of previous geological and hydrogeological studies, sediment sampling, and groundwater monitoring. Additional information for the conceptual model is provided in PNNL-11523 (Rev. 1), PNNL-12261, DOE/RL-2009-85, and in annual groundwater monitoring reports (e.g., DOE/RL-2010-11). The model provides a basis for designing the near-field well network.

The conceptual model for the PUREX Cribs includes the following elements:

- Liquid wastes released in the cribs migrated through the vadose zone and into the groundwater.
- As the mobile constituents intercepted and mixed with groundwater in the unconfined aquifer, the constituents moved laterally with groundwater flow.
- A water table mound was created by discharges to B Pond, resulting in changes to groundwater flow directions in the 200 East Area. Groundwater flowing radially away from B Pond had a southwest flow direction in the vicinity of the 216-A-37-1 during the years of high discharge to B Pond. More recently, groundwater flow has begun to revert toward the flow patterns that existed before the large discharges to B Pond. A southward flow near the 216-A-37-1 Crib is inferred primarily from observing contaminant plume migration. The water table in the 200 East Area has been declining significantly since discharges to B Pond ceased in 1997.
- Groundwater contamination tends to be higher in concentration near the water table, thus the near-field wells are screened (or casings perforated) near the water table (PNL-2724, *Vertical Contamination in the Unconfined Groundwater at the Hanford Site, Washington*).
- Near the 216-A-37-1 Crib, a large flood channel filled with Hanford formation sediment (deposited during cataclysmic Pleistocene floods) and older Cold Creek unit sediments extends across the 200 East Area from northwest to the southeast. This flood channel extends through Unit 8 (the Ringold lower mud unit, which is a locally confining layer), so the sand and gravel of the Hanford formation or Cold Creek unit lay directly upon the sand and gravel of the lower portions of Ringold Unit 9. It is possible that the Ringold Formation in that area may be entirely missing. Therefore, within and near the large flood channel, hydraulic communication occurs between the uppermost unconfined aquifer and any partially or locally confined aquifers in the lower portions of the Ringold Formation. Thus, in the area of the 216-A-37-1 Crib, the sediments above basalt constitute one combined aquifer.
- Because the hydraulic conductivity of the channel fill is generally higher than that of Unit 9 (near the 216-A-37-1 Crib), and because there is an upward hydraulic gradient in this region (DOE/RL-2010-11, Chapter 8.0), groundwater from the confined Ringold aquifer system discharges into the highly transmissive channel-fill sediments where it mixes with groundwater in the unconfined aquifer.

2.7 Data Quality Objectives

The DQO process is performed to ensure that data gathered during an investigation are of the appropriate quantity and quality to meet specific objectives. Although a formal DQO process was not used when the former groundwater monitoring plans (PNNL-11523, Rev. 0 and Rev. 1) were written, care was taken to ensure that the appropriate wells, groundwater constituents, and sampling frequencies were designed as part of the plan so all of the appropriate requirements of 40 CFR 265.91 ("Ground-Water Monitoring System") through 265.93 were met.

The current groundwater monitoring network for the 216-A-37-1 Crib is a result of previous groundwater monitoring efforts. Groundwater monitoring (indicator parameters evaluation) will continue at the 216-A-37-1 Crib in accordance with interim status regulations (40 CFR 265.92 through 265.93[b]). Table 2-3 provides a matrix of the data requirements for groundwater monitoring that are typically determined in a DQO process, the associated interim status regulations applicable to these requirements, and the current and historical documentation specifying how the monitoring program for the 216-A-37-1 Crib complies with the requirements.

Table 2-3. DQO Parameters, Associated Regulatory Requirements, and Documentation for the 216-A-37-1 Crib

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Scope	**40 CFR 265, Subpart F, incorporated by reference in WAC 173-303-400(3)(a), as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).** **40 CFR 265.90, Applicability.** (a) The owner or operator 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. (b) The owner or operator must install, operate, and maintain a ground-water monitoring system during the active life of the facility, and for disposal facilities, during the post-closure care period as well.	This plan, Chapters 1 and 2, and Appendix A 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* Future reports, if needed
Number and location of wells Point(s) of compliance	**40 CFR 265.91, Ground-Water Monitoring System.** (a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of: (1) Monitoring well(s) installed hydraulically upgradient 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. (2) At least three monitoring wells installed hydraulically downgradient at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.	This plan, Section 3.2 PNNL-11523, Rev. 0, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*

Table 2-3. DQO Parameters, Associated Regulatory Requirements, and Documentation for the 216-A-37-1 Crib

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Well configuration (depth and length of screened interval; well construction)	**40 CFR 265.91, Ground-Water Monitoring System.** (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary; to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water. **Additional requirements from WAC 173-303-400 (3)(c)(v)(C).** Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells.	This plan, Section 3.2 and Appendix A 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* BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report*
Follow written plan	**40 CFR 265.92, Sampling and Analysis.** (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. 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. [*Comment:* See EPA 530/SW-611, *Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities*, and EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*, for discussions of sampling and analysis procedures.]	This plan, Appendix A

Table 2-3. DQO Parameters, Associated Regulatory Requirements, and Documentation for the 216-A-37-1 Crib

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Parameters analyzed	**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: (2) Parameters establishing ground-water quality to be used as a basis for comparison in the event a ground-water quality assessment is required: (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 40 CFR 265.93(d).] (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific conductance (iii) Total organic carbon (iv) Total organic halogen	This plan, Chapter 3 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*

Table 2-3. DQO Parameters, Associated Regulatory Requirements, and Documentation for the 216-A-37-1 Crib

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Frequency of sampling	**40 CFR 265.92, Sampling and Analysis.** (c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters listed above by taking quarterly samples for one year. (2) For each of the indicator parameters in (b)(3) above, at least four replicate measurements must be obtained for each sample and the background arithmetic mean and variance determined by pooling the replicates 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) at least annually. (2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) above at least semiannually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	This plan, Section 3.1

Table 2-3. DQO Parameters, Associated Regulatory Requirements, and Documentation for the 216-A-37-1 Crib

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Methods used to evaluate the data collected	**40 CFR 265.93, Preparation, Evaluation, and Response.** (b) For each indicator parameter specified in 40 CFR 265.92(b)(3) listed above, 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, 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 to determine statistically significant increases (or decreases in the case of pH) over initial background. (c)(1) If the comparisons for the *upgradient* wells show a significant increase (or pH decrease), the owner or operator must submit this information to the Regional Administrator no later than March 1 of the following calendar year. (2) If the comparisons for *downgradient* wells show a significant increase (or pH decrease), the owner or operator must 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 verification analyses confirm the significant increase (or pH decrease) the owner or operator must provide written notice to the Regional Administrator within seven days of the date of such confirmation that the facility may be affecting ground-water quality. (2) Within 15 days of notifying the Regional Administrator, the owner or operator must develop a specific plan for a ground-water quality assessment at the facility.	This plan, Chapter 4 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*

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

DQO = data quality objective

3 Groundwater Monitoring Program

This chapter describes the 216-A-37-1 Crib near-field groundwater monitoring network, the constituents to be analyzed, and the sampling frequency. The QAPjP is provided in Appendix A.

3.1 Constituent List and Sampling Frequency

Table 3-1 presents the wells in the groundwater monitoring network, the constituents analyzed for RCRA monitoring, and the sampling frequency for monitoring the 216-A-37-1 Crib after the first year (groundwater monitoring for the first year is discussed in Section 3.3). The indicator parameters for detection monitoring are specific conductance, pH, total organic carbon, and total organic halogens (40 CFR 265.92(b)(3)). For each indicator parameter, four replicate measurements must be obtained for each sample (40 CFR 265.92(c)(2)). The groundwater quality constituents required include iron, manganese, sodium, chloride, sulfate, and phenols (40 CFR 265.92(b)(2)). In addition, selected inductively coupled plasma (ICP) metals, anions, and alkalinity will be analyzed to check the charge balance for calcium carbonate-type groundwater environments. As a minimum for charge balance, the required metals are calcium, magnesium, sodium, and potassium, and the required anions are sulfate, chloride, and nitrate. Because of the possibility that one or more of the VOCs may have reached groundwater (they are currently not analyzed in 216-A-37-1 Crib samples), they will analyzed in each of the monitoring wells for one year. If any of these VOCs are detected in downgradient wells (and not upgradient wells), analysis for the detected constituents will continue as long as these constituents continue to be detected; if the constituents are not detected, their analysis will cease after one year.

The sampling frequency for detection monitoring will be semiannually for the indicator parameters in accordance with 40 CFR 265.92(d)(2). Groundwater quality parameters will be analyzed annually in accordance with 40 CFR 265.92(d)(1) along with the constituents to check for charge balance.

3.2 Monitoring Well Network

The monitoring well network is comprised of four near-field wells (Figure 3-1). Table 3-1 lists the near-field well locations for the 216-A-37-1 Crib and their status relative to current well construction standards in WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

The upgradient well on the east side of the well network (299-E25-31) is no longer considered a suitable upgradient well for the eastern portion of the well network and will be replaced by well 299-E25-47 (which is compliant with WAC 173-160). While B Pond was in operation, groundwater flow direction was in a radial pattern from the pond. 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. However, as wastewater discharges ceased at B Pond, the groundwater flow pattern in the vicinity changed from the radiating pattern around B Pond to a southern flow direction near the 216-A-37-1 Crib. Well 299-E25-47 is north to northwest of the 216-A-37-1 Crib and will provide a better representation of upgradient groundwater. The well is located near the 216-A-29 Ditch and has been sampled since 1992. Specific conductance has been increasing in this well, as it has for other wells along the 216-A-29 Ditch and 216-A-37-1 Crib. Specific conductance is comparable to the wells at the 216-A-37-1 Crib and was 392 µS/cm the last time well 299-E25-47 was sampled in July 2009.

Table 3-2 provides general well configuration information and recent water levels. As-built well diagrams of wells 299-E25-17 and 299-E25-19 are provided in PNNL-11523 (Rev. 1). As-built well diagrams for wells 299-E25-47 and 299-E25-20 are provided in Appendix B.

Table 3-1. 216-A-37-1 Crib Monitoring Wells, Sampling Frequency, and Analyses After the First Year

Well	Purpose/ Comments	Well Standard[a]	IndicatorParameters[d]	Supporting Constituents				Other Field Parameters		
			Specific Conductance, pH, TOC, TOX	Anions[b]	Metals[c]	Alkalinity	Phenols	Temperature	Turbidity	Water Levels
299-E25-17	Downgradient from 216-A-37-1 Crib	PRE	S	A	A	A	A	S	S	S
299-E25-19	Downgradient from 216-A-37-1 Crib	PRE	S	A	A	A	A	S	S	S
299-E25-20	Downgradient from 216-A-37-1 Crib	PRE	S	A	A	A	A	S	S	S
299-E25-47	Upgradient from 216-A-37-1 Crib	WAC	S	A	A	A	A	S	S	S

Notes: All network wells are screened across the surface of the water table. Well construction information is provided in the appendices of 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.*

a. "PRE" indicates that well was not constructed to the standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"; "WAC" indicates that well was constructed to WAC 173-160 standards.

b. Anions analysis includes, at a minimum, the groundwater quality parameters chloride and sulfate.

c. Metals analysis includes, at a minimum, calcium, magnesium, potassium, and sodium, and the groundwater quality parameters iron and manganese.

d. Quadruplicate replicates collected during each sampling event.

S = semiannually

Q = quarterly

TOC = total organic carbon

TOX = total organic halides

VOC = volatile organic compound

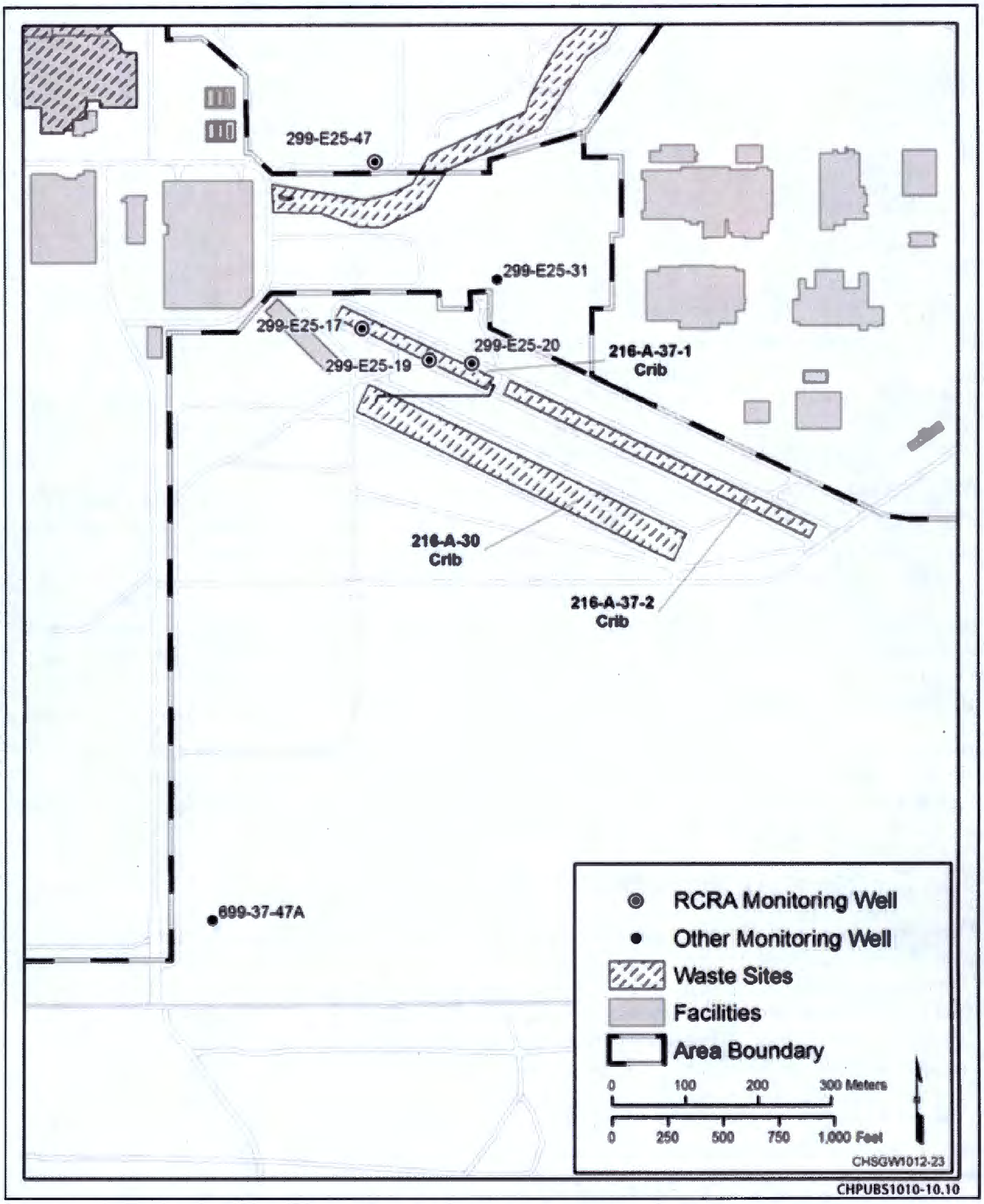

Figure 3-1. Near-Field Groundwater Monitoring Wells for the 216-A-37-1 Crib

Table 3-2. 216-A-37-1 Crib Near-Field Monitoring Wells

Well Name	Screen Top (m bgs)	Slots or Screen Bottom (m bgs)	Water-Level Date	Depth to Water (m bgs)	Approx. Screened Water Column (m)
299-E25-17	83.2	89.9	4/25/2010	84.8	5.1
299-E25-19	82.3	89.9	7/20/2010	85.1	4.8
299-E25-20	82.0	89.6	4/25/2010	85.1	4.5
299-E25-47	80.2	86.3	7/20/2010	83.5	2.8

bgs = below ground surface

Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If sampling of a well on a semiannual schedule is delayed by 4 months or more, that event will be cancelled, as it is nearly time for the next semiannual sampling event.

Table 3-2 summarizes well-depth information, including the screened intervals in each monitoring well. One well, 299-E25-47, is WAC-compliant (Table 3-1) and is constructed of stainless-steel casing and screens with full annular seals; the other three wells (299-E25-17, 299-E25-19, and 299-E25-20) have perforated carbon-steel casings. All wells are equipped with dedicated sampling pumps.

The water table elevation beneath the 216-A-37-1 Crib has been declining as a result of reduced effluent discharges to ground at the Hanford Site since peak discharges occurred in the 1980s. The water table elevation in the 200 East Area is expected to continue to decline for many years before equilibrium conditions are again established, although most of the decline has already occurred.

As a consequence of the declining water table elevation, well 299-E25-20 may go dry in the future. When a well is within approximately 2 years of going dry, a replacement well is proposed. All new RCRA wells proposed for installation at the Hanford Site are negotiated annually by Ecology, DOE, and EPA under Tri-Party Agreement Milestone M-24-00.

3.3 Constituent List and Sampling Frequency for the First Year

During the first year, the primary objective is to establish initial background concentrations in accordance with 40 CFR 265.92(c)(1) and (2). Table 3-3 presents the wells of the monitoring network, constituents to be analyzed, and the sampling frequency for monitoring during the first year. The only difference from Table 3-1 is the sampling frequency and the addition of the volatile organic compounds (to be analyzed during only two sampling events during the first year). Well 299-E25-47 (the upgradient well) will be sampled quarterly for the indicator parameters, anions, ICP metals, and phenols because it has not been used lately as a RCRA monitoring well (and has little background data). The indicator parameters and VOCs will be analyzed semiannually in the downgradient wells. Anions, metals, phenols, and alkalinity will be analyzed annually in the downgradient well samples. The field parameters (temperature, turbidity, and water level) are collected every time the wells are sampled.

Table 3-3. 216-A-37-1 Crib Monitoring Wells, Sampling Frequency, and Analyses for the First Year

			Indicator Parameters		Supporting Constituents				Other Field Parameters		
Well	Purpose/ Comments	Well Standard[a]	Specific Conductance, pH, TOC, TOX	Anions[b]	Metals[c]	Alkalinity	Phenols	VOCs[d]	Temperature	Turbidity	Water Levels
299-E25-17	Downgradient from 216-A-37-1 Crib	PRE	S	A	A	A	A	2	S	S	S
299-E25-19	Downgradient from 216-A-37-1 Crib	PRE	S	A	A	A	A	2	S	S	S
299-E25-20	Downgradient from 216-A-37-1 Crib	PRE	S	A	A	A	A	2	S	S	S
299-E25-47	Upgradient from 216-A-37-1 Crib	WAC	Q[e]	Q	Q	A	Q	2	Q	Q	Q

Notes: All network wells are screened across the surface of the water table. Well construction information is provided in the appendices of 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.*

a. "PRE" indicates that well was not constructed to the standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"; "WAC" indicates that well was constructed to WAC 173-160 standards.

b. Anions analysis includes, at a minimum, the groundwater quality parameters chloride and sulfate.

c. Metals analysis includes, at a minimum, calcium, magnesium, potassium, and sodium, and the groundwater quality parameters iron and manganese.

d. Samples analyzed for VOCs for one year (two sampling events).

e. Quadruplicate replicates collected during each sampling event.

S = semiannually

Q = quarterly

TOC = total organic carbon

TOX = total organic halides

VOC = volatile organic compound

3.4 Sampling and Analysis Protocol

Groundwater monitoring at the 216-A-37-1 Crib is conducted in accordance with the QAPjP. The sample collection, sample preservation and shipment, analytical procedures, and chain-of-custody control are discussed in the QAPjP (Appendix A).

4 Data Evaluation and Reporting

This chapter discusses the storage, retrieval, evaluation, and interpretation of groundwater data. The reporting requirements for the 216-A-37-1 Crib are also discussed.

4.1 Data Review

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

4.2 Interpretation

After data are validated and verified, the acceptable data are used to interpret groundwater conditions at the site. 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 to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituents in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of flow.
- **Contaminant ratios:** Can sometimes be used to distinguish between different sources of contamination.

4.3 Statistical Evaluation

Statistical evaluations of indicator parameter data will be performed using the AR t-test statistical method (WHC-SA-1124-FP, *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site*; 40 CFR 265.93[b]). A critical mean value for each indicator parameter will be computed annually from the previous eight upgradient sample results. Semiannual sample results for each downgradient well will be compared to the critical mean for each indicator parameter to determine if a statistically significant increase in downgradient indicator parameter has occurred.

4.4 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the network to determine if it remains adequate to monitor the WMA. The network must continue to provide adequate upgradient and downgradient coverage in the uppermost aquifer (Appendix A).

Water-level measurements are collected before each sampling event at the 216-A-37-1 Crib, and a more comprehensive set of water-level measurements of wells over the entire Hanford Site will be made in March of each year. Water-level measurements are used to determine the hydraulic gradient of the water table and, in turn, groundwater flow direction; however, the very small hydraulic gradient in the vicinity of the 216-A-37-1 Crib limits the use of this method to determine groundwater flow direction. Currently, the flow direction at the 216-A-37-1 Crib is based on a combination of regional flow directions, which are based on water table gradients and more local estimates of flow direction based on geometry and trends of the major contaminant plumes. In the last few years, improvements in the precision of measurements used to construct water table maps have resulted in improved determination of groundwater flow directions in the southeastern portion of the 200 East Area (at the Integrated Disposal Facility and 216-A-36B Crib) (DOE/RL-2010-11, Section 2.3.2); however, those studies have not yet progressed to the immediate area of the 216-A-37-1 Crib. In the two general areas where the studies have been used successfully (Integrated Disposal Facility/PUREX Cribs and Low-Level Waste Management Area 1), the results have shown agreement with previous flow interpretations based on the geometry of nearby contaminant plumes.

4.5 Reporting and Notification

The results of assessment monitoring are reported annually in accordance with 40 CFR 265.94(b), "Recordkeeping and Reporting." Reporting will be made in the annual Hanford Site groundwater monitoring and performance report.

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Appendix A

Quality Assurance Project Plan

Contents

Figure

Tables

Terms

DOE	U.S. Department of Energy
DQO	data quality objective
EB	equipment blank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FTB	full trip blank
FXR	field transfer blank
HEIS	Hanford Environmental Information System
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	DOE Richland Operations Office
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal

A Quality Assurance Project Plan

The contractor's quality assurance (QA) program describes the contractor's QA structure, requirements, implementation methods, and responsibilities. The contractor's environmental QA program plan provides the requirements for collecting and assessing environmental data in accordance with the following:

- 10 CFR 830, Subpart A, "Nuclear Safety Management," "Quality Assurance Requirements"
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD)
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5)
- U.S. Department of Energy (DOE) O 414.1C, *Quality Assurance*

This quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including the planning, implementation, and assessment of sampling, field measurements, and laboratory analyses. Section 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989a), Attachment 2, "Action Plan," requires that the QA/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal (TSD) units. The HASQARD requirements (DOE/RL-96-68) also apply to this work.

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of ANSI/ASQ E4, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*. This QAPjP is divided into four sections (as designated in EPA/240/B-01/003) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

A1 Project Management

This section addresses the basic aspects of project management and will ensure that the project has defined goals, that the participants understand the goals and the approaches used, and that the planned outputs are appropriately documented.

A1.1 Project/Task Organization

The project organization in regard to planning, sampling, analysis, and data assessment is described in the following subsections and is shown in Figure A-1. For each functional primary contractor role, there is a corresponding oversight role within DOE.

A1.1.1 Regulatory Project Manager

The Washington State Department of Ecology (Ecology) project manager is responsible for oversight of the work being performed under this groundwater monitoring plan. Ecology will work with the DOE Richland Operations Office (RL) to resolve concerns regarding the work as described in this QAPjP. Ecology can request this plan during a regulatory compliance inspection for review.

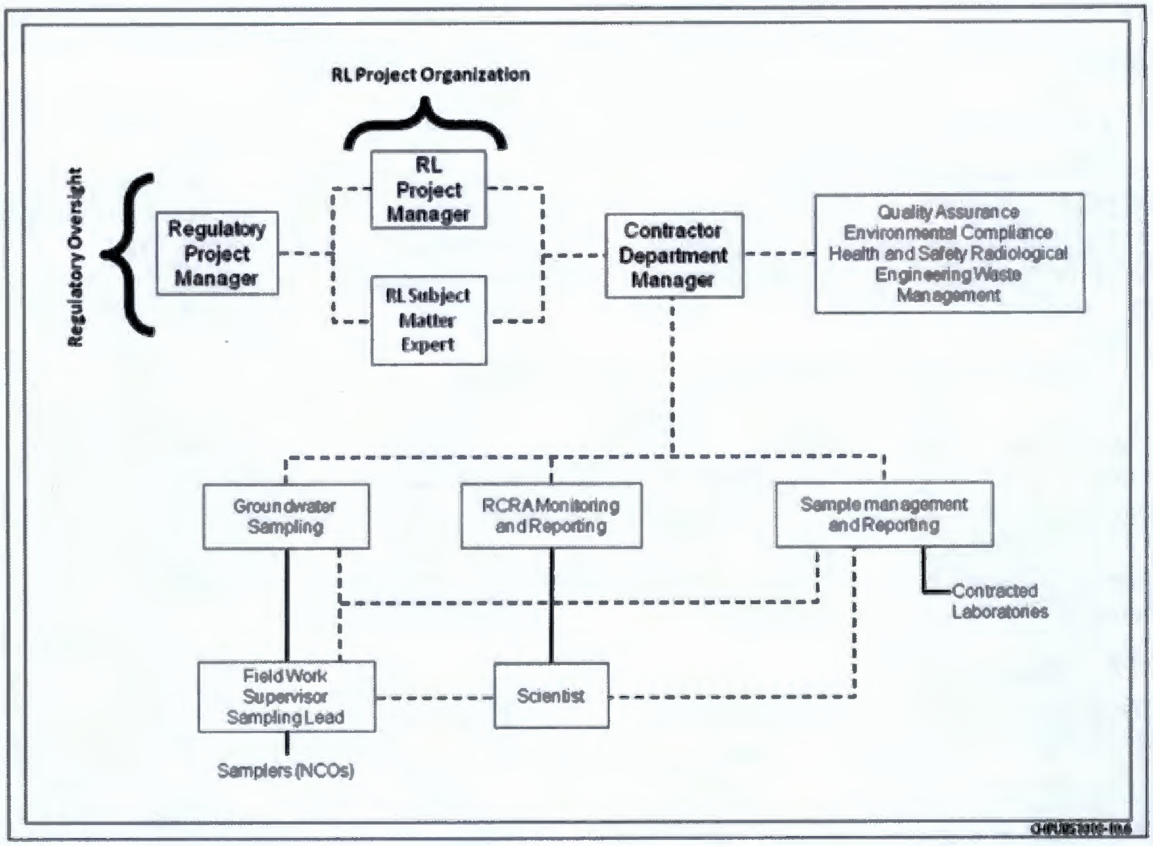

Figure A-1. Project Organization

A1.1.2 U.S. Department of Energy, Richland Operations Office Project Manager

Hanford Site cleanup is the responsibility of RL. The RL project manager is responsible for authorizing the contractor to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the Tri-Party Agreement for the Hanford Site.

A1.1.3 U.S. Department of Energy, Richland Operations Office Subject Matter Expert

The RL subject matter expert is responsible for day-to-day oversight of the contractor's performance of workscope, for working with the contractor and the regulatory agencies to identify and work through issues, and for providing technical input to the RL project manager.

A1.1.4 Contractor Groundwater Remediation Department Manager

The contractor groundwater remediation department manager provides oversight for all activities and coordinates with DOE, the regulators, and primary contractor management in support of sampling and reporting activities. The remediation department manager also provides support to the RCRA Monitoring and Reporting manager to ensure that work is performed safely and cost effectively.

A1.1.5 Groundwater Sampling Operations

Groundwater sampling operations is responsible for planning and coordinating field sampling resources and provides the field work supervisor for routine groundwater sampling operations. The field work supervisor directs the samplers, who collect groundwater samples in accordance with the sampling and analysis plan, and corresponding standard procedures and work packages. The samplers also complete the field logbook and chain-of-custody forms, including any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

A1.1.6 RCRA Monitoring and Reporting

The RCRA Monitoring and Reporting manager is responsible for direct management of activities performed to meet RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager coordinates with and reports to DOE and primary contractor management regarding RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager assigns scientists to provide technical expertise.

A1.1.7 Sample Management and Reporting Organization

The Sample Management and Reporting organization coordinates laboratory analytical work to ensure that the laboratories conform to HASQARD requirements (or their equivalent), as approved by DOE, the U.S. Environmental Protection Agency (EPA), and Ecology. Sample Management and Reporting receives analytical data from the laboratories, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. Sample Management and Reporting is responsible for informing the RCRA Monitoring and Reporting manager of any issues reported by the analytical laboratories.

A1.1.8 Contract Laboratories

The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanations of results to support data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project documentation, including data quality objective (DQO) summary reports, sampling and analysis plans, and the QAPjP; and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA point of contact must be independent of the unit generating the data.

A1.1.10 Environmental Compliance Officer

The environmental compliance officer 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.

A1.1.11 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 by internal primary contractor work requirements.

A1.1.12 Waste Management

Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

A1.2 Problem Definition/Background

The problem definition, as required by WAC 173-303-400 ("Dangerous Waste Regulations," "Interim Status Facility Standards") and 40 CFR 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"), is outlined in the main text discussion of this monitoring plan. The background is provided in the monitoring plan.

A1.3 Project/Task Description

The project description is provided in Chapters 3 and 4 of this monitoring plan and includes the selection of appropriate dangerous waste or dangerous waste constituents, collection and analyses of groundwater from the monitoring network, interpretation of analytical results, evaluation of the monitoring network, and reporting.

The target analytes, along with the monitoring wells and frequency of sampling, are provided in Chapter 3.

A1.4 Quality Objectives and Criteria

The quality objectives and criteria for groundwater monitoring are defined in this QAPjP in order to meet the evaluation requirements stated in the monitoring plan.

A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility of 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 field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

A1.6 Documents and Records

The project scientist is responsible for ensuring that the current version of the groundwater monitoring plan is used and for providing any updates to field personnel. Version control is maintained by through the administrative document control process. Significant changes to the plan that affect DQOs will be reviewed and approved by DOE and the regulatory agency prior to implementation. Table A-1 defines the types of changes that may be made to the sampling design and the documentation requirements.

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 HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. 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 will be managed in accordance with the requirements therein.

Table A-1. Actions and Documentation for Regulatory Notification

Type of Change	Action	Documentation
Temporary addition of wells or constituents, or increased sampling frequency	RCRA Monitoring and Reporting manager approval; notify regulatory agency, if appropriate	Project's schedule tracking system
Unintentional impact to groundwater monitoring plan including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of indicator parameters, loss of samples in transit, etc.	Electronic notification	RCRA annual report
Planned change to groundwater monitoring activities, including addition or deletion of constituents or wells, change of sampling frequency, etc.	Revise monitoring plan	Revised RCRA groundwater monitoring plan
Anticipated unavoidable changes (e.g., dry wells)	Electronic notification; revise monitoring plan	RCRA annual report and revised groundwater monitoring plan

RCRA = *Resource Conservation and Recovery Act of 1976*

The 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 annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2010-11, *Hanford Site Groundwater Monitoring, and Performance for Fiscal Year 2009*).

A2 Data Generation and Acquisition

This section 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.

A2.1 Sampling Process Design (Experimental Design)

The sampling design is based on regulatory requirements and judgmental sampling.

A2.1.1 Regulatory Requirements

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status TSD units.

A2.1.2 Judgmental Sampling

The selection of sampling and analysis requirements is based on knowledge of the feature or condition under investigation and is also based on professional judgment. The TSD monitoring is based on professional judgment. Conclusions depend on the validity and accuracy of professional judgment.

A2.2 Sampling Methods

Sampling is described in the contractor's environmental QA program plan, including the following:

- Field sampling methods
- Sample preservation, containers, and holding times
- Corrective actions for sampling activities
- Decontamination of sampling equipment

The groundwater sampling operations supervisor must ensure that situations that may impair the usability of samples and/or data are documented in the field logbook or on nonconformance report forms in accordance with internal corrective action procedures, as appropriate. The groundwater sampling operations supervisor will note any deviations that occur from the standard procedures for sample collection, contaminants of potential concern, sample transport, or monitoring. The groundwater sampling operations supervisor is also responsible for coordinating all activities related to the use of field monitoring equipment (e.g., dosimeters and industrial hygiene equipment). Field personnel will document in the logbook all noncompliant measurements taken during field sampling. Ultimately, the groundwater sampling operations supervisor will be responsible for developing, implementing, and communicating corrective action procedures; for documenting all deviations from procedure; and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact data quality or impair the ability to acquire data or failure to follow procedure will be documented in accordance with internal corrective action procedures, as appropriate.

A2.3 Sample Handling and Custody

A sampling and data tracking database is used to track samples from the point of collection through the laboratory analysis process. Laboratory analytical results are entered and maintained in the HEIS database. Each sample is identified and labeled with a unique HEIS sample number. The contractor's environmental QA program plan specifies sample handling information, including the following:

- Container requirements
- Container labeling and tracking process
- Sample custody requirements
- Shipping and transportation

A2.4 Analytical Methods

Information on analytical methods is provided in Table A-2. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor participates in oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

Laboratories providing analytical services in support of this QAPjP will report errors to the Sample Management and Reporting project coordinator, who will then initiate a sample disposition record. The error-reporting process is intended to document analytical errors and the resolution of those errors with the project scientist. The corrective action program addresses the following:

- Evaluation of impacts of laboratory QC failures on data quality
- Root-cause analysis of QC failures
- Evaluation of recurring conditions that are adverse to quality
- Trend analysis of quality-affecting problems
- Implementation of a quality improvement process
- Control of nonconforming materials that may affect quality

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Contamination Indicator Parameters			
Total organic carbon	G/P, HCL to pH <2	SW-846[d] Method 9060	1,000
Total organic halides	G, H_2SO_4 to pH <2, no head space	SW-846[d] Method 9020	20
Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered/Filtered			
Calcium	P, HNO_3 to pH <2	SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e]	1,000
Cadmium			5
Sodium			500
Manganese			5
Potassium			4,000
Iron			50
Magnesium			750
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	6
Arsenic			10
Aluminum			50
Barium			5
Beryllium			5
Boron			20
Bismuth			100
Chromium, (total)			10
Hexavalent chromium	G/P, cool to 4°C	SW-846 Method 7196	10
Cobalt	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	20
Copper			10
Lead			5
Mercury	G, HNO_3 to pH <2	SW-846 Method 7470A, EPA/600 Method 200.8	0.5
Lithium	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	25
Molybdenum			20
Nickel			40

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Selenium	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	10
Silicon			20
Silver			10
Strontium			10
Thallium			5
Tin			100
Titanium			5
Vanadium			25
Zinc			10
Zirconium			25
Anions by Ion Chromatography			
Bromide	P	EPA/600 Method 300.0[f]	250
Chloride			200
Fluoride			500
Nitrate			250
Nitrite			250
Phosphate			500
Sulfate			500
Volatile Organic Analyses			
Acetone (by volatile organic analysis)	G, no headspace	SW-846 Method 8260B	20
Benzene			5
Carbon tetrachloride			5
Chloroform			5
1,1,1-Trichloroethane			5
1,1,2-Trichloroethane			5
1, 1-Dichloroethane			10
1, 2-Dichloroethane			5
Methylene chloride			5

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Methyl ethyl ketone			10
Methyl isobutyl ketone			10
P-dichlorobenzene			5
Trichloroethylene			5
Tetrachloroethylene			5
Tetrahydrofuran			50
Toluene			5
Trans-1, 2-dichloroethylene			5
Vinyl chloride			10
Xylene-m			10
Xylene-o, p			10
Semivolatile Organic Analyses			
Benzo(a)pyrene	Amber glass	SW-846 Method 8270D	10
Bis(2ethylhexyl)phthalate (DEHP)			10
Cresol (o,p,m)			10
n-nitrosodimethylamine			10
Other			
Alkalinity	G/P	Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2	5,000
Ammonium ion	P, H_2SO_4 to pH <2	EPA/600 Method 350.1, EPA/600 Method 300.7	50
Coliform bacteria	P	Standard Method[g] 9223[h]	2.2[i]
Conductivity, laboratory	P	Instrument/meter	1 µohm
Conductivity, field	Field measurement	Instrument/meter	1 µohm
Cyanide	P, NaOH to pH >12	SW-846 Method 9012, Standard Method[g] 4500, EPA/600 Method 335.2	5
Dissolved oxygen, field	Field measurement	Instrument/meter	0 mg/L
Hydrazine	G, HCl	ASTM D1385	100
pH, laboratory measurement	P	Instrument/meter	0.1
pH, field measurement	Field measurement	Instrument/meter	0.1

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Phenol	G	SW-846 Method 8040, SW-846 Method 8041, SW-846 Method 8270D	5 5 10
Oxidation-reduction potential, field	Field measurement	Instrument/meter	
Temperature	Field measurement	Instrument/meter	
Total dissolved solids	P	EPA/600 Method 160.1	10,000
Total organic halogen	G, H_2SO_4 to pH <2, no headspace	SW-846 Method 9020	20
Total organic carbon	G, HCL or H_2SO_4 to pH <2	SW-846 Method 9060	1,000
Turbidity, field measurement	Field measurement	Instrument/meter	0.1 NTU

a. All samples will be collected in amber glass, plastic (P), or glass (G) containers and will be cooled to 4°C upon collection.

b. Constituents grouped together are analyzed by the same method, unless otherwise indicated.

c. Detection limit units, unless otherwise indicated.

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

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from Method 300.0, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography* (EPA-600/4-84-017).

g. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

h. Enzyme substrate test.

i. Most probable number.

ASTM = American Society for Testing and Materials

EPA = U.S. Environmental Protection Agency

N/A = not applicable

NTU = nephelometric turbidity unit

A2.5 Quality Control

The QC procedures must be followed in the field and 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 field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-3.

Table A-3. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field QC		
Full trip blank	Contamination from containers or transportation	1 per 20 well trips
Field transfer blank	Contamination from sampling site	1 each day; volatile organic compounds sampled
Equipment blank	Contamination from non-dedicated equipment	As needed[a]
Replicate/duplicate samples	Reproducibility	1 per 20 well trips
Laboratory QC		
Method blanks	Laboratory contamination	1 per batch
Laboratory duplicates	Laboratory reproducibility	See footnote[b]
Matrix spikes	Matrix effect and laboratory accuracy	See footnote[b]
Matrix spike duplicates	Laboratory reproducibility/accuracy	See footnote[b]
Surrogates	Recovery/yield	See footnote[b]
Laboratory control samples	Method accuracy	1 per batch

a. For portable Grundfos® (registered trademark of Grundfos Pumps Corporation, Colorado Springs, Colorado) pumps, equipment blanks are collected 1 per 10 well trips. Whenever a new type of non-dedicated equipment is used, an equipment blank shall be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.

b. As defined in the laboratory contract or quality assurance plan, and/or analysis procedures.

QC = quality control

A2.5.1 Field Quality Control Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and laboratory performance. The QC samples and the required frequency for collection are described in this section.

Full trip blanks (FTBs) are prepared by the sampling team prior to traveling to the sampling site. The FTB is filled with high-purity reagent water. The bottles are sealed and transported, unopened, to the field in the same storage containers used for samples collected that day. Collected FTBs are analyzed for the same constituents as the samples. The FTBs are used to evaluate potential contamination of the samples due to the sample bottles, preservative, handling, storage, or transportation.

Field transfer blanks (FXRs) are preserved volatile organic analysis sample bottles that are filled at the sample collection site with high-purity reagent water that has been transported to the field. After collection, FXR bottles are sealed and placed in the same storage containers with the samples from the associated sampling event. The FXR samples are analyzed for volatile organic compounds only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

Equipment blanks (EBs) are samples in which high-purity reagent water is passed through the pump or placed in contact with the sampling surfaces of the equipment to collect blank samples identical to the sample set that will be collected. The EB bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event. The EBs are used to evaluate the effectiveness of the cleaning process to ensure that samples are not cross-contaminated from previous sampling events.

For the field blanks (i.e., FTBs, FXRs, and EBs), results above two times the method detection limit are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit.

Field duplicates, also known as replicates, are two samples that are collected as close as possible to the same time and same location, and they are intended to be identical. Field duplicates are stored and transported together and are analyzed for the same constituents. The field duplicates are used to determine precision for both sampling and laboratory measurements. The results of the field duplicates must have precision within 20 percent, as measured by the relative percent difference. Only field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated.

Double-blind samples contain a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The laboratory is not informed that the samples are QC samples. The project submits double-blind samples to assess analytical precision and accuracy.

A2.5.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spikes, and matrix spikes) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, and will be run at the frequency specified in that reference, unless superseded by agreement.

A2.5.3 Quality Control Requirements

Table A-4 lists the acceptance criteria for QC samples, and Table A-5 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking Hanford Site background well water with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper limit of concentration determined in groundwater on the Hanford Site. Investigations shall be conducted for double-blind standards that are outside of acceptance limits. The results from these standards are used to determine the acceptability of the associated parameter data.

Holding time is the elapsed time period between sample collection and analysis. The contractor's environmental QA program plan provides a table with holding times. Exceeding the required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified in SW-846 or *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). Data associated with exceeded holding times are flagged with an "H" in the HEIS database. Data that exceed the holding time shall be maintained but potentially may not be used in statistical analyses.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The groundwater project periodically audits the analytical laboratories to identify and solve quality problems, or to prevent such problems from occurring. Audit results are used to improve performance, and the summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

Table A-4. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemical Parameters			
Alkalinity Chemical oxygen demand Conductivity Oil and grease pH Total dissolved solids Total organic carbon Total organic halides	MB[b]	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS[e]	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Ammonia and Anions			
Ammonia Anions by IC Cyanide	MB	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Metals			
Arsenic Cadmium Chromium Lead Mercury Selenium Thallium ICP metals ICP/MS metals	MB	<CRDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	MSD	≤20% RPD[c]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Volatile Organic Compounds			
Volatiles by GC/MS Total petroleum hydrocarbons by GC	MB	<MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB, FXR	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

Table A-4. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
Semivolatile Organic Compounds			
Herbicides by GC PCBs by GC Pesticides by GC Phenols by GC Semivolatiles by GC/MS	MB	<2 times MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed[d]
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

a. Refer to Table A-2 for specific analytical methods.

b. Does not apply to pH.

c. Laboratory-determined, statistically derived control limits may also be used. Such limits are reported with the data.

d. 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) or rejected ("R" flag).

e. Applies to total organic carbon and total organic halides only.

f. Applies only in cases where one or both results are greater than five times the detection limit.

g. Determined by the laboratory based on historical data. Control limits are reported with the data.

h. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is less than five times the MDL.

Data flags:

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)

Q = problem with associated field QC sample (blank and/or duplicate results were out of limits)

Abbreviations:

CRDL = contract-required detection limit

DUP = laboratory matrix duplicate

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

GC = gas chromatography

IC = ion chromatography

ICP = inductively coupled plasma

ICP/MS = inductively coupled plasma/mass spectrometry

LCS = laboratory control sample

MB = method blank

MDA = minimum detectable activity

MDL = method detection limit

MS = matrix spike

Table A-4. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action

MSD = matrix spike duplicate

PCB = polychlorinated biphenyl

QC = quality control

RPD = relative percent difference

SUR = surrogate

Table A-5. Blind Standard Constituents and Schedule

Constituents	Frequency	Accuracy (%)	Precision (% RSD)[a]
Carbon tetrachloride	Quarterly	±25%	≤25%
Chloroform	Quarterly	±25%	≤25%
Trichloroethylene	Quarterly	±25%	≤25%
Fluoride	Quarterly	±25%	≤25%
Nitrate	Quarterly	±25%	≤25%
Cyanide	Quarterly	±25%	≤25%
Chromium	Annually	±20%	≤25%
Total organic carbon[b]	Quarterly	Varies according to spiking compound	Varies according to spiking compound
Total organic halides[c]	Quarterly	Varies according to spiking compound	Varies according to spiking compound

a. If the results are less than five times the required detection limit, then the criterion is that the difference of the results of the replicates is less than the required detection limit.

b. The spiking compound generally used for total organic carbon is potassium phthalate. Other spiking compounds may also be used.

c. Two sets of spikes for total organic halides will be used. The spiking compound for one set should be 2,4,5-trichlorophenol. The spiking compound for the second set should include the constituents used for the volatile organic compounds sample (carbon tetrachloride, chloroform, and trichloroethylene).

RSD = relative standard deviation

Failure of QC will be determined and evaluated during data validation and the data quality assessment process. Data will be qualified, as appropriate.

A2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to minimize measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory's and the onsite organization's QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with SW-846, or with auditable HASQARD and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

A2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in the environmental QA program plan. Standards used for calibration will be certified and traceable to nationally recognized performance standards. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the contractor's acquisition system and the responsibilities and interfaces necessary to ensure that items procured/acquired for contractor meet specific technical and quality requirements. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

Supplies and consumables that are procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

A2.9 Non-Direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. If evaluation includes data from historical sources, whenever possible such data will be validated to the same extent as the data generated as part of this effort. All data used in evaluations will be identified by source.

A2.10 Data Management

The Sample Management and Reporting organization, in coordination with the RCRA Monitoring and Reporting manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements that govern data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the Tri Party Agreement Action Plan (Ecology et al. 1989b). The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file.

All field activities will be recorded in the field logbook.

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution of the errors with the RCRA Monitoring and Reporting manager. Sample disposition records become a permanent part of the analytical data package for future reference and for records management.

A3 Assessment and Oversight

The elements in this section address the activities for assessing the effectiveness of project implementation and the associated QA and QC activities. The purpose of the assessment is to ensure that the QAPjP is implemented as prescribed.

A3.1 Assessments and Response Actions

The contractor management, Regulatory Compliance, Quality, and/or Health and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this QAPjP.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratory's QA plan. The primary contractor conducts oversight of offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

A3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to the Sample Management and Reporting organization, which initiates a sample disposition record in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the RCRA Monitoring and Reporting manager.

A4 Data Validation and Usability

The elements in this section address the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying the project objectives. These elements are further discussed in the contractor's environmental QA program plan.

A4.1 Data Review, Verification, and Validation

The criteria for verification may include review for completeness (e.g., all samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

A4.2 Verification and Validation Methods

The work activities shall follow documented procedures and processes for data validation and verification, as summarized below. Validation of groundwater data consists of assessing whether the data collected and measured truly reflect aquifer conditions. Verification means assessing data accuracy, completeness, consistency, availability, and internal control practices to determine overall reliability of the data collected. Other DQOs that shall be met include proper chain-of-custody, sample handling, use of proper analytical techniques as applied for each constituent, and the quality and acceptability of the laboratory analyses conducted.

Groundwater monitoring staff perform checks on laboratory electronic data files for formatting, allowed values, data flagging (i.e., qualifiers), and completeness. Hardcopy results are verified to check for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems encountered during analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff work with the laboratory to correct the problem found during the analysis.

The data validation process provides the requirements and guidance for validating groundwater data that are routinely collected. Validation is a systematic process of reviewing verified data against a set of criteria (provided in Section A2.5) to determine whether the data are acceptable for their intended use.

Results of laboratory and field QC evaluations, double-blind sample results, laboratory performance evaluation samples, and holding-time criteria are considered when determining data usability. Staff review the data to identify whether observed changes reflect changes in groundwater quality or potential data errors, and they may request data reviews of laboratory, field, or water-level data for usability purposes. The laboratory may be asked to check calculations or re-analyze the sample, or the well may be resampled. Results of the data reviews are used to flag the data appropriately in the HEIS database (e.g., "R" for reject, "Y" for suspect, or "G" for good) and/or to add comments.

A4.3 Reconciliation with User Requirements

The data quality assessment 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 data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project's DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

A5 References

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Appendix B

Construction Information for Wells 299-E25-47 and 299-E25-20

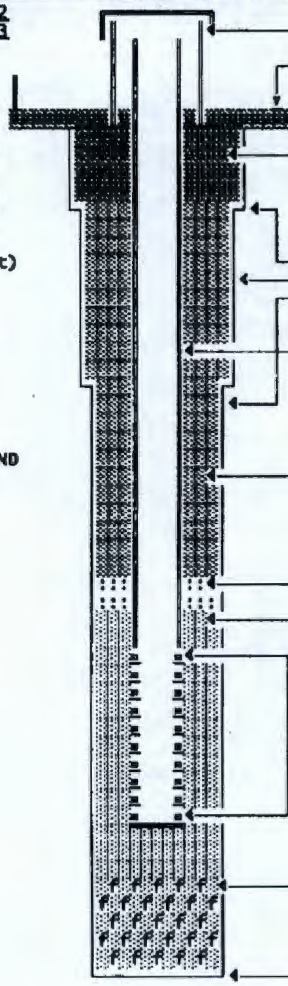
WELL CONSTRUCTION AND COMPLETION SUMMARY A4794

Drilling Method: Backhoe/Air rotary Downhole hammer	Sample Method: Continous Air returns	WELL NUMBER: 299-E25-47 TEMPORARY WELL NO:
Drilling Fluid Used: None	Additives Used: None documented	Hanford Coordinates: N/S N 40,835.3 E/W W 46,306.1
Driller's Name: D. Mingo	WA State Lic Nr: Not documented	State NAD83 Coordinates: N 135,931.0m 446,018 E 575,778.6m 2,248,914
Drilling Company: Jensen Drilling Co	Company Location: Not documented	Start Card #: Not documented T___ R___ S___
Date Started: 14Jul92	Date Complete: 06Aug92	Elevation Ground surface: 670.41-ft (Brass cap)

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

GENERALIZED STRATIGRAPHY Geologist's Log

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: (top of casing) [673.77-ft]

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

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

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	:	

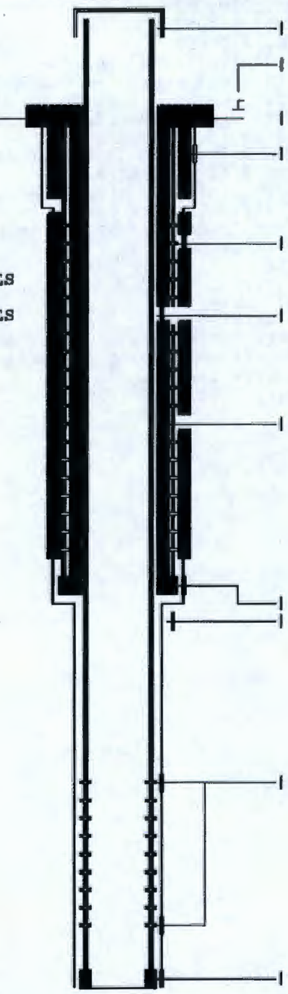
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 299-E25-20 — TEMPORARY WELL NO: 4
Drilling Fluid Used: Water	Additives Used: Bentonite	Hanford Coordinates: N/S N 39,925 E/W W 45,875
Driller's Name: Egan	WA State Lic Nr: Not documented	State Coordinates: N 445,109 E 2,249,348
Drilling Company: Not documented	Company Location: Not documented	Start Card #: Not documented T___ R___ S___
Date Started: 20May76	Date Complete: 06Aug76	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



Elevation of reference point: (top of casing) [676.30-ft]

Height of reference point above ground surface [ND]

Depth of surface seal [20.0-ft]

Type of surface seal:
Cement grout between 8 and 10-in casing 0-20-ft as 10-in pulled back.
2-ft pad, depth indeterminate

8-in ID carbon steel casing, 0-150-ft

6-in ID carbon steel casing, +ND-300-ft

Annular seal,
Cement grout between 6 and 8-in casing.
Perforated 21-149-ft, 4 cuts/rd/ft.
Used 270-gals cement
at 5.5-gals water/bag cement.

Hole diameter,
20-150-ft, 9-in nominal
150-300-ft, 7-in nominal

6-in casing perforations, 269-294-ft, 4 cuts/rd

Borehole drilled depth: [300-ft]

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

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	:	

Distribution

	MS	Quantity
U.S. Department of Energy, Richland Operations Office		
D.R. Hildebrand	A6-38	1
DOE Public Reading Room	H2-53	1
CH2M HILL Plateau Remediation Company		
J.W. Lindberg	R3-50	10
S.P. Luttrell	R3-50	1
Administrative Record	H6-08	1
Document Clearance	H6-08	1

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