**Department of Energy**
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

10-AMCP-0174

JUN 21 2010

Ms. J. A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton
Richland, Washington 99354

Dear Ms. Hedges:

INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE 216-A-29 DITCH, DOE/RL-2008-58, REVISION 0, INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE 216-S-10 POND AND DITCH, DOE/RL-2008-61, REVISION 0, INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE LLBG WMA-3, DOE/RL-2009-68, REVISION 0, INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE LLBG WMA-4, DOE/RL-2009-69, REVISION 0, INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE LLBG WMA-1, DOE/RL-2009-75, REVISION 0, INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE LLBG WMA-2, DOE/RL-2009-76, REVISION 0

This letter transmits the subject Groundwater Monitoring Plans for six Resource Conservation and Recovery Act Treatment, Storage, and Disposal Units for your information.

These plans describe the interim-status indicator-evaluation groundwater monitoring activities to meet requirements of Washington Administrative Code 173-303-400 (and by reference Code of Federal Regulations 40 CFR 265, Subpart F).

If you have any questions, please contact me, or your staff may contact Briant Charboneau, of my staff, on (509) 373-6137.

Sincerely,

Matthew S. McCormick, Assistant Manager
for the Central Plateau

AMCP:RDH

Attachments

cc: See Page 2

cc w/attach:
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N. M. Menard, Ecology
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Administrative Record
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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

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

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# 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* |

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# 1 Introduction

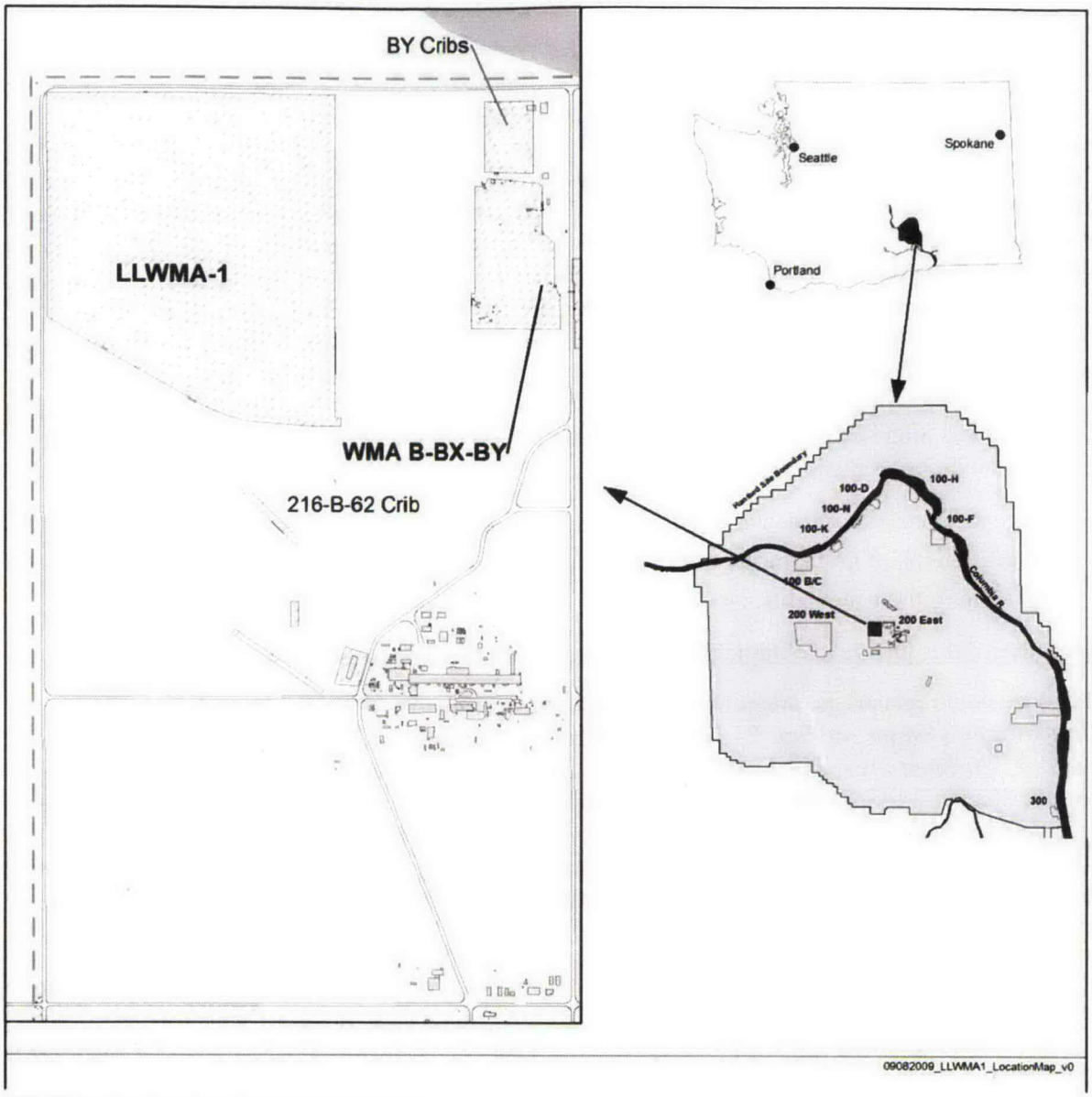
Low-Level Waste Management Area 1 (LLWMA-1) consists of the 218-E-10 Burial Ground, which contains 19 unlined trenches, and is located in the northwestern corner of the 200 East Area (Figure 1-1). The LLWMA-1 was used for disposal of low-level radioactive wastes and low-level mixed wastes beginning in 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.

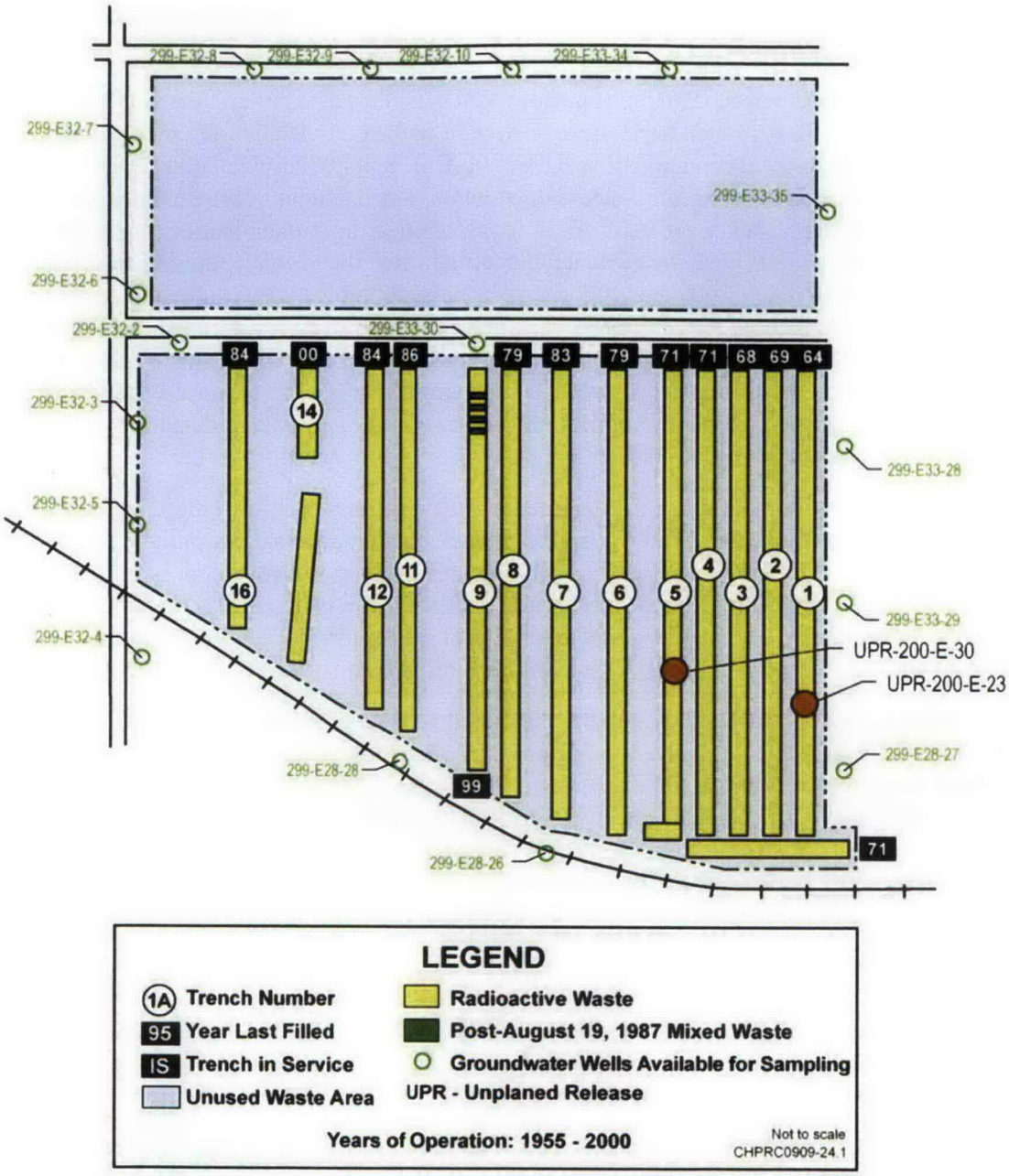



**Figure 2-1. 218-E-10 Burial Ground at Low-Level Waste Management Area 1**

## 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).

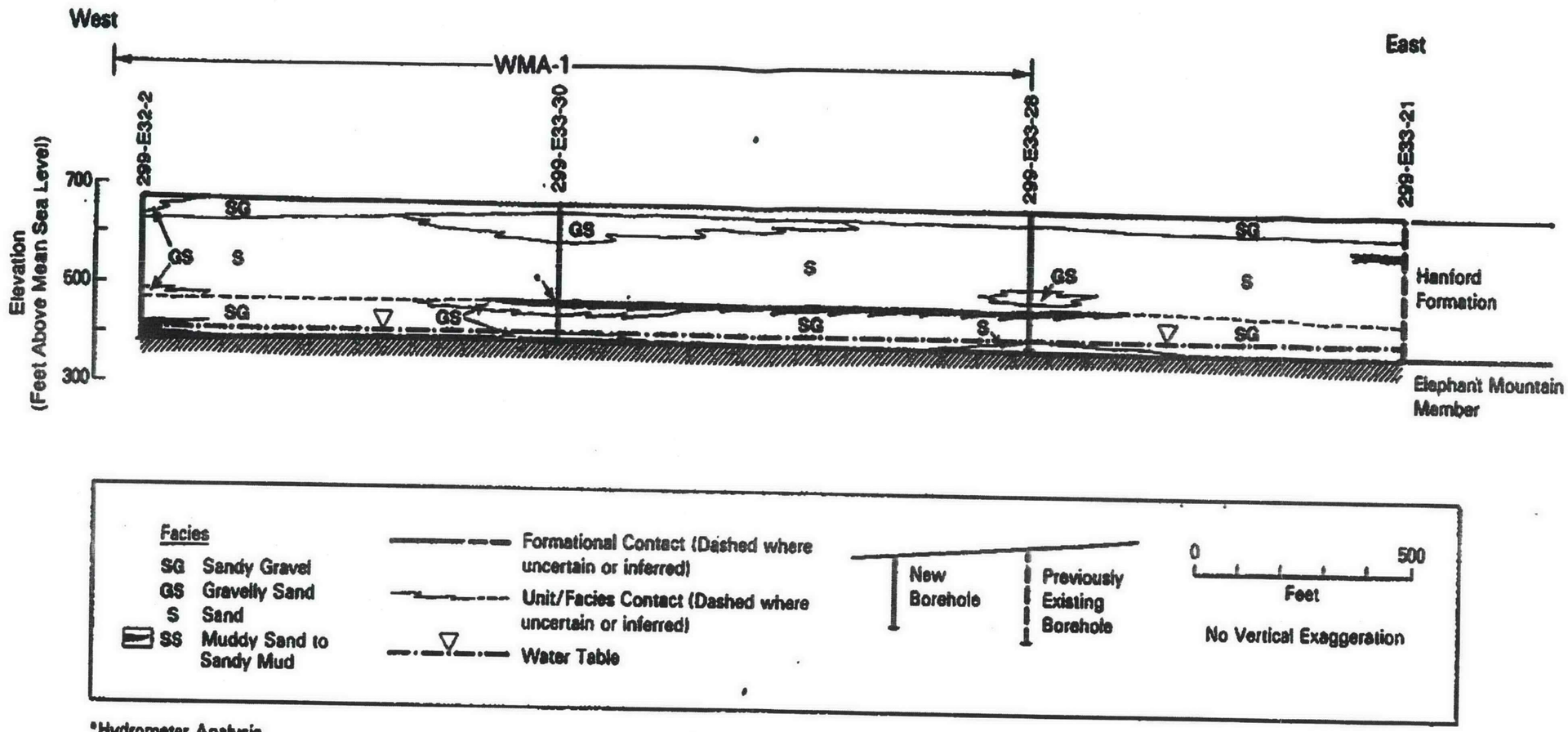
Trench 9 received mixed low-level waste after the mixed waste regulation effective date of August 19, 1987 (Figure 2-1). However, the disposal of mixed low-level waste to Trench 9 may no longer be regulated because it is believed to be associated with lead shielding and di-octyl phthalate (used for testing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

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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.

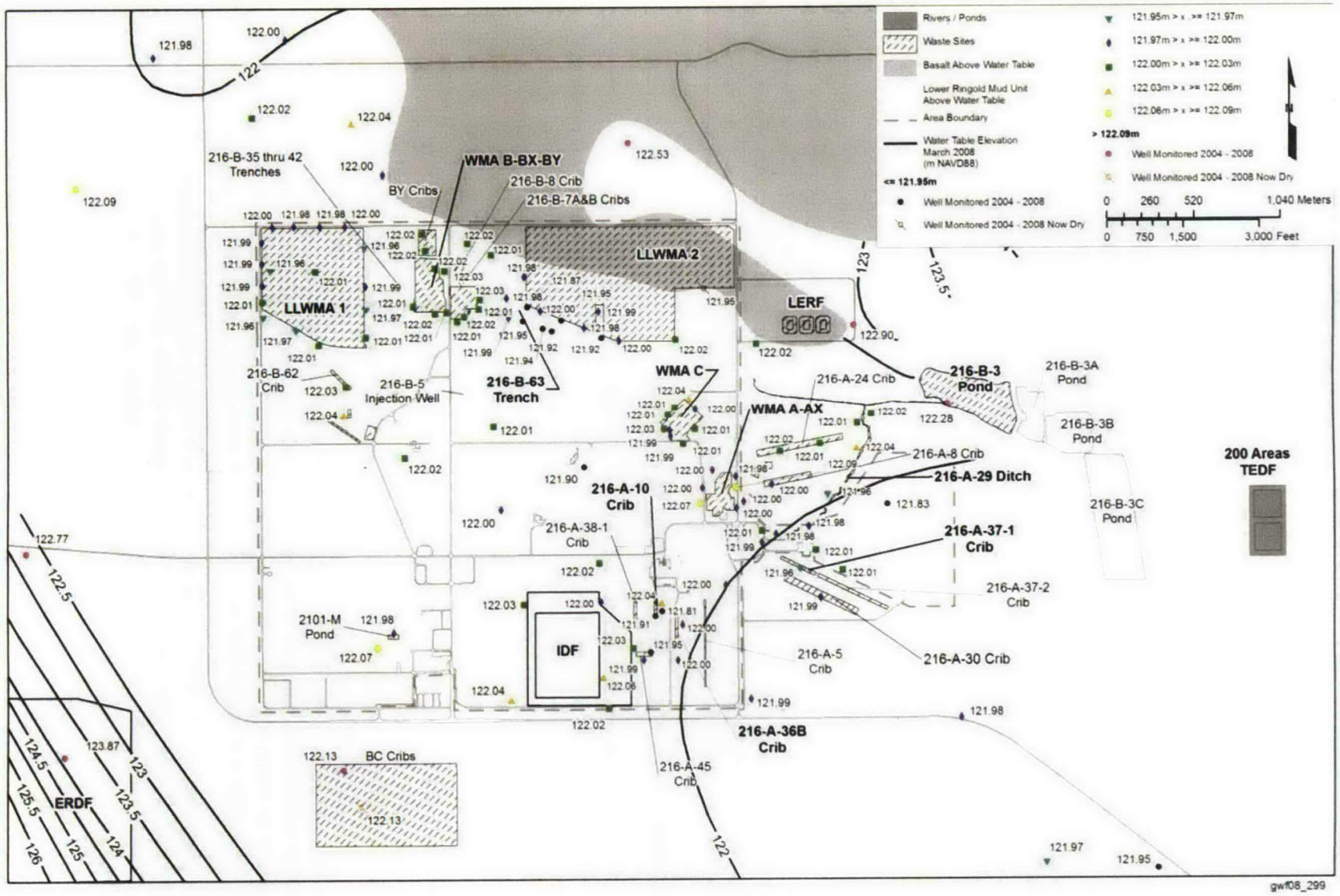


Figure 2-3. Water Table Map for the 200 East Area, March 2008

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.

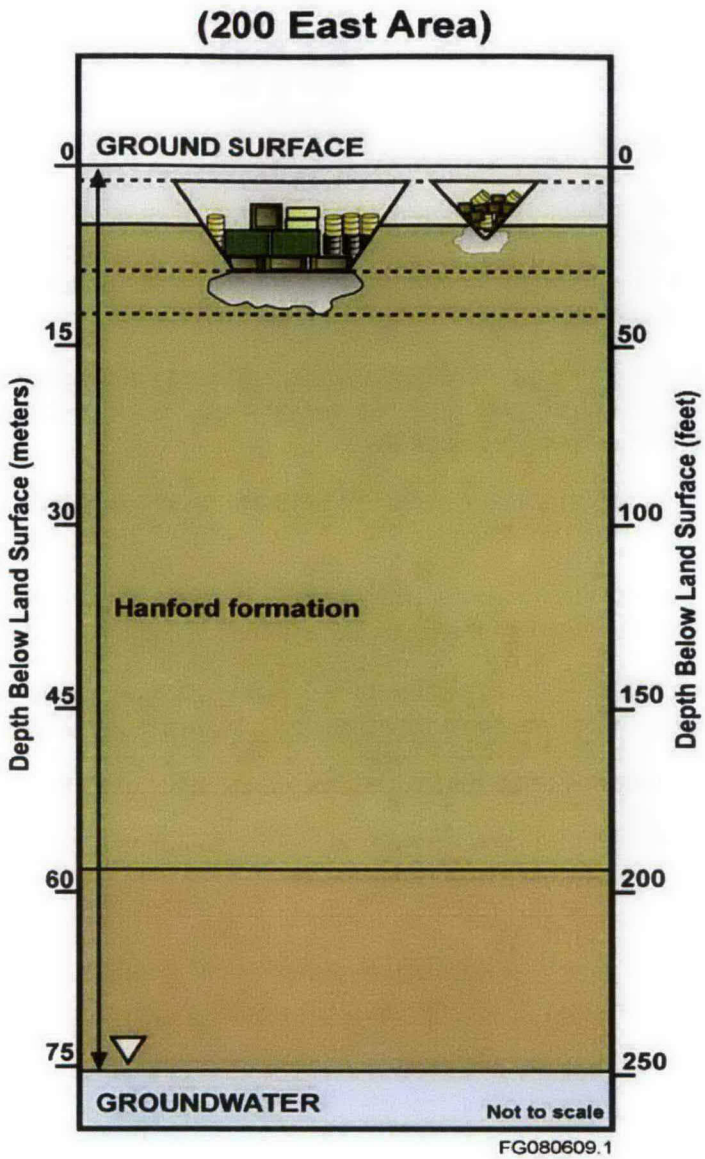


**Figure 2-4. Conceptual Model for Low-Level Waste Management Area 1**

### 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<br>Point(s) of compliance | § 265.91 Groundwater monitoring system.<br>(a) A groundwater monitoring system must be capable of yielding groundwater samples for analysis and must consist of:<br>(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:<br>(i) Representative of background groundwater quality in the uppermost aquifer near the facility; and<br>(ii) Not affected by the facility; and<br>(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<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>PNNL-14859-ICN-2 |
| Well configuration (depth and length of screened interval; well construction) | § 265.91 Groundwater monitoring system.<br>(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.<br>Additional Requirements from WAC 173-303-400(3)(c)(v)(C).<br>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<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision | § 265.92 Sampling and analysis.<br>(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:<br>(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.]<br>(2) Parameters establishing groundwater quality:<br>(i) Chloride<br>(ii) Iron<br>(iii) Manganese<br>(iv) Phenols<br>(v) Sodium<br>(vi) Sulfate<br>[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).]<br>(3) Parameters used as indicators of groundwater contamination:<br>(i) pH<br>(ii) Specific conductance<br>(iii) Total organic carbon<br>(iv) Total organic halogen<br>(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.<br>(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<br>This plan, Appendix A<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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)*.<br>(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:<br>(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.<br>(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.<br>(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.<br>(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<br>This plan, Appendix A<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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.

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# 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*

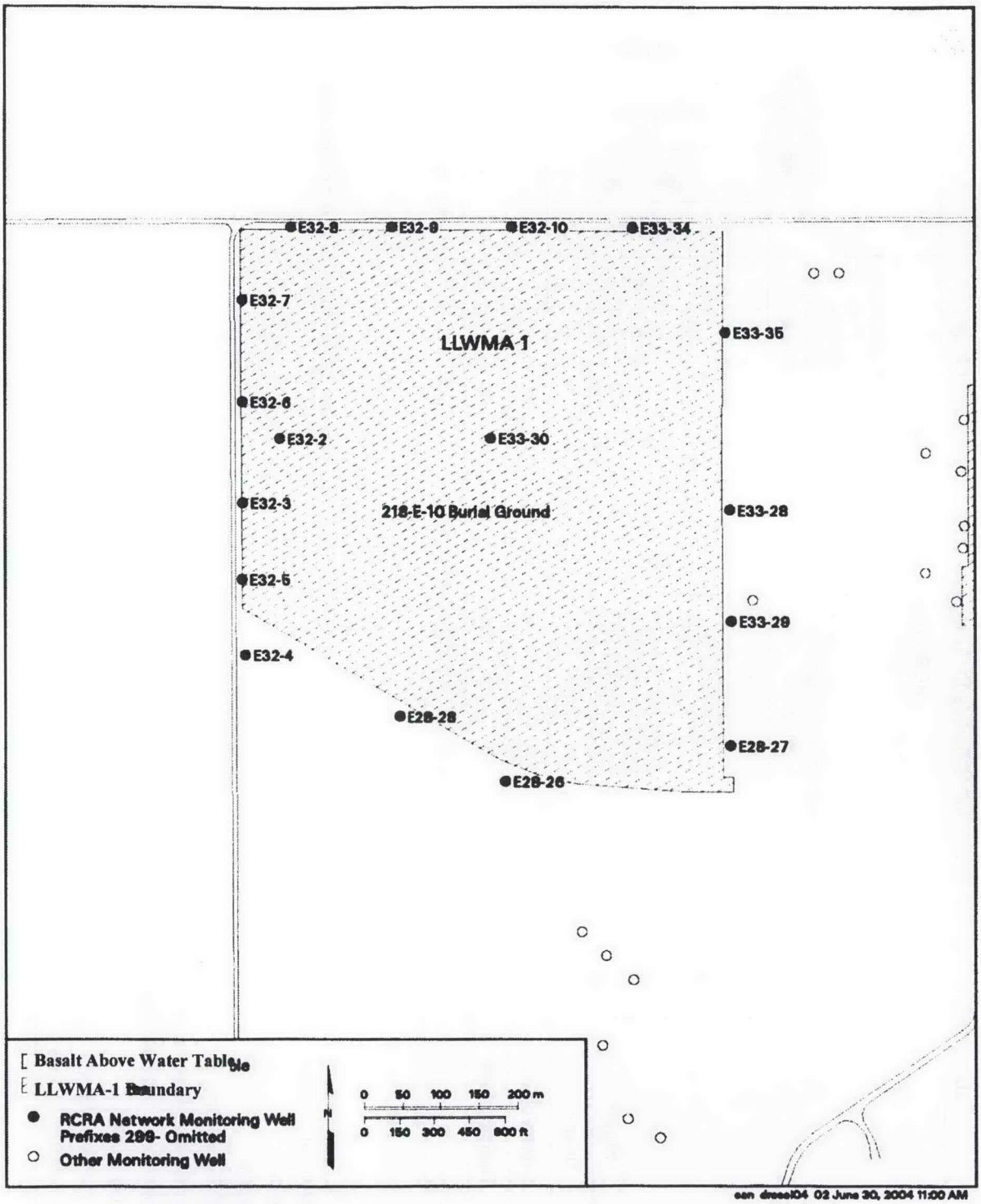


**Figure 3-1. Map Showing Locations of Existing RCRA Monitoring Wells at Low-Level Waste Management Area 1**

**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.

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# Appendix A

# Quality Assurance Project Plan

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# 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.

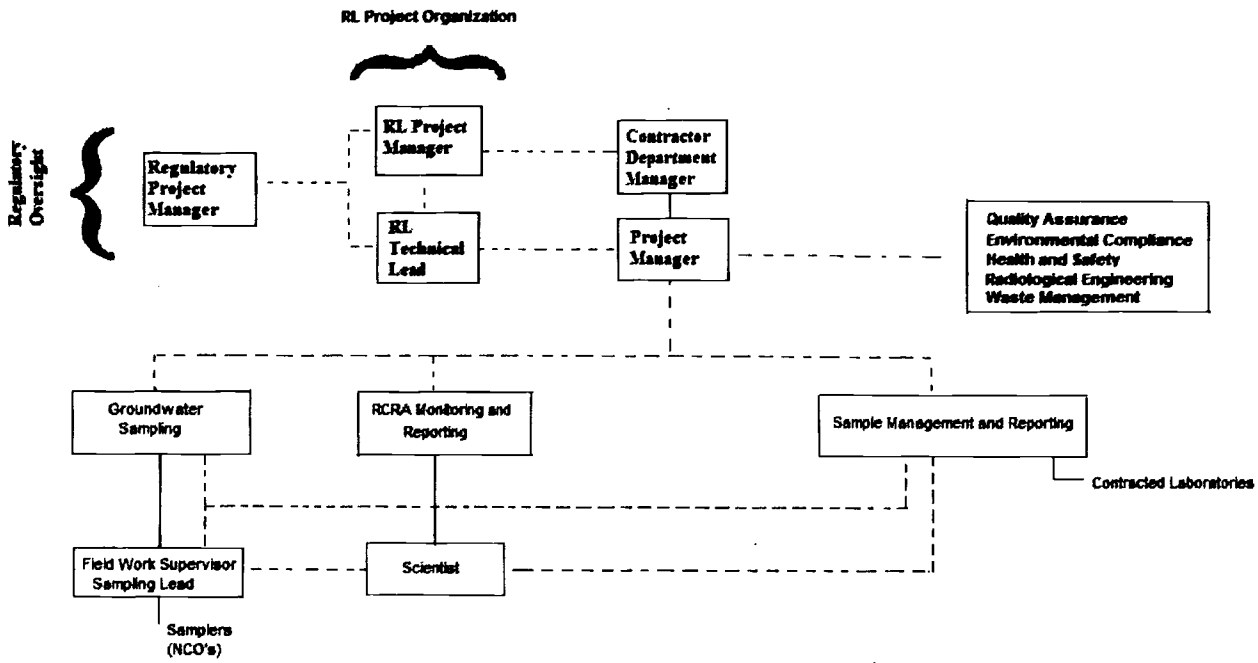


**Figure A-1. Project Organization**

## 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<br>EPA/600 Method 310.1<br>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<br>Chemical oxygen demand<br>Conductivity<br>pH<br>Total organic carbon<br>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<br>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.

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Revision 0

# Interim Status Groundwater Monitoring Plan for the LLBG WMA-2

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;
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# Executive Summary

The Low-Level Waste Management Area (LLWMA) 2, which consists of the 218-E-12B Burial Ground, is regulated via Washington State's "Hazardous Waste Management Act"[1] and its implementing requirements in *Washington Administrative Code* (WAC) 173-303-400.[2] The Washington State Department of Ecology has been authorized by the U.S. Environmental Protection Agency[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976*.[4]

This document replaces PNNL-14859,[5] as well as the two subsequent interim change notices,[6,7] to incorporate changes that have occurred at LLWMA-2 since the previous plan was written.

This document presents the groundwater monitoring plan for LLWMA-2. The plan addresses the following: (1) adequacy and attributes of the wells monitoring the groundwater at LLWMA-2; (2) sampling requirements and schedule; (3) constituents, groundwater parameters, and analytical methods necessary to determine whether past releases from the LLWMA are affecting groundwater quality; (4) procedures for evaluating groundwater quality data; and (5) reporting requirements.

This groundwater monitoring plan is the principal controlling document for conducting groundwater monitoring at LLWMA-2.

---

1 RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*.

2 WAC 173-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*.

3 *Authorized State Hazardous Waste Programs*, 42 U.S.C. 6926, et seq.

4 *Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901, et seq.

5 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.

6 PNNL-14859-ICN-1, 2006, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 1, Pacific Northwest National Laboratory, Richland, Washington.

7 PNNL-14859-ICN-2, 2007, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 2, Pacific Northwest National Laboratory, Richland, Washington.

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# Terms

| | |
|---|---|
| bgs | below ground surface |
| 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 | fiscal year |
| LLWMA | low-level waste management area |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| TOC | total organic carbon |
| TOX | total organic halides |
| Tri-Party Agreement | *Hanford Federal Facility Agreement and Consent Order* |
| WAC | *Washington Administrative Code* |

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# 1 Introduction

Low-Level Waste Management Area (LLWMA) 2 is located in the northeastern corner of the 200 East Area (Figure 1-1) of the Hanford Site and consists of the 218-E-12B Burial Ground, which contains 39 unlined trenches. The LLWMA-2 began receiving waste in 1967 and continues to receive U.S. Navy vessel reactor compartments in Trench 94. The other 38 trenches contain mainly unsegregated waste and low-level waste that have been covered with soil. The dangerous waste and dangerous waste constituents in the low-level mixed waste portions of LLWMA-2 are regulated under *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." A *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring program for LLWMA-2 was initiated in 1987 (WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*) based on the interim status monitoring requirements of 40 *Code of Federal Regulations* (CFR) 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring") and WAC 173-303-400 ("Interim Status Facilities"). The LLWMA-2 has remained under indicator evaluation monitoring since that time. The objectives for continued indicator evaluation monitoring at LLWMA-2, as required by 40 CFR 265.92(d) ("Sampling and Analysis") are to determine the following:

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

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

This document replaces the previous 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-2 since that plan was issued. Chapter 2 summarizes background information, with reference to other documents for more detailed information. Chapter 2 also describes LLWMA-2 and the types of waste present, provides a brief history of groundwater monitoring, and describes the geology and hydrology pertinent to the LLWMA. This information is summarized as a site conceptual model to aid in developing 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.

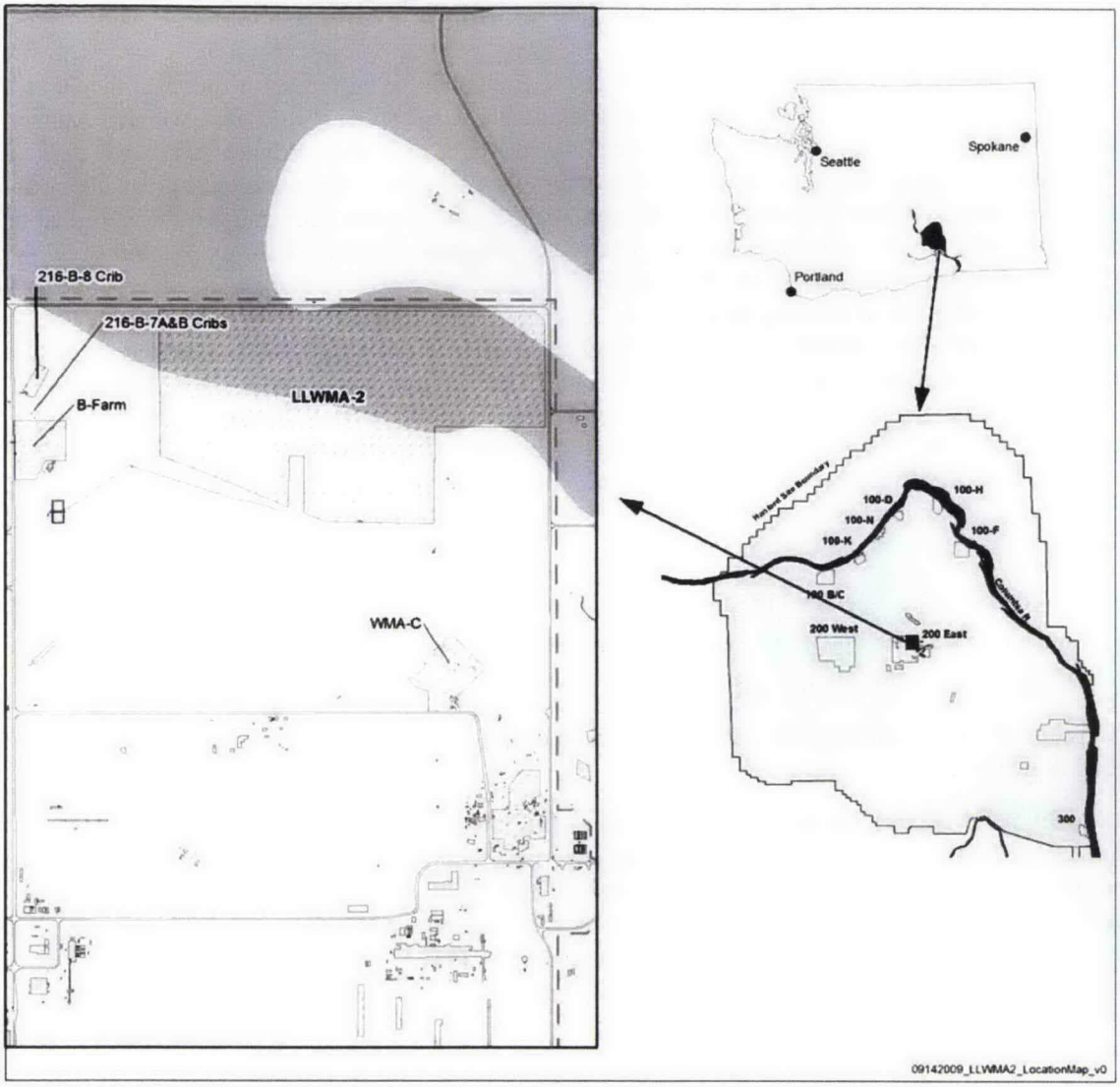



**Figure 1-1. Low-Level Waste Management Area 2 in the 200 East Area**

# 2 Background

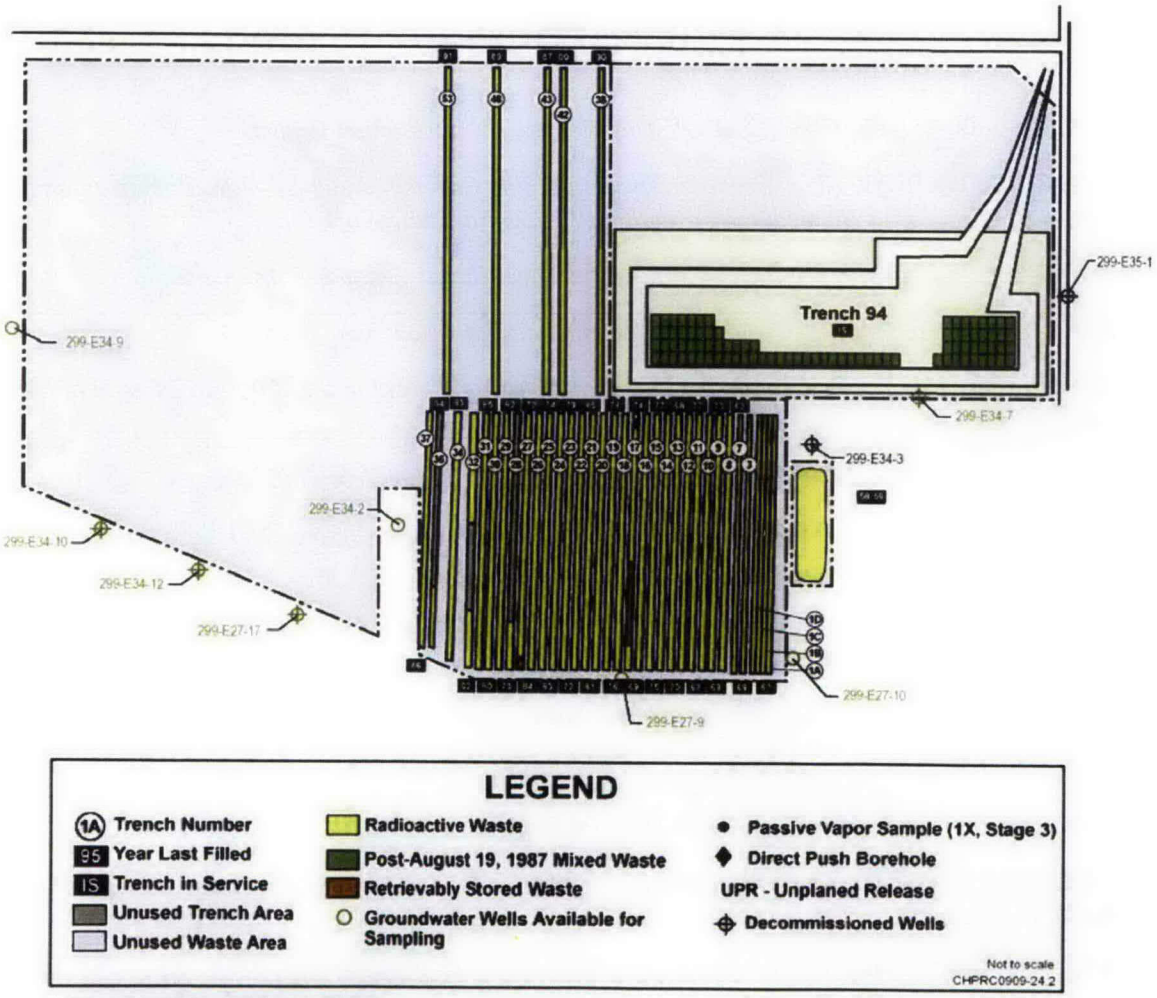
This chapter presents the LLWMA-2 facility and its operating history, the waste and waste characteristics associated with the site, the local geology and hydrology, a summary of previous monitoring of the groundwater and vadose zone contamination, and the conceptual model for groundwater flow and contaminant migration. The discussion in this chapter is summarized from earlier characterization activities reported in the following documents:

- BHI-00178, *PUREX Plant Aggregate Area Management Study Technical Baseline Report*
- BHI-01177, *Borehole Summary Report for the 216-B-2-2 Ditch*
- BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report*
- DOE/RL-93-74, *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan*
- DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report*
- 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*
- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report*
- PNNL-11470, *Hanford Site Groundwater Monitoring for Fiscal Year 1996*
- PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*
- PNNL-14187, *Hanford Site Groundwater Monitoring for Fiscal Year 2002*
- 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*
- RHO-CD-673, *Handbook for 200 Area Waste Sites*
- WHC-MR-0204, *200E & 200W Areas Low Level Burial Grounds Borehole Summary Report*
- WHC-MR-0207, *Borehole Completion Data Package for the 216-B-63 Trench – 1990*
- WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for 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-WM-TI-260, *Water Inflow Investigation at the 218-E-12A and 218-E-12B Burial Grounds*
- 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, PNL-6820, WHC-SD-WM-TI-260, and the Waste Information Data System. The operational history discussed below also includes a brief description of adjacent sites.

The LLWMA-2 is located in the northeastern corner of the 200 East Area (Figure 1-1). The LLWMA-2 began service in 1967 and consists of the 218-E-12B Burial Ground (approximately 73.7 ha [182 ac]). The 218-E-12B Burial Ground was expanded from approximately 27 ha [66.7 ac] to contain 34 trenches and up to a potential for 138 trenches, 40 of which store waste (Figure 2-1). The landfill continues to receive U.S. Navy vessel reactor compartments in Trench 94. The other 39 trenches contain mainly unsegregated waste and low-level waste that have been covered with soil. Two trenches contain retrievably stored waste.




**Years of Operation (218-E-8): 1958-59**
**Years of Operation (218-E-12B): 1967 - Present**

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

The 40 used, unlined trenches vary in length from 288 to 381 m (944 to 1,250 ft). All of the trenches are in a north-south orientation, except Trench 94 (Figure 2-1). Thirty-four of the trenches are located in the southeastern portion of the burial ground. Trench 94 is located in the northeast portion of the burial ground, and five other trenches are located to the west of Trench 94. The western portion of the burial ground has not been used.

During the operational history of the 218-E-12B Burial Ground, one unplanned release of diesel fuel was reported in Trench 94 in 1995 (e.g. waste site 200-E-8). Analytical results confirmed that the spill was #2 diesel fuel. The impacted soil was excavated and disposed.

Hanford Site history has documented the following adjacent sites, which have impacted the environment: 216-B-2-1 Ditch, 216-B-2-2 Ditch, 216-B-2-3 Ditch, 200-E-53 contaminated zone, and the 200-E burn pit. The three unlined ditches associated with unplanned releases were located to the south of LLWMA-2. One of the unplanned releases in 1986 associated with the 216-B-2-3 unlined ditch caused cooling water to enter into Trench 37 of the 218-E-12B Burial Ground (WHC-SD-WM-TI-260). Information on the releases associated with these unlined ditches is provided in Section 2.3.

The 200-E-53 contaminated zone, located to the east of the southern portion of LLWMA-2 and north of the 216-B-2-1 through 216-B-2-3 Ditches, was first documented in 1987. The source of the contamination is unknown. Further information is provided in Section 2.3.

The 200-E burn pit, located to the east of southern portion of LLWMA-2, apparently began operations in 1950 and was associated with eliminating construction and office waste, as well as paint and chemical solvent waste. Further information is provided 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-2. Groundwater monitoring is conducted at LLWMA-2 in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F), 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-2 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 and continues today.

## 2.3 Waste Characteristics

This section describes the waste disposed at 218-E-12B Burial Ground, unplanned releases adjacent to the burial ground, and contaminated zones adjacent the burial ground. The information was obtained from DOE/RL-2004-60, DOE/RL-2000-35, WHC-SD-WM-TI-260, BHI-00178, BHI-01177, RHO-CD-673, and the Waste Information Data System database.

The 218-E-12B Burial Ground contains solid unsegregated and low-level radiological waste. Examples of waste disposed in this burial ground include general trash, failed equipment, vent risers, filter boxes, liquid-level risers from the 216-B-14 Crib, and strontium-90-contaminated soil dredged from the 216-B-63 Ditch. The waste was generated primarily from the Plutonium-Uranium Extraction Plant, B Plant, and the 200 East Area tank farms (DOE/RL-2004-60).

Waste disposal at LLWMA-2 was generally dumped directly from trucks or was contained in cardboard cartons.[8] Historical documentation indicates that waste trenches were backfilled on a daily or weekly basis. No unplanned releases have been reported within the 218-E-12B Burial Ground. Herbicide application has been used to mitigate radioactive uptake by deep-rooted plant growth (DOE/RL-2004-60).

In 1986, water was observed in the 218-E-12B Burial Ground's Trench 36, which had not received any waste. It was determined that the water was from the unlined 216-B-2-3 Ditch. Seven investigation trenches and boreholes were used to determine the vertical and horizontal extent of released water. Based on the results of the investigation, only LLWMA-2 waste in the southern 19.8 m (65 ft) of Trench 37 (e.g., the westernmost trench in the southern portion of the 218-E-12B Burial Ground) had been contacted by the released water.

Two unplanned releases (UPR-200-E-32 and UPR-200-E-138) associated with the 216-B-2-1 and 216-B-2-2 Ditches were located to the south of LLWMA-2 and north of the 216-B-2-3 Ditch. Several inorganic chemicals are associated with the liquid disposed to these ditches, but the most prominent are sulfate and nitrate compounds (although chloride and carbonate compounds are also present) (DOE/RL-93-74).

The unplanned release at the 216-B-2-1 Ditch was associated with product via a storage tank coil leak in 1963. The total release volume, including decontamination flushing water, was approximately 4.9 million L (1.3 million gal). The extent of the contaminants is not known; however, a comparison of the release volume to the pore volume suggests that mobile contaminants have the potential to reach the groundwater.

The 216-B-2-2 Ditch received B Plant storage tank 8-1 condensate in 1970. The extent of the contamination is not known; however, a comparison of the release volume to the pore volume suggests that the effluent has the potential to reach the groundwater (DOE/RL-93-74). Subsequent remedial investigation results from the 216-B-2-2 Ditch indicated that elevated sulfate, nitrate, and chloride are present in the vadose zone soils. Sulfate had the highest reported maximum concentration (678 mg/kg), followed by nitrate with a maximum value of 330 mg/kg. The maximum concentration for chloride was 10.9 mg/kg (DOE/RL-2000-35). Four zones of increased moisture were also found at depths of 53 m, 54.9 m, 56.7 m, and 64.6 m (174 ft, 180 ft, 186 ft, and 212 ft) below ground surface (bgs). The first three zones correlate with probable thin silt horizons, and the fourth zone correlates with a potentially cemented sand interval (BHI-01177).

The 200-E-53 contaminated zone is located east of the southeast portion of the 218-E-12B Burial Ground and north of the 216-B-2 Ditches. No characterization sample results associated with this site were found.

The 200-E burn pit is a large depression with sparse vegetation located east of the southeast portion of LLWMA-2 and north of the 216-B-2 Ditches. The site received 1,500 $m^3$ (52,972 $ft^3$) of construction and office waste, paint wastes, and chemical solvents. This site was also used for a detonation event in 1984 for the disposal of unstable liquids. The chemicals detonated included: butoxyehtanol, dioxane,

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8 Information obtained from the Solid Waste Information and Tracking System database.

1,4-dioxane, hydrogen peroxide, isopropyl ether, methyl ethyl ketone, phosphoric acid, polyethylene glycol monoethyl ether, and sodium azide (BHI-00178).

## 2.4 Geology and Hydrogeology

The geology and hydrology of the 200 East Area, including the area of LLWMA-2, are described in detail in PNL-6820 and WHC-SD-EN-TI-290. Other reports providing significant information include PNNL-12261, WHC-MR-0204, WHC-MR-0207, WHC-SD-EN-AP-015, WHC-SD-EN-DP-044, and WHC-SD-EN-DP-049. The following discussion summarizes the information from these reports. This section also identifies the uppermost aquifer and the aquifers hydraulically interconnected beneath LLWMA-2.

In the past, LLWMA-2 underlying sediments, from the ground surface to the top of the basalt, were interpreted as Hanford formation sediments (PNL-6820). More recently, three Hanford units were defined beneath LLWMA-2 (Figure 2-2): the Hanford upper gravel unit (H1), the Hanford intermediate sand unit (H2), and the Hanford lower gravel unit (H3) (WHC-SD-EN-TI-290). Although these units were defined on the basis of the dominant lithology, significant subordinate lithologies are intercalcated in each unit. For example, the upper gravel unit, which thickens to the north and east, has silt-rich interbeds up to 1 m (3.3 ft) in thickness. These silt horizons are continuous to distances of several hundred meters and are capable of generating perched water conditions. This may have contributed to the northeastern migration of water from the 216-B-2-3 release (WHC-SD-WM-TI-260). The middle sand unit is the thickest in the southwestern portion of the 218-E-12B site and pinches out toward the east and north (Figure 2-2). The H2a (which is a transition zone between units H2 and H3) in Figure 2-2 represents a downward coursing of the Hanford sand unit where gravel horizons up to 6.1 m (20 ft) thick are present. The silt interbeds described in the Hanford upper gravels are also present in the lower gravels. The Hanford lower gravels extend into the unconfined aquifer and overly the Elephant Mountain Basalt.

The suprabasalt sediment beneath LLWMA-2 ranges from 54 m (177 ft) to more than 79.5 m (262 ft) thick. The water table as of June 2009 has ranged from 62.2 to 74.5 m (204 to 244.5 ft) bgs. Historically, the water table level was approximately 3.1 m (10 ft) higher in the late 1960s and 1980s due to peak production at the Hanford Site and associated artificial recharge. Initial transmissivity measurements from LLWMA-2 boreholes varied from 1,300 $m^2$/day (14,000 $ft^2$/day) in well 299-E34-3 to 7,900 $m^2$/day (85,000 $ft^2$/day) in well 299-E34-2. Due to the permeable nature of aquifer sediments, the groundwater gradient has historically been very small beneath LLWMA-2 (Figure 2-3). The groundwater flow direction beneath the LLWMA over the last 5 years has predominantly been reported as west-southwest in annual groundwater reports.

Underlying the suprabasalt sediments is the Elephant Mountain Member of the Saddle Mountains Basalt Formation. During the drilling of LLWMA-2 wells, some of the drilling extended into the upper portion of the Elephant Mountain Basalt. Examination of basalt drill cuttings found no vesicles in basalt chips from two 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.

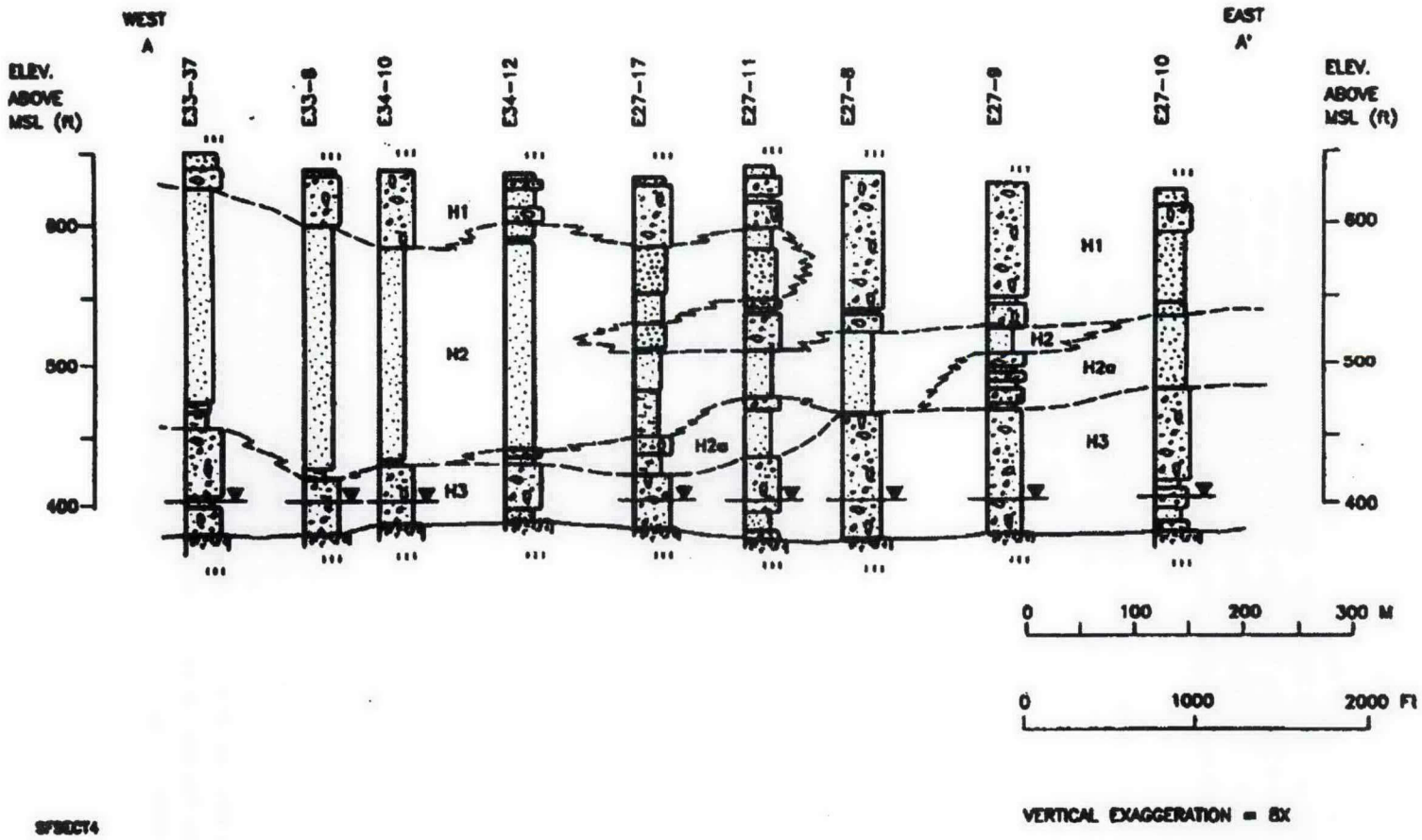


Figure 2-2. Geologic Cross-Section Along the Southern Boundary of Low-Level Waste Management Area 2

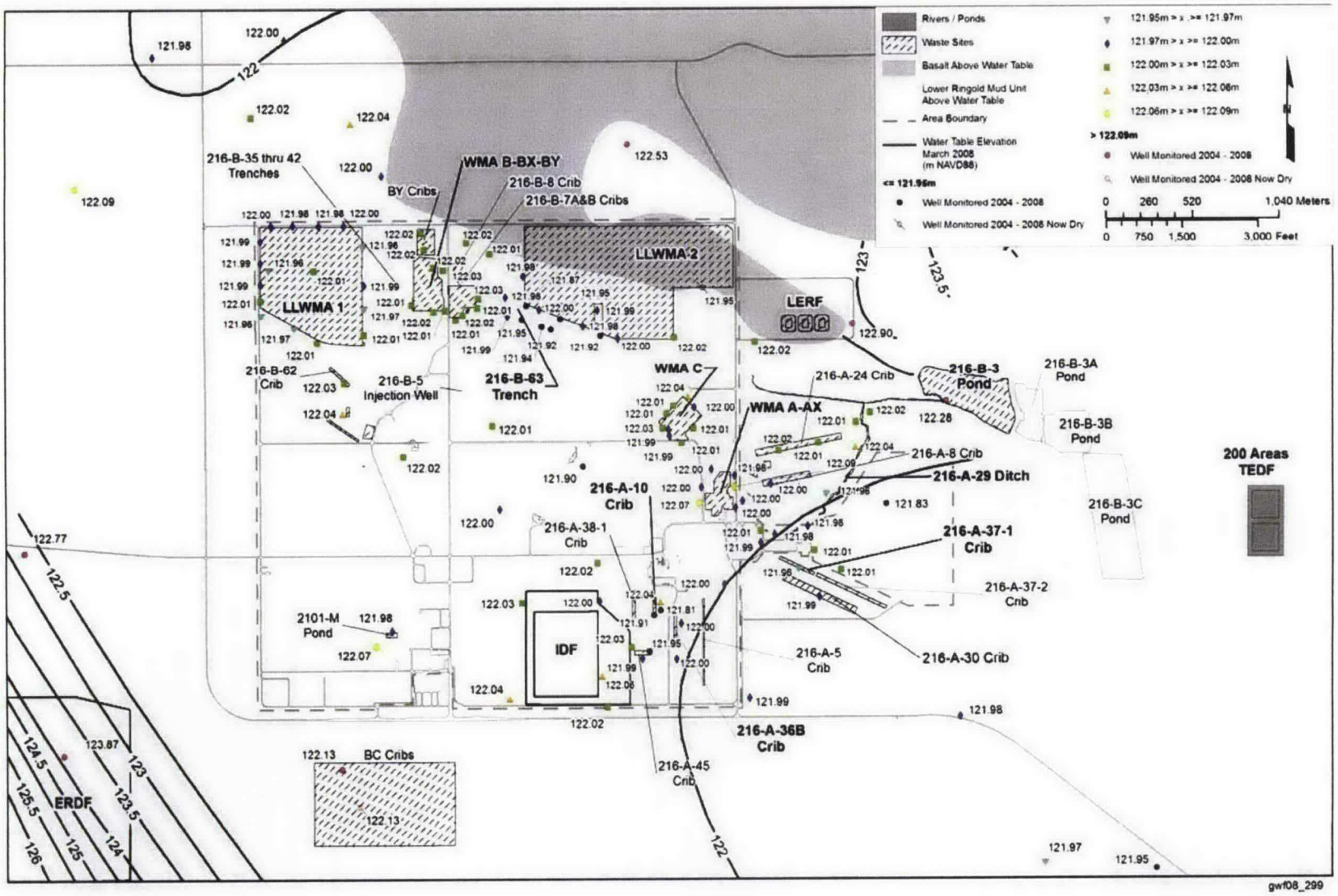


Figure 2-3. Water Table Map for the 200 East Area, March 2008

## 2.5 Summary of Previous Groundwater Monitoring

Groundwater monitoring was initiated at the LLWMA-2 in 1987 in accordance with WHC-SD-EN-AP-015. The groundwater beneath LLWMA-2 is sampled semiannually for indicator and groundwater quality parameters. Water levels are measured during each sampling event, as well as annually in March, as part of a comprehensive water-level measurement campaign. Groundwater monitoring results are summarized and presented in annual Hanford groundwater monitoring reports (i.e., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

The first eight RCRA-compliant monitoring wells were installed at LLWMA-2 in 1987. The initial network consisted of four upgradient wells and four downgradient wells. The initial flow direction was considered to the west and southwest. Additional wells were installed in 1989 (three wells), 1990 (one well), 1991 (three wells), and 1992 (two wells). The well screens extend from above the unconfined aquifer to various depths within the aquifer. All of the northern and eastern wells have gone dry over the past two decades for two reasons: (1) the basalt elevation is relatively high compared to the water table elevation beneath the northern and eastern portions of the burial ground, and (2) the water table level has continued to decline due to termination of Hanford Site production operations and effluent releases. The nine remaining active network monitoring wells are located along the southern and western boundary of the burial ground (Figure 2-1). The active wells monitor the upper portion of the aquifer and extend between 1.24 and 2.78 m (4.07 and 9.12 ft) into the aquifer.

Background monitoring at LLWMA-2 began in 1988, and initial background comparison values for indicator parameters (e.g., total organic carbon [TOC], total organic halides [TOX], pH, and specific conductivity) were established in 1989 using four quarters of data from upgradient wells 299-E27-10 and 299-E34-5 (PNNL-11470). Since September 1989, groundwater monitoring has been conducted primarily on a semiannual basis, except for the period between June 1990 and June 1991, when laboratory services were unavailable.

The local groundwater flow direction over the past 5 years has been reported to the west based on small differences within select wells along the southern boundary of LLWMA-2. However, over this same time period, other well groupings portray different groundwater flow directions. According to the *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project, Hanford Site* (SGW-38815), small measurement errors can have large effects on determining flow direction and velocity where the horizontal gradient is less than 0.001, as is the case for LLWMA-2. Therefore, the annual reports over this timeframe have added observations of mobile anion movement to depict flow direction. The nitrate- and sulfate-derived groundwater flow over the past 5 years has been reported to the southwest.

The derived background comparison value (i.e., critical mean) for all of the indicator parameters has been exceeded periodically throughout the history of detection monitoring. The downgradient wells that have exceeded the critical mean were explained by laboratory issues or sample collection errors. Upgradient wells (e.g., 299-E34-7) that exceeded the critical mean have been associated with either leaching or infiltration processes within the vadose zone (PNNL-14187). (Note that the source of infiltration has not been determined to date.) Well 299-E34-7, which is now dry, previously exceeded the critical mean for specific conductance, TOC, and TOX. The specific conductance was attributed mainly to sulfate, chloride, nitrate, and calcium. The TOC was consistent with subsequent oil/grease and total petroleum hydrocarbon results; however, later volatile and semivolatile analyses did not provide evidence for a specific contaminant. Likewise, no subsequent analytical contaminant result was able to be linked to the TOX results. Water level decline by 2005 caused well 299-E34-7 to be declared dry. Well 299-E27-10,

located to the southwest of well 299-E34-7, also exhibits some of the same characteristics described for well 299-E34-7.

The groundwater monitoring activities at LLWMA-2 currently consist of water-level monitoring and chemical constituent monitoring. The LLWMA-2 is sampled semiannually from a network of nine wells. Samples are analyzed semiannually for the indicator parameters, anions, and metals; samples are analyzed annually for alkalinity, mercury, lead, and phenols. Water-level measurements are collected each sampling event and in March for Hanford Sitewide monitoring. Regional water-level measurements have also been collected monthly since March 2008. Water levels will continue to be collected regionally on a monthly basis for an undetermined time period to resolve the groundwater gradient in the area with respect to high disposal discharges at the 200 Area Treated Effluent Disposal Facility, high Columbia River stages, and times when those influences are not present.

## 2.6 Conceptual Model

This section describes the LLWMA-2 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.
- Average precipitation and net infiltration (5 to 10 cm/year [2 to 3.9 in./year]) prevail over the time period 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, is 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, chemical nature of the waste constituents, and natural subsurface geochemical conditions.

Pore fluid in the unsaturated and saturated zones beneath LLWMA-2 is slightly alkaline ($7 < pH < 8$), with appreciable amounts of bicarbonate and very little natural organic material. The lack of organic material 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 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 total beta, strontium-90, and gamma energy analysis samples collected beneath LLWMA-2 in 1986 (associated with the 216-B-2-3 release), significant contaminant migration from LLWMA-2 appears unlikely (Figure 2-4). The sediment results indicated a general decrease in concentration with depth from the trench bottoms; however, increased concentrations were reported in the deepest sample results. This appears consistent with the conclusion of WHC-SD-EN-TI-260 regarding the elevated gamma results being associated with water migration from the 216-B-2-3 Trench and not the 218-E-12B Burial Ground.

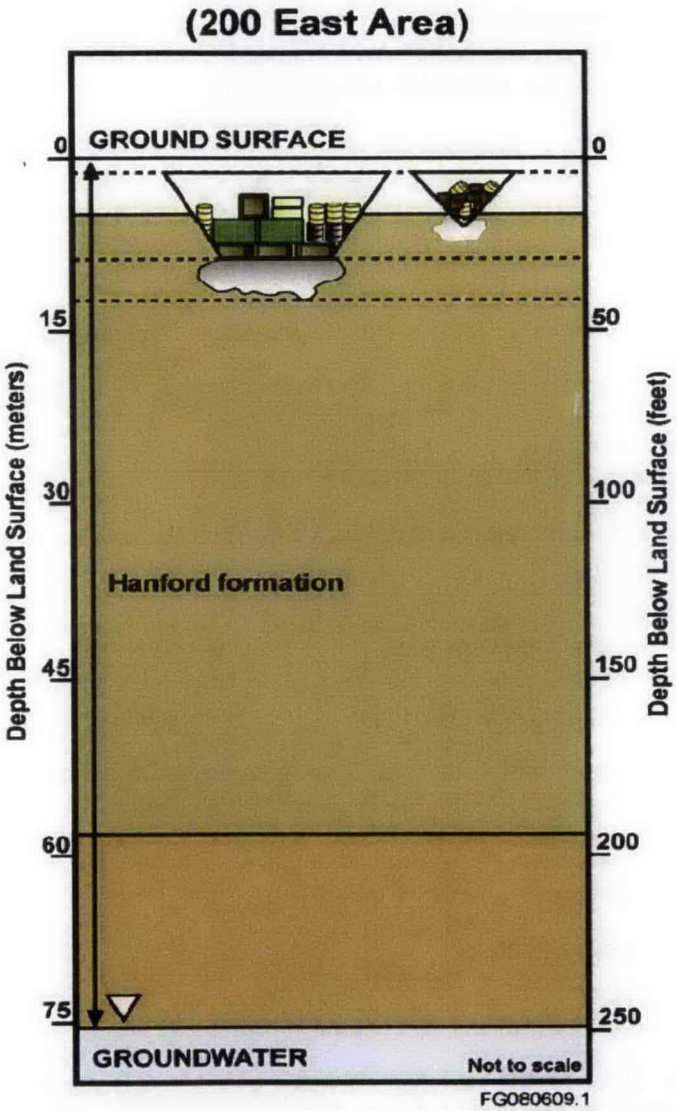


**Figure 2-4. Conceptual Model for Low-Level Waste Management Area 2**

### 2.6.2 Soil Moisture Factors

Direct precipitation is the primary driver for hypothetical leaching of waste constituents from the burial ground trenches and subsequent transport to groundwater. Contaminants in soil disposed to the trench or waste in degradable containers (e.g., cardboard 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, as well as the degree of vegetative cover. Stratigraphic features in the soil column beneath the buried waste can also influence or retard downward migration by spreading the soil moisture laterally.

Most of the burial ground trenches are backfilled with the 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 the unused portions of LLWMA-2.

A coarse, sparse to moderately vegetated cover material allows a moderate to major fraction of the precipitation to infiltrate and potentially drain to the groundwater. It is estimated that recharge rates at the Hanford Site range from near 0 mm/year at highly vegetated sites to greater than 50 mm/year at gravel-covered nonvegetated sites (PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*).

### 2.6.3 Hydrogeologic Considerations

A discussion on hydrology is provided in Section 2.4. The vadose zone (e.g., ground surface to water table) beneath LLWMA-2 ranges from 54 m (177 ft) to more than 79.5 m (262 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). Interbeds of sand and silt facies are present in each of the sequences and have the potential for generating perched aquifer (WHC-SD-EN-TI-290). These fine-grained facies also create conditions for retarding downward movement of contaminants. If the same northeast dip exists in these fine-grained sediments (which has been identified in many other sites in the 200 East Area), then lateral spreading within or on top of this unit may preferentially be toward the north-northeast.

If contaminants do breakthrough to groundwater beneath LLWMA-2, contaminants currently would move toward the southwest. This direction is based on the observed migration of nitrate and sulfate over the past 5 years and not on the subtle differences in water elevations along the southern boundary of LLWMA-2.

## 2.7 Data Quality Objectives

To define the required information for groundwater detection 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 regulatory requirements are outlined in Table 2-1.

**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 ground-water monitoring at sites where no impact to ground-water 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 WAC 173-303-400(3)(c)(v). | |
| Number and location of wells<br>Point(s) of compliance. | **40 CFR 265.91 Ground-Water Monitoring System.**<br>(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:<br>(1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are:<br>(i) Representative of background ground-water quality in the uppermost aquifer near the facility; and<br>(ii) Not affected by the facility; and<br>(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<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>PNNL-14859-ICN-2 |
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91 Ground-Water Monitoring System.**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional requirements for WAC 173-303-400 (3)(c)(v)(C).**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells. | This plan, Section 3.2<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision. | **40 CFR 265.92 Sampling and Analysis.**<br>(b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section:<br>(1) Parameters characterizing the suitability of the ground-water as a drinking water supply, as specified in Appendix III.<br>*[Note: Have not listed these parameters because, in accordance with 40 CFR 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.]*<br>(2) Parameters establishing ground-water quality:<br>(i) Chloride<br>(ii) Iron<br>(iii) Manganese<br>(iv) Phenols<br>(v) Sodium<br>(vi) Sulfate<br>*[Comment: These parameters are to be used as a basis for comparison in the event a groundwater quality assessment is required under 40 CFR 265.93(d).]*<br>(3) Parameters used as indicators of ground-water contamination:<br>(i) pH<br>(ii) Specific conductance<br>(iii) Total organic carbon<br>(iv) Total organic halides<br>(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. The owner or operator must do this quarterly for one year.<br>(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 and Appendix A<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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 |
|---|---|---|
| | **40 CFR 265.92 Sampling and Analysis (cont'd).**<br>(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:<br>(1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually.<br>(2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semiannually.<br>(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained. | |
| Methods used to evaluate the collected data | **40 CFR 265.93 Preparation, Evaluation, and Response.**<br>(b) For each indicator parameter specified in 40 CFR 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 40 CFR 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 and Appendix A<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>PNNL-14859-ICN-2 |

Notes:

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*

WAC = *Washington Administrative Code*

The assumptions regarding LLWMA-2 groundwater monitoring based on historical observations and the recent *Groundwater Monitoring Needs Assessment for Low-Level Burial Grounds Waste Management Areas* (SGW-40037) are as follows:

- The groundwater monitoring program described in PNNL-14859 (and interim change notices) does not meets the requirements of 40 CFR 265.90(b), "Applicability," based on a southwest flow direction because there is no true upgradient well.
- Elevated specific conductance and TOC in the southeast wells (e.g., 299-E27-9 and 299-E27-10) are driven primarily by sulfate, calcium, chloride, and nitrate from an unknown source.

- The western, unused portion of LLWMA-2 will be procedurally closed (Figure 2-1).
- Four new wells will be installed for the LLWMA (two wells along the eastern boundary as upgradient wells, and two wells along the western boundary as downgradient wells) (Figure 2-5).

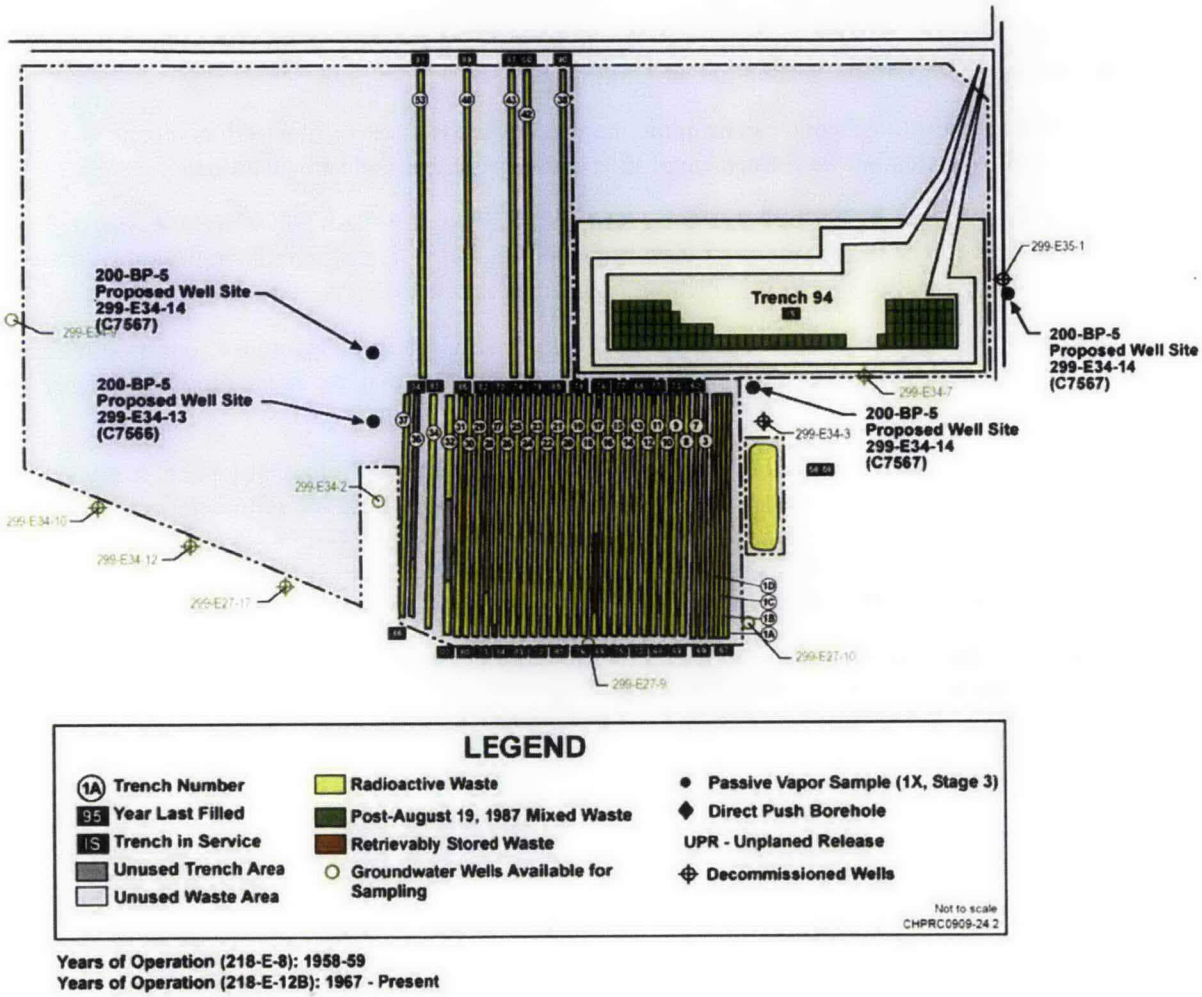


**Figure 2-5. Four New Low-Level Waste Management Area 2 Network Monitoring Wells**

Procedurally closing the western, unused portion and moving the western limit of the LLWMA to the west of Trenches 37 and 53 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 first tier changes included the following:

- Adding four new monitoring wells. Two wells will be installed along the new western boundary point of compliance, just west of Trenches 37 and 53. One additional well will be installed east of Trench 94 as a replacement for well 299-E35-1 and an upgradient well for LLWMA-2. Finally, one well will be installed to the east of Trench 1a as a replacement well for well 299-E34-3 and an upgradient well for LLWMA-2. One well is planned to be completed in fiscal year (FY) 2010 and the other three wells are planned for completion in FY 2011.

- Retain the existing downgradient wells for the new monitoring network (299-E27-11, 299-E27-17, and 299-E34-2).
- Change the status of the six existing wells along the southern and western boundary of LLWMA-2 to supplemental and continue monitoring at these wells.

The second tier requirement is to perform modeling to identify the need for additional wells. The third tier requirements were to install the second tier monitoring wells.

Recommended changes to the conclusions of the monitoring needs assessment based on recent information and re-evaluation for refinement of the needs assessment logic are as follows:

- Retain wells 299-E27-8, 299-E27-9, 299-E27-10, 299-E27-11, 299-E27-17, 299-E34-2, and 299-E34-12 as part of the monitoring network. These wells provide downgradient groundwater data based on southwest flow direction, which seems more probable than a western flow direction.
- Change the groundwater gradient description of well 299-E27-10 from upgradient to cross-gradient. Additional future low-level groundwater monitoring information may require additional changes to this designation.
- Drill proposed well 299-E34-13 in FY 2010. Drill at least 1.5 m (5 ft) into the Elephant Mountain Basalt to investigate the basalt chips and complete the screen across the basalt to determine water availability. Use this information to determine whether to drill wells 299-E34-14 and 299-E34-15 in FY 2011. This decision will be based on previous basalt chip observations from two wells (299-E34-2 and 299-E34-4) in this area, which provided no evidence of flow top.
- If evidence of flow top is not present in well 299-E34-13 and water availability is not sufficient, then do not drill wells 299-E34-14 and 299-E34-15.

# 3 Groundwater Monitoring

This chapter 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 and the frequency for the detection-level groundwater monitoring program at LLWMA-2. Note that wells 299-E34-13 through 299-E34-16 are new planned wells; one well will be drilled in FY 2010 and up to three wells will be drilled in FY 2011, depending on well production (as discussed in Section 2.7). Maintenance issues 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-2. Figure 2-5 shows the four new planned groundwater monitoring wells for LLWMA-2. Table 3-1 lists the wells in the groundwater monitoring network. Construction details and as-built diagrams for wells in LLWMA-2 monitoring network are described in PNL-6820, WHC-MR-0204, WHC-SD-EN-DP-044, and WHC-SD-EN-DP-049. The wells in the LLWMA-2 monitoring network may also be co-sampled as part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* sampling for the 200-BP-5 Operable Unit. Sampling for LLWMA-2 and the 200-BP-5 Operable Unit is coordinated to eliminate duplicate analyses and well trips.

Table 3-2 summarizes well attribute information, including the April 2009 depth to water in each well. All of the wells in the LLWMA-2 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/year [0.164 ft/year]), none of the wells in the LLWMA-2 monitoring network are expected to go dry for at least 20 years.

## 3.3 Sampling and Analysis Protocol

Groundwater monitoring at LLWMA-2 follows the conventions of the project and is described in the QAPjP (Appendix A).

## 3.4 Differences Between This Plan and Previous Plan

Initially, the only difference between this groundwater monitoring plan and the previous plan (PNNL-14859-ICN-2) is the deletion of the analytes lead and mercury. Over the next 2 years, another difference will be the addition of up to four new wells (e.g. 299-E34-13 through 299-E34-16) to the monitoring network (Figure 2-5). After completion of the two new wells at the new western edge of the burial ground, the two existing western wells will no longer be sampled for indicator or groundwater quality parameters. After the two new wells have been completed and sampled once, second tier modeling will be conducted to determine if additional monitoring wells may be needed at LLWMA-2. If additional wells are needed, a new monitoring plan will be completed. If some of the proposed wells are determined from the FY 2010 decision not to be drilled, then a revised groundwater monitoring plan will be developed to include any second tier proposed wells.

Table 3-1. Sampling Schedule for Low-Level Waste Management Area 2

| 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-E27-8 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E27-9 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E27-10 | Cross-gradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E27-11 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E27-17 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E34-2 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E34-9 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E34-10 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E34-12 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E34-13 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E34-14 | Downgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E34-15 | Upgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |
| 299-E34-16 | Upgradient | Y | S | S4 | S4 | S4 | S4 | S | S | A | S | S | S | S | S | S | S |

**Table 3-1. Sampling Schedule for Low-Level Waste Management Area 2**

| Well Name | Purpose | WAC Compliant | Water Level[c] | RCRA Required Constituents[a] | | | | | | | | | | Supporting Constituents[b] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contaminant Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | |
| | | | | | | | | 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] |

Notes:

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.

A = sampled annually

CFR = *Code of Federal Regulations*

LLWMA = low-level waste management area

RCRA = *Resource Conservation and Recovery Act of 1976*

S = sampled semiannually

S4 = sampled semiannually with quadruplicate samples taken

VOA = volatile organic analysis

WAC = *Washington Administrative Code*

Y = well is constructed to the resource protection well standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

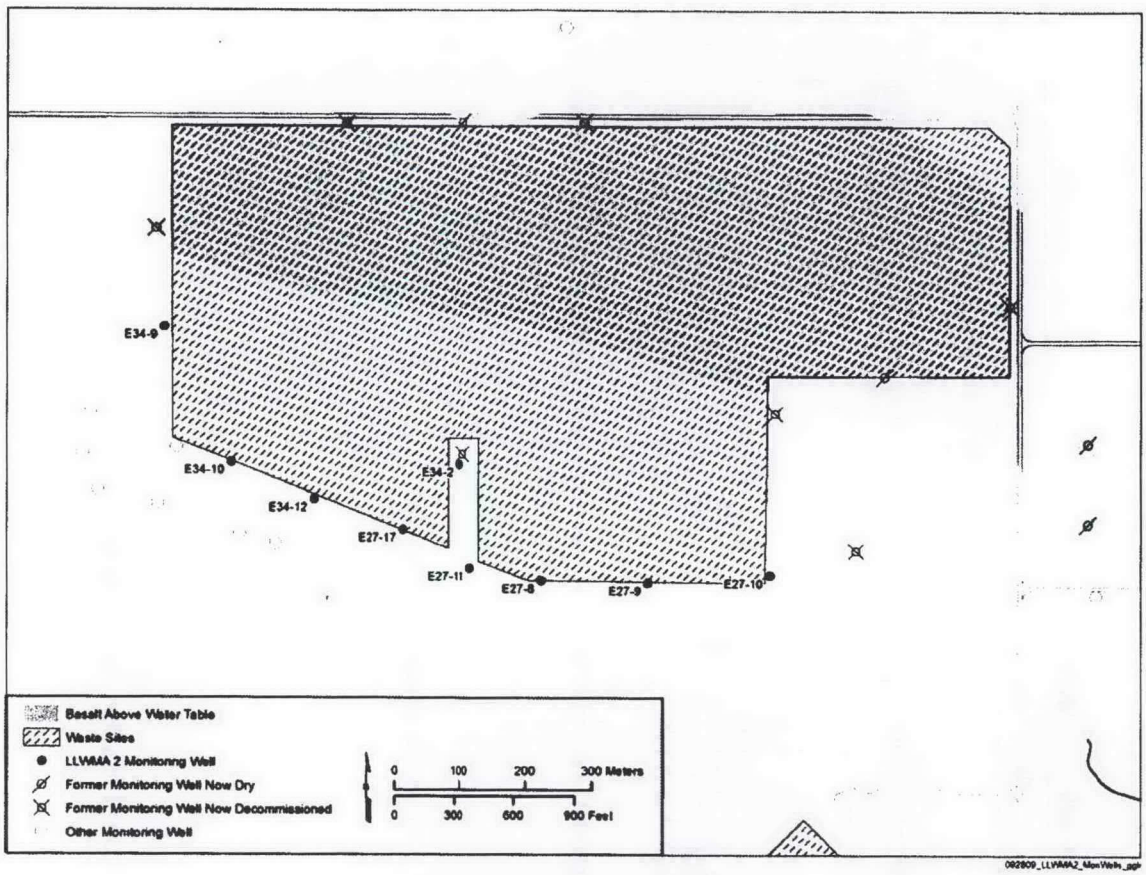


**Figure 3-1. Map Showing Locations of Existing RCRA Monitoring Wells at Low-Level Waste Management Area 2**

**Table 3-2. Attributes for Wells in the Low-Level Waste Management Area 2 Groundwater Monitoring Network**

| 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) (April 2009) |
|---|---|---|---|---|---|---|---|
| 299-E27-8 | 9/30/87 | 137044.178 | 574759.08 | No value | 121.972 | 225.5 - 245.5 | 2.23 |
| 299-E27-9 | 08/31/87 | 137040.904 | 574917.649 | *No value* | 121.987 | 219.8 - 239.1 | 2.5 |
| 299-E27-10 | 08/19/87 | 137052.481 | 575100.298 | *190.81* | 121.933 | 212.1 - 232.4 | 1.99 |
| 299-E27-11 | 10/18/89 | 137062.736 | 574652.93 | 196.264 | 121.909 | 230.4 – 251.4 | 2.26 |
| 299-E27-17 | 11/11/91 | 137122.01 | 574547.31 | No value | 121.929 | 223.2 - 224.2 | 2.78 |
| 299-E34-2 | 09/30/87 | 137220.694 | 574634.81 | No value | 121.919 | 230.2 - 240.4 | 2.39 |
| 299-E34-9 | 11/05/91 | 137429.82 | 574186.02 | No value | 121.984 | 212.63 - 233.4 | 1.24 |
| 299-E34-10 | 10/29/91 | 137224.57 | 574284.4 | No value | 122.032 | 225.29 - 246.0 | 1.73 |
| 299-E34-12 | 04/15/92 | 137168.544 | 574411.004 | 194.823 | 121.921 | 223.9 - 244.21 | 1.45 |
| 299-E34-13 | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| 299-E34-14 | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| ***299-E34-15*** | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| ***299-E34-16*** | TBD | TBD | TBD | TBD | TBD | TBD | TBD |

Notes:

All wells are constructed to the 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, and annular seal around casing.

Shaded rows show the anticipated network monitoring wells after the four new wells (299-E34-13 through 299-E34-16) are installed and sampled once.

Bold/italic print indicates upgradient wells for a southwest flow direction.

Water levels measured in April 2009.

amsl = above mean sea level

NAVD88 = North American Vertical Datum of 1988

TBD = to be determined

WAC = *Washington Administrative Code*

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# 4 Data Evaluation and Reporting

This chapter discusses the data evaluation and reporting for LLWMA-2.

## 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 detection monitoring is to determine if LLWMA-2 has affected groundwater quality beneath the site. For most RCRA treatment, storage, and disposal units 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., TOC, TOX, pH, and specific conductance) in downgradient wells to background levels obtained from upgradient wells.

There is one current cross-gradient well at LLWMA-2 (Table 3-1) that was previously used for deriving a statistical comparisons value. Each year, a new calculation is generally completed to derive the background comparison value of significance because of the variability of upgradient groundwater. Since there is no current upgradient well, the current values will remain in place until a new upgradient well is in place and sampled quarterly for one year. Thus, the current upgradient indicator parameter derived in January 2009 will be 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). Also, phenol analyses are ran for further evaluation of potentially elevated TOC or TOX indicator parameters.

## 4.3 Interpretation

After the data are validated and verified, acceptable data are used to interpret groundwater conditions at LLWMA-2. Interpretive techniques include the following:

- Hydrographs: Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- Water table maps: Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to 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 assist in determining plume movement and groundwater flow direction.
- 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 include an annual evaluation of the groundwater monitoring network to determine if it remains adequate to monitor the LLWMA. The network must include upgradient and downgradient wells in the uppermost aquifer. The groundwater flow direction beneath LLWMA-2 has been predominantly reported to the southwest since 2002 based on nitrate and sulfate movement.

Water-level measurements will be collected before each sampling event. A more comprehensive set of water-level measurements has been made for the northeastern portion of the 200 East Area each month since April 2009. The measurements are corrected, if needed, to account for borehole deviation from vertical, and the resulting data are plotted on a map. The data will be presented in the annual groundwater monitoring report.

Any new RCRA wells needed as a result of the second tier modeling at LLWMA-2 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

Results of detection monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66). Notifications will be made as outlined in Table 4-1.

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], "Preparation, Evaluation, and Response"). 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.

**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) | Annual Hanford Site groundwater monitoring report | 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) | Annual Hanford Site groundwater monitoring report | 40 CFR 265.94(a)(2)(iii) |
| 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 annual Hanford Site groundwater monitoring report | 40 CFR 265.93(d)(5) and 40 CFR 265.94(b) |

Notes:

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

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

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# Appendix A

# Quality Assurance Project Plan

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# Terms

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

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# A Quality Assurance Project Plan

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

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

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

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *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) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

## A1 Project Management

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

### A1.1 Project/Task Organization

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

#### A1.1.1 Regulatory Project Manager

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

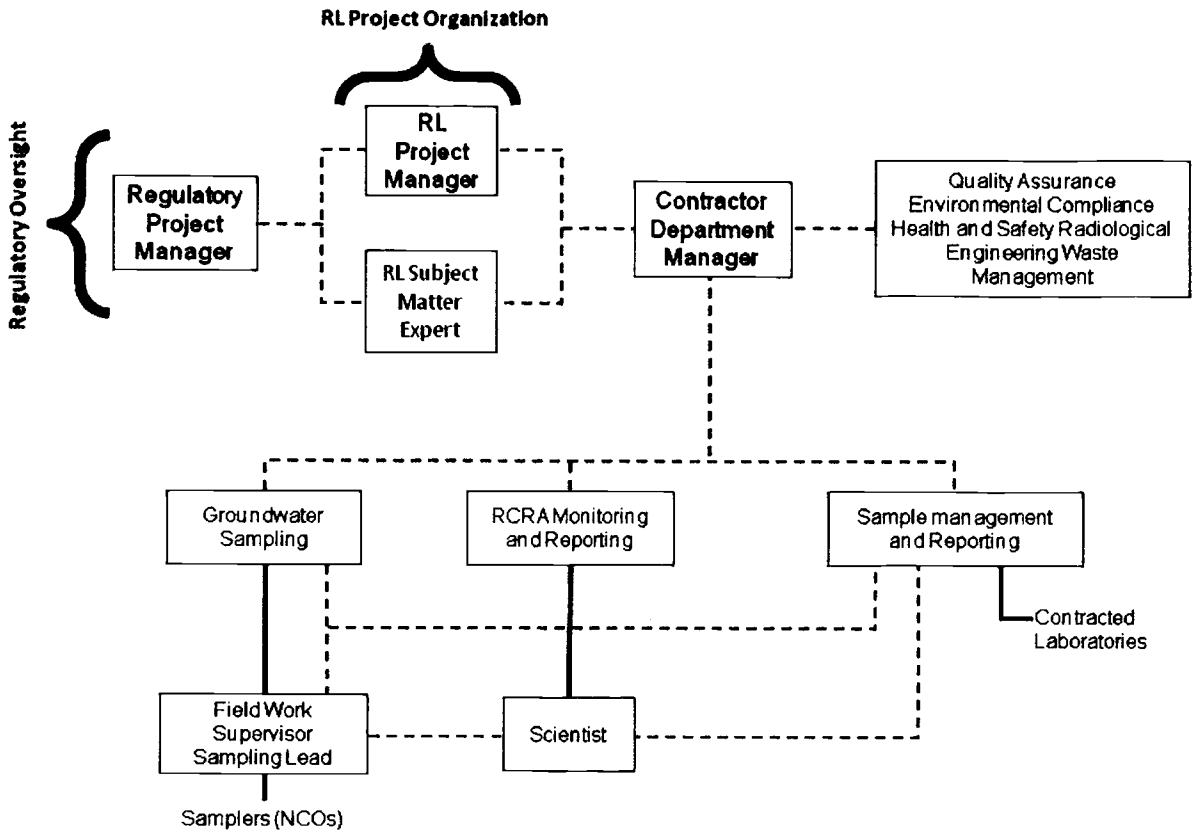


**Figure A-1. Project Organization**

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

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

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

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

### A1.1.4 Contractor Groundwater Remediation Department Manager

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

### A1.1.5 Groundwater Sampling Operations

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

### A1.1.6 RCRA Monitoring and Reporting

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

### A1.1.7 Sample Management and Reporting Organization

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

### A1.1.8 Contract Laboratories

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

### A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project 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.

### A1.1.10 Environmental Compliance Officer

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

### A1.1.11 Health and Safety

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

### A1.1.12 Waste Management

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

## A1.2 Problem Definition/Background

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

## A1.3 Project/Task Description

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

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

## A1.4 Quality Objectives and Criteria

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

## A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility of collecting and transporting groundwater samples according to the Dangerous Waste Training Plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

## A1.6 Documents and Records

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

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

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements therein.

**Table A-1. Actions and Documentation for Regulatory Notification**

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

Notes:

RCRA = *Resource Conservation and Recovery Act of 1976*

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

# A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

## A2.1 Sampling Process Design (Experimental Design)

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

### A2.1.1 Regulatory Requirements

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

### A2.1.2 Judgmental Sampling

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

## A2.2 Sampling Methods

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

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

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

## A2.3 Sample Handling and Custody

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

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

Sample custody during laboratory analysis is addressed in the applicable laboratory's 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.

## A2.4 Analytical Methods

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

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Contamination Indicator Parameters** | | | |
| Total organic carbon | G/P, HCL to pH <2 | SW-846[d] Method 9060 | 1,000 |
| Total organic halides | G, $H_2SO_4$ to pH <2, no head space | SW-846[d] Method 9020 | 20 |
| **Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered/Filtered** | | | |
| Calcium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e] | 1,000 |
| Cadmium | | | 5 |
| Sodium | | | 500 |
| Manganese | | | 5 |
| Potassium | | | 4,000 |
| Iron | | | 50 |
| Magnesium | | | 750 |
| **Anions by Ion Chromatography** | | | |
| Chloride | P; none | EPA/600 Method 300.0[f] | 200 |
| Nitrate | | | 250 |
| Nitrite | | | 250 |
| Sulfate | | | 500 |
| **Other** | | | |
| Alkalinity | G/P; none | Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2 | 5,000 |
| Conductivity, field | N/A | Instrument/meter | 1 µohm |
| pH, field measurement | N/A | Instrument/meter | 0.1 |
| Phenol | G, residual chlorine 0.0008% $Na_2S_2O_3$ | SW-846 Method 8040 | 5 |
| Temperature | Field measurement | Instrument/meter | |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|

Notes:

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

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

c. Detection limit units, unless otherwise indicated.

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

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

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

g. *Standard Methods for the Examination of Water and Wastewater* (APHA et al. 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 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

## A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-3.

**Table A-3. Quality Control Samples**

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

Notes:

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

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

QC = quality control

### A2.5.1 Field Quality Control Samples

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

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

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

Equipment blanks (EBs) are samples in which high-purity reagent water is passed through the pump or placed in contact with the sampling surfaces of the equipment to collect blank samples identical to the

sample set that will be collected. The EB bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event. The EBs are used to evaluate the effectiveness of the cleaning process to ensure that samples are not cross-contaminated from previous sampling events.

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

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

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

### A2.5.2 Laboratory Quality Control Samples

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

### A2.5.3 Quality Control Requirements

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

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

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

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

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **General Chemical Parameters** | | | |
| Alkalinity<br>Chemical oxygen demand<br>Conductivity<br>pH<br>Total organic carbon<br>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<br>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" |
| **Semivolatile 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 |
|---|---|---|---|

Notes:

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

b. Does not apply to pH.

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

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

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

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

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

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

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated method blank)

N = result may be biased (associated matrix spike result was outside the acceptance limits)

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

Abbreviations:

CRDL = contract-required detection limit

DUP = laboratory matrix duplicate

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

GC = gas chromatography

IC = ion chromatography

ICP = inductively coupled plasma

ICP/MS = inductively coupled plasma/mass spectrometry

LCS = laboratory control sample

MB = method blank

MDL = method detection limit

MS = matrix spike

MSD = matrix spike duplicate

QC = quality control

RPD = relative percent difference

SUR = surrogate

**Table A-5. Blind Standard Constituents and Schedule**

| Constituents | Frequency | Accuracy (%) | Precision (% RSD)[a] |
|---|---|---|---|
| Fluoride | Quarterly | ±25% | ≤25% |
| Chloride | Quarterly | ±25% | ≤25% |
| Chromium | Annually | ±20% | ≤20% |
| Iron | Semiannually | ±20% | ≤20% |
| Magnesium | Annually | ±20% | ≤20% |
| Manganese | Annually | ±20% | ≤20% |
| Nitrate | Quarterly | ±25% | ≤25% |
| Sodium | Annually | ±20% | ≤20% |
| TOC[b] | Quarterly | Varies according to spiking compound | Varies according to spiking compound |
| TOX[c] | Quarterly | Varies according to spiking compound | Varies according to spiking compound |

Notes:

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

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

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

RSD = relative standard deviation

TOC = total organic carbon

TOX = total organic halides

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

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

## A2.7 Instrument/Equipment Calibration and Frequency

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

## A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support 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.

## A2.9 Non-Direct Measurements

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

## A2.10 Data Management

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

All field activities will be recorded in the field logbook.

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

# A3 Assessment and Oversight

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

## A3.1 Assessments and Response Actions

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

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

## A3.2 Reports to Management

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

# A4 Data Validation and Usability

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

## A4.1 Data Review, Verification, and Validation

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

## A4.2 Verification and Validation Methods

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

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

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

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

## A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

# A5 References

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# Interim Status Groundwater Monitoring Plan for the LLBG WMA-3

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;**
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# Executive Summary

The Low-Level Waste Management Area 3 (LLWMA-3) consists of the 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds, is regulated via Washington State's "Hazardous Waste Management Act"[1] and its implementing requirements in *Washington Administrative Code* (WAC) 173-303-400.[2] The Washington State Department of Ecology has been authorized by the U.S. Environmental Protection Agency[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976.*[4]

This document supersedes PNNL-14859,[5] as revised in interim change notices PNNL-14859-ICN-1[6] and PNNL-14859-ICN-2,[7] to incorporate changes that have occurred at LLWMA-3 since the previous plan was written.

This document describes the groundwater monitoring plan for LLWMA-3. The plan addresses the following:

- Number, locations, and depths of wells in the LLWMA-3 groundwater monitoring network
- Sampling and analytical methods for groundwater parameters and hazardous wastes or hazardous waste constituents
- Procedures for evaluating groundwater quality information
- Schedule for groundwater monitoring at the LLWMA

This indicator monitoring plan is the principal controlling document for conducting groundwater monitoring at LLWMA-3.

---

1 RCW 70.105, "Hazardous Waste Management Act," *Revised Code of Washington.*

2 WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code.*

3 *Authorized State Hazardous Waste Programs*, 42 U.S.C. 6926, et seq.

4 *Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901, et seq.

5 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.

6 PNNL-14859-ICN-1, 2006, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 1, Pacific Northwest National Laboratory, Richland, Washington.

7 PNNL-14859-ICN-2, 2007, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 2, Pacific Northwest National Laboratory, Richland, Washington.

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# Terms

| | |
|---|---|
| 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 |
| 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* |
| TOC | total organic carbon |
| TOX | total organic halides |
| WAC | *Washington Administrative Code* |

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# 1 Introduction

Low-Level Waste Management Area 3 (LLWMA-3) consists of the 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds, which contain 75 unlined and 2 lined trenches. The LLWMA-3 is located in the northwest corner of the Hanford Site's 200 West Area (Figure 1-1) and was used for disposal of low-level radioactive and low-level mixed wastes beginning in 1970. The hazardous chemicals in the low-level mixed waste portions of LLWMA-3 are regulated under *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." The LLWMA-3 was placed in assessment monitoring in 1989 due to elevated total organic halides (TOX) (a *Resource Conservation and Recovery Act of 1976* [RCRA] indicator parameter) in one well. The LLWMA-3 was subsequently shown not to be the source for the elevated TOX, and indicator evaluation monitoring resumed in 1994; indicator evaluation monitoring has continued at the LLWMA since that time. The objectives for the continued indicator evaluation groundwater monitoring at LLWMA-3, as required 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 semiannually
- Elevation of the water table

The scope of this plan is to acquire 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-3 since that plan was issued. Chapter 2 of this plan summarizes background information and references other documents that contain more detailed information. Chapter 2 also describes the LLWMA and the types of waste present, provides a brief history of groundwater monitoring, and describes the geology and hydrology pertinent to LLWMA-3. 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 the references cited in this plan. Appendix A provides the quality assurance project plan (QAPjP).

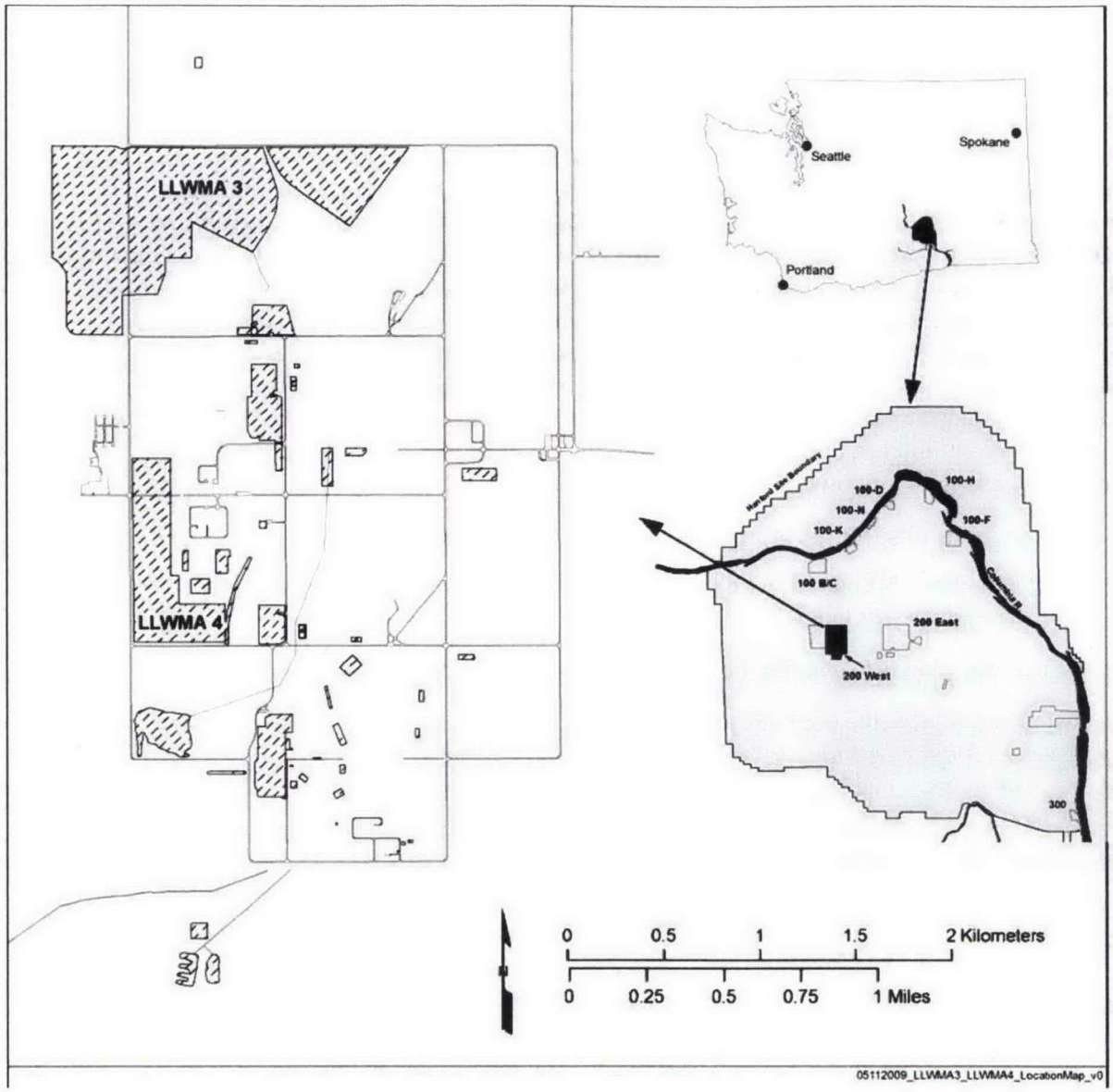


**Figure 1-1. Location Map for Low-Level Waste Management Area 3**

# 2 Background

This chapter describes the LLWMA-3 facility and operating history, the wastes and waste characteristics associated with the LLWMA, the local geology and hydrology, a summary of previous monitoring, the groundwater and vadose zone contamination at the LLWMA, and the conceptual model for the LLWMA. The discussion in this chapter is summarized from *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* (PNNL-14859).

## 2.1 Facility Description and Operating History

The LLWMA-3 is located in the northwest corner of the 200 West Area and consists of the following burial grounds:

- 218-W-3A Burial Ground, approximately 20.4 ha (50.4 ac)
- 218-W-3AE Burial Ground, approximately 20 ha (49.4 ac)
- 218-W-5 Burial Ground, approximately 37.2 ha (91.9 ac)

The locations of the burial grounds are shown in Figure 1-1.

The 218-W-3A Burial Ground contains 57 unlined trenches that vary in length from 120 to 285 m (393.7 to 935 ft). This burial ground began operating in 1970 but has not received waste since 1998.

The 218-W-3AE Burial Ground contains eight unlined trenches varying in length from 325 to 380 m (1,066.3 to 1,246.7 ft), with bottom widths between 5 and 6 m (16.4 and 19.7 ft). The burial ground began operating in 1981 and received waste until July 2004. All filled trenches are thought to contain 2.4 m (7.9 ft) of soil cover.

The 218-W-5 Burial Ground contains 10 unlined trenches and 2 lined trenches. The unlined trenches are between 160 and 350 m (524.9 and 1,148.3 ft) long, 4.5 to 12 m (14.8 to 39.4 ft) wide, and 5 to 6 m (16.4 to 19.7 ft) deep. The lined trenches were constructed in 2000 and are 36 m (118.1 ft) wide at the bottom, 9.1 m (29.9 ft) deep, and 230 m (754.6 ft) long. The burial ground began operating in 1986, and the two double-lined mixed waste trenches are the only trenches that continue to receive waste.

## 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-3. Groundwater monitoring is conducted at LLWMA-3 in accordance with WAC 173-303-400(3), "Interim Status Facility Standards" (and by reference, 40 CFR 265, Subpart F, "Ground-Water Monitoring"), which requires monitoring to determine whether the dangerous waste constituents from the waste site have entered the groundwater. A RCRA groundwater monitoring program for LLWMA-3 was initiated in 1987 (WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan*

*for the 200 Areas Low-Level Burial Grounds*) based on the interim status monitoring requirements of 40 CFR 265, Subpart F and WAC 173-303-400, and the groundwater monitoring program continues today.

Groundwater monitoring is conducted at LLWMA-3 in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F), 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-3 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 1989, TOX in well 299-W7-4 exceeded the statistical comparison value when the well was redefined as a downgradient well due to changes in groundwater flow direction. Total organic carbon (TOC) was also determined to be above the statistical comparison value at downgradient wells 299-W7-5 and 299-W8-1. A groundwater assessment program was initiated (WHC-SD-EN-AP-022, *Interim-Status Ground-Water Quality Assessment Plan for Waste Management Area 3 of the 200 Areas Low-Level Burial Grounds*). Analytical results from three additional upgradient monitoring wells indicated that the elevated TOX came from an upgradient source. An assessment report was prepared (WHC-SD-EN-EV-026, *Result of the Groundwater Quality Assessment Program at Low-Level Waste Management Area 3 of the Low-Level Burial Grounds*) 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). Interim status indicator evaluation monitoring continues to date.

The upgradient wells have all gone dry, so statistical comparisons have not been performed since fiscal year 2004. The *Hanford Site Groundwater Monitoring for Fiscal Year 2005* (PNNL-15070) discusses this condition.

## 2.3 Waste Characteristics

The 218-W-3A Burial Ground received shipments described as miscellaneous transuranic and non-transuranic waste from the Three-Mile Island accident cleanup; irradiated fuel elements from the General Electric Company in Vallecitos, California; radioactive soil from a salt waste spill (encased in concrete burial boxes); and industrial waste. Examples of waste disposed in this burial ground include ion-exchange resins, failed equipment, tanks, pumps, ovens, agitators, heaters, hoods, jumpers, vehicles, and accessories. Only a few areas in two trenches received mixed waste after August 19, 1987, the effective date of mixed waste in Washington State.

Waste historically received at 218-W-3AE Burial Ground includes miscellaneous waste (e.g., rags, paper, rubber gloves, disposable supplies, and broken tools), industrial waste (e.g., failed equipment, tanks, pumps, ovens, agitators, heaters, hoods, jumpers, vehicles, and accessories), and radiological waste. Only a few areas in two trenches in this burial ground received mixed waste after August 19, 1987.

The 218-W-5 Burial Ground received packaged waste materials from 200 West Area operations, as well as other wastes from the Hanford Site and offsite. Examples of waste disposed to this burial ground include rags, paper, rubber gloves, disposable supplies, and broken tools. Two lined trenches (Trenches 31 and 34) received mixed waste. Aside from the lined trenches (Trenches 31 and 34), one small area in one unlined trench received mixed waste after August 19, 1987.

## 2.4 Geology and Hydrogeology

The geology and hydrology of the 200 West Area, including the area of LLWMA-3, is described in detail in the following documents:

- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report*
- PNL-7336, *Geohydrology of the 218-W-5 Burial Ground*
- PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*
- PNNL-16887, *Geologic Descriptions for the Solid-Waste Low Level Burial Grounds*
- WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*
- WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds*

The following discussion summarizes descriptions from these documents. The uppermost aquifer and aquifers hydraulically interconnected beneath the LLWMAs are also discussed.

The LLWMA-3 is underlain from the ground surface to the top of the basalt by the Hanford formation, the Cold Creek unit, and the Ringold Formation. The Ringold Formation at this location is mostly sand and gravel, with minor units of finer grained sediment. The Ringold Lower Mud Unit is absent beneath the northernmost portion of the area (PNNL-13858).

The suprabasalt sediment ranges in thickness from 145 to 160 m (475.7 to 524.9 ft) and generally dips to the south. The Cold Creek unit rises to within 6 m (19.7 ft) of the surface along the northern boundary of LLWMA-3 (PNL-7336).

The vadose zone beneath LLWMA-3 is between approximately 74 and 78 m (242.8 and 255.9 ft) thick and consists of the Hanford formation, the Cold Creek unit, the Taylor Flats member of the Ringold Formation (not everywhere present beneath LLWMA-3), and the upper portion of Unit E of the Wooded Island member of the Ringold Formation. The water table is at approximately 134 to 137 m (439.6 to 449.5 ft) elevation and is entirely within the upper Ringold Unit E. The saturated thickness of the uppermost aquifer is approximately 60 m (196.8 ft) in the south and 75 m (246.1 ft) in the north where the Ringold Lower Mud Unit is absent (PNNL-13858). There is some evidence that a locally confining layer, or at least a zone of lower permeability, may be present just at the water table.

Water levels in the unconfined aquifer increased as much as 13 m (42.7 ft) above the pre-Hanford natural water table beneath Waste Management Area T (located approximately 400 m [1,312.3 ft] south of LLWMA-3) due to artificial recharge from liquid waste disposal operations between the mid-1940s and 1995. The height of the water table mound beneath LLWMA-3 is not known because there were no wells in the area with water-level measurements prior to initiating RCRA monitoring in the late 1980s. However, discharges to T Pond and U Pond from the 1940 through the 1970s changed the groundwater flow direction beneath the LLWMA from eastward (the pre-Hanford direction) to the north and northwest. More recently, flow direction has returned to the pre-Hanford east or east northeast direction. The State-Approved Land Disposal Site is located about 500 m (1,640.4 ft) north of LLWMA-3 and began operation in 1995. Since that time, more than 880 million L (232 million gal) of effluent have been discharged to the facility. Those discharges have not affected the groundwater flow direction beneath LLWMA-3.

The hydraulic conductivity values derived from aquifer testing in wells completed in the upper portion of the unconfined aquifer at LLWMA-3 varied from 0.02 to 9.8 m/day (0.07 to 32.2 ft/day). Assuming an average effective porosity of aquifer materials between 0.1 and 0.3, and a hydraulic gradient of 0.0014, the average flow rate is calculated at 0.0001 to 0.14 m/day (0.000328 to 0.459 ft/day). A current groundwater elevation map for LLWMA-3 is shown in Figure 2-1.

## 2.5 Summary of Previous Groundwater Monitoring

Groundwater monitoring was initiated at the LLWMA-3 in 1987 in accordance with WHC-SD-EN-AP-015. The LLWMAs are sampled semiannually for geochemical analyses and are included in the annual comprehensive March water-level measurement campaign. Groundwater monitoring results are summarized annually for the LLWMAs in the annual Hanford groundwater monitoring report (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

The first RCRA monitoring wells at LLWMA-3 were installed in 1987. The initial network contained three upgradient and eight downgradient wells. Additional wells were installed in 1989 (two wells), 1990 (one well), 1991 (two wells), and 1992 (one well). One of the upgradient wells and one downgradient well were completed at the bottom of the unconfined aquifer; all other wells monitored the upper 4.5 to 6 m (14.8 to 19.7 ft) of the unconfined aquifer. All of the wells were dry by 2007, except the two deep wells and two of the original wells monitoring the top of the aquifer. The LLWMA-3 was expanded in the late 1980s so well 299-W7-4, which was originally an upgradient well, became located in the middle of the burial ground and was redefined as a downgradient well. Later, well 299-W7-4 could no longer be sampled due to safety concerns regarding cave-in potential when traveling to the well. Three additional downgradient wells were installed in 2006. New upgradient wells have not been approved in the process of selecting and prioritizing well installation under the Tri-Party Agreement Milestone M-24 series. No new wells are currently planned for LLWMA-3 until the impact of the expanded 200-ZP-1 Groundwater Operable Unit (OU) pump-and-treat system is known.

Background monitoring at LLWMA-3 began in 1988. Critical mean values (WHC-SA-1124-FP, *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site*) for the indicator parameters TOC, TOX, pH, and specific conductivity were established in 1989 using data from four quarters from upgradient wells 299-W9-1 and 299-W10-13. The critical mean was exceeded for TOX in well 299-W7-4 and for TOC in wells 299-W7-5 and 299-W8-1 in September 1989. Resampling confirmed the elevated TOX, and an interim status groundwater quality assessment program was initiated (WHC-SD-EN-AP-022). Subsequent sampling indicated that the elevated TOC values were erroneous and that the critical mean for TOC was not exceeded.

The groundwater monitoring network at LLWMA-3 was sampled quarterly between 1988 and December 1993, with the exception of the period between June 1990 and June 1991 when laboratory services were unavailable. The additional sampling and groundwater quality assessment indicated that elevated TOX in well 299-W7-4 was due to carbon tetrachloride from upgradient sources. Consequently, LLWMA-3 returned to a background evaluation program in January 1994 to re-establish background and then to indicator evaluation monitoring after one year. The LLWMA-3 has remained in indicator evaluation monitoring since that time.

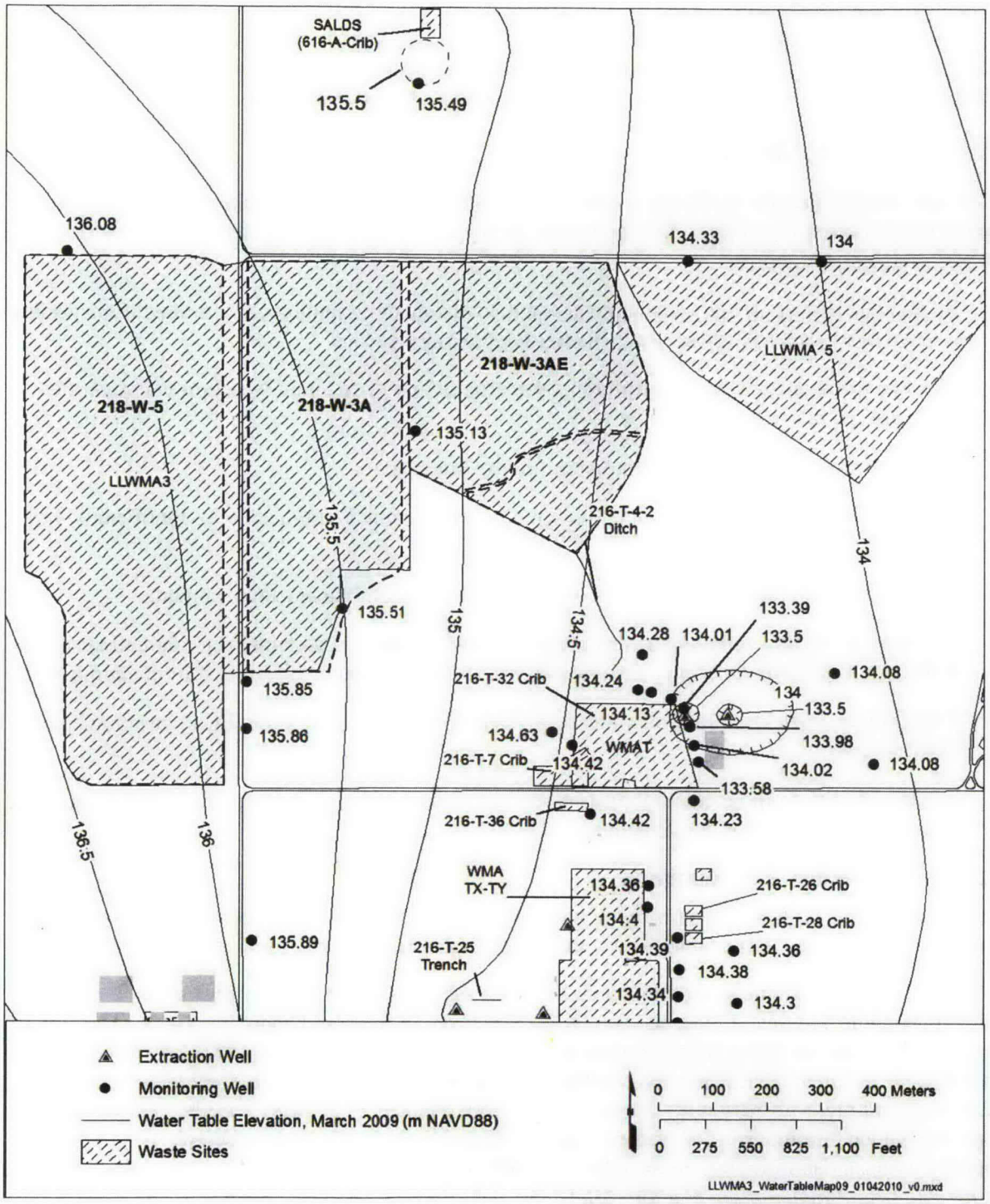


**Figure 2-1. Water Table Map for 200 West Area, March 2009**

The groundwater monitoring activities at LLWMA-3 currently consist of water-level monitoring and chemical constituent monitoring. The LLWMA-3 is sampled semiannually, every March and September, from a network of six wells. Samples are analyzed semiannually for the indicator parameters and annually for anions, metals, and phenols. Sitewide water-level measurements are collected every March.

## 2.6 Conceptual Model

This section describes the LLWMA-3 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/year [2 to 3.9 in./year]) 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 sources 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, chemical nature of the waste constituents, and natural subsurface geochemical conditions.

Pore fluid in the unsaturated and saturated zones beneath LLWMA-3 is slightly alkaline ($7 < pH < 8$), with appreciable amounts of bicarbonate ($HCO_3^-$) and very little natural organic material. The lack of organic matter means 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 (e.g., lead) and favor 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 (PNNL-11800, *Composite Analysis of Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*).

### 2.6.2 Soil Moisture Factors

With the exception of 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 subsequent transport to groundwater. Contaminants in the 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 by the amount 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-3 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 amount of vegetation exists on the established backfilled areas and the unused portions of the LLWMA. A coarse, nonvegetated cover material allows a major fraction of the precipitation to infiltrate and potentially drain to groundwater. It is estimated that recharge rates at the Hanford Site range from nearly 0 mm/year at highly vegetated sites to greater than 50 mm/year at gravel-covered, nonvegetated sites (PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*).

### 2.6.3 Hydrogeologic Considerations

The vadose zone beneath LLWMA-3 is approximately 75 m (246 ft) thick and consists of (from top to bottom) the Hanford formation, the Cold Creek unit, and the Ringold Formation. The Cold Creek unit is likely to retard downward movement of moisture and contaminants because of the finer textured sediment and cementing that characterize this stratigraphic feature in the vadose zone. The depth of the Cold Creek unit increases from north to south beneath the LLWMA, so any lateral spreading on top of the Cold Creek unit will be toward the south.

If contaminants do break through to groundwater beneath LLWMA-3, the contaminants would move toward the east-northeast. The flow direction has shifted from nearly north to northeast and is slowly changing eastward as the influence of the groundwater mound subsides. Because of the low permeability of the aquifer in this area, the groundwater flow rate is estimated to be between approximately 0.04 to 50 m/year (0.13 to 164 ft/year).

## 2.7 Data Quality Objectives

The data quality objectives (DQO) process is used to ensure that data gathered are of the appropriate quality and quantity to meet specific objectives.

The current groundwater monitoring network for LLWMA-3 is a result of previous investigations and DQO-equivalent studies. Groundwater monitoring is ongoing at LLWMA-3 in accordance with interim status regulations. Table 2-2 provides a matrix of data requirements that are typically determined using the DQO process, the associated interim status regulations applicable to these requirements, and the current and historical documentation specifying how the monitoring program for LLWMA-3 complies with the requirements.

**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 WAC 173-303-400(3)(c)(v). | |
| Number and location of wells<br>Point(s) of compliance | **40 CFR 265.91 Ground-Water Monitoring System.**<br>(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:<br>(1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are:<br>(i) Representative of background ground-water quality in the uppermost aquifer near the facility; and<br>(ii) Not affected by the facility; and<br>(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<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>PNNL-14859-ICN-2 |
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91 Ground-Water Monitoring System, and WAC 173-303-400.**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional Requirements from WAC 173-303-400(3)(c)(v)(C).**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells. | This plan, Section 3.2<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision | **40 CFR 265.92 Sampling and Analysis.**<br>(b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section:<br>(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, in accordance with 40 CFR 265.92(c)(1), these analyses are conducted only during the first year, and this site is not in the first year of monitoring.]*<br>(2) Parameters establishing ground-water quality:<br>(i) Chloride<br>(ii) Iron<br>(iii) Manganese<br>(iv) Phenols<br>(v) Sodium<br>(vi) Sulfate<br>*[Comment: These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under 40 CFR 265.93(d).]*<br>(3) Parameters used as indicators of ground-water contamination:<br>(i) pH<br>(ii) Specific conductance<br>(iii) Total organic carbon<br>(iv) Total organic halogen<br>(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. The owner or operator must do this quarterly for one year.<br>(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 and Appendix A<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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 |
|---|---|---|
| | **40 CFR 265.92 Sampling and Analysis. (cont'd)**<br>(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:<br>(1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually.<br>(2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semiannually.<br>(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained. | |
| Methods used to evaluate the collected data` | **40 CFR 265.93 Preparation, Evaluation, and Response.**<br>(b) For each indicator parameter specified in 40 CFR 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 40 CFR 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 and Appendix A<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>PNNL-14859-ICN-2 |

Notes:

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

CFR = *Code of Federal Regulations*

DQO = data quality objective

RCRA = *Resource Conservation and Recovery Act of 1976*

WAC = *Washington Administrative Code*

# 3 Groundwater Monitoring

This chapter 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 under this plan. All wells will be sampled semiannually and constituents monitored semiannually or annually, as indicated in Table 3-1.

Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If a well is delayed more than 3 months, that event will be cancelled, as it will be near the time for the next scheduled sampling event. Missed sampling events will be reported in the annual groundwater report.

## 3.2 Monitoring Well Network

Figure 3-1 shows the groundwater monitoring well network for LLWMA-3, and Table 3-1 lists the wells and their respective sampling schedules. Construction details and as-built diagrams for the wells in LLWMA-3 monitoring network are provided in the *Borehole Summary Report for RCRA Groundwater Monitoring Wells at Low-Level Waste Management Areas 3 and 4, FY 2006* (WMP-30613). The wells in the LLWMA-3 monitoring network may also be co-sampled with the 200-ZP-1 OU under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.* Sampling for LLWMA-3 and the 200-ZP-1 OU is coordinated to eliminate duplicate analyses and well trips.

Table 3-2 summarizes well attribute information, including the most recent (March 2009) depth to water in each well. All of the wells in the LLWMA-3 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. Based on the current rate of water table decline (0.3 to 0.4 m/year [0.98 to 1.3 ft/year]), none of the downgradient wells in the LLWMA-3 monitoring network are expected to go dry for at least 20 years.

As discussed in Section 2.2 of this plan, the upgradient wells have all gone dry, so statistical comparisons have not been performed since fiscal year 2004. Section 4.4 discusses the issues and plans with regards to constructing new RCRA wells to return the network to a compliant status.

## 3.3 Sampling and Analysis Protocol

Groundwater monitoring at LLWMA-3 follows the conventions of the project, which are described in the QAPjP in Appendix A.

**Table 3-1. Sampling Schedule for Low-Level Waste Management Area 3**

| Well Name | Purpose | WAC Compliant | RCRA Required Constituents[a] | | | | | | | | | | | | Supporting Constituents[b] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contamination Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | | |
| | | | | | | | | Anions[d] | | Metals (Filtered and Unfiltered)[d] | | | | | | | | |
| | | | Water Level[c] | pH[c] | Specific Conductance[c] | Total Organic Carbon | Total Organic Halides | Chloride | Sulfate | Sodium | Iron | Manganese | Phenols[d] | Temperature[c] | Turbidity[c] | Dissolved Oxygen[c] | Alkalinity |
| 299-W7-4[e] | Downgradient | Y | A | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 299-W10-29 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |
| 299-W10-30 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |
| 299-W10-31 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |

Notes:

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

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

c. Field measurement.

d. For anions, analytes include, but are not limited to, chloride, fluoride, nitrate, nitrite, and sulfate.

For metals, analytes include, but are not limited to, calcium, chromium, iron, magnesium, manganese, potassium, and sodium.

e. This well is not currently scheduled for parameter or constituent sampling due to access and safety issues; however, the well may become accessible for sampling if access and safety issues are resolved. The well can currently be accessed by foot to obtain annual water-level measurements.

A = sampled annually

CFR = *Code of Federal Regulations*

LLWMA = low-level waste management area

RCRA = *Resource Conservation and Recovery Act of 1976*

S = sampled semiannually

S4 = sampled semiannually with quadruplicate samples taken

VOA = volatile organic analysis

WAC = *Washington Administrative Code*

Y = well is constructed to the resource protection well standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

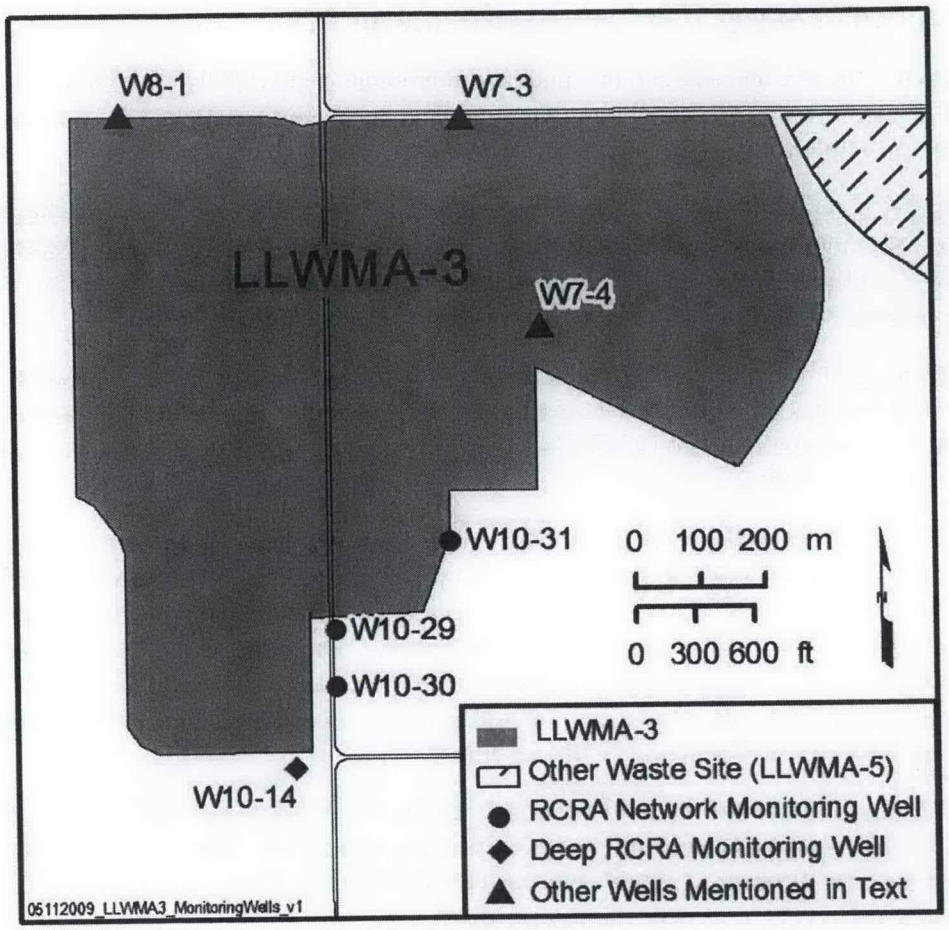


**Figure 3-1. Map Showing Locations of RCRA Monitoring Wells at Low-Level Waste Management Area 3**

**Table 3-2. Attributes for Wells in Low-Level Waste Management Area 3 Groundwater Monitoring Network**

| Well Name | Completion Date | Easting (m) | Northing (m) | Brass Survey Marker Elevation (m NAVD88) | Water Table Elevation (March 2009) (m amsl) | Open Interval Top (m amsl) | Open Interval Bottom (m amsl) | Water Remaining (m) |
|---|---|---|---|---|---|---|---|---|
| 299-W7-4 | 11/19/87 | 566,408.77 | 137,308.24 | 203.92 | 135.13 | 142.02 | 132.92 | 2.2 |
| 299-W10-29 | 3/13/06 | 566,082.98 | 136,828.74 | 211.62 | 135.85 | 136.92 | 126.32 | 9.53 |
| 299-W10-30 | 4/3/06 | 566,082.78 | 136,738.33 | 210.86 | 135.86 | 136.96 | 126.36 | 9.5 |
| 299-W10-31 | 5/10/06 | 566,266.44 | 136,968.34 | 209.67 | 135.51 | 136.57 | 125.87 | 9.64 |

Notes:

amsl = above mean sea level

NAVD88 = *North American Vertical Datum of 1988*

## 3.4 Differences Between This Plan and Previous Plan

There are several differences between this plan and the previous plan (PNNL-14859-ICN-2) in regard to the wells and analytes monitored, including three wells that have been removed from the network and one well that is inaccessible for sampling:

- Well 299-W7-3 and 299-W10-14: These two wells are screened deep in the unconfined aquifer, and both have been monitored since 1988. Data from both wells have never been used for statistical comparisons at the LLWMA, and neither well has detected contamination, except for elevated nitrate. For these reasons, both wells have been removed from the monitoring network.
- Well 299-W8-1: This well was originally drilled as a downgradient well when groundwater flow direction was toward the north. Flow direction has subsequently changed to the east, and the well is now located cross-gradient from LLWMA-3. For this reason, well 299-W8-1 has been removed from the monitoring network.
- Well 299-W7-4: This well was originally drilled as a downgradient well before the 218-W-3AE Burial Ground was expanded. The well is now in the interior of the 218-W-3AE Burial Ground. A decision was made in 2008 to forbid vehicle access to the well due to safety concerns regarding cave-in potential. This decision is currently under review. Therefore, well 299-W7-4 is currently not being sampled for RCRA parameters or constituents (other than water levels) and has been removed from the monitoring network. However, the well may be put back into the network pending resolution of safety issues associated with access for sampling.

One analyte has been removed from the LLWMA-3 analyte list. Reduction-oxidation potential was removed because the measurement is unreliable in the field. Mercury and lead have been removed from the analyte list because 20 years of monitoring for the constituents has shown that neither is a problem at LLWMA-3.

Groundwater quality parameter sampling frequency has been changed from semiannual to annual, which remains in compliance with 40 CFR 265.92(d)(1).

# 4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for LLWMA-3.

## 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 indicator evaluation monitoring is to determine if LLWMA-3 has affected groundwater quality beneath the site. For most RCRA treatment, storage, and disposal facilities 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 using a statistical method that compares mean concentrations of the four general contamination indicator parameters (i.e., TOC, TOX, pH, and specific conductance) in downgradient wells to background levels obtained from upgradient wells. Currently there are no upgradient wells at LLWMA-3, so statistical comparisons are not made for this LLWMA.

When statistical comparisons become applicable again in the future, the basic procedure is as follows. For each of the four indicator parameters, the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored, and then compare these results with the initial background arithmetic mean. The comparison must consider each of the individual wells in the monitoring system and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (and decreases, in the case of pH) over initial background. Implementation of the statistical test method at the Hanford Site, including at LLWMA-3, is described in further detail in *Hanford Site Groundwater Monitoring: Setting, Sources, and Methods* (PNNL-13080); *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site* (WHC-SA-1124-FP); and *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 530-R-09-007).

If comparisons for an upgradient well show a significant increase (or pH decrease), the information must be submitted in the Hanford Site annual groundwater report. If the comparisons for a downgradient well show a significant increase (or pH decrease), then 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. In addition, the original samples may be re-analyzed if laboratory error is suspected.

If the exceedance of the statistical comparison value is confirmed by resampling, written notice is then provided to the regional administrator within 7 days that the facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program must be developed and submitted. In some instances, it is possible to immediately determine that the statistical finding is not the result of contamination from the facility. In that case, the regional administrator is notified and an assessment program is not instituted.

## 4.3 Interpretation

After the data are validated and verified, acceptable data are used to interpret groundwater conditions at LLWMA-3. Interpretive techniques include the following:

- Hydrographs: Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- Water table maps: Use of 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 groundwater flow directions.
- Plume maps: Mapped distributions of chemical constituent concentrations in the aquifer to determine the extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- Contaminant ratios: Can sometimes be used to distinguish among different sources of contamination.

## 4.4 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an 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-3 may change in the future due to discharges at the State-Approved Land Disposal Site (north of the LLWMA) or changes in extraction and injection associated with the 200-ZP-1 OU pump-and-treat system. The 200-ZP-1 pump-and-treat system is currently being expanded and is expected to begin operations in late 2011. The expansion has delayed proposing new monitoring well construction until after the anticipated large effects of the expanded pump-and-treat system are measured. However, an evaluation is underway to site an upgradient well, near mixed waste Trenches 31 and 34 that would be functional even with the impact of the expanded 200-ZP-1 pump-and-treat system. Any new RCRA wells needed at LLWMA-3 will be negotiated and prioritized by Ecology, DOE, and EPA and approved in accordance with Tri-Party Agreement (Ecology et al. 1989) Milestone M-24-00.

Water-level measurements will be collected before each sampling event. A more comprehensive set of water-level measurements is made in the northern portion of the 200 West Area during March of each year, and the data are presented in the annual groundwater monitoring report (e.g., DOE/RL-2008-66).

## 4.5 Reporting and Notification

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

# 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, "Ground-Water Monitoring."

40 CFR 265.90, "Applicability."

40 CFR 265.91, "Ground-Water Monitoring System."

40 CFR 265.92, "Sampling and Analysis."

40 CFR 265.93, "Preparation, Evaluation, and Response."

40 CFR 265.94, "Recordkeeping and Reporting."

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

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# Appendix A

# Quality Assurance Project Plan

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# Terms

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

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# A Quality Assurance Project Plan

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

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

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

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *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) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

## A1 Project Management

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

### A1.1 Project/Task Organization

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

#### A1.1.1 Regulatory Project Manager

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

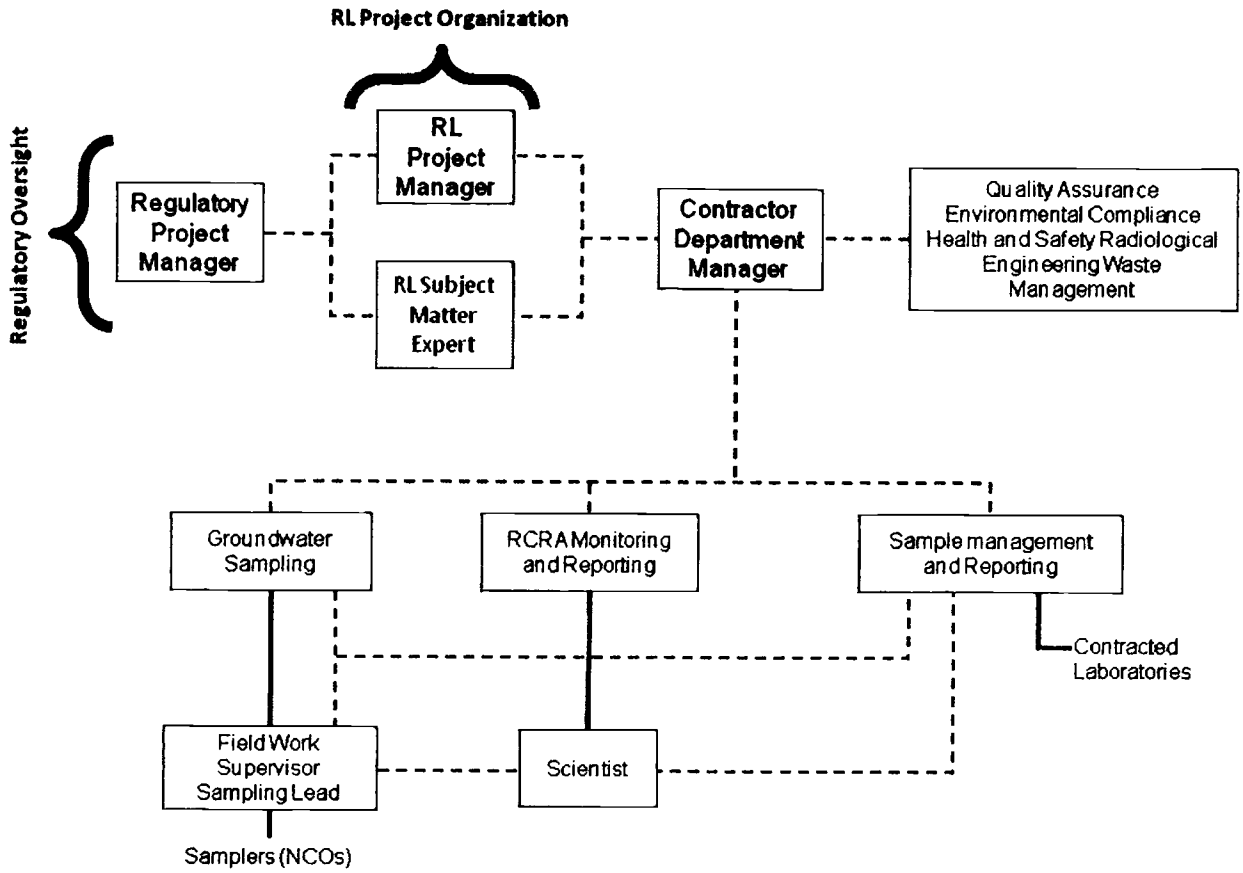


**Figure A-1. Project Organization**

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

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

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

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

### A1.1.4 Contractor Groundwater Remediation Department Manager

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

### A1.1.5 Groundwater Sampling Operations

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

### A1.1.6 RCRA Monitoring and Reporting

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

### A1.1.7 Sample Management and Reporting Organization

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

### A1.1.8 Contract Laboratories

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

### A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project 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.

### A1.1.10 Environmental Compliance Officer

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

### A1.1.11 Health and Safety

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

### A1.1.12 Waste Management

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

## A1.2 Problem Definition/Background

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

## A1.3 Project/Task Description

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

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

## A1.4 Quality Objectives and Criteria

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

## A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility of collecting and transporting groundwater samples according to the Dangerous Waste Training Plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

## A1.6 Documents and Records

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

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

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements therein.

**Table A-1. Actions and Documentation for Regulatory Notification**

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

Notes:

RCRA = *Resource Conservation and Recovery Act of 1976*

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

# A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

## A2.1 Sampling Process Design (Experimental Design)

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

### A2.1.1 Regulatory Requirements

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

### A2.1.2 Judgmental Sampling

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

## A2.2 Sampling Methods

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

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

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

## A2.3 Sample Handling and Custody

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

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

Sample custody during laboratory analysis is addressed in the applicable laboratory's 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.

## A2.4 Analytical Methods

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

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Contamination Indicator Parameters** | | | |
| Total organic carbon | G/P, HCL to pH <2 | SW-846[d] Method 9060 | 1,000 |
| Total organic halides | G, $H_2SO_4$ to pH <2, no head space | SW-846[d] Method 9020 | 20 |
| **Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered/Filtered** | | | |
| Calcium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e] | 1,000 |
| Cadmium | | | 5 |
| Sodium | | | 500 |
| Manganese | | | 5 |
| Potassium | | | 4,000 |
| Iron | | | 50 |
| Magnesium | | | 750 |
| **Anions by Ion Chromatography** | | | |
| Bromide | P | EPA/600 Method 300.0[f] | 250 |
| Chloride | | | 200 |
| Fluoride | | | 500 |
| Nitrate | | | 250 |
| Nitrite | | | 250 |
| Phosphate | | | 500 |
| Sulfate | | | 500 |
| **Other** | | | |
| Alkalinity | G/P | Standard Method[g] 2320, EPA/600 Method 310.1, EPA/600 Method 310.2 | 5,000 |
| Conductivity, field | Field measurement | Instrument/meter | 1 µohm |
| Dissolved oxygen, field | Field measurement | Instrument/meter | 0 mg/L |
| pH, field measurement | Field measurement | Instrument/meter | 0.1 |
| Phenol | G | SW-846 Method 8040, SW-846 Method 8041, SW-846 Method 8270D | 5<br>5<br>10 |
| Temperature | Field measurement | Instrument/meter | |
| Turbidity, field measurement | Field measurement | Instrument/meter | 0.1 NTU |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|

Notes:

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

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

c. Detection limit units, unless otherwise indicated.

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

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

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

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

EPA = U.S. Environmental Protection Agency

NTU = nephelometric turbidity unit

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

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

## A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-3.

### A2.5.1 Field Quality Control Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and field sampling 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.

**Table A-3. Quality Control Samples**

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

Notes:

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

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

QC = quality control

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

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

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

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

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

### A2.5.2 Laboratory Quality Control Samples

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

### A2.5.3 Quality Control Requirements

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

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **General Chemical Parameters** | | | |
| Alkalinity<br>Conductivity<br>pH<br>Total organic carbon<br>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" |
| **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" |

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **Metals** | | | |
| ICP metals<br>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" |

Notes:

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

b. Does not apply to pH.

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

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

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

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

Data flags:

C = possible laboratory contamination (analyte was detected in the associated method blank)

N = result may be biased (associated matrix spike result was outside the acceptance limits)

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

Abbreviations:

CRDL = contract-required detection limit
DUP = laboratory matrix duplicate
EB = equipment blank
FTB = full trip blank
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
LCS = laboratory control sample
MB = method blank
MDA = minimum detectable activity
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
QC = quality control
RPD = relative percent difference

**Table A-5. Blind Standard Constituents and Schedule**

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

Notes:

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

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

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

RSD = relative standard deviation

TOC = total organic carbon

TOX = total organic halides

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.

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

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

## A2.7 Instrument/Equipment Calibration and Frequency

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

## A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support 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.

## A2.9 Non-Direct Measurements

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

## A2.10 Data Management

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

All field activities will be recorded in the field logbook.

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution of the errors

with the RCRA Monitoring and Reporting manager. Sample disposition records become a permanent part of the analytical data package for future reference and for records management.

# A3 Assessment and Oversight

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

## A3.1 Assessments and Response Actions

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

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

## A3.2 Reports to Management

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

# A4 Data Validation and Usability

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

## A4.1 Data Review, Verification, and Validation

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

## A4.2 Verification and Validation Methods

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

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

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

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

## A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

# A5 References

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DOE/RL-2009-69
Revision 0

# Interim Status Groundwater Monitoring Plan for the LLBG WMA-4

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

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# Executive Summary

The Low-Level Waste Management Area 4 (LLWMA-4), which consists of the 218-W-4B and the 218-W-4C Burial Grounds, is regulated via Washington State's "Hazardous Waste Management Act"[1] and its implementing requirements in *Washington Administrative Code* (WAC) 173-303-400.[2] The Washington State Department of Ecology has been authorized by the U.S. Environmental Protection Agency[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976*.[4]

This document supersedes PNNL-14859,[5] as revised in interim change notices PNNL-14859-ICN-1[6] and PNNL-14859-ICN-2,[7] to incorporate changes that have occurred at LLWMA-4 and to incorporate changes to the monitoring program resulting from transfer of the groundwater monitoring workscope from Pacific Northwest National Laboratory to the Soil and Groundwater Remediation Project.

This document describes the groundwater monitoring plan for LLWMA-4. The plan addresses the following:

- Number, locations, and depths of wells in the LLWMA-4 groundwater monitoring network
- Sampling and analytical methods for groundwater parameters and hazardous wastes or hazardous waste constituents
- Procedures for evaluating groundwater quality information
- Schedule for groundwater monitoring at the LLWMA

---

1 RCW 70.105, "Hazardous Waste Management Act," *Revised Code of Washington*.

2 WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*.

3 *Authorized State Hazardous Waste Programs*, 42 U.S.C. 6926, et seq.

4 *Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901, et seq.

5 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.

6 PNNL-14859-ICN-1, 2006, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 1, Pacific Northwest National Laboratory, Richland, Washington.

7 PNNL-14859-ICN-2, 2007, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 2, Pacific Northwest National Laboratory, Richland, Washington.

This indicator monitoring plan is the principal controlling document for conducting groundwater monitoring at LLWMA-4.

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# Terms

| | |
|---|---|
| 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 |
| LLW | low-level waste |
| LLWMA | low-level waste management area |
| OU | operable unit |
| PFP | Plutonium Finishing Plant |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| RCW | *Revised Code of Washington* |
| SVOC | semivolatile organic compound |
| Tri-Party Agreement | *Hanford Federal Facility Agreement and Consent Order* |
| TOC | total organic carbon |
| TOX | total organic halides |
| TPH | total petroleum hydrocarbon |
| TRU | transuranic |
| VOC | volatile organic compound |
| WAC | *Washington Administrative Code* |

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# 1 Introduction

Low-Level Waste Management Area 4 (LLWMA-4) is located in the 200 West Area of the Hanford Site (Figure 1-1). The LLWMA-4 consists of the 218-W-4B and the 218-W-4C Burial Grounds, which contain 28 unlined trenches that were used for waste disposal. The 218-W-4B Burial Ground also contains 12 below-grade caissons at the southern end of the facility. The LLWMA-4 was used for disposal of low-level radioactive and low-level mixed wastes beginning in 1967. The caissons in the 218-W-4B Burial Ground contain remote-handled, low-level waste (LLW) and retrievable transuranic (TRU) waste. The dangerous chemicals in the low-level mixed waste portions of LLWMA-4 are regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA), as modified in 40 *Code of Federal Regulations* (CFR) 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," and Washington State's "Hazardous Waste Management Act" (*Revised Code of Washington* [RCW] 70.105) and its implementing requirements in Washington State's dangerous waste regulations (*Washington Administrative Code* [WAC] 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards").

The objectives for indicator evaluation monitoring, as required by 40 CFR 265.92(d), "Sampling and Analysis," are to determine the following:

- Concentrations of specified groundwater quality parameters annually
- Concentrations of groundwater contamination indicator parameters semiannually
- Annual elevation of the water table

The scope of this plan is to obtain the necessary groundwater data to reach the above 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*) to include several activities that have occurred at LLWMA-4 since that plan was written. Chapter 2 summarizes background information, with reference to other documents for detail. Chapter 2 also describes the LLWMA and the types of waste present, provides a brief history of groundwater monitoring, and describes the geology and hydrology pertinent to LLWMA-4. 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. Appendix A provides the quality assurance project plan (QAPjP).

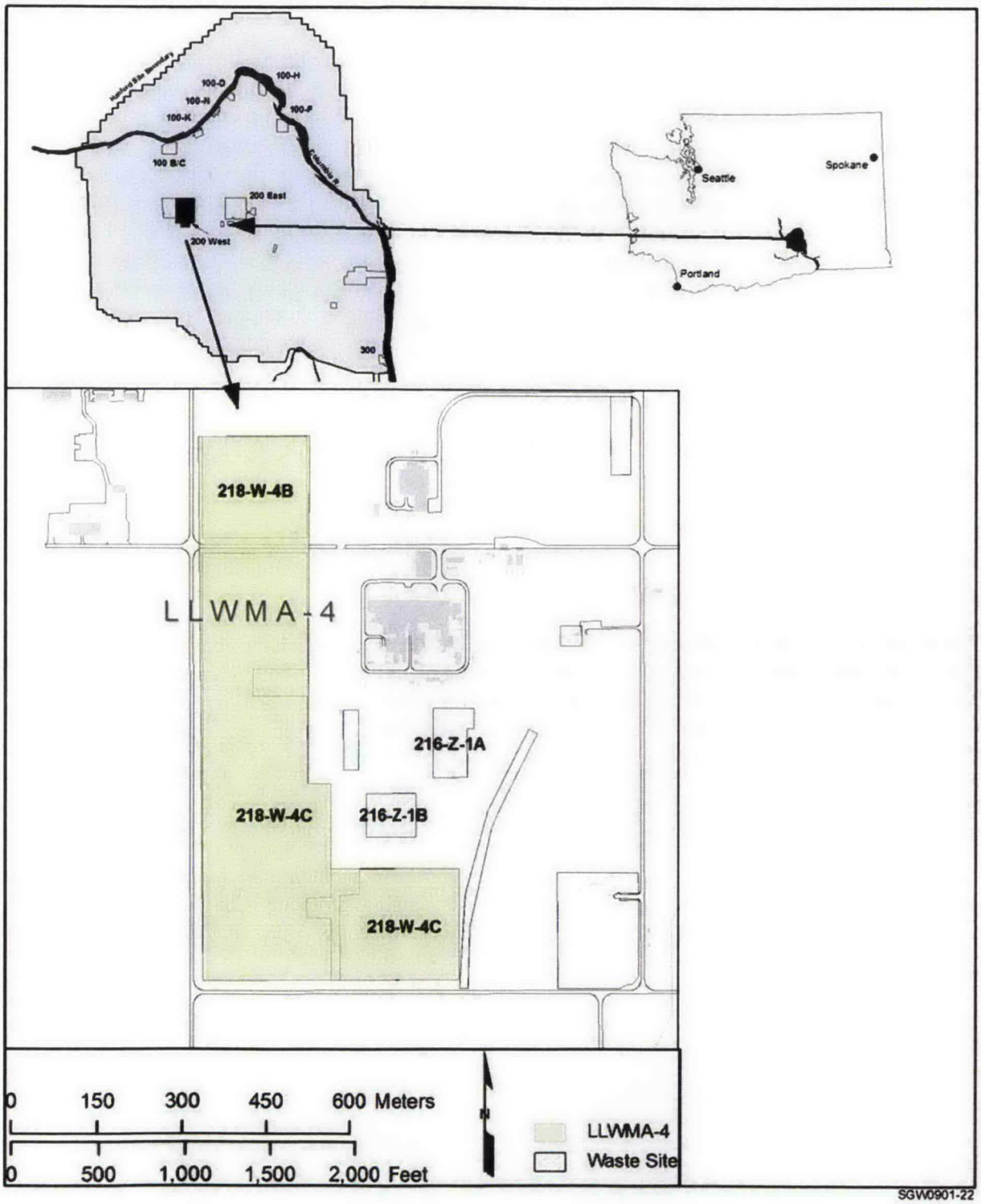


**Figure 1-1. Location Map for Low-Level Waste Management Area 4**

# 2 Background

This chapter describes the LLWMA-4 facility and operating history, the waste and waste characteristics associated with the LLWMA, the geology and hydrology local to the LLWMA, a summary of previous monitoring, the groundwater and vadose zone contamination at the LLWMA, and a conceptual model for the LLWMA. The discussion in this chapter is summarized from previous documents.

## 2.1 Facility Description and Operating History

The LLWMA-4 is located in the western portion of 200 West Area, west of the Plutonium Finishing Plant (PFP) and Waste Management Area U. The LLWMA-4 consists of the 218-W-4B and 218-W-4C Burial Grounds.

### 2.1.1 218-W-4B Burial Ground

The 218-W-4B Burial Ground began receiving waste in 1967. After August 19, 1987, RCRA and state-only designated, mixed LLW was not disposed to the 218-W-4B Burial Ground. It covers 4 ha (10 ac) and contains TRU and TRU mixed waste, some of which is contained in caissons (DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*).

The 218-W-4B Burial Ground is located in the central portion of the 200 West Area, about 150 m (500 ft) northwest of the 234-5Z Building and directly west of the 231-Z Building. It consists of 14 trenches (one trench contains 12 caissons, of which 4 caissons contain suspect TRU waste). The trenches are approximately 490 m (1,600 ft) long and 3.7 m (12 ft) deep.[8] The burial ground received miscellaneous radioactive waste from the 100, 200, and 300 Areas, as well as offsite waste shipments from 1967 to 1990 (a total of approximately 10,461 $m^3$ [13,682 $yd^3$] of waste). Solid waste disposed at the site consisted of rags, paper, cardboard, plastic, pumps, tanks, process equipment, and other miscellaneous high-dose-rate and TRU dry waste. The last waste trench at the 218-W-4B Burial Ground was closed in 1990 (DOE/RL-2004-60).

### 2.1.2 218-W-4C Burial Ground

The 218-W-4C Burial Ground began receiving waste in 1978. The 218-W-4C Burial Ground contains post-August 19, 1987, RCRA- and state-regulated mixed waste. It covers approximately 20 ha (50 ac) and contains TRU (some combustible) and test reactor fuel waste. The largest portion of the 218-W-4C Burial Ground is located west and southwest of the PFP, east of Dayton Avenue. A smaller section of the burial ground is located directly south of the PFP and north of 16th Street (DOE/RL-2004-60).

The 281-W-4C Burial Ground is designed to contain up to 65 trenches, including the following:

- Forty-eight trenches run east-west:
  - Twenty-four trenches are 184 m (602 ft) long
  - Nineteen trenches are 220 m (719 ft) long
  - Four trenches are 180 m (594 ft) long
  - One trench is 91 m (300 ft) long

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8 Based on Hanford Site drawing H-2-33055, *Dry Waste Burial Ground 218-W-4B*.

- Seventeen trenches at the 281-W-4C Burial Ground run north-south:
  - Fourteen trenches are 200 m (665 ft) long
  - Three trenches are 155 m (508 ft) long

Only 15 trenches, ranging from 91 to 219 m (300 to 719 ft) long, have been used for waste storage and/or disposal.

The 218-W-4C Burial Ground began accepting packaged waste materials from 200 West Area operations, other Hanford Site areas, and offsite sources in 1974. According to records, the 218-W-4C Burial Ground contains approximately 20,473 $m^3$ (26,777 $yd^3$) of low-level, TRU, and mixed waste. The TRU waste has been segregated from other burial ground waste since 1970 and was placed in separate burial trenches and/or areas of burial trenches where the packages are retrievably stored. In 2004, the last open trench at the 218-W-4B Burial Ground was closed (DOE/RL-2004-60).

## 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-4. Groundwater monitoring is conducted at LLWMA-4 in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F, "Ground-Water 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-4 was initiated in 1987 (WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*) based on the interim status monitoring requirements of 40 CFR 265, Subpart F and WAC 173-303-400, and the groundwater monitoring program continues today.

Groundwater monitoring is conducted at LLWMA-4 in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F), 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-4 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.

Between 1989 and January 2009, groundwater monitoring was conducted under an indicator evaluation monitoring program. In January 2009, a groundwater quality assessment program was initiated at LLWMA-4 (SGW-40211, *First Determination RCRA Groundwater Quality Assessment Plan for the Low-Level Burial Grounds Low-Level Waste Management Area 4*) due to elevated total organic carbon (TOC) in one downgradient well (299-W15-224). In March 2009, the groundwater was sampled from wells 299-W15-224, 299-W15-30, and 299-W15-83 and analyzed for coliform bacteria, oil and grease, chemical oxygen demand, total petroleum hydrocarbons (TPHs) (gasoline, diesel, kerosene), pesticides, herbicides, dioxins, polychlorinated biphenyls, and the 40 CFR 264, Appendix IX ("Standards for Owners

and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring List") list of volatile organic analyses and semivolatile organic analyses. In July 2009, the results of the March sampling did not find dangerous waste in the groundwater at LLWMA-4, and monitoring at the LLWMA returned to indicator evaluation monitoring.

## 2.3 Waste Characteristics

The waste characteristics for the 218-W-4B and 218-W-4C Burial Grounds are discussed below.

### 2.3.1 218-W-4B Burial Ground

The 218-W-4B Burial Ground received shipments described as miscellaneous, solid, radioactive mixed waste from several sources on the Hanford Site, including the 100-C, 100-N, 200 West, and 300 Areas. The waste disposed in the burial ground included rags, paper, rubber gloves, disposable supplies, and broken tools. The 12 caissons at the south end of the facility contain remote-handled, retrievable TRU and alpha LLW. Two trenches are also filled with retrievable TRU and TRU mixed waste. The 218-W-4B Burial Ground did not receive any post-August 19, 1987, RCRA- and state-only designated mixed LLW.

### 2.3.2 218-W-4C Burial Ground

The 218-W-4C Burial Ground started receiving waste in 1978. It covers ~23 ha (57 a) and contains TRU (some combustible) and test reactor fuel waste (DOE REG-0271, *Low-Level Burial Grounds Fact Sheet*).

The 218-W-4C Burial Ground began accepting packaged waste materials from 200 West Area operations, other Hanford Site areas, and from offsite sources in 1974 (based on information from the Waste Information Data System database). According to burial records, the 218-W-4C Burial Ground contained approximately 21,916 $m^3$ (28,665 $yd^3$) of low-level, TRU, and mixed waste. The TRU waste has been segregated from other landfill waste since 1970 and placed in separate burial trenches and/or areas of burial trenches, where the packages also were retrievably stored.

Trenches 1, 4, 7, 20, and 29, and the east end of Trench 24, contained retrievably stored suspect TRU waste. Trenches NC, 14, 19, 23, 28, 33, 48, 53, and 58 and the remainder of Trench 24 received buried LLW. In addition, some of the waste in Trenches NC, 14, and 58 currently is identified as mixed LLW and was disposed after the effective date of mixed waste regulation at the Hanford Site (August 19, 1987).

The northernmost trench (Trench NC) contains a number of core barrels originating from the U.S. Department of the Navy. Trench 1 contains drums generated from mining the 216-Z-9 Crib/Trench and approximately 500 cans of ash received in the early 1980s. The ash was generated by the 232-Z Waste Incinerator Facility, which incinerated miscellaneous waste (e.g., rubber gloves, rags, paper, spent solvent, and cutting oils).

Trench 7 is at the location of a former waste site. The Z Plant Burning Pit was a disposal site for combustible nonradioactive construction, office, and nonhazardous laboratory waste, including unnamed chemicals. The burning pit is reported to have received 2,000 $m^3$ (2,600 $yd^3$) of waste for burning, including less than 1,000 $m^3$ (1,300 $yd^3$) of laboratory chemicals. The burning pit was 15 m (50 ft) long, 12 m (40 ft) wide, and 3 m (10 ft) deep. The burning pit was used from 1950 to 1960.

The waste in the 218-W-4C Burial Ground is mainly from the 200 West Area (24 percent by volume), the 100 Area (12 percent), the 300 Area (9 percent), and offsite generators (47 percent). The remaining 8 percent is from miscellaneous Hanford Site areas and the tank farms. The eastern annex portion of this unit never received waste (DOE/RL-2004-60).

## 2.4 Geology and Hydrogeology

The geology and hydrology of the 200 West Area, including the area of LLWMA-4, has been described in detail in the following documents:

- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report*
- PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*
- PNNL-16887, *Geologic Descriptions for the Solid Waste Low-Level Burial Grounds*
- WHC-SD-EN-AP-015, *Revised Ground Water Monitoring Plan for the 200 Areas Low – Level Burial Grounds, DOE Directed Release*
- WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds*

The following discussion summarizes descriptions from these documents. The uppermost aquifer and aquifers hydraulically interconnected beneath the LLWMA are also discussed.

The LLWMA-4 is underlain from the ground surface to the top of the basalt by the Hanford formation, the Cold Creek unit, and the Ringold Formation. The vadose zone beneath LLWMA-4 is approximately 68 to 76 m (223 to 249 ft) thick and consists of the Hanford formation, the Cold Creek unit, the Taylor Flats member of the Ringold Formation, and the upper portion of Unit E of the Wooded Island member of the Ringold Formation. The water table is at approximately 136 to 137 m (446 to 449 ft) in elevation and is entirely within the Ringold Unit E. The Ringold lower mud unit is present everywhere beneath the LLWMA-4 and forms the bottom of the unconfined aquifer. The saturated thickness of the unconfined aquifer is approximately 69 m (226 ft) in the south (at well 299-W18-22) and 59 m (194 ft) in the north (at well 299-W15-17). The thickness of the aquifer, as well as the groundwater flow direction and flow rate, are influenced by the 200-ZP-1 Operable Unit (OU) pump-and-treat system injection wells to the west of the LLWMA and the extraction wells located northeast of the LLWMA.

Water levels in the unconfined aquifer increased as much as approximately 25 m (82 ft) above the pre-Hanford natural water table in the area of U Pond (about 325 m [1,066 ft] south of LLWMA-4) due to artificial recharge from liquid waste disposal operations active between the mid-1940s and 1995. The height of the water table mound beneath LLWMA-4 was at least 18 m (59 ft) above the pre-Hanford elevation, as indicated by water levels from well 699-39-79 (located just west of the LLWMA).

Discharges to U Pond and other disposal facilities from the 1940s through the 1970s changed the groundwater flow direction beneath the LLWMA from eastward (the pre-Hanford direction) to a north or northwest direction. The groundwater flow direction has more recently returned to the pre-Hanford eastward direction, which can be attributed to (1) the groundwater mound beneath U Pond dissipating as a result of cessation of discharges to U Pond, (2) the influence of the 200-ZP-1 OU pump-and-treat system extraction wells east of LLWMA-4, and (3) the injection wells west of the LLWMA reinforcing eastward movement of groundwater in the area.

The hydraulic conductivity in the unconfined aquifer beneath LLWMA-4 is on the order of 10 to 25 m/day (32.8 to 82 ft/day), and the hydraulic gradient is approximately 0.004. Using these values and assuming an average effective porosity of aquifer materials between 0.1 and 0.3, the groundwater flow rate is calculated at 0.13 to 1 m/day (0.43 to 3.28 ft/day). Figure 2-1 provides a current water table map for LLWMA-4.

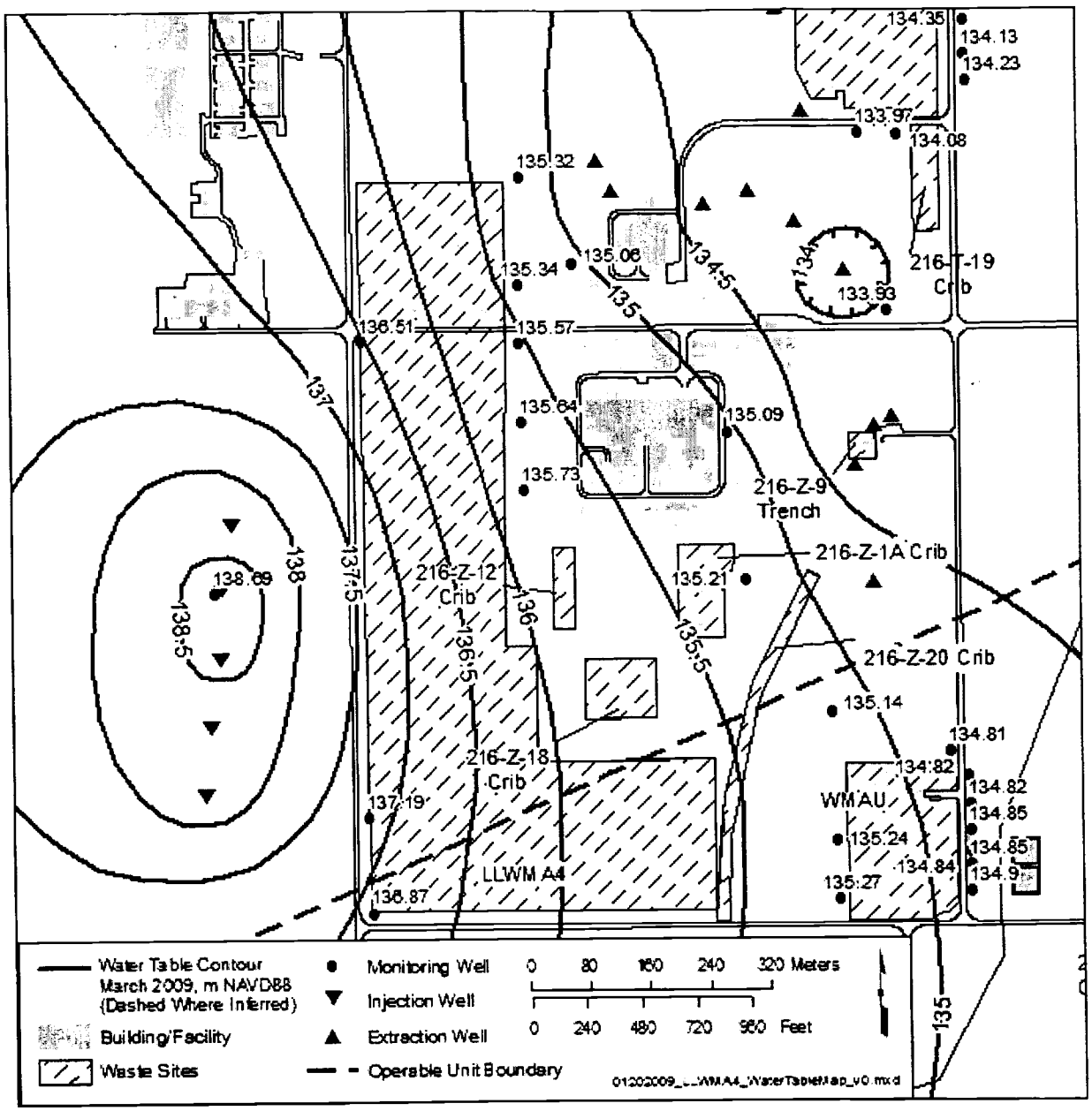


**Figure 2-1. Water Table Map for Low-Level Waste Management Area 4, March 2009**

## 2.5 Summary of Previous Groundwater Monitoring

Monitoring wells were installed at LLWMA-4 between 1987 and 1992. The original monitoring network included 17 wells. One well, 299-W18-29, was completed in a perched aquifer but went dry soon after it was drilled. Sampling at LLWMA-4 was suspended for a period in fiscal years1990 and 1991. Groundwater flow was toward the west at the beginning of RCRA monitoring, but the hydraulic gradient altered dramatically with termination of discharges to U Pond and other facilities. The initiation of the 200-ZP-1 OU pump-and-treat groundwater remediation also impacted groundwater flow and quality at LLWMA-4. The monitoring network was updated in 1998 to redefine the upgradient and downgradient wells. Four shallow wells were chosen to monitor upgradient conditions, and three shallow wells were

chosen to monitor downgradient of the burial ground. In addition, one deep upgradient well and one shallow upgradient well remained in the monitoring network. Since that time, two additional upgradient wells have gone dry (299-W15-15 and 299-W18-23). After the monitoring network was updated in 1998 to reflect the changing flow directions, newly designated downgradient well 299-W15-16 exceeded the statistical comparison value for total organic halides (TOX). The exceedance was attributed to the regional carbon tetrachloride plume that moved into the area under previous flow conditions. This exceedance was first reported to Ecology in August 1999. The TOX values continue to exceed the critical mean value at LLWMA-4.

The LLWMA-4 is affected by regional volatile organic compound (VOC) contamination, and the northern portion is within the capture zone of the 200-ZP-1 OU interim action pump-and-treat system. Carbon tetrachloride is the major contaminant in the plume, but chloroform, trichloroethene, tetrachloroethene, and nitrate are also present.

The TOC concentration exceeded the critical mean of 790 µg/L in well 299-W15-224, with a concentration between 1,090 and 1,300 µg/L in August 2008. This was the first time that the well had exceeded the critical mean for TOC. The well was resampled, and the new results available in November 2008 were 2,100 and 2,200 µg/L, again exceeding the critical mean. A request was then submitted to resample the well and analyze for an extensive list of VOCs, semivolatile organic compounds (SVOCs), and TPHs to identify the cause of elevated TOC. The resampling event occurred in December 2008, and the results received in January 2009 indicted that no organic compounds were identified that would account for the elevated TOC.

In January 2009, the Soil and Groundwater Remediation Project notified DOE and other CH2M HILL Plateau Remediation Company organizations regarding the elevated TOC concentration at LLWMA-4, and DOE then notified Ecology. The project also prepared a groundwater quality assessment plan to evaluate the elevated TOC, which proposed sampling wells 299-W15-224, 299-W15-30, and 299-W15-83 for analysis of 40 CFR 264, Appendix IX organic constituents and other constituents potentially responsible for elevated TOC.

Prior to assessment sampling, the pump was removed from well 299-W15-225 and a camera survey was completed to determine if there were any anomalies in the well. Nothing out of the ordinary was noted during the camera survey, the pump was replaced, and samples were collected on March 15 and 16, 2009. The samples were analyzed for 40 CFR 264, Appendix IX list of VOC and SVOC compounds, TOX, chemical oxygen demand, oil and grease, phenols, pesticides, herbicides, polychlorinated biphenyls, dioxans, dissolved oxygen, TPH (diesel, gasoline, and kerosene), and coliform bacteria. In July 2009, the results of the first determination did not find dangerous waste in the groundwater at LLWMA-4, and monitoring at the LLWMA returned to indicator evaluation monitoring.

## 2.6 Conceptual Model

This section describes the LLWMA-4 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/year [2 to 3.9 in./year]) 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 sources 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, chemical nature of the waste constituents, and natural subsurface geochemical conditions.

Pore fluid in the unsaturated and saturated zones beneath LLWMA-4 is slightly alkaline ($7 < pH < 8$), with appreciable amounts of bicarbonate and very little natural organic material. The lack of organic matter means 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 (e.g., uranium) and favor 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., WHC-EP-0645, *Performance Assessment of the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*; and PNNL-11800, *Composite Analysis of Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*).

### 2.6.2 Soil Moisture Factors

With the exception of 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 subsequent transport to groundwater. Contaminants in the 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 by the amount 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-4 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 amount of vegetation exists on the established backfilled areas and on unused portions of the LLWMA. A coarse, nonvegetated cover material allows a major fraction of the precipitation to infiltrate and potentially drain to groundwater. In "Hanford Site Vadose Zone Studies: An Overview" (Gee et al. 2007), it is estimated that recharge rates at the Hanford Site range from near zero at highly vegetated sites to greater than 50 mm/year at gravel-covered, nonvegetated sites.

### 2.6.3 Hydrogeologic Considerations

The vadose zone beneath LLWMA-4 is between 68 and 76 m (223 and 249 ft) thick and consists of (from top to bottom) the Hanford formation, the Cold Creek Unit, and the Ringold Formation. The Cold Creek unit is likely to retard downward movement of moisture and contaminants due to the finer textured sediment and cementing that characterize this stratigraphic feature in the vadose zone.

If contaminants do break through to groundwater beneath LLWMA-4, contaminants would move toward the east-northeast. The flow direction has shifted from nearly north to northeast and is slowly changing eastward as the influence of the groundwater mound subsides. Also, because of the low permeability of the aquifer in this area, groundwater flow rate is estimated to be between about 0.04 to 50 m/year (0.13 to 164 ft/year).

As the 200-ZP-1 OU pump-and-treat system is expanded to add extraction and injection wells to provide greater capacity, the pump-and-treat system may impact groundwater levels and gradients beneath LLWMA-4. After the system is completed and operating, groundwater-level data will be evaluated. Any hydrologic and hydrogeologic impacts that occur based on the operation of the pump-and-treat system will be reported and incorporated into the monitoring program.

## 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.

**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 ground-water monitoring at sites where no impact to ground-water 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 WAC 173-303-400(3)(c)(v). | |
| Number and location of wells<br>Point(s) of compliance | **40 CFR 265.91 Ground-Water Monitoring System.**<br>(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:<br>(1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are:<br>(i) Representative of background ground-water quality in the uppermost aquifer near the facility; and<br>(ii) Not affected by the facility; and | This plan, Section 3.2<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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 |
|---|---|---|
| | **40 CFR 265.91 Ground-Water Monitoring System. (cont'd)**<br>(2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the waste management area to the uppermost aquifer. | |
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91 Ground-Water Monitoring System, as modified by WAC 173-303-400.**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional Requirements from WAC 173-303-400(3)(c)(v)(C).**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells. | This plan, Section 3.2<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>PNNL-14859-ICN-2 |
| Frequency of sampling<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision | **40 CFR 265.92 Sampling and Analysis.**<br>(b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section:<br>(1) Parameters characterizing the suitability of the ground-water as a drinking water supply, as specified in Appendix III.<br>*[NOTE: Have not listed these because, in accordance with 40 CFR 265.92(c)(1), these analyses are only conducted for the first year, and this site is not in the first year of monitoring.]* | This plan, Section 3.1 and Appendix A<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>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 |
|---|---|---|
| | **40 CFR 265.92 Sampling and Analysis. (cont'd)**<br>(2) Parameters establishing ground-water quality:<br>(i) Chloride<br>(ii) Iron<br>(iii) Manganese<br>(iv) Phenols<br>(v) Sodium<br>(vi) Sulfate<br>*[COMMENT: These parameters are to be used as a basis for comparison in the event a groundwater quality assessment is required under 40 CFR 265.93(d).]*<br>(3) Parameters used as indicators of ground-water contamination:<br>(i) pH<br>(ii) Specific conductance<br>(iii) Total organic carbon<br>(iv) Total organic halogen<br>(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. The owner or operator must do this quarterly for one year.<br>(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.<br>(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:<br>(1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually.<br>(2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semiannually.<br>(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained. | |

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

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Methods used to evaluate the collected data | **40 CFR 265.93 Preparation, Evaluation, and Response.**<br>(b) For each indicator parameter specified in 40 CFR 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 40 CFR 265.92(d)(2) and compare these results with the 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 and Appendix A<br>PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*<br>PNNL-14859-ICN-1<br>PNNL-14859-ICN-2 |

Notes:

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

CFR = *Code of Federal Regulations*

DQO = data quality objective

RCRA = *Resource Conservation and Recovery Act of 1976*

WAC = *Washington Administrative Code*

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# 3 Groundwater Monitoring Program

This chapter lists the wells monitored, constituents analyzed, and sampling frequency. Protocols for sampling and analysis 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 RCRA. All wells are to be sampled semiannually and constituents are monitored semiannually or annually, as indicated in Table 3-1.

Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If a well is delayed more than 3 months, that event will be cancelled, as it would be nearly time for the next scheduled sampling event. Missed sampling events are reported in the annual groundwater report.

## 3.2 Monitoring Well Network

Figure 3-1 shows the groundwater monitoring well network for LLWMA-4. Table 3-1 lists the wells in the groundwater monitoring network, their constituents, and sampling frequencies. Some of the wells in the LLWMA-4 monitoring network are also sampled for the 200-ZP-1 OU. Sampling for LLWMA-4 and the 200-ZP-1 OU is coordinated to eliminate duplicate analyses and well trips.

Table 3-2 summarizes well construction information and provides the current water table elevation in each well. All of the wells in the LLWMA-4 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 (0.3 to 0.4 m/year [0.98 to1.31 ft/year]), only well 299-W18-21 is expected to go dry within the next 5 years, although continued injection of water upgradient of the well may extend the well's lifetime.

There is currently no true upgradient well at LLWMA-4. Well 299-W18-21 is listed as upgradient; however, since the injection wells have been used west of the LLWMA, flow direction is such that well 299-W18-21 is no longer upgradient. Four new downgradient wells were drilled in 2005 and 2006. Several alternatives are currently being considered regarding upgradient well compliance issues:

- Deepen existing wells upgradient of LLWMA-4: Four dry monitoring wells that have not yet been decommissioned are located along the western (upgradient) edge of LLWMA-4 and are candidates for deepening. The March 2008 depth to water is between approximately 76 m (249 ft) below ground surface at well 299-W15-15 and 67 m (221 ft) below ground surface at well 299-W18-21 (prior to the wells going dry). Thus, the dry wells located west of LLWMA-4 would need to be deepened as much as 7.6 m (25 ft) from original drilled depth to have about 6.1 m (20 ft) of water in the new screened interval.

- Identify one existing useable well upgradient: Only well 699-39-79 is a potential candidate for use as an upgradient well. The well is an old, perforated, carbon-steel well that is currently used for water-level measurements. There is no documentation regarding the surface casing, surface seals, or annual seals; therefore, the well is not WAC 173-160-compliant but it might be usable as a monitoring well after further evaluation and extensive well maintenance.

- Alternative statistics that do not require upgradient wells: The RCRA allows application of intrawell statistical methods for analysis of groundwater monitoring data at permitted facilities. These methods, allowable in accordance with WAC 173-303-645(8) ("Releases from Regulated Units"), include the use of a tolerance or prediction interval procedure (in WAC 173-303-645[8][h][ii])) and a control-chart approach (in WAC 173-303-645[8][h][iv]). These approaches may be applied without use of upgradient wells because each new analytical result from a downgradient well is compared to previously obtained results from the same well. For groundwater applications, procedures for both methods are discussed in EPA guidance (EPA/530-R-93-003, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Interim Final Guidance*, published in 1989; and EPA/530-R-93-003, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Draft Addendum to Interim Final Guidance* , published in 1992) and *Standard Guide for Developing Statistical Approaches for Ground-Water Detection Monitoring Programs* (ASTM D 6312-98).

- Temporary use of a new expanded 200 West Area pump-and-treat injection well: New injection well IW-6 is currently planned to be located on the west (downgradient) side of LLWMA-4.It may be feasible that when the well is drilled, it could be used as an upgradient monitoring wells until such time that it is needed for an injection well. The well is not scheduled to be drilled until 2012, but it may be possible to move the installation for well IW-6 to an earlier date. New injection well IW-7 is currently planned to be located on the east side (downgradient) of LLWMA-4, and this well is also scheduled for installation in 2012. Results of future modeling for the pump-and-treat system may result in moving well IW-7 further west, along the upgradient side of LLWMA-4.

## 3.3 Sampling and Analysis Protocol

Groundwater monitoring activities at LLWMA-4 follow the conventions of the project and are described in Chapter 4 and Appendix A.

## 3.4 Differences Between This Plan and Previous Plan

There are several differences between the wells and analytes monitored by this plan and the wells and analytes measured by the previous plan (PNNL-14859-ICN-2), including the following:

- Two wells that recently went dry (299-W15-15 and 299-W18-23) have been dropped from the network described in the previous plan.

- Two analytes, mercury and lead, have been dropped from the LLWMA-4 analyte list. Twenty years of monitoring for these constituents has shown that neither is a problem at the LLWMA.

- The sampling frequency for supporting parameters has been changed from semiannual to annual, which is still in compliance with 40 CFR 265.92(d)(1).

**Table 3-1. Sampling Schedule for Low-Level Waste Management Area 4**

| | | | RCRA Required Constituents[a] | | | | | | | | | | | | Supporting Constituents[b] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contamination Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | | |
| | | | | | | | | Anions[d] | | Metals (Filtered and Unfiltered)[d] | | | | | | | | |
| Well Name | Purpose | WAC Compliant | Water Level[c] | pH[c] | Specific Conductance[c] | Total Organic Carbon | Total Organic Halides | Chloride | Sulfate | Sodium | Iron | Manganese | Phenols[d] | Temperature[c] | Turbidity[c] | Dissolved Oxygen[c] | Alkalinity |
| 299-W15-17 | Downgradient | Y | S | S | S | S | S | A | A | A | A | A | A | S | S | S | S |
| 299-W15-30 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |
| 299-W15-83 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |
| 299-W15-94 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |
| 299-W15-152 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |
| 299-W15-224 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |
| 299-W18-21 | Upgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | S | S | S | S |
| 299-W18-22 | Upgradient | Y | S | S | S | S | S | A | A | A | A | A | A | S | S | S | S |

Notes:

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

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

c. Field measurement.

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

**Table 3-1. Sampling Schedule for Low-Level Waste Management Area 4**

| Well Name | Purpose | WAC Compliant | RCRA Required Constituents[a] | | | | | | | | | | | Supporting Constituents[b] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contamination Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | |
| | | | | | | | | Anions[d] | | Metals (Filtered and Unfiltered)[d] | | | | | | | |
| | | | Water Level[c] | pH[c] | Specific Conductance[c] | Total Organic Carbon | Total Organic Halides | Chloride | Sulfate | Sodium | Iron | Manganese | Phenols[d] | Temperature[c] | Turbidity[c] | Dissolved Oxygen[c] | Alkalinity |

A = sampled annually
CFR = *Code of Federal Regulations*
LLWMA = low-level waste management area
RCRA = *Resource Conservation and Recovery Act of 1976*
S = sampled semiannually
S4 = sampled semiannually, with quadruplicate samples taken
WAC = *Washington Administrative Code*
Y = well is constructed to the resource protection well standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

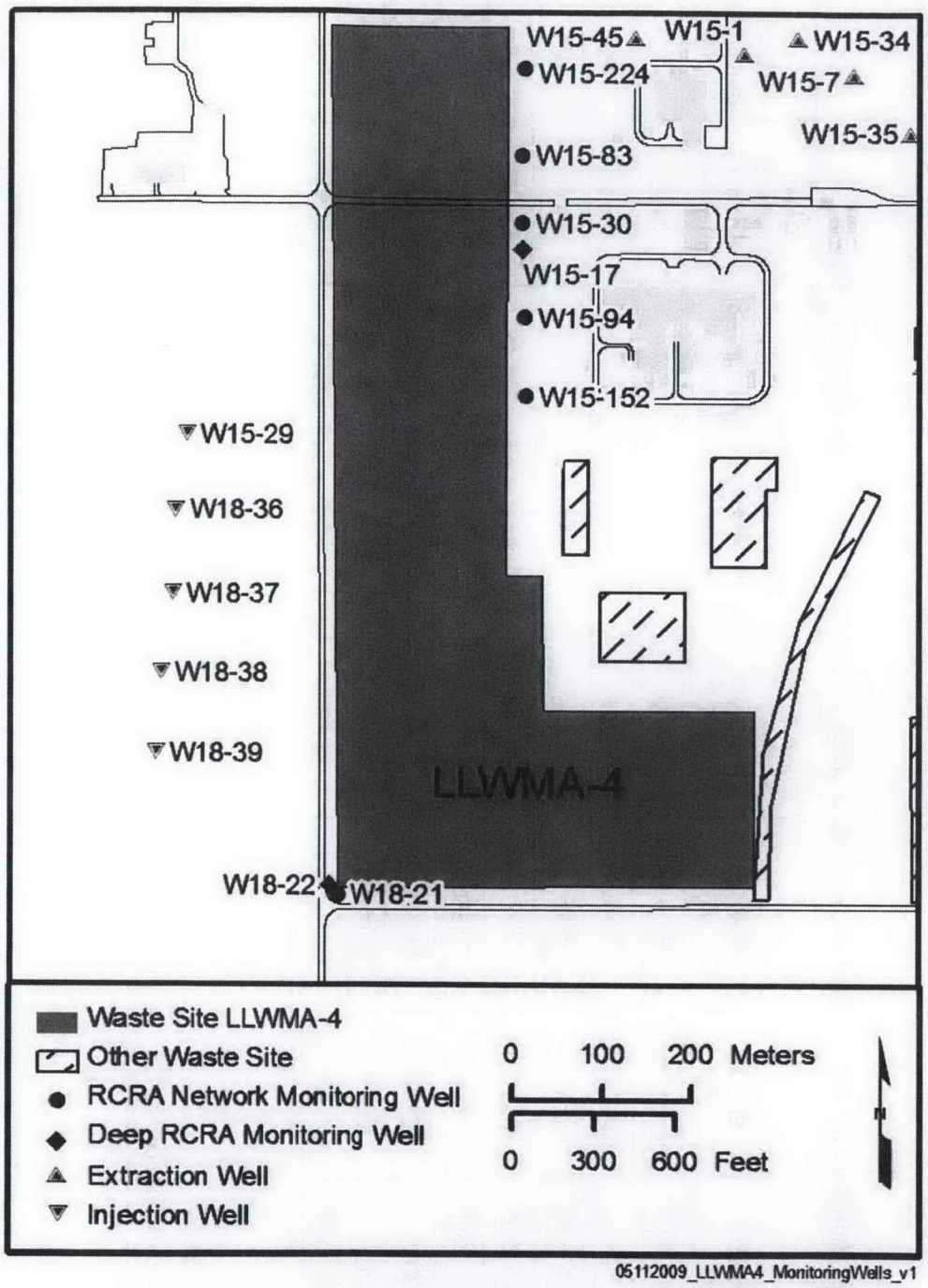


**Figure 3-1. Groundwater Monitoring Network for Low-Level Waste Management Area 4**

**Table 3-2. Attributes for Wells in the Low-Level Waste Management Area 4 Groundwater Monitoring Network**

| Well Name | Completion Date | Easting (m) | Northing (m) | Brass Survey Marker Elevation (m NAVD88) | Water Table Elevation (m amsl)* | Open Interval Top (m amsl) | Open Interval Bottom (m amsl) | Water Remaining (m) |
|---|---|---|---|---|---|---|---|---|
| 299-W15-17 | October 1987 | 566306.891 | 135718.958 | 209.24 | 135.57 | 79.33 | 76.33 | 59.24 |
| 299-W15-30 | May 1995 | 588304.617 | 135748.936 | 209.28 | 135.57 | 142.8 | 130.63 | 4.94 |
| 299-W15-83 | September 2005 | 566304.52 | 135826.24 | 208.95 | 135.32 | 137.33 | 126.66 | 8.66 |
| 299-W15-94 | September 2005 | 566307.58 | 135640.34 | 209.41 | 135.62 | 137.45 | 126.78 | 8.84 |
| 299-W15-152 | September 2005 | 566309.40 | 135550.00 | 209.414 | 135.72 | 137.46 | 126.79 | 8.93 |
| 299-W15-224 | April 2006 | 566307.89 | 135926.08 | 208.314 | 135.29 | 136.54 | 125.87 | 9.42 |
| 299-W18-21 | July 1987 | 566097.7 | 134978.692 | 204.25 | 136.87 | 143.39 | 134.25 | 2.62 |
| 299-W18-22 | September 1987 | 566088.632 | 134990.157 | 204.25 | 136.56 | 76.20 | 66.75 | 69.81 |

Notes:

* March 2009 water levels.

amsl = above mean sea level

NAVD88 = North American Vertical Datum of 1988

# 4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for LLWMA-4.

## 4.1 Data Review

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

## 4.2 Statistical Evaluation

Statistical upgradient and downgradient comparisons are required to test for potential impact to the groundwater at RCRA interim status facilities in accordance with 40 CFR 265.93, "Preparation, Evaluation, and Response." For each of the four indicator parameters, the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored, and compare these results with the initial background arithmetic mean. The comparison must consider each of the individual wells in the monitoring system and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (and decreases, in the case of pH) over initial background. Implementation of the statistical test method at the Hanford Site, including at LLWMA-4, is described in further detail in *Hanford Site Groundwater Monitoring: Setting, Sources, and Methods* (PNNL-13080); *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site* (WHC-SA-1124-FP); and *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities-Unified Guidance* (EPA 530-R-09-007).

If comparisons for an upgradient well show a significant increase (or pH decrease), the information must be submitted in the Hanford Site annual groundwater report. If the comparisons for a downgradient well show a significant increase (or pH decrease), then 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. In addition, the original samples may be re-analyzed if laboratory error is suspected.

If the exceedance of the statistical comparison value is confirmed by resampling, written notice is then provided to the regional administrator within 7 days that the facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program must be developed and submitted. In some instances, it is possible to immediately determine that the statistical finding is not the result of contamination from the facility. In that case, the regional administrator is notified and an assessment program is not instituted.

## 4.3 Interpretation

After data are validated and verified, acceptable data are used to interpret groundwater conditions at LLWMA-4. Interpretive techniques include the following:

- Hydrographs: Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- Water table maps: Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to 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 or radiological constituent concentrations in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement 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 include an annual evaluation of the groundwater monitoring network to determine if it remains adequate to monitor the LLWMA. The network must include upgradient and downgradient wells in the uppermost aquifer.

The groundwater flow direction beneath LLWMA-4 may change in the future due to increases or decreases in groundwater extraction and injection associated with the 200-ZP-1 OU pump-and-treat system. The 200-ZP-1 pump-and-treat system is currently being expanded and is expected to begin operations in late 2011. The expansion has delayed proposing new monitoring well construction until after the anticipated large effects of the expanded pump-and-treat system are measured. Any new RCRA wells needed at LLWMA-4 will be negotiated and prioritized by Ecology, DOE, and EPA and approved in accordance with Tri-Party Agreement (Ecology et al. 1989) Milestone M-24-00.

Water-level measurements will continue to be collected before each sampling event. A more comprehensive set of water-level measurements is made in the 200 West Area in March of each year. The resulting data presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

## 4.5 Reporting and Notification

The results of indicator evaluation monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2008-66).

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# Appendix A

# Quality Assurance Project Plan

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# Terms

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

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# A Quality Assurance Project Plan

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

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

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

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *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) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

## A1 Project Management

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

### A1.1 Project/Task Organization

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

#### A1.1.1 Regulatory Project Manager

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

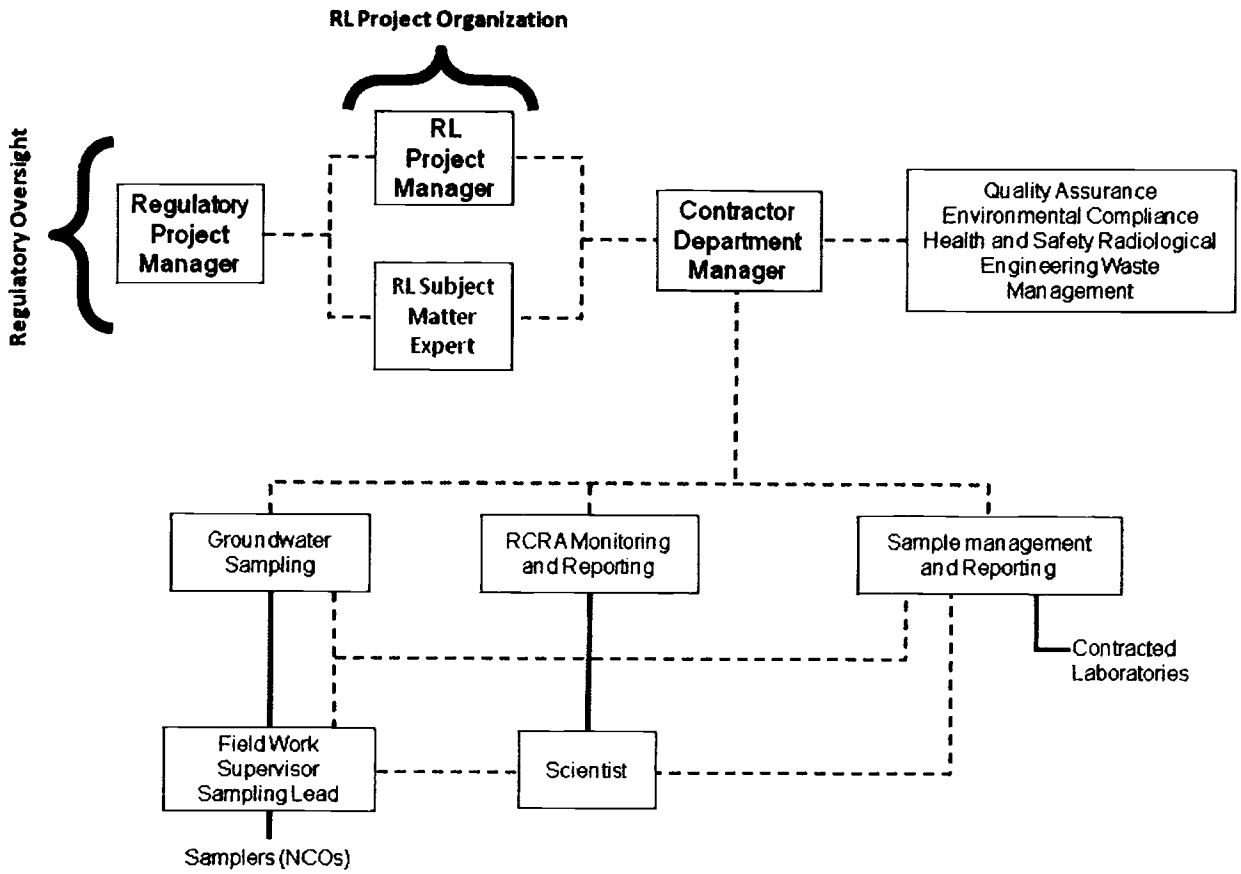


**Figure A-1. Project Organization**

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

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

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

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

### A1.1.4 Contractor Groundwater Remediation Department Manager

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

### A1.1.5 Groundwater Sampling Operations

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

### A1.1.6 RCRA Monitoring and Reporting

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

### A1.1.7 Sample Management and Reporting Organization

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

### A1.1.8 Contract Laboratories

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

### A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project 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.

### A1.1.10 Environmental Compliance Officer

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

### A1.1.11 Health and Safety

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

### A1.1.12 Waste Management

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

## A1.2 Problem Definition/Background

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

## A1.3 Project/Task Description

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

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

## A1.4 Quality Objectives and Criteria

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

## A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility of collecting and transporting groundwater samples according to the Dangerous Waste Training Plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

## A1.6 Documents and Records

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

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

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements therein.

**Table A-1. Actions and Documentation for Regulatory Notification**

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

Notes:

RCRA = *Resource Conservation and Recovery Act of 1976*

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

# A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

## A2.1 Sampling Process Design (Experimental Design)

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

### A2.1.1 Regulatory Requirements

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

### A2.1.2 Judgmental Sampling

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

## A2.2 Sampling Methods

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

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

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

## A2.3 Sample Handling and Custody

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

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

Sample custody during laboratory analysis is addressed in the applicable laboratory's 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.

## A2.4 Analytical Methods

Information on analytical methods is provided in Tables A-2 and A-3. 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 Continuing Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Contamination Indicator Parameters** | | | |
| Total organic carbon | G, HCl to pH <2 | SW-846 Method 9060 | 1,000 |
| Total organic halides | G, $H_2SO_4$ to pH <2, no headspace | SW-846 Method 9020 | 20 |
| **Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered/Filtered** | | | |
| Calcium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020, 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** | | | |
| Fluoride | P, none | EPA/600 Method 300.0[e] | 500 |
| Nitrate | | | 250 |
| Sulfate | | | 500 |
| Chloride | | | 200 |
| Nitrite | | | 250 |
| **Other** | | | |
| Temperature | Field measurement | Instrument/meter | – |
| Conductivity, field | N/A | Instrument/meter | 1 µohm |
| pH, field measurement | N/A | Instrument/meter | 0.1 |

Notes:

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

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

c. Detection limit units, except where indicated.

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

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

EPA = U.S. Environmental Protection Agency

N/A = not applicable

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Supporting Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Volatiles by Gas Chromatography/Mass Spectrometry** | | | |
| 1,1-Dichloroethane | G, no headspace | SW-846 Method 8260B | 10 |
| 1,1-Dichloroethylene | | | 10 |
| 1,1,1-Trichloroethane | | | 5 |
| 1,1,2,2-Tetrachloroethane | | | 5 |
| 1,1,2-Trichloroethane | | | 5 |
| 1,2-Dibromoethane | | | 5 |
| 1,2-Dichloroethane | | | 5 |
| 1,2-Dichloropropane | | | 5 |
| 1,2,4-Trichlorobenzene | | | 10 |
| 1,4-Dichlorobenzene | | | 5 |
| 1,4-Dioxane | | | 500 |
| 2-Butanone | | | 10 |
| 2-Hexanone | | | 20 |
| 2-Propanone | | | 20 |
| 3-Chloropropene | | | 10 |
| 4-Methyl-2-petanone | | | 10 |
| Acetonitrile | | | 100 |
| Acrolein | | | 100 |
| Acrylonitrile | | | 100 |
| Benzene | | | 5 |
| Bromomethane | | | 10 |
| Carbon disulfide | | | 5 |
| Carbon tetrachloride | | | 5 |
| Chlorobenzene | | | 5 |
| Chloroethene | | | 10 |
| Chloroform | | | 5 |
| Chloromethane | | | 10 |
| cis-1,3-Dichloropropene | | | 5 |

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Supporting Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| Dichlorodifluoromethane | | | 10 |
| Dichloromethane | | | 5 |
| Ethylbenzene | | | 5 |
| Ethyl cyanide | | | 10 |
| Methacrylonitrile | | | 10 |
| Styrene | | | 5 |
| Tetrachloroethene | | | 5 |
| Toluene | | | 5 |
| Trans-1,3-dichloropropene | | | 5 |
| Trichloroethylene | | | 5 |
| Trichlorofluoromethane | | | 10 |
| Xylene | | | 10 |
| **Other Supporting Constituents** | | | |
| Alkalinity | G/P, none | Standard Method[d] 2320<br>EPA/600 Method 310.1<br>EPA/600 Method 310.2 | 5,000 |

Notes:

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

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

c. Detection limit units.

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

EPA = U.S. Environmental Protection Agency

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

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

## A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

**Table A-4. Quality Control Samples**

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

Notes:

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

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

QC = quality control

### A2.5.1 Field Quality Control Samples

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

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

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

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

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

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

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

### A2.5.2 Laboratory Quality Control Samples

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

### A2.5.3 Quality Control Requirements

Table A-5 lists the acceptance criteria for QC samples, and Table A-6 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. Field and Laboratory Quality Control Elements and Acceptance Criteria**

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **General Chemical Parameters** | | | |
| Alkalinity<br>Conductivity<br>pH<br>Total organic carbon<br>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" |
| **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<br>ICP/MS metals | MB | <CRDL | Flagged with "C" |
| | LCS | 80-120% recovery[c] | Data reviewed[d] |
| | MS | 75-125% recovery[c] | Flagged with "N" |
| | MSD | <20% RPD[c] | Data reviewed[d] |
| | EB, FTB | <2 times MDL | Flagged with "Q" |
| | Field duplicate | ≤20% RPD[f] | Flagged with "Q" |
| **Volatile Organic Compounds** | | | |
| Volatiles by GC/MS | MB | <MDL | Flagged with "B" |
| | LCS | Statistically derived[g] | Data reviewed |
| | MS | Statistically derived[g] | Flagged with "N" |
| | MSD | Statistically derived[g] | Data reviewed[d] |
| | SUR | Statistically derived[g] | Data reviewed[d] |
| | EB, FTB, FXR | <2 times MDL[h] | Flagged with "Q" |
| | Field duplicate | ≤20% RPD[f] | Flagged with "Q" |

**Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria**

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **Semivolatile 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" |

Notes:

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 five times the detection limit.

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

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

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated method blank)

N = result may be biased (associated matrix spike result was outside the acceptance limits)

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

Abbreviations:

CRDL = contract-required detection limit

DUP = laboratory matrix duplicate

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

GC = gas chromatography

IC = ion chromatography

ICP = inductively coupled plasma

ICP/MS = inductively coupled plasma/mass spectrometry

LCS = laboratory control sample

MB = method blank

MDA = minimum detectable activity

MDL = method detection limit

MS = matrix spike

**Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria**

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|

MSD = matrix spike duplicate
QC = quality control
RPD = relative percent difference
SUR = surrogate

**Table A-6. Blind-Standard Constituents and Schedule**

| Constituents | Frequency | Accuracy (%) | Precision (% RSD)* |
|---|---|---|---|
| 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% |

Notes:

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

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.

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

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

## A2.7 Instrument/Equipment Calibration and Frequency

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

## A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support 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.

## A2.9 Non-Direct Measurements

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

## A2.10 Data Management

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

All field activities will be recorded in the field logbook.

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution of the errors

with the RCRA Monitoring and Reporting manager. Sample disposition records become a permanent part of the analytical data package for future reference and for records management.

# A3 Assessment and Oversight

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

## A3.1 Assessments and Response Actions

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

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

## A3.2 Reports to Management

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

# A4 Data Validation and Usability

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

## A4.1 Data Review, Verification, and Validation

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

## A4.2 Verification and Validation Methods

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

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

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

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

## A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

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DOE/RL-2008-58
Revision 0

# Interim Status Groundwater Monitoring Plan for the 216-A-29 Ditch

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;
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DOE/RL-2008-58
Revision 0

# Interim Status Groundwater Monitoring Plan for the 216-A-29 Ditch

Date Published
March 2010

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**
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# Executive Summary

This document presents a revision to the 1999 groundwater monitoring plan[1] for the 216-A-29 Ditch facility (hereafter referred to as the A-29 Ditch). This monitoring plan is based on requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA)[2] and amended by the *Revised Code of Washington* (RCW) 70.105.[3]

The A-29 Ditch is one of three non-operating treatment, storage, and disposal (TSD) units in the 200-CS-1 Chemical Sewer Operable Unit (OU). The A-29 Ditch is regulated as a surface impoundment and has been designated as a TSD because it received nonradioactive dangerous waste regulated by 40 *Code of Federal Regulations* (CFR) 261[4] after November 19, 1980.

This monitoring plan presents a groundwater contamination indicator evaluation monitoring program that will detect any adverse impact from past operations of the A-29 Ditch on the quality of groundwater in the uppermost aquifer beneath the TSD unit. This document addresses the operational history, current hydrogeology, and groundwater monitoring results for the site and incorporates the sum of knowledge about the potential for contamination originating from the A-29 Ditch. A conceptual model is developed based on these attributes of the A-29 Ditch and the data quality objectives process.

The A-29 Ditch was excavated to convey liquid effluent from the Plutonium-Uranium Extraction (PUREX) Plant chemical sewer (low level) (CSL) to the 216-B-3 Pond and was placed into service in November 1955. The A-29 Ditch ran northeast and connected with the 216-B-3-series ditches, which discharged to the 216-B-3 Pond. The A-29 Ditch was approximately 1.8 m (6 ft) wide and 1,097 m (3,600 ft) long; the ditch varied from 0.6 to 0.9 m (2 to 3 ft) deep at the south end to nearly 5 m (16 ft) deep at the north end. The A-29 Ditch is currently backfilled with material from the ditch sides and spoils piles in the bottom, and it is topped with clean material to form a series of 11 terraces that progress down the length of the ditch.

---

1 PNNL-13047, 1999, *Groundwater Monitoring Plan for the 216-A-29 Ditch*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

2 *Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901, et seq.

3 RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington.*

4 40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*.

The A-29 Ditch received a continuous discharge of corrosive waste and potentially hazardous spilled chemical materials from the PUREX Plant. The most significant chemical discharges included acidic and caustic effluents associated with backwashing for the regeneration of demineralizer columns. The ditch also received spills from the PUREX Plant CSL.

Because the A-29 Ditch received wastewater potentially contaminated with dangerous waste/dangerous waste constituents, a contamination indicator groundwater monitoring program was implemented in 1988. In January 1990, statistical evaluation of specific conductivity (field) showed that downgradient well 299-E25-35 was statistically greater than background levels. Resampling later verified this measurement, and a required groundwater quality assessment plan for the A-29 Ditch was prepared and initiated.[5] Elevated total organic halides (TOX) were also listed as a constituent of concern in the groundwater quality assessment plan.[5] The groundwater network was expanded to include new well installations and additional existing monitoring wells.

In 1995, the results of groundwater quality assessment program identified increased sodium, sulfate, and calcium as the cause of the elevated specific conductance.[6] Because these constituents are not regulated as dangerous wastes, it was concluded that the groundwater had not been adversely impacted.

In 2009, specific conductance continued above the critical mean in downgradient wells 299-E25-35, 299-E25-48, and 299-E26-13. Concentrations of sulfate, nitrate, chloride, and the major cations are also increasing in these wells. The cause of the increase remains unknown, but it appears to coincide with a general, multi-year increase in ionic strength throughout much of the 200 East Area and adjacent areas; the increase is not attributed to the A-29 Ditch.[7] No known or suspected cause of the elevated TOX was identified. Since the assessment, concentrations of TOX have subsequently dropped below the critical mean for the site.

---

5 WHC-SD-EN-AP-031, 1990, *Interim-Status Groundwater Quality Assessment Plan for the 216-A-29 Ditch*, Rev 0, Westinghouse Hanford Company, Richland, Washington.

6 WHC-SD-EN-EV-032, 1995, *Results of Groundwater Quality Assessment Program at the 216-A-29 Ditch RCRA Facility*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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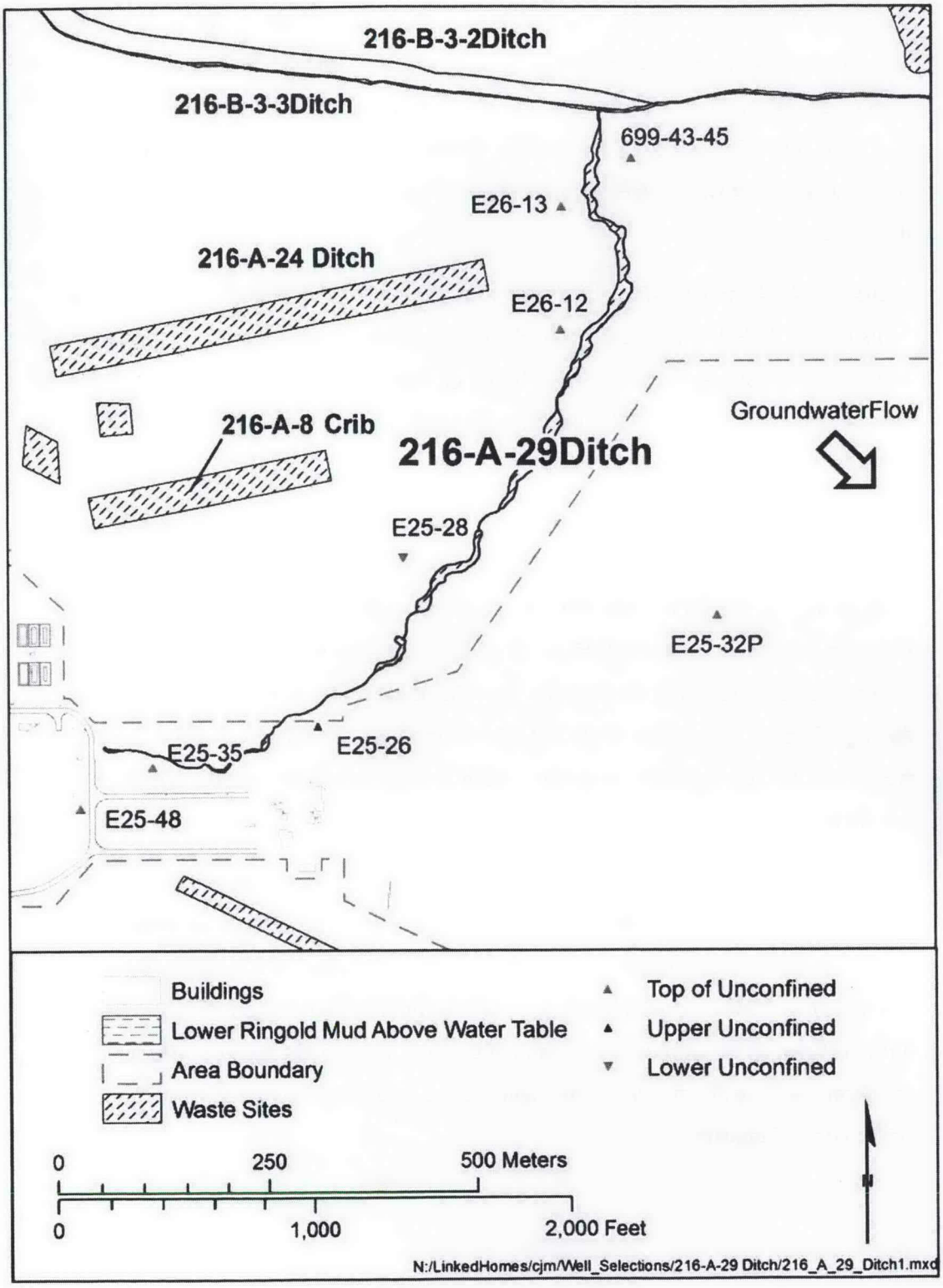


**Figure ES-1. Revised 216-A-29 Ditch Monitoring Network Wells**

Data from the 10 groundwater monitoring wells that currently comprise the A-2 Ditch monitoring network were re-evaluated to determine if redundant wells could be eliminated. Based on the re-evaluation, the former network of 10 wells is being reduced to 7 wells total (Figure ES-1). The revised network includes two upgradient and five downgradient wells. One supplemental downgradient well is also included in the network.

Wells 699-43-45 and 299-E26-13 will continue to serve as the upgradient monitoring wells for the A-29 Ditch. These two wells have historically served as the upgradient wells and remain in the upgradient direction based on current water levels in the 200 East Area. One upgradient well, 699-43 43, has been dropped from the network because it provided redundant information to well 699-43-45.

Wells 299-E25-26, 299-E25-35, and 299-E25-48 are located south, downgradient of the inlet end of the ditch. Well 299-E25-28 monitors the bottom of the aquifer along the center length of the ditch. Well 299-E25-28 monitors the upper portion of the aquifer at the same location as well 299-E25-34. Well 299-E25-28 is revised to be removed from the network because it has consistently provided data similar to wells both upgradient and downgradient of its location. Well 299-E26-12 monitors the distal end of the ditch, and well 299-E25-32P monitors composite conditions downgradient from the middle of the ditch.

The groundwater at the A-29 Ditch monitoring wells will be sampled and analyzed in compliance with WAC 173-303-400(3).[8] The A-29 Ditch network groundwater wells will be monitored semiannually for TOX, total organic carbon, pH, and specific conductance. Additional parameters (i.e., alkalinity, dissolved oxygen, temperature, and turbidity) will be measured as indicators of sample quality and general aquifer/well environmental conditions. Alkalinity, anions, and water levels will also be collected semiannually.

---

8 WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*.

Wells will be monitored annually for metals and phenols. Arsenic and nitrate are also identified as constituents of interest in groundwater that could be associated with A-29 Ditch operations. Because these constituents are also associated with existing plumes, they will be monitored on a regional scale by the 200-PO-1 OU to the extent possible and are not specifically included as constituents for the A-29 Ditch.

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# List of Terms

| | |
|---|---|
| bgs | below ground surface |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| CFR | *Code of Federal Regulations* |
| CSL | chemical sewer (low level) |
| DQO | data quality objective |
| Ecology | Washington State Department of Ecology |
| gpm | gallons per minute |
| OU | operable unit |
| PUREX | Plutonium-Uranium Extraction (Plant) |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| RCW | *Revised Code of Washington* |
| TOC | total organic carbon |
| TOX | total organic halides |
| TSD | treatment, storage, and disposal |
| WAC | *Washington Administrative Code* |

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# 1 Introduction

This document presents a revision to the 1999 groundwater monitoring plan for the 216-A-29 Ditch facility (hereafter referred to as the A-29 Ditch) (PNNL-13047, *Groundwater Monitoring Plan for the 216-A-29 Ditch*). This groundwater monitoring plan is based on requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA) and amended by Washington State's *Revised Code of Washington* (RCW) 70.105, "Hazardous Waste Management." These regulations are promulgated by the Washington State Department of Ecology (Ecology) in *Washington Administrative Code* (WAC) 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"; and by reference, 40 *Code of Federal Regulations* (CFR) 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring."

The A-29 Ditch is one of three non-operating treatment, storage, and disposal (TSD) units in the 200-CS-1 Chemical Sewer Operable Unit (OU). The A-29 Ditch is regulated as a surface impoundment, as defined in WAC 173-303-040, "Definitions" (Figure 1-1), and has been designated as a TSD unit because it received nonradioactive dangerous waste regulated by 40 CFR 261 ("Identification and Listing of Hazardous Waste") after November 19, 1980. For regulatory purposes, the TSD unit boundary of the A-29 Ditch is identified on the current Dangerous Waste Permit Application Part A form (WA7890008967, *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*).

The A-29 Ditch closure is coordinated with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) as part of the 200-CS-1 OU (vadose zone). Associated groundwater concerns are addressed under the 200-PO-1 Groundwater OU.

The A-29 Ditch is an artificial excavation that was used from 1955 to 1991. The ditch passed beneath the east-central portion of the 200 East Area security fence and ran northeast to the 216-B-3-series ditches, which discharged to the 216-B-3 Pond.

The purpose of this RCRA groundwater monitoring plan is to present a groundwater contamination indicator evaluation monitoring program that will detect any adverse impacts from past operations of the A-29 Ditch on the quality of the groundwater in the uppermost aquifer beneath the TSD unit (40 CFR 265.93[d], "Preparation, Evaluation, and Response"). This document addresses the operational history, current hydrogeology, and groundwater monitoring results for the site and incorporates the sum of knowledge about the potential for contamination originating from the A-29 Ditch. A conceptual model is developed based on these attributes of the A-29 Ditch and the data quality objective (DQO) process.

The groundwater contamination indicator evaluation monitoring program detailed here proposes continued semiannual sampling for the indicator parameters and annual sampling of groundwater quality parameters at one upgradient well and seven downgradient wells.

Chapter 1 provides a general introduction to the monitored waste site, including the objectives of the current monitoring program. Chapter 2 presents background information related to the successful implementation of the monitoring plan, which includes information on historical and present facility operations, waste characteristics, geology, hydrology, previous monitoring results, and a site conceptual model. Chapters 3 and 4 present details of the monitoring program, and data evaluation and reporting, respectively. Chapter 5 includes the references that are cited. Detailed procedures covering sample collection, preservation, shipment, analytical procedures, and documentation (e.g., chain-of-custody) are provided in the quality assurance project plan (QAPjP) in Appendix A. Appendix B includes lithologic logs and construction details for the wells in the monitoring network.

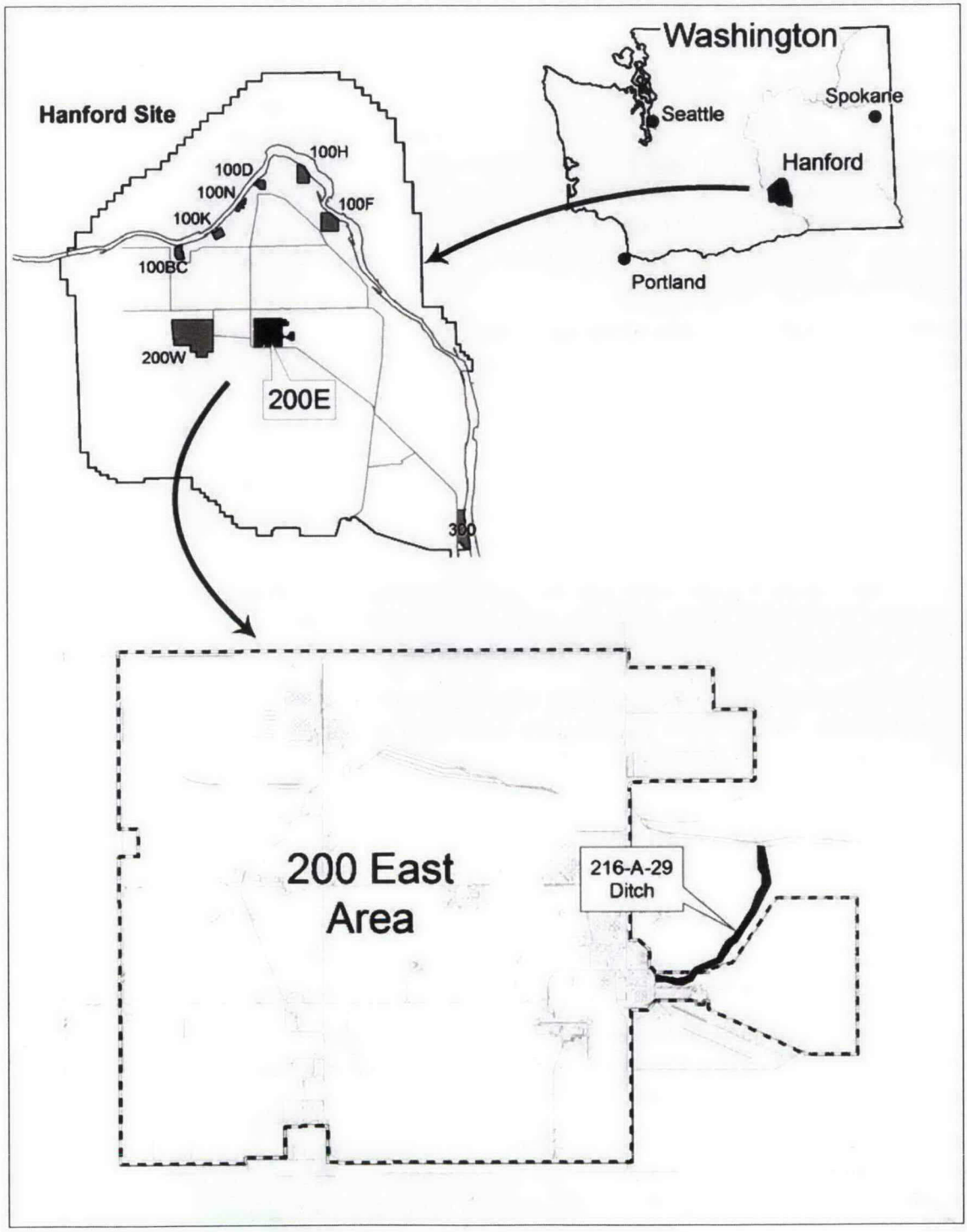



**Figure 1-1. Location of the 216-A-29 Ditch**

# 2 Background

This chapter presents background information related to the successful implementation of the groundwater monitoring plan, which includes information on historical and present facility operations, waste characteristics, geology, hydrology, previous monitoring results, and a site conceptual model.

## 2.1 Facility Description and Operational History

The A-29 Ditch was excavated to convey liquid effluent from the Plutonium-Uranium Extraction (PUREX) Plant chemical sewer (low level) (CSL) to the 216-B-3 Pond and was put into service in November 1955. The A-29 Ditch initially discharged to the 216-B-3-1 Ditch (Figure 2-1); however, when the 216-B-3-1 Ditch was retired in 1964, the A-29 Ditch was shortened and then discharged to the 216-B-3-2 Ditch. The 216-B-3-2 Ditch was retired in 1970. As a result, the A-29 Ditch was again re-routed and discharged to the 216-B-3-3 Ditch until 1994, when all CSL discharges were routed directly to the 216-B-3A Pond.

The A-29 Ditch was approximately 1.8 m (6 ft) wide, 1,097 m (3,600 ft) long, and varied from 0.6 to 0.9 m (2 to 3 ft) deep at the south end to nearly 5 m (16 ft) deep at the north end. The point of discharge to the ditch was approximately 274 m (900 ft) west of the east perimeter fence line of the 200 East Area. The ditch passed beneath the 200 East Area perimeter fence and ran northeast to the 216-B-3 Ditches, which discharged to the 216-B-3 Pond.

All discharges to the ditch originated within the 200 East Area perimeter fence and came from the PUREX CSL. Flow from the CSL was continuous, with the volume discharged ranging from 950 to 4,164 L/min (250 to 1,100 gallons per minute [gpm]). The average flow during use of the A-29 Ditch was approximately 3,671 L/min (1,000 gpm). An unknown amount of effluent discharged to the ditch infiltrated the soil while flowing along the course of the ditch.

The A-29 Ditch is currently backfilled with material from the ditch sides and spoils piles in the bottom. The portion of the A-29 Ditch inside the 200 East Area security fence was brought up to grade with clean material. The portion of A-29 Ditch outside of the 200 East Area security fence was topped with clean material in a series of 11 terraces progressing down the length of the ditch. Both areas have been revegetated and appropriate signage posted (the A-29 Ditch is an underground radioactive material area).

## 2.2 Regulatory Basis

The A-29 Ditch is classified as a TSD unit because it received dangerous waste after one of two effective dates. The effective date for nonradioactive dangerous waste discharges is November 19, 1980, for dangerous waste regulated by 40 CFR 261, or March 10, 1982, for dangerous waste regulated by WAC 173-303 only (e.g., state-only dangerous waste). Since the corrosive waste (D002) discharged to the A-29 Ditch is regulated under 40 CFR 261, the effective date of regulation for this unit is November 19, 1980. (See definition of "active portion" in WAC 173-303-040.)

The A-29 Ditch is currently subject to the regulatory rules set outlined in WAC 173-303-400 for interim status facility standards and those portions of 40 CFR 265, Subpart F, as incorporated by reference in WAC 173-303-400.

To date, no dangerous waste subject to WAC 173-303 has contaminated groundwater from the A-29 Ditch. Therefore, the site remains under indicator evaluation monitoring for indicator parameters, as specified in 40 CFR 265.92(b), "Sampling and Analysis."

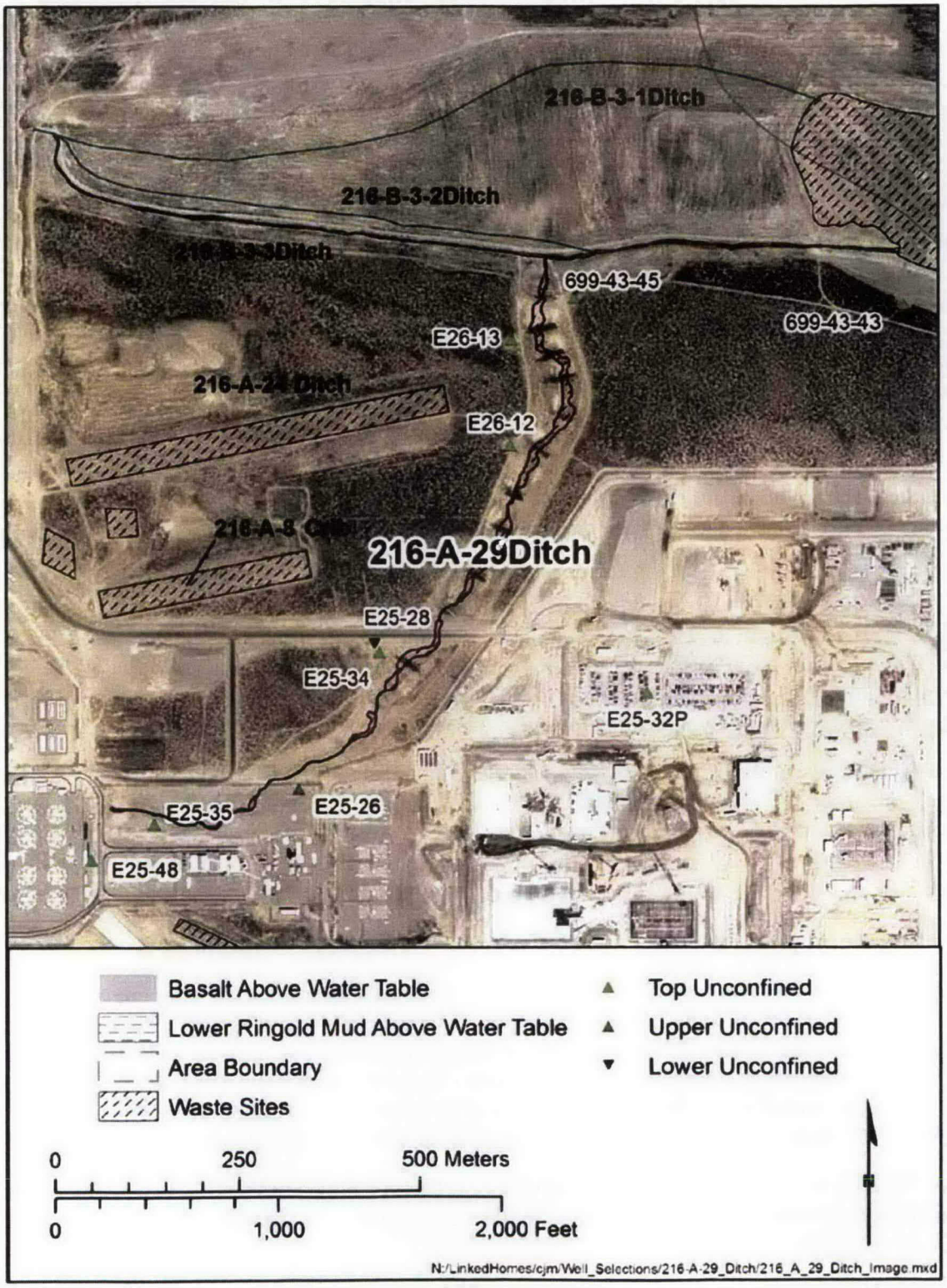



**Figure 2-1. Site Map for the 216-A-29 Ditch Showing Previous Monitoring Network**

The A-29 Ditch received a continuous discharge of corrosive waste and potentially hazardous spilled chemical materials from the PUREX Plant. The most significant chemical discharges included acidic and caustic effluents associated with backwashing for the regeneration of demineralizer columns. The ditch also received spills from the PUREX Plant CSL. The *Groundwater Monitoring Plan for the 216-A-29 Ditch* (WHC-SD-EN-AP-045) provides a complete inventory of materials discharged to the A-29 Ditch.

Groundwater monitoring has been conducted in accordance with the above-referenced RCRA requirements since 1988. Interim status monitoring was performed from 1988 to 1990, when monitoring was changed to an assessment program (40 CFR 265.93[d]) because of elevated levels of specific conductivity in downgradient well 299-E25-35. In 1995, *Results of Groundwater Quality Assessment Program at the 216-A-29 Ditch RCRA Facility* (WHC-SD-EN-EV-032) was issued, which identified increased sodium, sulfate, and calcium as the cause of the elevated specific conductance. Because these constituents are not regulated as hazardous wastes, the conclusion was drawn that the groundwater had not been adversely impacted.

Elevated total organic halides (TOX) were also listed as a constituent of concern in the *Interim-Status Groundwater Quality Assessment Plan for the 216-A-29 Ditch* (WHC-SD-EN-AP-031). No known or suspected cause of the TOX elevation was identified. As a result of these findings, the A-29 Ditch reverted to indicator parameter monitoring under the supplemental groundwater monitoring plan in the appendix to the assessment report (WHC-SD-EN-EV-032). This supplement was subsequently revised in 1999 as the groundwater monitoring plan for the A-29 Ditch (PNNL-13047). Since the assessment, concentrations of TOX have subsequently dropped below the critical mean for the site.

## 2.3 Waste Characteristics

The A-29 Ditch received corrosive dangerous waste from the PUREX Plant. The discharges consisted of acidic (sulfuric acid) and caustic (sodium hydroxide) backwashes from the regeneration of demineralizer columns in the PUREX Plant. The ditch also received spills from the PUREX Plant. The dangerous waste consists of toxicity characteristic waste, acutely dangerous discarded chemical products, and state-only waste. WHC-SD-EN-AP-045 provides a complete inventory of materials discharged to the A-2 Ditch.

The results of PUREX CSL effluent analyses for dangerous and radioactive components are provided in *Preliminary Evaluation of Hanford Liquid Discharges to Ground* (WHC-EP-0052). Additional analysis data are published in the *Liquid Effluent Study Final Project Report* (WHC-EP-0367). The identity and quantity of dangerous waste disposed to the A-29 Ditch are found in the RCRA Part A form. Dangerous waste disposed includes corrosive waste, cadmium, hydrazine, and dangerous waste/toxic dangerous waste.

## 2.4 Geology and Hydrology

The geology and hydrology of the A-29 Ditch are described in detail in WHC-SD-EN-AP-045 and in compilation reports on the 200 East Area (e.g., WHC-SD-EN-TI-012, *Geologic Setting of the 200 East Area: An Update*; and PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*). The summaries in the following subsections are from these documents.

### 2.4.1 Stratigraphy

The principal geologic units beneath the A-29 Ditch include, from youngest to oldest, the Pleistocene Hanford formation, the Miocene/Pliocene Ringold Formation, and Elephant Mountain Member of the Saddle Mountains Basalt. PNNL-12261 (upon which much of this section is based) uses the nomenclature

first described in the *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1994 Status Report* (PNNL-10195) for the vicinity of the 200 East Area. The nomenclature in PNNL-12261 is also referenced to the more recent descriptions in *Miocene-to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington* (BHI-00184).

PNNL-12261 divides the sediments in the 200 East Area above the Columbia River Basalt Group into four distinct hydrostratigraphic units. The lowermost unit is Ringold Unit A of BHI-00184 (Unit 9 in PNL-10195). In the southern and eastern portions of the 200 Areas, a particularly persistent layer of clay and silt within this unit allows for further subdivision of this unit into a lower confined unit (9C), a middle confining unit (9B), and an upper gravel/sand unit (9A).

Overlying Ringold Formation Units 9A through 9C is the lower mud unit (Unit 8 of PNL-10195). The Ringold lower mud sequence is not present in the northwestern portion of the B Pond but generally thickens south and southeast. The lower mud unit consists mostly of various mixtures of silt and clay (DOE/RL-93-74, *200-BP-11 Operable Unit and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan, Hanford Site, Richland, Washington*).

Above the lower mud unit lie the fluvial gravels and sands of Ringold Unit E (Unit 5 in PNL-10195). Unit E has been removed from Gable Gap and most of the 200 East Area to approximately the May Junction Fault by the ancestral Columbia River and Missoula floods.

The majority of the vadose zone above the Ringold Formation units is the Hanford formation. The Hanford formation is represented by three facies, in descending stratigraphic order: (1) an upper gravel sequence designated as H1, (2) a sandy sequence designated as H2, and (3) a lower gravel sequence designated as H3 (subdivisions after WHC-SD-EN-TI-012). The H1 and H3 gravel sequences are not differentiated in those areas where the intervening sandy H2 sequence is absent. Units H1 and H3 consist of coarse-grained, basalt-rich, sandy gravels with varying amounts of silt/clay. These gravel units may also contain interbedded sand and or silt/clay lenses. The H2 sequence is dominated by sand to gravelly sand, with minor sandy gravel or silt/clay interbeds. The sandy H2 sequence has a significant silt/clay component in the extreme western portion of the main 216-B-3 Pond beneath the 216-B-3-3 Ditch and A-29 Ditch.

### 2.4.2 Physical Hydrogeology

The uppermost aquifer beneath the A-29 Ditch is unconfined and occurs within the undifferentiated Hanford formation/Ringold Formation. According to as-built diagrams, existing shallow wells in the A-29 Ditch monitoring network are within a silty to gravelly sand unit. The water table elevation near and beneath the A-29 Ditch is approximately 122 m (400 ft) above mean sea level. Perched water conditions were observed during drilling near the northern end of the A-29 Ditch at well 699-43-45 in 1989, which was the year before discharges to the ditch ceased. Water was encountered from approximately 13 to 14 m (42 to 46 ft) below ground surface (bgs). The confining layer appeared to be a thin silty sand lens at 15 m (50 ft) bgs. It is unlikely that perched water conditions continue to exist now that discharges to the A-29 Ditch and 216-B-3 Pond have been terminated.

Historically, groundwater moved radially outward from a groundwater mound established beneath the 216-B-3 Pond, which lies directly northeast of the A-29 Ditch. This groundwater mound is evident on water table maps up through the 1990s. Groundwater flow during this period was generally from northeast to southwest across the ditch. With the termination of discharges to the A-29 Ditch and 216-B-3 Pond, this mound has largely dissipated, leading to a general decline in water levels throughout the 200 East Area. As this mound continues to disperse, it has less of an effect on groundwater flow direction. Based on general interpretations of the water table map in the 200 East Area, the direction of

groundwater flow near the A-29 Ditch is generally to the southeast (DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*). However, as with most of the 200 East Area, the water table gradient in the immediate vicinity of the A-29 Ditch is too flat to provide estimates of flow direction or rate with a high degree of confidence. A network of selected wells in the area of A-29 Ditch is currently undergoing a hyper-accurate study to determine flow direction.

Prominent manmade contributions to groundwater chemistry include nitrate, calcium, and sulfate. The effects of calcium and sulfate on the composition of groundwater are most clearly demonstrated in the specific conductivity of samples taken from A-29 Ditch monitoring wells. The relationship between these constituents and specific conductivity is identified in the assessment report (WHC-SD-EN-EV-032). The drop in specific conductivity, sulfate, calcium, and sodium coincided with termination of effluent discharge to the A-29 Ditch. The decline of specific conductivity to levels below the critical mean, combined with cessation of discharges to the A-29 Ditch, provided the justification for returning the facility to indicator evaluation monitoring.

## 2.5 Summary of Previous Groundwater Monitoring

Groundwater beneath the A-29 Ditch has been monitored by a RCRA-compliant monitoring network since November 1988. The original indication evaluation monitoring network consisted of one upgradient well (299-E25-32P) and four downgradient wells (299-E25-26, 299-E25-28, 299-E25-34, and 299-E25-35) (Figure 2-1). These wells were sampled quarterly for one year to establish background levels. In late 1989, network groundwater monitoring was completed for four quarters, and background values were established. The first scheduled contamination indicator parameter, semiannual sampling event occurred in January 1990. By December 1990, it was apparent that the flow direction in the network was changing. The water level in the upgradient network well (299-E25-32P) had decreased to where it was no longer representative of upgradient conditions. The monitoring network was then out of compliance with 40 CFR 265.91(a), "Ground-Water Monitoring System." After evaluating the December 1990 data, it was determined that a new upgradient groundwater monitoring well was necessary for the A-29 Ditch monitoring network and that the groundwater monitoring plan required revision. Some of the wells used during assessment monitoring were incorporated into the new monitoring network, and two new upgradient wells (699-43-43 and 699-43-45) were selected (PNNL-13047).

### 2.5.1 Groundwater Contamination

Statistical evaluation of the first indicator evaluation monitoring results in January 1990 indicated that the specific conductivity (field) value in downgradient well 299-E25-35 was statistically greater than the background levels. Resampling later verified this measurement, and the required groundwater quality assessment plan was prepared and initiated for the A-29 Ditch (WHC-SD-EN-AP-031). The groundwater network was expanded to include new well installations and additional existing monitoring wells.

The final assessment report was issued in 1995 (WHC-SD-EN-EV-032). The results of the report identified increased sulfate, sodium, and calcium as the cause of elevated specific conductivity in well 299-E25-35. Because these constituents are not regulated as dangerous wastes, the conclusion was drawn that groundwater had not been adversely impacted. Elevated TOX was also listed as a constituent of concern in the assessment plan (WHC-SD-EN-AP-031), but concentrations have subsequently dropped below the critical mean for the site. Subject to these findings, the A-29 Ditch reverted to indicator parameter monitoring under the supplemental groundwater monitoring plan in the appendix to the assessment report (WHC-SD-EN-EV-032) and, subsequently, in PNNL-13047.

Specific conductance continued above the critical mean in downgradient wells 299-E25-35, 299-E25-48, and 299-E26-13 in 2009. Concentrations of sulfate, nitrate, chloride, and the major cations are also increasing in these wells. The cause of this increase remains unknown but appears to coincide with a general, multi-year increase in ionic strength throughout much of the 200 East Area and adjacent areas; the increase is not attributed to the A-29 Ditch (DOE/RL-2008-01, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*).

### 2.5.2 Vadose Zone Contamination

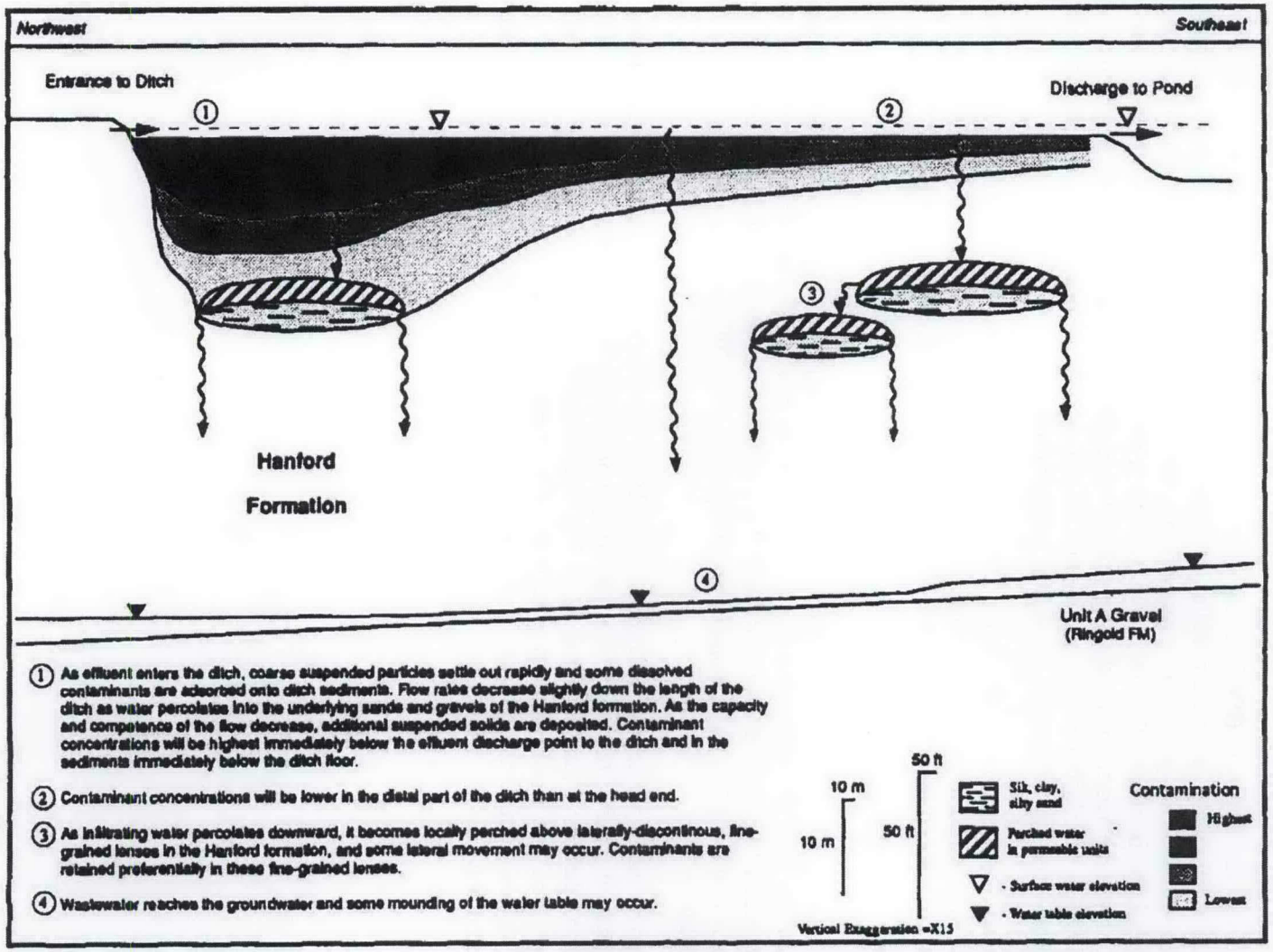
In 2002, one boring and three test pits were excavated as part of the CERCLA remedial investigation study for the site (DOE/RL-2004-17, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit*). In the *Proposed Plan for the 200-CS-1 Chemical Sewer Group Operable Unit* (DOE/RL-2005-64), two contaminants (cadmium and silver) were identified as human and/or ecological risk drivers.

Soil sample results were also compared against groundwater protection concentrations as part of the CERCLA remedial investigation study. Four metals regulated under RCRA (arsenic, cadmium, mercury, silver), nitrate, two polycyclic aromatic hydrocarbons (benzo[a]anthracene and chrysene), Aroclor 1254 (a polychlorinated biphenyl), and four volatile organic compounds (1,2-dichloroetane, methylene chloride, tetrachloroethylene, and tributyl phosphate) had maximum concentrations above their respective groundwater protection cleanup levels (DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*). None of these were predicted to reach groundwater at concentrations above the U.S. Environmental Protection Agency's maximum contaminant levels and were eliminated from the proposed plan.

## 2.6 Conceptual Model

The A-29 Ditch was one of several wastewater conveyances that discharged to the 216-B-3 Pond system. The open and unlined trench allowed liquid effluents to evaporate and percolate into the vadose sediments along its entire length. Groundwater monitoring results, however, indicate that infiltration and eventual migration of effluents to the unconfined aquifer have not been evenly distributed. The elevation of specific conductivity and associated ions (e.g., sulfate and calcium) in wells near the influent end of the ditch (as noted in WHC-SD-EN-EV-032) suggests that potential contamination may be confined to the head end (southwest end shown in Figure 2-1) of the ditch.

The conceptual model used to describe contaminant transport to the 216-B-3 Pond (DOE/RL-93-74) via the A-29 Ditch is central to the discussion of a conceptual model. As shown in Figure 2-2, the highest infiltration occurred within the first few meters of wastewater discharge to the ditch. Contaminants were carried to groundwater at a higher rate near the inlet end as a result of the constant head maintained by continuous discharges. Well logs from groundwater wells adjacent to the A-29 Ditch show that the upper vadose zone at the inlet end is dominated by sandy to silty-sandy gravels, while predominantly sandy units are found at the discharge end. This stratigraphic control of moisture migration (higher fines [silt] at the inlet end) in the vadose zone favors deposition of the majority of contaminants near the outfall of the CSL. Vadose zone excavations conducted in 2002 for CERCLA site characterization showed that the less mobile contaminants tended to be sorbed near the inlet end of the A-29 Ditch and in the upper 2.9 m (10 ft) of the soil column (DOE/RL-2005-63). It is also possible that the bulk of the mobile contaminants (nitrate and sulfate) have reached groundwater beneath the inlet end of the A-29 Ditch. Once the contaminants reached groundwater, the contaminants followed the hydraulic gradient and moved away from the A-29 Ditch in a southeasterly direction.




Source: This figure has been reproduced from the best available copy (DOE/RL-93-74, *200-BP-11 Operable Unit and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan, Hanford Site, Richland, Washington*).

**Figure 2-2. Conceptual Model of Effluent Infiltration Within a Ditch**

The potential for continued migration of residual contamination from the vadose zone to groundwater is unlikely due to the cessation of liquid effluent discharges to the A-29 Ditch, as well as the lack of any water lines or other direct sources of recharge. Infiltration of natural precipitation is the only potential force capable of moving a significant portion of the remaining contaminants to the groundwater. The current mean annual precipitation rate is 16 cm (6.3 in.), with most annual accumulation occurring between November and February (PNNL-10285, *Estimated Recharge Rates at the Hanford Site*). Recharge in the A-29 Ditch area is estimated to be between 10 and 20 mm (0.39 and 0.79 in.) annually based on PNNL-10285. The range of recharge rates depends on a variety of factors, but the coarse sediments beneath the inlet end of the facility may result in rates closer to 20 mm/year (0.79 in./year). No recent infiltration abatement measures (impermeable material covering) have been implemented at the A-29 Ditch. The risk of infiltration by snowmelt and the potential for vertical migration of contaminants, however, is considered low because of low annual precipitation.

Based on general interpretations of flow in the 200 East Area, the current direction of groundwater flow at the A-29 Ditch is assumed to be south-southwest. The hydraulic gradient in the immediate vicinity of the A-29 Ditch is too low to provide an accurate estimate of direction or velocity (DOE/RL-2008-01).

## 2.7 Data Quality Objectives

The DQO process is performed to ensure that data gathered during an investigation are of the appropriate quantity and quality to meet specific objectives. The DQOs for groundwater monitoring were presented in *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* (BHI-01276) and have been revised in *Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit* (SGW-34011).

The current groundwater monitoring network for A-29 Ditch is a result of previous investigations and DQOs. Contamination indicator evaluation monitoring is ongoing at this site in accordance with interim status regulations. Table 2-1 provides a matrix of data requirements that are typically determined in a DQO process, the associated interim status regulations applicable to these requirements, and the current and historical documentation specifying how the monitoring program for A-29 Ditch complies with the requirements.

**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 ground-water monitoring at sites where no impact to ground-water has been identified. 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 WAC 173-303-400(3)(c)(v). | |
| Number and location of wells<br>Point(s) of compliance | **40 CFR 265.91 Ground-Water Monitoring System.**<br>(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:<br>(1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are:<br>(i) Representative of background ground-water quality in the uppermost aquifer near the facility; and<br>(ii) Not affected by the facility; and<br>(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, Sections 2.4, 2.5, 2.6, and 3.2<br>PNNL-13047, *Groundwater Monitoring Plan for the 216-A-29 Ditch* |
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91 Ground-Water Monitoring System.**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional Requirements from WAC 173-303-400(3)(c)(v)(C).**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells. | This plan, Section 3.2 and Appendix B<br>PNNL-13047, *Groundwater Monitoring Plan for the 216-A-29 Ditch*<br>BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report*<br>BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* |

**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<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision | **40 CFR 265.92 Sampling and Analysis.**<br>(b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section:<br>(1) Parameters characterizing the suitability of the ground-water as a drinking water supply, as specified in Appendix III.<br>*[NOTE: Have not listed these because, in accordance with 40 CFR 265.92(c)(1) below, these analyses are only conducted for the first year. None of the RCRA sites are in the first year of monitoring.]*<br>(2) Parameters establishing ground-water quality:<br>(i) Chloride<br>(ii) Iron<br>(iii) Manganese<br>(iv) Phenols<br>(v) Sodium<br>(vi) Sulfate<br>*[COMMENT: These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required in accordance with 40 CFR 265.93(d).]*<br>(3) Parameters used as indicators of ground-water contamination:<br>(i) pH<br>(ii) Specific Conductance<br>(iii) Total Organic Carbon<br>(iv) Total Organic Halogen<br>(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. The owner or operator must do this quarterly for one year.<br>(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, Sections 3.1, 3.3, and 3.4; Appendix A<br>PNNL-13047, *Groundwater Monitoring Plan for the 216-A-29 Ditch*<br>BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report*<br>BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report*<br>SGW-34011, *Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit* |

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

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| | **40 CFR 265.92 Sampling and Analysis. (cont'd)**<br>(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:<br>(1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually.<br>(2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semiannually.<br>(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained. | |
| Methods used to evaluate the collected data | **40 CFR 265.93 Preparation, Evaluation, and Response.**<br>(b) For each indicator parameter specified in 40 CFR 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 40 CFR 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 3.2<br>This plan, Appendix B<br>PNNL-13047, *Groundwater Monitoring Plan for the 216-A-29 Ditch*<br>BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report*<br>BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report*<br>SGW-34011, *Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit* |

Notes:

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*

WAC = *Washington Administrative Code*

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# 3 Groundwater Monitoring Program

This chapter describes an interim status, indicator evaluation, groundwater monitoring program for the A-29 Ditch consisting of a monitoring well network, target constituents, and sampling and analysis protocol. The monitoring program presented here has been revised from PNNL-13047.

## 3.1 Constituent List and Sampling Frequency

The groundwater in A-29 Ditch monitoring wells will be sampled and analyzed for the parameters listed in Table 3-1. In compliance with 40 CFR 265.92, as incorporated by reference through WAC 173-303-400(3), the A-29 Ditch network groundwater wells will be monitored semiannually for TOX, total organic carbon (TOC), pH, and specific conductance. Wells will be monitored annually for metals and phenols. Alkalinity, anions, and water levels will also be collected semiannually. Alkalinity will be used to calculate a groundwater charge balance. Anions are included to detect potential nitrate contamination, as well as to provide input for charge balance calculations. The major ions will also be evaluated for geochemical relationships (e.g., stiff diagrams).

Arsenic and nitrate are also identified as constituents of interest in groundwater that could be associated with A-29 Ditch operations. Because these constituents are also associated with existing plumes, the constituents will be monitored on a regional scale by the 200-PO-1 OU to the extent possible and are not specifically included as constituents for the A-29 Ditch.

## 3.2 Monitoring Well Network

Information on the wells in the monitoring network is summarized in Table 3-2. Wells 699-43-45 and 299-E26-13 will continue to serve as the upgradient monitoring wells for the A-29 Ditch. These wells have historically served as the upgradient wells and remain in the upgradient direction based on current water levels in the 200 East Area. Both wells meet the standard resource protection well requirements of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

Wells 299-E25-26, 299-E25-35, and 299-E25-48 are located south, downgradient of the inlet end of the ditch. Well 299-E25-34 monitors the upper portion of the aquifer along the center length of the ditch. Well 299-E25-28 is screened to a depth of 103.2 m (340 ft) and monitors the bottom of the aquifer near well 299-E25-34. All of the wells have 6.1 m (20-ft) screened intervals. Well 299-E26-12 monitors the distal end of the ditch, while well 299-E25-32P monitors composite conditions downgradient of the middle of the ditch.

One upgradient well, 699-43-43, has been dropped from the network. This well provided redundant information to well 699-43-45.

Declining water table elevations throughout the 200 Areas have resulted in the removal of several groundwater monitoring wells from earlier RCRA networks due to insufficient water in the borehole for sampling. The 200 East Area is profoundly influenced by the decline of the 216-B-3 Pond groundwater mound. The revised upgradient well (699-43-45) has shown an average annual decline of 0.08 m/year (0.26 ft/year). Based on the most recent water-level measurements, this decline yields an estimated life expectancy of approximately 24 years before the well may go dry.

The eight groundwater monitoring wells that currently comprise the A-29 Ditch monitoring network are shown in Figure 3-1 and listed in Table 3-2. All but two of the groundwater monitoring wells were constructed to meet resource protection well standards (WAC 173-160).

**Table 3-1. Monitoring Well Network, Constituent List, and Sampling Frequency for the 216-A-29 Ditch**

| | | | RCRA Required Constituents[a] | | | | | | | | | | | Supporting Constituents[b] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | Field | | | Laboratory | | |
| Well | Purpose | WAC Compliant | Water Level | pH[c] | Specific Conductance[c] | TOC | TOX | Chloride | Iron (Filtered and Unfiltered) | Manganese (Filtered and Unfiltered) | Phenols | Sodium (Filtered and Unfiltered) | Sulfate | Oxidation/Reduction Potential[c] | Temperature[c] | Turbidity[c] | Alkalinity | Anions[d] | Metals[e] (Filtered and Unfiltered) |
| 699-43-45 | Upgradient | C | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | A | S | S | S | S | A |
| 299-E25-26 | Downgradient | C | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | A | S | S | S | S | A |
| 299-E25-28 | Downgradient | C | S | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| 299-E25-32P | Downgradient | C | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | A | S | S | S | S | A |
| 299-E25-34 | Downgradient | C | S | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| 299-E25-35 | Downgradient | C | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | A | S | S | S | S | A |
| 299-E25-48 | Downgradient | C | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | A | S | S | S | S | A |
| 299-E26-12 | Downgradient | C | S | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| 299-E26-13 | Upgradient | C | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | A | S | S | S | S | A |

Notes:

Arsenic and nitrate are of sitewide concern and are monitored on a regional scale as part of the 200-PO-1 Operable Unit. Neither is included specifically as constituent for the 216-A-29 Ditch, although nitrate is incorporated as a supporting constituent (anions) for charge balance computations.

a. Required by 40 CFR 265.92, "Interim Status Standards for 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. Anions; analytes include, but are not limited to, chloride, fluoride, sulfate, nitrate, and nitrite for charge balance computations.

e. Metals; analytes include, but are not limited to, common soil minerals; calcium, magnesium, potassium, and sodium for charge balance computations.

**Table 3-1. Monitoring Well Network, Constituent List, and Sampling Frequency for the 216-A-29 Ditch**

| Well | Purpose | WAC Compliant | RCRA Required Constituents[a] | | | | | | | | | | | Supporting Constituents[b] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | Field | | | Laboratory | | |
| | | | Water Level | pH[c] | Specific Conductance[c] | TOC | TOX | Chloride | Iron (Filtered and Unfiltered) | Manganese (Filtered and Unfiltered) | Phenols | Sodium (Filtered and Unfiltered) | Sulfate | Oxidation/Reduction Potential[c] | Temperature[c] | Turbidity[c] | Alkalinity | Anions[d] | Metals[e] (Filtered and Unfiltered) |

A = to be sampled annually
C = well is constructed as a WAC 173-160 ("Minimum Standards for Construction and Maintenance of Wells"), Part 2 resource protection well
CFR = *Code of Federal Regulations*
RCRA = *Resource Conservation and Recovery Act of 1976*
S = to be sampled semiannually
S4 = to be sampled semiannually with quadruplicate samples taken
TOC = total organic carbon
TOX = total organic halides
WAC = *Washington Administrative Code*

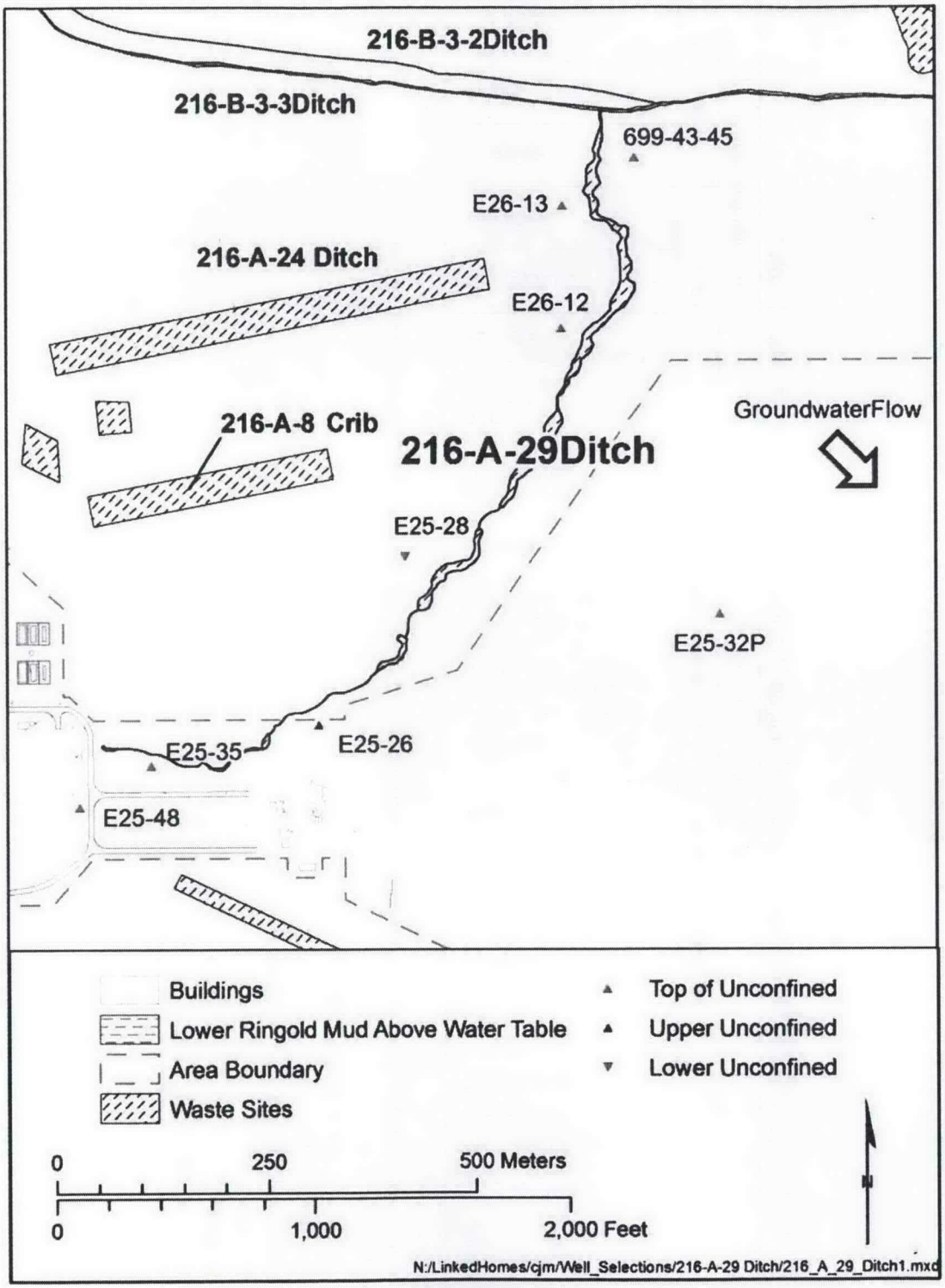


**Figure 3-1. RCRA Groundwater Monitoring Network at the 216-A-29 Ditch**

**Table 3-2. Groundwater Monitoring Well Network for the 216-A-29 Ditch**

| Well | Year Drilled | Construction Notes[a] | Units Monitored | Water Table Elevation[b] (m) | Top of Casing NAVD88 (m) | Bottom Elevation[c] (m) | Water Left (m) |
|---|---|---|---|---|---|---|---|
| 699-43-45 (upgradient) | 1989 | 4-in., ss, wire-wrap screen | Ringold Unit 5 – completed at water table | 122.08 | 183.15 | 119.12 | 2.96 |
| 299-E25-26 | 1985 | 6-in., ss, wire-wrap screen | Ringold Unit 5 – completed at water table | 122.06 | 204.847 | 115.67 | 6.39 |
| 299-E25-28 | 1985 | 6-in., ss, wire-wrap screen | Ringold Unit 5 – completed at water table | 122.05 | 203 | 97.64 | 24.41 |
| 299-E25-32P | 1988 | 4-in., ss, wire-wrap screen | Ringold Unit 5 – completed at bottom of aquifer | 121.81 | 205.03 | 96.65 | 35.53 |
| 299-E25-34 | 1988 | 8-in., ss, wire-wrap screen | Ringold Unit 5 – completed at water table | 122.03 | 273.6 | 118.57 | 3.46 |
| 299-E25-35 | 1988 | 4-in., ss, wire-wrap screen | Ringold Unit 5 – completed at water table | 122.06 | 206.636 | 118.87 | 3.19 |
| 299-E25-48 | 1992 | 4-in., ss, wire-wrap screen | Ringold Unit 5 – completed at water table | 122.07 | 208.982 | 117.37 | 4.70 |
| 299-E26-12 | 1991 | 4-in., ss, wire-wrap screen | Ringold Unit 5 – completed at water table | 122.10 | 193.312 | 118.47 | 3.63 |

Notes:

a. Includes (when available) well casing/screen material, screen type, and well seal type.

b. Water table elevation December 2007.

c. Bottom elevation from most recently available source (e.g., well inspection depth-to-bottom measurement or bottom of screen from as-built diagram).

NAVD88 = *North American Vertical Datum of 1988*

ss = stainless steel

Wells 299-E25-26 and 299-E25-28 were constructed of carbon-steel casing above the water table, with stainless-steel screens and casings below the water table. The stainless-steel casings in these wells do not have annular seals between the top of the screens and the bottom of the carbon-steel casings. The wells were developed naturally without filter pack and are completed in highly permeable material that does not necessitate an artificial filter pack. The integrity of these wells is maintained by the casings. As-built drawings for each of the revised wells in the network are provided in Appendix B.

## 3.3 Sampling and Analysis Protocol

Groundwater monitoring at the A-29 Ditch is part of project's routine network. Sampling and analysis protocols follow the conventions of the project. The QAPjP outlining procedures for sample collection, sample preservation and shipment, analytical procedures, and chain-of-custody control is provided in Appendix A.

# 4 Data Evaluation and Reporting

This chapter discusses the storage, retrieval, evaluation, and interpretation of groundwater data. Statistical evaluation methods and reporting requirements are also described.

## 4.1 Data Review

The data review, validation, and verification process is discussed in the QAPjP in Appendix A.

## 4.2 Statistical Evaluation

The goal of RCRA indicator evaluation monitoring is to determine if the A-29 Ditch has affected groundwater quality beneath the site. This is determined based on the results of specified statistical tests. Under this plan, 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 (TOC, TOX, pH, and specific conductance) to background levels to test for potential impacts to groundwater. Each time that a monitoring well for the A-29 Ditch is sampled, four replicate samples for TOC and TOX are collected, and four replicate field measurements are made for pH and specific conductance. Statistical evaluations are not performed on sample results from well 299-E25-28 because it monitors the bottom of the aquifer.

Implementation of the statistical test method at the Hanford Site, including the A-29 Ditch, is described in detail in *Hanford Site Groundwater Monitoring for Fiscal Year 1999* (PNNL-13116) and *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site* (WHC-SA-1124-FP). Twice each year, monitoring data from downgradient wells are compared to the upgradient (background) results to determine if there is any indication that contamination may have occurred, using a t-test to make this determination (40 CFR 265.93[b]). Critical mean values are recalculated annually, while limits of quantitation are recalculated for each sample event (PNNL-13080, *Hanford Site Groundwater Monitoring: Setting, Sources, and Methods*).

## 4.3 Interpretation

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

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

## 4.4 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements call for an annual evaluation of the network to determine if it remains adequate to monitor the waste management area. The network must include upgradient and downgradient wells in the uppermost aquifer. The gradient beneath the A-29 Ditch is extremely flat. It also continues to shift with the declining 216-B-3 Pond mound going from the south-southwest in 2007 to the southeast in 2008. The network includes both upgradient and downgradient wells based on current estimated flow direction.

The groundwater monitoring network, as it is currently configured, will continue to be re-evaluated to ensure that it is adequate to monitor the changing hydrogeologic conditions beneath the facility. If flow changes are observed, the A-29 Ditch conceptual model and geochemical trends will be re-evaluated to determine network efficiency and any necessary modification requirements for the network.

Water-level measurements will continue to be collected before each sampling event. More comprehensive water-level measurements are also made in selected wells around the 200 East Area. The wells used for this task have very exacting controls, allowing staff to correct the measurements to account for vertical borehole deviation and barometric effects. The resulting data are used in trend analysis, with statistical evaluation of the significance of a trend on the water table.

## 4.5 Reporting and Notification

Chemistry and water-level data are reviewed after each sampling event and are available in the Hanford Environmental Information System database. Formal reports will be issued annually (e.g., DOE/RL-2008-66).

If comparisons for an 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.

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# Appendix A

# Quality Assurance Project Plan

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# Terms

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

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# A Quality Assurance Project Plan

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

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

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

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *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) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

## A1 Project Management

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

### A1.1 Project/Task Organization

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

#### A1.1.1 Regulatory Project Manager

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

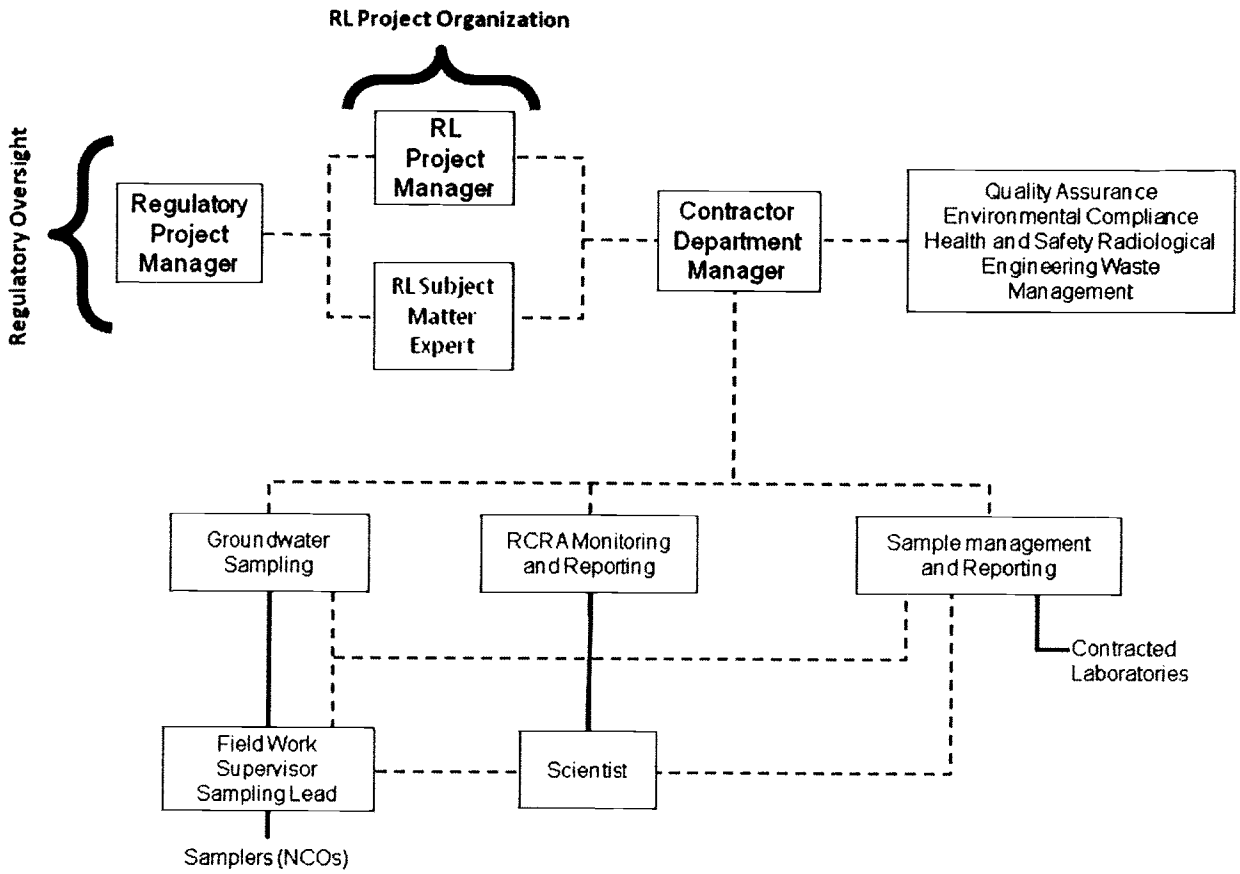


**Figure A-1. Project Organization**

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

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

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

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

### A1.1.4 Contractor Groundwater Remediation Department Manager

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

### A1.1.5 Groundwater Sampling Operations

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

### A1.1.6 RCRA Monitoring and Reporting

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

### A1.1.7 Sample Management and Reporting Organization

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

### A1.1.8 Contract Laboratories

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

### A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project 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.

### A1.1.10 Environmental Compliance Officer

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

### A1.1.11 Health and Safety

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

### A1.1.12 Waste Management

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

## A1.2 Problem Definition/Background

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

## A1.3 Project/Task Description

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

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

## A1.4 Quality Objectives and Criteria

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

## A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility of collecting and transporting groundwater samples according to the Dangerous Waste Training Plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

## A1.6 Documents and Records

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

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

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements therein.

**Table A-1. Actions and Documentation for Regulatory Notification**

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

Notes:

RCRA = *Resource Conservation and Recovery Act of 1976*

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

# A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

## A2.1 Sampling Process Design (Experimental Design)

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

### A2.1.1 Regulatory Requirements

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

### A2.1.2 Judgmental Sampling

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

## A2.2 Sampling Methods

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

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

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

## A2.3 Sample Handling and Custody

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

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

Sample custody during laboratory analysis is addressed in the applicable laboratory's 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.

## A2.4 Analytical Methods

Information on analytical methods is provided in Tables A-2 and A-3. 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 216-A-29 Ditch Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Contamination Indicator Parameters** | | | |
| Total organic carbon | G/P, HCL to pH <2 | SW-846[d] Method 9060 | 1,000 |
| Total organic halides | G, $H_2SO_4$ to pH <2, no head space | SW-846[d] Method 9020 | 20 |
| **Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered/Filtered** | | | |
| Calcium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020, or EPA/600 Method 200.8[e] | 1,000 |
| Iron | | | 50 |
| Magnesium | | | 750 |
| Manganese | | | 5 |
| Potassium | | | 4,000 |
| Sodium | | | 500 |
| **Trace Metals – Unfiltered/Filtered** | | | |
| Arsenic | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020[d], or EPA/600 Method 200.8[e] | 10 |
| Antimony | | | 6 |
| Barium | | | 20 |
| Beryllium | | | 5 |
| Cadmium | | | 5 |
| Chromium | | | 10 |
| Cobalt | | | 20 |
| Copper | | | 10 |
| Nickel | | | 40 |
| Silver | | | 10 |
| Strontium | | | 10 |
| Vanadium | | | 25 |
| Zinc | | | 10 |
| **Anions by Ion Chromatography** | | | |
| Nitrate | P, none | EPA/600 Method 300.0[e] | 250 |
| Sulfate | | | 500 |
| Chloride | | | 200 |
| Nitrite | | | 250 |

**Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for 216-A-29 Ditch Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Other** | | | |
| Alkalinity | G/P, none | Standard Method[f] 2320, EPA/600 Method 310.1, EPA/600 Method 310.2 | 5,000 |
| Conductivity, field | Field measurement | Instrument/meter | 1 µohm |
| Phenols | G, none | SW-846 Method 8040, SW-846 Method 8041, SW-846 Method 8270D | 5 |
| pH, field measurement | Field measurement | Instrument/meter | 0.1 |
| Temperature | Field measurement | Instrument/meter | N/A |
| Turbidity | Field measurement | Instrument/meter | N/A |

Notes:

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

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

c. Detection limit units, unless otherwise indicated.

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

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

f. *Standard Methods for the Examination of Water and Wastewater* (APHA et al. 2005).

EPA = U.S. Environmental Protection Agency

N/A = not applicable

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Trace Metals – Unfiltered/Filtered** | | | |
| Boron | P, $HNO_3$ to pH <2 | SW-846 Method 6020[d] or EPA/600 Method 200.8[e] | 20 |
| Bismuth | | | 100 |
| Hexavalent chromium | G/P, cool to 4°C | SW-846 Method 7196 | 10 |
| Lead | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 5 |

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| Mercury | G, $HNO_3$ to pH <2 | SW-846 Method 7470A, EPA/600 Method 200.8 | 0.5 |
| Lithium | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 25 |
| Molybdenum | | | 20 |
| Selenium | | | 10 |
| Silicon | | | 20 |
| Thallium | | | 5 |
| Tin | | | 100 |
| Titanium | | | 5 |
| Zirconium | | | 25 |
| **Anions by Ion Chromatography** | | | |
| Bromide | P | EPA/600 Method 300.0[f] | 250 |
| Phosphate | | | 500 |
| **Pesticides** | | | |
| Endrin | G | SW-846 Method 8081B | 0.1 |
| Lindane (four isomers) | | | 0.05 |
| Methoxychlor | | | 0.5 |
| Toxaphene | | | 2 |
| **Herbicides** | | | |
| 2,4-D | G | SW-846 Method 8151A | 20 |
| 2,4-5-TP silvex | | | 1 |
| 2,4,5-T | | | 1 |
| **Volatile Organic Analyses** | | | |
| Acetone (by volatile organic analysis) | G, no headspace | SW-846 Method 8260B | 20 |
| Benzene | | | 5 |
| Carbon tetrachloride | | | 5 |
| Chloroform | | | 5 |
| 1,1,1-trichloroethane | | | 5 |

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| 1,1,2-trichloroethane | | | 5 |
| 1, 1-dichloroethane | | | 10 |
| 1, 2-dichloroethane | | | 5 |
| Methylene chloride | | | 5 |
| Methyl ethyl ketone | | | 10 |
| Methyl isobutyl ketone | | | 10 |
| P-dichlorobenzene | | | 5 |
| Trichloroethylene | | | 5 |
| Tetrachloroethylene | | | 5 |
| Tetrahydrofuran | | | 50 |
| Toluene | | | 5 |
| Trans-1, 2-dichloroethylene | | | 5 |
| Vinyl chloride | | | 10 |
| Xylene-m | | | 10 |
| Xylene-o, p | | | 10 |
| **Semivolatile Organic Analyses** | | | |
| Benzo(a)pyrene | Amber glass | SW-846 Method 8270D | 10 |
| Bis(2ethylhexyl)phthalate (DEHP) | | | 10 |
| Cresol (o,p,m) | | | 10 |
| n-nitrosodimethylamine | | | 10 |
| **Polychlorinated Biphenyls** | | | |
| Aroclor-1016 | G | SW-846 Method 8082 | 0.5 |
| Aroclor-1221 | | | 0.5 |
| Aroclor-1232 | | | 0.5 |
| Aroclor-1242 | | | 0.5 |
| Aroclor-1248 | | | 0.5 |
| Aroclor-1254 | | | 0.5 |
| Aroclor-1260 | | | 0.5 |

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Other** | | | |
| Ammonium ion | P, $H_2SO_4$ to pH <2 | EPA/600 Method 350.1, EPA/600 Method 300.7 | 50 |
| Coliform bacteria | P | Standard Method[g] 9223[h] | 2.2[i] |
| Conductivity, laboratory | P | Instrument/meter | 1 µohm |
| Cyanide | P, NaOH to pH >12 | SW-846 Method 9012, Standard Method[g] 4500, EPA/600 Method 335.2 | 5 |
| pH, laboratory measurement | P | Instrument/meter | 0.1 |
| pH, field measurement | Field measurement | Instrument/meter | 0.1 |
| Phenol | G | SW-846 Method 8040, SW-846 Method 8041, SW-846 Method 8270D | 5<br>5<br>10 |
| Temperature | Field measurement | Instrument/meter | |
| Turbidity, field measurement | Field measurement | Instrument/meter | 0.1 NTU |

Notes:

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

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

c. Detection limit units, unless otherwise indicated.

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

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

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

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

h. Enzyme substrate test.

i. Most probable number.

EPA = U.S. Environmental Protection Agency

N/A = not applicable

NTU = nephelometric turbidity unit

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

- Evaluation of impacts of laboratory QC failures on data quality
- Root-cause analysis of QC failures

- Evaluation of recurring conditions that are adverse to quality
- Trend analysis of quality-affecting problems
- Implementation of a quality improvement process
- Control of nonconforming materials that may affect quality

## A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

**Table A-4. Quality Control Samples**

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

Notes:

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

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

QC = quality control

### A2.5.1 Field Quality Control Samples

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

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

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

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

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

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

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

### A2.5.2 Laboratory Quality Control Samples

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

### A2.5.3 Quality Control Requirements

Table A-5 lists the acceptance criteria for QC samples, and Table A-6 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. Field and Laboratory Quality Control Elements and Acceptance Criteria**

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **General Chemical Parameters** | | | |
| Alkalinity<br>Conductivity<br>pH | 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** | | | |
| Arsenic<br>Cadmium<br>Chromium<br>ICP metals<br>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" |
| **Semivolatile 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-5. Field and Laboratory Quality Control Elements and Acceptance Criteria**

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|

Notes:

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 five times the detection limit.

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

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

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated method blank)

N = result may be biased (associated matrix spike result was outside the acceptance limits)

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

Abbreviations:

CRDL = contract-required detection limit

DUP = laboratory matrix duplicate

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

GC = gas chromatography

IC = ion chromatography

ICP = inductively coupled plasma

ICP/MS = inductively coupled plasma/mass spectrometry

LCS = laboratory control sample

MB = method blank

MDA = minimum detectable activity

MDL = method detection limit

MS = matrix spike

MSD = matrix spike duplicate

QC = quality control

RPD = relative percent difference

SUR = surrogate

**Table A-6. Double-Blind Standard Constituents and Schedule**

| Constituents | Frequency | Accuracy (%)* | Precision (% RSD)* |
|---|---|---|---|
| Fluoride | Quarterly | ±25% | ≤25% |
| Nitrate | Quarterly | ±25% | ≤25% |
| Chromium | Annually | ±20% | ≤20% |

Notes:

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

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.

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

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

## A2.7 Instrument/Equipment Calibration and Frequency

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

## A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support 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.

## A2.9 Non-Direct Measurements

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

## A2.10 Data Management

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

All field activities will be recorded in the field logbook.

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

# A3 Assessment and Oversight

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

## A3.1 Assessments and Response Actions

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

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

## A3.2 Reports to Management

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

# A4 Data Validation and Usability

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

## A4.1 Data Review, Verification, and Validation

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

## A4.2 Verification and Validation Methods

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

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

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

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

## A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

# A5 References

10 CFR 830, Subpart A, "Nuclear Safety Management," "Quality Assurance Requirements," *Code of Federal Regulations*.
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40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*.
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# Appendix B

# Well Lithologic Logs and Construction Details

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WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: J. Bultena
Drilling Company: Onwego Drilling
Date Started: 01Mar85

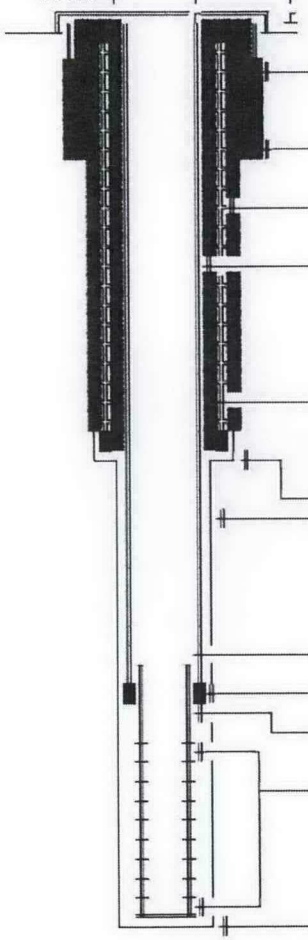
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: 0066
Company Location: Kennewick, WA
Date Complete: 11Apr85

WELL NUMBER: 299-E25-26
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 40,773 E/W W 45,884
State Coordinates: N 445,957 E 2,249,336
Start Card #: Not documented T R S
Elevation Ground surface: 668.51-ft Brass cap

Depth to water: 264-ft Apr85
[Ground surface] 266.1-ft 22Jun93

GENERALIZED STRATIGRAPHY — Geologist's Log

0-5: Silty SAND
5-10: Gravelly SAND
10-15: Silty SAND
15-20: Gravelly silty SAND
20-40: Gravelly SAND
40-65: SAND
65-75: SAND, SILT lenses
75-100: Gravelly SAND
100-103: SAND
103-105: Silty CLAY, silty SAND
105-110: SAND
110-130: SAND SILT CLAY lenses
130-150: SAND
150-160: Gravelly SAND
160-175: Sandy GRAVEL
175-195: Gravelly SAND
195-205: Sandy GRAVEL
205-240: Sandy GRAVEL, COBBLES
240-245: Sandy GRAVEL
245-255: Silty sandy GRAVEL
255-260: Gravelly silty SAND
260-285: Silty gravelly SAND
285-290: Silty SAND




Elevation of reference point: [668.55-ft] (top of casing)
Height of reference point above ground surface [0.04-ft]
Depth of surface seal [0-20-ft]
Type of surface seal: Cement grout between 8-in and 12-in casing which was partially pulled
Hole diameter, 13-in nominal 0-20-ft
8-in ID carbon steel casing, 0-150-ft, perforated 2 cuts/rd/ft
6-in ID carbon steel casing, 0-264-ft
Annular seal, cement grout between 6-in and perforated 8-in casing, 0-150-ft
Hole diameter, 20-150-ft, 9-in nominal
150-290-ft, 7-in nominal
Packer set, @ 248-ft
6-in casing pulled back from total depth
20-ft blank, 248-269-ft
6-in stainless steel telescoping screen, 269-289-ft, # 20-slot
Borehole drilled depth: [290-ft]

Drawing By: RKL/2E25-26.ASB
Date : 07Sep93
Reference : HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-26

| | | |
|---|---|---|
| WELL DESIGNATION | : | 299-E25-26 |
| RCRA FACILITY | : | A-29 Ditch |
| CERCLA UNIT | : | 200 Aggregate Area Management Study |
| HANFORD COORDINATES | : | N 40,772.8 W 45,884.5 [18JUl85] |
| LAMBERT COORDINATES | : | N 445,957 E 2,249,336 [HANCONV] |
| DATE DRILLED | : | Apr85 |
| DEPTH DRILLED (GS) | : | 290-ft |
| MEASURED DEPTH (GS) | : | Not documented |
| DEPTH TO WATER (GS) | : | 264-ft, Apr85;<br>266.1-ft, 22Jun93 |
| CASING DIAMETER | : | 8-in, carbon steel, 0-150-ft;<br>6-in, carbon steel, +.04-264-ft |
| ELEV TOP CASING | : | 668.55-ft, [18Jul85] |
| ELEV GROUND SURFACE | : | 668.51-ft, Brass cap [18Jul85] |
| PERFORATED INTERVAL | : | 8-in casing, 0-150; |
| SCREENED INTERVAL | : | 269-289-ft, 6-in #10 slot stainless steel |
| COMMENTS | : | FIELD INSPECTION, 09Apr93,<br>6 & 12-in carbon steel casing. Capped, not locked.<br>In middle of road under manhole cover.<br>No pad, posts or permanent identification.<br>Not in radiation zone. |
| AVAILABLE LOGS | : | Geologist |
| TV SCAN COMMENTS | : | Not applicable |
| DATE EVALUATED | : | Not applicable |
| EVAL RECOMMENDATION | : | Not applicable |
| LISTED USE | : | A29 Ditch monthly water level measurement, 01Jun85-22Jun93; |
| CURRENT USER | : | WHC ES&M w/l monitoring and RCRA sampling,<br>PNL sitewide sampling 93 |
| PUMP TYPE | : | Electric submersible |
| MAINTENANCE | : | |

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: L. Bultena
Drilling Company: Onwego Drilling
Date Started: 01Mar85

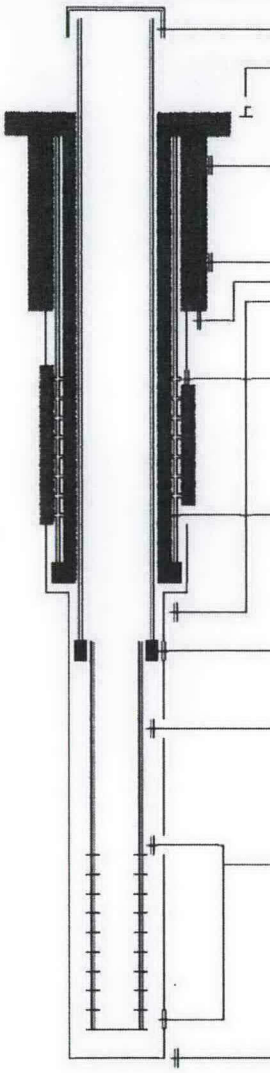
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Kennewick, WA
Date Complete: 11Apr85

WELL NUMBER: 299-E25-28
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 41,424 E/W W 45,541
State Coordinates: N 445,609 E 2,249,678
Start Card #: Not documented T R S
Elevation Ground surface: 660.34-ft Brass cap

Depth to water: 265-ft Apr85
(Ground surface) 258.1-ft 22Jun93

GENERALIZED STRATIGRAPHY — Geologist's Log

0-10: SAND
10-15: Fine SAND with SILT lenses
15-30: Coarse SAND
30-60: Coarse-fine SAND with SILT lenses
60-75: Silty SAND
75-90: Gravelly SAND
90-95: SAND
95-100: Silty gravelly SAND
100-115: Silty SAND
115-125: Layered SAND, BASALTIC GRAVEL
125-130: SAND
130-145: Silty SAND
145-155: Silty sandy GRAVEL
155-165: Silty GRAVEL/COBBLE
165-195: Silty GRAVEL
195-200: Silty sandy GRAVEL
200-210: Silty GRAVEL
210-220: Silty BASALTIC GRAVEL
220-225: Silty sandy BASALTIC GRAVEL
225-240: Sandy BASALTIC GRAVEL
240-245: Gravelly SAND
245-250: Silty clayey GRAVEL
250-255: Sandy GRAVEL
255-260: Silty sandy GRAVEL
260-265: SAND, clayey GRAVEL
265-275: Silty SAND
275-295: SAND
295-310: Sandy GRAVEL
310-315: Gravelly SAND
315-325: Sandy GRAVEL
325-330: Gravelly SAND
330-335: Clayey SAND
335-341: Silty gravelly SAND
341-348: BASALT



Elevation of reference point: [662.44-ft] (top of casing)
Height of reference point above round surface [2.1-ft]

Depth of surface seal [0-80-ft]
Type of surface seal: Cement grout between 8-in and 10-in casing as 10-casing was pulled back

Hole diameter,
0-80-ft, 11-in nominal
80-220-ft, 9-in nominal
220-348-ft, 7-in nominal

8-in ID carbon steel casing,
0-220-ft
Perforated,
148-198-ft, 2 cuts/rd/ft
198-202-ft, 2 cuts/rd, 2 rds/ft

Annular seal,
Cement/5% bentonite grout between 6-in and 8-in perforated casing
148-202-ft

6-in ID carbon steel casing,
+2.1-244-ft
(Pulled back from total depth)

80-ft blank,
240-320-ft
(Packer not documented)

6-in stainless steel telescoping screen,
320-340-ft, #10-slot

Borehole drilled depth: [348-ft]

Drawing By: RKL/2E25-28.ASB
Date : 07Sep93
Reference : HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-28

| | | |
|---|---|---|
| WELL DESIGNATION | : | 299-E25-28 |
| RCRA FACILITY | : | A-29 Ditch |
| CERCLA UNIT | : | 200 Aggregate Area Management Study |
| HANFORD COORDINATES | : | N 41,424 W 45,541 |
| LAMBERT COORDINATES | : | N 445,424 E 2,248,678 |
| DATE DRILLED | : | Apr85 |
| DEPTH DRILLED (GS) | : | 348-ft |
| MEASURED DEPTH (GS) | : | Not documented |
| DEPTH TO WATER (GS) | : | 265-ft, Apr85;<br>258.1-ft, 22Jun93 |
| CASING DIAMETER | : | 8-in, carbon steel, 0-220-ft;<br>6-in, carbon steel, +2.1-244-ft |
| ELEV TOP CASING | : | 662.44-ft, [15May86] |
| ELEV GROUND SURFACE | : | 660.34-ft, Brass cap [15May86] |
| PERFORATED INTERVAL | : | 8-in casing, 148-202-ft |
| SCREENED INTERVAL | : | 320-340-ft, telescoping, 6-in #10 slot stainless steel |
| COMMENTS | : | FIELD INSPECTION, 23Aug89,<br>6-in carbon steel casing.<br>18-in concrete pad, no posts, capped and locked.<br>No permanent identification. |
| AVAILABLE LOGS | : | Geologist |
| TV SCAN COMMENTS | : | Not applicable |
| DATE EVALUATED | : | Not applicable |
| EVAL RECOMMENDATION | : | Not applicable |
| LISTED USE | : | A29 Ditch monthly water level measurement, 01Jan87-22Jun93; |
| CURRENT USER | : | WHC ES&M w/l monitoring and RCRA sampling,<br>PNL sitewide sampling 93 |
| PUMP TYPE | : | Electric submersible |
| MAINTENANCE | : | |

NOTE: No as-built well log is available for well 299-E25-32P.

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WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200E Area Water
Driller's Name: Cordon/Garcia/Murphy
Drilling Company: Kaiser Engineers
Date Started: 03Jun88

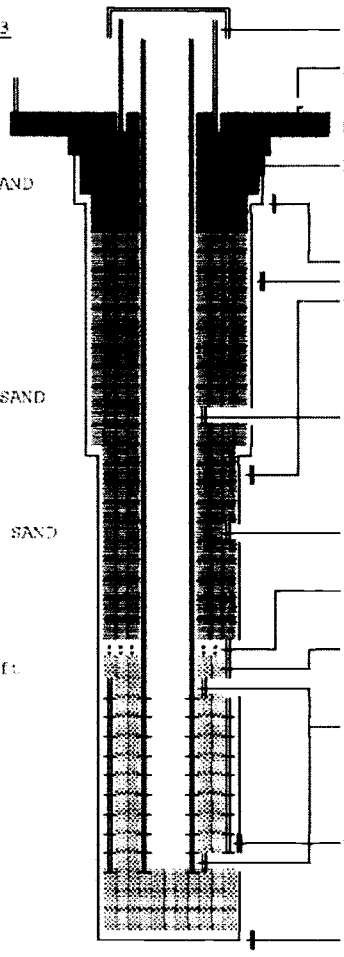
Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: 1143 (Garcia)
Company Location: Hanford
Date Complete: 19Sep88

WELL NUMBER: 299-E25-34
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 41,386 E/W W 45,517
State Coordinates: N 446,571 E 2,249,702
Start Card #: 007916 T 26E R 12N S 1
Elevation Ground surface: 660.62-ft (Brass cap)

Depth to water: 254.5-ft Sep88
(Ground surface) 258.2-ft 22Jun93

GENERALIZED Geologist's STRATIGRAPHY Log

0-10: Silty SAND
10-15: Silty sandy GRAVEL
15-20: Slightly silty gravelly SAND
20-30: Slightly gravelly slightly silty SAND
30-35: Slightly gravelly SAND
35-40: Silty SAND
40-55: SAND
55-65: Silty SAND
65-75: SAND
75-80: Gravelly SAND
80-85: Silty sandy GRAVEL
85-90: Gravelly silty SAND
90-100: Slightly silty gravelly SAND
100-105: Slightly gravelly slightly silty SAND
105-110: Gravelly SAND
110-115: SAND
115-120: Slightly gravelly SAND
120-125: Gravelly silty SAND
125-140: Slightly silty gravelly SAND
140-145: SAND
145-150: Slightly gravelly SAND
150-155: Gravelly SAND
155-180: Sandy GRAVEL
180-185: Silty sandy GRAVEL
185-195: Sandy GRAVEL
195-200: Apparent BOULDER @ 195 ft
200-210: Sandy GRAVEL
210-215: Silty sandy GRAVEL
215-225: Sandy GRAVEL
225-230: Gravelly SAND
230-245: Sandy GRAVEL
245-250: Gravelly SAND
250-255: Sandy GRAVEL
255-260: SAND
260-265: Silty sandy GRAVEL
265-270: SAND
270-275: Sandy GRAVEL
275-TD : Gravelly SAND



Elevation of reference point: [662.87-ft] (top of casing)
Height of reference point above ground surface [2.25-ft]

Depth of surface seal [2.2-20.1-ft]
Type of surface seal: Cement grout, 2.2-20.1-ft 4x4-ft x 4-in concrete pad extending 2.2-ft into annulus

Hole diameter,
0-10-ft, 13-in nominal
10-162.5-ft, 11-in nominal
162.5-276.0-ft, 9-in nominal

4-in ID T304 stainless steel casing, -ND-251.6-ft

Granular/powdered bentonite, 20.1-250.3-ft

1-in Enviroplug bentonite pellets, 250.3-251-ft

Silica sand pack, 251-276-ft, 6-30-mesh

4-in T304 stainless steel screen, 251.6-271.6-ft, #20-slot

8-in T304 stainless steel telescoping screen, 251.6-271.6-ft

Borehole drilled depth: [276.0-ft]

Drawing By: RKL/2E25-34.ASB
Date : 08Sep93
Reference : HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-34

| | | |
|---|---|---|
| WELL DESIGNATION | : | 299-E25-34 |
| RCRA FACILITY | : | A-29 Ditch |
| CERCLA UNIT | : | 200 Aggregate Area Management Study |
| HANFORD COORDINATES | : | N 41,385.9 W 45,516.8 [28Oct88-200E] |
| LAMBERT COORDINATES | : | N 446,571 E 2,249,702 [HANCONV] |
| DATE DRILLED | : | Sep88 |
| DEPTH DRILLED (GS) | : | 276-ft |
| MEASURED DEPTH (GS) | : | Not documented |
| DEPTH TO WATER (GS) | : | 254-ft, Sep88;<br>258.2-ft, 22Jun93 |
| CASING DIAMETER | : | 6-in, stainless steel, +2.25--0.5-ft;<br>4-in, stainless steel, +ND-252-ft |
| ELEV TOP CASING | : | 662.87-ft, [28Oct88-200E] |
| ELEV GROUND SURFACE | : | 660.62-ft, Brass cap [28Oct88-200E] |
| PERFORATED INTERVAL | : | Not applicable |
| SCREENED INTERVAL | : | 251.6-271.6-ft, 4-in stainless steel, #20-slot |
| COMMENTS | : | FIELD INSPECTION, 23Aug89;<br>Stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable capped and locked, brass cap in pad with well ID. |
| AVAILABLE LOGS | : | Geologist |
| TV SCAN COMMENTS | : | Not applicable |
| DATE EVALUATED | : | Not applicable |
| EVAL RECOMMENDATION | : | Not applicable |
| LISTED USE | : | A29 Ditch water level measurement, 18Oct88-22Jun93; |
| CURRENT USER | : | WHC ES&M w/l monitoring and RCRA sampling,<br>PNL sitewide w/l monitoring |
| PUMP TYPE | : | Hydrostar |
| MAINTENANCE | : | |

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200E Area Water
Driller's Name: Amos/Wamsley
Drilling Company: Kaiser Engineers
Date Started: 03May88
Date Complete: 27Aug88

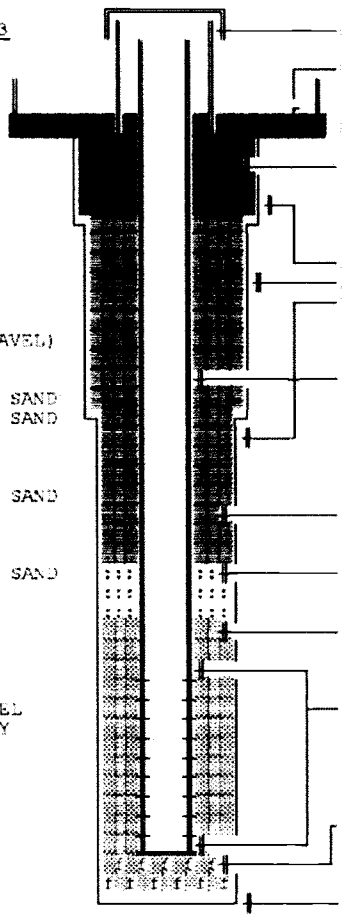
Sample Method: Not documented
Additives Used: Not documented
WA State Lic Nr: 1224 (Amos)
Company Location: Hanford

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

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

GENERALIZED Geologist's STRATIGRAPHY Log

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



Elevation of reference point: [674.39-ft] (top of casing)
Height of reference point above ground surface [3.4-ft]

Depth of surface seal [3-19.5-ft]
Type of surface seal: Cement grout 3-19.5-ft 4x4-ft x 4-in concrete pad extends 3.0-ft into annulus

Hole diameter,
3.0-20.2-ft, 13-in nominal
20.2-145.3-ft, 11-in nominal
145.3-285-ft, 9-in nominal

4-in ID T304 stainless steel casing, +ND-260.5-ft

Bentonite crumbles, 19.5-250.9-ft

Bentonite pellets, 250.9-256.2-ft

Silica sand pack, 256.2--281.0-ft, 10-20-mesh

4-in stainless steel screen, 260.5-281.0-ft, #20-slot

Fill, ~281-285.0-ft

Borehole drilled depth: [285.0-ft]

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

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

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

A4795 / 299-E25-48

## WELL CONSTRUCTION AND COMPLETION SUMMARY

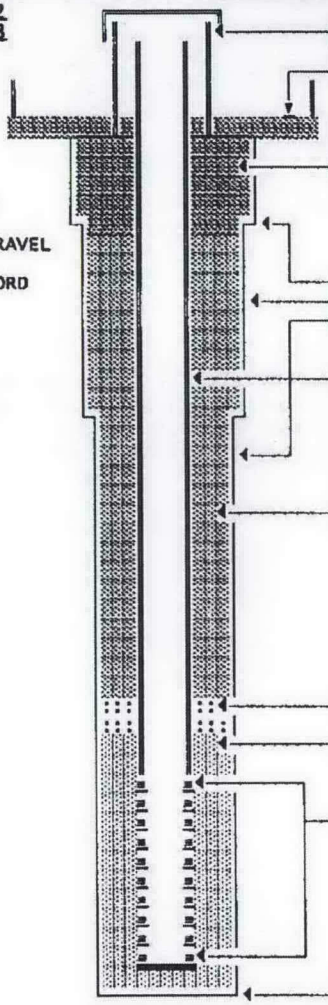
Drilling Method: Backhoe/Air rotary
Downhole hammer
Sample Method: Continous
Air returns
Drilling Fluid Used: None
Additives Used: None documented
Driller's Name: D. Mingo
WA State Lic Nr: Not documented
Drilling Company: Jensen Drilling Co
Company Location: Not documented
Date Started: 01Jul92
Date Complete: 01Oct92

WELL NUMBER: 299-E25-48
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 40,456.8 E/W W 46,816.1
State NAD83 N 135,815.16m 575,623.43m
Coordinates: N 445,638 E 2,248,405
Start Card #: Not documented T R S
Elevation Ground surface: 679.68-ft (Brass cap)

Depth to water: 276.3-ft 25Aug92
(Ground surface) 277.0-ft 22Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's

0↔20: SAND
20↔30: Gravelly (pebbly) SAND
30↔40: Sandy (pebble) GRAVEL
40↔50: Sl gravelly (pebbly) SAND
50↔60: Sandy (pebble) GRAVEL
60↔75: Sl silty sandy (pebble) GRAVEL
75↔85: (Pebble) GRAVEL
HANFORD Upper coarse/HANFORD Fine contact @85-ft
85↔90: (Pebbly) gravelly SAND
90↔110: Sl silty SAND
110↔202: SAND
202↔208: Silty SAND
208↔220: SAND
220↔225: (Pebbly) gravelly SAND
225↔230: Sandy (cobble) GRAVEL
230↔235: (Pebbly) gravelly SAND
235↔245: SAND
245↔248: Silty SAND
248↔266.5: SAND
HANFORD Fine/RINGOLD contact @ 266.5-ft
266.5↔280: Sandy SILT
280↔285: Sl gravelly SAND
285↔295: Sl sandy GRAVEL
295↔297.5: Sandy GRAVEL



Elevation of reference point: [682.31-ft] (top of casing)
Height of reference point above ground surface [2.63-ft]
Depth of surface seal [2.0↔10.3-ft]
Type of surface seal: Cement grout, 2.0↔10.3-ft 4x4-ft x 4-in concrete pad extends 2.0-ft into annulus
Hole diameter,
2.0↔9.5-ft, 13-in nominal
9.5↔168.8-ft, 11-in nominal
168.8↔297.5-ft, 9-in nominal
4-in ID stainless steel casing, +1.4↔274.3-ft
Bentonite crumbles, 10.3↔262.6-ft, 8↔20-mesh
3/8-in bentonite pellets 262.6↔268.4-ft
Silica sand pack, 268.4↔297.5-ft, 20↔40-mesh
4-in T304 stainless steel screen, 274.3↔294.6-ft, #10-slot w/cap
Borehole drilled depth: [297.5-ft]

Drawing By: RKL/2E25-48.ASB
Date : 08Sep93
Reference : WHC-SD-EN-DP-054

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-48

| | | |
|---|---|---|
| WELL DESIGNATION | : | 299-E25-48 |
| RCRA FACILITY | : | Grout |
| CERCLA UNIT | : | Not applicable |
| HANFORD COORDINATES | : | N 40,456.8 W 46,816.1 [30Dec92-200E] |
| LAMBERT COORDINATES | : | N 445,638 E 2,248,405 [HANCONV]; |
| | | N 135,815.16m E 575,623.43m [NAD83-30Dec92] |
| DATE DRILLED | : | Oct92 |
| DEPTH DRILLED (GS) | : | 297.5-ft |
| MEASURED DEPTH (GS) | : | 286.1-ft, 03Nov92 |
| DEPTH TO WATER (GS) | : | 276.3-ft, 25Aug92 |
| | | 277.0-ft, 22Jun93 |
| CASING DIAMETER | : | 6-in, stainless steel, +2.6↔-0.5-ft; |
| | | 4-in, stainless steel, +1.4↔274.3-ft |
| ELEV TOP CASING | : | 682.31-ft, [30Dec92-NGVD'29] |
| ELEV GROUND SURFACE | : | 679.68-ft, Brass cap [30Dec92-NGVD'29] |
| PERFORATED INTERVAL | : | Not applicable |
| SCREENED INTERVAL | : | 274.3↔294.6-ft, 4-in stainless steel, #10-slot |
| COMMENTS | : | FIELD INSPECTION, 03Nov92; |
| | | 4 and 6-in stainless steel casing. |
| | | 4-ft by 4-ft concrete pad, 4 posts, 1 removable. |
| | | Capped and locked, brass cap in pad with well ID. |
| | | Not in radiation zone. |
| AVAILABLE LOGS | : | Geologist |
| TV SCAN COMMENTS | : | Not applicable |
| DATE EVALUATED | : | Not applicable |
| EVAL RECOMMENDATION | : | Not applicable |
| LISTED USE | : | A-29 Ditch monthly water level measurement, 14Dec92↔22Jun93; |
| CURRENT USER | : | WHC ES&M w/l monitoring and RCRA sampling, |
| | | PNL sitewide sampling 93 |
| PUMP TYPE | : | Hydrostar, intake @ 257.4-ft (GS) |
| MAINTENANCE | : | |

WELL CONSTRUCTION AND COMPLETION SUMMARY A41801

Drilling Method: Cable tool
Drilling Fluid Used: None
Driller's Name: R Thomas/J Carpenter
Drilling Company: Kaiser Engineers
Date Started: 03Jun91

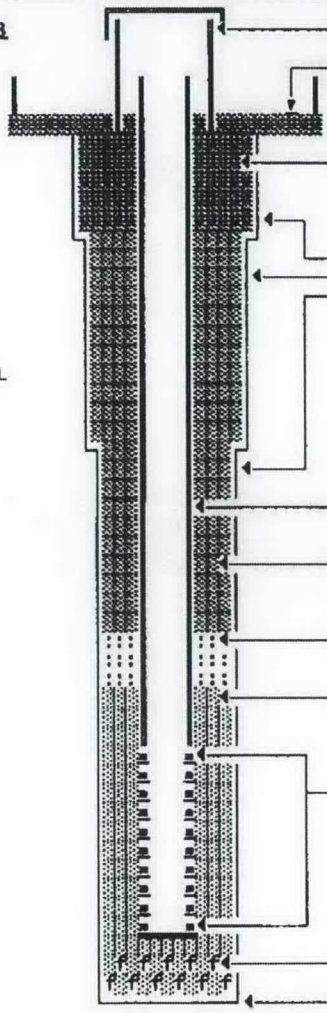
Sample Method: Drive barrel
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 13Aug91

WELL NUMBER: 299-E26-12
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 42,313.1 E/W W 44,929.2
State NAD83 N 136,383.2m E 576,197.7m
Coordinates: N 447,500 E 2,250,287
Start Card #: Not documented T___ R___ S___
Elevation Ground surface: 627.27-ft (Brass cap)

Depth to water: 222.5-ft Jul91
(Ground surface)224.4-ft 22Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-5: Silty gravelly SAND
5-10: Sl silty sl gravelly SAND
10-15: Sl silty SAND
15-30 Silty SAND
30-45: Sl silty SAND
45-55: Sl silty gravelly SAND
55-60: Sl gravelly SAND
60-65: Sl gravelly silty SAND
65-85: Sl silty gravelly SAND
85-95: Sl silty SAND
95-115: Gravelly SAND
115-155: Sandy GRAVEL
155-165: Sl silty sl sandy GRAVEL
165-170: GRAVEL
170-180: Sl sandy GRAVEL
180-185: Sandy GRAVEL
185-200: Sl sandy GRAVEL
200-210: Sandy GRAVEL
210-215: Sl silty sandy GRAVEL
215-235: Sandy GRAVEL
235-240: Sl silty sandy GRAVEL
240-242.2: Sandy GRAVEL



Elevation of reference point: [630.74-ft] (top of casing)
Height of reference point above ground surface [3.47-ft]
Depth of surface seal [2.5-20.4-ft]
Type of surface seal: Cement grout, 2.5-20.4-ft, 4x4-ft x 6-in concrete pad extending 2.5-ft into annulus
Hole diameter,
2.5-20.3-ft, 13-in nominal
20.3-153.3-ft, 11-in nominal
153.3-242.2-ft, 9-in nominal
4-in ID T304 stainless steel casing, +1.0-217.6-ft
Bentonite crumbles, 20.4-206.6-ft, 8-20-mesh
¼-in bentonite pellets, 206.6-213.1-ft
Silica sand pack, 213.1-240.0-ft, 10-20-mesh
4-in, T304 stainless steel screen, 217.6-238.6-ft, #20-slot
Fill, 240.0-242.2-ft
Depth to bottom of borehole: [242.2-ft]

Drawing By: RKL/2E26-12.ASB
Date : 09Sep93
Reference: WHC-SD-EN-DP-047

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E26-12

| | | |
|---|---|---|
| WELL DESIGNATION | : | 299-E26-12 |
| CERCLA UNIT | : | 200 Aggregate Area Management Study |
| RCRA FACILITY | : | A-29 Ditch |
| HANFORD COORDINATES | : | N 42,313.1 W 44,929.2 [200E-31Oct91] |
| LAMBERT COORDINATES | : | N 447,500 E 2,250,287 [HANCONV] |
| | | N 136,383.2m E 576,197.7m [NAD83-20May92] |
| DATE DRILLED | : | Aug91 |
| DEPTH DRILLED (GS) | : | 242.2-ft |
| MEASURED DEPTH (GS) | : | 239.2-ft, 08Apr93 |
| DEPTH TO WATER (GS) | : | 222.5-ft, 01Jul91 |
| | | 224.4-ft, 22Jun93 |
| CASING DIAMETER | : | 4-in stainless steel, +1.0↔217.6-ft; |
| | | 6-in stainless steel, +3.47↔-0.5-ft |
| ELEV TOP CASING | : | 630.74-ft, [NGVD'29-31Oct92] |
| ELEV GROUND SURFACE | : | 627.27-ft, Brass cap [NGVD'29-31Oct92] |
| PERFORATED INTERVAL | : | Not applicable |
| SCREENED INTERVAL | : | 217.6↔238.6-ft, 4-in #20-slot stainless steel; |
| COMMENTS | : | FIELD INSPECTION, 08Apr93; |
| | | 4 and 6-in stainless steel casing. |
| | | 4-ft by 4-ft concrete pad, 4 posts, 1 removable. |
| | | Capped and locked, brass cap in pad with well ID. |
| | | Not in radiation zone. |
| | | OTHER: |
| AVAILABLE LOGS | : | Geologist |
| TV SCAN COMMENTS | : | Not applicable |
| DATE EVALUATED | : | Not applicable |
| EVAL RECOMMENDATION | : | Not applicable |
| LISTED USE | : | A-29 Ditch monthly water level measurement, 28Oct91↔22Jun93; |
| CURRENT USER | : | WHC ES&M w/l monitoring and RCRA sampling, |
| | | PNL sitewide sampling 93 |
| PUMP TYPE | : | Hydrostar, intake @ 235.5-ft (GS) |
| MAINTENANCE | : | |

WELL CONSTRUCTION AND COMPLETION SUMMARY A4802

Drilling Method: Cable tool
Drilling Fluid Used: Raw water
Driller's Name: K Blackman/B Smith
Drilling Company: Kaiser Engineers
Date Started: 03Jun91

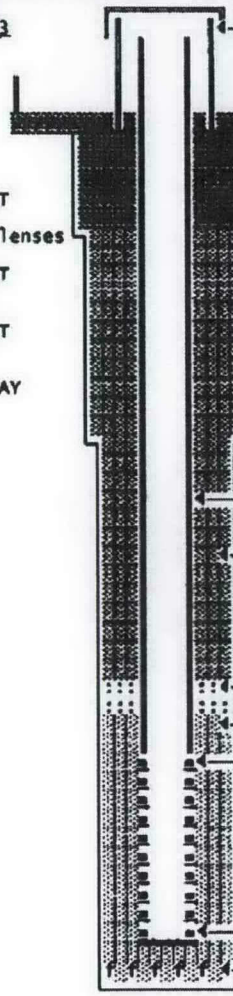
Sample Method: Drive barrel
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 16Aug91

WELL NUMBER: 299-E26-13
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 42,790.3 E/W W 44,922.6
State NAD83 N 136,528.6m E 576,199.3m
Coordinates: N 447,977 E 2,250,293
Start Card #: Not documented T___ R___ S___
Elevation Ground surface: 601.57-ft (Brass cap)

Depth to water: 197.0-ft Jun91
(Ground surface)198.8-ft 22Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-15: Sl silty gravelly SAND
15-20:Sl silty SAND
20-25: SAND w/trace SILT
25-40: Gravelly SAND w/trace SILT
40-45: Silty SAND w/SILT lenses
45-45: Silty SAND w/GRAVEL-SILT lenses
45-50: Silty SAND w/GRAVEL
50-65: Gravelly SAND w/trace SILT
65-70: SAND
70-80: Gravelly SAND
80-90: Gravelly SAND w/trace SILT
90-140: Sandy GRAVEL
140-160: Sandy clayey GRAVEL
160-170: Sandy GRAVEL w/trace CLAY
170-205: Sandy clayey GRAVEL
205-210: Sandy GRAVEL
210-215: Sandy clayey GRAVEL



Elevation of reference point: [605.02-ft] (top of casing)
Height of reference point above ground surface [ 3.47-ft ]
Depth of surface seal [2.9-18.8-ft]
Type of surface seal: Cement grout, 2.9-18.8-ft, 4x4-ft x 6-in concrete pad extends 2.9-ft into annulus
Hole diameter,
2.9-20.5-ft, 13-in nominal
20.5-156.3-ft, 11-in nominal
156.3-215.0-ft, 9-in nominal
4-in ID T304 stainless steel casing, +1.0-191.7-ft
Bentonite crumbles, 18.8-182.2-ft, 8-20-mesh
½-in bentonite pellets, 182.2-187.6-ft
Silica sand pack, 187.6-213.9-ft, 10-20-mesh
4-in T304 stainless steel screen, 191.7-212.3-ft, #20-slot
Fill, 213.9-215.0-ft
Borehole drilled depth: [ 215.0-ft]

Drawing By: RKL/2E26-13.ASB
Date : 09Sep93
Reference : WHC-SD-EN-DP-047

## SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
## RESOURCE PROTECTION WELL - 299-E26-13

| | | |
|---|---|---|
| WELL DESIGNATION | : | 299-E26-13 |
| CERCLA UNIT | : | 200 Aggregate Area Management Study |
| RCRA FACILITY | : | A-29 Ditch |
| HANFORD COORDINATES | : | N 42,790.3 W 44,922.6 [200E-31Oct91] |
| LAMBERT COORDINATES | : | N 447,977 E 2,250,293 [HANCONV] |
| | | N 136,528.6 E 576,199.3m [NAD83-31Oct91] |
| DATE DRILLED | : | Aug91 |
| DEPTH DRILLED (GS) | : | 215.0-ft |
| MEASURED DEPTH (GS) | : | 213.0-ft, 08Apr93 |
| DEPTH TO WATER (GS) | : | 197.0-ft, 19Jun91 |
| | | 198.8-ft, 22Jun93 |
| CASING DIAMETER | : | 4-in stainless steel, +1.0↔191.7-ft; |
| | | 6-in stainless steel, +3.45↔-0.5-ft |
| ELEV TOP CASING | : | 605.02-ft, [NGVD'29-31Oct92] |
| ELEV GROUND SURFACE | : | 601.57-ft, Brass cap [NGVD'29-31Oct92] |
| PERFORATED INTERVAL | : | Not applicable |
| SCREENED INTERVAL | : | 191.7↔212.3-ft, 4-in #20-slot stainless steel; |
| COMMENTS | : | FIELD INSPECTION, 08Apr93; |
| | | 4 and 6-in stainless steel casing. |
| | | 4-ft by 4-ft concrete pad, 4 posts, 1 removable. |
| | | Capped and locked, brass cap in pad with well ID. |
| | | Not in radiation zone. |
| | | OTHER: |
| AVAILABLE LOGS | : | Geologist |
| TV SCAN COMMENTS | : | Not applicable |
| DATE EVALUATED | : | Not applicable |
| EVAL RECOMMENDATION | : | Not applicable |
| LISTED USE | : | A-29 Ditch monthly water level measurement, 01Nov91↔22Jun93; |
| CURRENT USER | : | WHC ES&M w/l monitoring and RCRA sampling, |
| | | PNL sitewide sampling 93 |
| PUMP TYPE | : | Hydrostar, intake @ 208.6-ft (GS) |
| MAINTENANCE | : | |

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200E Area Water
Driller's Name: L. Watkins
Drilling Company: KEH
Date Started: 02May89

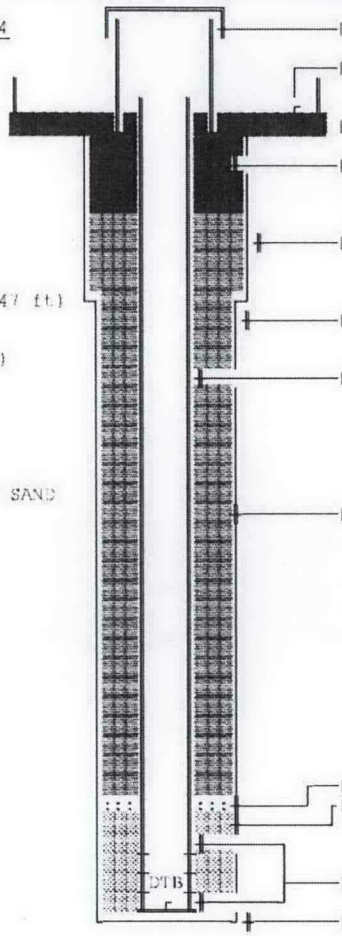
Sample Method: Drive barrel & Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 02Jun89

WELL NUMBER: 699-43-45 A5180
TEMPORARY WELL NO: BP-1
Hanford Coordinates: N/S N 42,977.4 E/W W 44,643.6
State Coordinates: N 448,164.7 E 2,250,571.2
Start Card #: 011453 T 12N R 26E S 1NW
Elevation Ground surface: 594.70-ft Brass cap

Depth to water: 187.7-ft Jun89
(Ground surface) 192.1-ft 22Jul94

GENERALIZED Geologist's STRATIGRAPHY Log

5-10: Muddy SAND
10-15: Gravelly SAND
15-20: SAND (medium)
20-25: Slightly gravelly SAND
25-40: Gravelly SAND
40-43: SAND
43-45: Slightly muddy med to very fine SAND
45-50: Muddy SAND(Perched water-47 ft)
50-60: SAND
60-70: Slightly gravelly SAND
70-85: SAND (COBBLES at 72-73 ft)
85-115: Sandy GRAVEL
115-135: Muddy sandy GRAVEL
135-146: Slightly sandy GRAVEL
146-150: Muddy GRAVEL
150-155: Sandy GRAVEL
155-195: Muddy sandy GRAVEL
195-200: Slightly muddy gravelly SAND
200-203: Gravelly SAND




Elevation of reference point: [597.68-ft] (top of casing)
Height of reference point above ground surface [3.0-ft]
Depth of surface seal [3.4-18.5-ft]
Type of surface seal: Cement grout to 18.5-ft 4 x 4-ft x 4-in concrete pad extends 3.4-ft into annulus
11-in nominal hole, 0-47-ft
9-in nominal hole, 47.0-203.4-ft
4-in ID T304 stainless steel casing, 40.5-183.0-ft
Granular bentonite, 18.5-173.4-ft
Bentonite pellets, 173.4-179.2-ft
Silica sand pack, 179.2-203.6-ft, 8-20-mesh
4-in T304 stainless steel screen, 183.0-203.3-ft, #20-slot
Borehole drilled depth: [203.6-ft]

DTB=Depth to bottom, 203.9-ft, 08Apr93

Drawing By: RKL/6N43W45.ASB
Date : 22Sep94
Reference : HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 699-43-45

| | | |
|---|---|---|
| WELL DESIGNATION | : | 699-43-45 |
| RCRA FACILITY | : | 216-B-3 Pond |
| CERCLA UNIT | : | Not applicable |
| HANFORD COORDINATES | : | N 42,977 W 44,644 [28Sep89-200E] |
| LAMBERT COORDINATES | : | N 448,165 E 2,250,571 [HANCONV] |
| | | N 136,585.7m E 576,284.2m [28Sep89-NAD83] |
| DATE DRILLED | : | Jun89 |
| DEPTH DRILLED (GS) | : | 203.6-ft |
| MEASURED DEPTH (GS) | : | 203.9-ft, 08Apr93 |
| DEPTH TO WATER (GS) | : | 187.7-ft, Jun89, |
| | | 192.1-ft, 22Jul94 |
| CASING DIAMETER | : | 4-in, stainless steel, +0.5-183.0-ft, |
| | | 6-in, stainless steel, +3.0--0.5-ft |
| ELEV TOP CASING | : | 597.68-ft (6-in) [28Sep89-UNK] |
| | | 595.2-ft, (4-in) [28Sep89-UNK] |
| ELEV GROUND SURFACE | : | 594.70-ft, Brass cap [28Sep89-UNK] |
| PERFORATED INTERVAL | : | Not applicable |
| SCREENED INTERVAL | : | 183.0-203.3-ft, 4-in stainless steel, #20-slot |
| COMMENTS | : | FIELD INSPECTION, 08Apr93; |
| | | 4 and 6-in stainless steel casing. |
| | | 4-ft by 4-ft concrete pad, 4 posts, 1 removable. |
| | | Capped and locked, brass cap in pad with well ID. |
| | | Not in radiation zone. |
| | | OTHER; |
| AVAILABLE LOGS | : | Geologist, Driller |
| TV SCAN COMMENTS | : | Not applicable |
| DATE EVALUATED | : | Not applicable |
| EVAL RECOMMENDATION | : | Not applicable |
| LISTED USE | : | B-Pond monthly water level measurement, 24Oct89-22Jul94, |
| CURRENT USER | : | WHC ES&M w/l monitoring and RCRA sampling, |
| | | PNL sitewide w/l monitoring |
| PUMP TYPE | : | Hydrostar, |
| MAINTENANCE | : | |

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DOE/RL-2008-61
Revision 0

# Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch

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-2008-61
Revision 0

# Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch

Date Published
January 2010

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

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# Executive Summary

This document presents a revision to the 2002 groundwater monitoring plan[1] for the 216-S-10 Pond and Ditch (hereinafter referred to collectively as the S-10 unit). This monitoring plan is based on requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA)[2] and amended by the *Revised Code of Washington* (RCW) 70.105.[3]

The S-10 unit is one of three non-operating treatment, storage, and disposal (TSD) units in the 200-CS-1 Chemical Sewer Operable Unit (OU). The S-10 unit is regulated as a surface impoundment and has been as designated as a TSD unit because it received nonradioactive dangerous waste regulated by 40 *Code of Federal Regulations* (CFR) 261[4] after November 19, 1980.

This monitoring plan describes the revised well network and updates the list of constituents based on knowledge gained from recent monitoring data collected for this site, the 2006 closure plan submittal process, and information from the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[5] 200-CS-1 OU. This plan includes the operational history, current hydrogeology, and groundwater monitoring results for the site and incorporates the sum of knowledge regarding the potential for contamination originating from the S-10 unit. A conceptual model is developed based on these attributes of the S-10 unit and the data quality objectives process.

The S-10 unit is located south-southwest of the Hanford Site's 200 West Area, outside of the perimeter fence. The 216-S-10 Ditch (S-10 Ditch) began receiving wastewater from the Reduction-Oxidation (REDOX) Plant in August 1951. The 216-S-10 Pond (S-10 Pond) was added to the southwest end of the S-10 Ditch in 1954. Both the pond and ditch served as an evaporation/infiltration basins for liquid discharges. Wastewater discharged into the S-10 Ditch flowed into the S-10 Pond, then infiltrated into the ground, which created perched water in the vadose zone and created a groundwater mound on the underlying aquifer.

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1 PNNL-14070, 2002, *Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

2 *Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901, et seq.

3 RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*.

4 40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*.

5 *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 U.S.C. 9601, et seq.

The S-10 Pond and the southwest end of the S-10 Ditch were decommissioned, backfilled, and stabilized in October 1985. The northern portion of the S-10 Ditch remained operational and received nondangerous chemical sewer waste from the REDOX Plant until October 1991. In July 1994, the effluent supply pipeline was plugged with concrete near the outfall. The remaining portion of the S-10 Ditch was permanently decommissioned in 1991.

The S-10 unit received discharges of nonregulated wastewater from the REDOX Plant chemical sewer through 1972. The most significant chemical discharges included acidic and caustic effluents associated with backwashing for regenerating the demineralizer columns. The S-10 Ditch last received nonregulated wastewater discharge in October 1991.

In September 1983, a documented dangerous waste discharge to the S-10 unit occurred. In this incident, 416.4 L (110 gal) of synthetic double-shell tank slurry was discharged to the S-10 unit from the Chemical Engineering Laboratory. The waste consisted largely of sodium nitrate (46 percent) and sodium hydroxide (41 percent), with small quantities of sodium phosphate, sodium fluoride, sodium chloride, and potassium chromate. Samples of this slurry taken from feed tanks were analyzed before the discharge occurred and include characteristic dangerous waste (ignitable [D001], corrosive [D002], and characteristic [D007]) and Washington-only toxic waste (WT01 and WT02).

Because the S-10 unit received a known discharge of dangerous waste/dangerous waste constituents, a contamination indicator groundwater monitoring program was implemented in 1991. Several past waste disposal sites are located upgradient of the S-10 unit, including the cribs, ponds, and associated ditches. It is important to note that historical discharges to these sites appear to have influenced the groundwater chemistry beneath the S-10 unit. Thus, it is not currently possible to distinguish the effects of these surrounding waste sites from that of the S-10 unit.

Elevated total organic halides (TOX) have been measured in both upgradient and downgradient wells, indicating a source outside of the S-10 unit. The elevated TOX is related to the carbon tetrachloride plume emanating from the 216-Z-1A, 216-Z-9, and 216-Z-18 Cribs upgradient of the S-10 unit.

To date, no dangerous waste that can be conclusively linked to the S-10 unit has contaminated groundwater beneath the S-10 unit. Therefore, the site remains under contamination indicator evaluation monitoring.

The declining water table in the 200 West Area, particularly near the S-10 unit, has resulted in many wells going dry. Water levels in all of the original upper aquifer monitoring wells have declined below their screened intervals. Until April 2008, only two downgradient wells (299-W26-13 and 299-W26-14) remained available for monitoring the S-10 unit. One supplemental deep well (299-W27-2, which monitors the base of the uppermost unconfined aquifer) was also available for sampling.

Three new wells (699-32-76, 699-33-75, and 699-33-76) were completed in April 2008, with first quarter sampling conducted in May. The revised groundwater monitoring network is made up of one upgradient and four downgradient wells. The supplemental deep downgradient well will also remain in the network

The newly installed well 699-33-76 will serve as the upgradient well. Starting in fiscal year 2010, critical mean data from this well will replace the 2003 data from well 299-W27-7 for use in statistical comparisons. The new wells 699-32-76 and 699-33-75 will be added to the existing downgradient wells 299-W26-13 and 299-W26-14. Deep well 299-W27-2 will continue to be monitored for supplemental information.

No additional replacement wells are currently anticipated for the current network. If replacement wells become necessary in the future, the replacement wells will be located after evaluating the then-current understanding of hydrogeologic conditions under the facility, evaluating the projected water-level elevations and flow conditions, and consulting with the Washington State Department of Ecology.

The groundwater in S-10 unit monitoring wells will be sampled and analyzed semiannually for contamination indicator parameters TOX, total organic carbon, pH, and specific conductance in accordance with *Washington Administrative Code* (WAC) 173-303-400(3).[6] Major dissolved anions, metals, phenols, alkalinity, turbidity, and temperature are included as indicators of sample and analytical quality, as well as general aquifer/well background conditions.

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6 WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code.*

Previous groundwater monitoring detected other constituents above background. The 200-CS-1 feasibility study[7] also identified constituents with the potential to present a future concern. These constituents will continue to be monitored under this monitoring plan.

[7] DOE/RL-2005-63, 2008, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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# Terms

| | |
|---|---|
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| CFR | *Code of Federal Regulations* |
| DQO | data quality objective |
| DWS | drinking water standard |
| Ecology | Washington State Department of Ecology |
| OU | operable unit |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| RCW | *Revised Code of Washington* |
| REDOX | Reduction-Oxidation (Plant) |
| TOC | total organic carbon |
| TOX | total organic halides |
| TSD | treatment, storage, and disposal |
| WAC | *Washington Administrative Code* |

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# 1 Introduction

This document establishes the groundwater monitoring plan for the 216-S-10 Pond and Ditch (hereinafter referred to collectively as the S-10 unit) and supersedes the previous monitoring plan, *Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch* (PNNL-14070). This plan is based on requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA) and amended by *Revised Code of Washington* (RCW) 70.105, "Hazardous Waste Management." These regulations are promulgated by the Washington State Department of Ecology (Ecology) in *Washington Administrative Code* (WAC) 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"; and by reference, 40 *Code of Federal Regulations* (CFR) 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring."

The S-10 unit is one of three non-operating treatment, storage, and disposal (TSD) units in the 200-CS-1 Chemical Sewer Operable Unit (OU). The S-10 unit is regulated as a surface impoundment, as defined in WAC 173-303-040 ("Definitions") (Figure 1-1) and has been designated as a TSD unit because it received nonradioactive dangerous waste regulated under 40 CFR 261 ("Identification and Listing of Hazardous Waste") after November 19, 1980. For regulatory purposes, the TSD unit boundary of the S-10 unit is identified on the current Dangerous Waste Permit Application Part A form (WA7890008967, *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*).

Closure of the S-10 unit will be coordinated in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) as part of the 200-CS-1 OU (vadose zone). It is anticipated that associated groundwater concerns will be addressed under the 200-UP-1 Groundwater OU.

This groundwater monitoring plan describes a revised well network and updates the list of constituents based on knowledge gained from recent monitoring data collected for this site, the 2006 closure plan submittal process, and information from the CERCLA 200-CS-1 OU. The plan includes the current interpretation of groundwater flow and a summary of recent groundwater analytical results. Additionally, a conceptual model of contaminant transport through the vadose zone beneath the S-10 unit is presented to assist in developing appropriate monitoring for this waste site.

The S-10 unit is located south-southwest of the 200 West Area, outside the perimeter fence (Figure 1-1). The 216-S-10 Ditch (S-10 Ditch) began receiving wastewater from the Reduction-Oxidation (REDOX) Facility in August 1951. The 216-S-10 Pond (S-10 Pond) was added to the southwest end of the S-10 Ditch in 1954 and, like the ditch, served as an evaporation/infiltration basin for liquid discharges. Wastewater discharged into the S-10 Ditch flowed into the S-10 Pond and infiltrated into the ground, which created perched water in the vadose zone and created a groundwater mound on the underlying aquifer.

The S-10 Pond and the southwest end of the S-10 Ditch were decommissioned, backfilled, and stabilized in October 1985. The northern portion of the S-10 Ditch remained operational and received nondangerous chemical sewer waste from the REDOX Facility until October 1991 (BHI-00176, *S Plant Aggregate Area Management Study Technical Baseline Report*). In July 1994, the effluent supply pipeline was plugged with concrete near the outfall. The remaining portion of the S-10 Ditch was decommissioned in 1991.

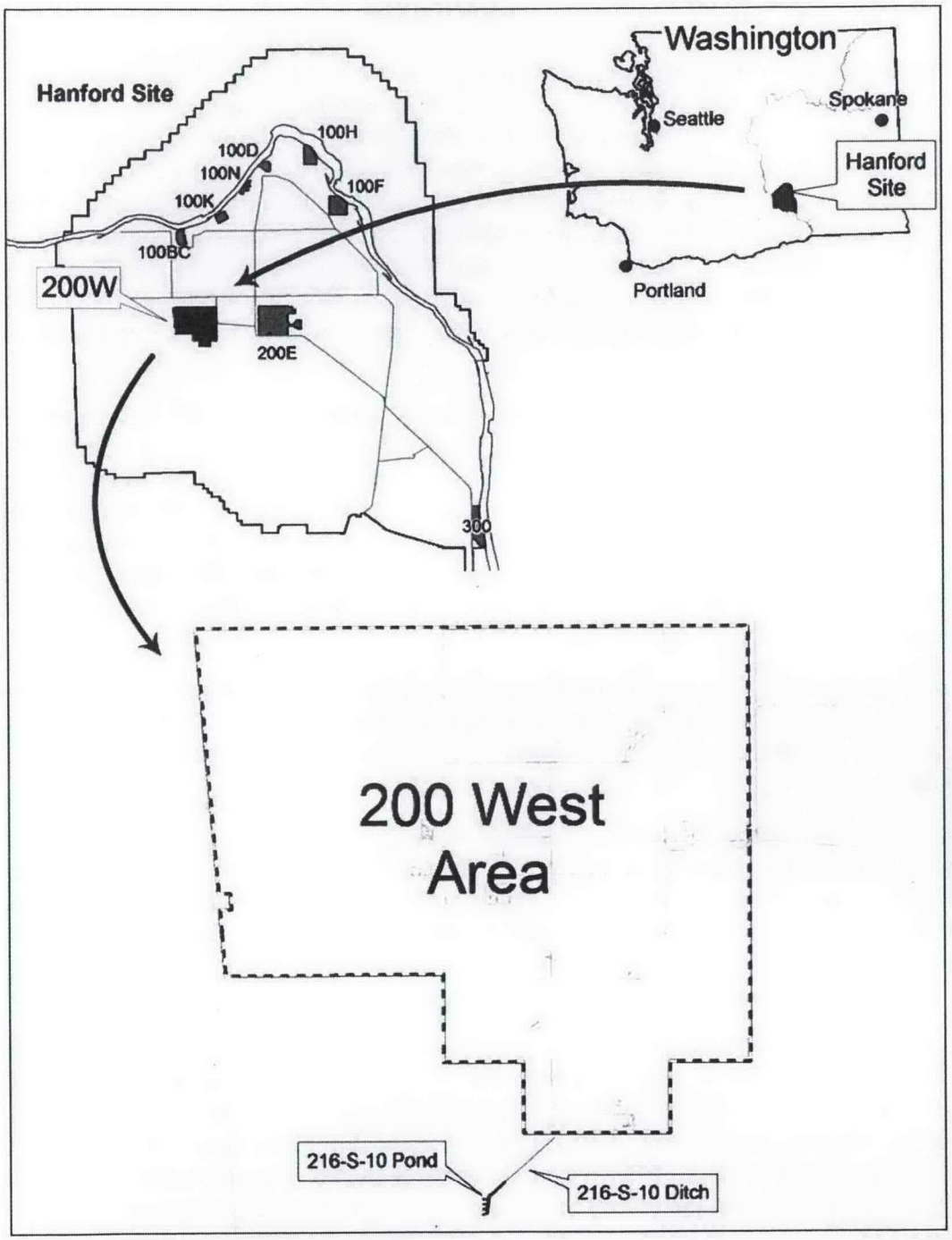


**Figure 1-1. Location of the 216-S-10 Pond and Ditch**

The purpose of this RCRA groundwater monitoring plan is to present a groundwater monitoring program for contamination indicator evaluation for the S-10 unit. This plan incorporates the sum of knowledge about the potential for groundwater contamination to originate from the S-10 unit, including groundwater monitoring results, hydrogeology, and operational history. A conceptual model is developed based on these attributes of the S-10 unit and the data quality objective (DQO) process. The groundwater monitoring program presented in this plan is intended specifically to satisfy monitoring requirements for TSD facilities, as required by WAC 173-303-400(3).

The groundwater contamination indicator evaluation monitoring program detailed in this plan proposes continued semiannual sampling for the indicator parameters and constituents of interest at one upgradient well and five downgradient wells. Annual sampling of groundwater quality and supporting chemical parameters will also be conducted (see Table 3-1 in Chapter 3).

Chapter 1 provides a general introduction to the monitored waste site, including the objectives of the current monitoring program. Chapter 2 presents background information related to successful implementation of the monitoring plan, which includes information on historical and present facility operations, waste characteristics, geology, hydrology, previous monitoring results, and a site conceptual model. Chapter 3 presents details of the monitoring program, and data evaluation and reporting are discussed in Chapter 4. The references cited in this document are included in Chapter 5. Detailed procedures covering sample collection, preservation, shipment, analytical procedures, and documentation (e.g., chain of custody) are provided in the quality assurance project plan (QAPjP) in Appendix A. Appendix B includes the construction details and lithologic logs for the monitoring network wells.

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# 2 Background

The information contained in this chapter was obtained from several sources, including Waste Information Data System database general summary reports and the following documents:

- DOE/RL-91-60, *S Plant Aggregate Area Management Study Report*
- DOE/RL-2005-63, *Feasibility Study for the 200-CS-1 Chemical Sewer Group Operable Unit*
- DOE/RL-2005-64, *Proposed Plan for the 200-CS-1 Chemical Sewer Group Operable Unit*
- PNNL-15731, *Post-Closure Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*
- RHO-CD-673, *200 Areas Waste Sites*

## 2.1 Facility Description and Operational History

The S-10 unit is located south-southwest of the 200 West Area, directly outside the perimeter fence (Figure 1-1). The initial configuration of the S-10 unit was a single, open, unlined ditch (S-10 Ditch), approximately 1.2 m (4 ft) wide at its base, at least 1.8 m (6 ft) deep, and 686 m (2,250 ft) long. The ditch began receiving wastewater in August 1951. Discharge to the ditch was through a 30.5 cm (12-in.) vitrified clay pipeline from the REDOX Facility. The S-10 Pond was added to the southwest end of the S-10 unit in February 1954 to provide additional wastewater capacity. The S-10 Pond covered 20,234 $m^2$ (5 ac) and resembled a backwards "E" with an extra leg; each "leg" was a separate leaching trench. The pond was approximately 2.4 m (8 ft) deep at its deepest point. Like the ditch, the pond was unlined and served as an evaporation/infiltration basin for liquid effluent discharges. Wastewater discharged into the S-10 Ditch then flowed into the S-10 Pond where it evaporated or infiltrated into the ground. This infiltration created perched water in the vadose zone and created a groundwater mound on the underlying aquifer.

The S-10 Ditch began receiving wastewater from the REDOX Facility chemical sewer in August 1951. In May 1954, increases in discharge to the S-10 unit necessitated the excavation of two additional ponds on the southeast side of the S-10 Ditch (i.e., 216-S-11 leach ponds [S-11 Ponds]). An inadvertent release of ammonium nitrate nonahydrate reduced the infiltration capacity in the S-10 unit. To improve infiltration in the S-10 Ditch, 0.6 m (2 ft) of sediment was dredged from the bottom of the ditch in 1955. The contaminated sediment was buried in excavation pits along the sides of the ditch.

In 1965, discharges decreased so wastewater no longer flowed into the channel to the S-11 Ponds. The southernmost portion of the S-11 Ponds was surveyed, determined to be free of radioactive contamination, and backfilled during the summer of 1975. The entire S-11 Ponds were stabilized by September 30, 1983. The REDOX Facility was closed in 1967 and, at that time, effluent to the S-10 unit was reduced primarily to chemical sewer waste. When the REDOX Facility was deactivated in 1972, physical controls were in place to eliminate dangerous waste discharges from the REDOX Facility to the S-10 unit. These controls reduced discharges from the REDOX Facility to only nondangerous chemical sewer effluent.

In September 1983, the S-10 unit received a dangerous waste discharge from the Chemical Engineering Laboratory. This laboratory produced synthetic waste tank slurry to test methods for recovering slurry from double-shell tanks (PNNL-15731). This discharge is described in more detail in Section 2.3.

The S-10 Pond and southwest end of the S-10 Ditch were decommissioned, backfilled, and stabilized in October 1985. The northern portion of the ditch remained operational and received nondangerous chemical sewer waste from the REDOX Facility until October 1991 (BHI-00176), when the remaining portion of the ditch was decommissioned. In July 1994, the effluent supply pipeline was plugged with

concrete near the outfall. Figure 2-1 shows the annual and cumulative volumes for discharges to the S-10 unit.

Since 1991, RCRA groundwater monitoring has been conducted in accordance with interim status requirements of WAC 173-303-400 (which incorporate 40 CFR 265, Subpart F by reference). The S-10 unit is currently monitored under interim status indicator evaluation.

The S-10 unit is located within the CERCLA 200-UP-1 Groundwater OU. In addition, the site is part of the CERCLA 200-CS-1 Source OU (chemical sewer group of waste sites) based on waste stream groupings. A remedial investigation, which included the S-10 unit, was conducted for the 200-CS-1 OU, and the results were presented in the *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit* (DOE/RL-2004-17). Comprehensive chemical and radiological analyses were performed on soil samples collected from boreholes and trenches excavated within the S-10 unit.

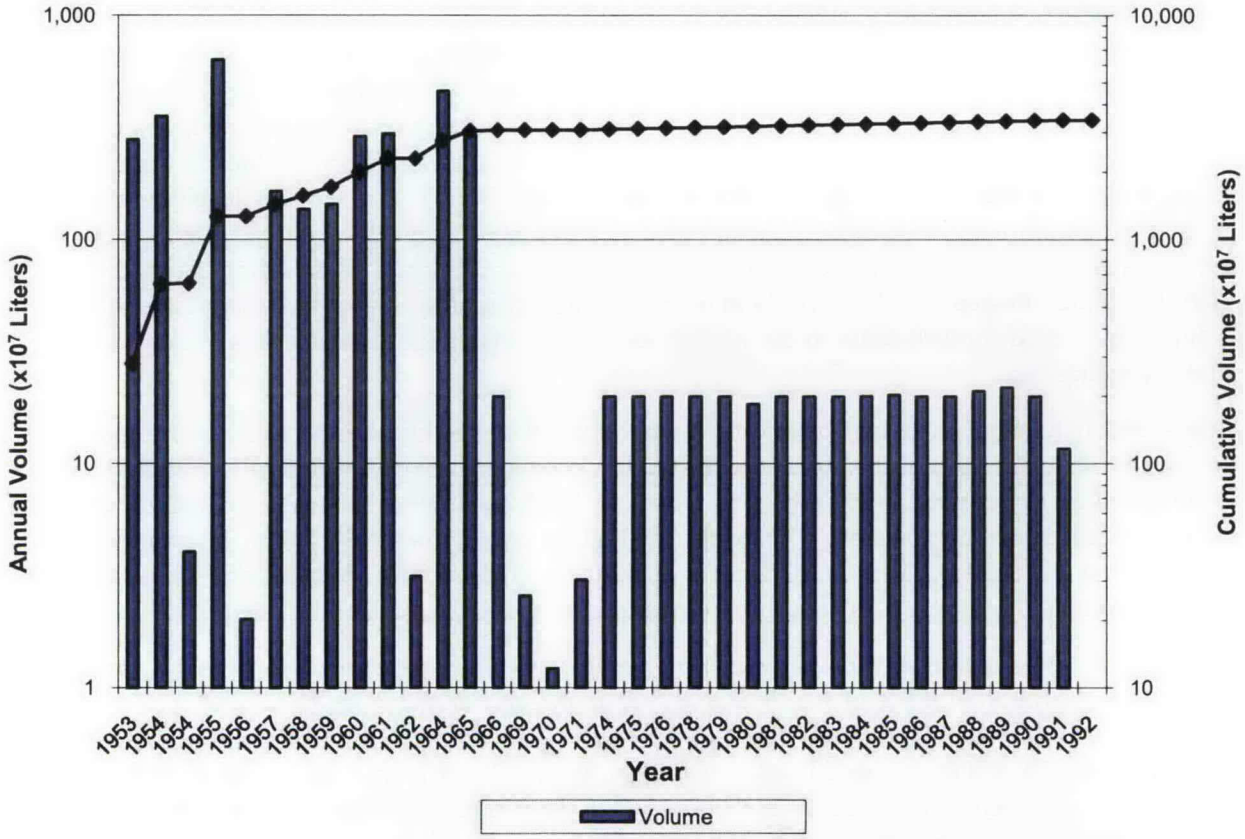



**Figure 2-1. Annual and Cumulative Discharge Volumes to the 216-S-10 Pond and Ditch**

## 2.2 Regulatory Basis

The S-10 unit is classified as a TSD unit because it received dangerous waste after one or two effective dates. The effective date for nonradioactive dangerous waste discharges is November 19, 1980, for dangerous waste regulated by 40 CFR 261, or March 10, 1982, for dangerous waste regulated by WAC 173-303 only (e.g., state-only dangerous waste). Since the corrosive waste (D002) discharged to the S-10 unit is regulated under 40 CFR 261, the effective date of regulation for this unit is November 19, 1980. (See the definition of "active portion" in WAC 173-303-040.)

The S-10 unit is currently subject to the regulatory rules set outlined in WAC 173-303-400 for interim status facility standards and those portions of 40 CFR 265, Subpart F, as incorporated by reference in WAC 173-303-400.

To date, no dangerous waste that can be conclusively linked to the S-10 unit has contaminated groundwater beneath the S-10 unit. Therefore, the site remains under indicator evaluation monitoring for indicator parameters, as specified in 40 CFR 265.92(b), "Sampling and Analysis."

The S-10 unit received discharges of nonregulated wastewater from the REDOX Facility chemical sewer through 1972. The most significant chemical discharges included acidic and caustic effluents associated with backwashing for regenerating the demineralizer columns. The unit also received a dangerous waste discharge from the Chemical Engineering Laboratory in 1983.

Groundwater monitoring has been conducted in accordance with the above-referenced RCRA requirements since 1991. Elevated total organic halides (TOX) have been measured in both upgradient and downgradient wells, indicating a source outside of the S-10 unit. The elevated TOX is related to the carbon tetrachloride plume emanating from the 216-Z-1A, 216-Z-9, and 216-Z-18 Cribs upgradient of the S-10 unit.

## 2.3 Waste Characteristics

The S-10 unit received nonregulated wastewater discharges consisting of water tower overflow, cooling water, and rainwater. The results of the effluent analyses for dangerous and radioactive components are published in *Liquid Effluent Study Final Project Report* (WHC-EP-0367). The unit was designed to percolate approximately 567,800 L (150,000 gal) of waste per day. The process design capacity reflects the maximum volume of water discharged daily rather than the physical capacity of the S-10 unit.

The S-10 Ditch last received nonregulated wastewater discharge in October 1991. In September 1983, a documented dangerous waste discharge to the S-10 unit occurred (PNNL-15731), and the waste was allowed to percolate into the soil column underlying the unit. In this incident, 416.4 L (110 gal) of synthetic double-shell tank slurry was discharged to the S-10 unit from the Chemical Engineering Laboratory. The waste consisted largely of sodium nitrate ($NaNO_3$) (46 percent) and sodium hydroxide (NaOH) (41 percent), with small quantities of sodium phosphate ($Na_3PO_4$), sodium fluoride (NaF), sodium chloride (NaCl), and potassium chromate ($K_2Cr_2O_7$). Samples of this slurry taken from feed tanks TK-505 and TK-509 were analyzed before the discharge occurred. The synthetic tank slurry constituents comprise the chemical compounds identified in the Part A Permit Application submitted for the S-10 unit and include characteristic dangerous waste (ignitable [D001], corrosive [D002], and characteristic [D007]) and state-only toxic waste (WT01 and WT02).

As shown in Figure 2-2, several past waste disposal sites are in the immediate vicinity of the S-10 unit, including the 216-S-5 and 216-S-6 Cribs; the 216-S-11, 216-S-16, and 216-S-17 Ponds; and associated ditches. It is important to note that historical discharges to these sites may have influenced the groundwater chemistry beneath the S-10 unit. It is not currently possible to distinguish the effects of these surrounding waste sites from that of the S-10 unit due to the lack of monitoring wells with sufficient screened intervals for sample collection in the area.

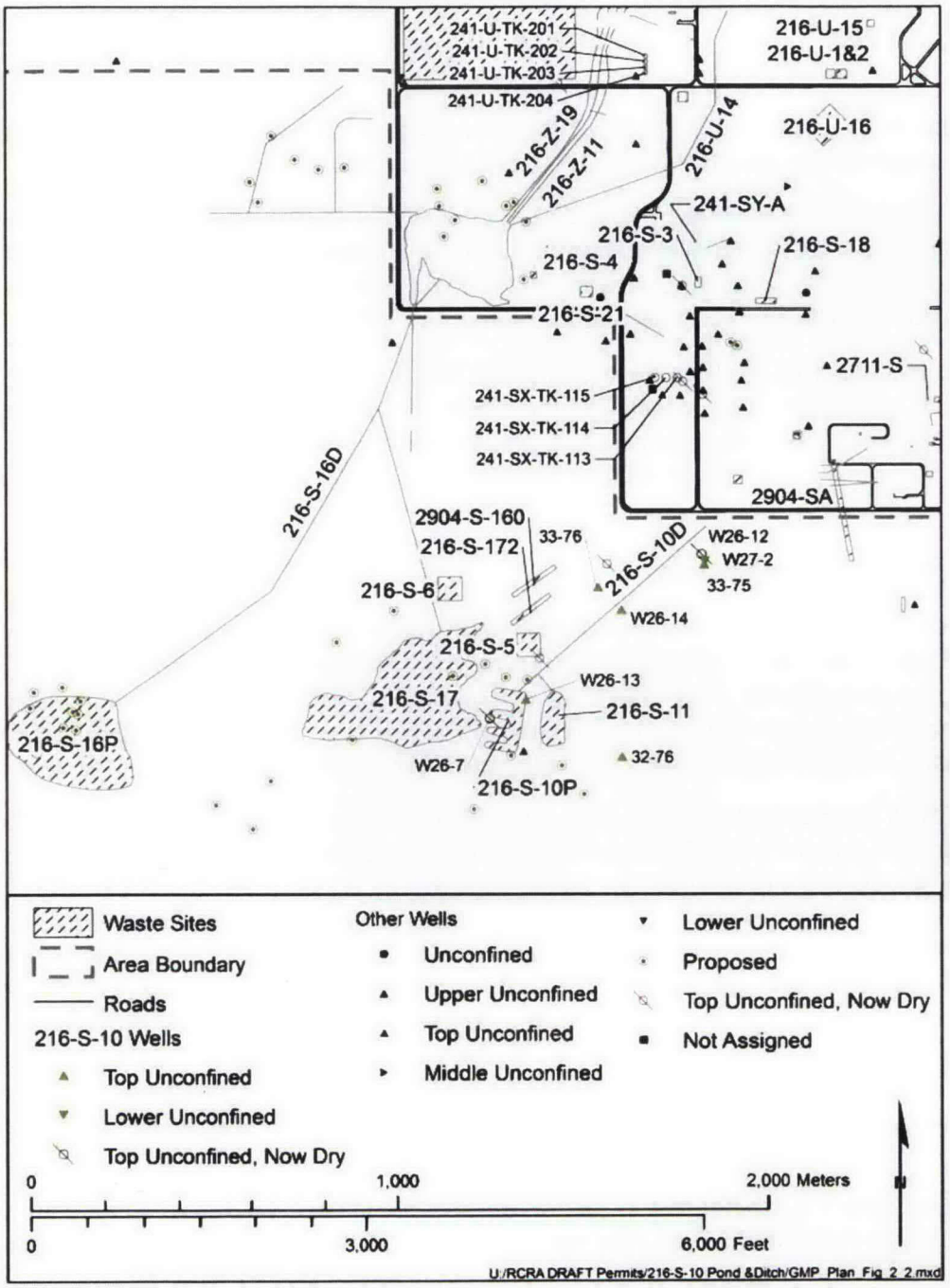



**Figure 2-2. Location of 216-S-10 Pond and Ditch Showing Adjacent Waste Sites**

## 2.4 Geology and Hydrology

This section summarizes recent reinterpretation of the hydrogeology of the S-10 unit. Data regarding the physical characteristics of the S-10 unit and the surrounding area (e.g., boreholes) are used to refine the understanding of the local hydrogeology beneath the unit, as well as the potential contaminant transport

pathways from the subsurface into groundwater and toward potential receptors. The data are used to develop the conceptual model beneath the waste site (see Section 2.6).

The geology and hydrology of the S-10 unit are described in detail in the *Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch* (WHC-SD-EN-AP-018) and in compilation reports on the 200 West Area (e.g., "Geohydrologic Setting of the Hanford Site, South-Central Washington" [Lindsey et al. 1994]; and PNNL-13858, *Revised Hydrogeology for the Supra-Basalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*). Other detailed descriptions of these geologic units are available in *Suprabasalt Stratigraphy Within and Adjacent to the Reference Repository Location* (SD-BWO-DP-039); "Late Cenozoic Stratigraphy and Tectonic Evolution Within a Subsiding Basin, South-Central Washington" (Bjornstad 1985); *Geology of the Separation Areas, Hanford Site, South-Central Washington* (RHO-ST-23); *Subsurface Geology of the Cold Creek Syncline* (RHO-BW-ST-14); *Hydrology of the Separation Area* (RHO-ST-42,); and more recently in *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin* (DOE/RL-2002-39). The most recent description of groundwater contamination in the region of the Hanford Site surrounding the S-10 unit is presented in *Hanford Site Groundwater Monitoring for Fiscal Year 2008* (DOE/RL-2008-66). The following information is summarized from these documents.

The 200 West Area, including the S-10 unit, is located on a broad, flat area that constitutes a local topographic high know as the Central Plateau. The Central Plateau is a flood bar formed during the cataclysmic flooding events of the Glacial Lake Missoula floods that occurred over 13,000 years ago (PNNL-13858).

### 2.4.1 Stratigraphy

The S-10 unit lies at an elevation of approximately 200 m (650 ft) above mean sea level. The three major sedimentary stratigraphic units beneath the S-10 unit are (from oldest to youngest) the Ringold Formation, the Cold Creek unit, and the Hanford formation.

The uppermost surface of the Elephant Mountain Member of the Saddle Mountain Basalt is considered the base of the suprabasalt aquifer system (bedrock) because of its dense, low-permeability interior relative to the overlying sediments. The basalt surface beneath the S-10 unit dips south-southwest, forming the southern limb of the Gable Mountain/Gable Butte anticline and the northeast flank of the Cold Creek syncline ("Paleodrainage of the Columbia River System on the Columbia Plateau of Washington State – A Summary" [Fecht et al. 1987]). Figure 2-3 provides a detailed hydrogeologic profile beneath the S-10 unit.

The uppermost aquifer system is contained in the Ringold Formation. The Ringold Formation consists of Units A through E (BHI-00184, *Miocene- to Pliocene-Ages Suprabasalt Sediments of the Hanford Site, South-Central Washington*), which are made up of continental fluvial and lacustrine sediments deposited by the ancestral Columbia and Clearwater-Salmon Rivers during late Miocene to Pliocene time periods (DOE/RW-0164, *Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*). Within the area of the S-10 unit, only stratigraphic Units A, E, and the lower mud unit of this sequence are present. These units generally correspond to Ringold Formation hydrostratigraphic Units 1, 8, and 9, respectively (PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*). The Ringold lower mud unit separates the suprabasalt aquifer system into a confined and unconfined aquifer (PNNL-13858).

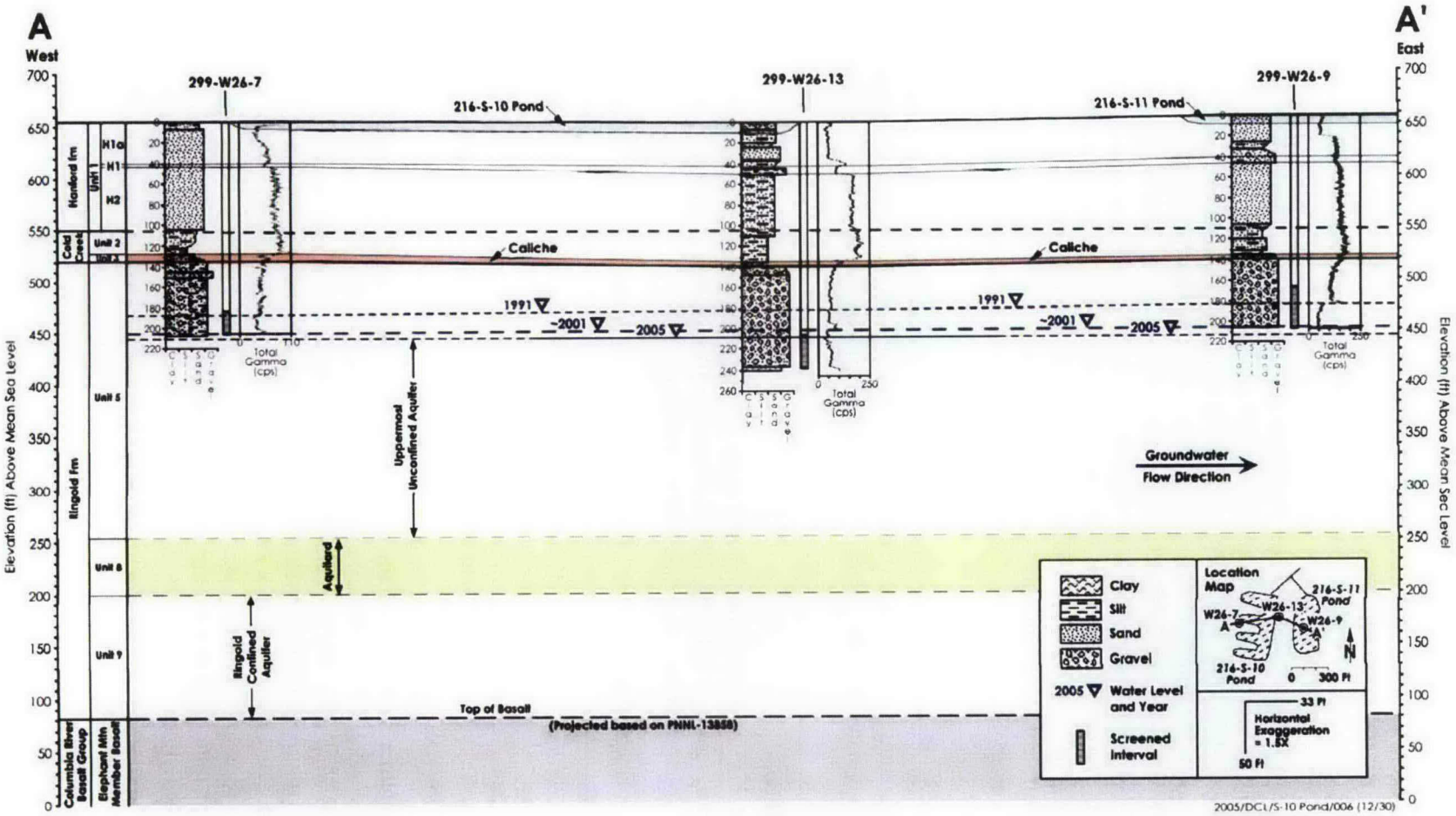



Figure 2-3. Detailed Hydrogeologic Cross-Section at the 216-S-10 Pond and Ditch

The Hanford formation and Cold Creek unit comprise the vadose zone. The Cold Creek unit (geologic units $CCU_g$ and $CCU_{cp}$) represent relatively thin but significant depositional units that are post-Ringold and pre-Hanford sedimentation. The lower Cold Creek unit ($CCU_{cp}$) is a calcic paleosol horizon that developed on the eroded surface of the Ringold Formation. The $CCU_{cp}$ is commonly referred to as the "calcic sequence" (caliche zone) or the lower Cold Creek unit. The upper Cold Creek unit ($CCU_{oe}$) is described as an overlying, fine-grained, overbank-eolian sequence considered to belong to the upper portion of the Cold Creek unit; it is equivalent to what has been called early Palouse soil (WHC-SD-EN-TI-014, *Hydrogeologic Model for the 200 West Groundwater Aggregate Area*). At the S-10 unit, the $CCU_{cp}$ is less than 1 m (3.3 ft) thick, while the $CCU_{oe}$ ranges from 10 to 15 m (33 to 50 ft) in thickness. The $CCU_{oe}$ is located from approximately 33 to 43 m (110 to 140 ft) below the surface.

The Hanford formation (hydrologic Unit 1) is the informal name given to Pleistocene-age cataclysmic flood deposits in the Pasco Basin (Lindsey et al. 1994). It consists predominantly of unconsolidated sediments, which cover a wide range in grain size: from pebble- to boulder-gravel; to fine- to coarse-grained pebbly sand; to sand, silty sand, and silt. Gravel clasts are composed of mostly sub-angular to sub-rounded basalt. Beneath the S-10 unit, the Hanford formation consists of essentially three facies: a lower facies (H3), composed of fine-grained sand to sandy silt that ranges from 12 to 18 m (40 to 60 ft) in thickness; a fine to coarse sand to sandy gravel sequence (H2) that ranges from 1 to 3 m (3 to 10 ft) in thickness; and an uppermost fine-grained sequence (H1).

### 2.4.2 Groundwater Hydrology

In the 200 West Area and the vicinity of the S-10 unit, PNNL-13858 used data from boreholes and groundwater monitoring to subdivide the suprabasalt sediments into two aquifers: an upper unconfined (Hanford/Ringold) aquifer, and a lower confined (Ringold confined aquifer). The hydrogeology beneath the S-10 unit fits this interpretation.

The vadose zone beneath the S-10 unit is up to 72 m (236 ft) thick. The vadose zone includes the Hanford formation, Cold Creek units, and the upper unsaturated portion of Ringold Unit E. Figure 2-3 provides input to the conceptual model for the area near the S-10 unit and the S-11 Ponds, as well as the depths, relative thicknesses, and hydraulic relationship of the hydrogeologic units beneath the facility.

Perched water created by wastewater disposal to the S-10 Ditch was observed above Cold Creek Unit 3. Well 299-W26-11, located near the pipeline outlet in the north end of the S-10 Ditch, was used to monitor dissipation of this perched water interval after liquid effluent disposal ceased at the waste site.

The uppermost aquifer beneath the S-10 unit is unconfined and comprises the saturated portion of Ringold Unit 5. It is approximately 57 m (187 ft) thick (based on 2005 measurements). Groundwater flow direction is approximately east to southeast in the vicinity of the S-10 unit and is calculated based on water-level measurements obtained from network and surrounding wells (e.g., Figure 2.8-2 in PNNL-15670, *Hanford Site Groundwater Monitoring for Fiscal Year 2005*).

Beneath the S-10 unit, groundwater in the uppermost unconfined aquifer is assumed to be isolated from groundwater in the confined Ringold aquifer by the lower mud unit. The intercommunication between Units E and A is assumed to be insignificant because groundwater flow through the lower mud unit is extremely low due to the thickness and relatively low permeability of the confining unit.

The lower mud unit is an aquitard that separates and confines groundwater in the underlying Ringold Unit A gravel (confined Ringold aquifer) from the unconfined aquifer in Unit E. Groundwater in the confined Ringold aquifer is interpreted to flow laterally through the Unit A gravel due to the thickness and relatively low vertical hydraulic conductivity of the overlying confining the lower mud unit.

Groundwater flow conditions beneath the S-10 unit have varied greatly over the past several decades due to changing wastewater disposal practices on the site, but groundwater flow has been generally to the east-southeast for the last several years. During fiscal year 2008, the direction of groundwater flow remained the same as the previous year, moving east-southeast. The addition of three new wells to the network indicated that the hydraulic gradient has changed by about a factor of five, meaning that the average linear velocity increased significantly, from 0.08 to 2.25 m/day (0.26 to 7.38 ft/day) to 0.23 to 6.81 m/day (0.75 to 22.34 ft/day), or from 29 to 820 m/year (94.9 to 2,693.7 ft/year) to 83.95 to 2,495 m/year (273.8 to 8,154 ft/year) (DOE/RL-2008-01, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*).

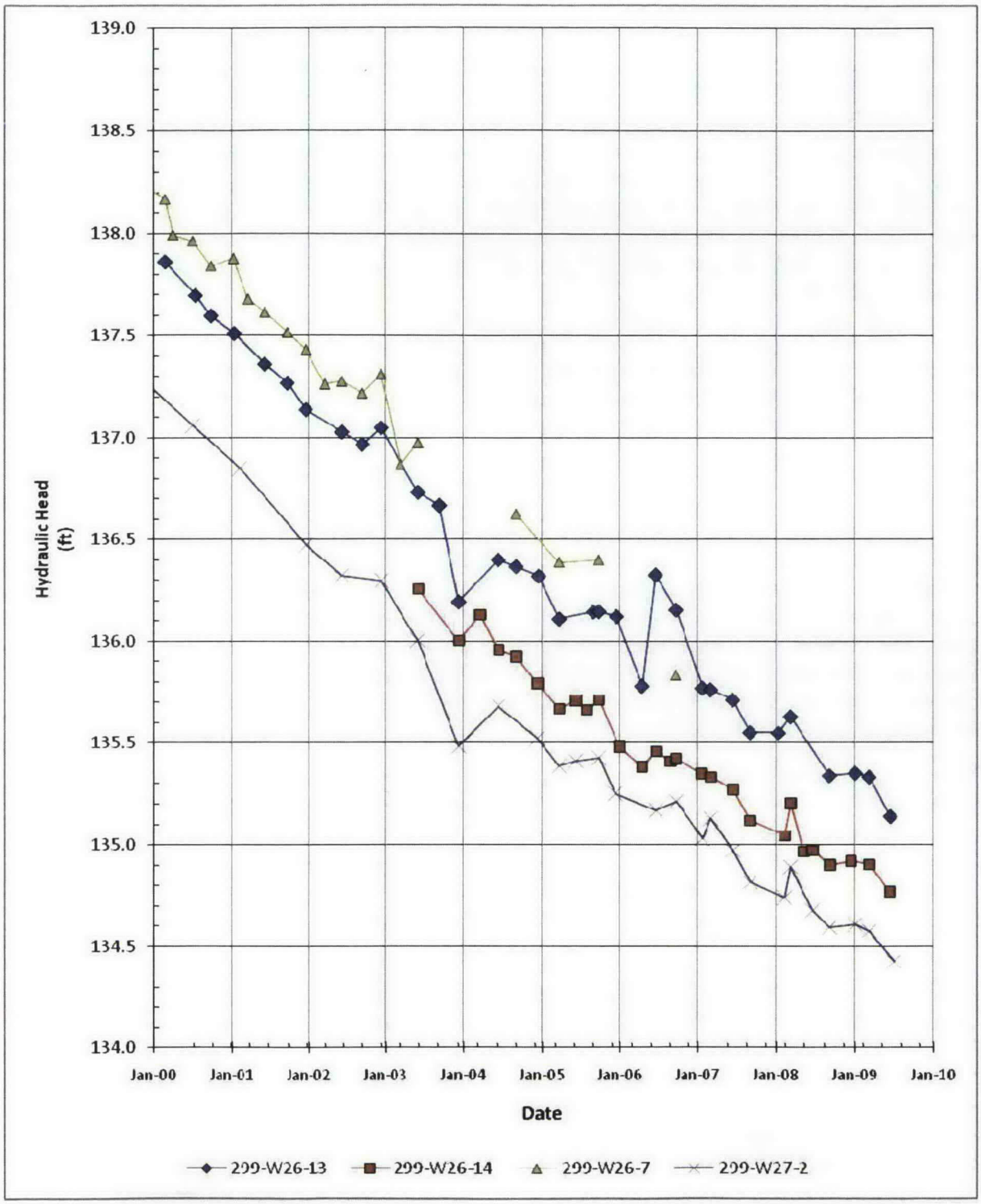
Natural recharge from precipitation is the only source of recharge to the vadose zone beneath the S-10 unit since discharges ceased in 1991. A likely range of recharge for the S-10 unit is between 5 and 25.4 cm/year (1.97 and 10 in./year), likely toward the higher end of this range because of the surface covering of coarse sand and sparse vegetation at the unit (PNL-10508, *Estimation of Natural Ground Water Recharge for the Performance Assessment of a Low-Level Waste Disposal Facility at the Hanford Site*). However, the average annual precipitation is only 17.7 cm/year (6.97 in./year).

As the groundwater mounds dissipate with the Hanford Sitewide cessation of liquid effluent disposal, the water table is declining throughout the 200 West Area, including at the S-10 unit. Hydrographs for monitoring wells near the S-10 unit are presented in Figure 2-4. The falling water table has resulted in many wells near the S-10 unit going dry.

## 2.5 Summary of Previous Groundwater Monitoring

Prior to the initiation of RCRA groundwater monitoring, the S-10 unit was monitored by various means, including effluent stream sampling, surface radiation surveys, aerial radiation surveys, composite weekly water quality samples from the ditch, and sediment and vegetation samples (DOE/RL-99-44, *200-CS-1 Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan*). Sampling and analysis of groundwater at the S-10 unit has been conducted under RCRA interim status requirements since the third quarter of 1991. The RCRA monitoring at the S-10 unit has not detected any impact to groundwater based on statistical comparisons of upgradient/downgradient indicator parameters. This section summarizes significant historical results of groundwater analyses for the S-10 unit through July 2009 using all of the RCRA-compliant (WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," as referenced by WAC 173-303-400[3][c][v][C] to be used as guidance) groundwater monitoring wells, including those that have gone dry. Hanford Site groundwater background concentrations of constituents discussed here are those determined in *Hanford Site Background: Part 3, Groundwater Background* (DOE/RL-96-61).

Wells 299-W26-7, 299-W26-8, 299-W26-9, 299-W26-10, and 299-W26-12 monitored the upper 4.5 to 6 m (15 to 20 ft) of the uppermost aquifer. Well 299-W26-11 was completed in a perched water zone above Cold Creek Units 2 and 3 to monitor perched effluent apparently recharging to the aquifer. Well 299-W27-2 was installed in 1992 and monitors the lower 3 m (10 ft) of the uppermost aquifer, just above Unit 8. Due to declining water levels, none of the original six wells monitoring the upper aquifer (299-W26-7 through 299-W26-12) remain in service today. Not including the perched aquifer well, four wells have gone dry; the last upgradient well (299-W26-7) went dry in 2003. Two downgradient replacement wells (299-W26-13 and 299-W26-14, completed in 2000 and 2003, respectively) have been added to the network near the S-10 unit. One new upgradient well (699-33-76) and two downgradient wells (699-32-76 and 699-33-75) were installed surrounding the S-10 unit in early 2008. Five wells now monitor the upper portion of the uppermost aquifer, downgradient of the S-10 unit.




Note: Well 299-W27-2 is screened immediately above the Ringold lower mud unit, approximately 55 m (180 ft) below the water table surface.

**Figure 2-4. Hydrographs for Network Wells with Historical Water-Level Data**

### 2.5.1 Groundwater Contamination

Required statistical evaluations of the contamination indicator parameters (specific conductance, pH, total organic carbon [TOC], and TOX) have been conducted since 1992, immediately after background values were established. Since then, background values have been revised several times to reflect changes in site conditions (e.g., wells gone dry). The most recently collected background values of listed contaminant indicator parameters are from well 299-W26-7 before it went dry in 2003. When compliant data become available for four quarters from the new upgradient well, new background values will be calculated and used for the required upgradient/downgradient comparisons. To date, statistical evaluations of indicator parameters have not indicated that the S-10 unit has affected the groundwater quality in the uppermost aquifer beneath the unit.

Concentrations of filtered (dissolved) metals have been measured using the inductively coupled plasma method. Cadmium, copper, mercury, selenium, and silver are essentially undetected. Detection of lead in S-10 unit wells is problematic. Several low-level lead detections (approximately 2 to 8 μg/L) have been reported, but these coincide with duplicate samples that were nondetects and, therefore, are suspect.

Chromium concentrations, especially in well 299-W26-7, increased above the 100 μg/L drinking water standard (DWS) (40 CFR 141, "National Primary Drinking Water Regulations") (the highest value was 576 μg/L) and then dropped below the DWS between October 1995 and July 1998, suggesting a transient release event. In September 1983, a release occurred to the S-10 unit of synthetic double-shell tank waste (a high-salt waste) containing potassium chromate (PNNL-15731). Assuming transport time of several years through the vadose zone to groundwater, and considering the volume of water and mass of chromium, the observed transient and approximate chromium concentrations detected are consistent with this historical release event. Although well 299-W26-7 is an upgradient well, it is located very close to one lobe of the pond system. Wastewater from the S-10 unit may have easily reached this well by spreading laterally in the subsurface.

Nitrate concentrations have been historically covariate with chromium concentrations in downgradient wells (299-W26-9, 299-W26-10, and 299-W26-12) and also in upgradient well 299-W26-7. The peak nitrate concentration was observed in December 1997 in wells 299-W26-7, 299-W26-10, and 299-W26-12. Peak concentrations of chromium and nitrate in well 299-W26-9 were observed in January 1999. Hence, it is possible that these trends reflect a recovery of groundwater to natural levels of nitrate after being diluted by relatively clean effluent for several years.

The only other constituent exceeding DWS occurred in wells 299-W27-2 and 299-26-12 for carbon tetrachloride. Well 299-W27-2 has had carbon tetrachloride results slightly above the 5 μg/L DWS, the highest of which was 6.4 μg/L in 2001. The only other result above the DWS occurred in well 299-W26-12 in 1999 (6.0 μg/L) before the well went dry. All other wells in the network have produced at least one detectable result of carbon tetrachloride. This compound is believed to have originated from a source upgradient of the S-10 unit. Carbon tetrachloride is not a constituent related to TSD unit activities and will be addressed by actions attending the 200-UP-1 and 200-ZP-1OU remedial investigation/feasibility study.

### 2.5.2 Vadose Zone Contamination

Past-practice spills and documented dangerous waste releases to the S-10 unit required investigation of the soil contamination to evaluate and develop waste-site-specific cleanup/closure options. An integrated process for characterizing the RCRA-regulated units within the CERCLA 200-CS-1 OU combined a remedial investigation/feasibility study work plan with *200 Area Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE/RL-98-28).

Based on this approach, a two-phased remedial investigation was completed in 2003 for the S-10 unit. The first phase of characterization involved deep sediment sampling in one borehole drilled at the S-10 Pond. The borehole was later completed as a RCRA downgradient monitoring well (299-W26-13) to replace well 299-W26-9, which had gone dry. A second phase of field characterization was completed in 2003 (DOE/RL-2004-17), which included seven test pit excavations for soil sampling along the ditch and pond, and one characterization borehole. This borehole was also completed as downgradient well 299-W26-14.

Sample results indicated that the contaminants chromium, copper, selenium, silver, thallium, zinc, Aroclor 1254, and dibutylphthalate were detected above background levels in soil at the S-10 Ditch and exceeded their respective ecological screening values (DOE/RL-2005-63). Contaminants presenting a potential ecological risk that were identified in samples associated with the S-10 Pond included selenium, silver, and thallium.

Soil sample results were also compared against groundwater protection concentrations as part of the CERCLA remedial investigation study. Three metals regulated under RCRA (cadmium, mercury, and silver), six polycyclic aromatic hydrocarbons (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, and chrysene], and Aroclor 1254 (a polychlorinated biphenyl) had maximum concentrations above their respective groundwater protection cleanup levels at the S-10 Ditch (DOE/RL-2005-64). Methylene chloride was the only contaminant detected above groundwater protection levels at the S-10 Pond.

Aroclor 1254, benzo(a)pyrene, total chromium, copper, mercury, and zinc are identified in DOE/RL-2005-64 as risk drivers for the S-10 Ditch based on their potential ecological risk and impact to groundwater. No risk drivers were identified for either the S-10 Pond or the S-11 Ponds.

## 2.6 Conceptual Model

A conceptual model of contaminant transport through the vadose zone to groundwater beneath the S-10 unit is used to develop an appropriate and cost-effective monitoring plan. The conceptualization begins with a summary of the physical and chemical conditions at the disposal site and related assumptions.

The S-10 unit was one of several wastewater conveyances that discharged wastewater to the ground surface. The open and unlined ditch allowed liquid effluents to evaporate and percolate into the vadose sediments along its entire length, while the unlined pond also allowed for evaporation and infiltration to the subsurface as the different lobes retained wastewater. The conceptual model assumes that the large volume of wastewater discharged (6.6 x 109 L [1.7 x 109 gal]) during operation to the S-10 unit was sufficient to saturate the soil column down to groundwater beneath both the unlined ditch and the pond. It is also likely that fine-grained and/or low-permeability sedimentary layers in the vadose zone beneath the S-10 unit created perched water conditions and/or allowed for subsurface lateral spreading, possibly beyond the boundary of the S-10 unit. Such lateral spreading could result in wastewater reaching upgradient monitoring wells. This could account for the occurrence of chromium in the former upgradient well 299-W26-7, but it does not eliminate other upgradient waste sites as possible sources.

Equally important to the S-10 unit conceptual model is the fact that adjacent disposal waste sites have similar hydrogeologic controls and received similar waste streams during their operational life. Therefore, distinguishing between contamination contributions from these waste sites and the S-10 unit may be difficult.

Based on the hydrogeology of the site, operational history, and the assumptions and conditions noted above, a schematic representation of contaminant transport through the vadose zone to groundwater is illustrated in Figure 2-5.

During operation, the conceptual model shows that saturated or semi-saturated flow conditions prevailed beneath the S-10 unit. Saturated conditions combined with the fact that many of the contaminants of concern are known to be mobile, either because they are either anions or are non-charged chemical species. In addition, it is anticipated that several multivalent metals (e.g., chromium and copper) are mobile via complexing agents or as oxymetallic anions (e.g., chromate and cuprate). Therefore, contaminants contained in wastewater discharged to the S-10 unit may have migrated through the soil column to the groundwater.

Lateral spreading may also have brought waste constituents to former upgradient well 299-W26-7. The coincidence of peak concentrations of chromium and nitrate in groundwater at the S-10 unit may reflect the release of potassium dichromate (hexavalent chromium) in wastewater discharged to the S-10 Ditch in September 1983 from a simulated double-shell tank waste (see Section 2.3). Hexavalent chromium (filtered samples) in both upgradient and downgradient monitoring wells at the S-10 unit demonstrates that this constituent is present in the groundwater, although it is unclear if it is from the S-10 unit or from another upgradient source. However, the presence of chromium in both upgradient and downgradient wells is consistent with the concept of lateral spreading.

The potential for continued migration of residual contamination from the vadose zone to groundwater is small due to the cessation of liquid effluent discharges to the S-10 unit and the lack of any water lines or other direct sources of recharge. Infiltration of natural precipitation is the only potential force capable of moving a significant portion of the remaining contaminants to groundwater. The current mean annual precipitation rate is 16 cm (6.3 in.), with most annual accumulation occurring between November and February (PNNL-10285, *Estimated Recharge Rates at the Hanford Site*). Recharge in the area of the S-10unit is estimated to be between 10 and 20 mm (0.39 and 0.79 in.) annually based on PNNL-10285. The range of recharge rates depends on a variety of factors, but because there is no surface barrier to natural infiltration and given the surface covering of coarse sand and sparse vegetation at the unit, the average recharge for the S-10 unit is likely toward the higher end of this range (PNNL-10508). No recent infiltration abatement measures (impermeable material covering) have been implemented at the S-10 unit. The risk of infiltration by snowmelt and the potential for vertical migration of contaminants is considered to be low because of low annual precipitation.

General groundwater flow direction beneath the S-10 unit is interpreted to be to the east-southeast and will likely retain that general direction even after the current water table has declined to pre-operational levels. The hydraulic gradient in the immediate vicinity of the S-10 unit is estimated at 0.005 m/m, with an estimated flow rate between 0.23 and 6.81 m/day (0.75 and 22.34 ft/day) (DOE/RL-2008-66).

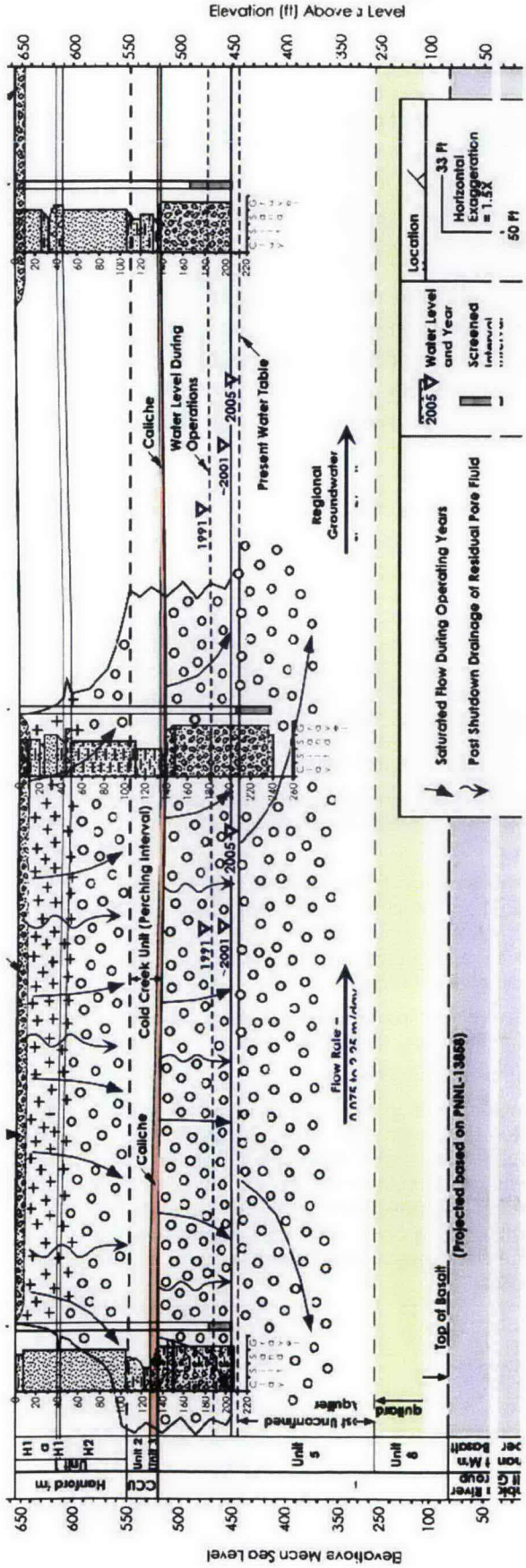



Figure 2-5. Conceptual Model of Effluent Infiltration at the 216-S-10 Pond and Ditch

## 2.7 Data Quality Objectives

The DQO process is performed to ensure that data gathered during an investigation are of the appropriate quantity and quality to meet specific objectives. The DQOs for groundwater monitoring were presented in *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* (BHI-01276) and have been revised in the *Data Quality Objectives Summary Report Supporting the 200-UP-1 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process* (CP-15315).

The current groundwater monitoring network for the S-10 unit is a result of previous investigations and DQOs. Contamination indicator evaluation monitoring is ongoing in accordance with interim status regulations. Table 2-1 provides a matrix of data requirements that are typically determined in the DQO process, the associated interim status regulations applicable to these requirements, and current and historical documentation specifying how the monitoring program for S-10 unit complies with requirements.

**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 ground-water monitoring at sites where no impact to ground-water has been identified. Requirements are found in WAC 173-303-400(3) and 40 CFR 265.90 through 40 CFR 265.94, as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v). | |
| Number and location of wells<br>Point(s) of compliance | **40 CFR 265.91 Ground-Water Monitoring System.**<br>(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:<br>(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:<br>(i) Representative of background groundwater quality in the uppermost aquifer near the facility; and<br>(ii) Not affected by the facility; and<br>(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, Sections 2.4, 2.5, 2.6, and 3.2<br>PNNL-14070, *Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*<br>BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* |

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

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91 Ground-Water Monitoring System.**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary; to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional Requirements from WAC 173-303-400(3)(c)(v)(C)**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells. | This plan, Section 3.2 and Appendix B<br>PNNL-14070, *Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*<br>BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* |
| Frequency of sampling<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision | **40 CFR 265.92 Sampling and Analysis.**<br>(b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section:<br>(1) Parameters characterizing the suitability of the ground-water as a drinking water supply, as specified in Appendix III.<br>*[NOTE: Have not listed these because, in accordance with 40 CFR 265.92(c)(1) below, these analyses are only conducted for the first year. None of the RCRA sites are in the first year of monitoring.]*<br>(2) Parameters establishing ground-water quality:<br>(i) Chloride<br>(ii) Iron<br>(iii) Manganese<br>(iv) Phenols<br>(v) Sodium<br>(vi) Sulfate<br>*[COMMENT: These parameters are to be used as a basis for comparison in the event that a ground-water quality assessment is required under 40 CFR 265.93(d).]* | This plan, Sections 3.1, 3.3, and 3.4 and Appendix A<br>PNNL-14070, *Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*<br>BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* |

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

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| | **40 CFR 265.92 Sampling and Analysis. (cont'd)**<br>(3) Parameters used as indicators of ground-water contamination:<br>(i) pH<br>(ii) Specific Conductance<br>(iii) Total Organic Carbon<br>(iv) Total Organic Halogen<br>(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. The owner or operator must do this quarterly for one year.<br>(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.<br>(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:<br>(1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually.<br>(2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semiannually.<br>(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained. | |
| Methods used to evaluate the collected data | **40 CFR 265.93 Preparation, Evaluation, and Response.**<br>(b) For each indicator parameter specified in 40 CFR 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 40 CFR 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 3.2 and Appendix B<br>PNNL-14070, *Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*<br>BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* |

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

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|

Notes:

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*

WAC = *Washington Administrative Code*

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# 3 Groundwater Monitoring Program

This chapter describes an interim status indicator evaluation groundwater monitoring program for the S-10 unit, which consists of a monitoring well network, target constituents, and sampling and analysis protocol. The monitoring program presented herein replaces the previous program (PNNL-15731).

## 3.1 Special Conditions at the 216-S-10 Pond and Ditch

The S-10 unit is located among other waste disposal sites with very similar operational histories. The proximity of the S-10 unit to these other waste sites suggests that at least some observed groundwater contamination beneath and downgradient of S-10 unit may have originated from waste sites other than the S-10 unit. For this reason, it may be infeasible to definitively discriminate between the contributions of each waste site to groundwater contamination beneath the S-10 unit, despite the installation of new groundwater monitoring wells. In addition, the declining water table in the 200 West Area, especially in the vicinity of the S-10 unit, has resulted in many RCRA-compliant wells going dry in recent years, including the only upgradient well (299-W26-7). However, this upgradient well was installed close to the S-10 Pond and draws into question whether the observed groundwater quality was affected by the pond itself or by an upgradient source (e.g., 216-S-17 Pond). These circumstances contribute to the difficulty in determining if a contaminant originates from the S-10 unit or another site.

## 3.2 Constituent List and Sampling Frequency

The groundwater in S-10 unit monitoring wells will be sampled and analyzed for the parameters listed in Table 3-1. In compliance with 40 CFR 265.92, the network of groundwater wells at the S-10 unit will be monitored semiannually for contamination indicator parameters TOX, TOC, pH, and specific conductance. Major dissolved ions, metals, phenols, alkalinity, turbidity, and temperature are included as indicators of sample and analytical quality, as well as general aquifer/well background conditions. Groundwater samples from the newly installed wells will be sampled quarterly for at least one year to obtain a sufficient number of samples to establish background. Alkalinity will be used with total anions and cations to calculate a groundwater charge balance for geochemistry comparison. Anions are included to detect potential nitrate contamination and to provide input for charge balance calculations. The major ions will also be evaluated for geochemical relationships (e.g., stiff diagrams).

Previous groundwater monitoring detected constituents above background. The 200-CS-1 feasibility study (DOE/RL-2005-63) also identified constituents with the potential to present a future concern (see Section 2.5.2). These constituents will continue to be monitored under this monitoring plan and are also included in Table 3-1.

Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If a well is delayed more than 3 months, that event will be cancelled, as it would be nearly time for the next scheduled sampling event. Missed sampling events are reported in the annual groundwater report.

## 3.3 Monitoring Well Network

The declining water table in the 200 West Area, particularly in the vicinity of the S-10 unit, has resulted in many wells going dry. Water levels in all of the original upper aquifer monitoring wells have declined below their screened intervals.

Until April 2008, only two downgradient wells (299-W26-13 and 299-W26-14) were available for monitoring the S-10 unit. One deep well (299-W27-2, which monitors groundwater conditions at the base of the uppermost unconfined aquifer) is also sampled for supplementary information.

Three new wells (699-32-76, 699-33-75, and 699-33-76) were completed in April 2008, with first quarter sampling conducted in May 2008. The revised network for groundwater monitoring will be evaluated annually to determine if it is adequate to provide groundwater monitoring through the post-closure period.

The well network (Figure 3-1) and revised monitoring constituents (Table 3-1) are designed in anticipation of post-closure use as follows:

- To represent the background quality of groundwater at the S-10 unit (WAC 173-303-645[8][a][i], "Releases from Regulated Units")
- To determine the quality of groundwater passing the point of compliance (WAC 173-303-645[8][a][ii])
- To allow for the detection of contamination of dangerous waste or waste constituents have migrated from the S-10 unit to the uppermost aquifer (WAC 173-303-645[8][a][iii])

Information on the wells in the monitoring network is summarized in Table 3-2. All wells have been constructed to meet resource protection well standards (WAC 173-160). Appendix B provides as-built drawings for each of the wells.

No additional replacement wells are currently anticipated for the current network. Should replacement wells become necessary in the future; the replacement wells will be located after evaluating the then-current understanding of hydrogeologic conditions under the facility, evaluating the projected water-level elevations and flow conditions, and consulting with Ecology.

## 3.4 Sampling and Analysis Protocol

Monitoring of the S-10 unit follows the conventions of project. The QAPjP outlining procedures for sample collection, sample preservation, and shipment, analytical procedures, and chain-of-custody control is provided in Appendix A.

**Table 3-1. Revised Monitoring Well Network for the 216-S-10 Pond and Ditch**

| Well Name | Purpose | WAC Compliant | RCRA Required Constituents[a] | | | | | | | | | | | Constituents of Interest | | | | | | | Supporting Constituents[b] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contamination Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | | | | | Field | | | Laboratory | | |
| | | | Water Level | pH[c] | Specific Conductance[c] | TOC | TOX | Chloride | Iron (Filtered and Unfiltered) | Manganese (Filtered and Unfiltered) | Phenols | Sodium (Filtered and Unfiltered) | Sulfate | Chromium (Total) | Hexavalent Chromium (Filtered and Unfiltered) | Copper | Mercury | Zinc | Aroclor 1254 | Benzo(a)pyrene | Oxidation/Reduction Potential[c] | Temperature[c] | Turbidity[c] | Alkalinity | Anions[d] | Metals[e] (Filtered and Unfiltered) |
| 699-33-76 | Upgradient | C | S[f] | S4[f] | S4 | S4 | S4 | S | A[f] | A | A | A | A | S | S | S | S | S | A | A | S | S | S | S | S | S |
| 299-W26-13 | Downgradient | C | S | S4 | S4 | S4 | S4 | S | A | A | A | A | A | S | S | S | S | S | A | A | S | S | S | S | S | S |
| 299-W26-14 | Downgradient | C | S | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| 699-33-75 | Downgradient | C | S | S4 | S4 | S4 | S4 | S | A | A | A | A | A | S | S | S | S | S | A | A | S | S | S | S | S | S |
| 699-32-76 | Downgradient | C | S | S4 | S4 | S4 | S4 | S | A | A | A | A | A | S | S | S | S | S | A | A | S | S | S | S | S | S |
| 299-W27-2[h] | Downgradient | C | S | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |

Notes:

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

b. Constituents not required by the *Resource Conservation and Recovery Act of 1976* but are needed to support interpretation.

c. Field measurement.

d. Anions; analytes include, but are not limited to, chloride, fluoride, nitrate, and nitrite.

e. Metals; analytes include, but are not limited to, calcium, chromium, potassium, magnesium, and sodium.

f. Samples to be collected quarterly through fiscal year 2010 to establish background.

g. Deep aquifer well.

A = to be sampled annually

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

CFR = *Code of Federal Regulations*

S = to be sampled semiannually

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

TOC = total organic carbon

TOX = total organic halides

WAC = *Washington Administrative Code*

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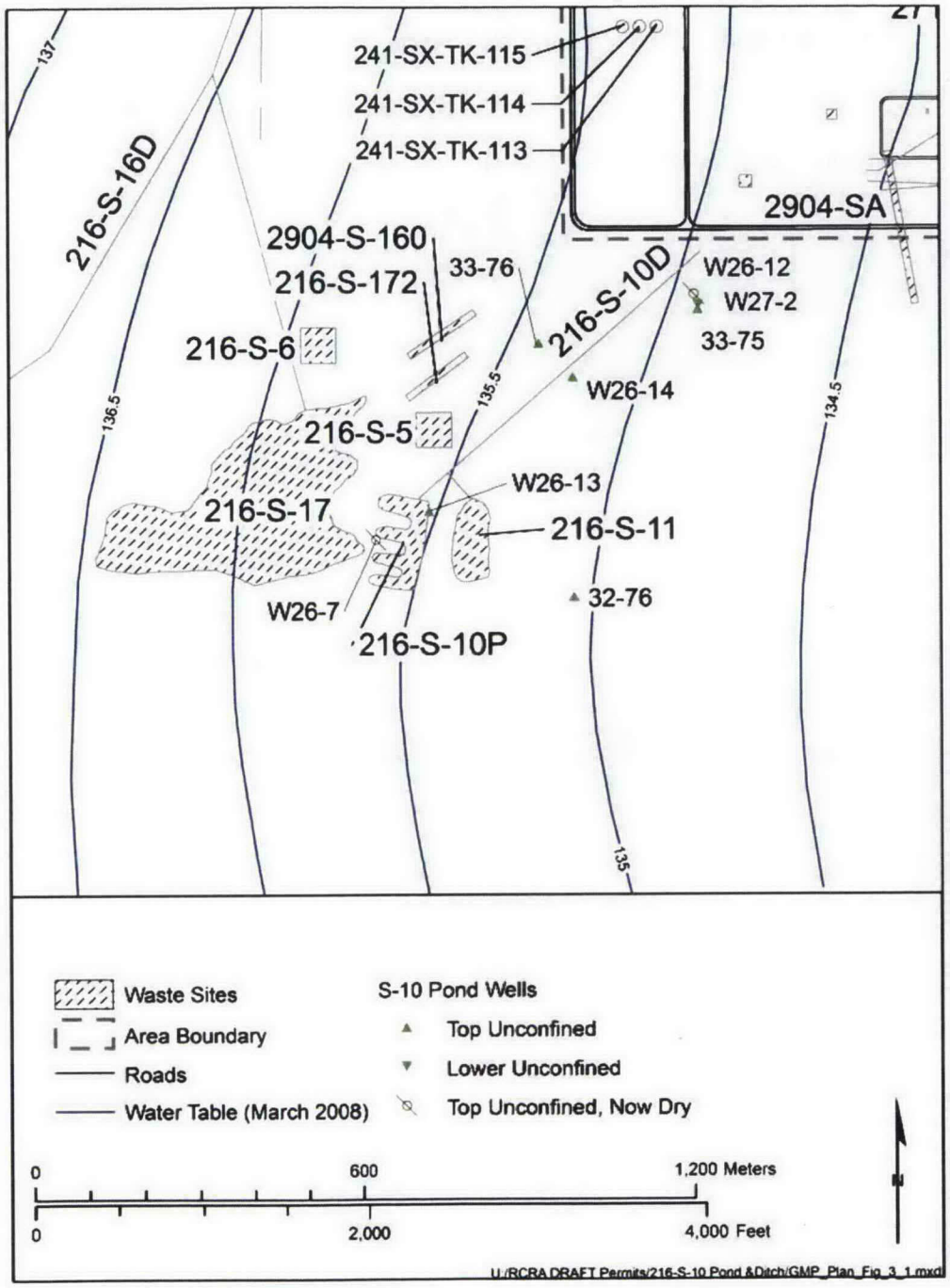


**Figure 3-1. RCRA Monitoring Well Network for the 216-S-10 Pond and Ditch**

**Table 3-2. Groundwater Monitoring Well Network for the 216-S-10 Pond and Ditch**

| Well | Year Drilled | Construction Notes[a] | Unit(s) Monitored | Water Table Elev.[b] (m) | Top of Casing NAVD88 (m) | Elev. Open Interval Base[c] (m) | Water Column Above Base (m) |
|---|---|---|---|---|---|---|---|
| 699-33-76 (upgradient) | 2008 | 4-in, 304 ss, wire-wrap screen | Ringold Unit 5 – completed at the water table | 136.80 | 203.94 | 124.87 | 11.93 |
| 299-W26-13 | 1999 | 4-in, ss, wire-wrap screen | Ringold Unit 5 – completed at the water table | 135.33 | 199.82 | 126.71 | 8.62 |
| 299-W26-14 | 2003 | 4-in, 304 ss, wire-wrap screen | Ringold Unit 5 – completed at the water table | 135.11 | 205.00 | 125.92 | 9.19 |
| 699-33-75 | 2008 | 4-in, 304 ss, wire-wrap screen | Ringold Unit 5 – completed at the water table | 135.52 | 207.36 | 124.31 | 11.21 |
| 699-32-76 | 2008 | 4-in, 304 ss, wire-wrap screen | Ringold Unit 5 – completed at the water table | 135.70 | 204.70 | 124.11 | 11.59 |
| 299-W27-2 | 2008 | 4-in, 304 ss, wire-wrap screen | Ringold Unit 5 – completed at the base of unit | 134.81 | 207.40 | 79.52 | 55.29 |

Notes:

a. Includes (when available) well casing/screen material, screen type, and well seal type.

b. Water table elevation December 2007 for wells 299-W26-13, 299-W26-14, and 299-W27-2 or March 2008 for wells 699-33-75, 699-33-76, and 699-32-76.

c. Bottom elevation from most recently available source (e.g., well inspection depth-to-bottom measurement or bottom of screen from as-built diagram).

ss = stainless steel

NA = not available

NAVD88 = North American Vertical Datum of 1988

# 4 Data Evaluation and Reporting

This chapter discusses the storage, retrieval, evaluation, and interpretation of groundwater data. The statistical evaluation methods and reporting requirements are also described.

## 4.1 Data Review

The data review, validation, and verification process is discussed in the QAPjP in Appendix A.

## 4.2 Statistical Evaluation

The goal of RCRA indicator evaluation monitoring is to determine if the groundwater quality beneath the S-10 unit has been affected, which is determined based on the results of specified statistical tests. Under this monitoring plan, 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 the mean concentrations of the four general contamination indicator parameters (i.e., TOC, TOX, pH, and specific conductance) to background levels to test for potential impacts to the groundwater. Each time a monitoring well is sampled, four replicate samples for TOC and TOX are collected, and four replicate field measurements are made for pH and specific conductance. Statistical evaluations are not performed on sample results from well 299-W27-2 because the well is used to monitor the bottom of the aquifer.

The implementation of the statistical test method at the Hanford Site, including the S-10 unit, is described in detail in *Hanford Site Groundwater Monitoring for Fiscal Year 1999* (PNNL-13116) and *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site* (WHC-SA-1124-FP). Twice each year, monitoring data from downgradient wells are compared to the upgradient (background) results to determine if there is any indication that contamination may have occurred. Revised critical mean values for the S-10 unit monitoring network will be calculated when there are sufficient data from the new upgradient wells; meanwhile, limits of quantitation are recalculated for each sample event (PNNL-13080, *Hanford Site Groundwater Monitoring: Setting, Sources and Methods*; PNNL-13788, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*). Once re-established, the critical means will be recalculated annually (PNNL-13080, PNNL-13788).

## 4.3 Interpretation

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

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

- Contaminant ratios: Can sometimes be used to distinguish between different sources of contamination.

## 4.4 Annual Determination of Monitoring Network

The RCRA requirements for groundwater monitoring call for an annual evaluation of the network to determine if it remains adequate to monitor the S-10 unit. The network must include upgradient and downgradient wells in the uppermost aquifer. The gradient beneath the S-10 unit is moderate, sloping 0.005 m/m to the east-southeast, with an estimated flow from 0.23 to 6.81 m/day (0.75 to 22.34 ft/day). The network includes both upgradient and downgradient wells based on current estimated flow direction.

The groundwater monitoring network, as it is currently configured, will continue to be re-evaluated to ensure that it is adequate to monitor the changing hydrogeologic conditions beneath the facility. If flow changes are observed, the S-10 unit conceptual model and geochemical trends will be re-evaluated to determine network efficiency and any necessary modification requirements for the network. Water-level measurements will continue to be collected before each sampling event.

## 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), "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66).

If comparisons for the upgradient well show a statistically significant increase (and/or pH decrease), the information is reported in the annual RCRA 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], "Preparation, Evaluation, and Response"). 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.

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# Appendix A

# Quality Assurance Project Plan

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# Terms

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

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# A Quality Assurance Project Plan

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

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

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

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *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) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

## A1 Project Management

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

### A1.1 Project/Task Organization

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

#### A1.1.1 Regulatory Project Manager

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

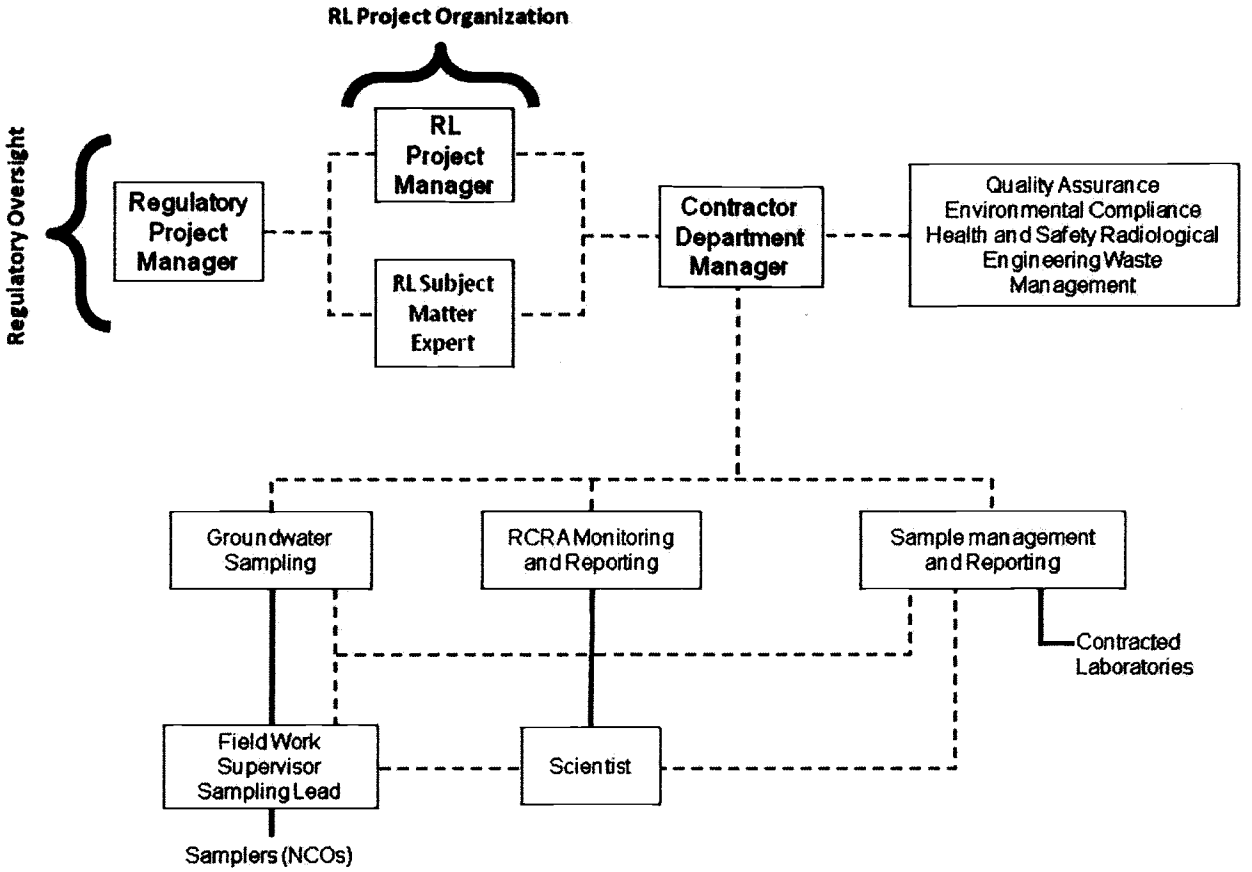


**Figure A-1. Project Organization**

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

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

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

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

### A1.1.4 Contractor Groundwater Remediation Department Manager

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

### A1.1.5 Groundwater Sampling Operations

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

### A1.1.6 RCRA Monitoring and Reporting

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

### A1.1.7 Sample Management and Reporting Organization

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

### A1.1.8 Contract Laboratories

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

### A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project 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.

### A1.1.10 Environmental Compliance Officer

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

### A1.1.11 Health and Safety

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

### A1.1.12 Waste Management

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

## A1.2 Problem Definition/Background

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

## A1.3 Project/Task Description

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

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

## A1.4 Quality Objectives and Criteria

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

## A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility of collecting and transporting groundwater samples according to the Dangerous Waste Training Plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

## A1.6 Documents and Records

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

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

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements therein.

**Table A-1. Actions and Documentation for Regulatory Notification**

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

Notes:

RCRA = *Resource Conservation and Recovery Act of 1976*

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

# A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

## A2.1 Sampling Process Design (Experimental Design)

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

### A2.1.1 Regulatory Requirements

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

### A2.1.2 Judgmental Sampling

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

## A2.2 Sampling Methods

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

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

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

## A2.3 Sample Handling and Custody

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

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

Sample custody during laboratory analysis is addressed in the applicable laboratory's 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.

## A2.4 Analytical Methods

Information on analytical methods is provided in Tables A-2 and A-3. 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 the 216-S-10 Pond and Ditch Constituents**

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

**Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for the 216-S-10 Pond and Ditch Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Anions by Ion Chromatography** | | | |
| Chloride | P | EPA/600 Method 300.0[f] | 200 |
| Fluoride | | | 500 |
| Nitrate | | | 250 |
| Nitrite | | | 250 |
| Sulfate | | | 500 |
| **Semivolatile Organic Analyses** | | | |
| Benzo(a)pyrene | Amber glass | SW-846 Method 8270D | 10 |
| **Polychlorinated Biphenyls** | | | |
| Aroclor-1254 | G | SW-846 Method 8082 | 0.5 |
| **Other** | | | |
| Alkalinity | G/P | Standard Method[g] 2320,<br>EPA/600 Method 310.1<br>EPA/600 Method 310.2 | 5,000 |
| Conductivity, field | Field measurement | Instrument/meter | 1 µohm |
| Oxidation-reduction potential, field | Field measurement | Instrument/meter | |
| pH, field measurement | Field measurement | Instrument/meter | 0.1 |
| Phenol | G | SW-846 Method 8040,<br>SW-846 Method 8041,<br>SW-846 Method 8270D | 5<br>5<br>10 |
| Temperature | Field measurement | Instrument/meter | |
| Turbidity, field measurement | Field measurement | Instrument/meter | 0.1 NTU |

Notes:

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

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

c. Detection limit units, unless otherwise indicated.

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

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

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

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

EPA = U.S. Environmental Protection Agency

NTU = nephelometric turbidity unit

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Trace Metals – Unfiltered/Filtered** | | | |
| Arsenic | P, $HNO_3$ to pH <2 | SW-846 Method 6020[d] or EPA/600 Method 200.8[e] | 10 |
| Aluminum | | | 50 |
| Boron | | | 20 |
| Bismuth | | | 100 |
| Lead | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 5 |
| Mercury | G, $HNO_3$ to pH <2 | SW-846 Method 7470A, EPA/600 Method 200.8 | 0.5 |
| Lithium | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 25 |
| Molybdenum | | | 20 |
| Selenium | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 10 |
| Silicon | | | 20 |
| Thallium | | | 5 |
| Tin | | | 100 |
| Titanium | | | 5 |
| Zirconium | | | 25 |
| **Anions by Ion Chromatography** | | | |
| Bromide | P | EPA/600 Method 300.0[f] | 250 |
| Phosphate | | | 500 |
| **Pesticides** | | | |
| Endrin | G | SW-846 Method 8081B | 0.1 |
| Lindane (four isomers) | | | 0.05 |
| Methoxychlor | | | 0.5 |
| Toxaphene | | | 2 |
| **Herbicides** | | | |
| 2,4-D | G | SW-846 Method 8151A | 20 |
| 2,4-5-TP silvex | | | 1 |
| 2,4,5-T | | | 1 |

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Volatile Organic Analyses** | | | |
| Acetone (by volatile organic analysis) | G, no headspace | SW-846 Method 8260B | 20 |
| Benzene | | | 5 |
| Carbon tetrachloride | | | 5 |
| Chloroform | | | 5 |
| 1,1,1-trichloroethane | | | 5 |
| 1,1,2-trichloroethane | | | 5 |
| 1, 1-dichloroethane | | | 10 |
| 1, 2-dichloroethane | | | 5 |
| Methylene chloride | | | 5 |
| Methyl ethyl ketone | | | 10 |
| Methyl isobutyl ketone | | | 10 |
| P-dichlorobenzene | | | 5 |
| Trichloroethylene | | | 5 |
| Tetrachloroethylene | | | 5 |
| Tetrahydrofuran | | | 50 |
| Toluene | | | 5 |
| Trans-1, 2-dichloroethylene | | | 5 |
| Vinyl chloride | | | 10 |
| Xylene-m | | | 10 |
| Xylene-o, p | | | 10 |
| **Semivolatile Organic Analyses** | | | |
| Benzo(a)pyrene | Amber glass | SW-846 Method 8270D | 10 |
| **Polychlorinated Biphenyls** | | | |
| Aroclor-1016 | G | SW-846 Method 8082 | 0.5 |
| Aroclor-1221 | | | 0.5 |
| Aroclor-1232 | | | 0.5 |

**Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents**

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| Aroclor-1242 | | | 0.5 |
| Aroclor-1248 | | | 0.5 |
| Aroclor-1260 | | | 0.5 |
| **Other** | | | |
| Ammonium ion | P, $H_2SO_4$ to pH <2 | EPA/600 Method 350.1, EPA/600 Method 300.7 | 50 |
| Coliform bacteria | P | Standard Method[g] 9223[h] | 2.2[i] |
| Conductivity, laboratory | P | Instrument/meter | 1 µohm |
| Cyanide | P, NaOH to pH >12 | SW-846 Method 9012, Standard Method[g] 4500, EPA/600 Method 335.2 | 5 |
| Dissolved oxygen, field | Field measurement | Instrument/meter | 0 mg/L |
| Hydrazine | G, HCl | ASTM D1385 | 100 |
| pH, laboratory measurement | P | Instrument/meter | 0.1 |
| Total dissolved solids | P | EPA/600 Method 160.1 | 10,000 |
| Total organic halogen | G, $H_2SO_4$ to pH <2, no headspace | SW-846 Method 9020 | 20 |
| Total organic carbon | G, HCL or $H_2SO_4$ to pH <2 | SW-846 Method 9060 | 1,000 |

Notes:

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

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

c. Detection limit units, unless otherwise indicated.

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

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

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

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

h. Enzyme substrate test.

i. Most probable number.

ASTM = American Society for Testing and Materials

EPA = U.S. Environmental Protection Agency

N/A = not applicable

NTU = nephelometric turbidity unit

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

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

## A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

### A2.5.1 Field Quality Control Samples

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

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

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

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

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

**Table A-4. Quality Control Samples**

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

Notes:

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

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

QC = quality control

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

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

### A2.5.2 Laboratory Quality Control Samples

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

### A2.5.3 Quality Control Requirements

Table A-5 lists the acceptance criteria for QC samples, and Table A-6 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. Field and Laboratory Quality Control Elements and Acceptance Criteria**

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **General Chemical Parameters** | | | |
| Alkalinity<br>Conductivity<br>pH<br>Total organic carbon<br>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** | | | |
| Cadmium<br>Chromium<br>Mercury<br>ICP metals<br>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" |

**Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria**

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

Notes:

a. Refer to Table A-2 and Table 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 five times the detection limit.

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

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

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated method blank)

N = result may be biased (associated matrix spike result was outside the acceptance limits)

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

Abbreviations:

CRDL = contract-required detection limit

DUP = laboratory matrix duplicate

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

GC = gas chromatography

IC = ion chromatography

ICP = inductively coupled plasma

ICP/MS = inductively coupled plasma/mass spectrometry

LCS = laboratory control sample

MB = method blank

MDA = minimum detectable activity

MDL = method detection limit

**Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria**

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|

MS = matrix spike
MSD = matrix spike duplicate
PCB = polychlorinated biphenyls.
QC = quality control
RPD = relative percent difference
SUR = surrogate

**Table A-6. Blind Standard Constituents and Schedule**

| Constituents | Frequency | Accuracy (%) | Precision (% RSD)[a] |
|---|---|---|---|
| Carbon tetrachloride | Quarterly | ±25% | ≤25% |
| Chloroform | Quarterly | ±25% | ≤25% |
| Chromium | Annually | ±20% | ≤25% |
| Fluoride | Quarterly | ±25% | ≤25% |
| Nitrate | Quarterly | ±25% | ≤25% |
| Trichloroethylene | Quarterly | ±25% | ≤25% |
| TOC[b] | Quarterly | Varies according to spiking compound | Varies according to spiking compound |
| TOX[c] | Quarterly | Varies according to spiking compound | Varies according to spiking compound |

Notes:

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

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

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

RSD = relative standard deviation
TOC = total organic carbon
TOX = total organic halides

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.

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

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

## A2.7 Instrument/Equipment Calibration and Frequency

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

## A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support 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.

## A2.9 Non-Direct Measurements

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

### A2.10 Data Management

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

All field activities will be recorded in the field logbook.

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

## A3 Assessment and Oversight

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

### A3.1 Assessments and Response Actions

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

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

### A3.2 Reports to Management

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

## A4 Data Validation and Usability

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

## A4.1 Data Review, Verification, and Validation

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

## A4.2 Verification and Validation Methods

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

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

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

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

## A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

# A5 References

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

40 CFR 265.93, "Preparation, Evaluation, and Response."

40 CFR 265.94, "Recordkeeping and Reporting."

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*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.

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*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.

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# Appendix B

# Well Construction/Lithologic Logs

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0515345

Page 1 of 1

# WELL SUMMARY SHEET

Date: 14 Dec 99

| | | | |
|---|---|---|---|
| Well ID: | B8817 | Well Name: | 299-W26-13 |
| Location: | 216-S-10 Pond | Project: | 200-CS-1/RCRA |
| Prepared By: | T.A. Lee | Date: 14 Dec 99 | Reviewed By: DCWeekes | Date: 12/29/99 |
| Signature: | [signature] | Signature: | [signature] |

## CONSTRUCTION DATA

**Description**

SS 304 Riser Pipe, 4½" OD, 4" ID, from +2.9 to 202.2 ft. bgs.

Temporary casings: 11¾" carbon steel 0'-36.3'
8⅝" carbon steel 0'-240.0'

Portland cement from 0' to 10.3'

Bentonite crumbles from 10.3 to 185.2 ft bgs

Bentonite holeplug from 185.2 to 190.7 ft bgs.

20-40 Colorado Silica Sand from 190.7 to 237.8 ft bgs.

W.L. = 200.1' bgs, 13 Dec 99, 0800 hrs

SS 304 Screen, 4½" OD, 4" ID, 0.010" slot, from 202.2 to 237.3 ft bgs. (46)

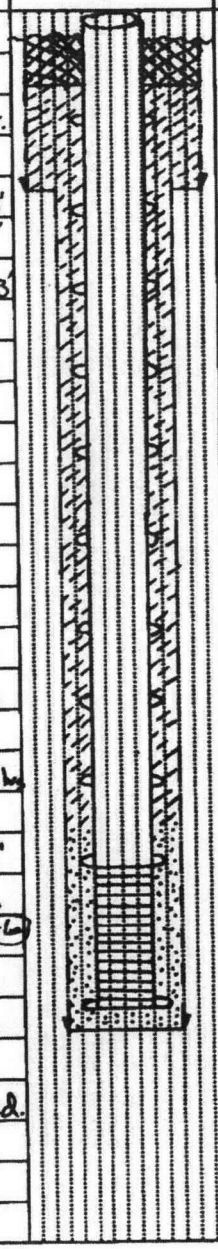
Blowout 237.3 to 240.7 ft

PVC Schedule 40 tail pipe from 237.3 to 237.8 ft bgs.

All depths in ft. below ground.

All Temporary casings removed.

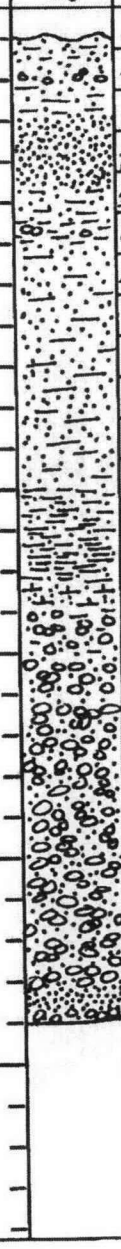
**Diagram**



## GEOLOGIC/HYDROLOGIC DATA

**Depth in Feet**: 0, 50, 100, 150, 200, 250

**Graphic Log**



**Lithologic Description**

0.0'-7.5' Slightly Silty SAND
7.5'-12.0' Gravelly SAND
12.0'-22.0' Silty SAND
22.0'-36.5' SAND
36.5'-47.0' Silty SAND
47.0'-51.0' Gravelly Sandy SILT
51.0'-110.0' Silty SAND
110.0'-134.0' Sandy SILT
134.0'-139.0' CALICHE ZONE
139.0'-148.0' Silty Sandy GRAVEL
148.0'-234.0' Sandy GRAVEL
Water level = 200.05' (12/13/99)
234.0'-237.0' SAND
237.0'-240.7' Sandy GRAVEL
T.D. = 240.7' bgs.

# WELL SUMMARY SHEET

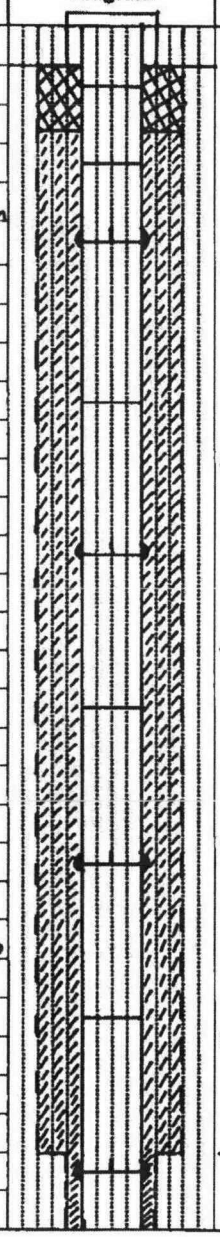
Start Date: 3/6/03
Finish Date: 4/3/03
Page: 1 of 2

| | |
|---|---|
| Well ID: B8828 | Well Name: 299-W26-14 |
| Location: 216-S-10 ditch | Project: FY2003 CERCLA CS-1 DRILLING |
| Prepared By: Jess Hocking — Date: 4/3/03 | Reviewed By: L.D. Walker — Date: 4/29/03 |
| Signature: [signature] | Signature: [signature] |

## CONSTRUCTION DATA

| Description |
|---|
| 4" TP-304/304L sch 05s Riser +2.00' → 223.37' |
| 4" TP-304/304L sch 05s 0.020" Cont. Wire Wrap screen 223.37' → 258.37' |
| 4" TP-304/304L sch 05s Sump 258.37' → 260.47' |
| Type I/II Portland Cement 0 → 9.65' |
| Pure Wyoming Bentonite Crumbles 9.65' → 200.98' |
| American Bentonite Pellets 200.98' → 211.05' |
| 10-20 mesh Colorado Silica Sand 211.05' → 267' |
| Temporary Casing, 10 3/4" OD 0' → 143' |
| NOTE: ALL DEPTHS REPORTED IN FT. BELOW GROUND SURFACE. |

Diagram



## GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 25, 50, 75, 100, 125

Graphic Log

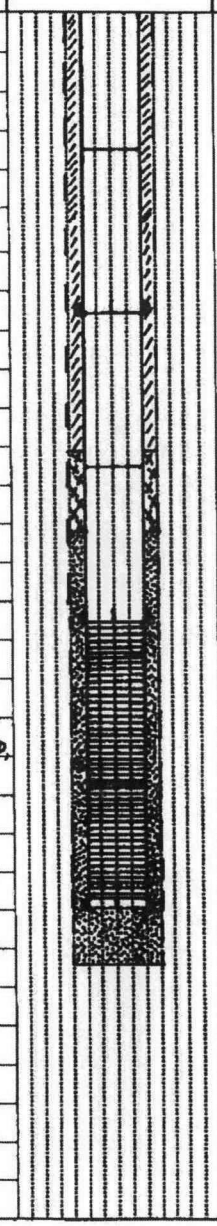
| Lithologic Description |
|---|
| 0-1' Drill Pad: Misc. Fill |
| 1-22' Slightly Silty Sand (m)S |
| 22-24' Sand S |
| 24-25' Silty Sand mS |
| 25-26' Slightly Silty Sand (m)S |
| 26-35.5' Sand S |
| 35.5-40' Slightly Silty Sand (m)S |
| 40-48' Silty Sand mS |
| 48-60' Sandy Silt sM |
| 60-74' Silty Sand mS |
| 74-76' Gravelly Silt gM |
| 76-77' Gravelly Sandy Silt gsM |
| 77-78.5' Gravelly Sand gS |
| 78.5-83' Slightly Silty Sand (m)S |
| 83-103.5' Sand S |
| 103.5-108' Slightly Silty Sand (m)S |
| 108-115' Sand S |
| 115-118' Slightly Silty Sand (m)S |
| 118-131' Sandy Silt sM |
| 131-135' Silt M |
| 135-135.5' Sand S |
| 135.5-163' Silt M |

# WELL SUMMARY SHEET

Start Date: 3/6/03
Finish Date: 4/3/03
Page: 2 of 2

| | |
|---|---|
| Well ID: B8828 | Well Name: 299-W26-14 |
| Location: 216-S-10 ditch. | Project: FY 2003 CERCLA CS-1 DRILLING |
| Prepared By: Jess Hocking — Date: 4/3/03 | Reviewed By: L. D. Walker — Date: 4/29/03 |
| Signature: Jess Hocking | Signature: LD Walker |

## CONSTRUCTION DATA

| Description | Diagram |
|---|---|
| Temporary Casing, 8 5/8" OD, to 267' |  |
| NOTE: ALL TEMP. CASING REMOVED FROM GROUND. | |
| NOT TO SCALE | |

## GEOLOGIC/HYDROLOGIC DATA

| Depth in Feet | Graphic Log | Lithologic Description |
|---|---|---|
| 150 | | 163 - 168' Sandy Gravel sG |
| | | 168 - 182' Gravelly Sand gS |
| | | 182 - 183' Slightly Silt Gravelly Sand (m) gS |
| | | 183 - 190' Gravelly Silty Sand gmS |
| 175 | | 190 - 192' Silty Sand mS |
| | | 192 - 214' Silty Sandy Gravel msG |
| | | 214 - 217' Sandy Gravel sG |
| 200 | | 217 - 219' Silty Sandy Gravel msG |
| | | 219 - 220' Sand S |
| | | 220 - 224' Sandy Gravel sG |
| | | 224 - 257' Silty Sandy Gravel msG |
| 225 | | 257 - 258' Sand S |
| | | 258 - 259' Silty Sandy Gravel msG |
| | | 259 - 260' Sandy Gravel sG |
| 250 | | 260 - 267' Sand S |
| | | 267 - Silty Sandy Gravel msG |
| | | TD = 267.0' bgs |
| | | DTW = 223' bgs (3/31/03) |
| 275 | | |

# WELL SUMMARY SHEET

0500615

Boring or Well No. 299-W27-2

Sheet 1 of 2

Location South of S test Area

Project WA/7H / S-10 Ditch

Elevation

Drilling Contractor K.C.H.

Driller G. Howell, G. Lydin

Drilling Method and Equipment Cable tool B.C. 22 in

Prepared By [Sign/Print Name] Date 10-8-92 Reviewed By [Sign/Print Name] Date 8/20/92

| CONSTRUCTION DATA | | Depth in Feet | GEOLOGIC/HYDROLOGIC DATA | |
|---|---|---|---|---|
| Description | Diagram | | Graphic Log | Lithologic Description |
| | | 0 | | Silty Sand with occasional pebble. |
| | | 5 | | |
| 16"Ø C.S Casing set at 9.85 | | 10 | | |
| | | 15 | | |
| 12"Ø C.S casing set at 179.88 | | 20 | | |
| 10"Ø C.S. casing set @ 302.92 | | 25 | | Pebble or Gravell loose |
| | | 30 | | Silty Sand |
| 9"Ø C.S. casing set @ 426.56 | | 35 | | |
| | | 40 | | |
| 4" stainless steel perforated | | 45 | | |
| casing set @ 416.56 | | 50 | | |
| Screened interval set @ 416.56 - 406.14 | | 55 | | |
| | | 60 | | |
| Slump: 3.2 w/cap on | | 65 | | |
| 12/15/92. | | 70 | | Silt/Clay pump class 3 |
| | | 75 | | Silty Sandy Gravel |
| | | 80 | | Gravel Silty Sand |
| | | 85 | | |
| | | 90 | | |
| | | 95 | | |
| | | 100 | | Silty Sand |
| | | 105 | | |
| | | 110 | | |
| | | 115 | | |
| | | 120 | | |
| | | 125 | | |
| | | 130 | | |
| | | 135 | | |
| | | 140 | | silt clay |
| | | 145 | | silty Sand |
| | | 150 | | |
| | | 155 | | |

**WELL SUMMARY SHEET**

Boring or Well No. 219 W27-2

Sheet 2 of 3

Location South of S Tank Farm

Project W017H / S-10

Elevation

Drilling Contractor K.E.H

Driller Gr. Lydon

Drilling Method and Equipment Cable tool BF. 22W

Prepared By (Sign/Print Name) Date 11/13/92

Reviewed By (Sign/Print Name) Date 12/10/92

| CONSTRUCTION DATA | | Depth in Feet | GEOLOGIC/HYDROLOGIC DATA | |
|---|---|---|---|---|
| Description | Diagram | | Graphic Log | Lithologic Description |
| | | 165 | | Silt clay |
| 12" ø CS Casing Sett. 179.88 | | 170 | | Silty Sandy Gravel |
| | | 175 | | |
| 10" ø CS Casing Sett. 303.92 | | 180 | | |
| | | 185 | | Silty Gravelly Sand |
| | | 190 | | Silty Sandy Gravel |
| | | 195 | | Gravelly Sand |
| | | 200 | | |
| | | 205 | | |
| | | 210 | | |
| Sealed @ 217.5 12/15/92 | | 215 | | |
| | | 220 | | Sand Sealed @ 217.5 on 12/15/92 |
| | | 225 | | Gravel |
| | | 230 | | |
| | | 235 | | Silty Sandy Gravel |
| | | 240 | | |
| | | 245 | | Gravelly Sand |
| | | 250 | | Silty Sandy Gravel |
| | | 255 | | Gravelly Sand |
| | | 260 | | |
| | | 265 | | Silty Sand |
| | | 270 | | Gravel |
| | | 275 | | Gravelly Sand w/ Gravel |
| | | 280 | | Interbeds |
| | | 285 | | |
| | | 290 | | |
| | | 295 | | |
| | | 300 | | |
| | | 305 | | Gravel |
| | | 310 | | |
| | | 315 | | |
| | | 320 | | |
| | | 325 | | |

A-6000-384 (04/90)

# WELL SUMMARY SHEET

Boring or Well No. 299-W27-2

Sheet 3 of 3

Location: South of "S" Tank Farm
Project: WDOH/S-10
Elevation:
Drilling Contractor: Jensen
Driller: D. Reinke
Drilling Method and Equipment: CFA/HSA/Air Rotary
Prepared By: Rob Witney (Sign/Print Name) Date: 12/10/92
Reviewed By: Edward C. Rogers (Sign/Print Name) Date: 2/26/93

| CONSTRUCTION DATA: Description | Diagram | Depth in Feet | GEOLOGIC/HYDROLOGIC DATA: Graphic Log | Lithologic Description |
|---|---|---|---|---|
| 8" ⌀ casing set to 416.56 | | 330 | | Sandy Gravel |
| | | 335 | | " " |
| | | 340 | | " " |
| | | 345 | | " " |
| | | 350 | | " " |
| | | 355 | | Gravel |
| | | 360 | | |
| | | 365 | | Sandy Gravel |
| | | 370 | | " " |
| | | 375 | | Gravel |
| | | 380 | | Sandy Gravel |
| | | 385 | | " " |
| | | 390 | | Medium Sand |
| Screen set @ 416.56 to 406.14 | | 395 | | " " |
| Portland cement 97'-20' | | 400 | | Sand |
| Bentonite chips (2 sk) 229.9-97 | | 405 | | Sandy Gravel |
| Bentonite chips 376.5-229.8 | | 410 | | Gravel |
| Portland cement 384.4-376.5 | | 415 | | " |
| 3 Bottle hole plug 399.4-384.4 | | 420 | | Sandy Gravel |
| 10/20 sand 420 - 377.4 | | 425 | | " " |
| Bentonite plug 428.2-420.0 | | 430 | | Clay/Silt |
| 1 bag cellulose to 428.2 | | 435 | | |
| | | 440 | | TD = 435.0' 11/20/92 |
| | | | | Redrilled from 376' to 445' |
| | | | | 12/4/92 - 12/9/92 w/13E32W |
| | | | | Rig # W-12 |

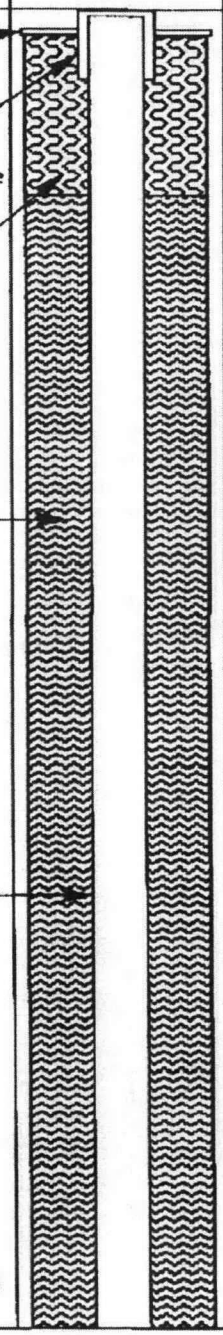
± 6000-384 (04.90)

| WELL SUMMARY SHEET | Start Date: 11/8/07<br>Finish Date: 01/4/08 | Page 1 of 4 |
|---|---|---|

| | | | |
|---|---|---|---|
| Well ID: C4975 | | Well Name: 699-32-76 | |
| Location: 1/2 mile SW of S-plant | | Project: Monitoring Wells for the UP-1 O.U. | |
| Prepared By: Erika Rincon | Date: 1/11/08 | Reviewed By: L. D. Walker | Date: 4/17/08 |
| Signature: Erika R | | Signature: | |

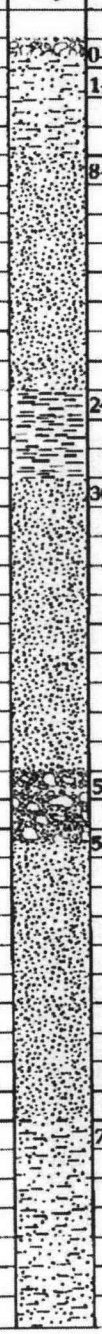
**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| 6-in Concrete Pad | |
| 6-in I.D. Type 304/304L Stainless Steel Protective Casing: +2.42 ft above Ground Surface | |
| Portland Cement Type I/II: 0 - 10.8 ft | |
| Granular Bentonite Crumbles: 10.8 - 212.4 ft | |
| 4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.82 - 227.0 ft | |
| All depths are in feet below ground surface. | |



**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 0 | | 0-1 Gravel, G (Fill) |
| | | 1-8 Sandy Silt, sM |
| 10 | | 8-24 Sand, S |
| 20 | | |
| | | 24-30 Silt, M |
| 30 | | 30-50 Sand, S |
| 40 | | |
| 50 | | 50-55 Sandy Gravel, sG |
| | | 55-74 Sand, S |
| 60 | | |
| 70 | | |
| | | 74-130 Silty Sand, mS |
| 80 | | |



| WELL SUMMARY SHEET | Start Date: 11/8/07<br>Finish Date: 01/4/08 | Page 2 of 4 |
|---|---|---|

| | |
|---|---|
| Well ID: C4975 | Well Name: 699-32-76 |
| Location: 1/2 mile SW of S-plant | Project: Monitoring Wells for the UP-1 O.U. |
| Prepared By: Erika Rincon — Date: 1/11/08 | Reviewed By: L.D. Walker — Date: 4/17/08 |
| Signature: Erika R | Signature: LD Walker |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| Granular Bentonite Crumbles: 10.8 - 212.4 ft | |
| 4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.82 - 227.0 ft | |
| All depths are in feet below ground surface. | |

**GEOLOGIC/HYDROLOGIC DATA**

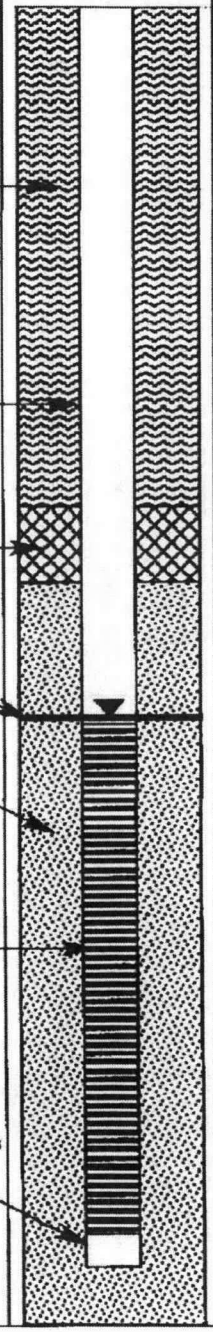
| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 90 | | |
| 100 | | |
| 110 | | |
| 120 | | |
| 130 | | 130-155 Sandy Silt, sM |
| 140 | | |
| 150 | | |
| | | 155-160 Sand, S |
| 160 | | 160-163 Silty Sand, mS |
| | | 163-170 Silty Gravely Sand, mgS |
| 170 | | 170-175 Gravely Sand, gS |
| | | 175-200.5 Sandy Gravel, sG |

| WELL SUMMARY SHEET | Start Date: 11/8/07<br>Finish Date: 01/4/08 | Page 3 of 4 |
|---|---|---|

| | |
|---|---|
| Well ID: C4975 | Well Name: 699-32-76 |
| Location: 1/2 mile SW of S-plant | Project: Monitoring Wells for the UP-1 O.U. |
| Prepared By: Erika Rincon — Date: 1/11/08 | Reviewed By: L.D. Walker — Date: 4/17/08 |
| Signature: Erika R | Signature: [illegible] |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| Granular Bentonite Crumbles: 10.8 - 212.4 ft | |
| 4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.82 - 227.0 ft | |
| 3/8-in Bentonite Pellets: 212.4 - 217.0 ft | |
| Static Water Level: 226.40 ft bgs (12-10-2007) | |
| Primary Filter pack 10-20 Mesh Colorado Silica Sand: 217.0 - 267.2 ft | |
| 4-in I.D. Stainless Steel, Type 304, Slot 20 (.020-in) Screen: 227.0 - 262.0 ft bgs | |
| 4-in I.D. Stainless Steel, Type 304, Schedule 10 Sump: 262.0 - 264.0 ft bgs | |
| All depths are in feet below ground surface. | |



**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 180 | | |
| 190 | | |
| 200 | | 200.5-210 Gravely Sand, gS |
| 210 | | 210-215 Sandy Gravel, sG |
| | | 215-230 Gravely Sand, gS |
| 220 | | |
| 230 | | 230-236 Silty Sandy Gravel, msG |
| | | 236-237 Grab Sample for Sieve Analysis |
| | | 236-255 Sandy Gravel, sG |
| 240 | | |
| | | 244 Water Sample HEIS: B1PM57 & B1PM85 |
| 250 | | |
| | | 255-257 Gravelly Silty Sand, gmS |
| | | 257-280 Silt Sandy Gravel, msG |
| | | 257 Grab Sample for Sieve Analysis |
| 260 | | |

| WELL SUMMARY SHEET | Start Date: 11/8/07<br>Finish Date: 01/4/08 | Page 4 of 4 |
|---|---|---|

| | |
|---|---|
| Well ID: C4975 | Well Name: 699-32-76 |
| Location: 1/2 mile SW of S-plant | Project: Monitoring Wells for the UP-1 O.U. |
| Prepared By: Erika Rincon — Date: 1/11/08 | Reviewed By: L.D. Walker — Date: 4/17/08 |
| Signature: Erika R | Signature: LD Walker |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| 3/8-in Bentonite Pellets: 267.2 - 272.0 ft | |
| 8-12 Mesh Colorado Silica Sand (Backfill): 272.0 - 344.0 ft | |

All depths are in feet below ground surface.

rehole drilled with 13-in threaded casing 0-198 ft and 10¾-in threaded casing 198-344 ft

All temporary drill casing was removed from the ground.

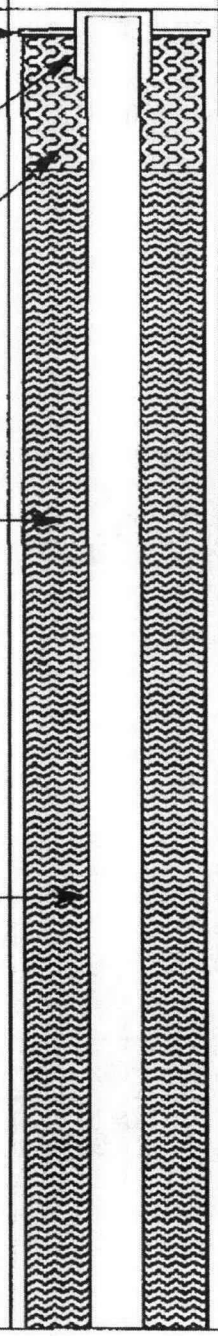
**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 270 | | |
| | | 273 Water Sample HEIS: B1PM54, B1PM58 & B1PM86 |
| 280 | | 280-300 Sandy Gravel, sG |
| 290 | | |
| 300 | | 299 Water Sample HEIS: B1PM59 & B1PM87<br>300-304 Silty Gravely Sand, mgS |
| | | 304-344 Sandy Gravel, sG |
| 310 | | |
| 320 | | |
| 330 | | |
| 340 | | 342 Water Sample HEIS: B1PM60 & B1PM88<br>344 Total Depth (12/13/2007) |
| 350 | | |

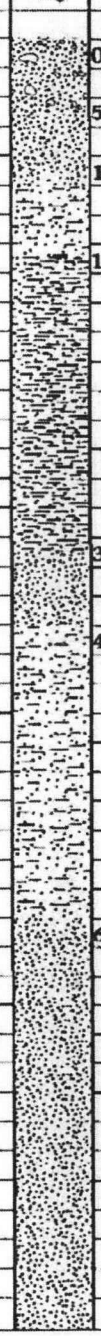
| WELL SUMMARY SHEET | Start Date: 01/08/08<br>Finish Date: 01/31/08 | Page 1 of 4 |
|---|---|---|

| | | | |
|---|---|---|---|
| Well ID: C4974 | | Well Name: 699-33-75 | |
| Location: 1/4 mile SW of S-plant | | Project: Monitoring Wells for the UP-1 O.U. | |
| Prepared By: Erika Rincon | Date: 2/1/08 | Reviewed By: L.D. Walker | Date: 4/17/08 |
| Signature: Erika Rincon | | Signature: LD Walker | |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| 6-in Concrete Pad<br>6-in I.D. Stainless Steel Type 304/304L Protective Casing: +2.48 ft above Ground Surface<br>Portland Cement Type I/II: 0 - 9.0 ft<br>Granular Bentonite Crumbles: 9.0 - 220.9 ft<br>4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.48 - 235.0 ft<br>All depths are in feet below ground surface. |  |

**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 0 |  | 0-5 Gravely Sand, gS |
| | | 5-10 Sand, S |
| 10 | | 10-15 Silty Sand, mS |
| | | 15-35 Sandy Silt, sM |
| 20 | | |
| 30 | | |
| | | 35-40 Sand, S |
| 40 | | 40-60 Silty Sand, mS |
| 50 | | |
| 60 | | 60-140 Sand, S |
| 70 | | |
| 80 | | |

| WELL SUMMARY SHEET | Start Date: 01/08/08<br>Finish Date: 01/31/08 | Page 2 of 4 |
|---|---|---|
| Well ID: C4974 | Well Name: 699-33-75 | |
| Location: 1/4 mile SW of S-plant | Project: Monitoring Wells for the UP-1 O.U. | |
| Prepared By: Erika Rincon | Date: 2/1/08 | Reviewed By: L.D. Walker | Date: 4/17/08 |
| Signature: Erika R | Signature: LD Walker | |

**CONSTRUCTION DATA**

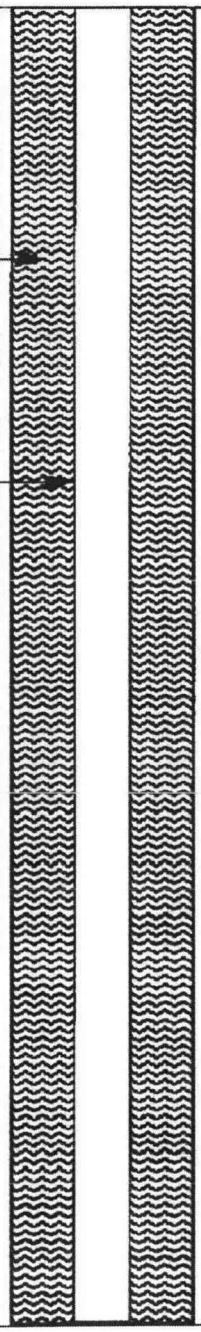
Description

Granular Bentonite Crumbles: 9.0 - 220.9 ft

4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.48 - 235.0 ft

All depths are in feet below ground surface.

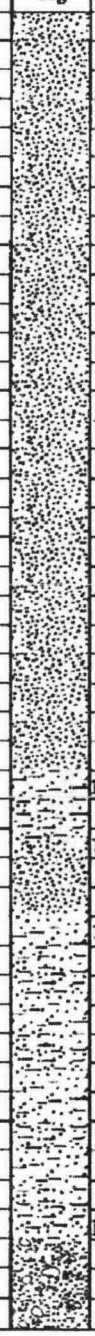
Diagram



**GEOLOGIC/HYDROLOGIC DATA**

Depth in Feet: 90, 100, 110, 120, 130, 140, 150, 160, 170

Graphic Log



Lithologic Description/Groundwater Sample Depths (ft bgs)

140-145 Silty Sand, mS

145-150 Sand, S

150-172 Silty Sand, mS

172-180 Silty Gravely Sand, mgS

| WELL SUMMARY SHEET | Start Date: 01/08/08<br>Finish Date: 01/31/08 | Page 3 of 4 |
|---|---|---|

| | |
|---|---|
| Well ID: C4974 | Well Name: 699-33-75 |
| Location: 1/4 mile SW of S-plant | Project: Monitoring Wells for the UP-1 O.U. |
| Prepared By: Erika Rincon — Date: 2/1/08 | Reviewed By: L.D. Walker — Date: 4/17/08 |
| Signature: Erika R | Signature: LD Walker |

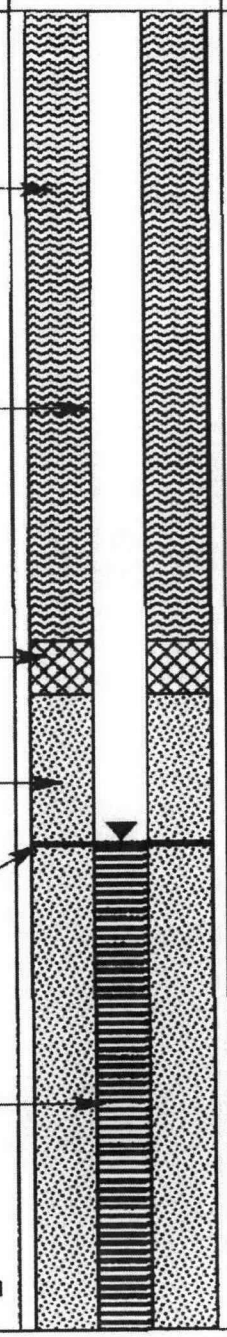
**CONSTRUCTION DATA**

Description

- Granular Bentonite Crumbles: 9.0 - 220.9 ft
- 4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.48 - 235.0 ft
- 3/8-in Bentonite Pellets: 220.9 - 224.5 ft
- Primary Filter pack 10-20 Mesh Colorado Silica Sand: 224.5 - 274.0 ft
- Static Water Level: 234.80 ft bgs (01-24-2008)
- 4 in I.D. Stainless Steel, Type 304, Slot 20 (.020-in) Screen: 235.0 - 270.0 ft bgs

All depths are in feet below ground surface.

Diagram



**GEOLOGIC/HYDROLOGIC DATA**

Depth in Feet: 180, 190, 200, 210, 220, 230, 240, 250, 260

Graphic Log

Lithologic Description/Groundwater Sample Depths (ft bgs)

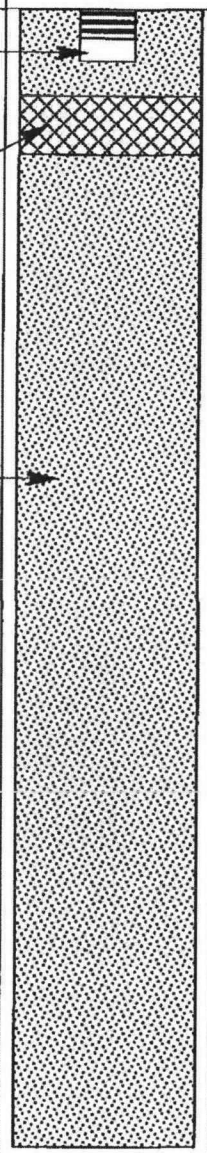
- 180-200 Gravely Silty Sand, gmS
- 200-205 Sandy Gravel, sG
- 205-210 Gravely Sand, gS
- 210-230 Sandy Gravel, sG
- 227-229 Split-Spoon Sample for Sieve Analysis
- 230-257 Silty Sandy Gravel, msG
- 244 Water Sample HEIS: B1PM53 & B1PM81
- 257-260 Sand, S
- 257-259 Split-Spoon Sample for Sieve Analysis
- 260-310 Silt Sandy Gravel, msG

| WELL SUMMARY SHEET | Start Date: 01/08/08<br>Finish Date: 01/31/08 | Page 4 of 4 |
|---|---|---|

| | |
|---|---|
| Well ID: C4974 | Well Name: 699-33-75 |
| Location: 1/4 mile SW of S-plant | Project: Monitoring Wells for the UP-1 O.U. |
| Prepared By: Erika Rincon — Date: 2/1/08 | Reviewed By: L.D. Walker — Date: 4/17/08 |
| Signature: Erika R | Signature: LD Walker |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| 4-in, I.D. Stainless Steel, Type 304, Schedule 10 Sump: 270.0 - 272.0 ft | |
| 3/8-in Bentonite Pellets: 274.0 - 277.8 ft | |
| 8-12 Mesh Colorado Silica Sand (Backfill): 227.8 - 346.0 ft | |



All depths are in feet below ground surface.

Borehole drilled with 13-in threaded casing 0-198.5 ft and 10¾-in threaded casing 198.5-346 ft

All temporary drill casing was removed from the ground.

**GEOLOGIC/HYDROLOGIC DATA**

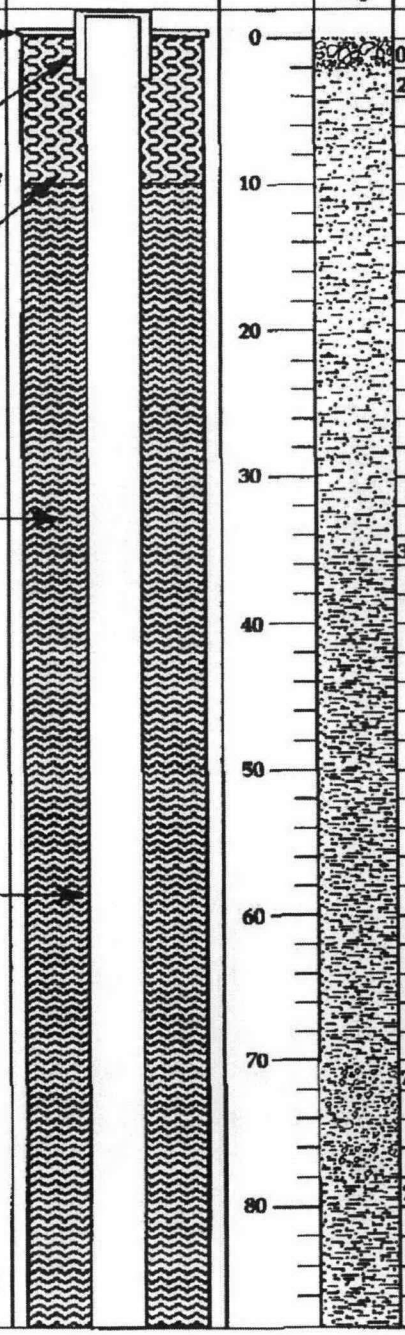
| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 270 | | |
| | | 277 Water Sample HEIS: B1PM54, B1PM82 |
| 280 | | |
| 290 | | |
| 300 | | |
| | | 307 Water Sample HEIS: B1PM55 & B1PM83 |
| 310 | | 310-335 Sandy Gravel, sG |
| 320 | | |
| 330 | | |
| | | 335-340 Gravel, G |
| 340 | | 340-346 Sandy Gravel, sG |
| | | 346 Water Sample HEIS: B1PM56 & B1PM84 |
| | | 346 Total Depth (01/21/2008) |
| 350 | | |

| WELL SUMMARY SHEET | Start Date: 01/31/08<br>Finish Date: 03/27/08 | Page 1 of 4 |
|---|---|---|

| | |
|---|---|
| Well ID: C4976 | Well Name: 699-33-76 |
| Location: 1/2 mile SW of S-plant | Project: Monitoring Wells for the UP-1 O.U. |
| Prepared By: Erika Garcia — Date: 4/21/08 | Reviewed By: L.J. Walker — Date: 6/5/08 |
| Signature: [illegible] | Signature: [illegible] |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| 6-in Concrete Pad | |
| 6-in I.D. Type 304/304L Stainless Steel Protective Casing: +2.42 ft above Ground Surface | |
| Portland Cement Type I/II: 0 - 10.0 ft | |
| Granular Bentonite Crumbles: 10.0 - 206.8 ft | |
| 4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.42 - 222.0 ft | |
| All depths are in feet below ground surface. | |



**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 0 | | 0-2 Gravel, G (Fill) |
| | | 2-35 Silty Sand, mS |
| 10 | | |
| 20 | | |
| 30 | | |
| | | 35-70 Sandy Silt, sM |
| 40 | | |
| 50 | | |
| 60 | | |
| 70 | | 70-78 Gravely Sandy Silt, gsM |
| 80 | | 78-100 Sandy Silt, sM |

| WELL SUMMARY SHEET | Start Date: 01/31/08<br>Finish Date: 03/27/08 | Page 2 of 4 |
|---|---|---|

| | | | |
|---|---|---|---|
| Well ID: C4976 | | Well Name: 699-33-76 | |
| Location: 1/2 mile SW of S-plant | | Project: Monitoring Wells for the UP-1 O.U. | |
| Prepared By: Erika Garcia | Date: 4/21/08 | Reviewed By: L.D. Walker | Date: 6-5-08 |
| Signature: G.L. Kasza | | Signature: | |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| Granular Bentonite Crumbles: 10.0 - 206.8 ft | |
| 4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.42 - 222.0 ft | |
| All depths are in feet below ground surface. | |

**GEOLOGIC/HYDROLOGIC DATA**

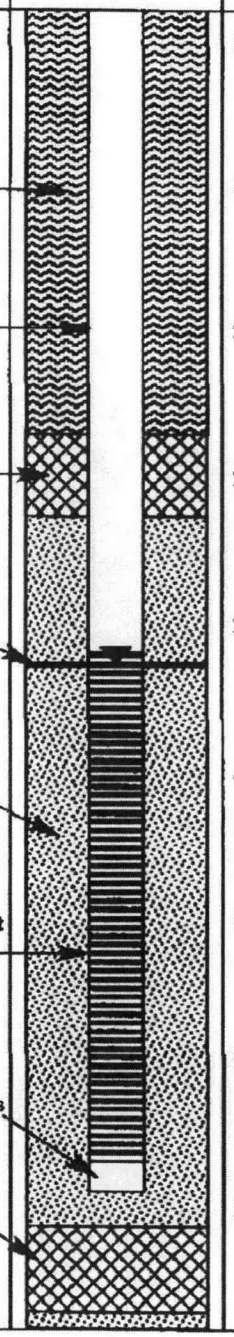
| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 90 | | |
| 100 | | 100-160 Silty Sand, mS |
| 110 | | |
| 120 | | |
| 130 | | |
| 140 | | |
| 150 | | |
| 160 | | 160-165 Sand, S |
| | | 165-170 Gravely Silty Sand, gmS |
| 170 | | 175-200 Sandy Gravel, sG |

| WELL SUMMARY SHEET | Start Date: 01/31/08<br>Finish Date: 03/27/08 | Page 3 of 4 |
|---|---|---|

| | | | |
|---|---|---|---|
| Well ID: C4976 | | Well Name: 699-33-76 | |
| Location: 1/2 mile SW of S-plant | | Project: Monitoring Wells for the UP-1 O.U. | |
| Prepared By: Erika Garcia | Date:4/21/08 | Reviewed By: L.A. Walker | Date: 6-5-08 |
| Signature: G.L. Kasza | | Signature: | |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| Granular Bentonite Crumbles: 10.0 - 206.8 ft | |
| 4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.42 - 222.0 ft | |
| 3/8-in Bentonite Pellets: 206.8 - 212.4 ft | |
| Static Water Level: 222.75 ft bgs (03/17/2008) | |
| Primary Filter pack 10-20 Mesh Colorado Silica Sand: 212.4 - 261.3 ft | |
| 4-in I.D. Stainless Steel, Type 304, Slot 20 (.020-in) Screen: 222.0 - 257.0 ft bgs | |
| 4-in I.D. Stainless Steel, Type 304, Schedule 10 Sump: 257.0 - 259.0 ft bgs | |
| 3/8-in Bentonite Pellets: 261.3 - 267.2 ft | |
| All depths are in feet below ground surface. | |



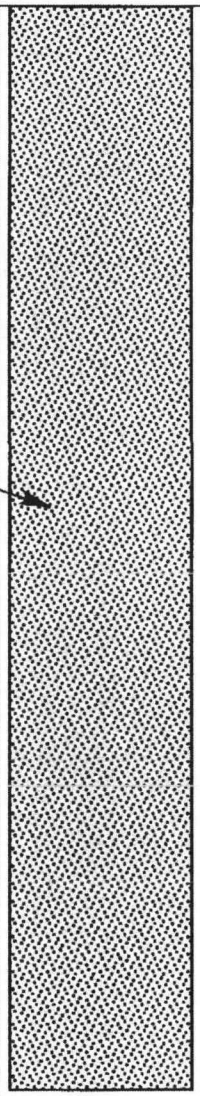
**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 180 | | |
| 190 | | |
| 200 | | 200-205 Gravely Sand, gS |
| 210 | | 205-342.4 Sandy Gravel, sG |
| 220 | | |
| 230 | | |
| 240 | | 243 Water Sample HEIS: B1PM61 & B1PM89 |
| 250 | | 252.5-255 Split-Spoon for Sieve Analysis |
| 260 | | 257-280 Silt Sandy Gravel, msG |

| WELL SUMMARY SHEET | Start Date: 01/31/08<br>Finish Date: 03/27/08 | Page 4 of 4 |
|---|---|---|

| | | | |
|---|---|---|---|
| Well ID: C4976 | | Well Name: 699-33-76 | |
| Location: 1/2 mile SW of S-plant | | Project: Monitoring Wells for the UP-1 O.U. | |
| Prepared By: Erika Garcia | Date: 4/21/08 | Reviewed By: L. D. Walker | Date: 6/5/08 |
| Signature: G. L. Kasza | | Signature: | |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| 10-20 Mesh Colorado Silica Sand (Backfill): 267.2 - 342.4 ft |  |

All depths are in feet below ground surface.

Borehole drilled with 11¾-in threaded casing 0-205 ft and 9⅝-in threaded casing 198-344 ft

All temporary drill casing was removed from the ground.

**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 270 | | 205-342.4 Sandy Gravel, sG |
| | | 273 Water Sample HEIS: B1PM62 & B1PM90 |
| 280 | | |
| 290 | | |
| 300 | | 302 Water Sample HEIS: B1PM63 & B1PM91 |
| 310 | | |
| 320 | | |
| 330 | | |
| 340 | | 342.4 Water Sample HEIS: B1PM64 & B1PM92 |
| | | 342.4 Total Depth (03/17/2008) |
| 350 | | |

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