DOE/RL-2009-75
Revision 0

Interim Status Groundwater Monitoring Plan for the LLBG WMA-1

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

U.S. DEPARTMENT OF ENERGY

Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2009-75
Revision 0

Interim Status Groundwater Monitoring Plan for the LLBG WMA-1

Date Published
December 2009

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

Release Approval

12/15/2009
Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

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

This report has been reproduced from the best available copy.

Printed in the United States of America

Contents

1 Introduction 1-1

2 Background 2-1

2.1 Facility Description and Operational History 2-1
2.2 Regulatory Basis 2-2
2.3 Waste Characteristics 2-3
2.4 Geology and Hydrogeology 2-4
2.5 Summary of Previous Groundwater Monitoring 2-7
2.6 Conceptual Model 2-9
2.6.1 Geochemical Considerations 2-10
2.6.2 Soil Moisture Factors 2-10
2.6.3 Hydrogeologic Considerations 2-11
2.7 Data Quality Objectives 2-12

3 Groundwater Monitoring 3-1

3.1 Constituent List and Sampling Frequency 3-1
3.2 Well Network 3-1
3.3 Sampling and Analysis Protocol 3-1
3.4 Differences Between This Plan and Previous Plan 3-1

4 Data Evaluation and Reporting 4-1

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

5 References 5-1

Appendix

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

Figures

Figure 1-1. Low-Level Burial Grounds in the 200 East Area 1-2
Figure 2-1. 218-E-10 Burial Ground at Low-Level Waste Management Area 1 2-3
Figure 2-2. Geologic Cross-Section Beneath the Northern Boundary of the Southern Portion of Low-Level Waste Management Area 1 2-5
Figure 2-3. Water Table Map for the 200 East Area, March 2008 2-8
Figure 2-4. Conceptual Model for Low-Level Waste Management Area 1 2-11
Figure 2-5. Two New Low-Level Waste Management Area 1 Network, Monitoring Well Locations and Well Names 2-16
Figure 3-1. Map Showing Locations of Existing RCRA Monitoring Wells at Low-Level Waste Management Area 1 3-4
Figure A-1. Project Organization 2

Tables

Table 2-1. Data Quality Objectives at RCRA Sites Monitoring for Indicator Parameters 2-13
Table 3-1. Groundwater Monitoring Schedule for Low-Level Waste Management Area 1 3-2
Table 3-2. Low-Level Waste Management Area 1 Groundwater Monitoring Well Construction and Relative Water Table Information 3-5
Table 4-1. Reports Required for Compliance with 40 CFR 265, Subpart F for Groundwater Monitoring 4-2

Terms

bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FY	iscal year
LLWMA	low-level waste management area
OU	operable unit
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WAC	*Washington Administrative Code*

This page intentionally left blank.

1 Introduction

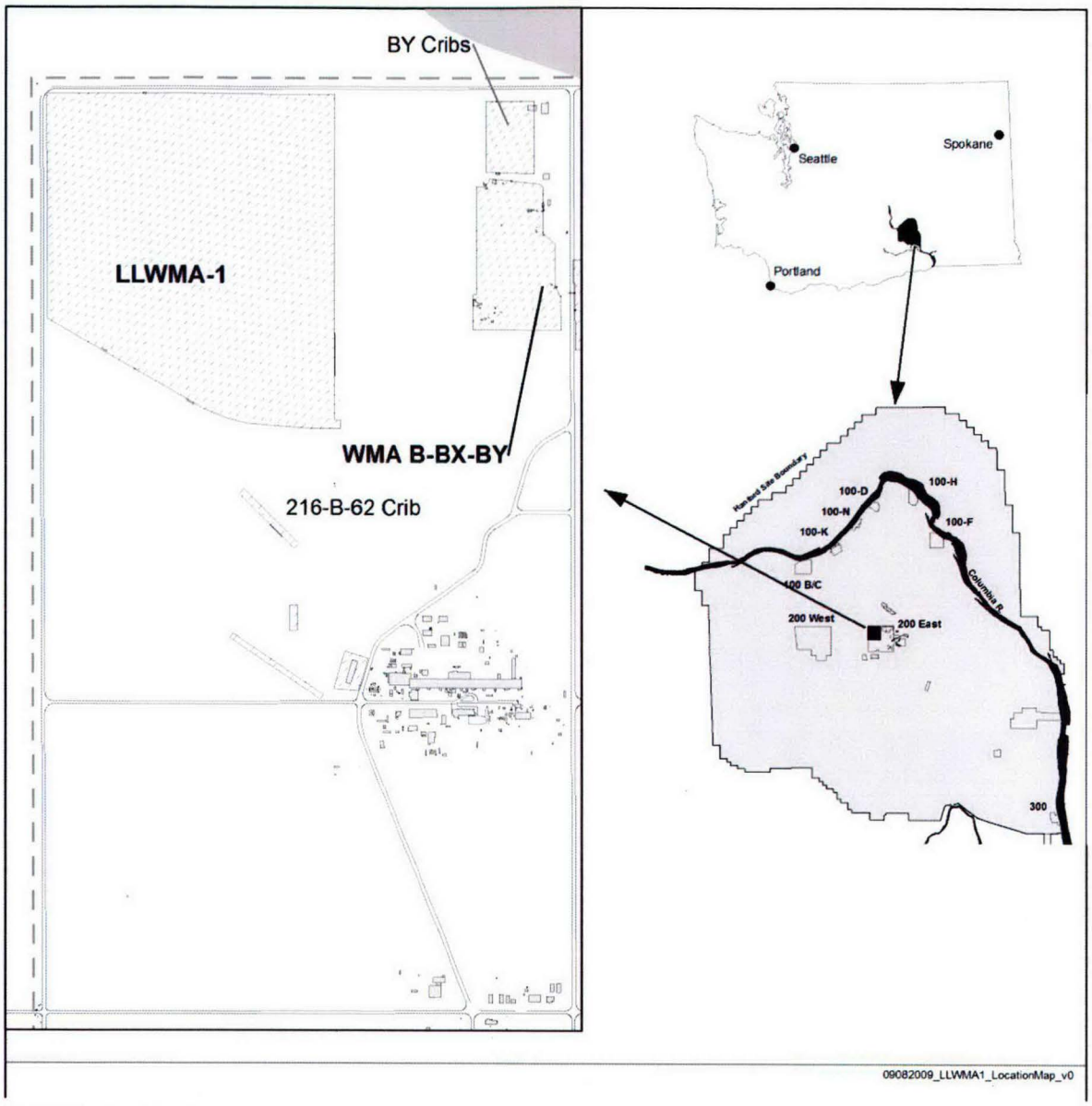
Low-Level Waste Management Area 1 (LLWMA-1) consists of the 218-E-10 Burial Ground, which contains 19 unlined trenches, and is located in the northwestern corner of the 200 East Area (Figure 1-1). The LLWMA-1 was used for disposal of low-level radioactive wastes and low-level mixed wastes beginning in 1955. The dangerous waste and dangerous waste constituents in the low-level mixed waste portions of LLWMA-1 are regulated under *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." The LLWMA-1 was placed in assessment monitoring in 1989 because of elevated specific conductance (a *Resource Conservation and Recovery Act of 1976* [RCRA] indicator parameter) in one well. The LLWMA-1 was subsequently shown not to be the source for the elevated specific conductance and indicator evaluation monitoring resumed in 1994; indicator evaluation monitoring has continued at LLWMA-1 since that time. The objectives for continued indicator evaluation monitoring at LLWMA-1, as required by WAC 173-303-400(3), "Dangerous Waste Regulations," "Interim Status Facility Standards," and defined by 40 *Code of Federal Regulations* (CFR) 265.92(d), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," are to determine the following:

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

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

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

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



LLWMA = low-level waste management area

WMA = waste management area

Figure 1-1. Low-Level Burial Grounds in the 200 East Area

2 Background

This section presents the LLWMA-1 facility and its operating history, the waste and waste characteristics associated with the site, the local geology and hydrology, a summary of previous monitoring of the groundwater and vadose zone contamination, and the conceptual model for groundwater flow and contaminant migration. The discussions in this section are summarized from earlier characterization activities reported in the documents listed below:

- DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills Group and 200-SW-2 Radioactive Landfills Group Operable Units Remedial Investigation/Feasibility Study Work Plan.*
- HNF-5507, *Subsurface Conditions Description of the B-BX-BY Waste Management Area.*
- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report.*
- PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington.*
- PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford Washington.*
- WHC-MR-0204, *200E & 200W Areas Low Level Burial Grounds Borehole Summary Report.*
- WHC-MR-0205, *Borehole Completion Data Package for the Low-Level Burial Grounds – 1990*
- WHC-SD-EN-AP-015, *Revised Groundwater Monitoring Plan for the 200 Areas Low-Level Burial Grounds.*
- WHC-SD-EN-AP-021, *Interim-Status Groundwater Quality Assessment Plan for Waste Management Area 1 of the 200 Areas Low-Level Burial Grounds.*
- WHC-SD-EN-DP-044, *1991 Borehole Completion Data Package for the Low-Level Burial Grounds.*
- WHC-SD-EN-DP-049, *1992 Borehole Completion Data Package for the Low-Level Burial Grounds.*
- WHC-SD-EN-DP-086, *1993 Borehole Completion Data Package for the Low-Level Burial Grounds.*
- WHC-SD-EN-EV-025, *Result of the Groundwater Quality Assessment Program at Low-Level Waste Management Area 1 of the Low-Level Burial Grounds.*
- WHC-SD-EN-TI-019, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area.*
- WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds.*

2.1 Facility Description and Operational History

The following summary was obtained from DOE/RL-2004-60 and PNL-6820, where additional details can be found.

> The LLWMA-1 is located in the northwestern corner of the 200 East Area (Figure 1-1). The LLWMA-1 consists of the 218-E-10 Burial Ground (approximately 36.5 ha

[90.2 ac]). The 218-E-10 Burial Ground was originally planned for 19 trenches, 14 of which were used (Figure 2-1).

A northern annexed portion later expanded the capacity of the 218-E-10 Burial Ground; however, it was never used. The 14 used, unlined trenches vary in length from 165 to 433 m (541 to 1,421 ft). The trenches are located in the southern portion of the 218-E-10 Burial Ground and occupy approximately 23 ha (57 ac). The burial ground began operating in 1955 and has not received waste since 2000.

During its operational history, two unplanned releases were reported within this burial ground in the early 1960s. One release, located in Trench 1, was identified as UPR-200-E-23. This release was reported twice, as UPR-200-E-23 and UPR-200-E-24. The other release, UPR-200-E-30, is assumed to be located in Trench 5. The release information is discussed in Section 2.3.

2.2 Regulatory Basis

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

In May 1989, DOE, EPA, and Ecology signed the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site, which includes LLWMA-1.

Groundwater monitoring is conducted at LLWMA-1 in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F, "Groundwater Monitoring"), which requires monitoring to determine whether dangerous waste or dangerous waste constituents from the waste site have entered the groundwater. A RCRA groundwater monitoring program for LLWMA-1 was initiated in 1987 (WHC-SD-EN-AP-015) based on the interim status monitoring requirements of 40 CFR 265, Subpart F and WAC 173-303-400.

In 1990, specific conductance in downgradient well 299-E28-26 significantly increased over the initial statistically derived background comparison value. The comparison value was derived using results from four previous quarterly samples from the upgradient wells in accordance with 40 CFR 265.93(c). A groundwater assessment program was then initiated (WHC-SD-EN-AP-021). Regional plumes of nitrate and sulfate originating upgradient of LLWMA-1 were concluded as the source of the elevated specific conductance. An assessment report was prepared (WHC-SD-EN-EV-025) and indicator evaluation monitoring resumed. The interim status groundwater monitoring plan was revised in 2004 (PNNL-14859), in 2006 (PNNL-14859-ICN-1), and in 2007 (PNNL-14859-ICN-2). The interim status indicator evaluation monitoring continues to date.

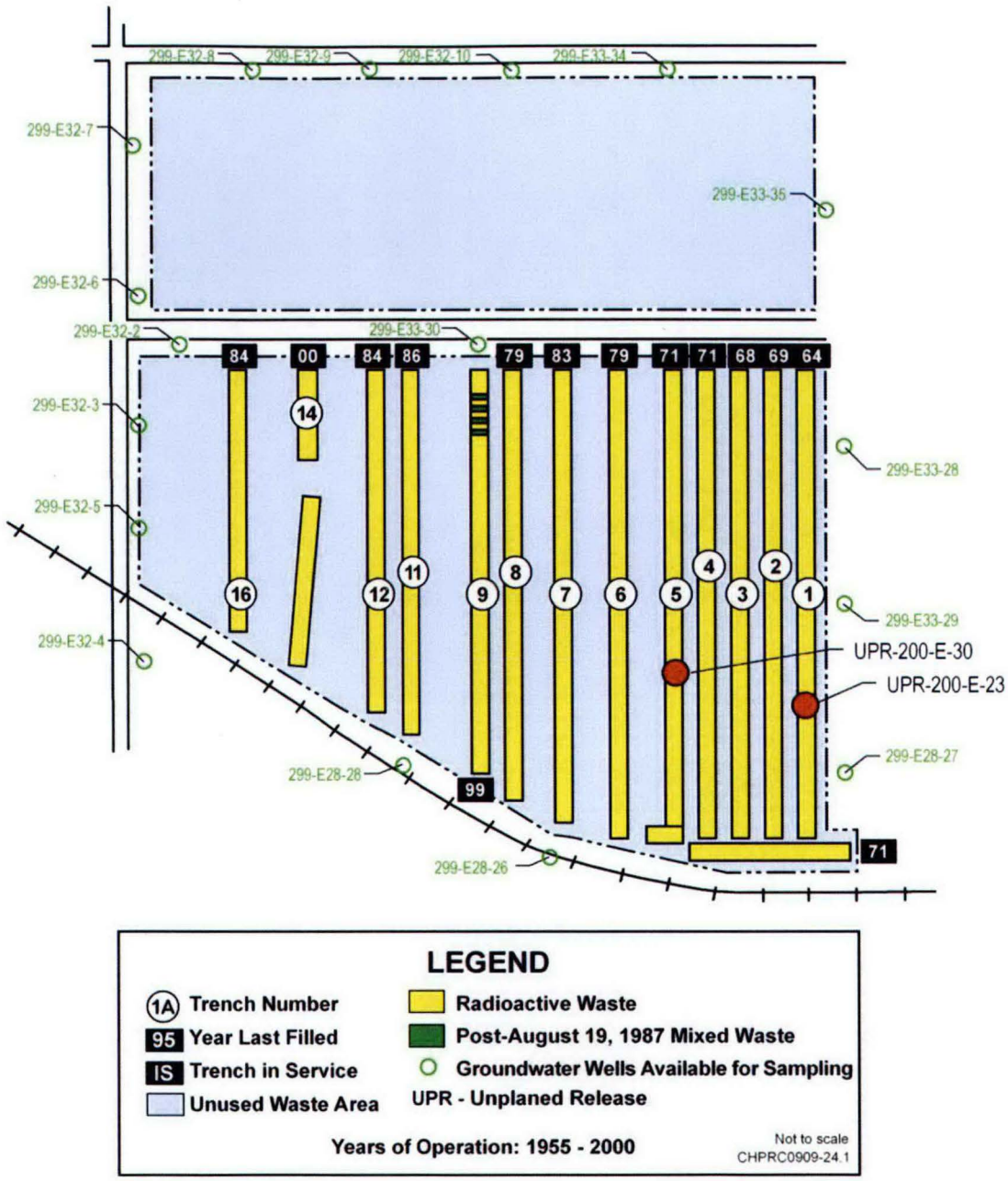


Figure 2-1. 218-E-10 Burial Ground at Low-Level Waste Management Area 1

2.3 Waste Characteristics

The 218-E-10 Burial Ground received shipments of low-level radiological waste; mixed low-level waste; and unsegregated, remote-handled waste. Examples of waste placed in this burial ground include failed equipment and mixed industrial wastes (e.g., concrete canyon cover blocks, centrifuge blocks, tubing bundles, jumper vessels, pumps, columns, and filters). Most of the waste was described as "industrial waste" from the Plutonium-Uranium Extraction Plant, B Plant, T Plant, offsite (mainly Formerly Utilized Sites Remedial Action Program waste), and the 100 Areas (mainly N Reactor waste). Industrial waste

trenches received large items, often packaged in drag-off boxes, which had doses associated with their wastes of up to 200 mrem/hr at 61 m (200 ft) (DOE/RL-2004-60).

Most of the waste buried before 1990 is in concrete boxes, while waste buried later was mainly dumped directly from trucks.[1] Two wooden burial boxes disposed in the early 1960s were reported to have collapsed releasing high-level contamination (UPR-200-E-23 and 200-UPR-E-30) (Figure 2-1). Only dose levels were reported in supporting release documents. The maximum dose readings were 60 and 500 mrem/hr, respectively. When UPR-200-E-23 was identified, the contamination was fixed by spraying water or road oil over the affected area. One document indicated that a conventional agricultural sprinkler system consisting of 366 m (1,200 ft) of 10.3 cm (4-in.) irrigation pipe was installed in an effort to stabilize the ground contamination. Rye seed was inferred to have been sown to form a root mat for preventing wind erosion. UPR-200-E-30 occurred during soil coverage, which was used to mitigate airborne contamination. Historical documentation indicates that waste trenches were backfilled on a daily or weekly basis. In addition, herbicide application has been used to mitigate radioactive uptake by deep-rooted plant growth (DOE/RL-2004-60).

Of the burial records within the scope of the remedial investigation/feasibility study for the 200-SW-2 Operable Unit (OU), only 12 percent list nonradiological contaminants that currently are (or once were) regulated. Records for the 218-E-10 Burial Ground included asbestos, lead, and di-octyl phthalate. One reason for this smaller percentage is that most waste packages with good records do not contain regulated constituents. Additionally, although a variety of chemical wastes may have been disposed to this landfill, chemical inventories were not consistently maintained until the mid-1980s (DOE/RL-2004-60).

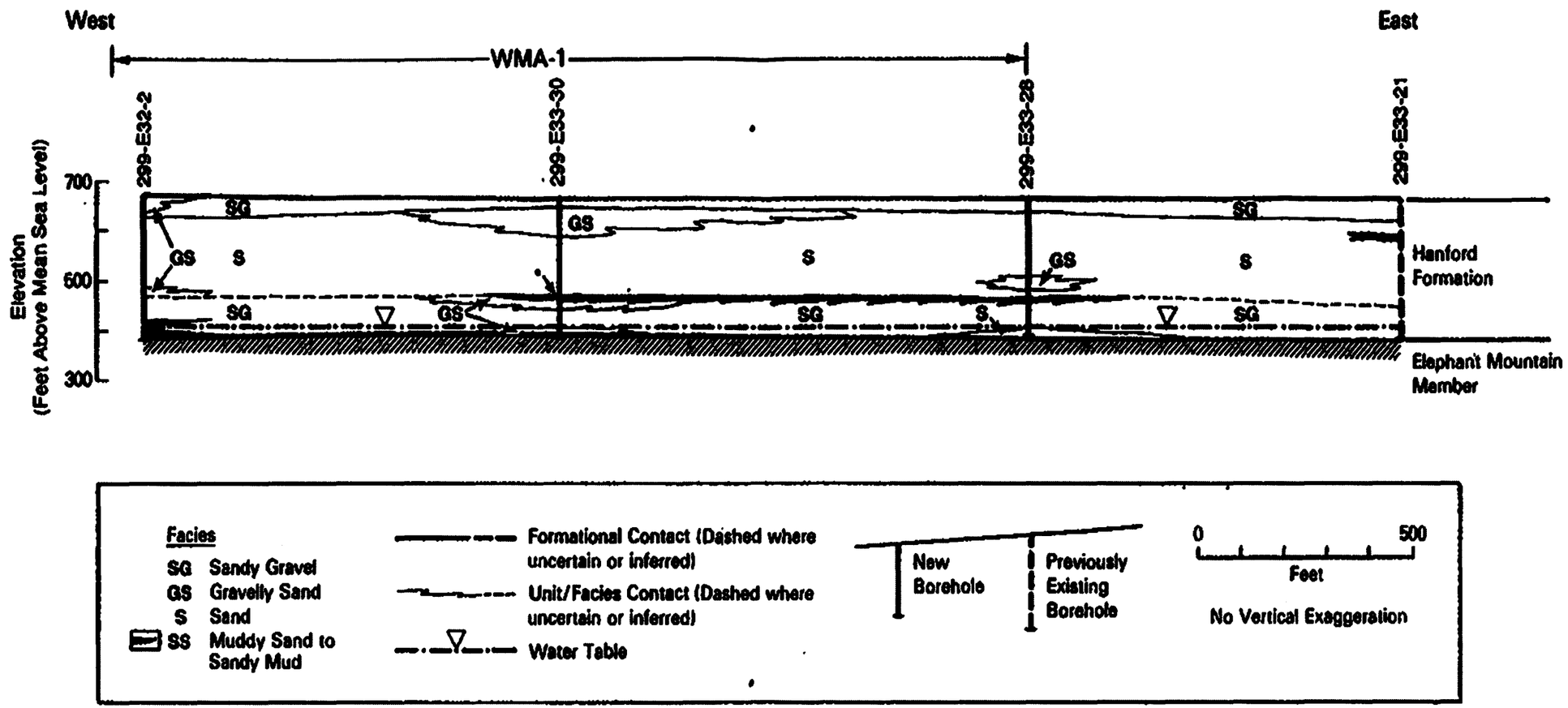
Trench 9 received mixed low-level waste after the mixed waste regulation effective date of August 19, 1987 (Figure 2-1). However, the disposal of mixed low-level waste to Trench 9 may no longer be regulated because it is believed to be associated with lead shielding and di-octyl phthalate (used for testing high-efficiency particulate air filters) (DOE/RL-2004-60).

2.4 Geology and Hydrogeology

The geology and hydrology of the 200 East Area, including the area of LLWMA-1, are described in detail in PNL-6820 and WHC-SD-EN-TI-290. Other reports providing significant information include the following: HNF-5507, WHC-SD-EN-TI-019, PNNL-12261, WHC-MR-0204, WHC-MR-0205, WHC-SD-EN-DP-044, WHC-SD-EN-DP-049, and WHC-SD-EN-DP-086. The following discussion summarizes information from these reports. This section also identifies the uppermost aquifer and the aquifers hydraulically interconnected beneath LLWMA-1.

In the past, LLWMA-1 underlying sediments from the ground surface to the top of the basalt were interpreted as Hanford and Ringold Formation sediments (PNL-6820). More recently, a determination that no Ringold Formation sediments are present beneath LLWMA-1 was made (WHC-SD-EN-TI-290). The suprabasalt sediments overlying the Elephant Mountain Basalt and extending into the lower vadose zone are described as mostly a gravel-dominated facies, with local intercalated intervals of sand-dominated facies (WHC-SD-EN-TI-290) (Figure 2-2).

[1] Information obtained from the Solid Waste Information and Tracking System (SWITS) database.



*Hydrometer Analysis
2% Sand
82% Silt
16% Clay

Figure 2-2. Geologic Cross-Section Beneath the Northern Boundary of the Southern Portion of Low-Level Waste Management Area 1

This page intentionally left blank.

Most recently, interpretation of the suprabasalt sediments beneath Waste Management Area B-BX-BY (located to the east) described the presences of Cold Creek sediments. The lowest unit is a gravel unit with undistinguishable texture from the Hanford basal gravels (H-3). The Cold Creek unit has previously been defined as the Hanford formation/Plio-Pleistocene unit (Hf/PPu). No new interpretation beneath LLWMA-1 has occurred for the aquifer sediments.

The suprabasalt sediment beneath LLWMA-1 ranges from 73 m (240 ft) to more than 100 m (328 ft) thick. The water table as of June 2009 ranged from 71.3 to 87.8 m (233.9 to 288.1 ft) below ground surface (bgs). Historically, the water table level was approximately 3.05 m (10 ft) higher in the late 1960s and 1980s due to peak production at Hanford and associated artificial recharge. Transmissivity measurements from LLWMA-1 boreholes varied from 148.6 m^2/day (1,600 ft^2/day) in well 299-E33-35 to more than 4,645.2 m^2/day (50,000 ft^2/day) in wells 299-E33-28 through 299-E33-30. Because of the permeable nature of aquifer sediments, the groundwater gradient has historically been very small beneath LLWMA-1 (Figure 2-3). Recent water table measurements have indicated variability of the flow direction beneath LLWMA-1, ranging from north to south during 2008 and 2009. The most recent flow direction (April through July 2009) has returned to a northwestern direction.

Underlying the suprabasalt sediments is the Elephant Mountain Member of the Saddle Mountains Basalt formation. During the drilling of LLWMA-1 wells, some of the drilling extended into the upper portion of the Elephant Mountain Basalt. Examination of basalt drill cuttings found only sparse vesicles in basalt chips from one well and none from two other wells (PNL-6820). Based on this information, it was concluded that past fluvial events removed part, to the entire, flow top from the Elephant Mountain Basalt in this area. This substantiates earlier conclusion that the Elephant Mountain Member acts hydrologically as an aquiclude, confining the underlying Rattlesnake Ridge aquifer.

2.5 Summary of Previous Groundwater Monitoring

Groundwater monitoring was initiated at the LLWMA-1 in 1987 in accordance with WHC-SD-EN-EV-015. The groundwater beneath LLWMA-1 is sampled semi-annually for indicator parameters and geochemical analyses. Water levels are measured during each sampling event and annually in March as part of a comprehensive water-level measurement campaign. The groundwater monitoring results are summarized annually and presented in the annual Hanford groundwater monitoring report (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

The first eight RCRA compliant monitoring wells were installed at LLWMA-1 in 1987. The initial network consisted of three RCRA upgradient and five downgradient wells. The initial flow direction was considered from east to west. Additional wells were installed in 1989 (one well), 1990 (three wells), 1991 (four wells), and 1992 (one well). The RCRA well screens extend from above the unconfined aquifer to various depths within the aquifer. The shortest screen intervals (e.g., 1.72 to 2.26 m [5.6 to 7.4 ft]) extending into the aquifer are in the northeast wells. Because the aquifer is so thin, the screened sections extend to within a few feet of the underlying basalt. The other wells basically monitor the upper portion of the aquifer and extend between 1.97 and 3.36 m (6.5 and 11.0 ft) into the aquifer.

Background monitoring at LLWMA-1 began in 1988, and initial background comparison values for the indicator parameters (e.g., total organic carbon, total organic halides, pH, and specific conductivity) were established in 1989 using data from four quarters from upgradient wells 299-E28-27, 299-E33-28, and 299-E33-29.

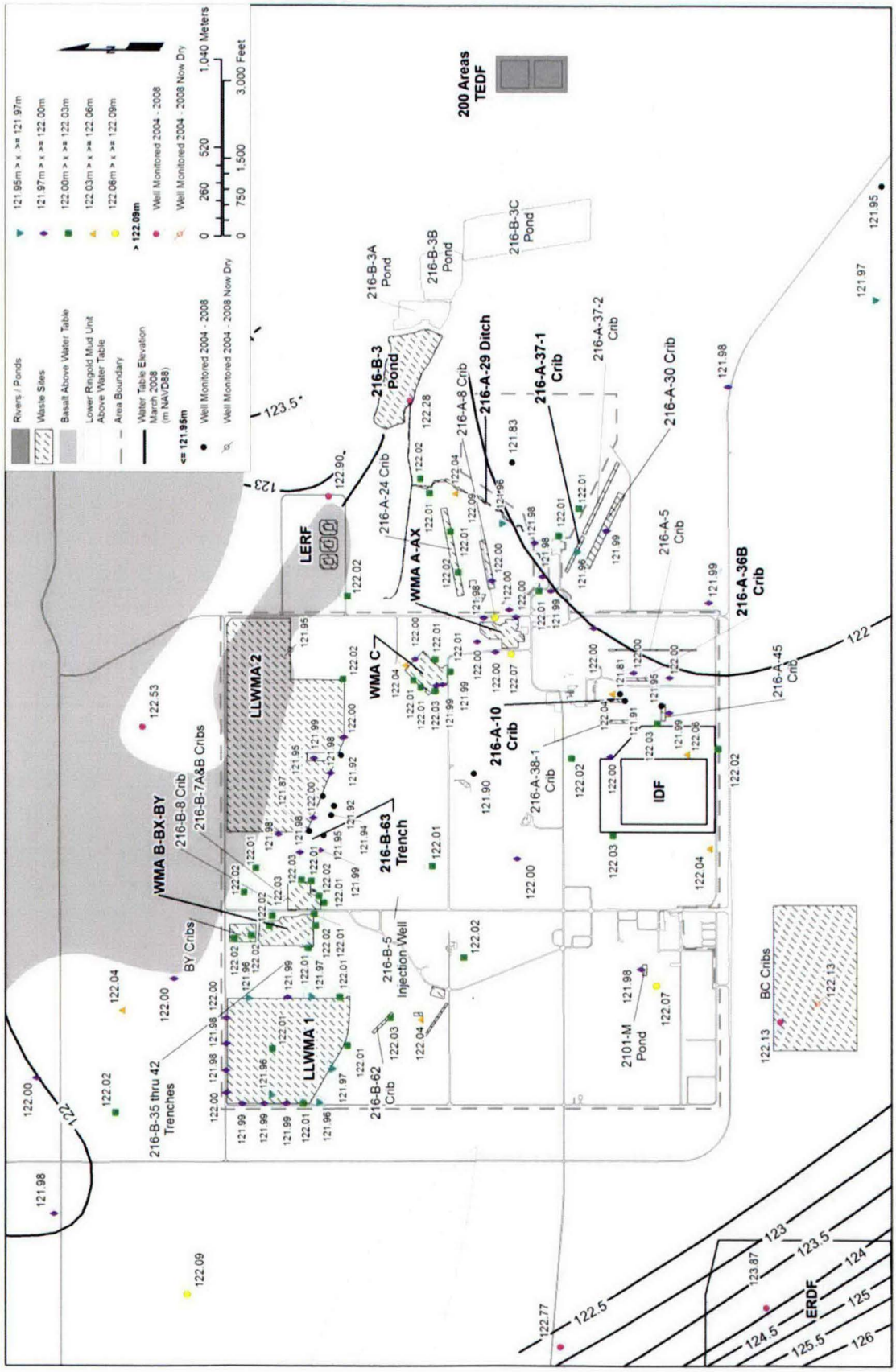


Figure 2-3. Water Table Map for the 200 East Area, March 2008

The derived background comparison value, critical mean, for specific conductance was exceeded in well 299-E28-26 in September 1989. Verification sampling confirmed the exceedance, and an interim status groundwater quality assessment program was initiated (WHC-SD-EN-AP-021). Subsequent sampling results provided evidence that LLWMA-1 did not contribute to the elevated specific conductance (WHC-SD-EN-EV-025); liquid waste disposal facilities to the south were identified as the most probable sources. More recently, specific conductance was exceeded in the northeast wells 299-E32-10 and 299-E33-34. Once again, the elevated specific conductance was determined not to be contributed by LLWMA-1 (PNNL-14859). Regional sampling results determined that the elevated specific conductance and associated contaminants were associated with the BY Cribs.

Groundwater monitoring at LLWMA-1 was conducted on a quarterly frequency between 1988 and April 1994, except for the period between June 1990 and June 1991 when laboratory services were unavailable. The sampling frequency changed to semi-annual in 1994 and remained as such until 2000. A quarterly sampling frequency was resumed in 2000 as a result of specific conductance levels exceeding the critical mean in well 299-E33-34 during 1999. The source was determined to be the BY Cribs, and the sampling frequency was returned to semi-annual in 2002. The sampling frequency has not changed since that time, and the site remains in interim indicator evaluation monitoring status.

Currently, groundwater monitoring activities at LLWMA-1 consist of water-level monitoring and chemical constituent monitoring. The LLWMA-1 is sampled semi-annually from a network of 17 wells. Samples are analyzed semi-annually for the indicator parameters, anions, and metals and annually for alkalinity, mercury, lead, and phenols. Sitewide water-level measurements are collected every March. Regional water-level measurements have also been collected monthly since June 2008.

2.6 Conceptual Model

This section describes the LLWMA-1 conceptual model for potential contaminant transport to guide future groundwater monitoring. The conceptual model for contaminant release and transport is based on the following assumptions.

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

2.6.1 Geochemical Considerations

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

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

Based on the general geochemical conditions and the nonradiological waste constituents reported beneath LLWMA-1, significant contaminant migration appears unlikely (Figure 2-4). Even if large volumes of water may have been applied to fix radiologic contamination (e.g., UPR-200-E-23), gross-gamma logging results from 1987 at proximal wells 299-E28-27 and 299-E33-29 (approximately 87 m and 118 m [285 ft and 387 ft], respectively) showed no elevated sign of gamma. The mobility of lead and cesium is approximately the same (PNNL-11800). Furthermore, asbestos (which is orders of magnitude larger in size than molecular ions associated with porewater) would have even less mobility.

2.6.2 Soil Moisture Factors

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

The amount of natural infiltration that can pass through the leachable buried waste and drain to the water table is controlled by the texture of the cover and backfill and the degree of vegetative cover. Stratigraphic features in the soil column beneath the buried waste can also influence or retard downward migration by spreading soil moisture laterally. Direct observational evidence to assess this effect at LLWMA-1 is lacking. Under the gravity drainage assumption, only a small horizontal gradient component is likely to be available to produce lateral spreading of infiltrating water.

Most of the burial ground trenches are backfilled with natural excavation materials (Hanford formation) consisting of coarse gravel, cobbles, and some interstitial sand. Some amounts of vegetation exist on the established backfilled areas and on unused portions of LLWMA-1.

A coarse, sparsely vegetated cover material allows a major fraction of the precipitation to infiltrate and potentially drain to the groundwater. It is estimated[2] that recharge rates at the Hanford Site range from near 0 mm/yr at highly vegetated sites to greater than 50 mm/yr at gravel-covered, nonvegetated sites.

---

[2] G. Gee (Pacific Northwest National Laboratory), personal communication with V. Johnson (Fluor Hanford, Inc.), dated February 2002.

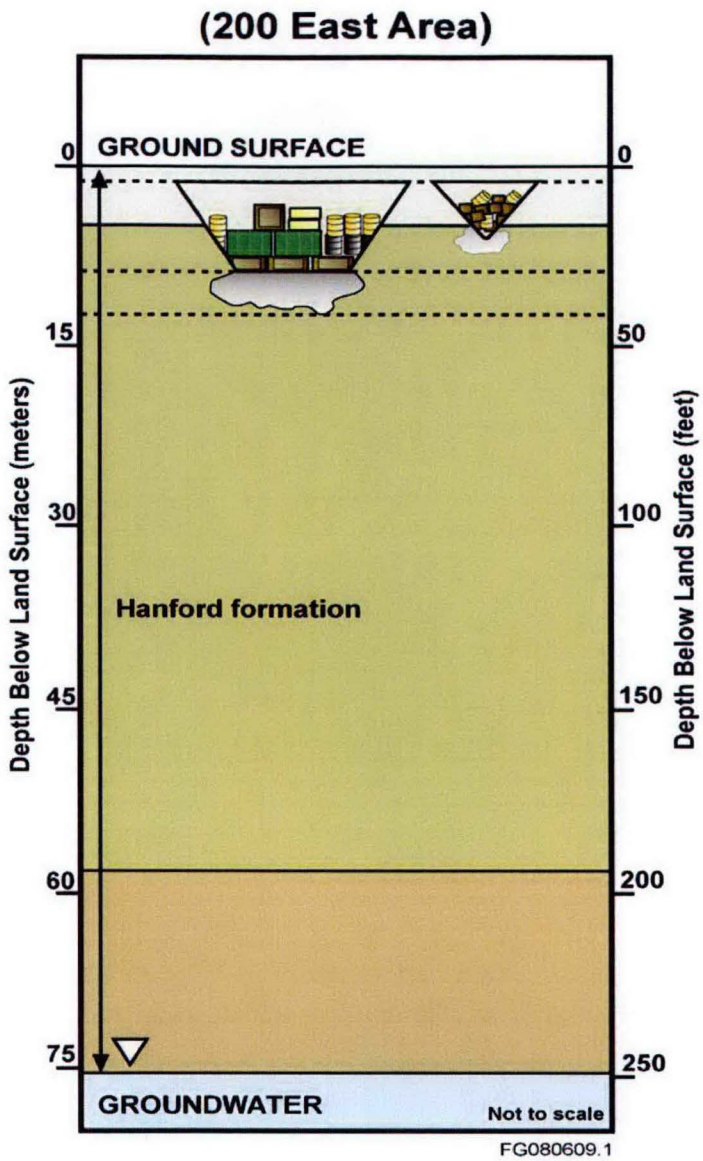


Figure 2-4. Conceptual Model for Low-Level Waste Management Area 1

2.6.3 Hydrogeologic Considerations

Hydrology is discussed in Section 2.4. The vadose zone (e.g., ground surface to water table) beneath LLWMA-1 ranges from 71.3 to 87.8 m (233.9 to 288.1 ft) bgs. The lithology of the vadose zone consists of the Hanford formation (e.g., upper gravel-dominated sequence, intermediate sand sequence, and a lower gravel sequence). Muddy sand to sandy mud located beneath the sand sequence or within the lower gravel sequence of the Hanford formation (where present) is likely to retard downward movement of moisture and contaminants because of the finer textured sediment (Figure 2-2).

If contaminants do break through to the groundwater beneath LLWMA-1, contaminants would, on average, move toward the northwest. The flow direction recently has been variable at this site, shifting between southerly and northwestern flow direction; however, data indicate that the long-term average direction is to the northwest. The changing flow directions have been attributed to high Columbia River

stages in the spring and occasional, large, permitted water treatment discharges at the 200 East Area Treated Effluent Disposal Facility (DOE/RL-2008-66). Because of these recent influences on the already low gradient, the groundwater flow rate is not provided at this time.

2.7 Data Quality Objectives

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

Assumptions regarding LLWMA-1 groundwater monitoring based on historical observations and a recent needs assessment (SGW-40037, *Groundwater Monitoring Needs Assessment for Low-Level Burial Grounds Waste Management Areas*) are as follows.

- The groundwater monitoring program described in PNNL-14859 (and interim change notices) meets the requirements of 40 CFR 265.90(b).
- Elevated specific conductance in the northeast wells (e.g., 299-E33-34, 299-E32-10, 299-E33-35, and 299-E32-9) is driven primarily by nitrate, sulfate, calcium, and chloride from the BY Cribs.
- High nitrate concentrations in the remaining LLWMA-1 monitoring network wells (other than those described in second bulleted item above) are from cribs located south of LLWMA-1.
- The northern, unused portion of LLWMA-1 will be procedurally closed (Figure 2-1).
- Two new wells will be installed between wells 299-E33-30 and 299-E32-2, which will become the new northwest boundary of LLWMA-1 (Figure 2-5).

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

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

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

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

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

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

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

CFR = *Code of Federal Regulations*

DQO = data quality objective

RCRA = *Resource Conservation and Recovery Act of 1976*

Figure 2-5. Two New Low-Level Waste Management Area 1 Network, Monitoring Well Locations and Well Names

Procedurally closing the northern unused portion of LLWMA-1 and moving the northern limit to the south requires a revised monitoring network and plan. The recent monitoring needs assessment (SGW-40037) developed a three-tiered approach for changing the monitoring network. The tier number one changes included the following.

- Adding two new monitoring wells located to the northwest of Trench 9, identified with the only post-August 19, 1987, mixed waste (RCRA) in LLWMA-1. One well is planned to be completed in fiscal year 2010 (FY10) and the other well is planned for completion in FY11.
- Change the status of the seven existing wells along the northern unused portion of LLWMA-1 to supplemental wells with continued monitoring.
- Add well 299-E33-10, located to the east of LLWMA-1 (upgradient), to the network.
- Change the status of four existing wells along the southern and eastern boundary of the southern portion of LLWMA-1 to supplemental and continue monitoring at these wells.

The tier number two requirement is to perform modeling to identify the need for additional wells. The tier number three requirements include installing the tier number two monitoring wells.

The following provides changes to the conclusions of the monitoring needs assessment based on recent information and re-evaluation. The recommendations presented for refinement of the needs assessment logic are as follows.

- Wells along the southern and southeastern boundary of LLWMA-1 will remain part of the monitoring network. These wells will provide upgradient groundwater data or downgradient groundwater data if the groundwater flow directions change.
- Omit well 299-E33-10 because it is noncompliant and proximal to network well 299-E33-29.
- Change the status of the seven existing wells along the northern unused portion of LLWMA-1 to supplemental wells with continued water-level monitoring.

This page intentionally left blank.

3 Groundwater Monitoring

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

3.1 Constituent List and Sampling Frequency

Table 3-1 lists the constituents to be analyzed for the indicator evaluation groundwater monitoring program at LLWMA-1. All wells and constituents are to be sampled semi-annually, as indicated in Table 3-1. Note that wells 299-E33-265 and 299-E33-266 are new planned wells (one well will be drilled in FY10 and one in FY11). Maintenance problems and sampling logistics can delay scheduled sampling events. If sampling of a well is delayed more than 3 months, that sampling event will be cancelled because it is nearly time for the next scheduled sampling event.

3.2 Well Network

Figure 3-1 shows the groundwater monitoring well network for LLWMA-1. Figure 2-5 shows the two new planned groundwater monitoring wells for LLWMA-1. Table 3-1 lists the wells in the groundwater monitoring network. Construction details and as-built diagrams for wells in the LLWMA-1 monitoring network are provided in PNL-6820, WHC-MR-0204, WHC-MR-0205, WHC-SD-EN-DP-044, and WHC-SD-EN-DP-049. The wells in the LLWMA-1 monitoring network may also be co-sampled for the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-BP-5 OU. Sampling for LLWMA-1 and the 200-BP-5 OU is coordinated to eliminate duplicate analyses and well trips.

Table 3-2 summarizes well attribute information, including the June 2009 depth to water in each well. All of the wells in the LLWMA-1 monitoring network are constructed to meet the requirements of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." These wells have stainless-steel casing and screen, sand pack in the screened interval, and full annular seal above. Given the current rate of water table decline (0.05 m/yr [0.164 ft/yr]), none of the wells in the LLWMA-1 monitoring network are expected to go dry for at least 30 years.

3.3 Sampling and Analysis Protocol

Groundwater monitoring at LLWMA-1 follows the conventions of the project and is described in Appendix A.

3.4 Differences Between This Plan and Previous Plan

Initially, the only difference between this plan and the previous plan (PNNL-14859-ICN-2) is the deletion of analytes lead and mercury. Over the next 2 years, another difference will be the addition of two new wells (e.g., 299-E33-265 and 299-E33-266) to the monitoring network (Figure 2-5). After the two new well are completed and sampled once (as part of the semi-annual monitoring event for LLWMA-1), the seven existing northern wells will no longer be sampled for indicator or groundwater quality parameters. Also, after the two new wells have been sampled once, the tier #2 modeling effort associated with the need assessment plan (SWG-40037) will be conducted to determine if additional monitoring wells may be needed adjacent to LLWMA-1. If additional wells are needed, a new monitoring plan will be completed. Also, if the northwestern groundwater flow direction is altered for more than one year, a new monitoring plan will be developed.

Table 3-1. Groundwater Monitoring Schedule for Low-Level Waste Management Area 1

Well Name	Purpose	WAC Compliant	Water Level[c]	RCRA Required Constituents[a]														
				Contaminant Indicator Parameters				Groundwater Quality Parameters						Supporting Constituents[b]			
								Anions[d]			Metals, Unfiltered, Filtered[d]						
				pH[c]	Specific Conductance[c]	Total Organic Carbon	Total Organic Halides	Chloride	Sulfate	Phenols[d]	Iron	Manganese	Sodium	Alkalinity	Dissolved Oxygen[c]	Temperature[c]	Turbidity[c]
299-E28-26	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E28-27	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E28-28	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-2	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-3	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-4	Cross-gradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-5	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-6	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-7	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-8	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-9	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E32-10	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E33-28	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E33-29	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E33-34	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S

Table 3-1. Groundwater Monitoring Schedule for Low-Level Waste Management Area 1

Well Name	Purpose	WAC Compliant	Water Level[c]	RCRA Required Constituents[a]														
				Contaminant Indicator Parameters				Groundwater Quality Parameters						Supporting Constituents[b]			
								Anions[d]			Metals, Unfiltered, Filtered[d]						
				pH[c]	Specific Conductance[c]	Total Organic Carbon	Total Organic Halides	Chloride	Sulfate	Phenols[d]	Iron	Manganese	Sodium	Alkalinity	Dissolved Oxygen[c]	Temperature[c]	Turbidity[c]
299-E33-35	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E33-265	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E33-266	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S

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

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

c. Field measurement.

d. For anions, analytes include chloride, fluoride, nitrate, nitrite, and sulfate. For metals, analytes include (but are not limited to) calcium, chromium, iron, manganese, potassium, and sodium.

4 = quadruplicate samples

A = to be sampled annually

CFR = *Code of Federal Regulations*

LLWMA = low-level waste management area

RCRA = *Resource Conservation and Recovery Act of 1976*

S = to be sampled semi-annually

Y = well is constructed to WAC 173-160

WAC = *Washington Administrative Code*

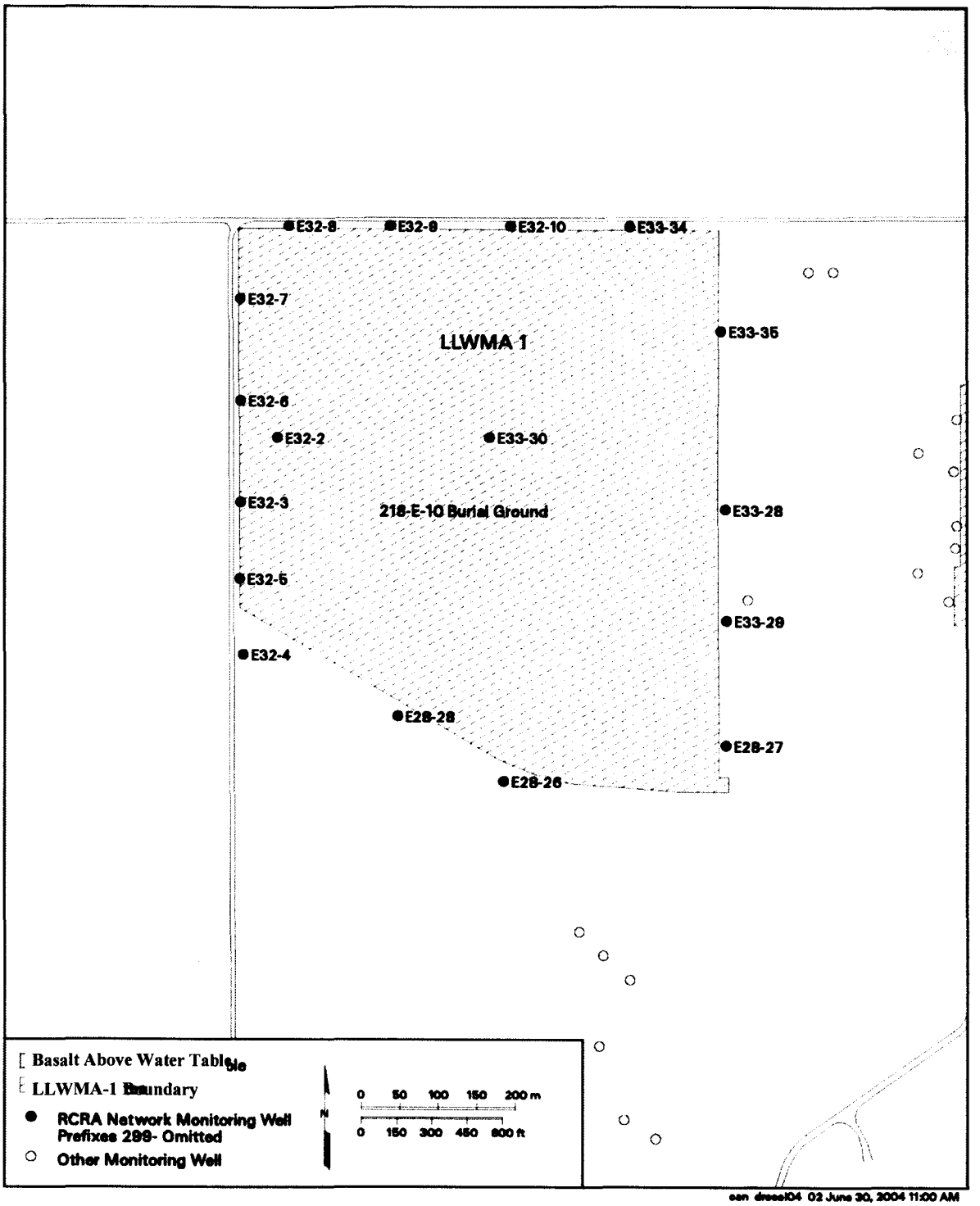


Figure 3-1. Map Showing Locations of Existing RCRA Monitoring Wells at Low-Level Waste Management Area 1

Table 3-2. Low-Level Waste Management Area 1 Groundwater Monitoring Well Construction and Relative Water Table Information

Well Name	Completion Date	Easting (m)	Northing (m)	Brass Survey Marker Elevation (m NAVD88)	Water Table Elevation (m amsl)	Screened Interval (m NAVD88)	Water Remaining, (m) (June 2009)
299-E28-26	11/06/1987	137024.016	572941.553	209.834	121.972	118.6 - 124.7	3.36
299-E28-27	09/30/1987	137070.063	573226.784	*No value*	121.987	119.4 - 125.5	2.63
299-E28-28	04/17/1990	137108.259	572804.351	*No value*	121.933	119.5 - 125.6	2.43
299-E32-2	09/30/1987	137467.509	572648.02	204.673	121.909	119.9 – 126.0	1.97
299-E32-3	09/30/1987	137383.996	572600.614	206.93	121.929	119.6 - 125.7	2.31
299-E32-4	09/30/1987	137187.218	572603.743	209.779	121.919	118.9 - 125.0	3.02
299-E32-5	11/09/89	137285.125	572599.697	208.086	121.984	119.0 - 125.4	2.99
299-E32-6	08/01/91	137515.1	572600.4	203.381	122.032	119.3 - 125.7	2.70
299-E32-7	07/26/91	137647.05	572600.38	200.627	121.921	119.3 - 125.7	2.63
299-E32-8	06/10/91	137741.47	572663.39	196.743	121.936	118.9 - 125.1	3.08
299-E32-9	07/12/91	137741.69	572795.11	196.028	121.926	119.4 - 125.6	2.57
299-E32-10	04/15/92	137741.69	572951.13	194.525	121.930	119.7 - 125.9	2.26
299-E33-28	11/06/87	137375.019	573226.365	203.07	121.943	119.0 - 125.1	2.92
299-E33-29	09/30/87	137231.193	573227.858	205.753	121.929	119.5 - 125.6	2.45
299-E33-30	09/30/87	137467.779	572923.796	202.85	121.963	119.0 – 125.1	3.01
299-E33-34	04/23/90	137740.427	573104.458	193.246	121.949	120.2 - 126.4	1.72
299-E33-35	04/17/90	137605.098	573220.798	196.174	121.924	120.2 - 126.6	1.75

Table 3-2. Low-Level Waste Management Area 1 Groundwater Monitoring Well Construction and Relative Water Table Information

Well Name	Completion Date	Easting (m)	Northing (m)	Brass Survey Marker Elevation (m NAVD88)	Water Table Elevation (m amsl)	Screened Interval (m NAVD88)	Water Remaining, (m) (June 2009)
299-E33-265	TBD	TBD	TBD	TBD	TBD	TBD	TBD
299-E33-266	TBD	TBD	TBD	TBD	TBD	TBD	TBD

NOTES:

1. All wells constructed to standards of resource protection wells in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." Stainless-steel casing and screen; sand pack around screen or "channel pack" screen; annular seal around casing.
2. Shaded rows show the anticipated network monitoring wells after the two new wells (299-E33-265 and 299-E33-266) are installed and sampled once.
3. Bold italics indicate upgradient wells for a northwesterly flow direction.
4. Water levels measured in June 2009.

amsl = above mean sea level

NAVD88 = North American Vertical Datum of 1988

TBD = to be determined

WAC = *Washington Administrative Code*

4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for LLWMA-1.

4.1 Data Review

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

4.2 Statistical Evaluation

The goal of RCRA indictor evaluation monitoring is to determine if LLWMA-1 has affected groundwater quality beneath the site. For most RCRA treatment, storage, and disposal unit at the Hanford Site, this is determined based on the results of specified statistical tests. The sampling procedures and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference in WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general contamination indicator parameters (e.g., total organic carbon, total organic halides, pH, and specific conductance) in downgradient wells to background levels obtained from upgradient wells.

Six upgradient wells at LLWMA-1 (Table 3-1) are currently used for deriving statistical comparison values. Each year, a new calculation is completed to derive the background comparison value of significance because of the variability of upgradient groundwater quality. This value is compared with each downgradient well indicator parameter result to determine if a significant increase has occurred. In addition, groundwater quality results are used to verify ion balance and relative change associated with specific conductance measurements. If questions arise from the ion balance, the laboratory results are reviewed for errors (as discussed in Appendix A). Phenol analyses are also conducted for further evaluation of potentially elevated total organic carbon or total organic halide indicator parameters.

Well 299-E33-35 is only upgradient well in the northern portion of LLWMA-1. This well will no longer be used when the northern portion of the LLWMA is procedurally closed and two new wells are added to the monitoring network.

4.3 Interpretation

After the data are validated and verified, the acceptable data are used to interpret groundwater conditions at LLWMA-1. Interpretive techniques include the following.

- Hydrographs: Graph water levels versus time to determine decreases, increases, seasonal, or man-made fluctuations in groundwater levels.
- Water table maps: Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential on the maps.
- Trend plots: Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.

- Plume maps: Mapped distributions of chemical constituent concentrations in the aquifer to determine extent of contamination. Changes in plume distribution over time aid in determining movement of plumes and direction of groundwater flow.
- Contaminant ratios: Can sometimes be used to distinguish among different sources of contamination.

4.4 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements call for annual evaluation of the groundwater monitoring network to determine if the network remains adequate to monitor the LLWMA. The network must include upgradient and downgradient wells in the uppermost aquifer. The groundwater flow direction beneath LLWMA-1 has been predominantly reported to the northwest from the early 1990s to 2008. However, the groundwater flow direction is susceptible to change for several months, as was reported last year due to high Columbia River stages in the spring and occasional, large, permitted water treatment discharges at the 200 East Area Treated Effluent Disposal Facility (DOE/RL-2008-66). Another potential factor affecting the future groundwater flow direction is the extraction and injection associated with the 200-ZP-1 OU pump-and-treat system.

Water-level measurements will be collected before each sampling event. A more comprehensive set of water-level measurements has been made for LLWMA-1 each month since June 2008. The measurements are corrected, if needed, to account for borehole deviation from vertical, and the resulting data are plotted on a map. The data are presented in the annual groundwater monitoring report.

Any new RCRA wells needed as a result of the tier #2 modeling at LLWMA-1 will be negotiated and prioritized by Ecology, DOE, and EPA and approved under Tri-Party Agreement Milestone M-24-00.

4.5 Reporting and Notification

The results of indicator evaluation monitoring are reported annually in accordance with the requirements of 40 CFR 265.94(b). Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66). Notifications are presented in Table 4-1.

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

Submittal	Submittal Period	Reporting Vehicle	Regulatory Requirement
First year of sampling: concentrations of interim primary drinking water constituents, identifying those that exceed limits	Quarterly	Complete[a]	40 CFR 265.94(a)(2)(i)
Concentration and statistical analyses of groundwater contamination indicator parameters, noting significant differences in upgradient wells	Annually (by March 1 of following year)	Hanford Site groundwater monitoring report (e.g., DOE/RL-2008-66)	40 CFR 265.94(a)(2)(ii)
Results of groundwater surface elevation evaluation and description of response, if appropriate	Annually (by March 1 of following year)	Hanford Site groundwater monitoring report	40 CFR 265.94(a)(2)(iii)

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

Submittal	Submittal Period	Reporting Vehicle	Regulatory Requirement
Outline for groundwater quality assessment program	Within one year after effective date of regulations	S&GRP document or letter	40 CFR 265.93(a)
Notification of statistical exceedance[b]	Within 7 days of verification	Letter to Ecology	40 CFR 265.93(c)
Assessment plan[b]	Within 15 days of notification	S&GRP document or letter	40 CFR 265.93(d)
Determinations under assessment program[b]	As soon as technically feasible; annually thereafter	S&GRP document, letter, or Hanford Site groundwater monitoring report	40 CFR 265.93(d)(5) and 265.94(b)

NOTES:

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

DOE/RL-2008-01, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*

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

b. Required if exceedance occurs and is verified.

CFR = *Code of Federal Regulations*

Ecology = Washington State Department of Ecology

S&GRP = Soil and Groundwater Remediation Project

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

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

This page intentionally left blank.

5 References

10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/10cfr962_08.html.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfr265_08.html.

40 CFR 265, Subpart F, "Groundwater Monitoring," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div5&view=text&node=40:25.0.1.1.6&idno=40#40:25.0.1.1.6.6.

51 FR 24504, 1986, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste," dated July 3, 1986, *Federal Register*.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq. Available at: http://www.epa.gov/oecaagct/lcla.html#Hazardous%20Substance%20Responses.

DOE/RL-2004-60, 2008, *200-SW-1 Nonradioactive Landfills Group Operable Unit and 200-SW-2 Radioactive Landfills Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2008-66, 2009, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0905131281. http://www5.hanford.gov/arpir/?content=findpage&AKey=0905131282.

Ecology, 1994, *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*, Permit No. WA780008967, Washington State Department of Ecology, Olympia, Washington.

Ecology, 2001, *Hanford Facility RCRA Permit*, Permit WA7890008967, Washington State Department of Ecology, Olympia, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement), 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Available at: Washington. http://www.hanford.gov/?page=91&parent=0.

HNF-5507, 2000, *Subsurface Conditions Description of the B-BX-BY Waste Management Area*, Rev. 0, CH2M Hill Hanford Group, Inc., Richland, Washington.

PNL-6820, 1989, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report*, Vols. 1 and 2, Rev. 0, Pacific Northwest Laboratory, Richland, Washington.

PNNL-11800, 1998, *Composite Analysis of Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/594543-mUGcOH/webviewable/594543.pdf.

PNNL-12261, 2000, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0906180659.

PNNL-14859, 2004, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14859.pdf.

PNNL-14859-ICN-1, 2006, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14859icn1.pdf.

PNNL-14859-ICN-2, 2007, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14859-ICN-2.pdf.

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

SGW-40037, 2009, *Groundwater Monitoring Needs Assessment for Low-Level Burial Grounds Waste Management Areas*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

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

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-300.

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

WHC-MR-0204, 1990, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196038070.

WHC-MR-0205, 1990, *Borehole Completion Data Package for the Low-Level Burial Grounds – 1990*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196035268.

WHC-SD-EN-AP-015, 1989, *Revised Groundwater Monitoring Plan for the 200 Areas Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-AP-021, 1990, *Interim-Status Groundwater Quality Assessment Plan for Waste Management Area 1 of the 200 Areas Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-DP-044, 1993, *1991 Borehole Completion Data Package for the Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-DP-049, 1993, *1992 Borehole Completion Data Package for the Low-Level Burial Grounds,* Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-DP-086, 1994, *1993 Borehole Completion Data Package for the Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-EV-025, 1994, *Results of Groundwater Quality Assessment Program at Low-Level Waste Management Area 1 of the Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-019, 1992, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-290, 1994, *Geologic Setting of the Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www.osti.gov/bridge/servlets/purl/10192359-6edUI3/webviewable/10192359.pdf.

This page intentionally left blank.

Appendix A

Quality Assurance Project Plan

This page intentionally left blank.

Terms

CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DQO	data quality objective
EB	equipment blank
EPA	Environmental Protection Agency
FTB	full trip blank
FXR	field transfer blank
HEIS	Hanford Environmental Information System
LLWMA	Low Level Waste Management Area
POE	point of exposure
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	Richland Operations Office
TSD	treatment, storage, and disposal

Appendix 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:

- U.S. Department of Energy (DOE) O 414.1C, *Quality Assurance.*
- 10 *Code of Federal Regulations* (CFR) 830, Subpart A, "Quality Assurance Requirements".
- *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5 (EPA/240/B-01/003).

This quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementing, and assessing the sampling, field measurements, and laboratory analysis. Section 6.5 of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989a), Attachment 2, "Action Plan," requires that QA/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal (TSD) units. The requirements of *Hanford Analytical Services Quality Assurance Requirements Document* (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 *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4). This QAPjP is divided into four sections (designated in EPA/240/B-01/003 as Sections A, B, C, and D), which describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

Section A – 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.

Project/Task Organization

The project organization in regard to planning, sampling, analysis, and data assessment is described in the subsections that follow and is shown in Figure A-1. The project manager maintains a list of the individuals or organizations that are the points of contact for each functional element shown in the figure. For each functional primary contractor role, there is a corresponding oversight role within DOE.

Regulatory Project Manager

The Washington State Department of Ecology (Ecology) project manager is responsible for the oversight of Low-Level Waste Management Area 1 (LLWMA-1). Ecology can request this plan during a regulatory compliance inspection for review. Ecology will work with the DOE Richland Operations (RL) to resolve concerns regarding the work as described in this QAPjP.

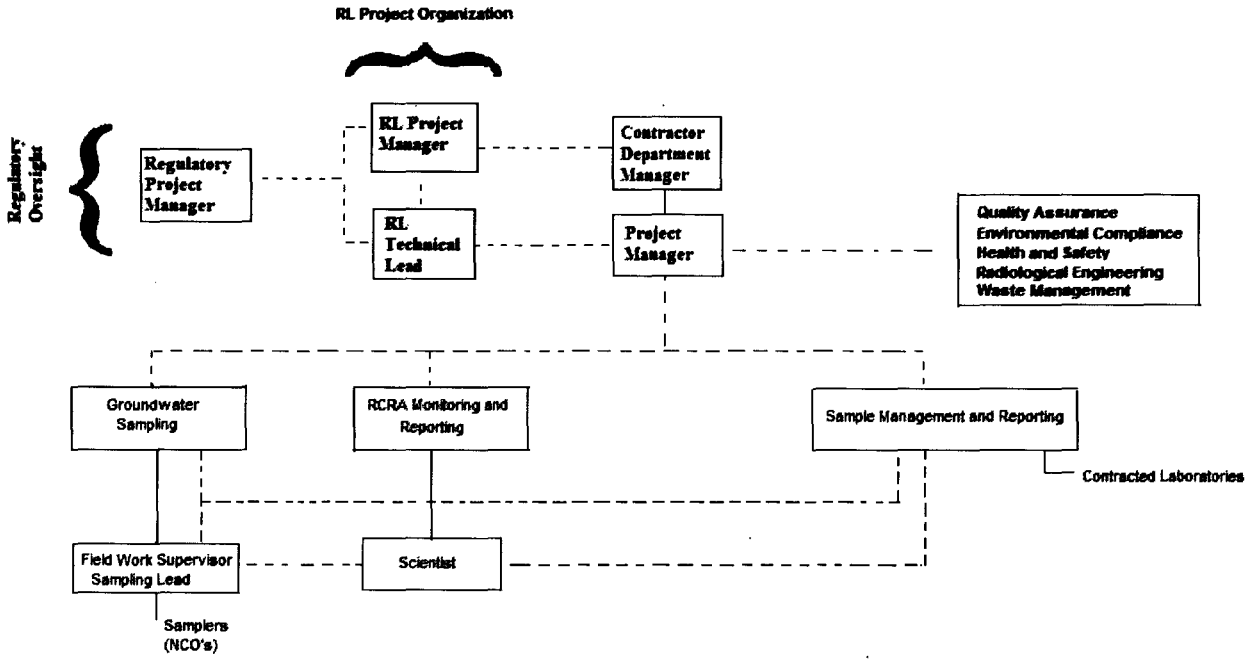


Figure A-1. Project Organization

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.

U.S. Department of Energy, Richland Operations Office Technical Lead

The RL technical lead 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.

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 project manager to ensure that work is performed safely and cost effectively.

Project Manager

The LLWMA-1 project manager is responsible for direct management of activities performed under this QAPjP and for ensuring that the project file is properly maintained. The project manager works with QA, Health and Safety, and the field work supervisor to plan and implement the workscope. In addition, the project manager is responsible for version control of the QAPjP to ensure that personnel are working to the most current job requirements. The project manager also coordinates with and reports to DOE and primary contractor management.

RCRA Monitoring and Reporting

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

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 the corresponding standard procedures and work packages. The samplers also complete the field logbook and chain-of-custody forms, as well as any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

Quality Assurance

The QA point of contact is matrixed to the project manager and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project documents, 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.

Environmental Compliance Officer

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

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.

Radiological Engineering

The Radiological Engineering lead is responsible for the radiological/health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for all work planning. In addition, the Radiological Engineer lead identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA (e.g., requiring personal protective equipment).

Sample Management and Reporting Organization

The Sample Management and Reporting organization coordinates laboratory analytical work to ensure that the laboratories conform to Hanford Site internal laboratory QA 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 project manager of any issues reported by the analytical laboratory.

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-specified QA requirements and must have an approved QA plan in place.

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.

Problem Definition/Background

The problem definitions, as required by 40 CFR 265.90(b) ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Applicability"), are provided in Section 2.7 of this monitoring plan. The background is provided in the sections prior to Section 2.7.

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 monitoring network, and reporting.

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

Quality Objectives and Criteria

The groundwater monitoring quality objectives and criteria are defined in Tables A-2, A-3, A-4, and A-5 of this QAPjP in order to meet the evaluation requirements in Chapter 4 of the monitoring plan.

Special Training/Certification

Workers receive a level of training that is commensurate with their responsibilities and that complies with applicable DOE orders and government regulations according to the Dangerous Waste Training Plan maintained for the TSD unit to meet the requirements of *Washington Administrative Code* (WAC) 173-303-330, "Dangerous Waste Regulations," "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

Documents and Records

The project scientist is responsible for ensuring that the current version of the groundwater monitoring plan is being used and for providing any updates to field personnel. Version control is maintained by the administrative document control process. Significant changes to the plan that affect data quality objectives 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.

Table A-1. Actions and Documentation for Regulator Notification

Type of Change	Action	Documentation
Temporary addition of wells or constituents, or increased sampling frequency	Project management approval; notify regulator agency if appropriate	Project's schedule tracking system
Unintentional impacts 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; changing 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*

Logbooks 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 persons 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 repository of data 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.

Groundwater monitoring results will be reported annually in accordance with the requirements of 40 CFR 265.94(b). The reports will be part of the annual Hanford Site groundwater monitoring report.

Section B – 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.

Sampling Process Design (Experimental Design)

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

Regulatory Requirements

The groundwater protection regulations of WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," dictate the groundwater sampling and analysis requirements applicable to TSD units.

Judgmental Sampling

Judgmental sampling is limited to the selection of sample locations, as well as supplemental sample collection and analytical analyses. The sample locations and supplemental sample collection and analytical analyses are based on knowledge of the feature or condition under investigation. The conclusions depend on the validity and accuracy of professional judgment.

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 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 from the standard procedures for sample collection, contaminants of potential concern, sample transport, or monitoring that occur. The groundwater sampling operations supervisor is also responsible for coordinating all activities relating 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, documenting all deviations from procedure, and ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact the quality of data, or that impair the ability to acquire data or failure to follow procedure, will be documented in accordance with internal corrective action procedures, as appropriate.

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

Sample custody during laboratory analysis is addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by the Sample Management and Reporting organization.

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.

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Low-Level Waste Management Area 1 Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Contamination Indicator Parameters			
Total organic carbon	G/P, HCL to pH<2	SW-846[e] Method 9060	1,000
Total organic halides	G, H_2SO_4 to pH<2, no head space	SW-846[e] Method 9020	20
Metals Analyzed by Inductively Coupled Plasma Method — Unfiltered/Filtered			
Calcium	P, HNO_3 to pH<2	SW-846[e] Method 6010B/C, SW-846 Method 6020, or EPA/600 Method 200.8	1,000
Chromium			10
Sodium			500
Manganese			5
Potassium			4,000
Iron			50
Magnesium			750
Anions by Ion Chromatography			
Nitrate	P, none	EPA/600 Method 300.0[f]	250
Sulfate			500
Chloride			200
Nitrite			250

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Low-Level Waste Management Area 1 Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Other			
Temperature	Field measurement	Instrument/meter	
Conductivity, field	N/A	Instrument/meter	1 µohm
pH, field measurement	N/A	Instrument/meter	0.1
Alkalinity	G/P, none	EPA Standard Method[g] 2320 EPA/600 Method 310.1 EPA/600 Method 310.2	5,000
Phenols	G, residual chlorine 0.0008% $Na_2S_2O_3$	SW-846 Method 8040	5

a. P = plastic; G = glass.

b. All samples will be cooled to 4°C upon collection.

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

d. Detection limit units, except where indicated.

e. SW-846, *Methods for Evaluation of Solid Waste: Physical/Chemical Methods*.

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/APHA 2005).

EPA = U.S. Environmental Protection Agency

N/A = not applicable

Laboratories providing analytical services in support of this QAPjP will report errors to the CHPRC 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.

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 (FTB)	Contamination from containers or transportation	1 per 20 well trips
Field transfer blank (FXR)	Contamination from sampling site	1 each day; volatile organic compounds sampled
Equipment blank (EB)	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 each 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

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 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 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 Soil and Groundwater Remediation Project submits double-blind samples to assess analytical precision and accuracy.

Laboratory Quality Control Samples

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

Quality Control Requirements

Table A-4 lists the acceptance criteria for QC samples.

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 pH 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			
Anions by IC	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			
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"
Semi-Volatile Organic Compounds			
Phenols by GC	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"

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

Method[a]	QC Element	Acceptance Criteria	Corrective Action

a. Refer to Tables A-2 and A-3 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 5 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 <5 times the MDL.

CRDL = contract-required detection limit

MDL = method detection limit

QC = quality control

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)

DUP = laboratory matrix duplicate

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

GC = gas 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

MSD = matrix spike duplicate

PCB = polychlorinated biphenyl

RPD = relative percent difference

SUR = surrogate

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.

Table A-5. Double-Blind Standard Constituents and Schedule (Low-Level Waste Management Area 1 Constituents)

Constituents	Frequency	Accuracy (%)[a]	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%	≤20%

a. If the results are less than 5 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.

RSD = relative standard deviation

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.

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

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 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 DOE Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in the environmental QA program plan. Calibration is conducted using certified equipment or standards with a known valid relationship to a nationally recognized performance standard. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

Inspection/Acceptance of Supplies and Consumables

Supplies and consumables that are 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 the 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.

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.

Data Management

The Sample Management and Reporting organization, in coordination with the project 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 repository of data for the Hanford Facility Operating Record unit file.

All field activities will be recorded in the field logbook, or on appropriate data forms.

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 project manager. The sample disposition records become a permanent part of the analytical data package for future reference and for records management.

Section C – 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.

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 laboratories' QA plans. The primary contractor conducts oversight of offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

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 project manager.

Section D – 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's objectives.

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.

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 the overall reliability of the data collected. Other data quality objectives 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 validation of groundwater data that are routinely collected. Validation is a systematic process of reviewing verified data against a set of criteria (listed in Table A-4) to determine if the data are acceptable for their intended use.

The 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.

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 data quality objectives. The project 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.

References

10 CFR 830, Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2008/janqtr/pdf/10cfr830.7.pdf.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfr265_08.html.

ANSI/ASQ E4, 2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*, American National Standards Institute/American Society for Quality, Milwaukee, Wisconsin.

Atomic Energy Act of 1954, 42 U.S.C. 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf#pagemode=bookmarks&page=14.

AWWA/APHA, 2005, *Standard Methods for the Examination of Water and Wastewater*, 21st Edition, American Water Well Association, Denver, Colorado; American Public Health Association, Washington, D.C.; and Water Pollution Control Federation, Washington, D.C.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq. Available at: http://www.epa.gov/oecaagct/lcla.html#Hazardous%20Substance%20Responses.

DOE O 414.1C, *Quality Assurance*, U.S. Department of Energy, Washington, D.C. Available at: http://www.directives.doe.gov/cgi-bin/explhcgi?qry1260562575;doe-145.

DOE/RL-96-68, 2007, *Hanford Analytical Services Quality Assurance Requirements Documents*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=91&parent=0.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Quality Assurance Division, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/QUALITY/qs-docs/r5-final.pdf.

EPA-600/4-79-020, 1983, *Methods for Chemical Analysis of Water and Wastes*, U.S. Environmental Protection Agency, Washington, D.C.

EPA-600/4-84-017, 1984, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*, U.S. Environmental Protection Agency, Washington, D.C.

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

SW-846, 1997, *Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods*, as amended, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/osw/hazard/testmethods/sw846/online/index.htm.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-300.

This page intentionally left blank.

Distribution

Hardcopy Distribution

Onsite

5	U.S. Department of Energy, Richland Operations Office	
	M. S. Collins	A6-38
	R. D. Hildebrand	A6-38
	J. G. Morse	A5-11
	DOE Public Reading Room (2)	H2-53

Offsite

	Pacific Northwest National Laboratory	
2	Technical Library (2)	P8-55
	Mission Support Alliance	
1	Document Processing Center	H6-08

Electronic Distribution

CH2M Hill Plateau Remediation Company

G. T. Berlin
S. C. Davis
L. L. Fritz
L. C. Hall
J. W. Lindberg
S. P. Luttrell
C. J. Martin
P.W. Martin
J. P. McDonald
A. G. Miskho
R. W. Oldham
J. F. Ollero
L. C. Petersen
V. J. Rohay
S. T. Smith
L. C. Swanson
W. R. Thackaberry
G. S. Thomas
J. A. Winterhalder
C. D. Wittreich
M. I. Wood
C. S. Wright

This page intentionally left blank