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Revision 1

Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
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Document Type: PMP

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Executive Summary

Waste Management Area (WMA) TX-TY, which contains the TX and TY Tank Farms, is regulated under RCW 70.105 [1] and its implementing requirements in WAC 173-303-400.[2] The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*,[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA),[4] including the requirements in 40 CFR 265, Subpart F.[5] The WMA TX-TY is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order*,[6] with Ecology identified as the lead regulatory agency for the unit.

The WMA TX-TY was placed in assessment monitoring in 1993 due to elevated specific conductance. A groundwater quality assessment plan was prepared in 1993 (WHC-SD-EN-AP-132)[7] that described the monitoring activities to determine whether WMA TX-TY had affected groundwater. The plan was updated in 2001 (PNNL-12072)[8] for continued RCRA groundwater quality assessment, as required by 40 CFR 265.93(d)(7).[9] The WMA TX-TY assessment plan was again updated in 2007 to include information obtained from eight new wells installed at the WMA after 1999 (PNNL-16005)[10] and information from routine quarterly groundwater monitoring during the previous 5 years. This document supersedes the 2010 assessment plan to include significant events that have occurred at WMA TX-TY since that time.

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

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

[3] *Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq.

[4] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.

[5] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," *Code of Federal Regulations*.

[6] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

[7] WHC-SD-EN-AP-132, 1993, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[8] PNNL-12072, 2001, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

[9] 40 CFR 265.93, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," *Code of Federal Regulations*.

[10] PNNL-16005, 2007, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*, Pacific Northwest National Laboratory, Richland, Washington.

This plan describes the WMA TX-TY facility and operating history, waste characteristics, hydrogeology, previous monitoring at the WMA, groundwater and vadose zone contamination associated with the WMA, and the conceptual model for the WMA. The plan also addresses the following:

- Number, locations, and attributes of wells in the WMA TX-TY groundwater monitoring network
- Sampling requirements and schedule for monitoring at WMA TX-TY
- Analytes, groundwater parameters, and analytical methods for dangerous wastes or dangerous waste constituents in the groundwater related to historical facility operations
- Procedures for evaluating groundwater quality information
- Reporting requirements

This assessment plan is the principal controlling document for conducting groundwater monitoring at WMA TX-TY.

Contents

1 Introduction 1-1

2 Background 2-1

2.1 Facility Description and Operating History 2-1
2.2 Regulatory Basis 2-2
2.3 Waste Characteristics 2-3
2.4 Geology and Hydrogeology 2-4
2.5 Summary of Previous Groundwater Monitoring 2-7
2.5.1 Groundwater Contamination 2-9
2.5.2 Vadose Zone Contamination 2-9
2.6 Conceptual Model 2-10
2.6.1 Contaminant Sources 2-13
2.6.2 Driving Forces 2-13
2.6.3 Migration 2-13
2.6.4 Changing Groundwater Flow Direction 2-14
2.6.5 Contaminant Distribution 2-14
2.7 Data Quality Objectives 2-14

3 Groundwater Monitoring Program 3-1

3.1 Constituent List and Sampling Frequency 3-1
3.2 Monitoring Well Network 3-3
3.3 Changes to Monitoring Plan 3-7
3.4 Sampling and Analysis Protocol 3-9

4 Data Evaluation and Reporting 4-1

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

5 References 5-1

Appendix

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

Figures

Figure 1-1. Location Map for Waste Management Area □□-□□ 1-2
Figure 2-1. Generali□ed Stratigraphic Column for the Hanford Site 2-6
Figure 2-2. Selected Monitoring Wells Showing Groundwater Level Declines in WMA □□-□□ 2-7
Figure 2-3. Water □able Map for Area Around WMA □□ □□□March 2011 ..... 2-□
Figure 2-4. Well-to-Well Resistivity Inversion Model Results for the □□ □ank Farm 2-11
Figure 2-5. Well-to-Well Resistivity Inversion Model Results for the □□ □ank Farm 2-12
Figure 3-1. General Layout of WMA □□-□□□Including Locations of Nearby Past-Practice Facilities and Monitoring Wells 3-6

Tables

□able 2-1. Dangerous Wastes in the Single-Shell □ank System □Dangerous Waste Permit Application Part A Form□ 2-3
□able 2-2. DQO Parameters□Associated Regulatory Requirements□and Documentation for WMA □□-□□ 2-15
□able 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell □ank Farm System 3-1
□able 3-2. Monitoring Network□Constituent List□and Sampling Frequency for WMA □□-□□ 3-4
□able 3-3. WMA □□-□□ Well Depths and Water □able □levation 3-7
□able 3-4. WMA □□-□□ Monitoring Well Network Sample Frequencies ..... 3-□

Terms

amsl	above mean sea level
CAS	Chemical Abstract Services
CC	Cold Creek unit
C RCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
C	calendar year
DO	.S. Department of nergy
DQO	data quality objective
BF	electromagnetic borehole flow meter
cology	Washington State Department of cology
PA	.S. nvironmental Protection Agency
F	fiscal year
ID	identification
NAVD	North American Vertical Datum of 19
O	operable unit
PFP	Plutonium Finishing Plant
P R	plutonium-uranium e traction
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
R DO	reduction-o dation
SS	single-shell tank
ri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
VOC	volatile organic compound
WMA	waste management area

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1 Introduction

Waste Management Area (WMA) □□□-□□□ which contains the □□ and □□ Tank Farms) is located in the northern portion of the 200 West Area of the Hanford Site (Figure 1-1). The WMA was used for interim storage of radioactive waste from chemical processing of reactor fuel for plutonium production. The WMA is regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA) as modified in 40 CFR 265 (Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring") RCW 70.105, "Hazardous Waste Management Act," and its implementing requirements in Washington State dangerous waste regulations (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"). The WMA □□-□□ was placed in assessment monitoring in 1993 due to elevated specific conductance (a RCRA indicator parameter) in two downgradient wells. Assessment monitoring has continued at WMA □□-□□ since that time due to the presence of chromium (a dangerous constituent). The objectives for the continued assessment of groundwater quality at WMA □□-□□□ as required by 40 CFR 265.93(d)(7)(i), "Preparation, Evaluation, and Response," are to determine the following:

- Rate and extent of migration of the dangerous waste or dangerous waste constituents in the groundwater; and
- Concentration of dangerous waste or dangerous waste constituents in the groundwater.

The scope of this plan is to acquire necessary groundwater data to achieve these objectives. The objectives are also related to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-ZP-1 Groundwater Operable Unit (OU) investigations and the vadose zone RCRA facility investigation/corrective measures study at WMA □□-□□. The integration of the RCRA groundwater quality assessment with the 200-ZP-1 OU and the vadose zone RCRA facility investigation/corrective measures study requires consideration of certain nondangerous waste constituents and radionuclides, in addition to the dangerous waste constituents regulated under RCRA. Radionuclides are monitored under separate plans to support the objectives of CERCLA and the *Atomic Energy Act of 1954*.

This document is a revision of the previous groundwater assessment plan (PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*) and includes significant events that have occurred at WMA □□-□□ since the previous plan was issued. This monitoring plan is prepared to be consistent, to the extent possible, with the final status monitoring plan that will be incorporated into the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967) in the future.

Chapter 2 of this plan summarizes background information, with references to other documents for more detailed information. Chapter 2 also describes the WMA and the types of waste present, provides a brief history of groundwater monitoring, and describes geology and hydrology pertinent to WMA □□-□□. 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, interpretation, and reporting. A list of the references cited in this document is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP).

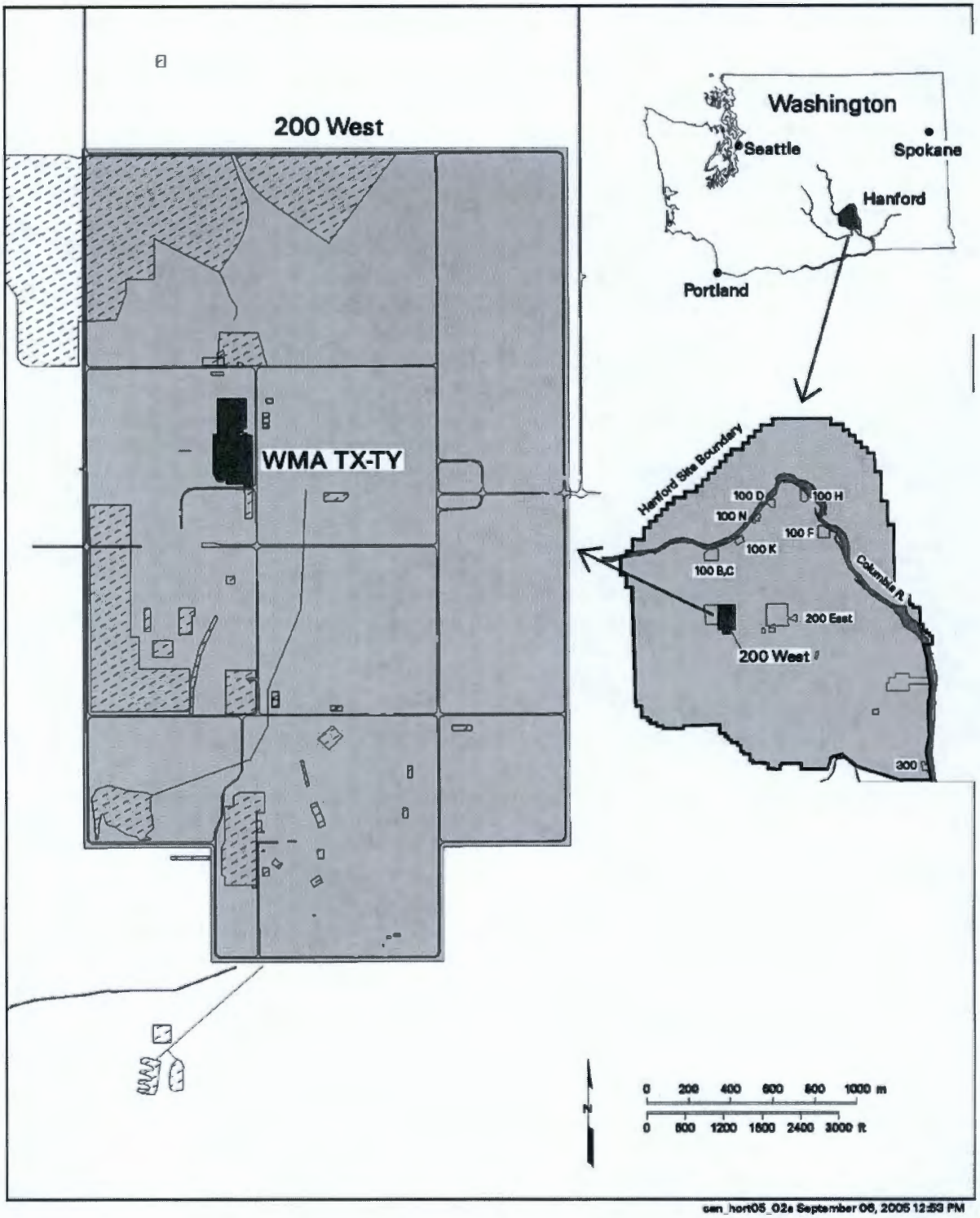


Figure 1-1. Location Map for Waste Management Area TX-TY

2 Background

This chapter describes the WMA TX-TY facility and its operating history. Discussion is also included on associated waste and waste characteristics at the WMA, local geology and hydrology, a summary of previous monitoring, groundwater and vadose zone contamination at the WMA, and a conceptual model.

The discussions in this chapter are summarized from previous documents, including the following:

- PNNL-11509 *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas T and TX-TY at the Hanford Site*
- PNNL-12072 *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site*
- PNNL-14099 *Groundwater Conditions at Single-Shell Tank Waste Management Area TX-TY (January 1998 through December 2001)*
- PNNL-15537 *Data Package for Past and Current Groundwater Flow and Contamination Beneath Single-Shell Tank Waste Management Areas*
- PNNL-16005 *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
- RPP-23752 *Field Investigation Report for Waste Management Areas T and TX-TY,* and
- RPP-RPT-3320 *Surface Geophysical Exploration of the TX and TY Tank Farms at the Hanford Site.*

2.1 Facility Description and Operating History

The WMA TX-TY is located in the northern portion of the 200 West Area (Figure 1-1). The WMA contains 24 underground single-shell tanks (SSTs) constructed in 1947 and 1948 for the TX Tank Farm and in 1951 and 1952 for the TY Tank Farm. Each tank has a capacity of 2.84 million L (750,000 gal). The 18 tanks in the TX Tank Farm are arranged in three 4-tank cascades and two 3-tank cascades. The six tanks in the TY Tank Farm are arranged in three 2-tank cascades. Tank cascades are sets of tanks that were constructed with elevation differences between tanks which allow gravity-driven flow (cascading) of the waste stream from one tank to another. This allowed cooling and precipitation of radionuclides and solids to occur in each tank of the cascade. Some of the supernatant from the last tank in a cascade was sent to cribs via surface pipelines because of shortage in tank storage capacity. As a result, it is difficult to estimate the composition of the wastes remaining in the tanks based on operational records. In addition to the tanks, six diversion boxes and ancillary pumps, valves, and pipes are included in the Dangerous Waste Permit Application Part A Form (WA7890009967) for the SSTs in the TX-TY Tank Farms system.

The tanks in WMA TX-TY began receiving waste in 1949. The tanks in both the TX and TY Tank Farms were used to support the bismuth phosphate process and the uranium-recovery program. Some of the tanks in WMA TX-TY also received waste from Reduction-Oxidation (REDOX) Plant and Plutonium-Uranium Extraction (PUREX) Plant operations.

Waste management operations have created a complex intermingling of the tank wastes. Nonradioactive chemicals have been added to the tanks, and varying amounts of waste and heat-producing radionuclides have been removed. In addition, natural processes have caused settling, stratification, and segregation of waste components. A detailed history of tank farm operations is provided in *A History of the 200 Area Tank Farms* (WHC-MR-0132).

The pumpable liquid has been removed from all of the SSTs in WMA TX-TY and all tanks have been interim stabilized. Each tank currently contains less than 1 [illegible] 250 L (50 000 gal) of drainable interstitial liquid and less than 1 [illegible] 925 L (5 000 gal) of supernatant liquid (HNF-EP-01[illegible]2 *Waste Tank Summary Report for Month Ending September 30, 2004,* Rev. 197).

Initial corrective actions have been implemented at WMA TX-TY. Berms were constructed around the TX and TY Tank Farms in 2001 to stop run-on of natural precipitation and all known water lines leading to the tank farms were cut and capped at that time. Additionally, an interim barrier over the TX Tank Farm was constructed and completed in 2010. An interim measures maintenance plan consisting of annual inspections of drywell covers and visual inspections of run-off collection areas and culverts is in place and documented in the *Interim Measures Maintenance Plan* (WRPS-09003[illegible]).

HNF-EP-01[illegible]2 assumed that 13 of the tanks in WMA TX-TY have leaked based on liquid losses, however, little information and no previous leak inventory estimates are available for seven of the tanks (RPP-23405 *Tank Farm Vadose Zone Contamination Volume Estimates*). Contamination associated with the latter seven tanks may be the result of waste pipeline leaks or nearby tanks that are known to have leaked. The tanks with the three largest confirmed leaks from WMA TX-TY are tanks TX-103, TY-105, and TX-106 (RPP-23405).

In 2010, the *Hanford TY-Farm Leak Assessment Report* (RPP-RPT-42296) revised some of the leak estimates from HNF-EP-01[illegible]2. For instance, RPP-RPT-42296 states that tank TX-101, which was previously identified as a leaker, is not actually a leaker based on the new methodology that shows the liquid level decreases were within the margin of error of equipment. In addition to leaks, 11 unplanned releases have been documented in the area of WMA TX-TY. The unplanned releases are described in *T Plant Source Aggregate Area Management Study Report* (DOE/RL-91-61) and PNNL-16005.

2.2 Regulatory Basis

In May 19[illegible]7 the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, Byproduct Material) stating that the dangerous waste components of mixed waste are subject to RCRA regulations. In November 19[illegible]7 the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these dangerous 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[illegible]97.

Groundwater monitoring is conducted at WMA TX-TY in accordance with 40 CFR 265, Subpart F (Ground-Water Monitoring) and by reference of WAC 173-303-400(3). An indicator evaluation RCRA groundwater monitoring program for WMA TX-TY was initiated in 19[illegible]9 (WHC-SD-EN-AP-012, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*, Rev. 0, followed by Rev. 1 in 1991). The WMA was placed into assessment monitoring in 1993 because specific conductance values in downgradient wells 299-W10-17 and 299-W14-12 exceeded the upgradient background (critical mean) value (WHC-SD-EN-AP-132, *Interim-Status Groundwater Quality Assessment Plan for the Single Shell Waste Management Areas T and TX-TY*). The first assessment report (PNNL-11[illegible]09) concluded the following: (1) elevated contamination in well 299-W14-12 was consistent with a source within the WMA, and (2) an upgradient source (216-[illegible]-25 trench) was possible. Subsequent drilling and sampling of well 299-W15-40 (located between the 216-[illegible]-25 trench and the WMA) eliminated the 216-[illegible]-25 trench as a possible source of contamination downgradient of the WMA. The second assessment report (*RCRA Groundwater Quality Assessment Report for Single-Shell Tank Waste Management Area TX-TY (January 1998 through December 2001*, PNNL-14004) was not able to eliminate WMA TX-TY as

a source for the downgradient contamination. The presence of chromium, a dangerous constituent in groundwater, requires continued groundwater assessment. Accordingly, continued groundwater assessment is required, and this plan describes the activities for continued assessment.

2.3 Waste Characteristics

Two basic chemical-processing operations were the source of most of the dangerous waste transferred to the [illegible] and [illegible] Tank Farms: the bismuth phosphate process and the tributyl phosphate process. Lesser quantities of waste from the R[illegible]DO[illegible] and P[illegible]R[illegible] processes were also sent to the tank farms. The bismuth phosphate, R[illegible]DO[illegible], and P[illegible]R[illegible] processes were chemical separations programs used to recover plutonium from irradiated reactor fuels. The tributyl phosphate process recovered uranium metal in waste generated by the bismuth phosphate process. Waste from these processes was made alkaline for storage in the tanks. WHC-MR-0132. WHC-MR-0132 provides approximate chemical compositions for the major waste types sent to the SSTs in the [illegible] and [illegible] Tank Farms, and *Hanford Soil Inventory Model, Rev. 1* (RPP-26744) provides detailed estimates for chemical and radioisotope concentrations in each tank leak in the WMA.

Table 2-1 lists the dangerous wastes specified in the Dangerous Waste Permit Application Part A Form (WA7[illegible]9000[illegible]967).

Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)

Dangerous Waste Code	Contaminant Description	Dangerous Waste Code	Contaminant Description
D001	Ignitable waste	D030	2,4-Dinitrotoluene
D002	Corrosive waste	D033	Hexachlorobutadiene
D003	Reactive waste	D034	Hexachloroethane
D004	Arsenic	D035	Methyl ethyl ketone
D005	Barium	D036	Nitrobenzene
D006	Cadmium	D040	Trichloroethene
D007	Chromium	D041	2,4,5-Trichlorophenol
D008	Lead	D043	Vinyl chloride
D009	Mercury	F001	1,1,1-Trichloroethane
D010	Selenium	F002	Methylene chloride
D011	Silver	F003	Acetone, methyl isobutyl ketone
D018	Benzene	F004	Cresol-m,-o,-p
D019	Carbon tetrachloride	F005	Methyl ethyl ketone
D022	Chloroform	WP01	Extremely hazardous waste, persistent dangerous waste

Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)

Dangerous Waste Code	Contaminant Description	Dangerous Waste Code	Contaminant Description
D02□	1□2-Dichloroethane	WP02	Dangerous waste□persistent dangerous waste
D03□	Pyridine	W□01	□□tremely ha□ardous waste□ to□ic dangerous waste
D029	1□1-Dichloroethylene	W□02	Dangerous waste□to□ic dangerous waste
D039	□etrachloroethylene		

Notes□

1. □his table is based on the Dangerous Waste Permit Application Part A Form WA7□9000□967.

2. Analytes associated with the □F001□through □F005□waste codes are from WHC-MR-0517□*Listed Waste History at Hanford Facility TSD Units.*

2.4 Geology and Hydrogeology

□his section describes of the geology and hydrology beneath WMA □□-□□. □he geology specific to this WMA was first described in *Geology of the 241-TX Tank Farm* □ARH-LD-136□and *Geology of the 241-TY Tank Farm* □ARH-LD-137□□ nd later in WHC-SD-□N-AP-012. More recently□□he WMA □□-□□ geology has been summari□ed in the following□

- HNF-2603□*A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination*
- PNNL-15955□*Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*
- PNNL-16005□*RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
- RPP-7123□*Subsurface Conditions Description of the T and TX-TY Waste Management Areas*
- RPP-2374□□*Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*

PNNL-15□37provided updated information on the geology and hydrogeology at WMA □□-□□□ including the most recent observations from new wells.

□he vadose □one beneath WMA □□-□□ is between appro□imately 66 and 70 m □216 and 229 ft□thick and consists of the Hanford formation□the Cold Creek unit □CC□□□□he □aylor Flats member of the Ringold Formation□and the upper portion of unit □ of the Wooded Island member of the Ringold Formation. □he water table elevation is at appro□imately 133.2 m □437 ft□based on fiscal year □F□□2011 water table elevations. □he unconfined aquifer beneath WMA □□-□□ is estimated to be between 4□.5and 56.5 m □159 to 1□5 ft□thick based on water levels and the depth of the Ringold Formation lower mud unit□which serves as a confining or semiconfining layer separating the unconfined aquifer from a confined □or partly confined□aquifer in the underlying Ringold □nit A.

Figure 2-1 shows a generalized hydrostratigraphic column for the Hanford Site. The geology beneath WMA □□-□□ consists of basalt basement overlain by nine sedimentary sequences, which are distinguished mainly by texture, particle size, mineralogy, responses to natural gamma logs, and stratigraphic position.

Water levels in the unconfined aquifer increased as much as 14 m (46 ft) above the pre-Hanford natural water table beneath WMA □□-□□ due to artificial recharge from liquid waste disposal operations active between the mid-1940s and 1995. During that time, the groundwater flow direction changed from eastward (the pre-Hanford direction), to southward, then northward, and finally back toward the east as a result of changes in waste management practices. Groundwater levels continue to decline due to cessation of artificial recharge from liquid waste disposal operations in the area (Figure 2-2).

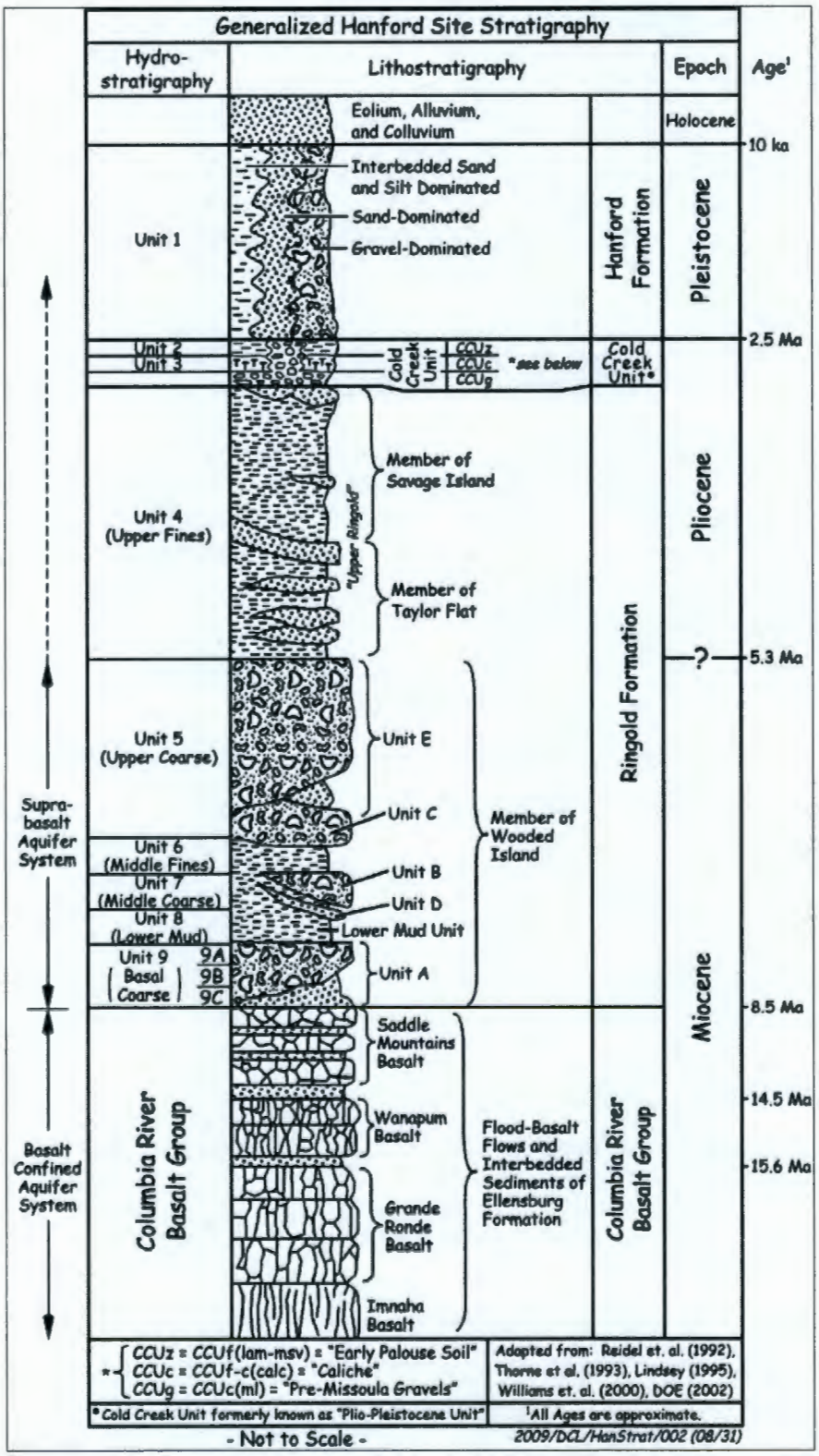
More recently, extraction wells for the 200-ZP-1 OU interim pump-and-treat system altered the flow direction. In 2005, upgradient wells were converted to extraction wells, shifting the flow southward in the southern portion of the WMA. Possible stagnation points exist in the middle portion of the WMA east of the extraction wells, and some flow is currently eastward in the middle of the WMA. Therefore, it must be assumed that the water table gradient is variable beneath WMA □□-□□ due to influences from pump-and-treat system extraction wells. The large shifts in groundwater flow direction have large implications for contaminant distribution in the uppermost aquifer beneath WMA □□-□□. Figure 2-3 provides a current groundwater map for WMA □□-□□.

Aquifer tests have been performed on new wells at WMA □□-□□ since 1999. The details of the tests, data analysis, and test results are provided in the following:

- PNNL-1337□ *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 1999*
- PNNL-13514 *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2000*
- PNNL-14113 *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2001*
- PNNL-141□6 *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2002*
- PNNL-1734□ *Results of Detailed Hydrologic Characterization Tests – Fiscal and Calendar Year 2005*
- PNNL-1□279 *Aquifer Testing Recommendations for Well 299-W15-225: Supporting Phase 1 of the 200-ZP-1 Groundwater Operable Unit Remedial Design*

The salient results are listed below using the pertinent historical or latest compiled data from the above-listed documents:

- Hydraulic conductivities range between about 0.07 and 19.9 m/d (0.23 and 65.3 ft/d), with a geometric mean of 2.20 m/d (7.22 ft/d).
- Vertical heterogeneities in hydraulic conductivity exist among wells and within individual well screens.
- The in-well, upward, vertical groundwater flow conditions were measured in 2005 in monitoring well 299-W14-11□ which has a screened interval of 3 m (10 ft) and is located approximately 14 m (46 ft) below the water table. Vertical flow was measured in the borehole using electromagnetic borehole flow meter (EBF) surveys. Maximum vertical flow velocity recorded by the EBF was 0.014 to 0.027 m/m.



Note: The member of Savage Island, the member of Wooded Island units C, B, and D, and the Snipes Mountain Conglomerate are not present at WMA □□-□□.

Figure 2-1. Generalized Stratigraphic Column for the Hanford Site

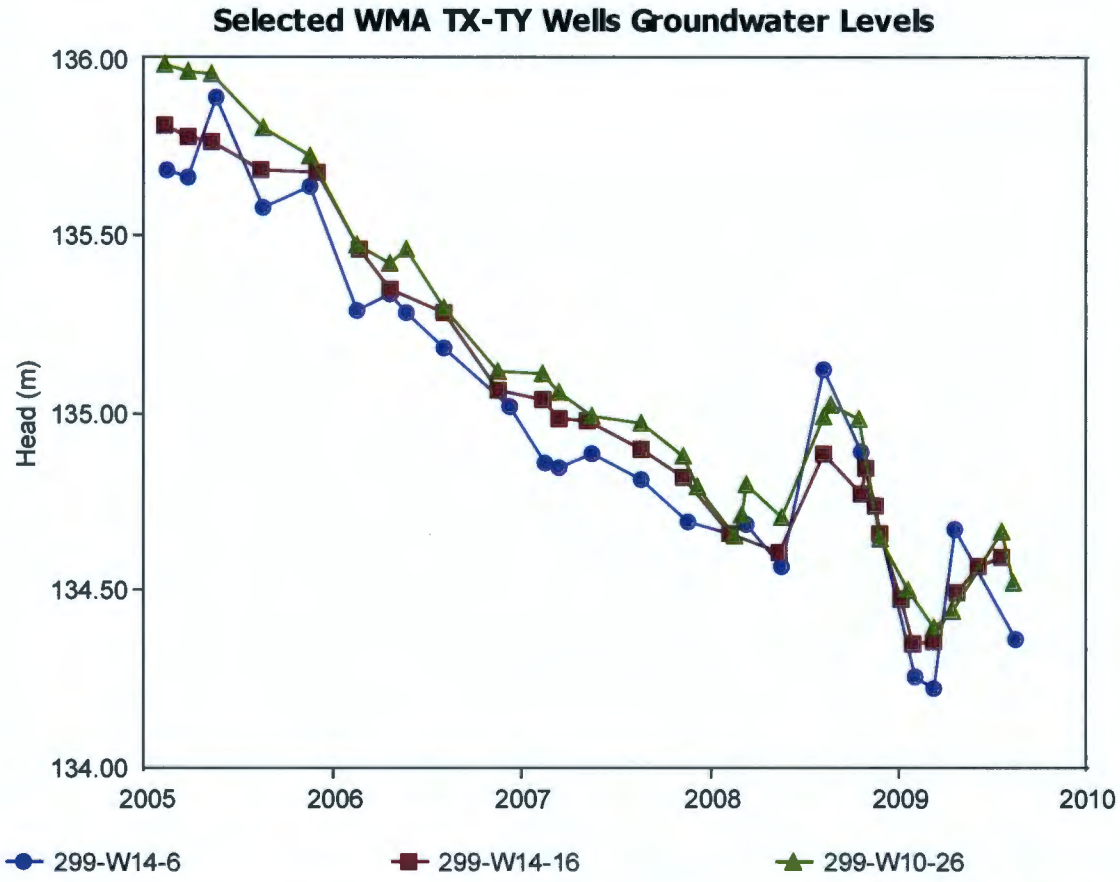


Figure 2-2. Selected Monitoring Wells Showing Groundwater Level Declines in WMA TX-TY

- In-well downward vertical groundwater flow conditions were measured in well 299-W14-13 in 2002 using vertical-flow tracer tests and BF surveys. his well is screened across the water table and the bottom of the screened interval is appro imately 7 m 23 ft below the water table. Well 299-W14-13 is located 6 m 19 ft south of well 299-W14-11. Average vertical downward flow velocities were 0.011 to 0.012 m m and were reproducible over a 9-month period during testing.

It is important to note that the e istence of vertical flow is not necessarily reflective of the actual groundwater flow conditions within the surrounding aquifer. However the presence of vertical flow implies a vertical flow gradient and has implications pertaining to the representativeness of groundwater samples collected from such monitoring wells near the WMA.

2.5 Summary of Previous Groundwater Monitoring

his section summari es the current and historical groundwater contamination at WMA -. he vadose one contamination is also summari ed because any residual vadose one contamination is a potential source for future groundwater contamination.

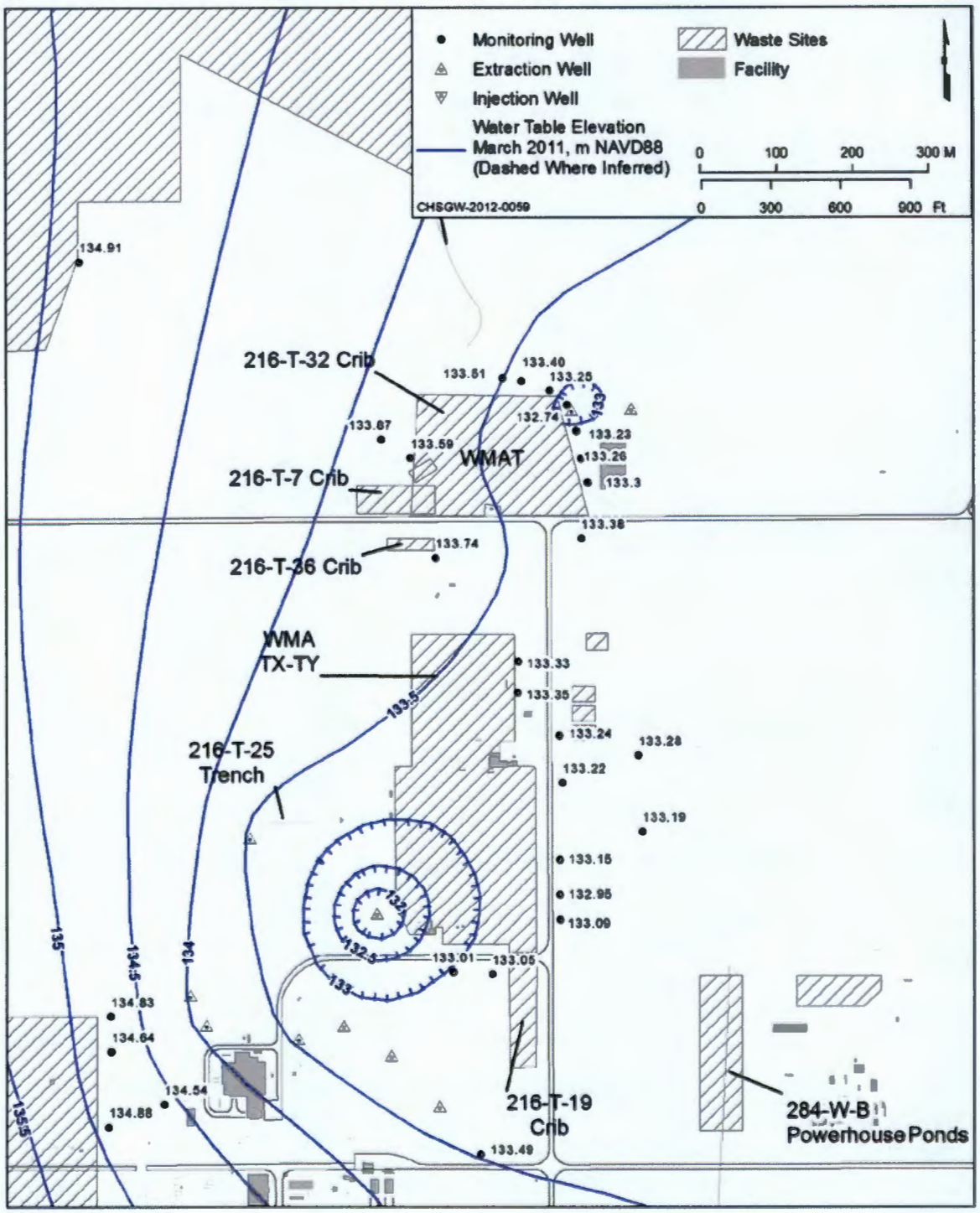


Figure 2-3. Water Table Map for Area Around WMA TX TY, March 2011

2.5.1 Groundwater Contamination

Chromium is the sole RCRA dangerous constituent found beneath WMA □□-□□□with an associated source in the WMA. Carbon tetrachloride and trichloroethene are also present□but the source of these constituents was liquid disposal associated with processes at the Plutonium Finishing Plant □PFP□and not WMA □□-□□. □hese constituents are monitored as part of the 200-ZP-1 Groundwater O□. Nitrate is also found in the groundwater beneath the WMA and is monitored as a groundwater quality constituent. Plume maps for all of these constituents are provided in *Hanford Site Groundwater Monitoring for 2011* □DO□□RL-2011-11□□.

2.5.1.1 Chromium

In 2011, chromium concentrations exceeded the drinking water standard (100 µg/L) in three wells during routine sampling at WMA TX-TY. The highest chromium concentrations have historically been in well 299-W14-13, screened at the water table and located downgradient of the WMA between nearby past-practice liquid disposal designated waste sites (216-TX-TY Cribs and 241-153-TX diversion box unplanned release). The chromium concentration in 2011 was 374 µg/L. The chromium concentration in adjacent well 299-W14-11, screened 11.6 to 14.6 m (38.1 to 47.9 ft) below the water table, was 112 µg/L in 2011. The chromium concentration in 299-W10-27 was 119 µg/L in 2011. The chromium concentrations in these three wells suggest that the highest concentrations occur near the water table in this area. Concentrations have historically fluctuated in the WMA TX-TY wells and were exhibiting a decreasing trend at the end of calendar year (CY) 2011.

2.5.2 Vadose Zone Contamination

Geophysical logging of dry wells adjacent to SSTs in the TX and TY Tank Farms has delineated the extent of gamma-emitting vadose zone contamination, as presented in the following reports:

- GJO-97-13-TAR, *Hanford Tank Farms Vadose Zone – TX Tank Farm Report*
- GJO-97-13-TARA, *Hanford Tank Farms Vadose Zone – Addendum to the TX Tank Farm Report*
- GJO-97-30-TAR, *Hanford Tank Farms Vadose Zone – TY Tank Farm Report*
- GJO-97-30-TARA, *Hanford Tank Farms Vadose Zone – Addendum to the TY Tank Farm Report*

The maximum depth of vadose zone contamination is not known because the contamination extends deeper than the deepest vadose zone wells in the tank farms, as determined by sampling results obtained during drilling of the vadose zone wells.

More recently, a geophysical investigation at WMA TX-TY (RPP-RPT-38320) used a well-to-well, long electrode-resistivity measurement method. The well-to-well measurements were made using 105 steel-cased vadose zone wells, 30 groundwater wells, and 27 point electrodes. This study further defined the distribution of low-resistivity anomalies associated with the specific retention trenches and cribs, as well as along the pipelines that cross the WMA. The distribution of low-resistivity anomalies that are usually related to tank-process contamination should be of particular interest in regard to assessment and remediation of the WMA and associated facilities.

Figures 2-4 and 2-5 show the geophysical anomalies detected during surface geophysical characterization performed at WMA TX-TY during FY 2008. The objective of the investigation was to collect and analyze electrical resistivity data in order to identify and locate discrete, low-resistivity regions in the subsurface to guide future sampling and analysis efforts. The figures show the results from the well-to-well, long

electrode electrical resistivity measurement method. Tanks assumed to have leaked are colored differently in the figures for reference.

An in-depth summary and discussion of the investigation results are presented in RPP-RPT-38320. A brief description of the investigation findings is provided below:

- For the TY Tank Farm, the resistivity inversion model results indicate several low-resistivity targets, which are located in close proximity to underground storage tanks that are assumed to have leaked.
  - In contrast, no significant low-resistivity targets were located near tank TY-102, which is not known to have leaked.
  - The well-to-well results suggest that infrastructure within the TY Tank Farm does not control the distribution of low-resistivity targets found in association with the tanks that are assumed to have leaked.
- For the TX Tank Farm, the resistivity inversion model results within the tank farm show more dispersed low-resistivity targets, which are in some cases linear-shaped along locations of known pipelines.
  - The shape and position of the low-resistivity targets with respect to known infrastructure suggests that the numerous pipelines may be influencing the size, shape, and locations of the low-resistivity targets within the TX Tank Farm.
  - Although the more numerous buried infrastructure may be affecting the low-resistivity targets when compared to the TY Tank Farm results, a clustering of low-resistivity targets exist around tanks 107, 108, 111, and 112.

2.6 Conceptual Model

P□□L-16005 describes the conceptual model for WMA TX-TY. The conceptual model illustrates the complexity and the spatial and temporal relationships of five important parameters, which are outlined in this section:

- Contaminant sources
- □riving forces
- Migration pathways to groundwater
- Changes in groundwater flow direction and flow rate, and
- Current contaminant distributions in the aquifer.

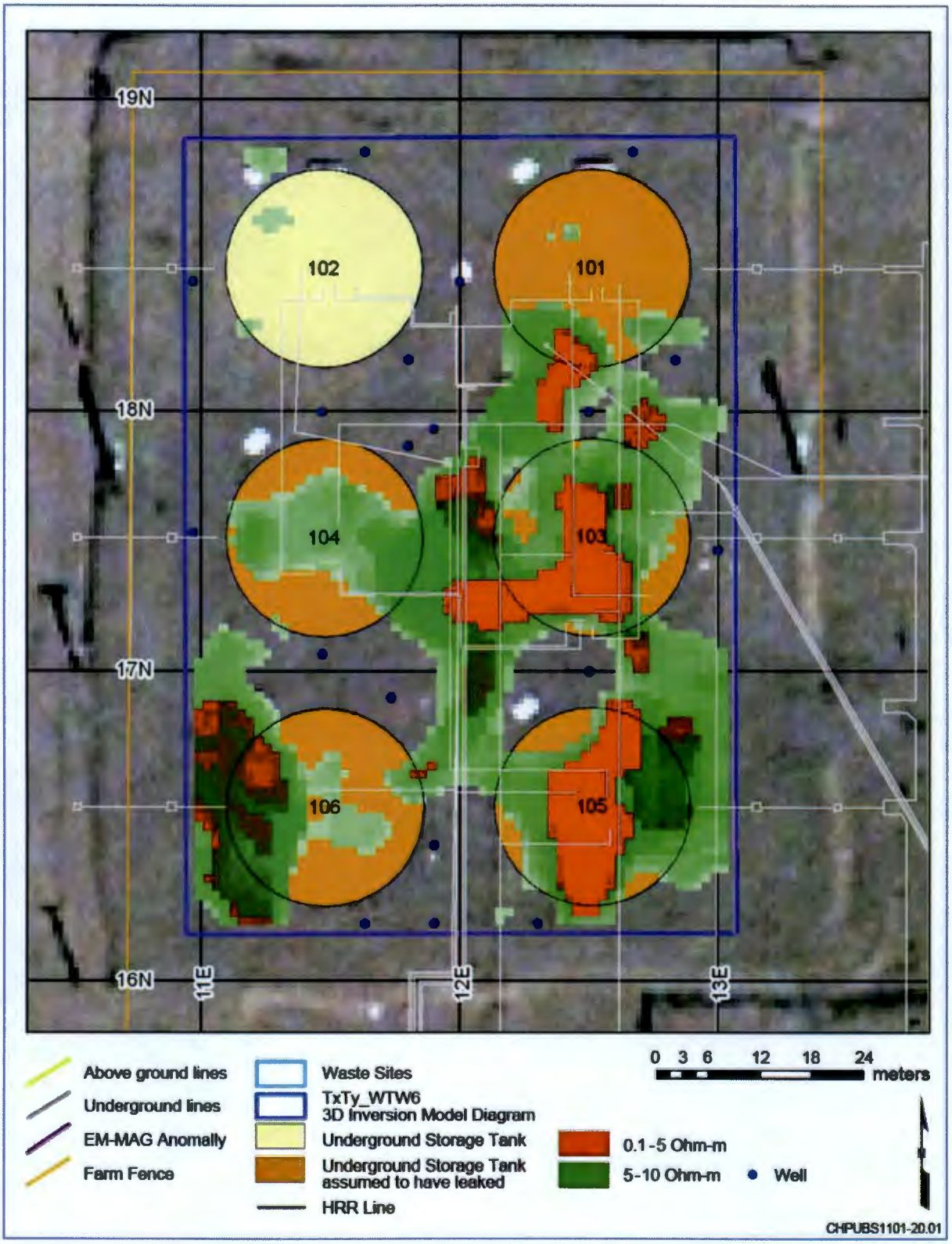


Figure 2-4. Well-to-Well Resistivity Inversion Model Results for the TY Tank Farm

Figure 2-5. Well-to-Well Resistivity Inversion Model Results for the TX Tank Farm

2.6.1 Contaminant Sources

Several potential sources for groundwater contamination exist in WMA TX-TY, including tank leaks□ liquid wastes disposed to past-practice facilities (located east, west, and south of the WMA)□unplanned releases (including leaking pipelines)□and regional contamination from far-field sources (e.g., PFP).

- All tanks in WMA TX-TY have been interim stabilized□thus, the impact of future large tank leaks on groundwater is not a threat. □owever, contaminants remaining in the vadose zone from past tank leaks have the potential to migrate to groundwater.
- Pipeline leaks have been suggested to account for some near-surface and deeper vadose zone contamination in WMA TX-TY (RPP-7218, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*). Any contamination remaining in the vadose zone from past pipeline leaks or overfill events remains a possible source for future groundwater contamination.
- Regional sources are responsible for most of the carbon tetrachloride and much of the nitrate found in the groundwater beneath WMA TX-TY. An exception exists for a probable nearby source for the high contamination immediately east of the WMA.

2.6.2 Driving Forces

In general, contaminants are transported to groundwater in two ways: (1) transport associated with very large leaks when the amount of liquid is sufficient to reach groundwater through gravitational forces and capillary action, and (2) transport associated with an external source of water (or other liquid) available to remobilize residual waste in vadose zone plumes. The SSTs in WMA TX-TY no longer contain large amounts of liquid waste□thus, large tank leaks emanating from WMA TX-TY are not likely.

All intentional disposal of water to non-permitted facilities ceased in 1995□therefore, effluent disposal to nearby ponds, cribs, and ditches is no longer mobilizing vadose zone contamination to the groundwater. All known water lines in WMA TX-TY have been tested and cut off (□O□/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*). It is possible, but unlikely, that a previously unidentified water line will leak and substantially mobilize existing vadose zone contamination to groundwater in the area.

Infiltration of natural precipitation remains the likely principal driver to mobilize vadose zone contamination. Steps have been taken to reduce infiltration or precipitation at WMA TX-TY. □erms have been erected around the tank farm to stop run-on of rain and melting snow. In CY 2009 a design for an interim surface barrier for the TY Tank Farm was completed. The interim surface barrier was completed and operational by □ecember 2010 to meet the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement□□cology et al., 1989) Milestone M-045-92.

2.6.3 Migration

Contaminant migration through the vadose zone is not well understood because it is highly dependent on heterogeneities and anisotropy in the soil properties. □eterogeneities at smaller than formation scale also affect flow and transport, as evidenced by logs of drywells and cone penetrometer logs that reveal moisture-rich strata, likely reflecting finer grained units with permeability contrast.

The sediment layer with the most influence on moisture migration through the vadose zone beneath WMA TX-TY is the CC□. The relatively low permeability of the CC□ impedes vertical moisture migration. The CC□ is known to pond water locally in several places in the 200 West Area.

Improperly sealed wells can act as a preferential pathway through the vadose zone. □ocumentation in *Hanford Wells* (P□L-8800) identified 6 of the 95 vadose zone wells in the TX Tank Farm, and none of the vadose zone wells in the TY Tank Farm, used for secondary leak detection that have been modified to retrofit an annular seal. Therefore, the potential exists for unsealed wells to promote vertical moisture migration in WMA TX-TY.

Lateral migration of effluent beneath past-practice liquid disposal facilities has been documented east of WMA TX-TY at the 216-T-26 through 216-T-28 Cribs (AR□-ST-156, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells: Volume I*).

The groundwater flow direction and rate at WMA TX-TY is variable, depending on location relative to the 200-□P-1 O□ pump-and-treat extraction wells.

2.6.4 Changing Groundwater Flow Direction

Prior to startup of the 200-□P-1 O□ interim pump-and-treat system, large changes occurred in groundwater flow direction beneath WMA TX-TY during □anford Site operations. Groundwater could have traveled and carried contaminants from WMA TX-TY and nearby past-practice disposal facilities. The approximate travel directions identified in P□□L-16005 are south (between 1954 and 1956), northeast (between 1957 and 1982), and north or northwest (between 1983 and 1995). Since 1995, groundwater flow direction has been primarily toward the east, except where influenced by the 200-□P-1 O□ interim pump-and-treat system. These changes in the groundwater flow direction could have contributed to relatively widespread contaminant distribution.

A large-scale pump-and-treat system was installed in the 200 West Area in 2011, which is expected to change the groundwater flow direction and flow velocity at WMA TX-TY. The magnitude and direction of the changes will not be known until after the system becomes fully operational in 2012.

2.6.5 Contaminant Distribution

The current understanding of the spatial distribution of contaminants at WMA TX-TY is shown in recent plume maps (□O□/RL-2011-118). Several lines of evidence show that vertical contaminant concentration gradients exist in the area of downgradient wells 299-W14-11 and 299-W14-13.

2.7 Data Quality Objectives

To define the required information for groundwater indicator evaluation monitoring, the data quality objectives (□□O) process is used to ensure that data gathered are of the appropriate quantity and quality to meet specific objectives. The □□Os for the groundwater quality assessment at WMA TX-TY are presented in P□□L-16005.

The current groundwater monitoring network for WMA TX-TY is a result of previous investigations and □□O processes. Assessment monitoring continues at the WMA in accordance with interim status regulations. Table 2-2 outlines the □□O parameters, regulatory interim status requirements, and associated reports supporting the regulatory requirements.

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA TX-TY

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Scope	**40 CFR 265; incorporated by reference in WAC 173-303-400(3)(a), as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v)(E)** **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(7) If the owner or operator determines□ that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator: (i) Must continue to make the determinations required under paragraph (d)(4) of this section□ **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water□and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(3) The plan to be submitted under 40 CFR 265.90(d)(1) or paragraph (d)(2) of this section must specify: (i) The number, location, and depth of wells□ (ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility□ (iii) □valuation procedures, including any use of previously gathered ground-water quality information□and (iv) A schedule of implementation.	This plan, Sections 3.1 and 3.2, Chapter 4, and Appendix A P□□L-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
□umber and location of wells Point(s) of compliance	**40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water□and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	This plan, Chapters 1 and 3, and Appendix A P□□L-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA TX-TY

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Well configuration (depth and length of screened interval□ well construction)	**40 CFR 265.91, "Ground-Water Monitoring System."** (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water. **Additional Requirements from WAC 173-303-400(3)(c)(v)(C).** Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. WAC 173-160 may be used as guidance in the installation of wells.	This plan, Section 3.2 and Appendix A P□□L-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
Frequency of sampling Types of analysis or measurement Method detection limits or accuracy and precision Methods used to evaluate the collected data	**40 CFR 265.93"Preparation, Evaluation, and Response."** (d)(7) If the owner or operator determines□ that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator: (i) Must continue to make the determinations required under paragraph (d)(4) of this section on a quarterly basis until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility□or (ii) May cease to make the determinations required under paragraph (d)(4) of this section, if the ground-water quality assessment plan was implemented during the post-closure care period. (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) *[see scope in first row of this table]* of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water□and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	This plan, Section 3.1, Chapter 4, and Appendix A P□□L-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*, Pacific □orthwest □ational Laboratory, Richland, Washington

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

□□O □ data quality objective

3 Groundwater Monitoring Program

This chapter lists the wells monitored, constituents analyzed, and sampling frequency for WMA TX-TY. The quality assurance and quality control requirements are provided in the □APjP (Appendix A).

3.1 Constituent List and Sampling Frequency

The constituent list for groundwater sampling consists of RCRA-regulated analytes that may be present in SST waste. To identify these analytes, the list of primary nonradiological constituents potentially present in SST waste (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*) was compared to those constituents listed in Appendix 5 of □cology Publication □o. 97-407 (*Chemical Test Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*), which references 40 CFR 264, Appendix IX (□Standards for Owners and Operators of □azardous Waste Treatment, Storage, and □isposal Facilities,□□Ground-Water Monitoring List□). Those constituents identified in RPP-23403 that are RCRA-regulated (i.e., listed in Appendix 5 of □cology Publication □o. 97-407) are included in Table 3-1.

Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System

Constituent	CAS ID	Constituent	CAS ID
Volatile Organic Compounds			
1,1,1-Trichloroethane	71-55-6	Chloroform	67-66-3
1,1,2,2-Tetrachloroethane	79-34-5	□thylbenzene	100-41-4
1,1,2-Trichloroethane	79-00-5	Isobutanol	78-83-1
1,1-□ichloroethene	75-35-4	Methylene chloride	75-09-2
1,2-□ichloroethane	107-06-2	Tetrachloroethene	127-18-4
2-□utanone (methyl ethyl ketone)	78-93-3	Toluene	108-88-3
2-Propanone (acetone)	67-64-1	trans-1,3-□ichloropropene	10061-02-6
4-Methyl-2-pentanone (MI□□)	108-10-1	Trichloroethene	79-01-6
□enzene	71-43-2	Trichlorofluoromethane	75-69-4
Carbon disulfide	75-15-0	□inyl chloride (chloroethene)	75-01-4
Carbon tetrachloride	56-23-5	Xylenes	1330-20-7
Chlorobenzene	108-90-7		
Semi-Volatile Organic Compounds			
1,2,4-Trichlorobenzene	120-82-1	Aroclor 1260	11096-82-5
2,4,5-Trichlorophenol	95-95-4	□utylbenzylphthalate	85-68-7
2,4,6-Trichlorophenol	88-06-2	□i-n-butylphthalate	84-74-2
2,4-□initrotoluene	121-14-2	□i-n-octylphthalate	117-84-0
2-Chlorophenol	95-57-8	Fluoranthene	206-44-0

Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System

Constituent	CAS ID	Constituent	CAS ID
2-Methylphenol (o-cresol)	95-48-7	□exachlorobutadiene	87-68-3
3-Methylphenol (m-Cresol)	108-39-4	□exachloroethane	67-72-1
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	□aphthalene	91-20-3
4-Methylphenol (p-cresol)	106-44-5	□itrobenzene	98-95-3
Acenaphthene	83-32-9	n-□itroso-di-n-propylamine	621-64-7
Aroclor 1016	12674-11-2	n-□itrosomorpholine	59-89-2
Aroclor 1221	11104-28-2	1,2-□ichlorobenzene (o-□ichlorobenzene)	95-50-1
Aroclor 1232	11141-16-5	2-□itrophenol (o-□itrophenol)	88-75-5
Aroclor 1242	53469-21-9	Pyrene	129-00-0
Aroclor 1248	12672-29-6	Pyridine	110-86-1
Aroclor 1254	11097-69-1		
Inorganic Constituents (Nonradiological)			
Antimony (Sb)	7440-36-0	Lead (Pb)	7439-92-1
Arsenic (As)	7440-38-2	Mercury (□g)	7439-97-6
□arium (□a)	7440-39-3	□ickel (□i)	7440-02-0
□eryllium (□e)	7440-41-7	Selenium (Se)	7782-49-2
Cadmium (Cd)	7440-43-9	Silver (Ag)	7440-22-4
Chromium (Cr)	7440-47-3	Sulfide (S^{2-})	18496-25-8
Cobalt (Co)	7440-48-4	Thallium (Tl)	7440-28-0
Copper (Cu)	7440-50-8	□anadium (□)	7440-62-2
Cyanide (C□⁻)	57-12-5	□inc (□n)	7440-66-6

□otes: This table lists the primary nonradiological constituents provided in RPP-23403 that are regulated by RCRA (i.e., also listed in Appendix 5 of □cology Publication □o. 97-407).

CAS □ Chemical Abstract Services

I□ □ identification

RCRA □ *Resource Conservation and Recovery Act of 1976*

□OC □ volatile organic compound

One of the 72 analytes listed in Table 3-1, chromium, has been found in groundwater and is attributed to releases from the WMA only. Nitrate is also present in groundwater and a portion is attributed to WMA TX-TY (Section 2.5.1). Carbon tetrachloride and trichloroethene are also found in the groundwater, but originate from waste sites associated with the PFP. Thus, chromium and the supporting constituents alkalinity, major cations (metals), and major anions (e.g., nitrate) are routinely sampled for RCRA in the network monitoring wells (Table 3-2). The supporting constituents provide information on general chemistry and allow for charge-balance computations to assess laboratory performance.

Sampling for the remaining constituents identified in Table 3-1 was performed once in the upgradient and near-field downgradient monitoring wells (Table 3-2) to determine if these constituents impacted groundwater quality. The constituents not detected in groundwater were removed from future sampling. If an organic constituent from Table 3-1 is detected in a groundwater sample and it is not attributed to contamination from another facility (e.g., carbon tetrachloride from the PFP), a confirmation sample will be collected at the next scheduled sample event, with split samples sent to different analytical laboratories. If the detection is confirmed by positive results from both laboratories, the constituent will be added to the list of analytes for routine sampling to evaluate the extent of contamination. If the detection is not confirmed, the analyte will be removed from future sampling.

Some of the inorganic constituents included in Table 3-1 occur naturally in groundwater (e.g., barium, selenium, vanadium, and zinc). Detections of an inorganic constituent will be evaluated to determine if the constituent is present naturally by comparison to sample results from the upgradient wells and comparisons to Hanford Site background values (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If it is determined that an inorganic constituent may be present as a contaminant from the WMA, confirmation samples will be collected (as described for the organic constituents). If contamination is confirmed, then the constituent will be added to the routine sample list to evaluate the extent of contamination. If the contamination is not confirmed, the constituent will be removed from future sampling.

3.2 Monitoring Well Network

Figure 3-1 shows the groundwater monitoring well network for WMA TX-TY. Table 3-2 lists the wells in the groundwater monitoring network, including constituents and sampling frequency. Some of the wells in the WMA TX-TY monitoring network are also sampled for the 200-UP-1 OU. Sampling for WMA TX-TY and the 200-UP-1 OU is coordinated to eliminate duplicate analyses and well trips. Wells are to be sampled quarterly or semiannually each year. Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If a sampling event is delayed more than 6 weeks, that sample may be cancelled because it is nearly time for the next quarter's sampling.

Table 3-2 indicates the purpose of each well and whether the wells meet WAC requirements. Table 3-3 summarizes well construction information, including the current (March 2011) water table elevations in each well. As-built diagrams for the wells showing construction details are available in PNNL-16005. Wells installed since the 1980s 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. Other wells in the network are much older and were installed before the requirements of WAC 173-160 were implemented. These wells have carbon-steel casings and perforated intervals instead of screens. In some cases, wells were later retrofit with annular seals at the surface. The use of the older wells permits continuity with historical data. The current rate of water table decline is 0.3 to 0.4 m/yr (0.98 to 1.3 ft/yr). Well 299-W14-6 went dry in 2010 and well 299-W15-41 went dry in 2011 (Table 3-3).

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

Well Name	Purpose[a]	WAC Compliant	Water Level[b]	RCRA Dangerous Constituents	Supporting Parameters			Field-Measured Parameters					Table 3-1 Analytes
				Hexavalent Chromium	Metals, Unfiltered[c]	Anions[d]	Alkalinity	pH[b]	Specific Conductance[b]	Turbidity[b]	Temperature[b]	Dissolved Oxygen[b]	
299-W10-26	□owngradient	Y	□	□	SA	SA	A	□	□	□	□	□	Once
299-W10-27	□owngradient	Y	□	□	SA	SA	A	□	□	□	□	□	Once
299-W14-11	□owngradient	Y	SA	SA	SA	SA	A	SA	SA	SA	SA	SA	Once
299-W14-13	□owngradient	Y	□	□	SA	SA	A	□	□	□	□	□	Once
299-W14-14	□owngradient	Y	SA	SA	SA	SA	A	SA	SA	SA	SA	SA	Once
299-W14-15	□owngradient	Y	□	□	SA	SA	A	□	□	□	□	□	Once
299-W14-16	Far-field[a]	Y	A	A	A	A	A	A	A	A	A	A	Once
299-W14-17	Far-field[a]	Y	A	A	A	A	A	A	A	A	A	A	Once
299-W14-18	□owngradient	Y	□	□	SA	SA	A	□	□	□	□	□	Once
299-W14-19	□owngradient	Y	SA	SA	A	SA	A	SA	SA	SA	SA	SA	Once
299-W15-44	□owngradient	Y	SA	SA	SA	SA	A	SA	SA	SA	SA	SA	Once
299-W15-763	□owngradient	Y	SA	SA	SA	SA	A	SA	SA	SA	SA	SA	Once
299-W15-765	□pgradient	Y	SA	SA	SA	SA	A	SA	SA	SA	SA	SA	Once

a. Far-field wells are wells located farther downgradient and used to determine lateral extent of contamination.

b. Field measurement.

c. Cations/Metals□analytes include, but are not limited to, aluminum, chromium, sodium, magnesium, potassium, and calcium.

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

[redacted]

d. Anions analytes include, but are not limited to, nitrate, chloride, sulfate, and fluoride.

A annually

quarterly

SA semiannually

RCRA *Resource Conversation and Recovery Act of 1976*

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

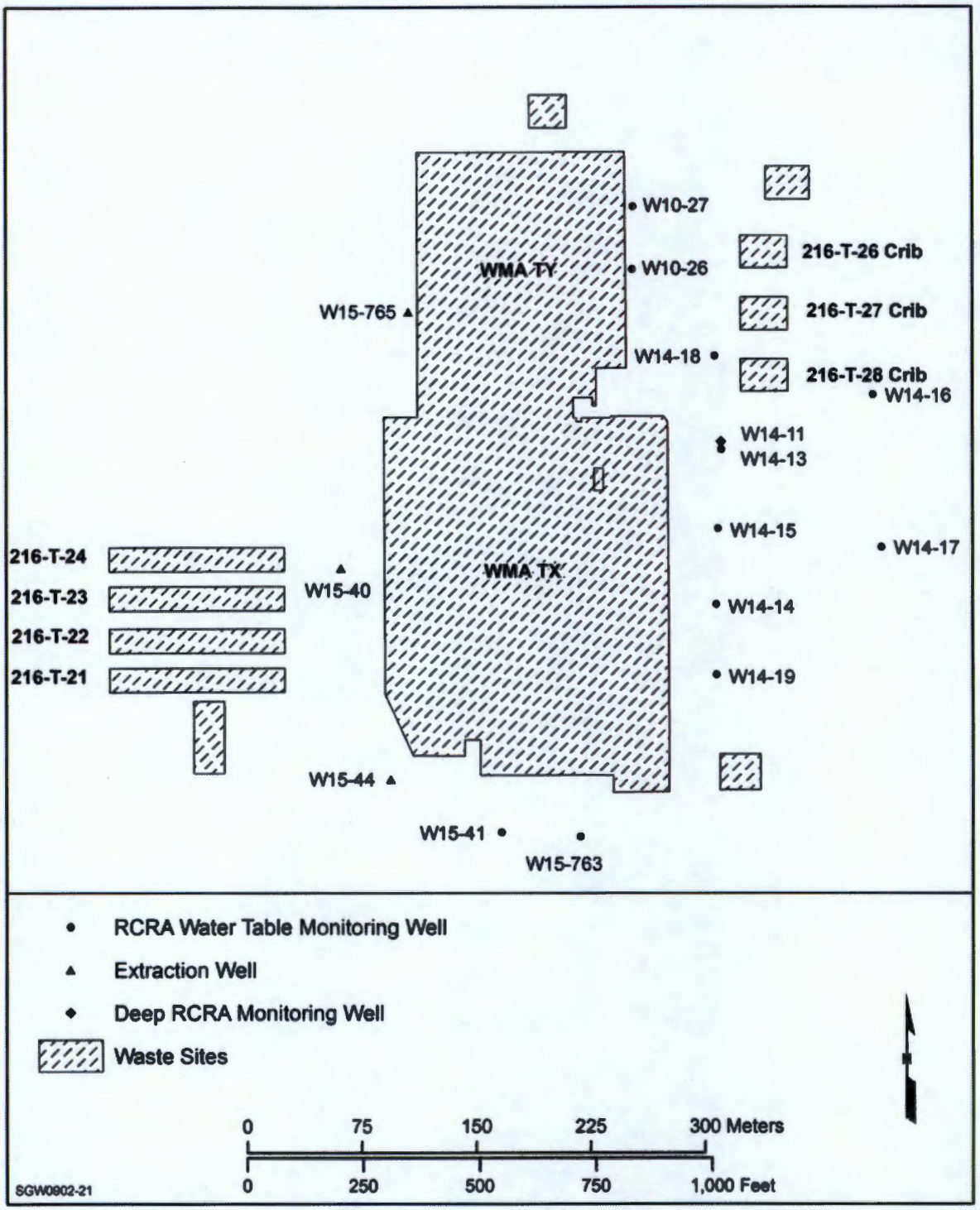


Figure 3-1. General Layout of WMA TX-TY, Including Locations of Nearby Past-Practice Facilities and Monitoring Wells

Table 3-3. WMA TX-TY Well Depths and Water Table Elevation

Well Name	Completion Date	Surface Elevation NAVD88, amsl (m)	Water Table Elevation (m), March 2011	Screened Interval Bottom Elevation (m)	Water Column (m), March 2011
299-W10-26	1998	204.63	133.35	127.78	5.57
299-W10-27	2001	204.90	133.33	126.90	6.43
299-W14-11	2005	203.00	133.21	120.20	13.01
299-W14-13	1998	204.35	133.21	127.62	5.59
299-W14-14	1998	204.62	133.15	127.81	5.34
299-W14-15	2000	204.58	133.57	126.97	6.60
299-W14-16	2000	205.37	133.28	126.77	6.51
299-W14-17	2000	205.08	133.19	126.76	6.43
299-W14-18	2000	204.26	133.24	127.13	6.11
299-W14-19	2002	204.90	132.95	126.11	6.82
299-W15-44	2002	204.17	132.57	127.59	4.98
299-W15-763	2001	202.18	133.05	126.95	6.10
299-W15-765	2001	204.51	133.00	126.79	6.21

□otes: □old/italic print indicates upgradient well.
amsl □ above mean sea level
□A□□88 □ □orth American □ertical □atum of 1988

Well 299-W15-765 was considered a true upgradient monitoring well prior to its conversion to an interim pump-and-treat extraction well in 2005. With the permanent shutdown of the interim pump and treat in FY 2012, 299-W15-765 was also taken offline permanently. Well 299-W15-765 is scheduled to be converted to a monitoring well early in FY 2013. □o other wells currently are upgradient for RCRA compliance. □ue to fluctuating local groundwater gradients and flow directions, as well as capture zones created by extraction wells in the area, the addition or construction of compliant upgradient monitoring wells will be difficult. As previously discussed, the 200 West pump-and-treat operations in 2012 will further impact hydrologic conditions near WMA TX-TY.

It can be assumed that contamination upgradient of the WMA would be captured by the current extraction wells. Plumes localized to WMA TX-TY will either be captured by the current extraction wells or will continue to migrate via groundwater downgradient and be detected by downgradient monitoring wells. This assumption will be part of the ongoing analysis of groundwater sampling data and pump-and-treat system performance until data from the larger scale system can be analyzed when the system is fully operational.

3.3 Changes to Monitoring Plan

Several changes have been made to the WMA TX-TY monitoring schedule since Revision 0 of this monitoring plan was issued. Well 299-W14-6 has been removed from the network because it went dry in

2010 due to decreasing water levels (Section 3.2). □exavalent chromium analyses have been added quarterly or semiannually at all downgradient wells and semiannually to the upgradient well. This allows elimination of filtered metals analyses so only unfiltered metals will be sampled in the future. Sampling frequency for many constituents has been changed as follows:

- Former upgradient (west) wells 299-W15-40 and 299-W15-765 are no longer 200-□P-1 interim pump-and-treat system extraction wells and are now offline. Work is underway to convert well 299-W15-765 from an extraction well to an upgradient monitoring well. Once converted, the well will be sampled semiannually.
- □ear-field downgradient wells 299-W14-14 and 299-W14-19 have been changed from quarterly to semiannual sampling.
- Far-field downgradient wells 299-W14-16 and 299-W14-17 have been changed from quarterly to annual sampling.
- □ear-field downgradient wells 299-W15-44 and 299-W15-763 south of the WMA TX-TY have been changed from quarterly to semiannual sampling.

Table 3-4 presents the sampling frequencies for all wells in the monitoring network and further describes the rationale for changes in frequency to applicable wells.

Table 3-4. WMA TX-TY Monitoring Well Network Sample Frequencies

Well	Sample Frequency	Rationale
299-W10-26, 299-W10-27, 299-W14-13, 299-W14-15, and 299-14-18	□uarterly	□ear-field downgradient monitoring wells located within higher concentration areas of existing dangerous constituent chromium (RCRA) contaminant plume that exhibit substantial constituent concentration variability. A quarterly frequency is needed to track concentration variations near edges of contaminant plume.
299-14-11, 299-W14-14, and 299-W14-19	Semiannually	□ear-field downgradient monitoring wells located outside of higher concentration areas of RCRA contaminant plume.
299-W14-16 and 299-W14-17	Annually	Far-field downgradient monitoring wells located outside RCRA contaminant plume.
299-W15-44 and 299-W15-763	Semiannually	□ear-field downgradient monitoring wells south of the WMA in low- to medium-concentration areas of existing RCRA contaminant plume.
299-W15-765	Semiannually	□pgradient well previously monitored to establish background water quality conditions. This well was also an extraction well for the 200-□P-1 O□ interim pump-and-treat system, which is now offline. Work is underway to convert 299-W15-765 to a monitoring well to be sampled on a semiannual frequency.

□otes: □old and italic print indicates upgradient well.

O□ □ operable unit

RCRA □ *Resource Conservation and Recovery Act of 1976*

WMA □ waste management area

3.4 Sampling and Analysis Protocol

Sampling and analysis protocols at WMA TX-TY follow the conventions of the project and are described in the □APjP (Appendix A).

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4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for WMA TX-TY.

4.1 Data Review

□ata review, validation, and verification are discussed in the □APjP in Appendix A.

4.2 Interpretation

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

4.3 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring well network to determine if it remains adequate to monitor the WMA. The groundwater flow direction beneath WMA TX-TY is variable, depending on location and proximity to extraction wells.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made in the northern portion of the 200 West Area in March of each year. 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 □anford Site groundwater monitoring report (e.g., □O□/RL-2011-118).

Well 299-W14-6 went dry and has been removed from the network. Most other wells in the WMA TX-TY monitoring network are not expected to go dry for several years□however, well 266-W15-41 has less than 2 m (6.6 ft) of water remaining and may be dry for sampling purposes within 3 years. Impact from the expanded 200-□P-1 O□ pump-and-treat system may cause an increase in the rate of water-level declines in all wells, which will continue to be evaluated.

Any new RCRA wells needed at WMA TX-TY will be negotiated and prioritized by □cology, □O□, and □PA and approved under Tri-Party Agreement Milestone M-24-00.

4.4 Reporting and Notification

Results of assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, □Recordkeeping and Reporting.□ Reporting will be in the annual □anford Site groundwater monitoring report.

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Appendix A

Quality Assurance Project Plan

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Contents

A1 Project Management A-1

A1.1 Project/Task Organization A-1

A1.1.1 Regulatory Project Manager A-1

A1.1.2 U.S. Department of Energy, Richland Operations Office Project Manager A-2

A1.1.3 U.S. Department of Energy, Richland Operations Office Subject Matter Expert A-2

A1.1.4 Contractor Groundwater Remediation Department Manager A-2

A1.1.5 Groundwater Sampling Operations A-3

A1.1.6 RCRA Monitoring and Reporting A-3

A1.1.7 Sample Management and Reporting Organization A-3

A1.1.8 Contract Laboratories A-3

A1.1.9 Quality Assurance A-3

A1.1.10 Environmental Compliance Officer A-3

A1.1.11 Health and Safety A-3

A1.1.12 Waste Management A-3

A1.2 Problem Definition/Background A-4

A1.3 Project/Task Description A-4

A1.4 Quality Objectives and Criteria A-4

A1.5 Special Training/Certification A-4

A1.6 Documents and Records A-4

A2 Data Generation and Acquisition A-5

A2.1 Sampling Process Design (Experimental Design) A-5

A2.1.1 Regulatory Requirements A-5

A2.1.2 Judgmental Sampling A-5

A2.2 Sampling Methods A-6

A2.3 Sample Handling and Custody A-6

A2.4 Analytical Methods A-6

A2.5 Quality Control A-11

A2.5.1 Field Quality Control Samples A-11

A2.5.2 Laboratory Quality Control Samples A-12

A2.5.3 Quality Control Requirements A-13

A2.6 Instrument/Equipment Testing, Inspection, and Maintenance A-16

A2.7 Instrument/Equipment Calibration and Frequency A-16

A2.8 Inspection/Acceptance of Supplies and Consumables A-16

A2.9 Non-Direct Measurements A-16

A2.10 Data Management A-16

A3 Assessment and Oversight A-17

A3.1 Assessments and Response Actions A-17

A3.2 Reports to Management A-17

A4 Data Validation and Usability A-17

A4.1 Data Review, □erification, and □alidation A-17

A4.2 □erification and □alidation Methods A-18

A4.3 Reconciliation with User Requirements A-18

A5 References A-18

Figure

Figure A-1. Project Organization A-2

Tables

Table A-1. Actions and Documentation for Regulatory Notification A-5

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents A-7

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents A-8

Table A-4. Quality Control Samples A-11

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria A-13

Table A-6. Blind Standard Constituents and Schedule A-15

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
F R	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 414.1D, *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.

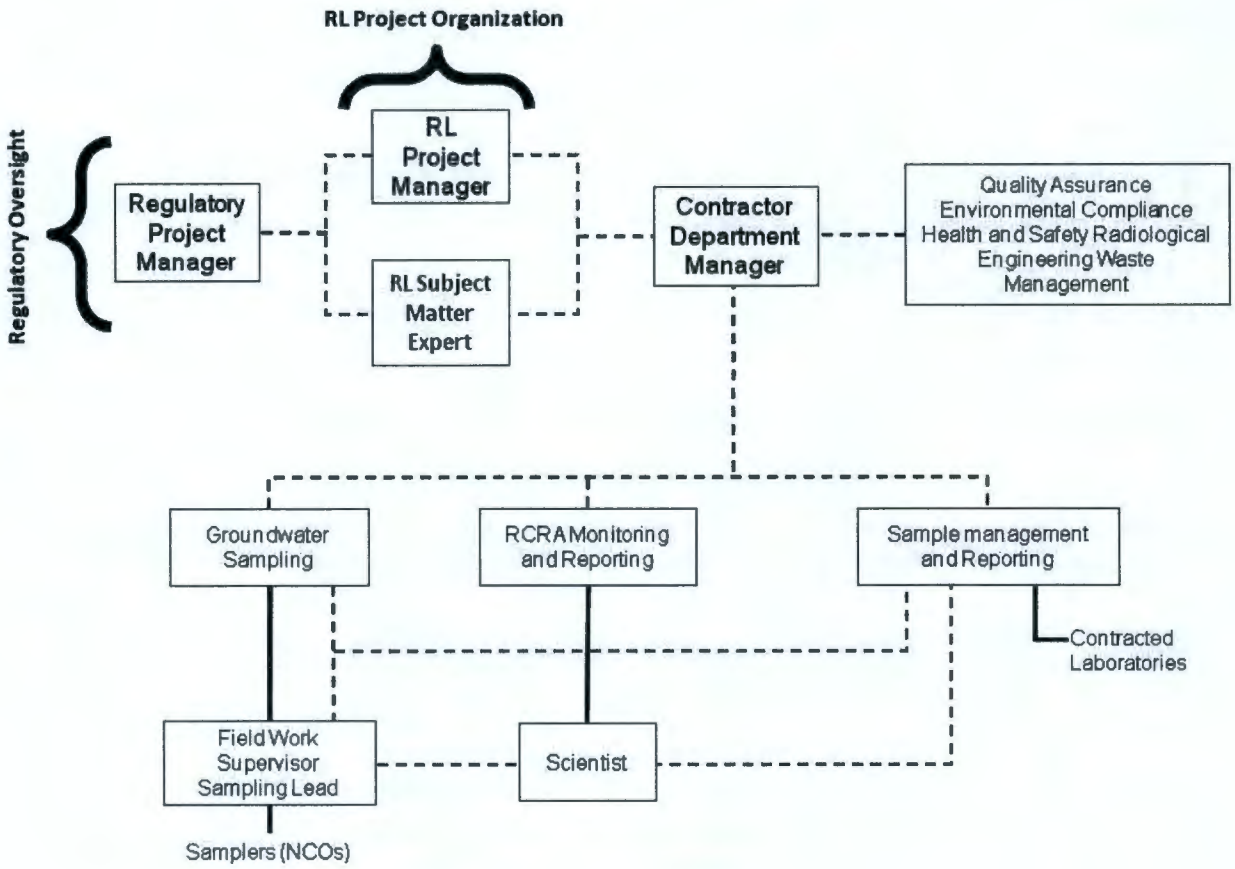

Figure A-1. Project Organization

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 in accordance with 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. □ersion 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-2011-118, *Hanford Site Groundwater Monitoring for Fiscal Year 2011*).

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 Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered			
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
Chromium			10
Sodium			500
Potassium			4,000
Magnesium			750
Trace Metals – Unfiltered			
Hexavalent chromium	G/P, cool to 4°C	SW-846 Method 7196	10
Anions by Ion Chromatography			
Chloride	P	EPA/600 Method 300.0[f]	200
Nitrate			250
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
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).

ASTM = American Society for Testing and Materials

EPA = U.S. Environmental Protection Agency

N/A = not applicable

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]
Metals Analyzed by the Inductively Coupled Plasma Method — Unfiltered/Filtered			
Barium	P, HNO_3 to pH <2	SW-845[d] Method 6010B/C SW-846 Method 6020[e] or EPA/600 Method 200.8[f]	20
Beryllium			5
Cadmium			5
Chromium			10
Cobalt			20
Copper			10
Nickel			40
Silver			10
Vanadium			25
Zinc			10
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	6
Arsenic			10
Lead			5
Selenium			10
Thallium			5
Trace Metals – Unfiltered/Filtered			
Mercury	G, HNO_3 to pH <2	SW-846 Method 7470A, EPA/600 Method 200.8	0.5
Volatiles by Gas Chromatography/Mass Spectrometry			
1,1-Dichloroethene	G, no headspace	SW-846 Method 8260B	10
1,1,1-Trichloroethane			5
1,1,2,2-Tetrachloroethane			5
1,1,2-Trichloroethane			5
1,2-Dichloroethane			5
2-Butanone (methyl ethyl ketone)			10
2-Propanone (acetone)			20
4-Methyl-2-petanone (MIBK)			10
Benzene			5
Carbon disulfide			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]
Carbon tetrachloride			5
Chlorobenzene			5
Chloroform			5
Ethylbenzene			5
Isobutanol			500
Methylene chloride			5
Tetrachloroethene			5
Toluene			5
trans-1,3-Dichloropropene			5
Trichloroethene			5
Trichlorofluoromethane			10
Vinyl chloride (chloroethene)			10
Xylenes			10
Semivolatiles by Gas Chromatography/Mass Spectrometry			
1,2-Dichlorobenzene (o-Dichlorobenzene)	Amber glass	SW-846 Method 8270D	10
1,2,4-Trichlorobenzene			10
2-Chlorophenol			10
2-Methylphenol (o-cresol)			10
2-Nitrophenol (o-Nitrophenol)			20
2,4-Dinitrotoluene			10
2,4,5-Trichlorophenol			10
2,4,6-Trichlorophenol			10
3-Methylphenol (m-cresol)			20
4-Chloro-3-methylphenol (p-Chloro-m-cresol)			10
4-Methylphenol (p-cresol)			10
Acenaphthene			10
Butylbenzylphthalate			10
Di-n-butylphthalate			10
Di-n-octylphthalate			10
Fluoranthene			10

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]
Hexachlorobutadiene			10
Hexachloroethane			10
n-Nitroso-di-n-propylamine			10
n-Nitrosomorpholine			10
Naphthalene			10
Nitrobenzene			10
Pyrene			10
Pyridine			20
Polychlorinated Biphenyls			
Aroclor-1016			0.5
Aroclor-1221			0.5
Aroclor-1232			0.5
Aroclor-1242	G	SW-846 Method 8082	0.5
Aroclor-1248			0.5
Aroclor-1254			0.5
Aroclor-1260			0.5
Other			
Cyanide	P, NaOH to pH >12	SW-846 Method 9012 Standard Method[f] 4500 EPA/600 Method 335.2	5
Sulfide	G,P, 2 mL 2 N zinc acetate and NaOH pH >9, cool 4°C	Sulfides – 9030	500

Notes:

a. All samples will be collected in glass (G), plastic (P), or amber glass containers and 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. 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 listed method quantitation limit is met.

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

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.

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-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]

Table A-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
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 (F□Rs) 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, F□R bottles are sealed and placed in the same storage containers with the samples from the associated sampling event. The F□R samples are analyzed for volatile organic compounds only. The F□Rs 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, F□Rs, and EBs), results above two times the method detection limit are identified as suspected contamination. □owever, for common laboratory contaminants such as acetone, methylene chloride, □-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 □□percent, as measured by the relative percent difference. □nly field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated.

□ouble-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 matri□ spikes) are defined in Chapter □ ofS□-□4□*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-□lists the acceptance criteria for QC samples, and Table A-□lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking □anford 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 □anford 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 Conductivity 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 Cyanide Sulfide	MB	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Metals			
Arsenic Cadmium Chromium Lead Mercury Selenium Thallium ICP metals ICP/MS metals	MB	<CRDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	MSD	≤20% RPD[c]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

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

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

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)

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

Method[a]	QC Element	Acceptance Criteria	Corrective Action

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
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)*
Nitrate	Quarterly	±25%	≤25%
Chromium	Annually	±20%	≤25%

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

olding time is the elapsed time period between sample collection and analysis. The contractor s environmental QA program plan provides a table with holding times. E ceeding 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 S -4 o*Methods of Chemical Analysis of Water and Wastes* (EPA 4-) ata associated with e ceeded holding times are flagged with an in the EIS database. ata that e ceed 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 □ ater Pollution and □ ater 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. □ata 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 S□ -□4□, or with auditable □ASQAR□ and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with S□ -□4□ 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

□on-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 e□tent 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., EIS or a project-specific database). here electronic data are not available, hardcopies will be provided in accordance with Section of the Tri Party Agreement Action Plan (Ecology et al. b). The EIS database will be identified as a data repository for the anford Facility perating 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 ealth and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this QAPjP.

versight 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 anford 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. □alidation of groundwater data consists of assessing whether the data collected and measured truly reflect aquifer conditions. □erification means assessing data accuracy, completeness, consistency, availability, and internal control practices to determine overall reliability of the data collected. □ther □Q□s 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.

□roundwater monitoring staff perform checks on laboratory electronic data files for formatting, allowed values, data flagging (i.e., qualifiers), and completeness. □ardcopy results are verified to check for (□) completeness, (□) notes on condition of samples upon receipt by the laboratory, (□) 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. □alidation is a systematic process of reviewing verified data against a set of criteria (provided in Section A□□) 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 □EIS database (e.g., □R□for reject, □□□for suspect, or □□□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 □Q□s. 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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