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Hanford Site RCRA Groundwater Monitoring Report for 2018

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

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Executive Summary

The U.S. Department of Energy conducts groundwater monitoring at 25 dangerous waste management units (DWMUs) regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA)[1] at the Hanford Site. RCRA regulates the management of solid waste, hazardous waste, and certain underground storage tanks, and it applies to active or recently active DWMUs. Groundwater monitoring is required at land disposal units (including surface impoundments, landfills, or land treatment facilities) to determine impacts to groundwater quality in the uppermost aquifer. Groundwater monitoring requirements for Hanford Site RCRA DWMUs fall into one of two broad categories: interim status or final status. Final status units are incorporated into the *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*[2] (hereinafter referred to as the Hanford RCRA Permit), and require groundwater monitoring under Washington State dangerous waste regulations (WAC 173-303-645, Subpart F[3]). The units not currently incorporated into the Hanford RCRA Permit require interim status groundwater monitoring under WAC 173-303-400(3)(c)(v),[4] and by reference 40 CFR 265.[5] Annual reporting is required by March 1 each year under interim status requirements.

During 2018, the U.S. Department of Energy monitored groundwater at nine DWMUs under interim status indicator evaluation programs and at five DWMUs under final status detection programs. Nine DWMUs were monitored under interim status groundwater quality assessment programs to evaluate the nature and extent of contamination.

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[1] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

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

[3] WAC 173-303-645, "Dangerous Waste Regulations," "Releases from Regulated Units," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-645.

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

[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*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5.

Two DWMUs, the 183-H Solar Evaporation Basins and the 300 Area Process Trenches, continued to be monitored under final status corrective action programs in 2018.

The most significant changes during 2018 were the following:

- The 1324-N/NA DWMU was approved as clean closed and retired from the Hanford RCRA Permit[6] in June 2018.
- The 1301-N and 1325-N DWMUs were approved as clean closed and retired from the Hanford RCRA Permit[7] in December 2018.
- New monitoring requirements for the Liquid Effluent Retention Facility were implemented in 2018 based on a revision to the Hanford RCRA Permit in November 2017.

[6] 18-ESQ-0079, 2018, *Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit, Quarter Ending June 30, 2018*, Washington State Department of Ecology, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0065267H.

[7] 19-ESQ-0024, 2019, *Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit, Quarter Ending December 31, 2018*, Washington State Department of Ecology, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0064027H.

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Terms

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
cis-1,2-DCE	*cis*-1,2-dichloroethene
Cr(VI)	hexavalent chromium
DOE	U.S. Department of Energy
DST	double-shell tank
DWMU	dangerous waste management unit
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GEL	GEL Laboratories
IDF	Integrated Disposal Facility
LERF	Liquid Effluent Retention Facility
LLBG	low-level burial ground
LOQ	limit of quantitation
MTCA	Model Toxics Control Act
NRDWL	Nonradioactive Dangerous Waste Landfill
OU	operable unit
OUG	operating unit group
P&T	pump and treat
PFP	Plutonium Finishing Plant
PUREX	Plutonium-Uranium Extraction (Plant)
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction-Oxidation (Plant)
SST	single-shell tank
SWL	Solid Waste Landfill
TCE	trichloroethene
TOC	total organic carbon
TOX	total organic halides

Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRIM	Tikhonov regularized inverse method
UCL	upper confidence limit
WMA	waste management area

1 Introduction

The U.S. Department of Energy (DOE) conducts groundwater monitoring at 25 dangerous waste management units (DWMUs) at the Hanford Site (Figure 1-1). These units are regulated under Washington State dangerous waste regulations with authorization from the *Resource Conservation and Recovery Act of 1976* (RCRA). RCRA regulates the management of solid waste, hazardous waste, and certain underground storage tanks. It applies to active or recently active treatment, storage, and disposal units. Groundwater monitoring is required at land disposal units (including surface impoundments, landfills, or land treatment facilities) to determine if these units are affecting water quality in the uppermost aquifer.

Groundwater monitoring requirements for Hanford Site RCRA DWMUs fall into two broad categories: interim status or final status. Final status units have been incorporated into WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended (hereinafter referred to as the Hanford RCRA Permit). A permitted RCRA unit requires final status monitoring under WAC 173-303-645, "Dangerous Waste Regulations," "Releases from Regulated Units." The RCRA units not currently incorporated into a permit require interim status monitoring under WAC 173-303-400(3)(c)(v), "Interim Status Facility Standards," as implemented by 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring."

In 1989, DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) (hereinafter referred to as the Tri-Parties) signed Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). The Tri-Party Agreement implemented remediation of the Hanford Site under federal facility provisions of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), Section 120, "Federal Facilities," and brought the Hanford Site into compliance with environmental requirements under RCRA, including groundwater monitoring. In the early 1990s, certain DWMUs had ceased operations and were scheduled for closure. These units included ponds, ditches, trenches, cribs, and retention basins. Tri-Party Agreement milestones were agreed upon for the submission of closure plans, and individual closure plans were submitted for regulatory approval and eventual implementation. While awaiting approval and implementation of these closure plans, DOE developed interim status groundwater monitoring plans to monitor the effects of these units on groundwater until closures could be implemented. Until these closures have been implemented or the units are included in the Hanford RCRA Permit, interim status groundwater monitoring will continue.

Chapters 2 through 4 include summaries of the 2018 monitoring results from RCRA sampling campaigns. Only the well networks, constituents, and sampling events identified in the current RCRA monitoring plans are used for RCRA groundwater monitoring compliance. Wells may be sampled for other programs (e.g., CERCLA), but the data generated by those programs are not used to satisfy RCRA compliance. For informational purposes, Appendix A of this report provides all of the 2018 data for the RCRA wells, including data from other groundwater monitoring programs.

Some of the data summary tables in this report include comparison values such as the federal primary drinking water standards (DWSs), secondary DWSs, and Model Toxics Control Act (MTCA) cleanup levels (WAC 173-340, "Model Toxics Control Act—Cleanup"), which are provided for information only. These comparison values are not used to determine RCRA or *Washington Administrative Code* groundwater monitoring exceedances, nor to satisfy any RCRA or *Washington Administrative Code* groundwater monitoring requirements at the 25 DWMUs at the Hanford Site.

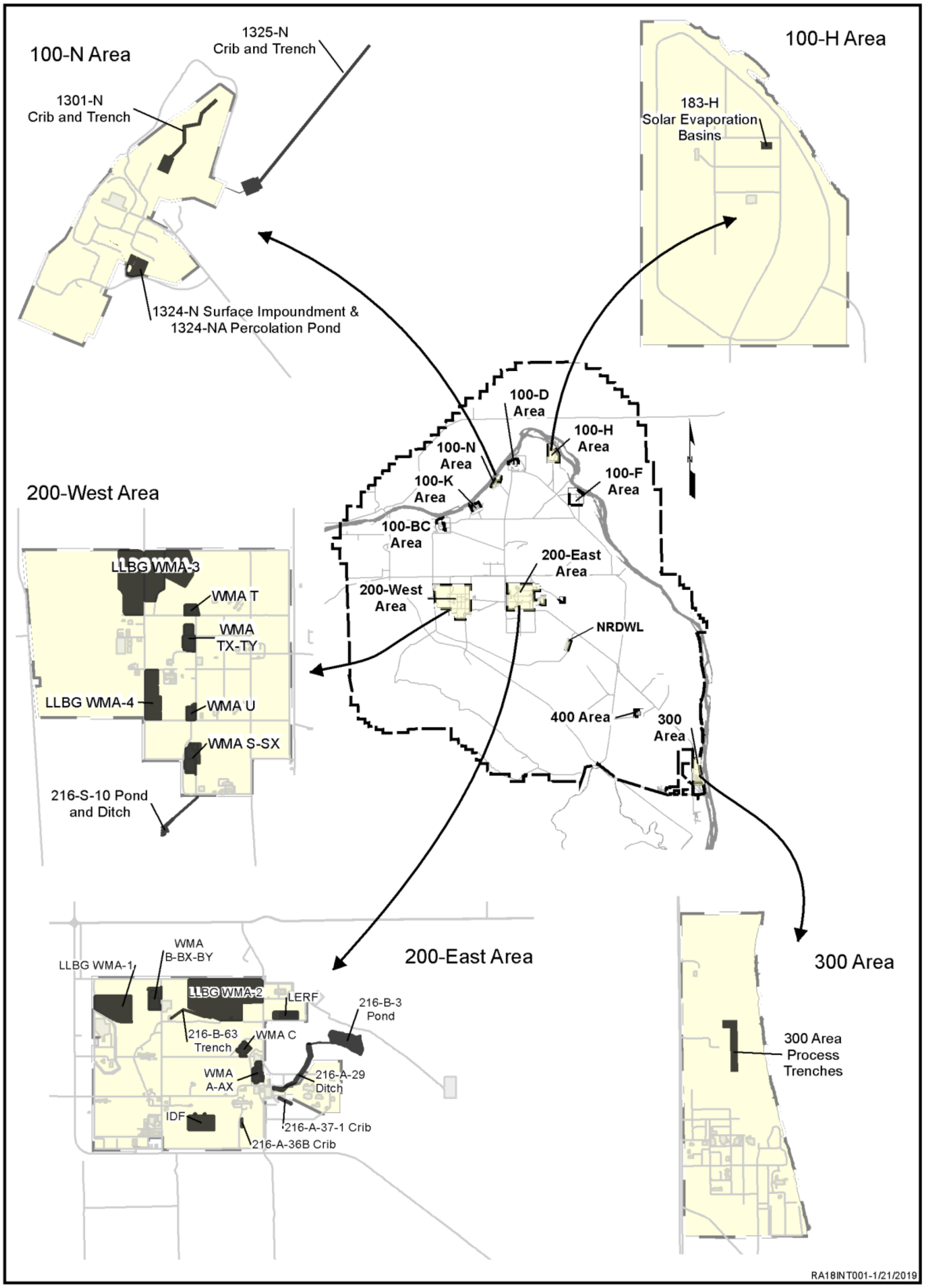


Figure 1-1. Hanford Site RCRA Units

1.1 RCRA Groundwater Monitoring Programs

DOE conducts RCRA groundwater monitoring under four types of programs:

- Interim status indicator evaluation
- Interim status groundwater quality assessment
- Final status detection
- Final status corrective action

Table 1-1 lists the Hanford Site RCRA units and their 2018 monitoring status. Natural or anthropogenic changes in groundwater flow and water quality (e.g., those imposed by pump-and-treat [P&T] systems) may affect the adequacy of RCRA groundwater monitoring networks. DOE is working with Ecology to review the monitoring networks and is evaluating the need for additional wells through the Hanford RCRA Permit working group. DOE is preparing RCRA engineering evaluation reports (Table 1-1) and related final status monitoring plans, which are expected to be added to the Hanford RCRA Permit.

Table 1-1. RCRA Monitoring Status, 2018

RCRA Unit	Section	Status	Engineering Evaluation[a]
1301-N Crib and Trench	2.1	Continued final status detection monitoring[b] until December 2018. Clean closed in December 2018.	No
1324-N Surface Impoundment and 1324-NA Percolation Pond	2.3	Continued final status detection monitoring[b] until June 2018. Clean closed; removed from the Hanford RCRA Permit in June 2018.	No
1325-N Crib and Trench	2.2	Continued final status detection monitoring[b] until December 2018. Clean closed in December 2018.	No
183-H Evaporation Basins	4.1	Continued final status corrective action monitoring program during CERCLA remedial action.	No
216-A-29 Ditch	3.8	Continued interim status assessment monitoring (elevated specific conductance).	Yes (anticipated in 2019)
216-A-36B Crib	2.4	Continued interim status indicator evaluation monitoring[b]	Yes (anticipated in 2020)
216-A-37-1 Crib	2.5	Continued interim status indicator evaluation monitoring[b]	Yes (anticipated in 2019)
216-B-3 Main Pond	2.6	Continued interim status indicator evaluation monitoring.[b]	Yes (anticipated in 2019)
216-B-63 Trench	2.7	Continued interim status indicator evaluation monitoring.[b]	Yes (anticipated in 2020)
216-S-10 Pond and Ditch	2.8	Continued interim status indicator evaluation monitoring.[b]	Yes (SGW-60585)
300 Area Process Trenches	4.2	Continued final status corrective action monitoring program during CERCLA remedial action.	No
IDF	2.9	Not yet in use; monitoring results added to baseline data set.	Yes (anticipated in 2019)

Table 1-1. RCRA Monitoring Status, 2018

RCRA Unit	Section	Status	Engineering Evaluation[a]
LERF	2.10	Continued final status detection monitoring.[b]	Yes (SGW-41072)
LLBG WMA-1	2.11	Continued interim status indicator evaluation monitoring.[b]	Yes (anticipated in 2020)
LLBG WMA-2	2.12	Continued interim status indicator evaluation monitoring.[b]	No; DOE has submitted a waiver for groundwater monitoring
LLBG WMA-3	2.13	Continued interim status indicator evaluation monitoring.[b]	SGW-59564 (Trenches 31 and 34) and SGW-60583 (Green Islands)
LLBG WMA-4	2.14	Continued interim status indicator evaluation monitoring.[b]	SGW-60584
NRDWL	3.9	Continued interim status assessment monitoring (specific conductance exceedance).	Yes (anticipated in 2019)
SST WMA A-AX	3.1	Continued interim status assessment monitoring (elevated specific conductance).	Yes (anticipated in 2019)
SST WMA B-BX-BY	3.2	Continued interim status assessment monitoring (cyanide[c]).	Yes (anticipated in 2020)
SST WMA C	3.3	Continued interim status assessment monitoring (cyanide[c]).	Yes anticipated in 2019)
SST WMA S-SX	3.4	Continued interim status assessment monitoring (chromium[c]).	SGW-60577
SST WMA T	3.5	Continued interim status assessment monitoring (chromium[c]).	SGW-60575
SST WMA TX-TY	3.6	Continued interim status assessment monitoring (chromium[c]).	SGW-60576
SST WMA U	3.7	Continued interim status assessment monitoring (chromium[c]).	SGW-60578

References:

SGW-41072, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report.*

SGW-59564, *Engineering Evaluation of the 200 West Pump and Treat Influence on Groundwater Monitoring for the Low-Level Burial Ground Trenches 31 and 34.*

SGW-60575, *Engineering Evaluation Report for Single-Shell Tank Waste Management Area T Groundwater Monitoring*.

SGW-60576, *Engineering Evaluation Report for Single-Shell Tank Waste Management Area TX-TY Groundwater Monitoring*.

SGW-60577, *Engineering Evaluation Report for Single-Shell Tank Waste Management Area S-SX Groundwater Monitoring.*

SGW-60578, *Engineering Evaluation Report for Single-Shell Tank Waste Management Area U Groundwater Monitoring*.

SGW-60583, *Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-3 Green Islands Groundwater Monitoring*.

SGW-60585, *Engineering Evaluation Report for the 216-S-10 Pond and Ditch Groundwater Monitoring*.

a. Engineering evaluations will be used to determine the need for new or replacement monitoring wells for these units.

b. Analysis of RCRA contamination indicator parameters provided no evidence of groundwater contamination with dangerous waste or dangerous waste constituents from the unit.

c. Primary RCRA constituent at this unit.

Table 1-1. RCRA Monitoring Status, 2018

RCRA Unit	Section	Status	Engineering Evaluation[a]

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE = U.S. Department of Energy
IDF = Integrated Disposal Facility
LERF = Liquid Effluent Retention Facility
LLBG = low-level burial ground
NRDWL = Nonradioactive Dangerous Waste Landfill
RCRA = *Resource Conservation and Recovery Act of 1976*
SST = single-shell tank
WMA = waste management area

Interim status indicator evaluation programs monitor specific conductance, pH, total organic carbon (TOC), and total organic halides[1] (TOX) (40 CFR 265.92(b)(3), "Sampling and Analysis") to determine if the RCRA unit has impacted groundwater in the uppermost aquifer. A statistically significant change is determined by comparing concentrations of the indicator parameters in downgradient wells to a statistical comparison value (critical mean) that is derived from background measurements (usually from upgradient wells). If a downgradient well exceeds a critical mean value for any of the indicator parameters, the well is resampled. If the results of the second sampling event confirm the exceedance, the detection monitoring program changes to an assessment monitoring program. The critical mean values for the indicator parameters represent 99% prediction limits, calculated based on samples from upgradient wells. The methodology used to calculate the critical mean value is the Student's t-test in accordance with 40 CFR 265.93(b), "Preparation, Evaluation, and Response."

Critical mean values are recalculated annually or whenever the number of analyses changes (e.g., due to adding or removing wells). ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*, describes the 2018 critical mean calculations. The tables presented in Chapter 2 provide the 2018 critical mean values and the results of statistical comparisons for each unit monitored under a detection program. Annual recalculation accounts for changing hydrologic conditions due to natural or manmade causes (e.g., P&T systems). If changes occur in a monitoring well network, critical mean values are recalculated for subsequent sampling events using the new well network. In 2018, when a critical mean for TOC or TOX could not be calculated using a parametric statistical test because >50% of data from the upgradient well(s) were below detection limits, DOE used the limit of quantitation (LOQ) as the upper reporting limit.

The LOQs for TOC and TOX are estimated from quality control sample results, and the LOQs vary from laboratory to laboratory and from quarter to quarter. An indicator parameter exceedance is not declared unless the downgradient concentration exceeds both the critical mean and the applicable LOQ. If an LOQ is not yet available for the current quarter, the previous quarter's LOQ is used as a comparison value. The indicator parameter tables in Chapter 2 list the applicable LOQs. The 2018 LOQ calculations are documented in ECF-Hanford-19-0002, *Calendar Year 2018 Total Organic Carbon / Total Organic Halides Limit of Detection / Limit of Quantitation* (in publication).

If an exceeded critical mean is verified in a downgradient well, an interim status groundwater quality assessment plan is implemented (40 CFR 265.93(d)). The objective of the monitoring program is to assess the rate and extent of migration, and the groundwater concentration of the dangerous waste from the unit.

[1] Total organic halides (TOX) are synonymous with total organic halogens, which is the term used in 40 CFR 265.92.

Interim status groundwater quality assessments may also consider and test for alternative explanations for critical mean exceedances. For example, specific conductance exceedances may be caused by nondangerous waste constituents such as sulfate (Section 1.5). Because of changes in the direction of groundwater flow and the presence of multiple past-practice CERCLA release sites, some assessments require determining if the detected dangerous waste originated from other sources. These assessments can take time to evaluate before a first determination is made, and some DWMUs in assessment can be returned to detection monitoring in accordance with 40 CFR 265.93(d)(6).

For final status detection monitoring (WAC 173-303-645(9)), appropriate indicator parameters, waste constituents, or reaction products are specified in the Hanford RCRA Permit for groundwater monitoring. If statistically significant evidence of contamination is determined at the point of compliance, DOE must notify Ecology and resample the well(s). The results of these analyses form the basis for a final status compliance monitoring program, which is established through a permit modification.

For final status compliance monitoring (WAC 173-303-645(10)), if contaminant concentrations in groundwater have exceeded a permit concentration limit, a corrective action program must be established. Corrective action groundwater monitoring under WAC 173-303-645(11) would then be initiated to determine if the corrective action is effective. Currently, none of the units at the Hanford Site are monitored under final status compliance monitoring programs.

1.2 Interim Status Reporting Requirements

40 CFR 265.94, "Recordkeeping and Reporting," includes reporting requirements for interim status groundwater monitoring programs. For indicator evaluation programs, the owner/operator must report the following information no later than March 1 each year (40 CFR 265.94(a)(2)(ii)):

- Concentrations of the contamination indicator parameters for each groundwater monitoring well, along with the required evaluations for these parameters (i.e., comparison to critical mean values)
- Any significant differences from initial background found in the upgradient wells
- Results of evaluations of groundwater surface elevations and a description of the response to that evaluation, where applicable

For groundwater quality assessments, the owner/operator must submit an annual report with the results of the groundwater quality assessment program no later than March 1 (40 CFR 265.94(b)(2)). The report must include the calculated (or measured) rate of migration of dangerous waste constituents in groundwater during the reporting period.

Chapter 2 describes the 2018 results for sites monitored under interim status indicator evaluation, and Chapter 3 provides the interim status assessment results for 2018.

1.3 Final Status Reporting Requirements

Under the final status requirements of WAC 173-303-645(8)(j), reporting requirements are specified in the Hanford RCRA Permit. The following requirements apply to final status units on the Hanford Site:

- The 100-N Area RCRA units (1301-N, 1325-N, and 1324-N/NA) and the Liquid Effluent Retention Facility (LERF) are monitored under final status detection programs, with data reported annually. Sections 2.1, 2.2, 2.3, and 2.10 summarize the monitoring results for 2018.

- For the Integrated Disposal Facility (IDF), Hanford RCRA Permit, Part III, Operating Unit Group 11 (OUG-11), Section 5.5.4.3.3, "Groundwater Monitoring," requires the following: "The results of the statistical evaluation and associated information will be submitted to Ecology quarterly in Hanford Site groundwater monitoring reports." Because the IDF is not in use, this statistical evaluation has not been prepared to date. Section 2.9 summarizes the monitoring results for 2018.
- The 183-H Solar Evaporation Basins and 300 Area Process Trenches are monitored under corrective action, which is reported in semiannual and annual reports. Sections 4.1 and 4.2 summarize the monitoring results for 2018.

1.4 Groundwater Flow

Well location maps in this report illustrate the water table contours and indicate the interpreted direction of flow. For those RCRA units not in the 200 East Area, the contours are based on the Hanford Site water table map for 2018, as described in ECF-Hanford-18-0048, *Preparation of the March 2018 Hanford Site Water Table and Potentiometric Surface Maps*. For those maps, manual water-level measurements from March 2018 were contoured manually using a geographic information system. In areas with active P&T systems, a computer model guided the contours.

For the 200 East Area where the water table is very flat, a regularized inverse interpolation technique, the Tikhonov regularized inverse method (TRIM), was applied. TRIM is founded upon a formal mathematical method that balances the complexity of the method or model that is used to interpret measured data with the "fit" to the measured data. Figure 1-2 provides the TRIM map for the 200 East Area based on the average of monthly water-level measurements in the low-gradient monitoring network from May through September 2018. ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites* (in publication), describes the creation of the map and resulting hydraulic gradients.

1.5 Specific Conductance

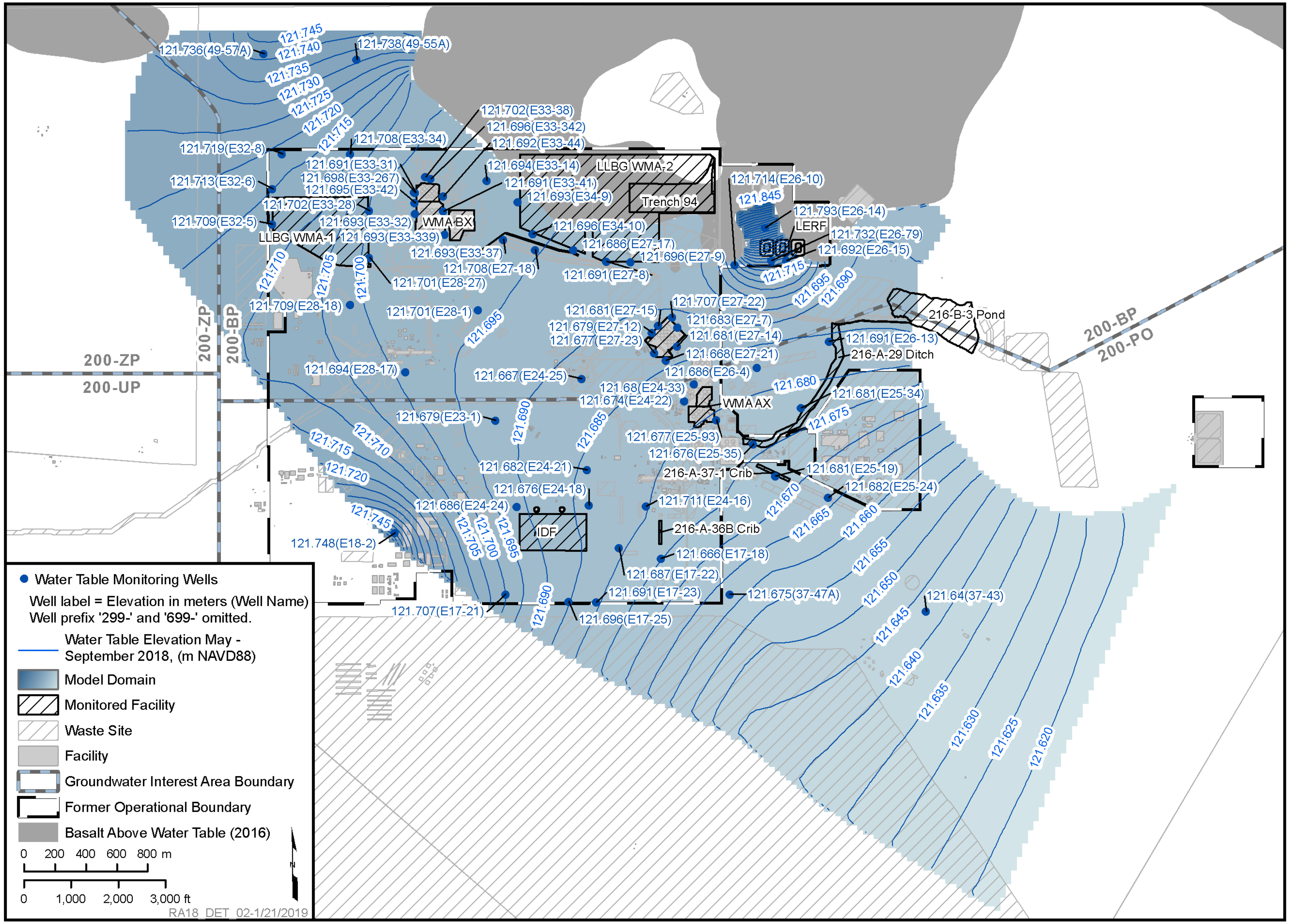
Specific conductance, one of the interim status contamination indicator parameters, is a measure of the ability of water to pass an electrical current, and it is affected by the presence of dissolved solids. The primary contributors to specific conductance in Hanford Site groundwater are bicarbonate, chloride, nitrate, sulfate, calcium, potassium, magnesium, and sodium. Many of these ions are present from natural sources, and others (notably nitrate and sulfate) were also introduced from Hanford Site waste disposal. Contaminants such as nitrate are commonly detected in concentrations of tens of mg/L and have a large effect on specific conductance. Specific conductance is not a good indicator of contaminants such as chromium that are present in concentrations of tens of µg/L (three orders of magnitude less).

Regional nitrate and sulfate plumes influence the contamination indicator parameter specific conductance. These plumes originated at past-practice waste sites and some RCRA units. Many of the RCRA units in 200 East, 200 West, and 100-N Areas are located within regional nitrate or sulfate plumes. Interactive groundwater monitoring report tools[2] allow users to view nitrate plumes as they migrated from 1993 to 2017.

[2] The interactive groundwater monitoring report tools are available online at https://higrv.hanford.gov/Hanford_Reports_2017/Hanford_GW_Report/.

1.6 Other Hanford Site Groundwater Reports

DOE has reported annually on RCRA groundwater monitoring since 1988. Table 1-2 lists the various forms and schedules that the reports have taken over the years. DOE combined the RCRA annual report with the annual Hanford Sitewide groundwater reports from 1996 through 2014. Since calendar year 2015, DOE has provided separate reports for the RCRA units by March 1, as specified in 40 CFR 265.94.



References:ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*; NAVD88, *North American Vertical Datum of 1988*, as revised.

Figure 1-2. 200 East Water Table Based on Low-Gradient Monitoring Network

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Table 1-2. Hanford Site RCRA Monitoring Reports

Years	Publication Date	Reporting Year	Explanation
1988 to 1995	March 1	Fiscal year (October 1 to September 30)	Standalone RCRA reports. Hanford Sitewide groundwater reports published separately.
1996 to 2008	March 1	Fiscal year (October 1 to September 30)	Comprehensive report (RCRA, Hanford Sitewide, and CERCLA*).
2009 to 2014	July or August	Calendar year	Comprehensive report (RCRA, Hanford Sitewide, CERCLA,* and AEA). DOE and Ecology agreed on alternative schedules to allow the change to calendar year and extend time for reviewing the draft report.
2015 to 2018	March 1	Calendar year	Standalone RCRA report.
	August or September	Calendar year	Comprehensive report (RCRA, Hanford Sitewide, CERCLA,* and AEA). Included revisions to RCRA sections based on Ecology comments on RCRA report.

*The comprehensive groundwater annual reports include the results of CERCLA monitoring. Additional details are provided in separate annual reports for operable units with active remedial actions.

AEA = *Atomic Energy Act of 1954*

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

DOE = U.S. Department of Energy

Ecology = Washington State Department of Ecology

RCRA = *Resource Conservation and Recovery Act of 1976*

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2 Indicator Evaluation and Detection Monitoring

This chapter discusses the monitoring results for five DWMUs monitored under final status detection and nine DWMUs monitored under interim status indicator evaluation programs.

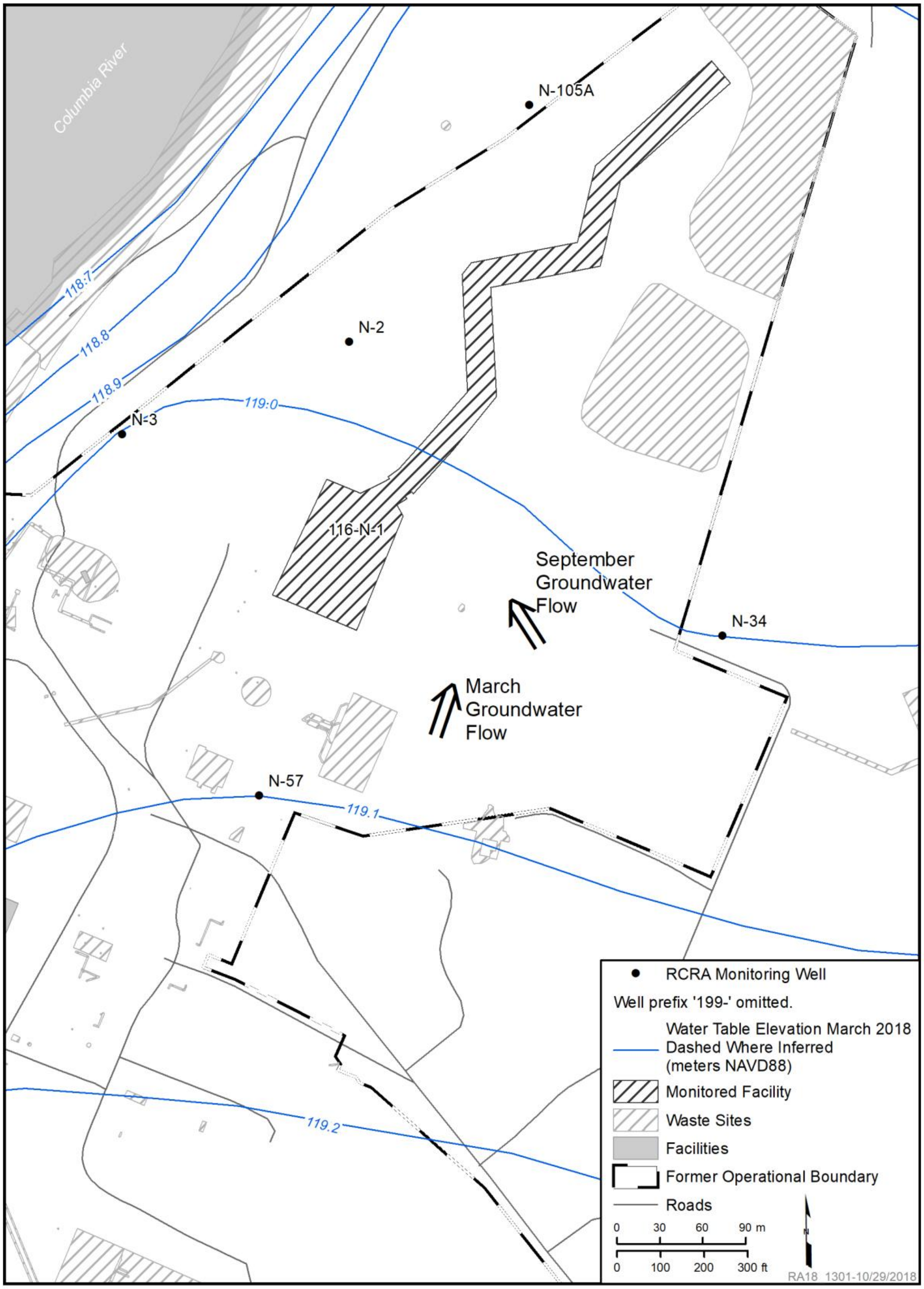
2.1 1301-N Crib and Trench

The 1301-N Crib and Trench, also known as the 116-N-1 waste site (Figures 1-1 and 2-1), were used to dispose liquid effluent from the 1960s through 1985. The effluent contained small quantities of dangerous waste and large volumes of radioactive waste. During remediation, the waste site was excavated from 4.6 to 6.1 m (15 to 20 ft) to remove shallow vadose zone sediment where most of the radionuclide contamination resided. The waste site was backfilled with clean soil and revegetated with native shrubs and grasses. The waste site has undergone RCRA closure, and the requirements were removed from the permit in December 2018 (19-ESQ-0024, *Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit, Quarter Ending December 31, 2018*). This report summarizes RCRA groundwater monitoring for 2018. This unit will no longer be included in future RCRA annual reports.

Groundwater monitoring conducted during the RCRA closure period followed the requirements of BHI-00725, *100-N Pilot Project: Proposed Consolidated Groundwater Monitoring Program*; and WHC-SD-EN-AP-038, *Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N Sites*, as referenced in the Hanford RCRA Permit (WA7890008967, Part V, Closure Unit Group 2 (CUG-2), "1301-N Liquid Waste Disposal Facility," Chapter 3.0, "Groundwater Monitoring"). The RCRA monitoring network included two upgradient wells and three downgradient wells (Table 2-1). The water table in the 100-N Area fluctuates in response to river stage, but it is not declining overall. During 2018, the monitoring wells produced representative samples, and no changes to the monitoring network were made.

The water table sloped to the north and northeast in March 2018, and to the northwest in September 2018 (Figure 2-1). The March 2018 trend surface analysis of water-level data showed a hydraulic gradient of 3.6×10^{-4} m/m. Groundwater flow rate estimates ranged from 0.007 to 0.13 m/d (0.02 to 0.43 ft/d) (Table 2-2). September 2018 trend surface analysis of the water-level data showed a hydraulic gradient of 3.0×10^{-3} m/m, and groundwater flow rate estimates ranged from 0.06 to 1.1 m/d (0.20 to 3.7 ft/d).

Upgradient and downgradient wells were scheduled for sampling twice each year for RCRA contamination indicator parameters (pH, specific conductance, TOC, and TOX) (Table 2-3) and turbidity, and once each year for groundwater quality and supporting parameters (chloride, iron, lead, manganese, mercury, selenium, sodium, sulfate, and alkalinity) (Table 2-4). Well sampling was conducted as scheduled in 2018, with no critical mean exceedances. Unfiltered samples from well 199-N-2 had iron concentrations above the secondary DWS. The presence of chromium and manganese indicates that these metals are potential corrosion products from the carbon steel well casing.



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

Figure 2-1. 1301-N Crib and Trench (116-N-1 Waste Site)

Table 2-1. 1301-N Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
199-N-2	DG	1964 (P)	129.9	426.2	111.6	366.2	118.42	388.53	9/20/2018	6.8	22.4	S	None
199-N-3	DG	1964 (P)	130.2	427.1	111.6	366.1	118.09	387.42	9/20/2018	6.5	21.3	S	None
199-N-34	UG	1983 (P)	130.3	427.6	116.9	383.6	119.23	391.16	9/20/2018	2.3	7.6	S	None
199-N-57	UG	1987 (C)	122.4	401.5	117.8	386.5	119.13	390.86	9/17/2018	1.3	4.4	S	None
199-N-105A	DG	1995 (C)	118.6	389.1	111.0	364.1	118.19	387.77	9/21/2018	7.2	23.7	S	None

Note: Requirements from WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, Part V, Closure Unit Group 2 (CUG-2), "1301-N Liquid Waste Disposal Facility," Chapter 3.0, "Groundwater Monitoring."

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

S = semiannually

UG = upgradient

Table 2-2. Groundwater Velocity at the 1301-N Crib and Trench

Flow Direction	March 2018: 21 degrees (north-northeast) September 2018: 325 degrees (northwest)
Flow Rate (m/d)	March 2018: 0.007 to 0.13 September 2018: 0.06 to 1.1
Hydraulic Conductivity (m/d) (Source)	6.1 to 37 (PNL-8335, *Application of Three Aquifer Test Methods for Estimating Hydraulic Properties Within the 100-N Area*)
Effective Porosity	0.1 and 0.3 (assumed range based on geology)
Gradient (m/m)	March 2018: 3.6×10^{-4} September 2018: 3.0×10^{-3}
Comments	Gradient and direction determined by trend surface analysis using March and September 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-3. 1301-N Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)				
Critical Mean[a]		**5.5**	**10.1**	**2,100**		**1,980**			**27.7**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**	**Lab**	**Comment**
199-N-105A	3/7/2018	8.05	0.00	646	3	450	66	530	<7.7	0.0	21.6	TADN	
	9/21/2018	8.14	0.00	697	1	491	45	—[b]	<5.9	3.1	9.7	GEL	
199-N-2	3/6/2018	7.94	0.00	732	1	<500	0	1,670	<2.6	0.6	16.7	TASL	
	9/20/2018	8.02	0.00	550	0	383	26	—[b]	<5.1	1.6	9.7	GEL	
199-N-3	3/6/2018	7.29	0.00	903	2	832	3	530	<10.3	4.5	21.6	TADN	
	9/20/2018	7.23	0.00	982	0	814	79	—[b]	7.4	0.7	9.7	GEL	
199-N-34	3/6/2018	8.05	0.00	756	4	<500	0	1,670	7.0	1.4	16.7	TASL	
	9/20/2018	8.03	0.00	718	0	556	52	—[b]	<5.0	1.7	9.7	GEL	
199-N-57	3/7/2018	7.49	0.02	846	3	474	5	530	9.8	1.7	21.6	TADN	
	9/17/2018	7.40	0.00	1,009	1	794	21	—[b]	12.8	2.4	9.7	GEL	

a. Critical mean values from Table 10 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

<	=	one or more of the replicate values was below the detection limit
Avg	=	average
GEL	=	GEL Laboratories
LOQ	=	limit of quantitation
SD	=	standard deviation
TADN	=	TestAmerica – Denver
TASL	=	TestAmerica – St. Louis
TOC	=	total organic carbon
TOX	=	total organic halides

Table 2-4. 1301-N Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	70	235	—	
Chloride	mg/L	11	100	250[b]	
Iron (unfiltered)	µg/L	<30	1,300	300[b]	199-N-2
Iron (filtered)	µg/L	<23	71.0	300[b]	
Lead (unfiltered)	µg/L	<0.090	0.68	50	
Lead (filtered)	µg/L	<0.078	0.50	50	
Manganese (unfiltered)	µg/L	<1.0	34.0	50[b]	
Manganese (filtered)	µg/L	<0.3	9.2	50[b]	
Mercury (unfiltered)	µg/L	<0.016	<0.067	2	
Mercury (filtered)	µg/L	<0.016	<0.067	2	
Selenium (unfiltered)	µg/L	1.1	3.5	50	
Selenium (filtered)	µg/L	1.0	3.1	50	
Sodium (unfiltered)	µg/L	5,250	54,000	—	
Sodium (filtered)	µg/L	5,150	53,000	—	
Sulfate	mg/L	45	150	250[b]	
Turbidity	NTU	0.5	7.5	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

2.2 1325-N Crib and Trench

The 1325-N Crib and Trench, also known as the 116-N-3 waste site (Figures 1-1 and 2-2), was used to dispose liquid effluent from 1983 through 1991. The effluent contained small quantities of dangerous waste and a large volume of radioactive waste. The waste site was excavated to 1.5 m (5 ft) below the engineered structure to remove vadose zone material (containing the highest concentrations of radionuclides), backfilled with clean soil, and revegetated with native shrubs and grasses. The waste site has undergone RCRA closure, and the requirements were removed from the permit in December 2018 (19-ESQ-0024). This report summarizes RCRA groundwater monitoring for 2018. This unit will no longer be included in future RCRA annual reports.

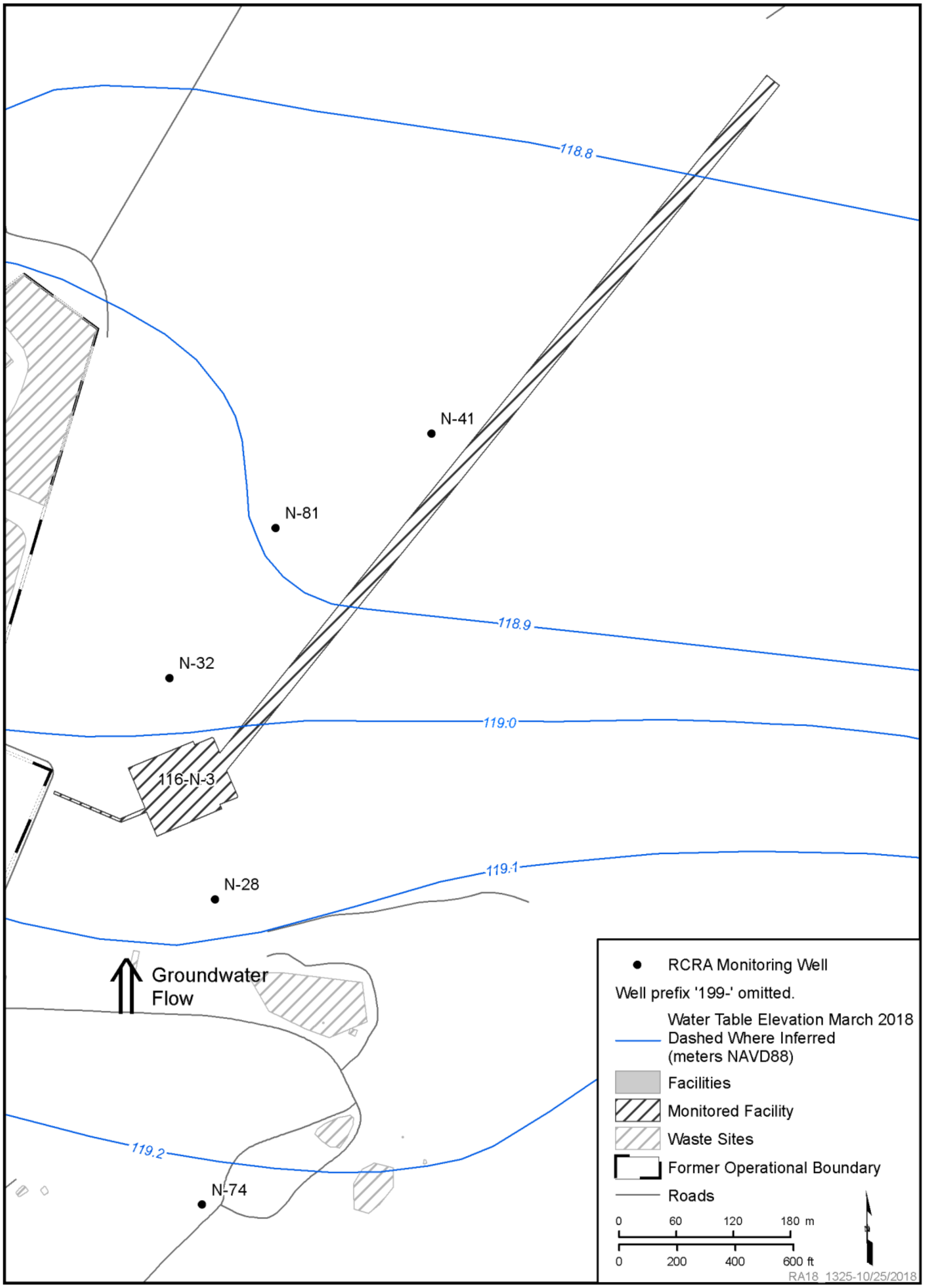
Groundwater monitoring conducted during the RCRA closure period followed the requirements of BHI-00725 and WHC-SD-EN-AP-038, as referenced in the Hanford RCRA Permit (WA7890008967, Part V, Closure Unit 1 (CUG-1), "1325-N Liquid Waste Disposal Facility," Chapter 3.0, "Groundwater Monitoring"). Upgradient well 199-N-74 and downgradient wells 199-N-32, 199-N-41, and 199-N-81 monitored the site (Table 2-5). Well 199-N-28 was monitored for supporting information and previously reflected potential impacts from treated groundwater injected into a nearby well during 100-N Area P&T operations. Data from well 199-N-28 were not evaluated statistically. In 2018, monitoring wells produced representative samples, and no changes to the monitoring network were made.

The water table in the 100-N Area fluctuates in response to river stage, but it is not declining overall. Groundwater flows to the north beneath the 1325-N site (Figure 2-2). The hydraulic gradient in March 2018 was 5.5×10^{-4} m/m, with the groundwater flow rate estimated from 0.01 to 0.20 m/d (0.04 to 0.66 ft/d) (Table 2-6). September 2018 trend surface analysis of water-level data showed a hydraulic gradient of 8.7×10^{-4} m/m, and groundwater flow rate estimates ranged from 0.02 to 0.32 m/d (0.06 to 1.1 ft/d).

In 2018, all five wells in the RCRA network were sampled twice (in March and September) for RCRA contamination indicator parameters (pH, specific conductance, TOC, and TOX) (Table 2-7) and turbidity, and once (in September) for groundwater quality and supporting parameters (chloride, iron, lead, manganese, mercury, selenium, sodium, sulfate, and alkalinity) (Table 2-8). Well sampling was conducted as scheduled in 2018 with no critical mean exceedances.

Statistical comparisons for specific conductance were performed in 2018 using the intrawell testing method for 1325-N. Applying intrawell testing (as identified in EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*) provides a method to account for the spatial variability in the specific conductance indicator parameter for statistical comparisons. Intrawell testing is a parametric analysis of variance method applicable for detection monitoring as provided in WAC 173-303-645(8)(h)(i). Applying the intrawell comparison for specific conductance reduces the number of false positives associated with the nonregulated sulfate present in groundwater. As discussed in Section 2.2 of DOE/RL-2016-66, *Hanford Site RCRA Groundwater Monitoring Report for 2016*, the presence of sulfate in groundwater causes exceedances of the specific conductance critical mean in upgradient/downgradient (interwell) statistical comparisons. Sulfate is not a regulated waste constituent, but its presence results in significant spatial variability in specific conductance (Section 1.5).

Iron concentrations in samples from well 199-N-32 were above the secondary DWS. The presence of chromium and manganese indicates that these metals are potential corrosion products from the carbon steel well screens and casing.



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

Figure 2-2. 1325-N Crib and Trench (116-N-3 Waste Site)

Table 2-5. 1325-N Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
199-N-28	SI	1983 (P)	127.7	419.1	116.9	383.6	119.32	391.47	10/1/2018	2.4	7.9	S	None
199-N-32	DG	1983 (P)	128.6	421.9	117.6	385.9	119.20	391.09	9/17/2018	1.6	5.1	S	None
199-N-41	DG	1984 (P)	123.7	406.0	117.6	386.0	118.50	388.77	9/17/2018	0.9	2.8	S	None
199-N-74	UG	1991 (C)	121.5	398.5	115.3	378.2	119.55	392.21	9/17/2018	4.3	14.0	S	None
199-N-81	DG	1993 (C)	119.9	393.4	113.9	373.6	119.00	390.43	9/20/2018	5.1	16.8	S	None

Note: Requirements from WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, Part V, Closure Unit Group 1 (CUG-1), "1325-N Liquid Waste Disposal Facility," Chapter 3.0, "Groundwater Monitoring."

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

S = semiannually

SI = sampled for supporting information; not used in statistical comparisons

UG = upgradient

Table 2-6. Groundwater Velocity at the 1325-N Crib and Trench

Flow Direction	March 2018: 349 degrees (north) September 2018: 355 degrees (north)
Flow Rate (m/d)	March 2018: 0.01 to 0.20 September 2018: 0.02 to 0.32
Hydraulic Conductivity (m/d) (Source)	6.1 to 37 (PNL-8335, *Application of Three Aquifer Test Methods for Estimating Hydraulic Properties Within the 100-N Area*)
Effective Porosity	0.1 and 0.3 (assumed range based on geology)
Gradient (m/m)	March 2018: 5.5×10^{-4} September 2018: 8.7×10^{-4}
Comments	Gradient and direction determined by trend surface analysis using March and September 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-7. 1325-N Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)			TOC (µg/L)			TOX (µg/L)				
Critical Mean[a]		7.59	8.5	Varies by well			1,100			21.30				
Well	Sample Date	Avg	SD	Critical Mean	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ	Lab	Comment
199-N-28	3/7/2018	8.19	N/A	N/A	481	N/A	334	N/A	390	3.5	N/A	12.3	GEL	Statistical comparisons not required
	9/17/2018	8.29	N/A		408	N/A	<330	N/A	—[b]	4.6	N/A	9.7	GEL	
199-N-32	3/7/2018	7.83	0.0	527	493	1	379	9	390	<4.9	1.0	12.3	GEL	
	9/17/2018	7.99	0.1		465	3	<330	0	—[b]	4.1	1.3	9.7	GEL	
199-N-41	3/6/2018	8.11	0.0	675	556	1	451	6	390	19.4[c]	1.0[c]	12.3	GEL	
	9/17/2018	8.06	0.0		543	1	344	16	—[b]	6.6	3.4	9.7	GEL	
199-N-74	3/7/2018	8.07	0.0	483	441	0	<330	0	390	<3.3	0.0	12.3	GEL	
	9/17/2018	8.02	0.0		434	0	<341	18	—[b]	<3.3	0.0	9.7	GEL	
199-N-81	3/6/2018	8.14	0.0	566	556	1	<500	0	1,670	6.7	1.1	16.7	TASL	
	9/20/2018	8.08	0.0		545	0	<374	48	—[b]	<4.9	2.7	9.7	GEL	

a. Critical mean values from Tables 11 and 12 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

c. TOX statistics exclude one “Y”-flagged value (inconsistent with other three replicate samples).

< = one or more of the replicate values was below the detection limit

Avg = average

GEL = GEL Laboratories

LOQ = limit of quantitation

N/A = not applicable

SD = standard deviation

TASL = TestAmerica – St. Louis

TOC = total organic carbon

TOX = total organic halides

Table 2-8. 1325-N Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	69	88	—	
Chloride	mg/L	13	31	250[b]	
Lead (unfiltered)	µg/L	<0.18	0.50	50	
Lead (filtered)	µg/L	<0.18	0.50	50	
Iron (unfiltered)	µg/L	<30	490	300[b]	199-N-32
Iron (filtered)	µg/L	<30	485	300[b]	199-N-32
Manganese (unfiltered)	µg/L	<1.0	21.6	50	
Manganese (filtered)	µg/L	<1.0	21.4	50	
Mercury (unfiltered)	µg/L	<0.027	<0.067	2	
Mercury (filtered)	µg/L	<0.027	<0.067	2	
Selenium (unfiltered)	µg/L	<0.70	2.9	50	
Selenium (filtered)	µg/L	<0.70	2.4	50	
Sodium (unfiltered)	µg/L	6,980	13,900	—	
Sodium (filtered)	µg/L	6,470	13,700	—	
Sulfate	mg/L	70	110	250[b]	
Turbidity	NTU	0.8	4.8	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

2.3 1324-N Surface Impoundment and 1324-NA Percolation Pond

The 1324-N and 1324-NA facilities, also known as the 120-N-2 and 120-N-1 waste sites (Figures 1-1 and 2-3), were used to treat and dispose corrosive, nonradioactive waste from 1977 to 1990. The facilities have been remediated by removing and disposing the site structures, which included a liner system, a small sampling shed, fencing, and other miscellaneous debris.

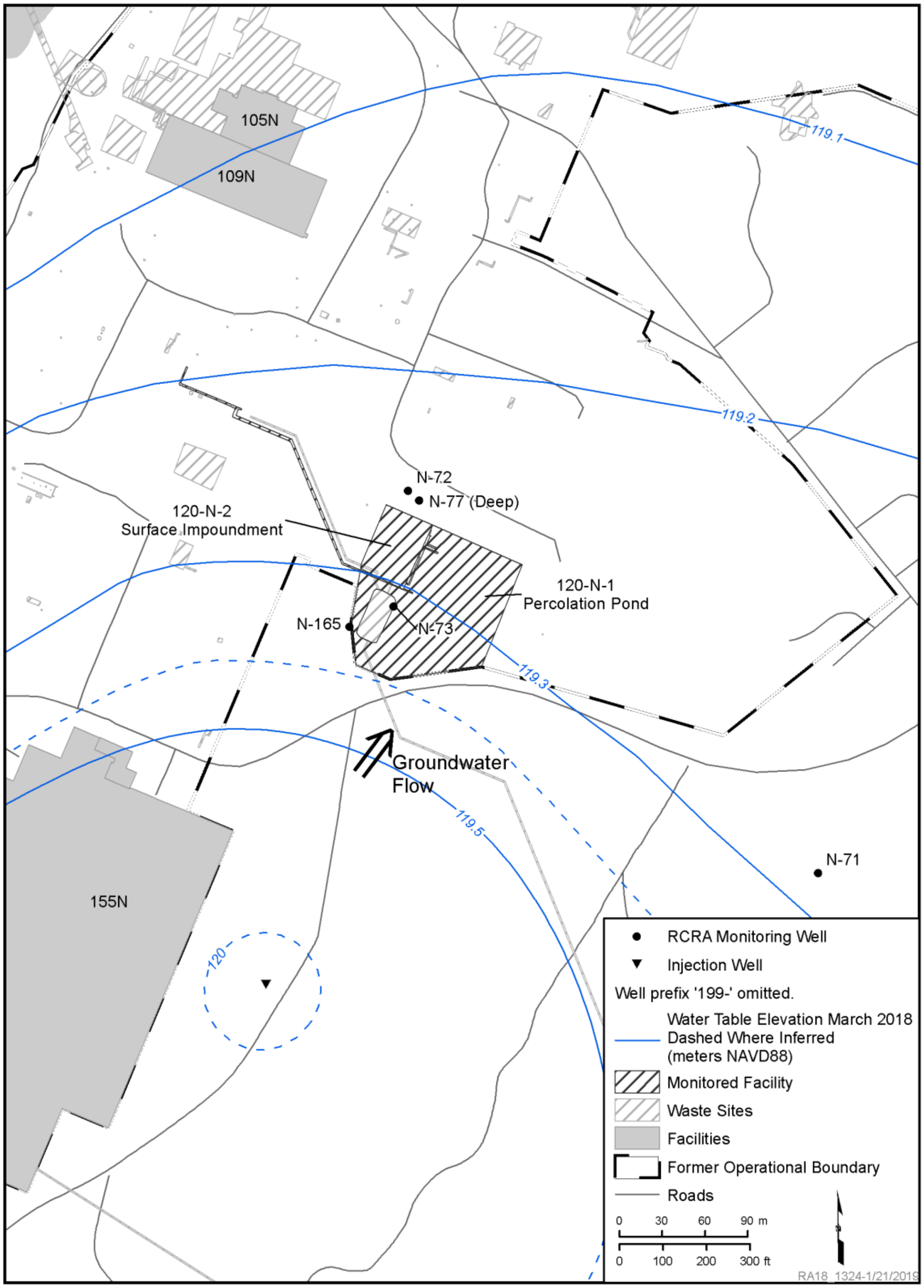
The waste sites have undergone RCRA closure and were removed from the Hanford RCRA Permit in June 2018 (18-ESQ-0079, *Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit, Quarter Ending June 30, 2018*). This report summarizes RCRA groundwater monitoring for the first half of 2018, prior to the permit modification. The 1324-N/NA DWMU will no longer be included in future RCRA annual reports.

Groundwater monitoring during the RCRA closure period followed the requirements of BHI-00725 and WHC-SD-EN-AP-038, as referenced in the Hanford RCRA Permit (WA7890008967, Part V, Closure Unit 3 (CUG-3), "1324-N Surface Impoundment & 1324-NA Percolation Pond," Chapter 3.0, "Groundwater Monitoring"). The surface impoundment and percolation pond were monitored as a single DWMU due to their proximity and similar waste types. The monitoring network included one upgradient well and four downgradient wells (Table 2-9). The 199-N-77 well screen is at the base of the unconfined aquifer, and statistical data comparisons were not performed on this well. No changes were made to the monitoring network in 2018.

The 100-KR-4 Operable Unit (OU) injection wells, located south and west of the 1324-N/NA DWMU, have raised the water table and continued to affect groundwater flow in 2018. Trend surface analysis of March 2018 data from the 1324-N/NA monitoring well network indicated that the local water table sloped to the northeast (Figure 2-3). The hydraulic gradient was estimated to be 5.3×10^{-4} m/m in March 2018, with flow rates from 0.011 to 0.19 m/d (0.035 to 0.64 ft/d) (Table 2-10). The direction of flow has varied from northeast to north-northwest over the past 3 years.

All five monitoring wells were sampled in March 2018 as planned for RCRA contamination indicator parameters (pH, specific conductance, TOC, and TOX) (Table 2-11) and turbidity. No indicator parameter exceedances were identified. Statistical comparisons for specific conductance used the intrawell testing method (Section 2.2). As discussed in Section 2.3 of DOE/RL-2016-66, the presence of sulfate in groundwater causes exceedances of the specific conductance critical mean in downgradient to upgradient (interwell) statistical comparisons. Sulfate is a not a regulated waste constituent, but its presence results in significant spatial variability in specific conductance (Section 1.5). Section 2.3 of DOE/RL-2016-66 discusses the sources and migration of sulfate in 100-N Area groundwater.

Because 1324-N/NA was removed from the Hanford RCRA Permit in June 2018 and the sampling event for annual constituents was routinely conducted in September, groundwater quality and supporting parameters (chloride, lead, iron, manganese, mercury, selenium, sodium, sulfate, and alkalinity) were not collected in 2018.



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

Figure 2-3. 1324-N Surface Impoundment and 1324-NA Percolation Pond (120-N-2 and 120-N-1 Waste Sites)

Table 2-9. 1324-N/NA Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
199-N-71	UG	1991 (C)	121.8	399.6	115.5	378.9	119.27	391.32	3/6/2018	3.8	12.5	S*	None
199-N-72	DG	1991 (C)	121.2	397.7	114.9	376.9	119.24	391.20	3/6/2018	4.3	14.3	S*	None
199-N-73	DG	1991 (C)	121.2	397.7	115.0	377.2	119.31	391.42	3/6/2018	4.3	14.2	S*	None
199-N-77	DG deep	1992 (C)	114.2	374.7	111.2	364.8	119.25	391.22	3/6/2018	8.1	26.4	S*	None
199-N-165	DG	2008 (C)	120.0	393.8	115.5	378.8	119.31	391.42	3/6/2018	3.8	12.6	S*	None

Note: Requirements from WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, Part V, Closure Unit Group 3 (CUG-3), "1324-N Surface Impoundment & 1324-NA Percolation Pond," Chapter 3.0, "Groundwater Monitoring."

*The RCRA sampling event scheduled for September was not performed because the requirements for this RCRA unit group were removed from the permit in June 2018 (18-ESQ-0079, *Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit, Quarter Ending June 30, 2018*).

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

RCRA = *Resource Conservation and Recovery Act of 1976*

S = semiannually

UG = upgradient

Table 2-10. Groundwater Velocity at 1324-N/NA Facilities

Flow Direction	March 2018: 37 degrees (northeast)
Flow Rate (m/d)	March 2018: 0.011 to 0.19
Hydraulic Conductivity (m/d) (Source)	6.1 to 37 (PNL-8335, *Application of Three Aquifer Test Methods for Estimating Hydraulic Properties Within the 100-N Area*)
Effective Porosity	0.1 and 0.3 (assumed range based on geology)
Gradient (m/m)	March 2018: 5.3×10^{-4}
Comments	Gradient and direction determined by trend surface analysis using March 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-11. 1324-N/NA Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)			TOC (µg/L)			TOX (µg/L)				
Critical Mean[a]		**7.24**	**8.87**	**Varies by well[a]**			**Use LOQ**			**45.7**				
Well	**Sample Date**	**Avg**	**SD**	**Critical Mean**	**Avg**	**SD**	**Avg**	**SD**	**LOQ 4th Quarter 2017/1st Quarter 2018[b]**	**Avg**	**SD**	**LOQ**	**Lab (TOC and TOX)**	**Comment**
199-N-165	3/6/2018	8.41	0.00	795	543	5.4	378	14	540/390[c]	<4.1	0.8	12.3	GEL	
199-N-71	3/6/2018	8.08	0.00	421	381	0.0	<500	0.0	1,490/1,670	4.9	0.9	16.7	TASL	
199-N-72	3/6/2018	8.36	0.00	1,090	748	8.2	494	12	540/390[c]	5.7	1.0	12.3	GEL	
199-N-73	3/6/2018	8.33	0.00	1,170	659	1.5	487	7.9	580/530	<7.7	0.0	21.6	TADN	
199-N-77	3/6/2018	8.43	0.00	NC[d]	601	0.7	<500	0.0	1,490/1,670	12	2.5	16.7	TASL	Statistical comparisons not required

a. Critical mean values from Tables 13 and 14 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. TOC concentrations were compared to fourth quarter 2017 LOQ values because the first quarter 2018 LOQ values were not calculated until May 2018, when field blank data were available.

c. The calculated TOC first quarter 2018 LOQ for GEL is biased low because field blank results were left-censored to zero, resulting in erroneously low standard deviations.

d. Critical mean not calculated for well 199-N-77 (deep well); no statistical comparisons required.

< = one or more of the replicate values was below the detection limit

Avg = average

GEL = GEL Laboratories

LOQ = limit of quantitation

NC = not calculated

SD = standard deviation

TADN = TestAmerica – Denver

TASL = TestAmerica – St. Louis

TOC = total organic carbon

TOX = total organic halides

2.4 216-A-36B Crib

The 216-A-36B Crib was located in the southeastern portion of the 200 East Area (Figures 1-1 and 2-4). The crib was 7 m (23 ft) deep, 150 m (500 ft) long, and 2.3 to 3.4 m (7.5 to 11 ft) wide at the base; the sides sloped at 1:1.5 (H-2-59129, *Crib 216-A36B, Plan Profiles & Details*). The crib construction includes 7 m (23 ft) of naturally revegetated clean backfill soil. The crib was originally part of the 180 m (590 ft) long 216-A-36 Crib, which received Plutonium-Uranium Extraction (PUREX) Plant effluent from September 1965 to March 1966. In March 1966, the northernmost 30 m (98 ft) of the crib was isolated with a grout barrier. The southern portion of the crib (now known as 216-A-36B) is the only portion regulated as a RCRA DWMU. The 216-A-36B Crib operated from March 1966 to October 1972 and was reactivated in November 1982 for the PUREX Plant restart. It received 290 million L (76.6 million gal) of PUREX ammonia scrubber distillate and was permanently removed from service in September 1987. In May 2010, 15 cm (6 in.) of gravel was added to the surface of the 216-A-36B Crib.

The 216-A-36B Crib is monitored under an indicator evaluation program (DOE/RL-2010-93, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*). The monitoring network includes two upgradient wells and four downgradient wells (Figure 2-4; Table 2-12).

The low-gradient groundwater contour map for 2018 indicated groundwater flow to the east-southeast near the 216-A-36B Crib (Figures 1-2 and 2-4). The calculated groundwater flow rate is 0.0006 m/d (0.002 ft/d) (Table 2-13) with a gradient of 1.9×10^{-5} m/m. Table 2-12 summarizes water-level information for the 216-A-36B monitoring network. The average rate of water-level decline between 2013 and 2018 was 2.5 cm/yr (1.0 in./yr). Based on this information, the monitoring wells have adequate water in the screened interval for continued sampling.

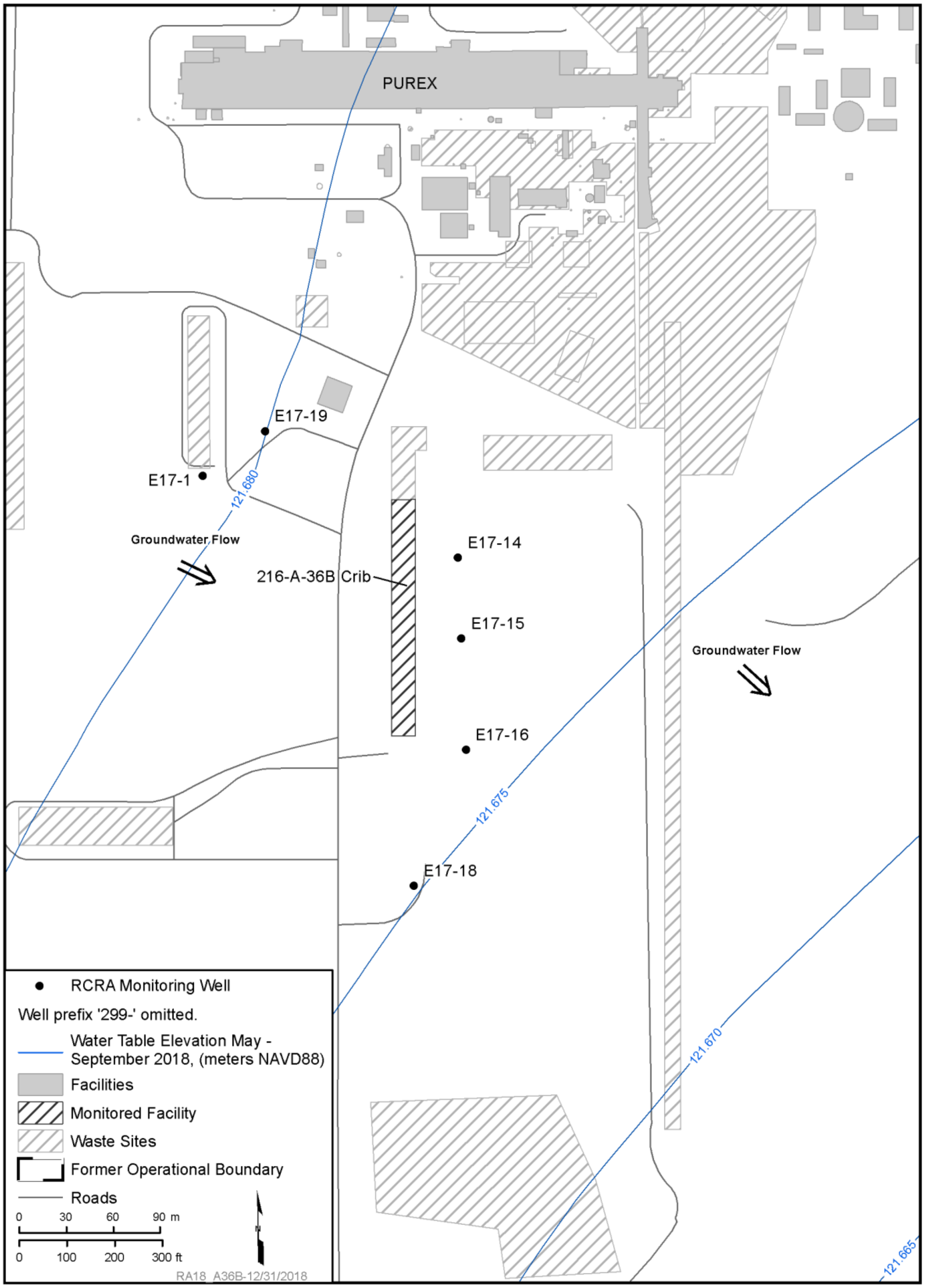
The 216-A-36B Crib groundwater wells were monitored in 2018 for RCRA indicator parameters (TOC, TOX, pH, and specific conductance) (Table 2-14) and water quality parameters (Table 2-15). There were no exceedances of the 2018 critical mean values.

Groundwater quality parameters monitored for the site include chloride, iron, manganese, nitrate, phenols, sodium, and sulfate (Table 2-15). Although not required by 40 CFR 265 Subpart F, site-specific constituents (alkalinity, fluoride, nitrate, nitrite, calcium, and potassium) were also analyzed. Samples for analyses of alkalinity, calcium, magnesium, and potassium are collected to support cation-anion balance calculations for the calcium-bicarbonate-type groundwater. In 2018, nitrate continued to be above the DWS in all of the network wells associated with a regional nitrate plume.

Nitrate is a constituent of interest at the 216-A-36B Crib because it is a breakdown product of nitric acid, which was disposed to the 216-A-10 Crib, 120 m (390 ft) to the west.

Iron concentrations were above the secondary DWS in unfiltered, bailed samples from well 299-E17-1 (Table 2-15). Other metals such as manganese and nickel were also elevated, and the samples had high turbidity. Well maintenance is expected to be performed in 2019.

Sampling for volatile organic compounds is required every 3 years and was not scheduled in 2018. Table 2-16 of DOE/RL-2017-65, *Hanford Site RCRA Groundwater Monitoring Report for 2017*, summarizes the detections for 2017.



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

Figure 2-4. 216-A-36B Crib

Table 2-12. 216-A-36B Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E17-1	UG	1955 (P)	127.2	417.4	118.1	387.4	121.5	398.8	7/12/2018	3.5	11.3	S	Sampled with bailer
299-E17-14	DG	1988 (C)	126.0	413.2	119.2	391.2	121.68	399.20	1/22/2018	2.4	8.0	S	None
299-E17-15	DG	1988 (C)	125.5	411.8	119.6	392.3	121.38	398.22	7/12/2018	1.8	5.9	S	None
299-E17-16	DG	1988 (C)	125.4	411.4	119.3	391.4	121.56	398.83	7/13/2018	2.3	7.4	S	None
299-E17-18*	DG	1988 (C)	125.8	412.6	118.8	389.8	121.64	399.08	7/13/2018	2.8	9.3	S	None
299-E17-19	UG	1988 (C)	126.8	416.0	119.9	393.4	121.46	398.48	7/13/2018	1.5	5.1	S	None

Note: Requirements from Table 3-1 of DOE/RL-2010-93, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*.

*Hydraulic head data for this well corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

S = semiannually

UG = upgradient

Table 2-13. Groundwater Velocity at the 216-A-36B Crib

Flow Direction	125 degrees (east-southeast)
Flow Rate (m/d)	0.0006
Hydraulic Conductivity (m/d) (Source)	3.26 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.1 (CP-57037)
Gradient (m/m)	1.9×10^{-5}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-14. 216-A-36B Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		6.47	9.11	933		1,940			27.6				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
299-E17-1	1/22/2018	8.16	0.02	582	9	<332	3	390	<4.1	1.0	12.3	GEL	
	7/12/2018	8.00	0.05	567	21	418	7	430	<8.0	0.4	11.5	TADN	
299-E17-14	1/22/2018	7.91	0.00	733	14	<500	0	1,670	<2.8	1.0	16.7	TASL	
	7/12/2018	7.80	0.00	720	3	393	13	430	<7.7	0.0	11.5	TADN	
299-E17-15	1/22/2018	8.07	0.00	627	0	<500	0	1,670	3.3	0.5	16.7	TASL	
	7/12/2018	7.99	0.00	635	6	<330	0	—[b]	<3.9	0.9	9.7	GEL	
299-E17-16	1/22/2018	7.94	0.01	603	8	<350	29	390	<4.1	1.3	12.3	GEL	
	7/13/2018	7.96	0.00	620	0	<330	0	—[b]	<3.3	0.0	9.7	GEL	
299-E17-18	1/22/2018	8.06	0.00	571	1	<500	0	1,670	<3.9	1.3	16.7	TASL	
	7/13/2018	8.02	0.00	617	1	301	14	430	<7.7	0.0	11.5	TADN	
299-E17-19	1/22/2018	7.87	0.00	737	6	<330	0	390	<3.8	0.8	12.3	GEL	
	7/13/2018	7.88	0.00	760	6	<330	0	—[b]	<3.3	0.0	9.7	GEL	

a. Critical mean values from Table 15 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

< = one or more of the replicate values was below the detection limit
Avg = average
GEL = GEL Laboratories
LOQ = limit of quantitation
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-15. 216-A-36B Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	110	138	—	
Calcium (unfiltered)	µg/L	57,000	74,400	—	
Calcium (filtered)	µg/L	57,700	78,300	—	
Chloride	mg/L	15	17	250[b]	
Dissolved oxygen	mg/L	6.6	10.0	—	
Fluoride	mg/L	0.29	0.39	4[c]	
Iron (unfiltered)	µg/L	30	2,290	300[b]	299-E17-1
Iron (filtered)	µg/L	<23	63.3	300[b]	
Magnesium (unfiltered)	µg/L	18,500	23,700	—	
Magnesium (filtered)	µg/L	18,300	24,400	—	
Manganese (unfiltered)	µg/L	1.1	45.4	50[b]	
Manganese (filtered)	µg/L	1.01	6.4	50[b]	
Nitrate	mg/L	70.8	146	45[d]	All
Nitrite	mg/L	<0.125	0.394	3.3[d]	
Phenol	µg/L	<1.9	2.91	2,400[e]	
Potassium (unfiltered)	µg/L	7440	8,080	—	
Potassium (filtered)	µg/L	7,290	8,400	—	
Sodium (unfiltered)	µg/L	24,300	31,700	—	
Sodium (filtered)	µg/L	24,800	29,900	—	
Sulfate	mg/L	75	110	250[b]	
Temperature	°C	15.1	22.8	—	
Turbidity	NTU	0.34	41.8	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

e. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

2.5 216-A-37-1 Crib

The 216-A-37-1 Crib was located east of the 200 East Area (Figures 1-1 and 2-5). The crib was approximately 5.2 m (17.1 ft) deep, 213 m (699 ft) long, and 33 m (108 ft) wide at the base, with sides sloped at 1:1. The crib operated from March 1977 through April 1989 and was used to percolate 242A evaporator process condensate to the soil column. It received spent halogenated and nonhalogenated solvents, as well as ammonia. During its operational life, this crib received 380 million L (98 million gal) of process condensate. In 1994, the bottom of the diversion box was filled with grout to prevent inadvertent discharges to the crib. In July 2000, vent risers from the crib were sealed to prevent potential passive radioactive emissions.

The 216-A-37-1 Crib is monitored under an indicator evaluation program under DOE/RL-2010-92, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib.* The monitoring network includes two upgradient wells and four downgradient wells (Table 2-16). The average rate of water-level decline between 2013 and 2018 was 2.8 cm/yr (1.4 in./yr). Based on this information, the monitoring wells have adequate water in the screened interval for continued sampling.

Near the 216-A-37-1 Crib, the estimated groundwater flow in 2018 was toward the southeast. Flow directions are influenced by a northwest-southeast-trending paleochannel with high-permeability Hanford formation sediments near the crib, the Ringold lower mud unit at the water table east of the 200 East Area, and the higher water table elevations to the west and north. The 216-A-37-1 Crib monitoring network water-level measurements are collected semiannually, and regional low-gradient water levels are collected monthly. In 2018, calculations using the regional water-level network produced a gradient magnitude of 1.8×10^{-5} m/m, and the estimated groundwater flow rate was 1.5 m/d (5.0 ft/d) (Table 2-17).

The 216-A-37-1 Crib network wells are monitored for RCRA indicator parameters (TOC, TOX, pH, and specific conductance) (Table 2-18), temperature, turbidity, water quality parameters, and other constituents (Table 2-19). The 216-A-37-1 network wells were sampled semiannually as scheduled in 2018. Analytical results for RCRA indicator parameters did not exceed the 2018 critical mean values, so the site remains in interim status indicator evaluation monitoring. Well 299-E25-95 was added to the network in 2017 and was sampled quarterly between October 2017 and October 2018. The sampling schedule for well 299-E25-95 was switched to semiannual sampling beginning January 2019.

Table 2-19 summarizes the 2018 results for groundwater quality parameters (40 CFR 265.92(d)(1)) and additional constituents required by the monitoring plan (Tables 3-1 and 3-2 of DOE/RL-2010-92). Manganese, iron, nitrate, arsenic, and gross beta were reported above the primary or secondary DWS and are explained below:

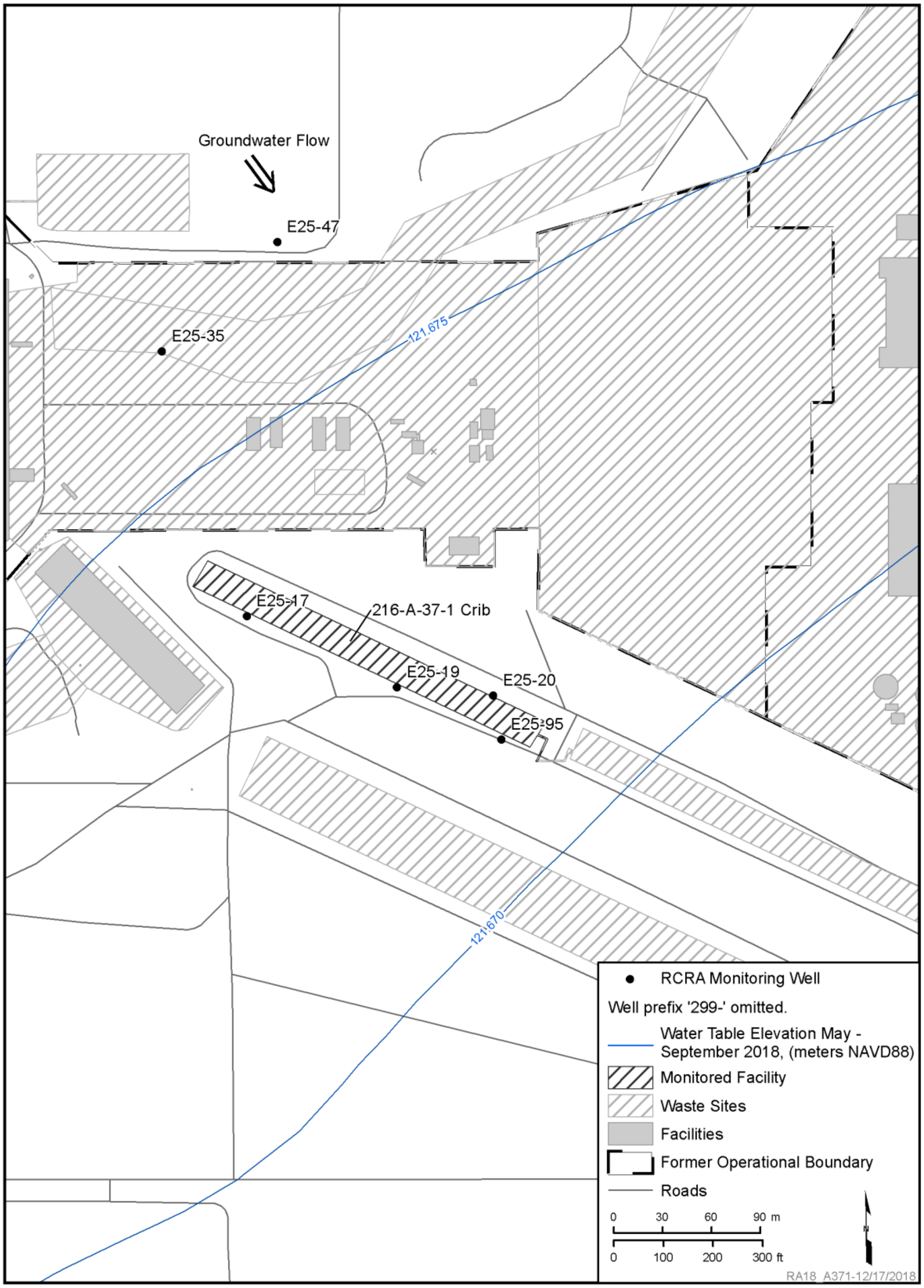
- Filtered and unfiltered manganese remained above the 50 µg/L secondary DWS at wells 299-E25-19 and 299-E25-20 in 2018 (Table 2-19). In addition, elevated levels of iron, turbidity, unfiltered chromium, and nickel suggest potential well casing corrosion in well 299-E25-19. A video log of well 299-E25-19 in November 2016 documented significant well incrustation with iron oxide and biological material. The well was cleaned, and the post-cleaning video revealed debris from a damaged well pump within the sump. The debris cannot be removed, so the well will be considered for decommissioning and replacement. Corrosion indicator metals nickel and chromium were not elevated in well 299-E25-20; therefore, this well has not been scheduled for camera surveying.

- Unfiltered iron at wells 299-E25-17 and 299-E25-20 was above the 300 µg/L secondary DWS. The January 2018 result from well 299-E25-20 was the first exceedance in the well, but well 299-E25-17 had unfiltered iron above the DWS several times in the past. Samples from these wells did not have elevated turbidity, nickel, or chromium and, therefore, were not scheduled for camera surveying.

- Nitrate concentrations were above the DWS equivalent in downgradient wells 299-E25-20 and 299-E25-95. Nitrate has exceeded the DWS in samples from well 299-E25-95 since its initial sampling in October 2017. Nitrate concentrations at well 299-E25-20 have been above the DWS since March 2011. The 216-A-37-1 Crib was determined to be a source of nitrate groundwater contamination (Section 2.5 of DOE/RL-2010-92).

- Filtered and unfiltered arsenic concentrations were above the 10 µg/L DWS in upgradient well 299-E25-35 in April and July 2018, but concentrations were below the standard in January and October 2018. Arsenic was not used in production or separations processes; thus, the arsenic appears to be associated with natural sediments. The maximum concentrations were less than the 11.8 µg/L background concentration in Hanford Site groundwater (95^{th} percentile) (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*).

- Gross beta at 189 pCi/L was reported in new downgradient well 299-E25-95 in July 2018. Concentrations have been above the comparison value of 50 pCi/L in each of the five sampling events since the well was installed in October 2017. Gross beta is part of the 40 CFR 265, Appendix III, “EPA Interim Primary Drinking Water Standards,” parameters that are required for one year of sampling in the new well, which was completed in October 2018. Gross beta is not scheduled for further sampling under RCRA.



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

Figure 2-5. 216-A-37-1 Crib

Table 2-16. 216-A-37-1 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E25-17	DG	1976 (P)	123.5	405.1	116.8	383.1	121.67	399.19	7/17/2018	4.9	16.1	S	None
299-E25-19*	DG	1976 (P)	124.5	408.6	116.9	383.6	121.70	399.27	7/13/2018	4.8	15.7	S	None
299-E25-20	DG	1976 (P)	124.5	408.6	116.9	383.6	121.59	398.91	7/13/2018	4.7	15.3	S	None
299-E25-35*	UG	1988 (C)	126.2	414.0	119.9	393.5	121.68	399.20	7/17/2018	1.7	5.7	Q/S	None
299-E25-47	UG	1992 (C)	125.2	410.7	119.0	390.5	121.68	399.22	7/17/2018	2.6	8.7	S	None
299-E25-95	DG	2017 (C)	122.3	401.2	113.1	371.2	121.67	399.19	7/13/2018	8.5	28.0	Q/S	None

Note: Requirements from DOE/RL-2010-92, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*.

*Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q/S = quarterly for first year; semiannually thereafter (wells 299-E25-35 and 299-E25-95 completed the quarterly sampling requirement in July 2018)

S = semiannually

UG = upgradient

Table 2-17. Groundwater Velocity at the 216-A-37-1 Crib

Flow Direction	135 degrees (southeast)
Flow Rate (m/d)	1.5
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	1.80×10^{-5}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-18. 216-A-37-1 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean*		**7.38**	**9.25**	**749**		**803**			**NC; use LOQ**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
299-E25-17	1/15/2018	7.98	0.00	570	1	<500	0	1,670	6.8	1.4	16.7	TASL	
	7/17/2018	7.69	0.02	567	0	323	7	430	<4.3	1.1	9.7	TADN/GEL	
299-E25-19	1/15/2018	8.14	0.00	429	1	<500	0	1,670	4.4	0.7	16.7	TASL	
	7/13/2018	7.80	0.01	430	1	449	8	430	<7.7	0.0	11.5	TADN	
299-E25-20	1/17/2018	7.66	0.00	456	1	<500	0	1,670	<3.1	1.6	16.7	TASL	
	7/13/2018	7.49	0.01	467	1	326	8	430	<7.7	0.0	11.5	TADN	
299-E25-35	1/16/2018	8.12	0.00	536	3	<330	0	450	<3.3	0.0	12.3	GEL	
	4/19/2018	8.20	0.00	525	1	390	43	430	<7.7	0.0	18.9	TADN	
	7/17/2018	8.23	0.00	545	1	274	12	430	<3.3	0.0	9.7	TADN/GEL	
299-E25-47	1/16/2018	8.31	0.01	427	1	345	5	450	7.8	0.7	12.3	GEL	
	7/17/2018	8.25	0.01	432	2	330	16	430	<3.3	0.0	9.7	TADN/GEL	
299-E25-95	1/15/2018	8.05	0.00	513	0	<500	0	1,670	<4.6	1.7	16.7	TASL	
	4/19/2018	7.97	0.00	491	1	689	69	430	<7.7	0.0	18.9	TADN	
	7/13/2018	7.74	0.00	510	1	554	19	430	<3.3	0.0	9.7	TADN/GEL	

*Critical mean values are from Table 16 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

< = one or more of the replicate values was below the detection limit
Avg = average
GEL = GEL Laboratories
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-19. 216-A-37-1 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	80.4	98	—	
Arsenic (unfiltered)	µg/L	4.6	10.7	10[b]	299-E25-35
Arsenic (filtered)	µg/L	4.3	10.9	10[b]	299-E25-35
Cadmium (unfiltered)	µg/L	<0.2	<0.3	5[b]	
Cadmium (filtered)	µg/L	<0.2	<0.3	5[b]	
Calcium (unfiltered)	µg/L	35,000	51,200	—	
Calcium (filtered)	µg/L	35,100	54,200	—	
Chloride	mg/L	7.7	18	250[c]	
Chromium (unfiltered)	µg/L	0.89	40.3	100[b]	
Chromium (filtered)	µg/L	0.87	9.4	100[b]	
Cr(VI) (unfiltered)	µg/L	<1.5	1.6	48[d]	
Cr(VI) (filtered)	µg/L	<1.5	1.6	48[d]	
Fluoride	mg/L	0.22	0.41	4.0[b]	
Iron (unfiltered)	µg/L	<22	1,360	300[c]	299-E25-17, 299-E25-19, 299-E25-20
Iron (filtered)	µg/L	<22	174	300[c]	
Magnesium (unfiltered)	µg/L	10,200	15,700	—	
Magnesium (filtered)	µg/L	10,400	16,900	—	
Manganese (unfiltered)	µg/L	<0.36	104	50[c]	299-E25-19, 299-E25-20
Manganese (filtered)	µg/L	<0.31	95.5	50[c]	299-E25-19, 299-E25-20
Nickel (unfiltered)	µg/L	<0.3	24.9	—	
Nickel (filtered)	µg/L	<0.3	14.2	—	
Nitrate	mg/L	5.75	75.3	45[e]	299-E25-20, 299-E25-95
Nitrite	mg/L	<0.125	0.328	3.3[e]	
Phenol	µg/L	<1.90	<2.86	2,400[d]	
Potassium (unfiltered)	µg/L	6,230	7850	—	
Potassium (filtered)	µg/L	6,130	8,410	—	
Sodium (unfiltered)	µg/L	16,200	27,800	—	
Sodium (filtered)	µg/L	16,300	28,100	—	
Sulfate	mg/L	54	140	250[c]	
Temperature	°C	16.3	23.7	—	
Turbidity	NTU	0.12	35.4	—	

Table 2-19. 216-A-37-1 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Additional Constituents Monitored First Year in Wells 299-E25-35 and 299-E25-95					
2,4,5-TP Silvex	µg/L	<0.078	<0.180	50[b]	
2,4-D	µg/L	<0.078	<4.00	70[b]	
Barium (unfiltered)	µg/L	34.7	51.8	2,000[b]	
Barium (filtered)	µg/L	34.1	51.8	2,000[b]	
Chromium (unfiltered)	µg/L	<0.9	40.3	100[b]	
Chromium (filtered)	µg/L	<0.9	9.4	100[b]	
Coliform bacteria	MPN	<1	<1	TC+	
Endrin	µg/L	<0.008	<0.017	2[b]	
Gamma-BHC (Lindane)	µg/L	<0.007	<0.010	0.2[b]	
Gross alpha	pCi/L	<0.95	2.95	15[f]	
Gross beta	pCi/L	18.5	189	50[f]	299-E25-95
Lead (unfiltered)	µg/L	<0.18	<1.00	15[g]	
Lead (filtered)	µg/L	<0.18	<1.00	15[g]	
Mercury (unfiltered)	µg/L	<0.027	<0.067	2[b]	
Mercury (filtered)	µg/L	<0.027	<0.067	2[b]	
Methoxychlor	µg/L	<0.012	<0.013	40[b]	
Radium-226	pCi/L	<-0.20	<0.28	5[h]	
Radium-228	pCi/L	<0.13	0.97		
Selenium (unfiltered)	µg/L	<1.80	3.20	50[b]	
Selenium (filtered)	µg/L	<1.90	4.40	50[b]	
Silver (unfiltered)	µg/L	<0.03	<0.90	100[c]	
Silver (filtered)	µg/L	<0.03	<0.90	100[c]	
Toxaphene	µg/L	<0.25	<0.35	3[b]	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

c. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

d. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

e. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

f. Concentration assumed to yield a dose equivalent of 4 mrem/yr (40 CFR 141.16, "Maximum Contaminant Levels for Beta Particle and Photon Radioactivity from Man-Made Radionuclides in Community Water Systems").

Table 2-19. 216-A-37-1 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value

g. Action level (40 CFR 141, Subpart I, "Control of Lead and Copper").

h. Combined radium-226 and radium-228 not to exceed 5 pCi/L (40 CFR 141.15, "Maximum Contaminant Levels for Radium-226, Radium-228, and Gross Alpha Particle Radioactivity in Community Water Systems").

< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

MPN = most probable number

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

TC+ = positive for total coliform (EPA 815-B-13-001, *Revised Total Coliform Rule: A Quick Reference Guide*)

2.6 216-B-3 Main Pond

The inactive 216-B-3 main pond and an adjoining portion of the 216-B-3-3 Ditch (collectively known as B Pond) were located east of the 200 East Area fence line (Figures 1-1 and 2-6). The main pond was in a natural topographic depression, diked on the eastern margin, and covered 14.2 ha (35 ac). During its operation, which began in 1945, B Pond received effluent from several 200 East Area facilities, including the PUREX Plant, B Plant, 241-A Tank Farm, 242-A evaporator, 244-AR vault, and 284-E power plant. Dangerous waste was received from the 216-A-29 Ditch, conveyed to the eastern portion of the 216-B-3-3 Ditch, and then flowed eastward into the main pond. The last known reportable discharge of chemical waste (sodium nitrite) occurred in 1987. In 1994, all discharges ceased, B Pond was backfilled with coarse-grained material and then covered with fine-grained material. The total estimated discharge to B Pond since 1945 exceeded 1 trillion L (260 billion gal) (PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*).

DOE/RL-2008-59, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, provides a detailed description of the geology and hydrogeology at B Pond. In summary, because of the dipping beds of the Ringold Formation in this area and the erosional contact with the overlying Hanford formation, groundwater beneath B Pond can occur in both confined and unconfined states, depending on the location. The uppermost aquifer is unconfined west, southwest, and northwest of the main pond where the Ringold Formation confining units 8 and 9B are absent. The aquifer is progressively more confined to the east and southeast of the main pond. Confinement of the Ringold unit 9 aquifers to the east is supported by the fact that hydrologic response to Treated Effluent Disposal Facility discharges has not been observed in the Treated Effluent Disposal Facility wells completed in Ringold unit 9A since the facility began operating in 1995 (DOE/RL-2008-59). Figure 2-6 presents the approximate boundary of the Ringold Formation mud above the water table near B Pond.

The B Pond groundwater monitoring network currently includes two upgradient wells and two downgradient wells (Table 2-20). Upgradient well 699-44-43C was installed in summer of 2017 and was sampled quarterly for the first year for required interim status parameters and for 40 CFR 265, Appendix III parameters. The last quarterly sampling event occurred in October 2018, marking the end of Appendix III parameter sampling at the well. An additional downgradient well is planned in 2019.

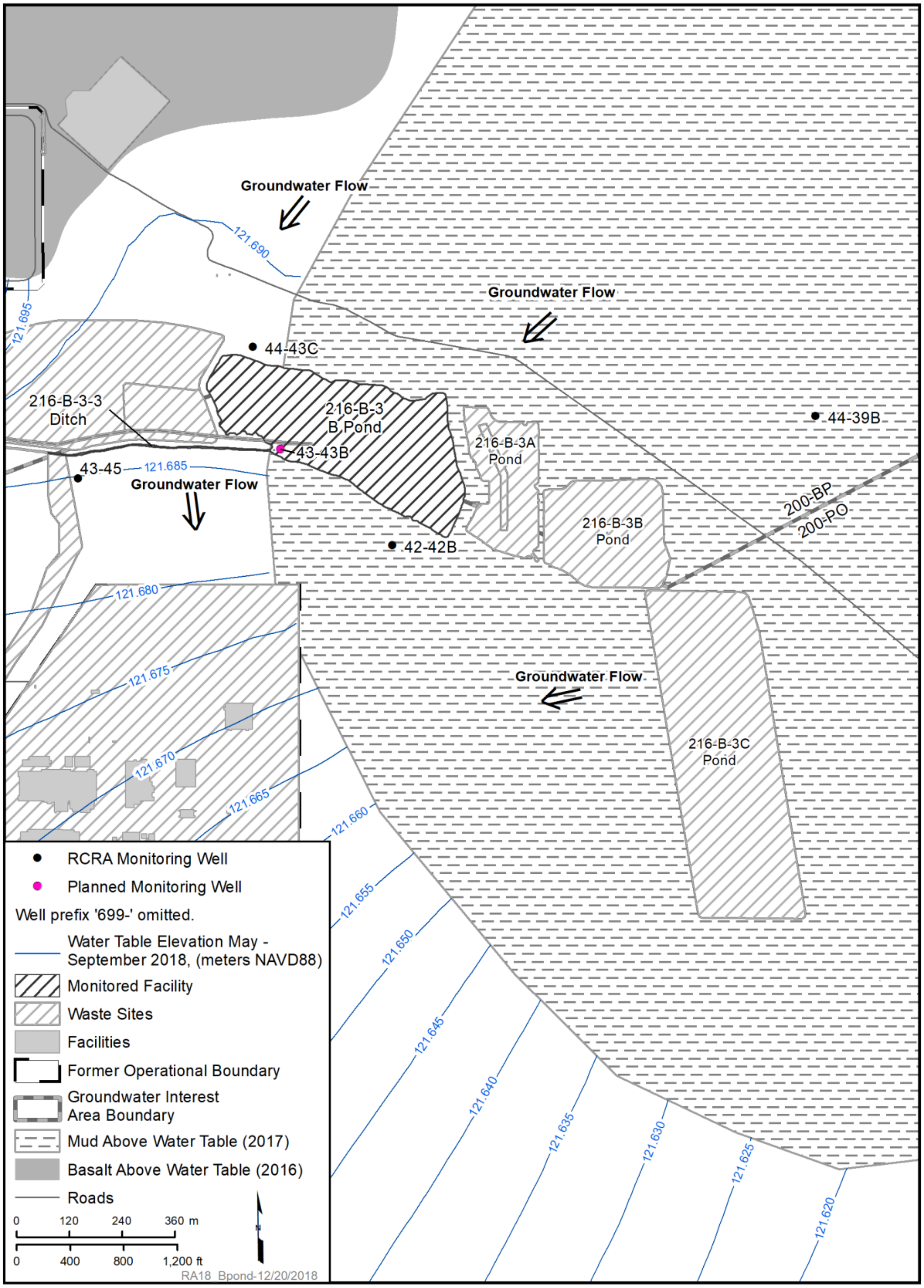
Groundwater flow directions beneath B Pond range from southwestward within the semi-confined Ringold Formation and southward within the unconfined Hanford formation (Table 2-21). Flow rate estimates range from 0.066 m/d (0.22 ft/d) in the Ringold Formation to 1.2 m/d (4.0 ft/d) in the Hanford formation.

The network wells are screened across the top 1.3 to 6.4 m (4.2 to 21 ft) of the aquifer. The average rate of water-level decline over the last 5 years for network wells ranged from 2 cm/yr (0.8 in./yr) for well 699-43-45 to 6 cm/yr (2 in./yr) for well 699-44-39B. The rate of decline varies across the network because of differences in hydrogeology. The network wells have adequate water in the screened interval for representative sampling over the next decade.

In accordance with WAC 173-303-400 and 40 CFR 265.92, the B Pond network wells are monitored semiannually for RCRA indicator parameters (TOC, TOX, pH, and specific conductance) (Table 2-22). Indicator parameter results for the network during 2018 were below their critical mean values.

Table 2-23 summarizes the 2018 results for groundwater quality constituents (40 CFR 265.92(d)(1)) and additional constituents required by Tables 3-1 and 3-2 of the monitoring plan (DOE/RL-2008-59). Iron, manganese, and coliform bacteria were reported above the comparison values and are explained below:

- The unfiltered iron concentration in well 699-44-43C was above the secondary DWS in the July sampling event. Manganese concentrations were above the secondary DWS in both filtered and unfiltered samples in January. Since chromium and nickel concentrations were not elevated, well 699-44-43C was not scheduled for camera surveying.
- Coliform bacteria levels were above the comparison value in well 699-44-43C in January, April, and October 2018. Coliform bacteria is a 40 CFR 265, Appendix III parameter. One year of quarterly Appendix III sampling was required for well 699-44-43C because it was a new well added in 2017. The last quarterly event was in October 2018. Well 699-44-43C is scheduled for semiannual sampling in 2019.



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

Figure 2-6. 216-B-3 Main Pond and 216-B-3-3 Ditch (B Pond)

Table 2-20. B Pond Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
699-42-42B	DG	1988 (C)	121.8	399.6	115.7	379.6	122.12	400.67	7/12/2018	6.4	21.1	S	None
699-43-45	DG	1989 (C)	126.5	414.9	120.3	394.6	121.69	399.24	7/12/2018	1.4	4.6	S	None
699-44-39B	UG	1992 (C)	126.2	414.1	120.1	394.1	123.30	404.54	7/12/2018	3.2	10.4	S	None
699-44-43C	UG	2017 (C)	124.1	407.0	116.4	382.0	122.68	402.50	7/12/2018	6.2	20.5	Q/S	New well
699-43-43B	DG	Planned for 2019	—	—	—	—	—	—	—	—	—	Q/S	Not yet installed

Note: Requirements from Table 3-1 of DOE/RL-2008-59, Rev. 2, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*.

— = no information (well not yet installed)

C = constructed as a resource protection well in accordance with WAC173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

Q/S = quarterly for first year; semiannually thereafter (quarterly sampling for well 699-44-43C was completed in 2018)

S = semiannually

UG = upgradient

Table 2-21. Groundwater Velocity at the B Pond

Flow Direction	Ringold semiconfined: 229 degrees (southwest); Hanford unconfined: 184 degrees (south)
Flow Rate (m/d)	Ringold semiconfined: 0.066; Hanford unconfined: 1.2
Hydraulic Conductivity (m/d) (Source)	Ringold Formation: 5.0 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*) Hanford formation: 17,000 (CP-57037)
Effective Porosity	Ringold Formation: 0.1 (CP-57037) Hanford formation: 0.2 (CP-57037)
Gradient (m/m)	Ringold semiconfined: 1.3×10^{-3}; Hanford unconfined: 1.4×10^{-5}
Comments	Ringold gradient based on three-point analysis of data collected in March 2018. Hanford formation gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-22. B Pond Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		**7.42**	**8.71**	**520**		**885**			**NC; use LOQ**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
699-42-42B	1/15/2018	7.9	0.0	315	0	<330	0	390	<3.3	0.0	12.3	GEL	
	7/12/2018	8.0	0.0	315	0	<330	0	—[b]	<3.3	0.0	9.7	GEL	
699-43-45	1/15/2018	8.3	0.0	292	0	<330	0	390	<3.3	0.0	12.3	GEL	
	7/12/2018	8.3	0.0	299	2	<330	0	—[b]	<4.0	1.1	9.7	GEL	
699-44-39B	1/17/2018	8.2	0.0	273	0	<330	0	390	<3.3	0.0	12.3	GEL	
	7/12/2018	8.2	0.0	273	3	<330	0	—[b]	<3.3	0.0	9.7	GEL	
699-44-43C	1/15/2018	8.0	0.0	287	1	<337	7	390	<3.3	0.0	12.3	GEL	
	4/12/2018	8.0	0.0	274	0	628	12	430	<7.8	0.2	18.9	TADN	
	7/12/2018	8.1	0.0	281	0	671	201	—[b]	<3.3	0.0	9.7	GEL	
	10/2/2018	8.0	0.0	275	1	<330	0	—[b]	<4.1	1.4	7.3	GEL	

a. Critical mean values are from Table 17 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

< = one or more of the replicate values was below the detection limit

Avg = average

GEL = GEL Laboratories

LOQ = limit of quantitation

NC = not calculated

SD = standard deviation

TADN = TestAmerica – Denver

TOC = total organic carbon

TOX = total organic halides

Table 2-23. B Pond Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	94.1	111	—	
Arsenic (unfiltered)	µg/L	<4	8.5	10[b]	
Arsenic (filtered)	µg/L	<4	8.2	10[b]	
Cadmium (unfiltered)	µg/L	<0.2	<0.45	5[b]	
Cadmium (filtered)	µg/L	<0.2	<0.45	5[b]	
Calcium (unfiltered)	µg/L	21,800	31,500	—	
Calcium (filtered)	µg/L	22,800	31,300	—	
Chloride	mg/L	4.5	5.4	250[c]	
Dissolved oxygen	mg/L	7.69	13.3	—	
Fluoride	mg/L	0.45	0.52	4[b]	
Iron (unfiltered)	µg/L	43.7	308	300[c]	699-44-43C
Iron (filtered)	µg/L	<22.4	74.4	300[c]	
Magnesium (unfiltered)	µg/L	8,670	9,890	—	
Magnesium (filtered)	µg/L	7,770	10,300	—	
Manganese (unfiltered)	µg/L	0.89	63.00	50[c]	699-44-43C
Manganese (filtered)	µg/L	<0.85	59.80	50[c]	699-44-43C
Nitrate	mg/L	4.38	16.8	45[d]	
Phenol	µg/L	<1.90	<2.91	2,400[e]	
Potassium (unfiltered)	µg/L	3,960	5,340	—	
Potassium (filtered)	µg/L	4,040	4,810	—	
Sodium (unfiltered)	µg/L	9,930	20,900	—	
Sodium (filtered)	µg/L	10,200	21,000	—	
Sulfate	mg/L	20	30	250[c]	
Temperature	°C	15.3	19.1	—	
Turbidity	NTU	0.94	10	—	
Additional Constituents Monitored First Year in Well 699-44-43C					
2,4,5-TP Silvex	µg/L	<0.078	<0.083	50[b]	
2,4-D	µg/L	<0.078	<0.083	70[b]	
Barium (unfiltered)	µg/L	47.9	54.7	2,000[b]	
Barium (filtered)	µg/L	50.1	56.8	2,000[b]	
Chromium (unfiltered)	µg/L	<0.6	4.0	100[b]	
Chromium (filtered)	µg/L	<0.6	4.0	100[b]	
Coliform bacteria	MPN	<1	2,420	TC+	699-44-43C

Table 2-23. B Pond Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Endrin	µg/L	<0.009	<0.010	2[b]	
Gamma-BHC (Lindane)	µg/L	<0.006	<0.006	0.2[b]	
Gross alpha	pCi/L	<2.48	4.93	15[f]	
Gross beta	pCi/L	4.74	6.53	50[f]	
Lead (unfiltered)	µg/L	<0.18	<1.0	15[g]	
Lead (filtered)	µg/L	<0.18	<1.0	15[g]	
Mercury (unfiltered)	µg/L	<0.027	<0.060	2[b]	
Mercury (filtered)	µg/L	<0.027	<0.060	2[b]	
Methoxychlor	µg/L	<0.044	<0.049	40[b]	
Radium-226	pCi/L	<0.14	1.38	5[h]	
Radium-228	pCi/L	<0.36	<1.42		
Selenium (unfiltered)	µg/L	<0.70	2.0	50[b]	
Selenium (filtered)	µg/L	<0.70	2.0	50[b]	
Silver (unfiltered)	µg/L	<0.03	<0.90	100[c]	
Silver (filtered)	µg/L	<0.03	<0.90	100[c]	
Toxaphene	µg/L	<0.133	<0.146	3[b]	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Annual samples were collected in January 2018. Appendix A presents full the data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

c. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

d. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

e. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

f. Concentration assumed to yield a dose equivalent of 4 mrem/yr (40 CFR 141.16, "Maximum Contaminant Levels for Beta Particle and Photon Radioactivity from Man-Made Radionuclides in Community Water Systems").

g. Action level (40 CFR 141, Subpart I, "Control of Lead and Copper").

h. Combined radium-226 and radium-228 not to exceed 5 pCi/L (40 CFR 141.15, "Maximum Contaminant Levels for Radium-226, Radium-228, and Gross Alpha Particle Radioactivity in Community Water Systems").

< = one or more of the results was below the detection limit

— = no comparison value

MPN = most probable number

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

TC+ = positive for total coliform (EPA 815-B-13-001, *Revised Total Coliform Rule: A Quick Reference Guide*)

2.7 216-B-63 Trench

The 216-B-63 Trench is located in the north-central portion of the 200 East Area (Figures 1-1 and 2-7). Beginning in 1970, it was used as an emergency percolation trench for chemical sewer waste from B Plant (RHO-CD-798, *Current Status of the 200 Area Ponds*). Major contributors to this waste stream were the 2902-B high tank (contains potable sanitary water), cooling water from B Plant and the 225B Waste Encapsulation and Separation Facility, some 221B steam condensate, and demineralizer effluent. Minor contributions may have included the chemical makeup overflow system (sodium hydroxide and sodium nitrite), air conditioning units, and space heaters (radiators). The effluent compositions were kept below regulated values (WHC-EP-0342, Addendum 6, *B Plant Chemical Sewer Stream-Specific Report*).

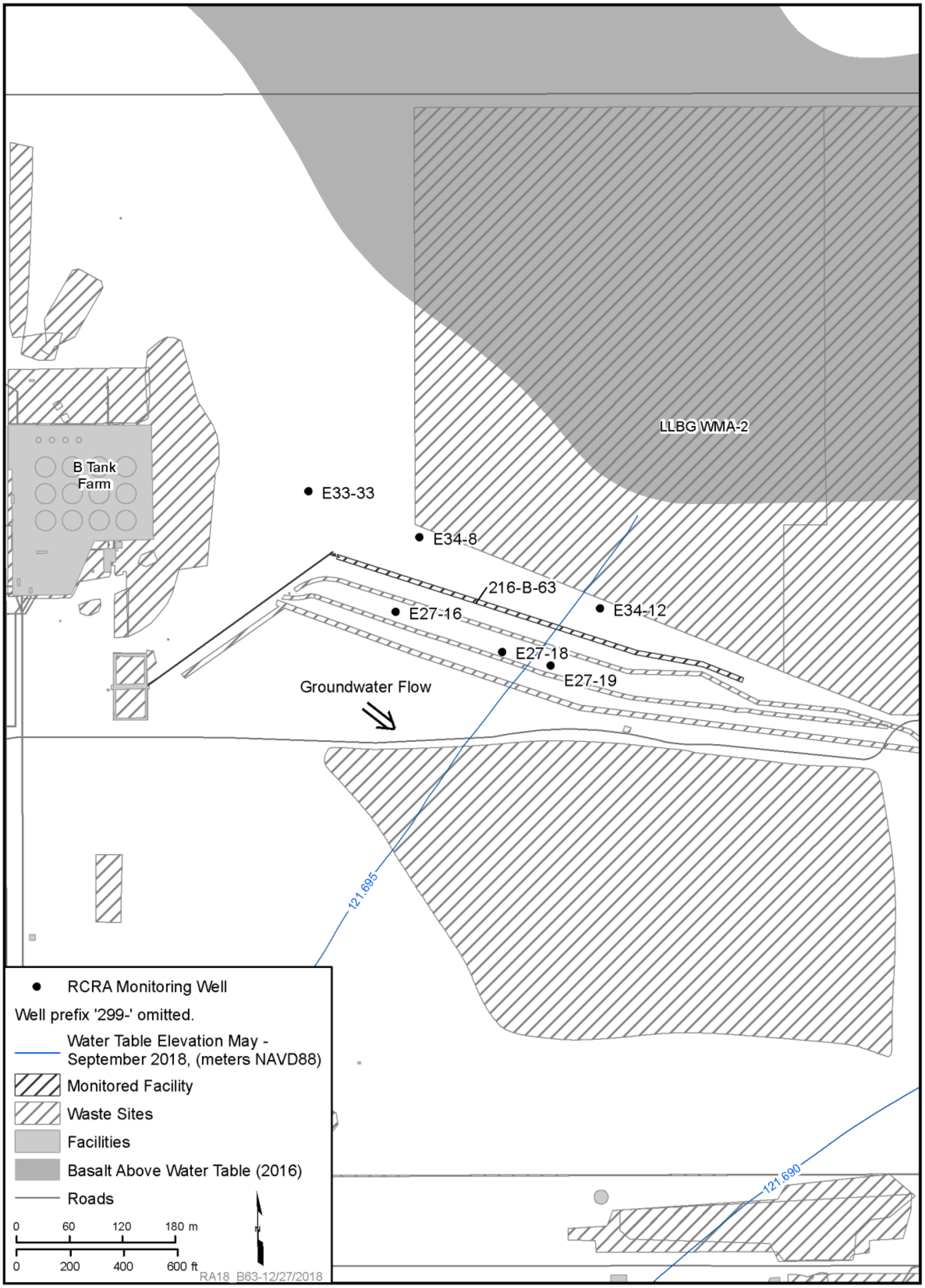
Before November 1985, acidic effluent from anion exchanger regeneration and the basic effluent from cation exchanger regeneration were discharged without neutralization (WHC-EP-0287, *Waste Stream Characterization Report*, p. A.9-2). In March and April 1987, incidental corrosive liquid waste releases were discharged to the 216-B-63 Trench. The corrosive waste discharges were regulated under RCW 70.105, "Hazardous Waste Management," and its implementing requirements in WAC 173-303. Discharges to the 216-B-63 Trench ceased in 1992.

DOE monitors groundwater at the 216-B-63 Trench under an interim status indicator evaluation program in accordance with 40 CFR 265, Subpart F, as defined in DOE/RL-2008-60, *Interim Status Groundwater Monitoring Plan for the 216-B-63 Trench*. Table 2-24 presents construction information and water levels for the 216-B-63 wells. The monitoring network consists of three upgradient and three downgradient wells screened in the upper portion of the aquifer at the water table. Most of the well screens extend to within 1.5 m (5 ft) of the underlying basalt surface. The water table elevation at the 216-B-63 Trench declined an average of 1.6 cm/yr (0.63 in./yr) between 2013 and 2018. Based on this information, the 216-B-63 Trench monitoring wells have adequate water in the screened interval for sampling over the next two decades or longer.

Groundwater gradient magnitude and flow direction were inferred using a low-gradient monitoring network across the 200 East Area (Figure 1-2). The groundwater gradient calculated for the 216-B-63 Trench area was 4.5×10^{-6} m/m, dipping to the southeast, and the estimated groundwater flow rate was 0.38 m/d (1.3 ft/d) (Table 2-25). Groundwater extraction west of the 216-B-63 Trench may cause local deviations from the estimated groundwater flow direction and rate.

In 2018, the 216-B-63 Trench monitoring wells were sampled semiannually for indicator parameters as scheduled (Table 2-26). Specific conductance, pH, TOC, and TOX did not exceed critical mean values, and the 216-B-63 Trench remains in indicator evaluation monitoring.

Table 2-27 summarizes the 2018 results for groundwater quality parameters (40 CFR 265.92(b)(2) and (d)(1)) and additional constituents required by the monitoring plan (DOE/RL-2008-60). Nitrate was the only parameter with a concentration above a water quality standard. Nitrate reflects contaminant migration from sources northwest of 216-B-63 (e.g., BY Cribs).



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

Figure 2-7. 216-B-63 Trench

Table 2-24. 216-B-63 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E27-16	DG	1990 (C)	126.2	414.1	119.8	393.1	121.62	399.03	11/5/2018	1.8	5.9	S	None
299-E27-18*	DG	1992 (C)	124.7	409.1	118.6	389.0	121.69	399.23	11/5/2018	3.1	10.3	S	None
299-E27-19	DG	1992 (C)	124.7	409.1	118.9	390.0	121.59	398.91	11/5/2018	2.7	8.9	S	None
299-E33-33	UG	1989 (C)	126.0	413.4	119.6	392.4	121.66	399.15	11/5/2018	2.0	6.7	S	None
299-E34-8	UG	1990 (C)	126.0	413.2	119.4	391.7	121.55	398.78	11/5/2018	2.1	7.0	S	None
299-E34-12	UG	1992 (C)	126.6	415.3	120.4	395.0	121.59	398.90	11/5/2018	1.2	3.9	S	None

Note: Requirements from Table 3-1 of DOE/RL-2008-60, *Interim Status Groundwater Monitoring Plan for the 216-B-63 Trench*.

*Hydraulic head data for this well were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

S = semiannually

UG = upgradient

Table 2-25. Groundwater Velocity at the 216-B-63 Trench

Flow Direction	130 degrees (southeast)
Flow Rate (m/d)	0.38
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	4.5×10^{-6}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-26. 216-B-63 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
2018 Critical Mean[a]		**7.71**	**8.55**	**982**		**722**			**NC; use LOQ**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
299-E27-16	4/9/2018	8.15	0.01	599	1	<330	0	—[b]	<3.3	0.0	12.3	GEL	
	11/5/2018	7.97	0.01	620	0	<332	3	—[b]	<3.4	0.1	9.7	GEL	
299-E27-18	4/9/2018	8.22	0.01	674	1	<330	0	—[b]	<3.3	0.0	12.3	GEL	
	11/5/2018	7.76	0.01	666	1	<330	0	—[b]	<3.3	0.0	9.7	GEL	
299-E27-19	4/9/2018	8.25	0.02	665	1	478	21	430	<7.7	0.0	18.9	TADN	
	11/5/2018	7.89	0.01	736	2	<330	0	—[b]	<3.3	0.0	9.7	GEL	
299-E33-33	4/9/2018	8.18	0.00	651	0	<330	0	—[b]	<3.3	0.0	12.3	GEL	
	11/5/2018	8.21	0.01	630	1	<330	0	—[b]	<4.4	1.5	9.7	GEL	
299-E34-12	4/9/2018	8.05	0.01	597	2	<330	0	—[b]	<3.3	0.0	12.3	GEL	
	11/5/2018	7.98	0.00	699	1	<330	0	—[b]	<3.4	0.1	9.7	GEL	
299-E34-8	4/9/2018	8.35	0.02	689	1	476	5	430	<7.7	0.0	18.9	TADN	
	11/5/2018	8.15	0.01	707	0	<330	0	—[b]	<3.3	0.0	9.7	GEL	

a. Critical mean values from Table 18 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

< = one or more of the replicate values was below the detection limit
Avg = average
GEL = GEL Laboratories
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TOC = total organic carbon
TOX = total organic halides

Table 2-27. 216-B-63 Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	96.4	110	—	
Calcium (unfiltered)	µg/L	63,300	76,400	—	
Calcium (filtered)	µg/L	63,200	75,200	—	
Chloride	mg/L	17.2	26	250[b]	
Dissolved oxygen	mg/L	7.72	9.59	—	
Fluoride	mg/L	0.26	0.34	4.0[c]	
Iron (unfiltered)	µg/L	35.5	120	300[b]	
Iron (filtered)	µg/L	<24.0	44.5	300[b]	
Magnesium (unfiltered)	µg/L	15,900	20,800	—	
Magnesium (filtered)	µg/L	15,800	20,400	—	
Manganese (unfiltered)	µg/L	<0.71	4	50[b]	
Manganese (filtered)	µg/L	<0.49	4	50[b]	
Nitrate	mg/L	82.3	151	45[d]	All
Nitrite	mg/L	<0.108	0.273	3.3[d]	
Phenol	µg/L	<1.90	<2.86	2,400[e]	
Potassium (unfiltered)	µg/L	8,060	9,700	—	
Potassium (filtered)	µg/L	8,130	9,700	—	
Sodium (unfiltered)	µg/L	21,900	27,700	—	
Sodium (filtered)	µg/L	21,100	27,500	—	
Sulfate	mg/L	77	100	250[b]	
Temperature	°C	17.3	18.8	—	
Turbidity	NTU	0.39	4.02	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

e. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

2.8 216-S-10 Pond and Ditch

The 216-S-10 Pond and Ditch, located outside the southwestern corner of the 200 West Area, comprised an unlined ditch, 1.2 m (3.9 ft) wide at its base and 686 m (2,250 ft) long, connected to a pond covering 0.748 ha (1.82 ac). The pond was shaped like a backward "E" with an extra leg, where each leg was a separate leaching trench. The ditch was also connected to the 216-S-11 Pond between 1954 and 1965, which was an overflow pond to accommodate excess discharges. During its active life from 1951 to 1991, the site received 6.6 billion L (1.7 billion gal) of effluent from the Reduction-Oxidation (REDOX) Plant chemical sewer. Figure 2-8 shows the major site features and monitoring well locations.

The groundwater beneath 216-S-10 is monitored under interim status regulations to determine whether dangerous waste constituents have affected groundwater (DOE/RL-2008-61, *Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*). The monitoring well network consists of an upgradient well, four downgradient wells screened in the upper portion of the aquifer at the water table, and a downgradient well screened 50 m (164 ft) below the water table (Table 2-28).

Table 2-29 summarizes groundwater flow beneath the 216-S-10 Pond and Ditch. The hydraulic gradient was determined by trend surface analysis using water-level measurements collected during March 2018 from five wells. The calculated flow direction was east-southeast (105 degrees azimuth), the hydraulic gradient magnitude was 3.2×10^{-3} m/m, and the estimated velocity was 0.16 m/d (0.52 ft/d). Water levels in the network wells declined at an average rate of 24 cm/yr (9.5 in./yr) from 2012 to 2018. Based on the calculated groundwater flow direction, the monitoring well network remains capable of detecting constituents migrating from 216-S-10 into the uppermost aquifer. A revised monitoring network, including four new wells, was recommended by SGW-60585, *Engineering Evaluation Report for the 216-S-10 Pond and Ditch Groundwater Monitoring.* The Tri-Parties negotiate replacement wells annually in accordance with Tri-Party Agreement Milestone M-24-00.

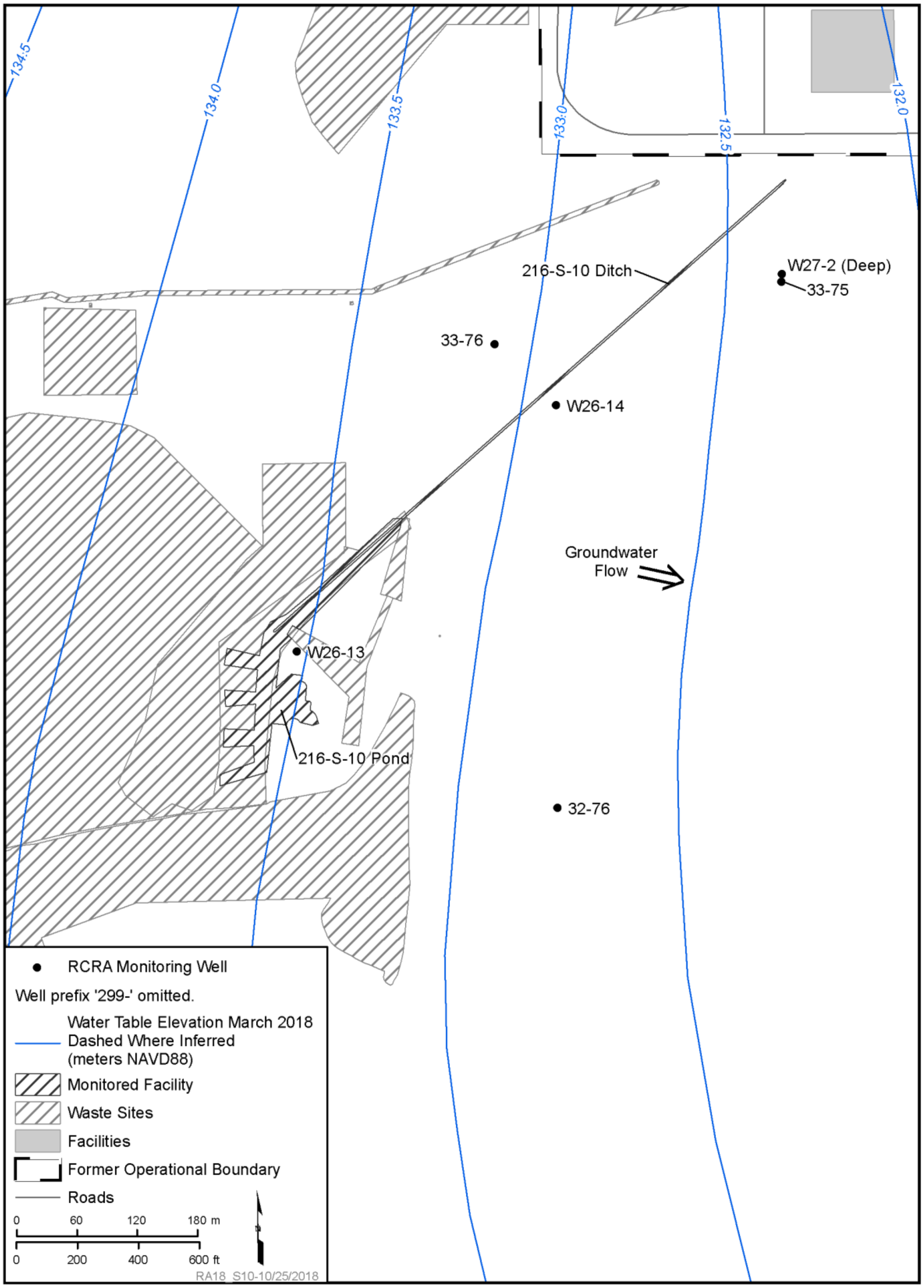
All of the network wells were sampled as planned in 2018. The wells completed at the water table were sampled twice for RCRA contamination indicator parameters (pH, specific conductance, TOC, and TOX) (Table 2-30) and once for groundwater quality parameters and site-specific analytes (Table 2-31).

No indicator parameter critical mean exceedances occurred in 2018. Between 2007 and 2012, specific conductance in well 299-W26-13 generally trended upward, with annual average values rising from 270 to 310 µS/cm. This increasing trend correlated to increasing chromium and nitrate concentrations. From 2012 through 2018, specific conductance has been relatively stable, consistent with a stable nitrate trend.

The network monitoring wells routinely show low to nondetected levels of TOX. The highest average concentration from quadruplicate samples was in downgradient well 299-W26-14 (8.6 µg/L in May 2018), which was below the critical mean (32.9 µg/L). The TOX detections are attributed to carbon tetrachloride in several 216-S-10 wells. Well 699-33-75 had the highest carbon tetrachloride concentration in the network (6.52 µg/L in 2018), which is above the 3.4 µg/L cleanup level for the 200-UP-1 OU (Table 14 in EPA et al., 2012, *Record of Decision for Interim Remedial Action Hanford 200 Area Superfund Site 200-UP-1 Operable Unit*). Carbon tetrachloride was also detected in upgradient well 699-33-76 (3.30 µg/L in 2018). This constituent does not originate from 216-S-10; carbon tetrachloride is widespread in the groundwater beneath and near the 200 West Area and originated from waste disposal sites at Plutonium Finishing Plant (PFP) (Chapter 12 of DOE/RL-2016-67, *Hanford Site Groundwater Monitoring Report for 2016*).

In 2018, total chromium concentrations in well 299-W26-13 remained above the 100 µg/L DWS and hexavalent chromium (Cr(VI)) above the 48 µg/L MTCA standard (WAC 173-340) (Table 2-31). The 216-S-10 Pond and Ditch system was the most substantial source of chromium in this area (Appendix C of RPP-26744*, Hanford Soil Inventory, Rev. 1*), but other sources of chromium also exist (e.g., 216-S-5 Crib, 216-S-6 Crib, 216-S-11, 216-S-16, and 216-S-17 Ponds, and associated ditches). In particular, the 216-S-11 overflow pond received waste similar to 216-S-10 but is not part of the RCRA unit.

Concentrations of chromium (unfiltered), iron (unfiltered), and nickel (filtered and unfiltered) continue to be elevated in deep well 299-W27-2. These constituents are stainless-steel corrosion products, and this well has stainless-steel components. A downhole video of the well screen in 2017 confirmed corrosion in this well. Chromium analysis completed in 2017 included filtered and unfiltered total chromium, as well as filtered and unfiltered Cr(VI). Total chromium analysis provides a summation of both trivalent chromium and mobile Cr(VI). Similar to the 2017 analysis results, the elevated chromium identified in well 299-W27-2 during 2018 comprised primarily undissolved trivalent chromium. Results for filtered total chromium and both filtered and unfiltered Cr(VI) were near or below the detection limits. The presence of undissolved trivalent chromium is consistent with corrosion in well 299-W17-2.



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

Figure 2-8. 216-S-10 Pond and Ditch

Table 2-28. 216-S-10 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W26-13	DG	1999 (C)	137.4	450.8	126.7	415.7	133.48	437.93	5/2/2018	6.8	22.2	S	November water level erroneous
299-W26-14	DG	2003 (C)	136.6	448.1	125.9	413.1	132.84	435.82	11/14/2018	6.9	22.7	S	None
299-W27-2	DG/deep	1992 (C)	82.7	271.4	79.5	260.9	132.20	433.73	5/2/2018	52.7	172.9	A	None
699-32-76	DG	2008 (C)	134.8	442.2	124.1	407.2	132.48	434.64	11/14/2018	8.4	27.4	S	None
699-33-75	DG	2008 (C)	135.0	442.8	124.3	407.8	132.27	433.96	11/14/2018	8.0	26.1	S	None
699-33-76	UG	2008 (C)	135.5	444.7	124.9	409.7	133.05	436.53	11/14/2018	8.2	26.9	S	None

Note: Requirements from Table 3-1 of DOE/RL-2008-61, *Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*.

A = annually

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

S = semiannually

UG = upgradient

Table 2-29. Groundwater Velocity at the 216-S-10 Pond and Ditch

Flow Direction	105 degrees (east-southeast)
Flow Rate (m/d)	0.16
Hydraulic Conductivity (m/d) (Source)	5 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	3.2×10^{-3}
Comments	Gradient and direction determined by trend surface analysis using March 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-30. 216-S-10 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		**4.45**	**10.7**	**368**		**NC; use LOQ**			**32.9**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
299-W26-13	5/2/2018	7.82	0.0	301	0	<330	0	—[b]	<3.3	0.0	12.3	GEL	
	11/14/2018	7.51	0.0	316	0	<330	0	—[b]	3.3	0.0	7.3	GEL	
299-W26-14	5/2/2018	7.78	0.0	275	0	381	19	430	<8.6	0.9	18.9	TADN	
	11/1/2017	7.42	0.0	283	1	<330	0	—[b]	<3.7	0.4	7.3	GEL	
299-W27-2	5/2/2018	7.71	—	355	—	314	—	430	9.1	—	18.9	TADN	Quads and statistical comparisons not required
699-32-76	5/1/2018	7.63	0.0	312	1	318	5	430	<7.7	0.0	18.9	TADN	
	11/14/2018	7.36	0.0	318	0	<330	0	—[b]	<4.6	1.4	7.3	GEL	
699-33-75	5/1/2018	7.65	0.0	280	0	<330	0	—[b]	7.0	1.6	12.3	GEL	
	11/14/2018	7.26	0.0	284	0	<330	0	—[b]	<5.0	2.0	7.3	GEL	
699-33-76	5/1/2018	7.57	0.0	296	0	<330	0	—[b]	<3.8	0.9	12.3	GEL	
	11/14/2018	7.45	0.0	309	1	<330	0	—[b]	<3.6	0.3	7.3	GEL	

a. Critical mean values from Table 19 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

< = one or more of the replicate values was below the detection limit

— = no data or not applicable

Avg = average

GEL = GEL Laboratories

LOQ = limit of quantitation

NC = not calculated

SD = standard deviation

TADN = TestAmerica – Denver

TOC = total organic carbon

TOX = total organic halides

Table 2-31. 216-S-10 Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	101	130	—	
Calcium (unfiltered)	μg/L	23,000	32,700	—	
Calcium (filtered)	μg/L	23,000	31,900	—	
Carbon tetrachloride	μg/L	<0.3	6.52	5[b]	699-33-75
Chloride	mg/L	6	22	250[c]	
Chromium (unfiltered)	μg/L	<1.9	164	100[b]	299-W26-13
Chromium (filtered)	μg/L	<1.7	155	100[b]	299-W26-13
Cr(VI) (unfiltered)	μg/L	<1.5	150	48[d]	299-W26-13
Cr(VI) (filtered)	μg/L	<1.5	150	48[d]	299-W26-13
Iron (unfiltered)	μg/L	<22	288	300[c]	
Iron (filtered)	μg/L	<22	40	300[c]	
Magnesium (unfiltered)	μg/L	7,700	11,900	—	
Magnesium (filtered)	μg/L	7,700	11,600	—	
Manganese (unfiltered)	μg/L	<0.42	4.68	50[c]	
Manganese (filtered)	μg/L	<0.26	4	50[c]	
Nickel (unfiltered)	μg/L	<1.1	21.5	—	
Nickel (filtered)	μg/L	<1.1	17	—	
Nitrate	mg/L	5.31	31.9	45[e]	
Phenol	μg/L	<1.9	<2.8	2,400[d]	
Potassium (unfiltered)	μg/L	2,700	3,760	—	
Potassium (filtered)	μg/L	2,700	3,680	—	
Sodium (unfiltered)	μg/L	13,000	22,600	—	
Sodium (filtered)	μg/L	13,000	22,700	—	
Sulfate	mg/L	16	24	250[c]	
Temperature	°C	17.2	19.6	—	
Turbidity	NTU	0.45	4.85	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

c. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

d. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

e. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

Table 2-31. 216-S-10 Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value

< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

2.9 Integrated Disposal Facility

The IDF is an expandable, double-lined landfill in the 200 East Area with 0.07 km^2 (0.027 mi^2) of liner. It includes two distinct cells: an east cell for low-level radioactive waste, and a west cell for mixed waste. The IDF is not yet in use.

Construction of the first phase for IDF was completed in April 2006. DOE submitted a Part B RCRA Permit application to Ecology, which was incorporated into the Hanford RCRA Permit on April 9, 2006. The start date for IDF operations has not been determined, but it is monitored as part of a detection monitoring program under the Hanford RCRA Permit (WA7890008967, Part III, OUG-11, Chapter 5.0, "Groundwater Monitoring").

The monitoring network for the IDF consists of two upgradient wells, one cross-gradient well, and four downgradient wells (Figure 2-9; Table 2-32). Since the IDF is not operational, the current monitoring objective is to collect baseline groundwater information. The network wells were sampled as scheduled during 2018.

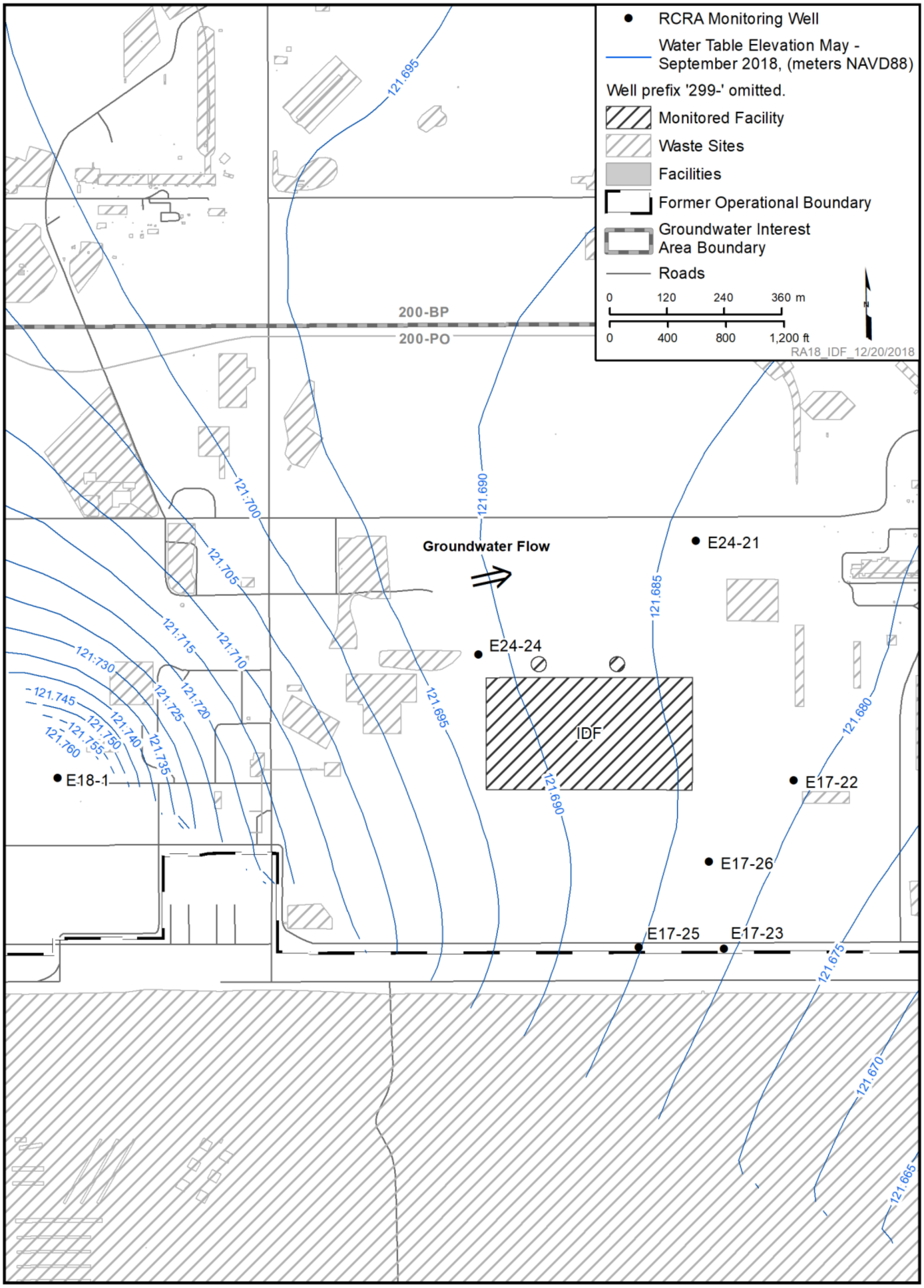
The groundwater flow direction in 2018 was slightly north of east, with an estimated gradient of 1.7×10^{-5} m/m and a flow rate of up to 2.8 m/d (9.3 ft/d) (Table 2-33). In recent years, the flow direction has varied from east-northeast (2008 to 2011) to southeast (2013 to 2014). Hydraulic conductivity is markedly different between the two unconfined aquifer units beneath the IDF. The water table is at an elevation of 121.7 m (399 ft) in Hanford formation flood channel deposits, which have an estimated hydraulic conductivity of 17,000 m/d (56,000 ft/d). The top of the Ringold Formation unit E, with an estimated hydraulic conductivity of 3.26 m/d (10.7 ft/d), is at an elevation of about 104.5 m (343 ft) where it is thickest in the eastern portion of the IDF site. Hanford formation saturated thickness ranges from 15 to 20 m (49 to 66 ft) from east to west. The maximum saturated thickness of the Ringold Formation unit E is about 2 m (7 ft) in the eastern portion of the IDF site. Because the Hanford formation comprises a majority of the total saturated thickness, its associated hydraulic conductivity is considered the primary driver for overall groundwater flow velocity.

The wells are monitored annually for indicator parameters chromium (filtered), pH, specific conductance, TOC, and TOX (Table 2-34). In addition, monitoring includes the supplemental constituents alkalinity, anions, metals, and turbidity (Table 2-35). Upgradient/downgradient comparisons of indicator parameters are not required because the IDF is not in use.

Unfiltered chromium, nickel, and iron were detected in well 299-E18-1, and concentrations were higher in 2018 than in 2017. Sulfate and sodium also increased sharply in 2018, with sulfate above the secondary DWS. All of these results were flagged with "P" review qualifiers, indicating that these sample values are questionable because of sampling circumstances. Well 299-E18-1 was sampled with a bailer, which introduced excess suspended solids from the formation and from within the well (i.e., particulate matter in the sump) that could have affected analytical results. A video survey of the well was performed in

February 2017, and the well was then brushed and relogged in February 2018. No signs of obvious casing corrosion were noted in the video surveys. However, metal debris was seen in the bottom of the well in the initial camera survey, and debris was seen floating on top of the water in the video taken after cleaning. Since the well was cleaned after the 2018 sampling event, it is not yet known if the rehabilitation efforts affected sample quality. If indications of corrosion persist, the well will be evaluated for decommissioning and replacement. The Tri-Parties negotiate replacement wells annually in accordance with Tri-Party Agreement Milestone M-24-00.

Nitrate concentrations in 2018 were >45 mg/L in six IDF wells (Table 2-35). Wells monitoring the IDF are within the regional 200 East Area nitrate plume.



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

Figure 2-9. Integrated Disposal Facility

Table 2-32. IDF Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E17-22	DG	2002 (C)	122.6	402.1	111.9	367.0	121.68	399.21	2/20/2018	9.8	32.2	A	None
299-E17-23	DG	2002 (C)	122.3	401.4	111.9	367.3	121.69	399.26	1/22/2018	9.7	32.0	A	None
299-E17-25	DG	2002 (C)	122.4	401.7	111.8	366.7	121.70	399.29	1/22/2018	9.9	32.6	A	None
299-E17-26[b]	DG	2005 (C)	121.4	398.2	110.7	363.2	121.72	399.34	1/22/2018	11.0	36.1	A	None
299-E18-1[c]	UG	1988 (C)	125.5	411.6	118.4	388.6	121.75	399.45	1/25/2018	3.3	10.9	A	Sampled with a bailer; debris in well (see text)
299-E24-21	CG	2001 (C)	122.7	402.5	116.6	382.5	121.69	399.25	1/22/2018	5.1	16.7	A	None
299-E24-24[d]	UG	2005 (C)	122.5	402.0	111.9	367.0	121.69	399.23	1/22/2018	9.8	32.2	A	None
New downgradient Well #2	DG	Planned	—	—	—	—	—	—	—	—	—	—	Not yet installed

Note: Requirements from the Hanford RCRA Permit (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part III, Operating Unit Group 11 (OUG-11), Chapter 5.0, "Groundwater Monitoring").

a. The Integrated Disposal Facility is not yet in use. In accordance with the Hanford RCRA Permit, OUG-11, Unit-Specific Condition III.11.E.1.b, groundwater sampling under the permit will continue annually during the pre-active life.

b. Listed in Part III, OUG-11, Chapter 5.0 of the Hanford RCRA Permit as "New Downgradient Well #1."

c. Depth-to-water measuring point was re-established and surveyed in 2018.

d. Listed in Part III, OUG-11, Chapter 5.0 of the Hanford RCRA Permit as "New Upgradient Well."

— = no information (well not yet installed)

A = annually

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

CG = cross gradient (designated at upgradient in Part III, OUG-11, Chapter 5.0 of the Hanford RCRA Permit)

DG = downgradient

OUG = operating unit group

RCRA = *Resource Conservation and Recovery Act of 1976*

UG = upgradient

Table 2-33. Groundwater Velocity at the IDF

Flow Direction	79 degrees (east)
Flow Rate (m/d)	0.00027 (Ringold unit E) to 2.84 (Hanford formation)
Hydraulic Conductivity (m/d) (Source)	3.26 (Ringold unit E) to 17,000 (Hanford formation) (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.1 (CP-57037)
Gradient (m/m)	1.7×10^{-5}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-34. IDF Contamination Indicator Parameters, 2018

Well Name	Sample Date	Chromium (Filtered) (µg/L)	pH (standard units)	Specific Conductance (µS/cm)	TOC (µg/L)	TOX (µg/L)
299-E17-22	1/22/2018	3.9 B	7.92	568	500 U	5
299-E17-23	1/22/2018	10.3	7.88	502	330 U	3.33 U
299-E17-25	1/22/2018	7.2 BD	7.81	513	500 U	2.2 B
299-E17-26	1/22/2018	6.1 B	7.88	517	330 U	3.54 B
299-E18-1	1/25/2018	385 AP	8.62 P	952 P	620 BP	11.2 P
299-E24-21	1/22/2018	3 U	8	562	820 B	3.33 U
299-E24-24	1/22/2018	3 U	7.85	521	500 U	5.1

A = discrepancy in chain of custody or other paperwork

B = greater than detection limit but less than quantitation limit

D = analyte reported at a secondary dilution factor

P = potential problem; many of the analytical data from this sample were out of trend; the anomalies may relate to the fact that the sample was bailed and the well was not purged

TOC = total organic carbon

TOX = total organic halides

U = undetected

Table 2-35. IDF Sampling Summary for Supplemental Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	64	144	—	
Calcium (unfiltered)	µg/L	25,800	58,300	—	
Calcium (filtered)	µg/L	26,800	60,200	—	
Chloride	mg/L	12	18	250[b]	
Magnesium (unfiltered)	µg/L	15,900	19,500	—	
Magnesium (filtered)	µg/L	16,200	20,200	—	
Nitrate	mg/L	31	75.3	45[c]	299-E17-22, 299-17-23, 299-E17-25, 299-E17-26, 299-E24-21, 299-E24-24
Potassium (unfiltered)	µg/L	6,140	14,600	—	
Potassium (filtered)	µg/L	6,130	15,500	—	
Sodium (unfiltered)	µg/L	20,100	117,000	—	
Sodium (filtered)	µg/L	20,300	124,000	—	
Sulfate	mg/L	43	270 P	250[b]	299-E18-1 (see table note regarding "P"-flagged data)
Turbidity	NTU	0.13	138 P	—	

Notes:

Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

Table 5.2 of the groundwater monitoring plan (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, as amended, Part III, Operating Unit Group 11 (OUG-11), Chapter 5.0, "Groundwater Monitoring") calls for alkalinity, anions, metals, and turbidity to provide supplemental data on general groundwater chemistry. The plan does not list specific metals or anions. This table lists the constituents typically needed to characterize general groundwater chemistry.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels"). This equates to 45 mg/L when expressed as NO_3.

— = no comparison value

NTU = nephelometric turbidity unit

P = potential problem; many of the analytical data from this sample were out of trend; the anomalies may relate to the fact that the sample was bailed and the well was not purged

RCRA = *Resource Conservation and Recovery Act of 1976*

2.10 Liquid Effluent Retention Facility

Located on the eastern boundary of the 200 East Area, the LERF consists of three lined surface impoundment basins (Figures 1-1 and 2-10). LERF construction was completed in 1991 using a dual-confinement barrier concept (i.e., dual basin liners and pipe-in-a-pipe transfer piping system) to minimize human exposure and the potential for accidental releases to the environment. A leachate detection, collection, and removal system and the basin covers also reduce possible environmental or personnel exposure. The basins are located side by side, with 18 m (60 ft) of separation between each basin. Each basin (cell) is 100 by 82 m (330 by 270 ft), with a maximum fluid depth of 6.7 m (22 ft).

The LERF provides aqueous waste storage and treatment prior to final treatment in the 200 Area Effluent Treatment Facility. Treatment at LERF consists of flow and pH equalization. Flow equalization allows for several smaller waste streams that are intermittently received at the LERF basins to accumulate for continuous higher volume campaign processing at the Effluent Treatment Facility. The LERF continues to receive liquid waste from a number of onsite facilities, with the largest volume from the 242A evaporator.

Groundwater at LERF is monitored under the Hanford RCRA Permit (WA7890008967, Part III, OUG-3, Addendum D, "Groundwater Monitoring Plan"), which incorporated DOE/RL-2013-46, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*. The plan was revised in 2017, and a permit modification became effective November 26, 2017.

The uppermost aquifer suprabasalt sediments beneath LERF range from possibly not present to >8 m (26 ft) thick. The sediments beneath and north of LERF are interpreted as Hanford formation, but groundwater gradient and hydraulic conductivity indicate that the sediments are characteristic of the Ringold Formation. South of LERF, the hydraulic conductivity increases substantially, which is characteristic of Hanford sediments. Underlying the suprabasalt sediments is weathered and fractured Elephant Mountain basalt. Basalt observations and geophysical investigations indicate that the upper 2 to 3 m (6 to 9 ft) of the fractured basalt can be hydraulically connected to the unconfined aquifer in much of the area beneath LERF (Figures D-6 and D-11 in the LERF groundwater monitoring plan in the Hanford RCRA Permit [WA7890008967, Part III, OUG-3, Addendum D, "Groundwater Monitoring Plan"]).

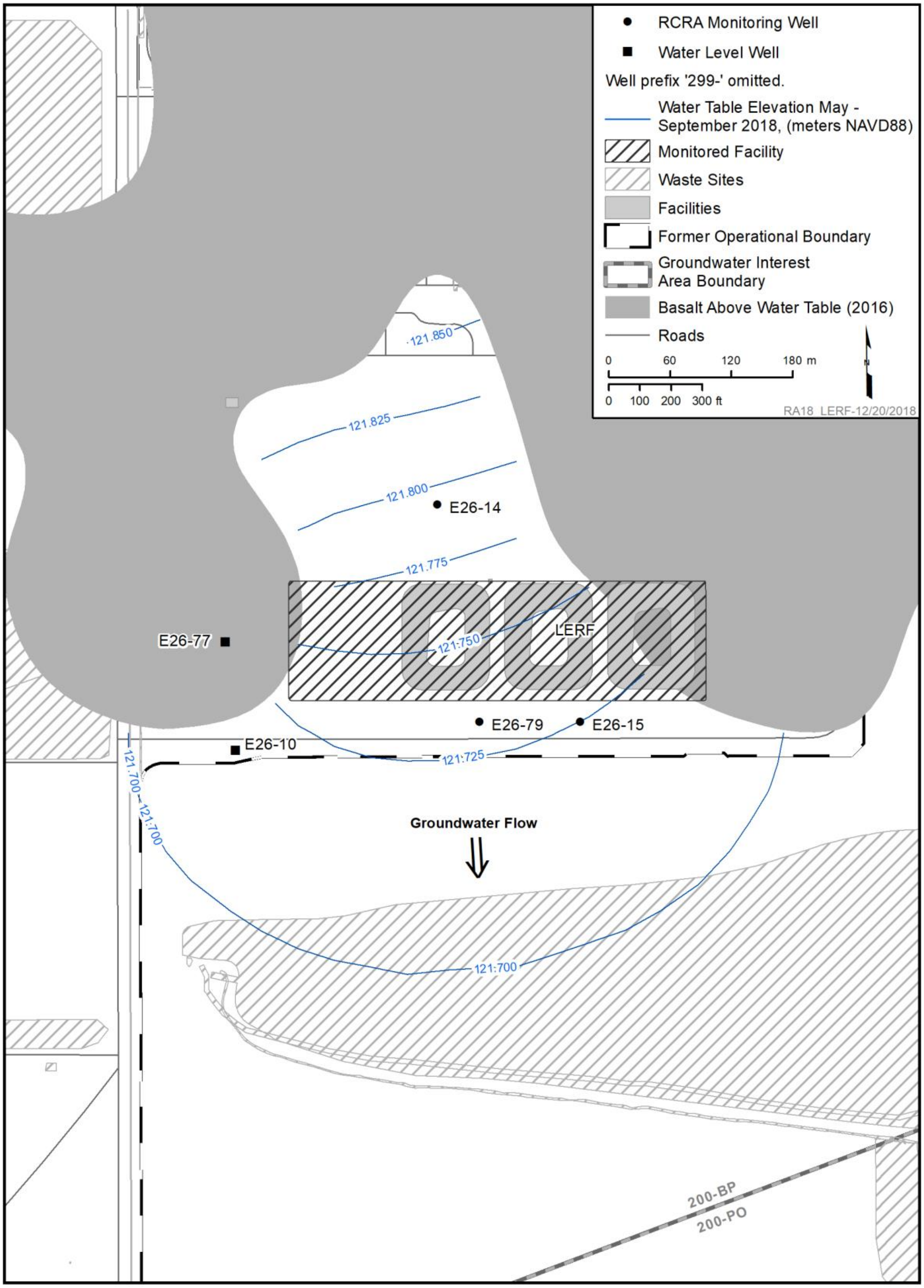
Table 2-36 lists wells in the LERF monitoring network. Four of the five well screens extend to the underlying basalt or within the basalt fracture zone. Well 299-E26-14 extends to within 0.9 m (3 ft) of the underlying basalt surface. The water table elevation at LERF declined an average of 1.8 cm/yr (0.7 in./yr) between 2013 and 2018. Based on this information, the LERF groundwater wells have adequate water columns in the screened interval for sampling during the next two decades.

Based on the low-gradient water table elevations from January, March, and June 2018, the magnitude of the hydraulic gradient beneath LERF was calculated at 3.7×10^{-4} m/m (Table 2-37). The flow direction, when fitted to a plane, was nearly due south (174 degrees azimuth). The TRIM results (Figures 1-2 and 2-10) correlate well with the hydraulic gradient calculation for LERF. Because of the heterogeneous nature of the hydraulic conductivity beneath and south of LERF, the TRIM contours become convex south of LERF. The estimated 2018 groundwater flow rate is 0.15 m/d (0.48 ft/d).

In 2018, the LERF monitoring well sampling frequency was quarterly to set a baseline for regional plume characteristics, groundwater quality, and field parameters. In addition, indicator waste constituents were sampled, analyzed and evaluated quarterly. All of the waste constituent analytical results were less than laboratory detection during 2018 (Table 2-38). Therefore, groundwater monitoring at LERF continues under a final status detection program.

Table 2-39 summarizes the 2018 monitoring results for other constituents. Nitrate, sulfate, and manganese were above comparison values in 2018:

- Nitrate remained >45 mg/L in upgradient well 299-E26-14 and downgradient well 299-E26-79 due to a regional plume.
- Sulfate is elevated throughout the eastern part of the 200 East Area, and concentrations were above the 250 mg/L secondary DWS at LERF well 299-E26-15.
- Manganese was above the secondary DWS at well 299-E26-15 for the April 10, 2018, sampling event. Well maintenance brushed, purged, and reinstalled the pump at well 299-E26-15 on April 9, 2018. From the one-time occurrence of elevated manganese, it appears that some residual manganese and iron remained in the well but were subsequently removed during repeated purging and sampling events.



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

Figure 2-10. Liquid Effluent Retention Facility

Table 2-36. LERF Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head*		Head Date	Water Column		Sample Frequency	Comment
			m	ft	m	ft	m	ft		m	ft		
299-E26-10	CG	1990 (C)	125.4	411.6	120.7	396.0	121.71	399.30	7/30/2018	1.0	3.3	—	Used for water levels only
299-E26-14	UG	2011 (C)	122.8	402.8	116.7	382.8	121.80	399.60	10/1/2018	5.1	16.8	Q/S	
299-E26-15	DG	2015 (C)	124.2	407.3	119.5	392.0	121.71	399.30	10/1/2018	2.2	7.3	Q/S	
299-E26-77	CG	2008 (C)	122.0	400.3	114.5	375.5	121.76	399.46	7/3/2018	7.3	23.9	—	Used for water levels only
299-E26-79	DG	2008 (C)	122.1	400.6	114.5	375.6	121.74	399.40	10/1/2018	7.2	23.8	Q/S	

Note: Requirements from WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part III, Operating Unit Group 3 (OUG-3), Addendum D, "Groundwater Monitoring Plan," Table D-7.

*Hydraulic head has been corrected for borehole deviation from vertical in all wells in this network.

— = no sampling required

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

CG = cross gradient

DG = downgradient

Q/S = quarterly for first 2 years beginning January 2018; semiannually thereafter

RCRA = *Resource Conservation and Recovery Act of 1976*

UG = upgradient

Table 2-37. Groundwater Velocity at the LERF

Flow Direction	174 degrees (south)
Flow Rate (m/d)	0.15
Hydraulic Conductivity (m/d) (Source)	39.5 (DOE/RL-2013-46, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*)
Effective Porosity	0.1 (DOE/RL-2013-46)
Gradient (m/m)	3.7×10^{-4}
Comments	Gradient and direction determined by trend surface analysis using January, March, and June 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-38. LERF Sampling Summary for Waste Constituents, 2018

Well Name	Sample Date	1-Butanol	Carbon Tetrachloride	Hexavalent Chromium	n-Nitrosodi-methylamine
299-E26-14	1/9/2018	U	U	U	U
	4/10/2018	U	U	U	U
	7/31/2018	U	U	U	U
	10/1/2018	U	U	U	U
299-E26-15	1/9/2018	U	U	U	U
	4/10/2018	U	U	U	U
	7/31/2018	U	U	U	U
	10/1/2018	U	U	U	U
299-E26-79	1/10/2018	U	U	U	U
	4/10/2018	U	U	U	U
	7/31/2018	U	U	U	U
	10/1/2018	U	U	U	U

U = not detected

Table 2-39. LERF Sampling Summary for Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	82.4	96.4	—	
Calcium (unfiltered)	µg/L	71,200	108,000	—	
Calcium (filtered)	µg/L	70,800	107,000	—	
Chromium (unfiltered)	µg/L	<1.4	19.3	100[b]	
Chromium (filtered)	µg/L	<1.1	4.0	100[b]	
Dissolved oxygen	mg/L	6.69	8.98	—	
Iron (unfiltered)	µg/L	<30	240	300[c]	
Iron (filtered)	µg/L	<22	150	300[c]	
Magnesium (unfiltered)	µg/L	24,200	31,100	—	
Magnesium (filtered)	µg/L	24,000	31,400	—	
Manganese (unfiltered)	µg/L	<2.0	62.2	50[c]	299-E26-15
Manganese (filtered)	µg/L	0.76	64.7	50[c]	299-E26-15
Nickel (unfiltered)	µg/L	5.13	33.4	—	
Nickel (filtered)	µg/L	2.06	24.8	—	
Nitrate	mg/L	39.7	106	45[d]	299-E26-14, 299-E26-79
Oxidation-reduction potential	mV	49.1	350.5	—	
pH Measurement		7.14	8.16	6.5 – 8.5[c]	
Potassium (unfiltered)	µg/L	9,380	11,200	—	
Potassium (filtered)	µg/L	9,520	11,600	—	
Sodium (unfiltered)	µg/L	29,600	49,400	—	
Sodium (filtered)	µg/L	28,700	50,900	—	
Sulfate	mg/L	149	290	250[c]	299-E26-15
Temperature	°C	18.1	22.2	—	
Turbidity	NTU	0.4	6.88	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

c. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

d. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity units

RCRA = *Resource Conservation and Recovery Act of 1976*

2.11 Low-Level Burial Ground Waste Management Area 1

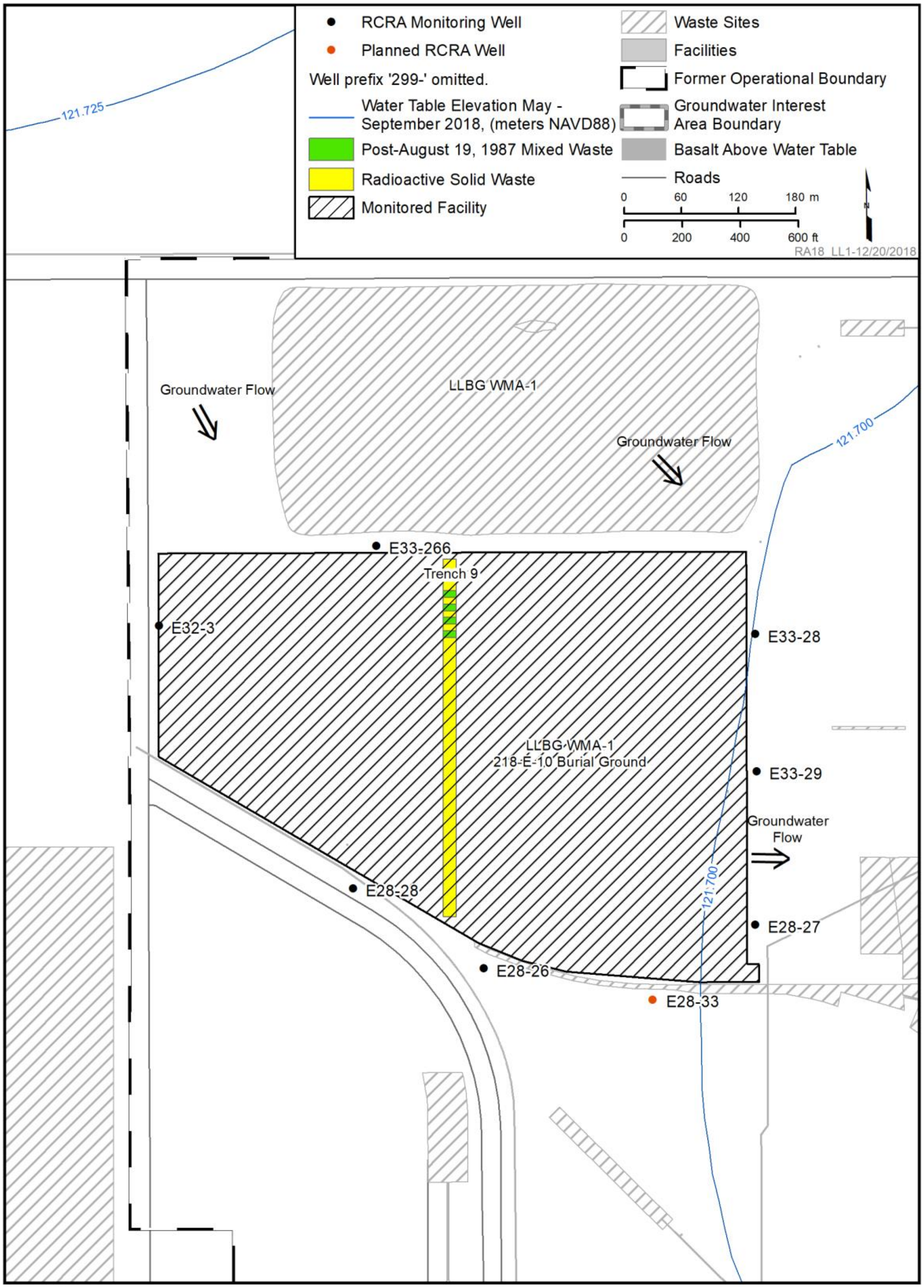
Low-Level Burial Ground Waste Management Area 1 (LLBG WMA-1) is located in the northwest corner of the 200 East Area (Figures 1-1 and 2-11). The 218-E-10 Burial Ground (14 unlined and soil covered trenches) received low-level radiological waste from 1955 to 2000. Trench 9 received low-level mixed waste from 1987 to 1993. Dangerous chemicals in the low-level mixed waste portion of the 218-E-10 Burial Ground (only Trench 9) are regulated under RCRA and its implementing requirements in 40 CFR 265, Subpart F, as referenced by WAC 173-303-400. The LLBG WMA-1 monitoring network is designed to detect indicators of dangerous waste or dangerous waste constituents affecting groundwater from the 218-E-10 Burial Ground. The monitoring network encompasses the LLBG WMA-1 boundary to provide coverage for potential groundwater flow direction changes. DOE monitors groundwater under an interim status indicator evaluation program as described in DOE/RL-2009-75, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*.

The current LLBG WMA-1 monitoring network consists of seven wells screened in the upper portion of the aquifer at the water table (Table 2-40). The water table elevation at LLBG WMA-1 declined an average 2.7 cm/yr (1.1 in./yr) between 2012 and 2017. Water levels in six low-gradient wells bordering the burial ground and the former expansion area to the north varied between November 2017 and November 2018 but on average decreased 3.1 cm (1.2 in.). Based on this information, the LLBG WMA-1 wells should have adequate water columns in the screened interval for several decades. A new well is planned near the southeast corner of LLBG WMA-1 (Figure 2-11).

The low-gradient water table contours (Section 1.4) indicate that the direction of flow varies from south-southeast to nearly due east below LLBG WMA-1 (Figures 1-2 and 2-11). The average hydraulic gradient was 2.6×10^{-5} m/m, sloping to the east-southeast (Table 2-41). The associated groundwater flow rate was 2.2 m/d (7.3 ft/d).

In 2018, LLBG WMA-1 monitoring wells were sampled semiannually for indicator parameters as scheduled (Table 2-42). Specific conductance, pH, TOC, and TOX did not exceed critical mean values, and LLBG WMA-1 remains in indicator evaluation monitoring.

Table 2-43 summarizes the groundwater quality parameters and other constituents for LLBG WMA-1. Nitrate concentrations were >45 mg/L in three wells due to a regional nitrate plume. The iron concentration in one unfiltered sample from well 299-E28-26 exceeded the secondary DWS. However, a duplicate unfiltered sample and two filtered samples had much lower concentrations.



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

Figure 2-11. Low-Level Burial Ground Waste Management Area 1

Table 2-40. LLBG WMA-1 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E28-26	DG	1987 (C)	124.9	409.6	118.7	389.5	121.69	399.25	7/11/2018	3.0	9.7	S	None
299-E28-27[b]	DG	1987 (C)	125.6	411.9	119.5	392.0	121.69	399.23	7/11/2018	2.2	7.2	S	None
299-E28-28	DG	1990 (C)	125.6	412.1	119.5	392.2	121.65	399.12	7/11/2018	2.1	6.9	S	None
299-E28-33[c]	DG	Planned	—	—	—	—	—	—	—	—	—	Q/S	Awaiting drilling
299-E32-3	UG	1987 (C)	125.8	412.7	119.7	392.8	121.67	399.18	7/11/2018	1.9	6.4	S	None
299-E33-28[b]	DG	1987 (C)	125.2	410.6	119.1	390.6	121.69	399.23	7/11/2018	2.6	8.6	S	None
299-E33-29	DG	1987 (C)	120.6	395.5	117.5	385.6	121.65	399.11	7/11/2018	4.1	13.5	S	None
299-E33-266	UG	2010 (C)	123.4	404.8	117.3	384.8	121.59	398.91	7/20/2018	4.3	14.1	S	None

Note: Requirements from Table 3-1 of DOE/RL-2009-75, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

c. Listed as "Proposed Well" in Table 3-1 of DOE/RL-2009-75.

— = no information (well not yet installed)

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

Q/S = quarterly for first year; semiannually thereafter

UG = upgradient

S = semiannually

Table 2-41. Groundwater Velocity at LLBG WMA-1

Flow Direction	112 degrees (east-southeast)
Flow Rate Range (m/d)	2.2
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	2.6×10^{-5}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-42. LLBG WMA-1 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		**pH**		**Specific Conductance (µS/cm)**		**TOC (µg/L)**			**TOX (µg/L)**			**Lab (TOC and TOX)**	**Comment**
Critical Mean[a]		**6.99**	**8.85**	**548**		**2,060**			**21.3**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
299-E28-26	1/10/2018	7.91	0.01	482	3	<500	0	1,670	<3.3	1.3	16.7	TASL	
	7/11/2018	7.92	0.00	485	1	209	11	430	<7.7	0.0	11.5	TADN	
299-E28-27	1/11/2018	7.99	0.00	456	0	<330	0	390	<3.3	0.0	12.3	GEL	
	7/11/2018	8.03	0.00	435	0	<330	0	—[b]	<3.3	0.0	9.7	GEL	
299-E28-28	1/10/2018	8.11	0.01	461	1	<500	0	1,670	<2.5	0.6	16.7	TASL	
	7/11/2018	8.10	0.00	457	1	191	4	430	<7.7	0.0	11.5	TADN	
299-E32-3	1/15/2018	8.09	0.00	404	0	<330	0	390	<3.4	0.1	12.3	GEL	
	7/11/2018	7.90	0.00	399	0	<330	0	—[b]	<3.3	0.0	9.7	GEL	

Table 2-42. LLBG WMA-1 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		**6.99**	**8.85**	**548**		**2,060**			**21.3**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
299-E33-266	1/10/2018	8.02	0.00	431	0	<500	0	1,670	<3.8	2.3	16.7	TASL	
	7/20/2018	8.10	0.00	444	0	578	51	430	<7.7	0.0	11.5	TADN	
299-E33-28	1/15/2018	8.09	0.00	504	1	<330	0	390	<3.9	0.9	12.3	GEL	
	7/11/2018	8.07	0.00	526	0	<330	0	—[b]	<3.3	0.0	9.7	GEL	No quadruplicates collected
299-E33-29	1/10/2018	8.06	0.00	438	0	<500	0	1,670	3.7	0.2	16.7	TASL	
	7/11/2018	8.11	0.00	427	0	205	13	430	<7.7	0.0	11.5	TADN	

a. Critical mean values from Table 21 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

< = one or more of the replicate values was below the detection limit

Avg = average

GEL = GEL Laboratories

LOQ = limit of quantitation

SD = standard deviation

TADN = TestAmerica – Denver

TASL = TestAmerica – St. Louis

TOC = total organic carbon

TOX = total organic halides

Table 2-43. LLBG WMA-1 Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Calcium (unfiltered)	µg/L	33,100	48,700	—	
Calcium (filtered)	µg/L	34,300	47,400	—	
Chloride	mg/L	10	15	250[b]	
Dissolved oxygen	mg/L	7.7	10.0	—	
Fluoride	mg/L	0.4	0.5	4.0[c]	
Iron (unfiltered)	µg/L	<29	589	300[b]	299-E28-26
Iron (filtered)	µg/L	<22	30	300[b]	
Magnesium (unfiltered)	µg/L	10,100	14,400	—	
Magnesium (filtered)	µg/L	10,400	14,100	—	
Manganese (unfiltered)	µg/L	<0.5	4.0	50[b]	
Manganese (filtered)	µg/L	<0.6	4.0	50[b]	
Nitrate	mg/L	40	62	45[d]	299-E28-26, 299-E28-28, 299-E33-28
Nitrite	mg/L	<0.13	<0.13	3.3[d]	
Phenol	µg/L	<1.9	<2.9	2,400[e]	
Potassium (unfiltered)	µg/L	4,760	6,330	—	
Potassium (filtered)	µg/L	5,040	6,400	—	
Sodium (unfiltered)	µg/L	20,600	25,900	—	
Sodium (filtered)	µg/L	20,900	26,000	—	
Sulfate	mg/L	37	65	250[b]	
Temperature	°C	15.2	19.0	—	
Turbidity	NTU	0.12	3.33	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

e. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

2.12 Low-Level Burial Ground Waste Management Area 2

LLBG WMA-2 is located in the northeast corner of the 200 East Area (Figures 1-1 and 2-12) and consists of the 218-E-12B and 200-E-304 Burial Grounds, which contain 39 inactive and soil-covered, north-south-oriented trenches (in 218-E-12B) and one active uncovered trench (Trench 94 in 200-E-304). The 218-E-12B Burial Ground received solid, low-level, radiological, and transuranic waste from 1967 to 2004. The 218-E-12B Burial Ground was permitted because retrievably stored waste was located in Trench 17. In 2011, retrievably stored waste (mainly drums) was removed from Trenches 17 and 27 under Tri-Party Agreement Milestone M-091-40; since that time, the 218-E-12B Burial Ground has not been subject to the requirements of WAC 173-303. LLBG WMA-2 continues to follow the implementing requirements in WAC 173-303-400, as defined in DOE/RL-2009-76, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-2*.

Table 2-44 lists construction information and water levels for LLBG WMA-2 wells. The water table elevation decline at LLBG WMA-2 monitoring wells varied over the past 5 years, from 1.3 to 19.2 cm (0.5 to 7.6 in.), but the average decline among six wells with consistent declining averages is 1.9 cm/yr (0.75 in./yr). The wells should have adequate water in the screened interval for sampling during the next two decades.

The low-gradient water table contours (Section 1.4) indicate that the direction of flow varies from south along the east side to southeast below the west side of LLBG WMA-2 (Figures 1-2 and 2-12). There is uncertainty regarding the interpolated flow directions and gradients because of the flat water table and limits of water table measurement precision. For example, well 299-E34-10 has a consistently higher water table elevation than the surrounding wells (0.10 to 16 cm [0.04 to 6.3 in.]), suggesting radial flow from this well; however, increasing nitrate concentrations, consistent with the adjacent wells, suggest nitrate migration from the northwest to southeast. The average hydraulic gradient in 2018 was estimated to be 5.3×10^{-6} m/m (Table 2-45). The associated groundwater flow rate for the east side of LLBG WMA-2 was 0.04 to 0.18 m/d (0.13 to 0.58 ft/d) and for the west side was 0.45 m/d (1.5 ft/d).

The LLBG WMA-2 wells are scheduled for semiannual sampling. In 2018, several wells had critical mean exceedances and verification sampling was conducted (Table 2-46). However, groundwater flow conditions and chemical results indicated the exceedances were not the result of contamination from LLBG WMA-2. As stated in Section 4.5 of DOE/RL-2009-76, “In some instances, it is possible to determine immediately that the statistical finding is not the result of contamination from the facility. In that case, the regulatory agency is notified but an assessment program is not instituted.” DOE notified Ecology of the exceedances based on the June and December 2018 verification sample results. Further explanation of 2018 critical mean exceedances is provided below.

The April 2018 field measurements for pH at well 299-E27-11 exceeded the upper limit, but verification sampling results did not confirm the exceedance.

In April, TOC at downgradient well 299-E27-9 and cross-gradient well 299-E27-10 exceeded the LOQ (Table 2-46). Verification sampling of well 299-E27-9 in June confirmed the exceedance, and DOE notified Ecology. Because TOC was elevated in both the cross-gradient and downgradient wells, DOE recommended that, in the future, TOC data be collected for information purposes and not for comparison to the critical mean or LOQ. Despite this recommendation, statistical comparisons were made again in November, with exceedances confirmed in both wells (Table 2-46).

Repeated occurrences of elevated TOC as high as 6,500 µg/L were previously reported at other wells in the northern 200 East Area (e.g., well 299-E34-7, located approximately 350 m [1,150 ft] northeast of well 299-E27-10). Characterization at well 299-E34-7 between 2000 and 2005 found no indication of dangerous waste or dangerous waste constituents (Section 2.10.3.4 of PNNL-15670, *Hanford Site Groundwater Monitoring for Fiscal Year 2005*). Further characterization of TOC occurred in 2015 at wells 299-E26-14, 299-E26-10, and 299-E27-10 (Section 9.10.4 of DOE/RL-2016-09, *Hanford Site Groundwater Monitoring Report for 2015*). Based on the mass spectra results, dissolved organic matter (e.g., fluvic and/or humic acids) is the most likely cause of the elevated TOC.

The TOC at well 299-E34-2 also exceeded the LOQ in April 2018 (Table 2-46), but the exceedance was not recognized at the time because the LOQ was initially calculated at a higher concentration. Well 299-E34-2 was sampled again in November, and TOC results were below detection limits, indicating no exceedance. The April 2018 TOC results were flagged with "C" for the presence of TOC in the laboratory control blank.

November 2018 specific conductance at well 299-E34-9 exceeded the critical mean value, and the December verification sample confirmed the exceedance (Table 2-46). Well 299-E34-9 was designated as a downgradient well in DOE/RL-2009-76, but the direction of groundwater flow has changed. Based on 2018 water table map interpretations (Figures 1-2 and 2-12) and the migration of nitrate and sulfate plumes, well 299-E34-9 is currently upgradient of LLBG WMA-2. For example, increasing specific conductance at well 299-E34-9 (Figure 2-13) parallels the trend at well 299-E33-14, located 243 m (797 ft) to the northwest, which indicates a southeast flow direction. Therefore, the exceedance reflects migration of contamination from sources other than LLBG WMA-2.

In November at well 299-E27-17, three of the four TOC samples were nondetects (<330 µg/L), and the fourth was reported as a detection at 330 µg/L and flagged with "B." Because a meaningful LOQ could not be calculated for TOC at GEL Laboratories (GEL) that quarter, the detection was considered an exceedance and verification sampling occurred in December. Quadruplicates from GEL averaged 500 µg/L, but split samples analyzed at another laboratory averaged 212 µg/L, which was below the applicable LOQ; therefore, the exceedance was not confirmed.

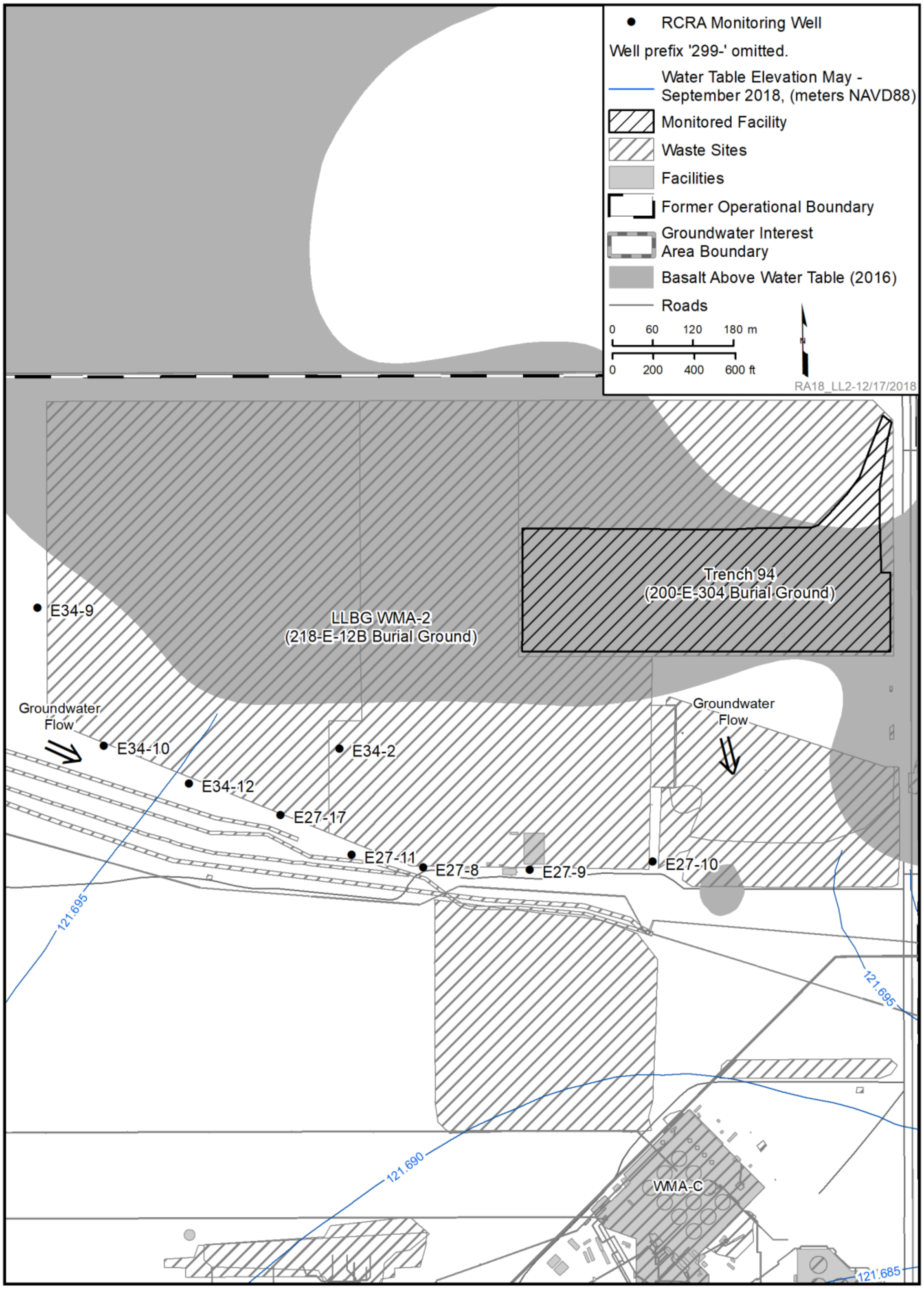
Table 2-47 summarizes groundwater quality parameters and other constituents required by 40 CFR 265.92(b)(2). Iron, nitrate, and sulfate concentrations were above DWSs but did not originate in LLBG WMA-2, as explained below:

- Iron concentrations were above the secondary DWS in unfiltered samples from well 299-E27-10. Previous video surveys of the well show moderate encrustation of apparent amorphous ferric hydroxide (orange in color). Other metals associated with stainless-steel corrosion (chromium and nickel) are also found in this well at elevated levels. It is likely that corrosion in this well affected the sample. Well 299-E27-10 has been added to the well maintenance priority list for cleaning.

- Sulfate and nitrate concentrations remained above applicable standards in wells 299-E27-9 and 299-E27-10. The elevated sulfate and nitrate appear to be ongoing loading from the vadose zone associated with unplanned releases to the 216-B-2 Ditches in the early 1960s and 1970s. The conceptual model for migration from the 216-B-2 Ditches includes northeast migration through the vadose zone to groundwater and southward migration within the aquifer to wells 299-E27-9 and 299-E27-10. Sulfate could also be associated with gypsum mobilized by dust-suppression water used during Trench 94 sediment excavation.

- The elevated nitrate in wells 299-E34-9, 299-E34-10, and 299-E34-12 appears to be associated with southeast migration from sources to the northwest, primarily the BY Cribs.

- The elevated sulfate in well 299-E34-9 appears to be associated with southeast migration from sources to the northwest, primarily the BY Cribs.



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

Figure 2-12. Low-Level Burial Ground Waste Management Area 2

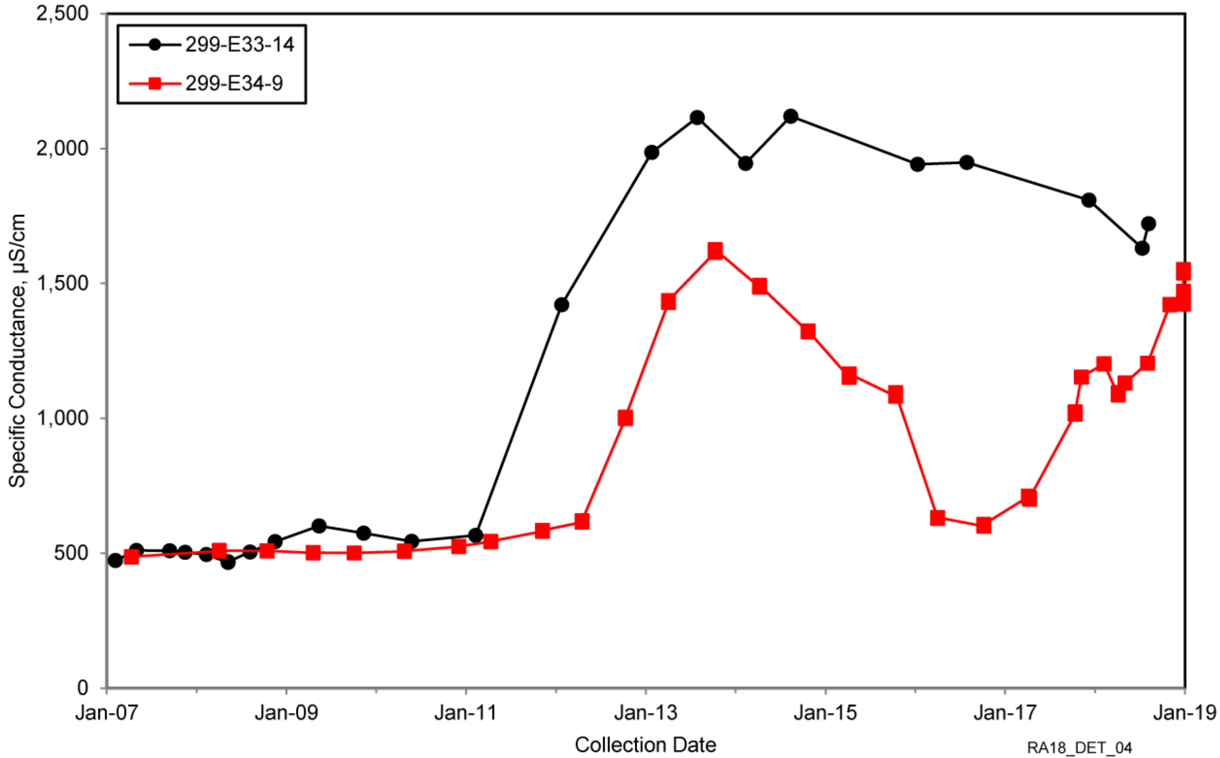


Figure 2-13. Specific Conductance Data for Wells 299-E33-14 and 299-E34-9 at LLBG WMA-2

Table 2-44. LLBG WMA-2 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E27-8*	DG	1987 (C)	125.8	412.7	119.7	392.7	121.69	399.23	11/2/2018	2.0	6.5	S	None
299-E27-9*	DG	1987 (C)	125.3	411.1	119.4	391.8	121.69	399.23	11/2/2018	2.3	7.4	S	See Table 2-46
299-E27-10	CG	1987 (C)	126.2	413.9	120.0	393.6	121.62	399.02	11/2/2018	1.6	5.4	S	See Table 2-46
299-E27-11	DG	1989 (C)	126.0	413.5	119.6	392.5	121.65	399.12	11/2/2018	2.0	6.6	S	See Table 2-46
299-E27-17*	DG	1991 (C)	125.5	411.9	119.1	390.9	121.70	399.29	11/2/2018	2.6	8.4	S	See Table 2-46
299-E34-2	DG	1987 (C)	125.2	410.9	119.2	390.9	121.70	399.29	11/2/2018	2.6	8.4	S	None
299-E34-9*	DG	1991 (C)	127.0	416.7	120.7	395.9	121.71	399.32	11/2/2018	1.0	3.4	S	See Table 2-46
299-E34-10*	DG	1991 (C)	126.5	415.0	120.1	394.0	121.71	399.31	11/2/2018	1.6	5.3	S	None
299-E34-12	DG	1992 (C)	126.6	415.3	120.4	395.0	121.59	398.90	11/5/2018	1.2	3.9	S	None

Note: Requirements from Table 3-1 of DOE/RL-2009-76, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-2*. Planned wells 299-E34-13 through 299-E34-16 were not installed.

*Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

CG = cross gradient

DG = downgradient

S = semiannually

UG = upgradient

Table 2-45. Groundwater Velocity at LLBG WMA-2

Flow Direction	150 degrees (southeast)
Flow Rate (m/d)	East portion: 0.040 to 018; west portion: 0.45
Hydraulic Conductivity Range (m/d) (Source)	For the east portion of LLBG WMA-2, 1,500 to 6,700 (pump test results from PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds — An Interim Report*). For the western portion of the WMA, 17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	5.3×10^{-6}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

LLBG = low-level burial ground

WMA = waste management area

Table 2-46. LLBG WMA-2 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean		7.41	8.16	1,350		NC; use LOQ			35.0				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E27-8	4/5/2018	8.12	0.00	491	3	<500	0	—[b]	<6.10	2.38	—[b]	TASL	
	11/2/2018	8.07	0.00	537	1	<330	0	—[b]	<5.01	2.01	7.3	GEL	
299-E27-9	4/5/2018	8.04	0.00	1,055	7	689	7	—[b]	<4.17	1.16	12.3	GEL	
	6/1/2018	7.87	0.01	1,083	6	744	87	—[b]	—	—	—	GEL	Verification for TOC; confirmed
						807	64	430	—	—	—	TADN	
	11/2/2018	8.02	0.00	1,194	5	802	9	—[b]	<3.75	0.43	7.3	GEL	
	12/26/2018	7.93	0.00	1,116	8	970	4	—[b]	—	—	—	GEL	Verification for TOC; confirmed
						793	8	—[b]	—	—	—	TADN	
299-E27-10	4/10/2018	7.82	0.01	1,174	3	1,020	16	430	<7.73	0.04	18.9	TADN	
	11/2/2018	7.82	0.01	1,339	2	848	14	—[b]	<4.45	1.17	7.3	GEL	
	12/26/2018	7.74	0.02	1,270	2	1,103	16	—[b]	—	—	—	GEL	Verification for TOC; confirmed
						862	7	—[b]	—	—	—	TADN	
299-E27-11	4/5/2018	8.40	0.01	489	1	<330	0	—[b]	<3.33	0.00	12.3	GEL	
	5/14/2018	7.90	0.12	513	4	—	—	—	—	—	—	—	Verification for pH; not confirmed
	11/2/2018	8.12	0.00	510	0	<330	0	—[b]	<5.17	2.61	7.3	GEL	
299-E27-17	4/5/2018	8.07	0.00	497	0	329	8	430	<7.70	0.00	18.9	TADN	
	11/2/2018	8.06	0.00	510	0	<330	0	—[b]	<3.33	0.00	7.3	GEL	See note c
	12/26/2018	7.99	0.00	538	7	500	16	—[b]	—	—	—	GEL	Verification for TOC; TADN value below previous LOQ; not confirmed
						212	18	—[b]	—	—	—	TADN	

Table 2-46. LLBG WMA-2 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean		**7.41**	**8.16**	**1,350**		**NC; use LOQ**			**35.0**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
299-E34-2	4/10/2018	8.05	0.00	573	1	494	12	430	<7.70	0.00	18.9	TADN	See text
	11/2/2018	8.00	0.00	597	0	<330	0	—[b]	<4.15	1.23	7.3	GEL	
299-E34-9	4/5/2018	7.88	0.01	1,090	3	<500	0	—[b]	6.23	2.19	—[b]	TASL	
	11/2/2018	7.82	0.01	1,422	1	577	21	—[b]	<3.33	0.00	7.3	GEL	
	12/26/2018	7.77	0.01	1,491	44	766	13	—[b]	—	—	—	GEL	Verification for specific conductance and TOC; confirmed
						680	16	—[b]	—	—	—	TADN	
299-E34-10	4/5/2018	8.01	0.00	673	5	376	37	430	<7.70	0.00	18.9	TADN	
	11/2/2018	7.96	0.00	733	1	<330	0	—[b]	<3.66	0.57	7.3	GEL	
299-E34-12	4/9/2018	8.05	0.01	597	2	<330	0	—[b]	<3.33	0.00	12.3	GEL	
	11/5/2018	7.98	0.00	699	1	<330	0	—[b]	<3.37	0.07	7.3	GEL	

Note: Yellow-highlighted cells indicate exceedance of a critical mean.

a. Critical mean values from Table 22 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

c. Three TOC quadruplicates were below detection limit and one was reported at the detection limit and flagged with "B." This was considered an LOQ exceedance because a meaningful LOQ could not be calculated for GEL.

< = one or more of the replicate values was below the detection limit

— = no data or not applicable

Avg = average

GEL = GEL Laboratories

LOQ = limit of quantitation

NC = not calculated

SD = standard deviation

TADN = TestAmerica – Denver

TASL = TestAmerica – St. Louis

TOC = total organic carbon

TOX = total organic halides

Table 2-47. LLBG WMA-2 Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	62	108	—	
Calcium (unfiltered)	µg/L	49,400	165,000	—	
Calcium (filtered)	µg/L	48,900	165,000	—	
Chloride	mg/L	17	93	250[b]	
Chromium (unfiltered)	µg/L	7.2	72.0	—	
Chromium (filtered)	µg/L	<3.0	27.4	—	
Dissolved oxygen	mg/L	7.1	9.6	—	
Fluoride	mg/L	0.2	0.4	4.0[c]	
Iron (unfiltered)	µg/L	<36	600	300[b]	299-E27-10
Iron (filtered)	µg/L	<22	150	300[b]	
Manganese (unfiltered)	µg/L	<0.7	8.4	50[b]	
Manganese (filtered)	µg/L	<0.4	4.1	50[b]	
Nitrate	mg/L	15	204	45[d]	299-E27-10, 299-E27-9, 299-E34-10, 299-E34-12, 299-E34-9; maximum excludes outlier
Nitrite	mg/L	<0.1	0.5	3.3[d]	
Phenol	µg/L	<1.9	<2.8	2,400[e]	
Potassium (unfiltered)	µg/L	6,950	14,000	—	
Potassium (filtered)	µg/L	7,080	14,000	—	
Sodium (unfiltered)	µg/L	17,000	56,000	—	
Sodium (filtered)	µg/L	16,700	56,400	—	
Sulfate	mg/L	74	410	250[b]	299-E27-10, 299-E27-9, 299-E34-9; maximum excludes outlier
Temperature	°C	16	21	—	
Turbidity	NTU	0.6	7.6	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

e. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

2.13 Low-Level Burial Ground Waste Management Area 3

LLBG WMA-3 (Figures 1-1 and 2-14) is located in the northwest quadrant of the 200 West Area and has four burial grounds (218-W-3A, 218-W-3AE, 218-W-5, and 200-W-254) within its boundary. The 218-W-3A Burial Ground (0.204 km^2 [0.079 mi^2]) has 57 unlined trenches and operated between 1970 and 1998. The 218-W-3AE Burial Ground (0.200 km^2 [0.077 mi^2]) has eight unlined trenches and operated between 1981 and July 2004. The 218-W-5 Burial Ground (0.27 km^2 [0.103 mi^2]) has 10 unlined trenches and began operating in 1986. The 200-W-254 Burial Ground (0.105 km^2 [0.041 mi^2] was originally within the 218-W-5 Burial Ground boundary.

In 2014, a new waste site code (200-W-254) was placed in the Waste Information Data System database to specifically identify the OUs (i.e., active areas) of the 218-W-5 Burial Ground containing Trenches 31 and 34 and associated waste treatment and storage pads. Constructed with double polyethylene liners, the trenches and pads are unique within LLBG WMA-3 and direct all surface runoff to a leachate collection and removal system. The 200-W-254 Burial Ground began operating in 1999 and continues to receive waste. Trenches 31 and 34 and associated waste treatment and storage pads are considered to be four separate DWMUs.

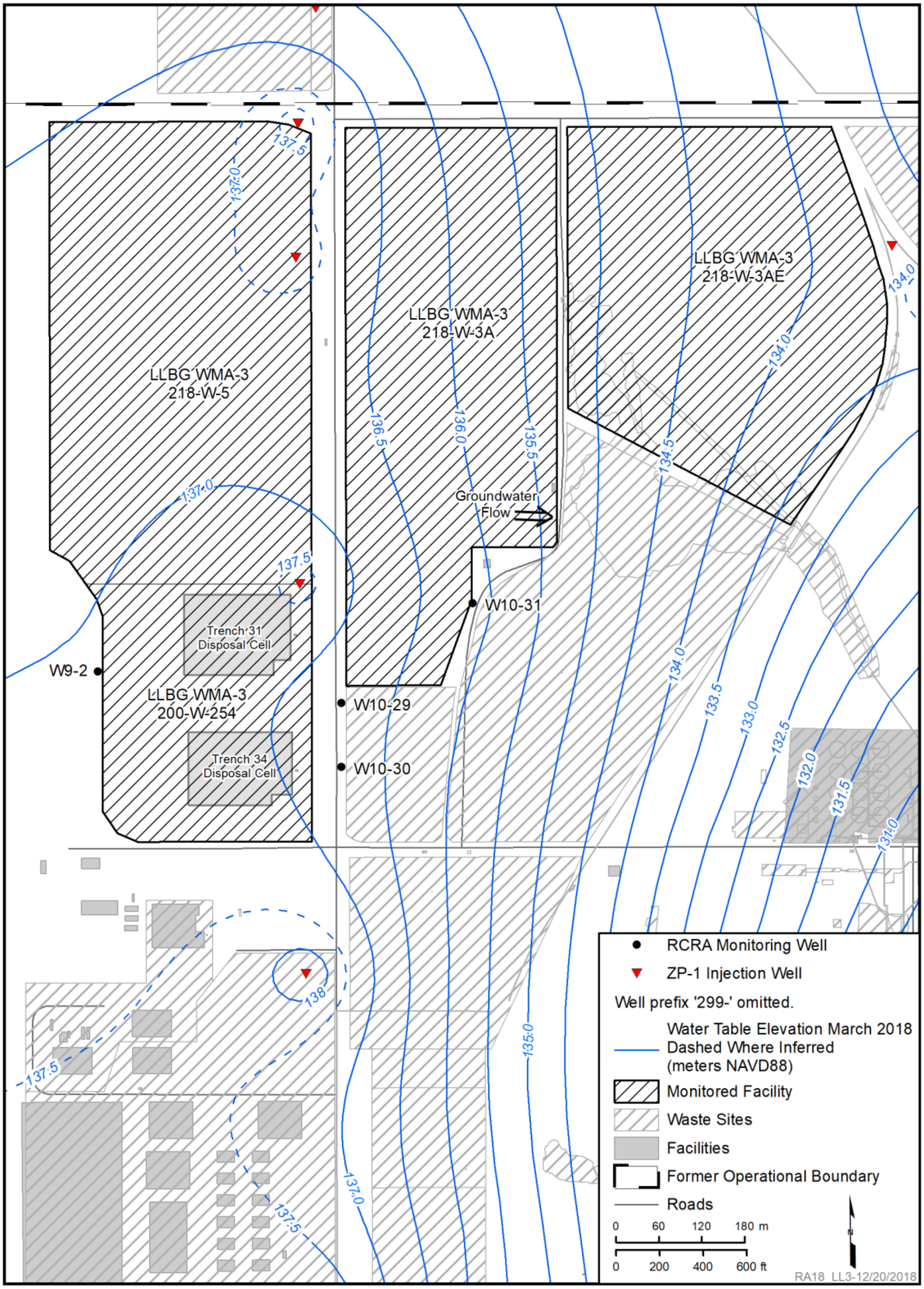
LLBG WMA-3 is monitored under an interim status indicator program as described in DOE/RL-2009-68, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*. The monitoring network consists of one upgradient well and three downgradient wells that monitor Trenches 31 and 34 (Table 2-48). Each well was constructed according to WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the saturated thickness across screen intervals is expected to be adequate for future groundwater sampling. Two engineering evaluation reports have been published for portions of LLBG WMA-3: SGW-59564, *Engineering Evaluation of the 200 West Pump and Treat Influence on Groundwater Monitoring for the Low-Level Burial Ground Trenches 31 and 34*; and SGW-60583, *Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-3 Green Islands Groundwater Monitoring*. The Tri-Parties negotiate new wells annually in accordance with Tri-Party Agreement Milestone M-24-00.

Treated water from the 200 West P&T system is injected into wells in and adjacent to LLBG WMA-3 (Figure 2-14). Water levels continue to vary as the volume of injected water changes. Groundwater levels increased about 38 cm (15 in.) between 2017 and 2018.

The water table elevation in upgradient well 299-W9-2 remains higher than in downgradient wells by at least 24 cm (9.4 in.). Groundwater flows predominately to the east beneath LLBG WMA-3 but is locally affected by P&T injection wells (Figure 2-14). The estimated groundwater flow rate beneath the LLBG WMA-3 is 0.37 m/d (0.12 ft/d) (Table 2-49).

Wells in the LLBG WMA-3 monitoring network were sampled in 2018 for indicator parameters (specific conductance, pH, TOC, and TOX) (Table 2-50), water quality parameters (chloride, iron, manganese, phenol, sodium, and sulfate), and other parameters (Table 2-51). Critical mean exceedances occurred in two wells in 2018, as had also occurred in 2017. DOE notified Ecology of the 2018 exceedances, concluding that LLBG WMA-3 was not the cause and indicator parameter monitoring should continue. Ecology concurred with this conclusion. Previous exceedances were discussed in SGW-59713-VA, *LLWMA-3 Groundwater Monitoring: 299-W10-31 Specific Conductance and TOX*; and SGW-61120, *Meeting Notes – Briefing to Ecology on LLWMA-3 RCRA Groundwater Monitoring)*. Details of the 2018 exceedances (Table 2-50) are as follows:

- The average specific conductance in downgradient well 299-W10-31 exceeded the critical mean value in March and September. Verification sampling was not conducted because the 2018 results were consistent with previous data, and the elevated specific conductance is presumed to be from increasing nitrate concentration associated with the migration of a regional nitrate plume. In 2018, the highest nitrate concentration in a LLBG WMA-3 well (299-W10-31) was 40.5 mg/L, which is below the 45 mg/L DWS equivalent and is a decrease from 44.7 mg/L in 2017.
- The TOX average concentration in well 299-W10-30 exceeded the critical mean value in September. Verification sampling was not conducted because the TOX concentrations are consistent with observed levels of carbon tetrachloride in the well (23.6 µg/L in 2018). A portion of LLBG WMA-3 lies within the regional carbon tetrachloride plume (Figure 12-5 of DOE/RL-2017-66).



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

Figure 2-14. Low-Level Waste Management Area 3

Table 2-48. LLBG WMA-3 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W9-2	UG	2011 (C)	135.9	445.8	125.2	410.8	137.10	449.79	9/10/2018	11.9	39.0	S	None
299-W10-29	DG	2006 (C)	136.9	449.3	126.3	414.3	136.84	448.96	9/10/2018	10.6	34.7	S	None
299-W10-30	DG	2006 (C)	137.1	449.8	126.4	414.8	136.89	449.10	9/10/2018	10.5	34.3	S	None
299-W10-31	DG	2006 (C)	136.5	447.9	125.8	412.9	136.27	447.09	9/10/2018	10.4	34.2	S	None

Note: Requirements from Table 3-1 of DOE/RL-2009-68, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

S = semiannually

UG = upgradient

Table 2-49. Groundwater Velocity at LLBG WMA-3

Flow Direction	101 degrees (east; locally disrupted by groundwater injection wells)
Flow Rate (m/d)	Southern portion (Trenches 31 and 34): 0.37
Hydraulic Conductivity (m/d) (Source)	5.0 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	Southern portion (Trenches 31 and 34): 7.4×10^{-3}
Comments	Gradient and direction determined by trend surface analysis using March 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-50. LLBG WMA-3 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		7.46	8.63	458		747			15.1				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-W10-29	3/12/2018	7.87	0.00	414	0	360	70	530	5.9	1.1	21.6	TADN	
	9/10/2018	8.09	0.00	402	0	<155	0	430	<9.2	1.3	11.5	TADN	
299-W10-30	3/12/2018	7.82	0.00	398	1	<330	0	390	14.2	0.6	12.3	GEL	See text regarding exceedance
	9/10/2018	8.04	0.00	376	0	<330	0	—[b]	15.3	1.2	9.7	GEL	
299-W10-31	3/12/2018	7.82	0.00	503	1	201	20	530	9.4	0.5	21.6	TADN	See text regarding exceedances
	9/10/2018	8.04	0.00	488	0	<330	0	—[b]	8.8	1.6	9.7	GEL	
299-W9-2	3/12/2018	7.89	0.01	405	1	<330	0	390	<3.8	0.6	12.3	GEL	
	9/10/2018	8.11	0.01	383	18	<330	0	—[b]	<5.0	1.6	9.7	GEL	

Note: Yellow-highlighted cells indicate exceedances of a critical mean.

a. Critical mean values from Table 24 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

<	=	one or more of the replicate values was below the detection limit
Avg	=	average
GEL	=	GEL Laboratories
LOQ	=	limit of quantitation
NC	=	not calculated
SD	=	standard deviation
TADN	=	TestAmerica – Denver
TASL	=	TestAmerica – St. Louis
TOC	=	total organic carbon
TOX	=	total organic halides

Table 2-51. LLBG WMA-3 Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	105	118	—	
Calcium (unfiltered)	µg/L	42,400	61,000	—	
Chloride	mg/L	13.9	25	250[b]	
Chromium (unfiltered)	µg/L	1.3	3.45	100[c]	
Dissolved oxygen	mg/L	7.7	1,018	—	
Fluoride	mg/L	0.251	0.333	4[c]	
Iron (unfiltered)	µg/L	17	94.3	300[b]	
Magnesium (unfiltered)	µg/L	13,100	18,000	—	
Manganese (unfiltered)	µg/L	<1.5	2.16	50[b]	
Nitrate	mg/L	27.7	40.5	45[d]	
Nitrite	mg/L	<0.108	0.108	3.3[d]	
Oxidation-reduction potential	mV	125.9	320.2	—	
Phenol	µg/L	<1.9	2.83	2,400[e]	
Potassium (unfiltered)	µg/L	3,960	4,300	—	
Sodium (unfiltered)	µg/L	9,900	10,700	—	
Sulfate	mg/L	35.1	53	250[b]	
Temperature	°C	18.6	21.4	—	
Turbidity	NTU	0.34	3.92	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, “National Secondary Drinking Water Regulations,” “Secondary Maximum Contaminant Levels.”

c. 40 CFR 141, Subpart G, “National Primary Drinking Water Regulations,” “Maximum Contaminant Levels and Maximum Residual Disinfectant Levels.”

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

e. WAC 173-340-705, “Model Toxics Control Act—Cleanup,” “Use of Method B.”

< = one or more of the results was below the detection limit

— = no comparison value

RCRA = *Resource Conservation and Recovery Act of 1976*

NTU = nephelometric turbidity unit

2.14 Low-Level Burial Ground Waste Management Area 4

LLBG WMA-4 (Figures 1-1 and 2-15) is located in 200 West Area and includes the 218-W-4B and 218-W-4C Burial Grounds and contains 28 unlined trenches used to dispose low-level radioactive waste and low-level mixed waste. The 218-W-4B Burial Ground also has 12 below-grade caissons at its southern end that contain remote-handled, low-level waste and retrievable transuranic waste. The 218-W-4B Burial Ground was closed in 1990, and the 218-W-4C Burial Ground was closed in 2004. RCRA monitoring is limited to dangerous waste in the low-level mixed waste portions of Trenches NC, 14, and 58 under DOE/RL-2009-69, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-4*, as modified by TPA-CN-718, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-69, Interim Status Groundwater Monitoring Plan for the LLBG WMA-4, Revision 2*.

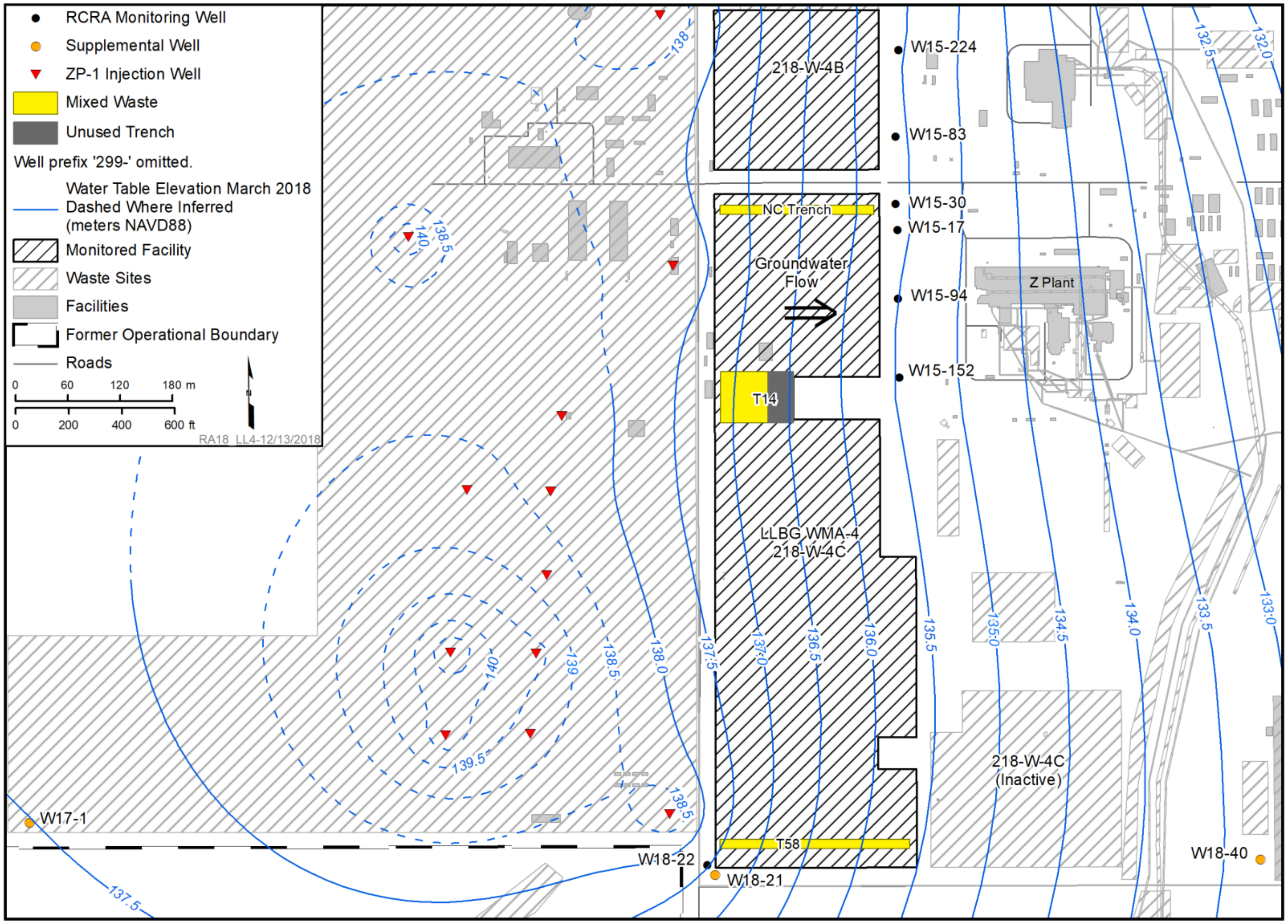
Table 2-51 lists the wells monitored for LLBG WMA-4 in 2018. The water level in upgradient well 299-W18-21, screened at the top of the aquifer, varies in response to changes in operation of nearby injection wells. The well was sampled with a bailer in 2018. Between 2012 and 2018, water levels increased in most LLBG WMA-4 monitoring wells (up to 1.1 m [3.6 ft] in well 299-W15-224).

Although not formally included in the LLBG WMA-4 monitoring network under DOE/RL-2009-69, upgradient well 299-W17-1 and downgradient well 299-W18-40 were sampled in 2017 and 2018 to provide supplemental groundwater data. Well 299-W17-1 was sampled quarterly for indicator parameters beginning in October 2016. Well 299-W18-40 was sampled semiannually beginning in January 2017. An engineering evaluation report published in 2018 recommended a revised monitoring network (SGW-60584, *Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-4 Green Islands Groundwater Monitoring).* The Tri-Parties negotiate new wells annually in accordance with Tri-Party Agreement Milestone M-24-00.

The P&T injection wells upgradient of LLBG WMA-4 (Figure 2-15) have caused the water table to rise and increased the hydraulic gradient since injection began in 2012. The general direction of groundwater flow is east, the gradient magnitude in 2018 was 8.6×10^{-3}, and the estimated flow rate was 0.43 m/d (1.4 ft/d) beneath LLBG WMA-4 (Table 2-53).

The well network was sampled in 2018 for indicator parameters pH, specific conductance, TOC, and TOX, which did not exceed critical mean values (Table 2-54). Due to the PFP radiological controlled area restrictions in 2018, the January 2018 samples were collected in March and the July 2018 samples were collected in June.

Nitrate concentrations >45 mg/L were detected in five wells (Table 2-55) as a result of a regional nitrate plume. Concentrations of iron and manganese were above secondary DWS in unfiltered samples from well 299-W15-152.



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

Figure 2-15. Low-Level Waste Management Area 4

Table 2-52. LLBG WMA-4 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W15-17	Deep DG	1987 (C)	80.6	264.5	77.3	253.5	135.74	445.33	6/15/2018	58.5	191.9	S	See note a
299-W15-30	DG	1995 (C)	142.8	468.6	130.6	428.6	135.70	445.21	6/15/2018	5.1	16.6	S	See note a
299-W15-83	DG	2005 (C)	137.3	450.5	126.7	415.5	135.89	445.83	6/15/2018	9.2	30.3	S	See note a
299-W15-94	DG	2005 (C)	137.5	451.0	126.8	416.0	135.60	444.89	6/15/2018	8.8	28.8	S	See note a
299-W15-152	DG	2005 (C)	137.5	451.1	126.8	416.1	135.52	444.62	6/15/2018	8.7	28.6	S	See note a
299-W15-224	DG	2006 (C)	136.5	447.9	125.9	412.9	135.52	444.62	4/2/2018	9.7	31.7	S	See note a
299-W17-1	UG	2003 (C)	139.4	457.4	128.7	422.3	137.50	451.12	6/19/2018	8.8	28.8	Q[b]	Not formally in network; also see note a
299-W18-21	UG	1987 (C)	144.7	474.6	135.5	444.6	137.39	450.77	6/15/2018	1.9	6.1	S	Sampled with a bailer; also see note a
299-W18-22	UG Deep	1987 (C)	77.5	254.1	68.0	223.1	136.92	449.22	6/15/2018	68.9	226.1	S	See note a
299-W18-40	DG	2001 (C)	136.2	446.9	125.5	411.9	133.34	437.47	6/18/2018	7.8	25.6	S	Not formally in network; also see note a

Note: Requirements from Table 3-1 of DOE/RL-2009-69, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-4*, as modified by TPA-CN-718, 2016, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-69, Interim Status Groundwater Monitoring Plan for the LLBG WMA-4, Revision 2*.

a. Sampling scheduled for January was delayed until March in all wells, and sampling scheduled for July was performed in June.

b. Well 299-W17-1 was sampled quarterly until June 2018.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

S = semiannually

UG = upgradient

Table 2-53. Groundwater Velocity at LLBG WMA-4

Flow Direction	East
Flow Rate (m/d)	0.43
Hydraulic Conductivity (m/d) (Source)	5.0 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	8.6×10^{-3}
Comments	Gradient and direction estimated from March 2018 water table map. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 2-54. LLBG WMA-4 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)				
Critical Mean[a]		**6.83**	**9.09**	**736**		**2,150**			**49.7**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**	**Lab**	**Comment**
299-W15-152	3/5/2018	7.76	0.00	561	1	<500	0	1,670	8.4	0.4	16.7	TASL	Delayed from January
	6/15/2018	7.92	0.01	583	1	283	28	430	8.4	0.8	18.9	TADN	Sampled for July early
299-W15-17	3/5/2018	7.87	0.00	367	0	<330	0	390	8.8	0.0	12.3	GEL	Deep well; no statistics; delayed from January
	6/15/2018	8.06	0.00	381	0	<330	0	—[b]	<3.3	0.0	12.3	GEL	Sampled for July early
299-W15-224	3/5/2018	7.79	0.00	539	0	<500	0	1,670	21.2	2.4	16.7	TASL	Delayed from January
	6/18/2018	7.62	0.01	547	0	389	28	430	20.2	0.5	18.9	TADN	Sampled for July early
299-W15-30	3/5/2018	7.92	0.00	534	3	<330	0	390	18.6	4.3	12.3	GEL	Delayed from January
	6/15/2018	8.22	0.01	547	0	<330	0	—[b]	12.3	1.2	12.3	GEL	Sampled for July early

Table 2-54. LLBG WMA-4 Sampling Summary for Contamination Indicator Parameters, 2018

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)				
Critical Mean[a]		**6.83**	**9.09**	**736**		**2,150**			**49.7**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**	**Lab**	**Comment**
299-W15-83	3/5/2018	7.81	0.00	524	0	<500	0	1,670	19.7	2.0	16.7	TASL	Delayed from January
	6/15/2018	7.99	0.00	556	1	256	53	430	19.8	0.8	18.9	TADN	Sampled for July early
299-W15-94	3/5/2018	7.76	0.00	554	0	<330	0	390	<7.7	3.8	12.3	GEL	Delayed from January
	6/15/2018	7.93	0.01	581	1	<330	0	—[b]	<5.40	2.07	12.3	GEL	Sampled for July early
299-W18-21	3/5/2018	8.23	0.04	611	1	<500	0	1,670	8.3	1.8	16.7	TASL	Delayed from January.
	6/15/2018	8.37	0.04	617	2	334	44	430	9.0	1.1	18.9	TADN	Sampled for July early
299-W18-22	3/5/2018	8.03	0.00	385	3	<500	0	1,670	7.4	1.3	16.7	TASL	Deep upgradient well; no statistics; delayed from January
	6/15/2018	8.04	0.00	415	0	<167	20	430	<9.3	1.6	18.9	TADN	Sampled for July early

a. Critical mean values from Table 26 of ECF-Hanford-18-0004, *Calculation of Critical Means for Calendar Year 2018 RCRA Groundwater Monitoring*.

b. Insufficient data to calculate a meaningful LOQ.

<	=	one or more of the replicate values was below the detection limit
Avg	=	average
GEL	=	GEL Laboratories
LOQ	=	limit of quantitation
SD	=	standard deviation
TADN	=	TestAmerica – Denver
TASL	=	TestAmerica – St. Louis
TOC	=	total organic carbon
TOX	=	total organic halides

Table 2-55. LLBG WMA-4 Sampling Summary for Water Quality Parameters and Other Constituents, 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	110	136	—	
Calcium (unfiltered)	μg/L	33,800	60,300	—	
Chloride	mg/L	13	43	250[b]	
Chromium (unfiltered)	μg/L	5.4	89.2	100[c]	
Dissolved oxygen	mg/L	5.73	10.13	—	
Fluoride	mg/L	0.27	0.46	4[c]	
Iron (unfiltered)	μg/L	<30	1,370	300[b]	299-W15-152
Magnesium (unfiltered)	μg/L	11,500	19,700	—	
Manganese (unfiltered)	μg/L	0.67	110	50[b]	299-W15-152
Nitrate	mg/L	20.8	75.3	45[d]	299-W15-152, 299-W15-224, 299-W15-30, 299-W15-83, 299-W15-94
Nitrite	mg/L	<0.125	0.46	3.3[d]	
Phenol	μg/L	<1.9	<2.91	2,400[e]	
Potassium (unfiltered)	μg/L	4,240	5,970	—	
Sodium (unfiltered)	μg/L	12,400	26,000	—	
Sulfate	mg/L	24	83	250[b]	
Temperature	°C	18.3	20.2	—	
Turbidity	NTU	0.37	22.9	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

e. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

WMA = waste management area

3 Groundwater Quality Assessment Monitoring

This chapter presents the groundwater monitoring results for units monitored under interim status groundwater quality assessment programs: seven single-shell tank (SST) WMAs, the 216-A-29 Ditch, and the Nonradioactive Dangerous Waste Landfill (NRDWL).

3.1 Waste Management Area A-AX

WMA A-AX is located in the southeast quarter of the 200 East Area (Figures 1-1 and 3-1) and consists of 10 underground storage tanks with an operating capacity of 3,785,000 L (1,000,000 gal), two of which are confirmed or assumed to have leaked in the past (HNF-EP-0182, Rev. 359, *Waste Tank Summary Report for Month Ending November 30, 2017*). Leaks were reassessed in the 2014 revision of RPP-ENV-37956, *Hanford A and AX-Farm Leak Assessments Report*. To minimize the probability and severity of future leaks, most of the drainable liquid in each tank has been removed and transferred to double-shell tanks (DSTs). Although dangerous waste groundwater contamination has not been attributed to the tank releases, the WMA is in an interim status assessment program because specific conductance exceeded the critical mean value in 2005. Specific conductance of groundwater in the 200 East Area is elevated regionally.

WMA A-AX remained in assessment monitoring in accordance with 40 CFR 265.93(d) (as referenced by WAC 173-303-400) during 2018 and is monitored under DOE/RL-2015-49, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX*. The plan is a continuation of the first determination process and includes a comprehensive list of dangerous waste constituents for assessment.

The monitoring network includes three upgradient and six downgradient wells (Table 3-1). The average rate of water-level decline between 2013 and 2018 was 2.3 cm/yr (0.9 in./yr), and the wells all have adequate water in the screened interval for continued sampling. Water levels increased slightly between 2017 and 2018. Wells are screened across the water table and monitor the upper portion of the unconfined aquifer. The estimated thickness of the unconfined aquifer is from 24 to 31 m (79 to 102 ft) near WMA A-AX.

Indications of corrosion were identified in well 299-E25-41 in 2016 and were confirmed with an inspection video log. Sampling of this well continued in 2018, with elevated unfiltered chromium, iron, and nickel attributed to corrosion. Cleaning the well may improve sample quality until it can be replaced.

In 2018, groundwater near WMA A-AX was interpreted to flow to the southeast based on the low-gradient water table map (Figures 1-2 and 3-1). Supporting evidence for the flow orientation included water-level measurements with slightly higher hydraulic heads to the northwest, as well as the distribution and migration of the nitrate plume in this area. This flow direction also corresponds to the orientation of a southeast-trending paleochannel in the area (Appendix E of DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*). In 2018, the estimated hydraulic gradient was 1.1×10^{-5} m/m, with an estimated groundwater flow rate of 0.97 m/d (3.2 ft/d) (Table 3-2).

The monitoring network was sampled quarterly in 2018 to assess whether dangerous waste or dangerous waste constituents are present in the groundwater and to determine the rate and extent of migration. When the assessment has been completed, data will be evaluated in detail in a first determination report (40 CFR 265.94 (d)(4)).

Table 3-3 summarizes the monitoring results for 2018. Nitrate concentrations were above the DWS equivalent in several wells due to a regional plume. Chromium was elevated in one unfiltered sample from well 299-E25-40 in June, but the filtered sample had much lower chromium. Iron and nickel were also elevated in the June unfiltered sample, suggesting the presence of particulate matter from the stainless-steel casing or screen. The well is scheduled for cleaning and inspection via video logging to evaluate the casing condition.

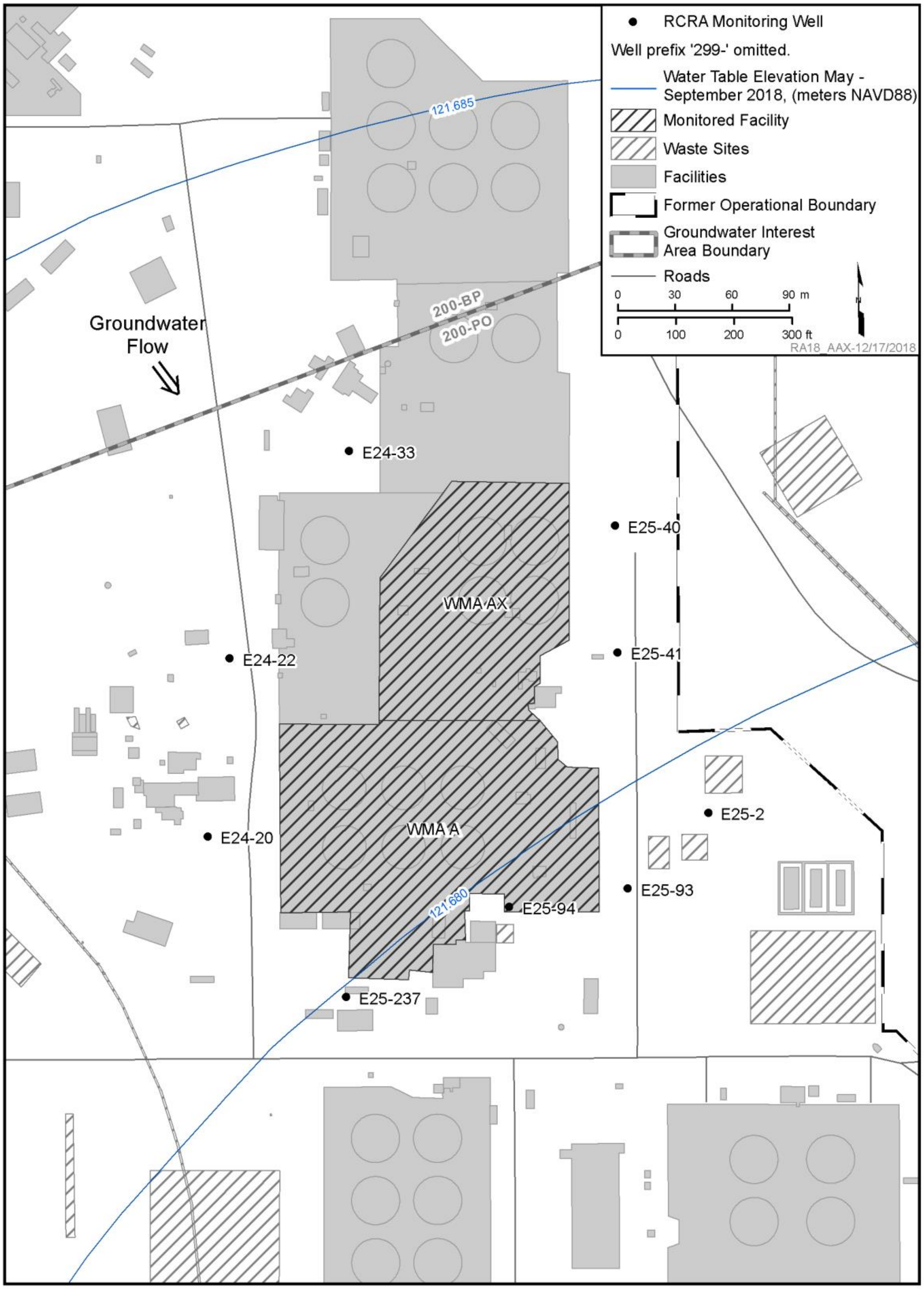
Low-level detections of several organic compounds were noted in 2018 (Table 3-3). All results were below practical quantitation limits (flagged with “J”), except for acetone. All but two of the quantifiable acetone results were flagged with “Q” (associated field blank showed contamination). The two unflagged detections were in March samples from well 299-E24-20 (3.6 µg/L) and well 299-E25-41 (2.9 µg/L). Acetone is a common analytical laboratory contaminant. Detailed evaluation and discussion of the groundwater quality assessment results will be presented in a first determination report.

Cyanide is detected in WMA C monitoring wells (Section 3.3), located upgradient of WMA A-AX. The highest total cyanide concentration in a WMA A-AX well in 2018 was 6.4 µg/L in upgradient well 299-E24-33. Cyanide also was detected in downgradient well 299-E25-94. EPA 815-B-16-012, *Cyanide Clarification of Free and Total Cyanide Analysis for Safe Drinking Water Act (SDWA) Compliance*, clarifies that total cyanide methods are allowed for screening, but cyanide is regulated as free cyanide, and the 200 µg/L DWS applies to free cyanide.

Filtered arsenic was detected above the 10 µg/L DWS in well 299-E25-40 in the March 2018 sampling event. However, the detected value of 10.6 µg/L is less than the sitewide background value of 11.8 µg/L (DOE/RL-96-61). All unfiltered aliquots of arsenic were below the comparison value.

Coliform bacteria was detected in well 299-E25-237 in the September 2018 sampling event. Gross beta was detected in three sampling events (June, September, and December) above the comparison value of 50 pCi/L in well 299-E25-237. The gross beta detections are likely associated with technetium-99 that has been detected in the well.

Coliform bacteria and gross beta are part of the 40 CFR 265, Appendix III sampling parameters that are required for one year on a quarterly basis for new wells added to the network. Well 299-E25-237 has received adequate Appendix III samplings for satisfying the 40 CFR 265 requirements; therefore, Appendix III sampling will not be scheduled for 2019.



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

Figure 3-1. Waste Management Area A-AX

Table 3-1. WMA A-AX Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
299-E24-20	UG	1991 (C)	125.0	410.2	118.9	390.0	121.70	399.27	9/25/2018	2.8	9.3	Q	2, 3, 6, 9, 12
299-E24-22[b]	UG	2003 (C)	122.3	401.3	111.6	366.2	121.66	399.15	9/13/2018	10.0	32.9	Q	2, 3, 6, 9, 12
299-E24-33[b]	UG	2004 (C)	121.3	397.9	111.5	365.9	121.69	399.25	9/21/2018	10.2	33.4	Q	2, 3, 6, 9, 12
299-E25-2	DG	1955 (P)	122.1	400.6	109.9	360.6	121.66	399.14	9/19/2018	11.8	38.6	Q	2, 3, 6, 9, 12
299-E25-40	DG	1989 (C)	126.3	414.4	119.9	393.4	121.67	399.18	9/21/2018	1.8	5.8	Q	2, 3, 6, 9, 12
299-E25-41	DG	1989 (C)	126.9	416.4	120.5	395.4	121.69	399.26	9/21/2018	1.2	3.9	Q	2, 3, 6, 9, 12
299-E25-93[b]	DG	2003 (C)	122.5	401.8	111.8	366.7	121.67	399.18	9/19/2018	9.9	32.5	Q	2, 3, 6, 9, 12
299-E25-94[b]	DG	2004 (C)	121.4	398.2	110.7	363.2	121.88	399.86	9/19/2018	11.2	36.7	Q	2, 3, 6, 9, 12
299-E25-237	DG	2015 (C)	123.2	404.1	112.5	369.1	121.60	398.96	9/21/2018	9.1	29.8	Q	2, 3, 6, 9, 12

Note: Requirements from Table 3-2 of DOE/RL-2015-49, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX*.

a. Wells were sampled in February 2018 because of missed holding times in December 2017.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause the reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly

UG = upgradient

Table 3-2. Groundwater Velocity at WMA A-AX

Flow Direction	145 degrees (southeast)
Flow Rate (m/d)	0.97
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	1.1×10^{-5}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-3. WMA A-AX Sampling Summary for 2018: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value; Comments
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	µg/L	U	2.38×10^{-5}	—	All <PQL
2,4,5-T(2,4,5-Trichlorophenoxyacetic acid)	µg/L	U	0.79	—	All <PQL
2,4,5-TP(2-(2,4,5-Trichlorophenoxy)propionic acid)Silvex	µg/L	U	0.93	50[b]	All <PQL
Acetone	µg/L	U	8.2	—	
Alkalinity	mg/L	79.3	146	—	
Antimony (unfiltered)	µg/L	U	2.00	6[b]	All <PQL
Antimony (filtered)	µg/L	U	2.00	6[b]	All <PQL
Arsenic (unfiltered)	µg/L	4.2	9.37	10[b]	
Arsenic (filtered)	µg/L	U	10.6	10[b]	299-E25-40
Barium (unfiltered)	µg/L	39	87.9	2,000[b]	
Barium (filtered)	µg/L	38.3	90.6	2,000[b]	
Calcium (unfiltered)	µg/L	53,400	96,900	—	
Calcium (filtered)	µg/L	54,100	95,600	—	
Chloride	mg/L	12	39	250[c]	
Chloroform	µg/L	U	2.19	80[b]	All <PQL
Chromium (unfiltered)	µg/L	U	40	100[b]	
Chromium (filtered)	µg/L	U	6.7	100[b]	

Table 3-3. WMA A-AX Sampling Summary for 2018: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value; Comments
Cobalt (unfiltered)	µg/L	U	0.90	—	All <PQL
Cobalt (filtered)	µg/L	U	0.90	—	All <PQL
Coliform bacteria[d]	MPN	U	5.2	TC+	299-E25-237
Copper (unfiltered)	µg/L	U	9.4	1,000[e]	
Copper (filtered)	µg/L	U	3.2	1,000[e]	
Cyanide	µg/L	U	6.4	—	
Gross alpha[d]	pCi/L	2.1	6.75	15[f]	
Gross beta[d]	pCi/L	230	637	50[f]	299-E25-237
Heptachlorodibenzo-p-dioxins	µg/L	U	2.38×10^{-5}	—	All <PQL
Heptachlorodibenzofurans	µg/L	U	$2.38E\times10^{-5}$	—	All <PQL
Hexachlorodibenzo-p-dioxin	µg/L	U	2.38×10^{-5}	—	All <PQL
Iron (unfiltered)	µg/L	U	184	300[c]	
Iron (filtered)	µg/L	U	33.6	300[c]	
Lead (unfiltered)	µg/L	U	1.0	15[e]	
Lead (filtered)	µg/L	U	2.1	15[e]	
Magnesium (unfiltered)	µg/L	16,300	27,500	—	
Magnesium (filtered)	µg/L	15,900	27,200	—	
Manganese (unfiltered)	µg/L	U	4.79	50[c]	
Manganese (filtered)	µg/L	U	6.4	50[c]	
Mercury (unfiltered)	µg/L	U	0.67	2[b]	All <PQL
Mercury (filtered)	µg/L	U	0.67	2[b]	All <PQL
Methylene chloride	µg/L	U	2.3	—	All <PQL
Nickel (unfiltered)	µg/L	U	38.4	—	
Nickel (filtered)	µg/L	U	13.9	—	
Nitrate	mg/L	9.74	66.4	45[g]	299-E24-20, 299-E24-33, 299-E25-237, 299-E25-93
Octachlorodibenzofuran	µg/L	U	4.76×10^{-5}	—	All <PQL
Octachlorodibenzo-p-dioxin	µg/L	U	4.76×10^{-5}	—	All <PQL
pH Measurement	None	7.68	8.16	6.5 – 8.5[c]	
Potassium (unfiltered)	µg/L	6,900	9,600	—	
Potassium (filtered)	µg/L	7,000	9,700	—	
Radium-228[d]	pCi/L	U	0.964	—	All <PQL

Table 3-3. WMA A-AX Sampling Summary for 2018: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value; Comments
Selenium (unfiltered)	µg/L	2.6	13.1	50[b]	
Selenium (filtered)	µg/L	2.5	12.9	50[b]	
Silver (unfiltered)	µg/L	U	0.90	100[c]	All <PQL
Sodium (unfiltered)	µg/L	17,400	29,200	—	
Sodium (filtered)	µg/L	17,900	30,000	—	
Specific conductance	µS/cm	546	836	—	
Sulfate	mg/L	110	250	250[c]	
Temperature	ºC	16.7	27.1	—	
Tetrachlorodibenzo-p-dioxins	µg/L	U	9.52×10^{-6}	—	All <PQL
Tin (unfiltered)	µg/L	U	1.2	—	All <PQL
Tin (filtered)	µg/L	U	1.2	—	All <PQL
Turbidity	NTU	0.1	4.81	—	
Vanadium (unfiltered)	µg/L	17	25.4	—	
Vanadium (filtered)	µg/L	17	24.9	—	
Zinc (unfiltered)	µg/L	U	7.5	5,000[c]	All <PQL
Zinc (filtered)	µg/L	U	7.5	5,000[c]	All <PQL

Note: Samples were analyzed for all constituents listed in Tables 3-1, 3-2, and 3-3 of DOE/RL-2015-49, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX*. Only detected constituents are listed in this table. Some of the December 2018 sample results had not yet been received from the laboratory when this table was created.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

c. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

d. These constituents only in well 299-E25-237 (Table 3-3 of DOE/RL-2015-49).

e. Action level (40 CFR 141, Subpart I, "Control of Lead and Copper").

f. Gross alpha standard excludes uranium and radium (40 CFR 141.15, "Maximum Contaminant Levels for Radium-226, Radium-228, and Gross Alpha Particle Radioactivity in Community Water Systems"). Gross beta standard is a concentration assumed to yield a dose equivalent of 4 mrem/yr (40 CFR 141.16, "Maximum Contaminant Levels for Beta Particle and Photon Radioactivity from Man-Made Radionuclides in Community Water Systems").

g. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

— = no comparison value

NTU = nephelometric turbidity unit

PQL = practical quantitation limit

RCRA = *Resource Conservation and Recovery Act of 1976*

TC+ = positive for total coliform (EPA 815-B-13-001, *Revised Total Coliform Rule: A Quick Reference Guide*)

U = below the detection limit

3.2 Waste Management Area B-BX-BY

WMA B-BX-BY is located in the northwestern 200 East Area (Figures 1-1 and 3-2). It was constructed in stages: B Tank Farm between 1943 and 1944, BX Tank Farm between 1946 and 1947, and BY Tank Farm between 1948 and 1949. All three tank farms provided interim storage for radioactive mixed waste, primarily from the bismuth phosphate, PUREX, and uranium extraction processes. However, no self-boiling waste from the PUREX or REDOX Plants was sent to the B-BX-BY Tank Farms prior to removal of high heat-generating fission products. All of the 24 SSTs in the B and BX Tank Farms were built to store up to 2.0 million L (530,000 gal) of liquid waste. In the B Tank Farm, four additional tanks each had a capacity of 208,000 L (55,000 gal). Each of the 12 SSTs in the BY Tank Farm had a 2.9 million L (770,000 gal) capacity. Ancillary equipment at WMA B-BX-BY includes diversion boxes, underground catch tanks, connecting underground pipelines, and the 244-BXR waste transfer vault.

Of the 40 SSTs in WMA B-BX-BY, 20 are assumed or confirmed to have leaked in the past (Table 4-1 of HNF-EP-0182). To minimize the probability and severity of future leaks, most of the drainable liquid in each tank has been removed and transferred to DSTs. Additional sources of unplanned releases within WMA B-BX-BY include tank overfills, waste loss from spare inlet nozzles or cascade lines, pipeline leaks, and surface releases.

DOE monitors groundwater beneath WMA B-BX-BY under an interim status assessment program in accordance with 40 CFR 265.93(d)(4), as defined in DOE/RL-2012-53, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area B-BX-BY*. While developing DOE/RL-2012-53, an assessment of historical process chemistry, leak assessment reports, and groundwater contaminants concluded that cyanide had affected groundwater quality beneath the B Tank Farm. The probable cyanide source and a conceptual model for transport were provided as part of the determination. Although other releases from WMA B-BX-BY have affected groundwater, there is currently no evidence of additional dangerous waste or dangerous waste constituents.

Six upgradient and nine downgradient wells were sampled for WMA B-BX-BY in 2018 (Table 3-4). Most of the well screens extend across the entire unconfined aquifer to the underlying basalt surface. The water table elevation at WMA B-BX-BY declined an average of 1.4 cm/yr (0.6 in./yr) between 2012 and 2017. The water table elevation between November 2017 and November 2018 declined an average of 5.4 cm/yr (2.1 in./yr). Water levels were variable between 2017 and 2018 due to high Columbia River stage. The wells have adequate water columns in the screened interval for sampling during the next decade. All of the network wells were sampled quarterly during the reporting period, except for decommissioned well 299-E33-18 (Table 3-4).

Groundwater gradient magnitudes and flow directions were determined using the 200 East Area low-gradient monitoring network for the period of May 2018 through September 2018 (Figure 1-2). The local gradient converges from the east, west, and north at extraction well 299-E33-360. Regionally, the average gradient is 3.0×10^{-6} m/m, dipping to the southeast (Table 3-5). The estimated groundwater flow rate ranged from 0.26 to 0.28 m/d (0.84 to 0.93 ft/d).

Local flow directions in 2018 were affected by groundwater extraction from well 299-E33-360 (Figure 3-2). Groundwater extraction (from a different well) began in 2015 under a treatability test (DOE/RL-2015-75, *Aquifer Treatability Test Report for the 200-BP-5 Groundwater Operable Unit*) and continues as part of a CERCLA removal action (DOE/RL-2016-41, *Action Memorandum for the 200-BP-5 Operable Unit Groundwater Extraction*). During the treatability test, extrapolated water table measurement declines indicated a radius of influence of 210 m (690 ft). The 2018 chemical data trends in well 299-E33-360 and nearby monitoring wells indicate cyanide capture from existing sources at

WMA B-BX-BY. Water-level elevations are not consistent enough to provide an interpretation of the capture zone.

The WMA B-BX-BY monitoring wells were sampled as planned in 2018, with the following exceptions (Table 3-4):

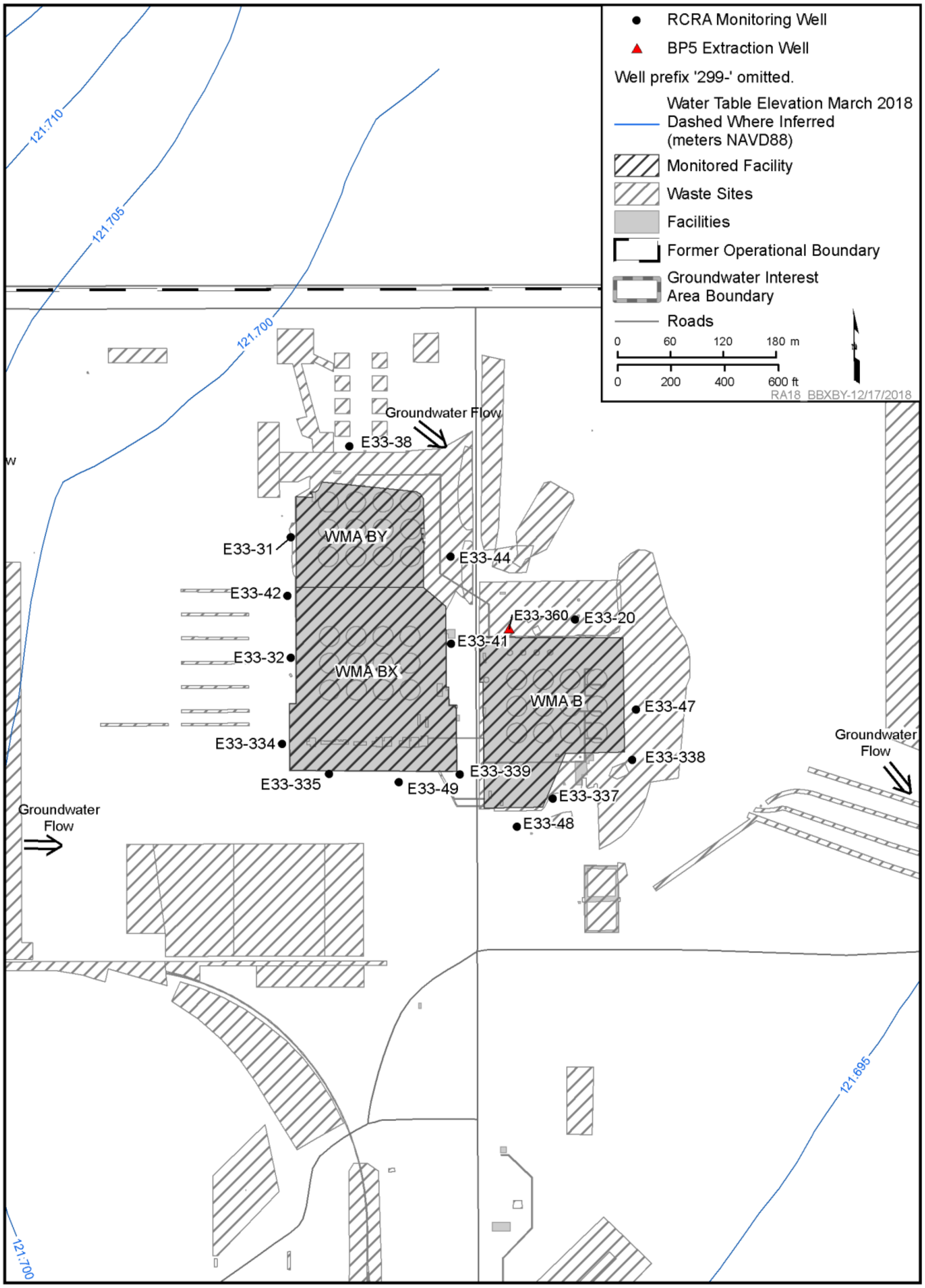
- The November TOC sample from well 299-E33-47 could not be analyzed because of a laboratory error.
- November TOC sample from well 299-E33-38 and cyanide samples from well 299-E33-47 and 299-E33-337 were lost during transport to the laboratory. When the samples were found, the sample temperature was outside applicable limits, so the analyses were canceled.

In accordance with item C.c. of Section 4.4 of DOE/RL-2012-53, the wells were scheduled for the missing analyses the following quarter (February 2019), and the deviations are noted in this annual report.

Monitoring at WMA B-BX-BY focuses on cyanide, which is a dangerous waste constituent that is present in groundwater upgradient, beneath, and downgradient of WMA B-BX-BY. Four wells had total cyanide results >200 µg/L in 2018 (299-E33-20, 299-E33-38, 299-E33-44, and 299-E33-47). Well 299-E33-38 is upgradient of WMA B-BX-BY and had the lowest concentrations by the end of 2018. Total cyanide concentrations at wells 299-E33-44 and 299-E33-47 ranged from 620 to 1,030 µg/L in 2018. These two wells are located near vadose zone release sites and extraction well 299-E33-360. Total cyanide concentrations have decreased in these two wells since implementing extraction well 299-E33-360. Well 299-E33-20 is within the capture zone and appears to be downgradient of cyanide sources to the northwest or south. Cyanide concentrations increased at this well in 2018, indicating continued capture of elevated concentrations of cyanide.

Groundwater samples from WMA B-BX-BY wells are analyzed for free cyanide, although not specifically required by the monitoring plan. In 2018, none of the free cyanide concentrations exceeded 200 µg/L. The MTCA cleanup level for free cyanide is 4.8 µg/L (WAC 173-340). Four wells detected concentrations >4.8 µg/L (Table 3-6). Free cyanide concentrations were low in 2018 (generally <10 µg/L), and only three wells had multiple detections >4.8 µg/L (299-E33-20, 299-E33-44, and 299-E33-47). All three wells are within the interpreted capture zone of extraction well 299-E33-360.

Table 3-6 summarizes groundwater quality parameters and other constituents required by DOE/RL-2012-53. Nitrate concentrations were >45 mg/L at all wells due to regional and local nitrate plumes. Nitrate concentrations have decreased at WMA B-BX-BY since implementing extraction well 299-E33-360.



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

Figure 3-2. Waste Management Area B-BX-BY

Table 3-4. WMA B-BX-BY Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E33-18	UG	1950(P)	—	—	—	—	—	—	—	—	—	—	Decommissioned[a]
299-E33-20[b]	UG	1956 (P)	125.9	413.1	118.6	389.1	121.79	399.56	11/9/2018	3.2	10.4	Q	2, 5, 8, 11
299-E33-31	UG	1989 (C)	125.8	412.8	119.4	391.8	121.70	399.27	11/9/2018	2.3	7.4	Q	2, 5, 8, 11
299-E33-32	UG	1989 (C)	126.1	413.8	119.7	392.8	121.68	399.20	11/9/2018	1.9	6.4	Q	2, 5, 8, 11
299-E33-38	UG	1991 (C)	126.4	414.7	120.0	393.7	121.68	399.20	11/9/2018	1.7	5.5	Q	2, 5, 8, 11; missed TOC in November (see text)
299-E33-41	DG	1991 (C)	124.9	409.9	119.7	392.8	121.67	399.19	11/9/2018	1.9	6.4	Q	2, 5[b], 8, 11
299-E33-42	UG	1991 (C)	126.7	415.7	120.4	395.0	121.68	399.21	11/9/2018	1.3	4.2	Q	2, 5, 8, 11
299-E33-44	DG	1998 (C)	123.5	405.1	118.9	390.1	121.70	399.28	8/3/2018	2.8	9.1	Q	2, 5, 8, 11
299-E33-47	DG	2004 (C)	123.3	404.7	117.3	384.7	121.69	399.24	11/7/2018	4.4	14.6	Q	2, 5, 8, 11; missed cyanide and TOC in November (see text)
299-E33-48	DG	2004 (C)	123.3	404.5	115.7	379.5	121.69	399.24	11/7/2018	6.0	19.8	Q	2, 5, 8, 11
299-E33-49	DG	2004 (C)	122.9	403.3	116.8	383.3	121.68	399.20	11/9/2018	4.8	15.9	Q	2, 5, 8, 11
299-E33-334	UG	2000 (C)	124.7	409.3	117.1	384.3	121.69	399.24	11/7/2018	4.6	15.0	Q	2, 5, 8, 11
299-E33-335[b]	DG	2000 (C)	124.2	407.4	118.1	387.4	121.66	399.16	11/7/2018	3.6	11.8	Q	2, 5, 8, 11
299-E33-337	DG	2001 (C)	124.1	407.3	116.5	382.3	121.68	399.20	11/7/2018	5.2	16.9	Q	2, 5, 8, 11; missed cyanide in November (see text)
299-E33-338	DG	2001 (C)	123.8	406.1	117.7	386.1	121.69	399.23	11/7/2018	4.0	13.1	Q	2, 5, 8, 11

Table 3-4. WMA B-BX-BY Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E33-339	DG	2001 (C)	123.2	404.3	117.2	384.4	121.67	399.19	11/9/2018	4.5	14.8	Q	2, 5, 8, 11

Note: Requirements from Table 3-1 of DOE/RL-2012-53, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area B-BX-BY*.

a. Decommissioned in 2013 because it was a potential conduit for migration of contaminated perched water into the underlying aquifer.

b. Hydraulic head data for these wells were not corrected for borehole deviation from vertical, which may cause reported head to be less than actual head.

— = no information (well decommissioned)

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly

UG = upgradient

Table 3-5. Groundwater Velocity at WMA B-BX-BY

Flow Direction	142 degrees (southeast)
Flow Rate Range (m/d)	0.26 to 0.28
Hydraulic Conductivity Range (m/d) (Source)	17,000 to 18,800 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model, Version 7.1*, and 200-BP-5 Operable Unit treatability test results, respectively
Effective Porosity	0.2
Gradient Range (m/m)	3.0×10^{-6}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-6. WMA B-BX-BY Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	89.6	128	—	
Calcium (unfiltered)	µg/L	38,500	190,000	—	
Calcium (filtered)	µg/L	39,000	190,000	—	
Chloride	mg/L	10.9	41	250[b]	
Cyanide (total)	µg/L	<1.67	1,030	—	
Cyanide (free)[c]	µg/L	<1.0	16.7	200/4.8[d]	299-E33-20, 299-E33-44, 299-E33-47, and 299-E33-337
Magnesium (unfiltered)	µg/L	11,000	51,800	—	
Magnesium (filtered)	µg/L	11,500	53,300	—	
Nitrate	mg/L	41.8	1,060	45[e]	All wells; minimum value excludes a suspect value
pH		7.58	8.21	—	
Potassium (unfiltered)	µg/L	6,130	19,000	—	
Potassium (filtered)	µg/L	6,090	19,000	—	
Sodium (unfiltered)	µg/L	21,900	220,000	—	
Sodium (filtered)	µg/L	21,700	222,000	—	
Specific conductance	µS/cm	425	2,445	—	
Sulfate	mg/L	47	228	250[b]	
Total organic carbon	µg/L	<234	2,290	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. This analysis is not required under the groundwater monitoring plan but was performed in 2018.

d. These comparison values apply to free cyanide:

- 200 µg/L, 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels"
- 4.8 µg/L, WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B"

e. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

RCRA = *Resource Conservation and Recovery Act of 1976*

3.3 Waste Management Area C

WMA C is located in the east-central portion of the 200 East Area (Figures 1-1 and 3-3). Constructed in 1943 and 1944, WMA C provided interim storage for radioactive mixed waste, primarily from the bismuth phosphate, PUREX, and uranium extraction processes. High-level liquid waste from these processes was stored in 12 SSTs, each with a capacity of 2.01 million L (530,000 gal). Four additional SSTs, each with a capacity of 208,000 L (55,000 gal), were also used to store high-level liquid waste. Ancillary equipment at WMA C includes diversion boxes, underground catch tanks, connecting underground pipelines, and the 244-CR vault. Of the 16 underground SSTs in WMA C, 7 tanks were confirmed or assumed to have leaked in the past (DOE/RL-2009-77, *Groundwater Quality Assessment Plan for the Single-Shell Waste Management Area C*), and retrieval processes since 1998 have removed the remaining liquid waste. Additional release sources include past waste losses from spare inlet nozzles or cascade lines, pipeline leaks, and surface releases.

DOE monitors groundwater beneath WMA C under an interim status assessment program in accordance with 40 CFR 265.93(d)(4), as defined in DOE/RL-2009-77. While developing DOE/RL-2009-77, an assessment of historical process chemistry, leak assessment reports, and groundwater contaminant distribution concluded that cyanide had affected groundwater beneath the C Tank Farm. Although other releases from WMA C have affected groundwater, there is currently no significant evidence of additional dangerous waste or dangerous waste constituents.

Table 3-7 lists the wells monitored for WMA C. Well 299-E27-4 was formerly in the monitoring network, but because of casing corrosion, it was removed from service in 2016 and decommissioned in 2017. WMA C monitoring wells are *Washington Administrative Code* compliant, except for well 299-E27-7. Replacement well 299-E27-26 was installed in 2016, and samples were collected from both wells in 2017 and 2018. Total cyanide concentrations are on average 5 μg/L higher in the new well than in the old well. Nitrate is also slightly higher in the new well (on average 1.3 mg/L). A revised assessment plan is expected to remove well 299-E27-7 and add well 299-E27-26. All of the wells were sampled quarterly during the reporting period (Table 3-7).

Excluding outliers, the water table elevation at WMA C declined an average of 1.2 cm/yr (0.5 in./yr) between 2012 and 2016. By comparison, the water table declined on average 4.9 cm (1.9 in.) between December 2017 and December 2018. The WMA C groundwater wells have adequate water in the screened intervals for sampling during the next two decades. The well network remains adequate for monitoring dangerous waste constituents originating from WMA C.

Groundwater gradient magnitude and flow direction were determined using a low-gradient monitoring network across the 200 East Area (Figures 1-2 and 3-3). The estimated average gradient was 1.4×10^{-5} m/m, dipping toward the south-southeast (Table 3-8). The estimated flow rate was 1.2 m/d (4 ft/d).

Monitoring at WMA C focuses on cyanide, which is a dangerous waste constituent and detected in 8 of the 11 WMA C groundwater wells. None of the wells had total cyanide results >200 μg/L in 2018. The highest total cyanide concentrations are at cross-gradient well 299-E27-155 (2018 maximum of 72 μg/L and average of 47 μg/L), which appear to be associated with the leading edge of the plume from the B Complex area. The well with the next highest total cyanide concentration is well 299-E27-24 (2018 average of 19.2 μg/L), which also appears to be associated with the leading edge of plumes from the B Complex area. Both of these wells are screened across the lower part of the unconfined aquifer. In the upper part of the unconfined aquifer, wells 299-E27-14 and 299-E27-26 had the highest total cyanide concentrations. The concentrations in these wells are <10 μg/L and appear to be associated with releases from WMA C. A planned CERCLA Record of Decision for interim action includes installing an extraction system (containing one or more extraction wells) in or downgradient of WMA C.

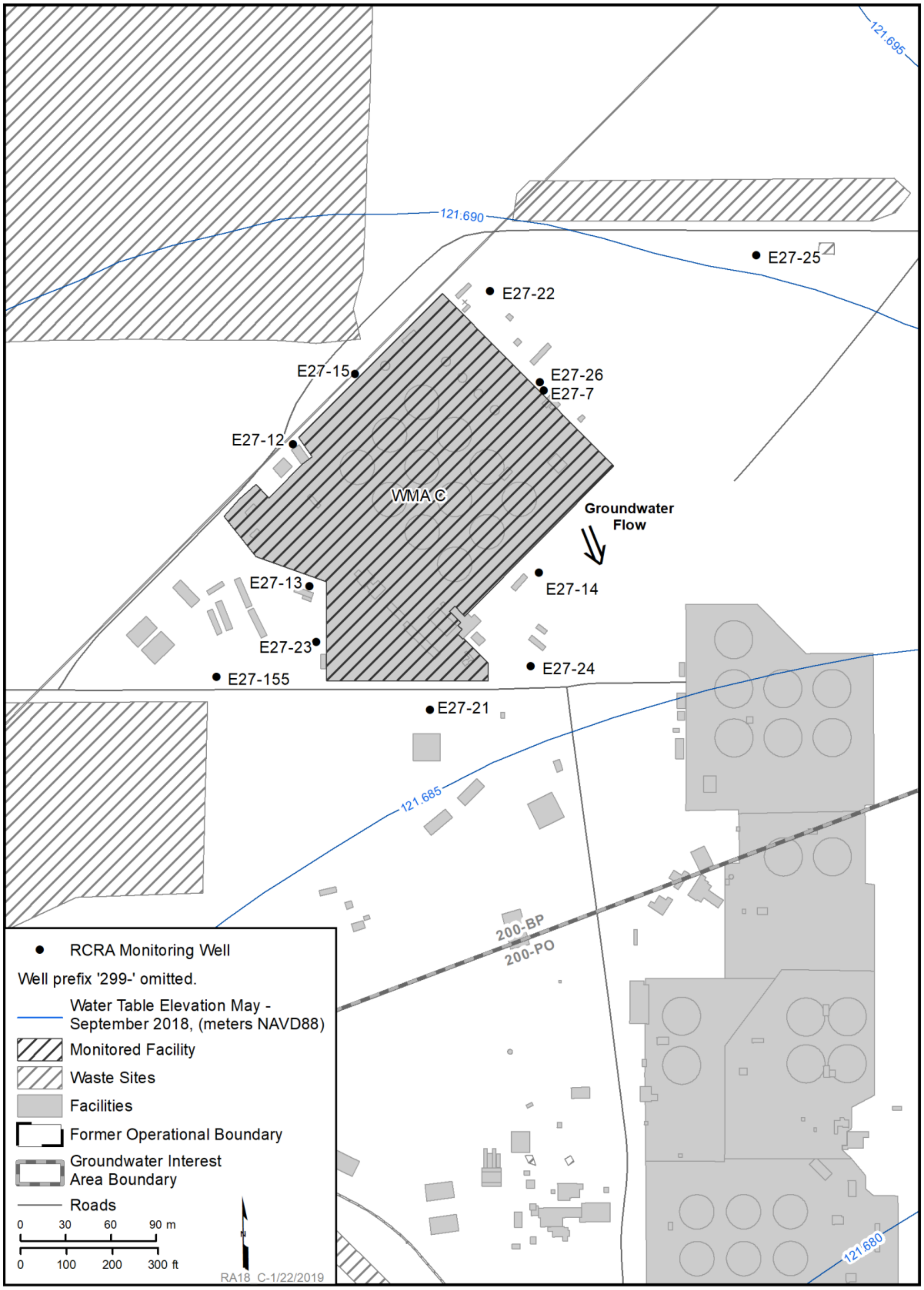
Groundwater samples from WMA C wells are analyzed for free cyanide, although not specifically required by the monitoring plan. Except for one outlier, free cyanide concentrations in 2018 were <6 µg/L. The maximum free cyanide concentration at well 299-E27-26 (18.2 µg/L) was flagged as suspect because it was inconsistent with a filtered sample (nondetect) and with the remainder of the 2018 sample results (maximum of 1.11 µg/L). Free cyanide was periodically detected at wells 299-E27-14 and 299-E27-24, but 2018 average concentrations in these wells were below the MTCA cleanup standard of 4.8 µg/L (WAC 173-340).

Table 3-9 summarizes the 2018 groundwater quality parameters and other constituents required by DOE/RL-2009-77. Iron, nitrate, and sulfate were above comparison values in 2018, and a discussion of each follows.

Iron was above the secondary DWS in a filtered sample from well 299-E27-13 and in unfiltered samples from three wells (Table 3-9). Well maintenance brushed, purged, and reinstalled the pump at well 299-E27-13 on February 14, 2018, but the filtered and unfiltered March samples still had elevated iron. Subsequent filtered samples had undetected iron. It appears that some residual iron remained in the well in March, which was subsequently removed during repeated purging and sampling. Iron was above the secondary DWS in unfiltered samples from well 299-E27-25 in March and June 2018, but concentrations were lower in September. Unfiltered iron results were above the secondary DWS at well 299-E27-7 for all of the 2018 sampling events. This well is an older carbon steel well that has been replaced with well 299-E27-26 and will be evaluated for decommissioning in the future.

Nitrate concentrations were >45 mg/L at all but three of the WMA C wells in 2018 due to local and regional nitrate plumes. Nitrate concentrations increased an average of 16 mg/L since December 2017, largely due to increases at wells 299-E27-14 and 299-E27-155. Well 299-E27-14 is affected by local WMA C releases, while well 299-E27-155 is affected by a regional B Complex plume migrating into the area.

Sulfate concentrations were >250 mg/L in six WMA C wells in 2018 (Table 3-9) due to local and regional sulfate plumes. Sulfate concentrations increased an average of 21 mg/L since December 2017. Only wells 299-E27-14 and 299-E27-24 are impacted by local WMA C sources. The other wells are affected by a regional plume sourced to the north.



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

Figure 3-3. Waste Management Area C

Table 3-7. WMA C Groundwater Monitoring Network

Well Name	Location[a]	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Comments
			m	ft	m	ft	m	ft		m	ft		
299-E27-4	DG	2003 (C)	—	—	—	—	—	—	—	—	—	—	Decommissioned in 2017 because of casing corrosion
299-E27-7[b]	DG	1982 (P)	120.8	396.2	108.6	356.2	121.68	399.21	8/21/2018	13.1	43.0	Q	3, 6, 9, 12. To be replaced by 299-E27-26 when assessment plan revised
299-E27-12[b]	UG	1989 (C)	126.4	414.7	120.0	393.6	121.69	399.23	9/28/2018	1.7	5.6	Q	3, 6, 9, 12
299-E27-13	DG	1989 (C)	126.8	416.0	120.4	394.9	121.64	399.07	9/28/2018	1.3	4.2	Q	3, 6, 9, 12
299-E27-14[b]	DG	1989 (C)	125.9	413.1	119.5	392.1	121.68	399.20	9/25/2018	2.2	7.1	Q	3, 6, 9, 12
299-E27-15[b]	UG	1989 (C)	126.6	415.4	120.2	394.4	121.68	399.22	9/26/2018	1.5	4.8	Q	3, 6, 9, 12
299-E27-21[b]	DG	2003 (C)	122.3	401.1	111.6	366.1	121.67	399.16	9/26/2018	10.1	33.0	Q	3, 6, 9, 12
299-E27-22[b]	UG	2003 (C)	123.1	403.8	110.9	363.9	121.71	399.31	9/25/2018	10.8	35.4	Q	3, 6, 9, 12
299-E27-23[b]	DG	2003 (C)	122.3	401.2	111.6	366.2	121.68	399.20	9/26/2018	10.0	33.0	Q	3, 6, 9, 12
299-E27-24[c]	DG (deep)	2010 (C)	113.0	370.9	107.0	350.9	121.61	398.97	6/25/2018	14.7	48.1	Q	3, 6, 9, 12
299-E27-25[c]	CG	2010 (C)	123.1	404.0	117.0	383.9	121.52	398.68	9/25/2018	4.5	14.8	Q	3, 6, 9, 12
299-E27-26[d]	DG	2016 (C)	122.9	403.2	110.7	363.2	121.13	397.41	9/28/2018	10.4	34.2	Q	3, 6, 9, 12; installed as replacement for 299-E27-7; not listed in DOE/RL-2009-77

Table 3-7. WMA C Groundwater Monitoring Network

Well Name	Location[a]	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Comments
			m	ft	m	ft	m	ft		m	ft		
299-E27-155	CG (deep)	2007 (C)	116.1	380.9	105.4	345.9	121.67	399.16	9/26/2018	16.2	53.3	S	Sampled quarterly 3, 6, 9, 12

Note: Requirements from Table 3-1 of DOE/RL-2009-77, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area C*.

a. Designations as upgradient, downgradient, and cross gradient have been modified from DOE/RL-2009-77 due to a change in flow direction.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

c. Wells 299-E27-24 and 299-E27-25 were listed as “proposed well south of 299-E27-14” and “proposed upgradient well,” respectively, in Table 3-1 of DOE/RL-2009-77.

d. Head in this well is consistently much lower than other wells in the network, suggesting that the well is deviated from vertical.

— = no information (well decommissioned)

C = constructed as a resource protection well in accordance with WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells”

CG = cross gradient

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly

S = semiannually

UG = upgradient

Table 3-8. Groundwater Velocity at WMA C

Flow Direction	158 degrees (south-southeast)
Flow Rate Range (m/d)	1.2
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	1.4×10^{-5}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-9. WMA C Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	75.5	132	—	
Chloride	mg/L	11.7	79	250[b]	
Cyanide (total; unfiltered and filtered)	µg/L	<1.67	72	—	
Cyanide (free; unfiltered and filtered)[c]	µg/L	<1	5.73	200/4.8[d]	299-E27-14, 299-E27-24; range excludes "Y"-flagged data
Fluoride	mg/L	0.10	0.53	4[e]	
Iron (unfiltered)	µg/L	<17	1,800	300[b]	299-E27-13, 299-E27-25, 299-E27-7
Iron (filtered)	µg/L	<17	773	300[b]	299-E27-13
Manganese (unfiltered)	µg/L	<0.32	43	50[b]	
Manganese (filtered)	µg/L	<0.32	51.8	50[b]	299-E27-13
Nitrate	mg/L	10.2	204	45[f]	299-E27-14, 299-E27-155, 299-E27-21, 299-E27-22, 299-E27-23, 299-E27-24, 299-E27-25, 299-E27-26, 299-E27-7
Nitrite	mg/L	<0.06	0.79	3.3[f]	
pH		7.02	8.67	—	Range excludes "Y"-flagged data
Sodium (unfiltered)	µg/L	12,000	31,200	—	

Table 3-9. WMA C Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Sodium (filtered)	µg/L	12,000	31,300	—	
Specific conductance	µS/cm	406	1,184	—	Range excludes flagged data
Sulfate	mg/L	63.3	380	250[b]	299-E27-14, 299-E27-22, 299-E27-24, 299-E27-25, 299-E27-26, 299-E27-7; range excludes "Y"-flagged data

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018. Constituents as specified in Table 3-1 of DOE/RL-2009-77, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area C.*

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. This analysis is not required under the groundwater monitoring plan but was performed in 2018.

d. These comparison values apply to free cyanide:

- 200 µg/L, 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels"
- 4.8 µg/L, WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B"

e. 40 CFR 141, Subpart G.

f. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L expressed as nitrogen (40 CFR 141, Subpart G). These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

< = one or more of the results was below the detection limit

— = no comparison value

RCRA = *Resource Conservation and Recovery Act of 1976*

3.4 Waste Management Area S-SX

WMA S-SX (Figure 3-4) consists of the S and the SX Tank Farms. The S Tank Farm contains 12 SSTs, each with a capacity of 2.9 million L (758,000 gal). The SX Tank Farm contains 15 SSTs, each with a capacity of 3.8 million L (1,000,000 gal) (Section 1.2 of RPP-7884, *Field Investigation Report for Waste Management Area S-SX*). The WMA also includes the following ancillary equipment: three catch tanks; one receiver tank; six diversion boxes; and associated piping, valve pits, and pumps (Section 1.2 of RPP-7884). Both tank farms received waste from the REDOX Plant in the 1950s and 1960s. To minimize the probability and severity of future leaks, most of the drainable liquid in each tank has been removed and transferred to DSTs.

In 1996, at the direction of Ecology, WMA S-SX was placed into assessment status because of elevated specific conductance in downgradient monitoring wells. The first determination assessment found that multiple sources within the WMA had affected groundwater quality with elevated chromium (Chapter 5.0 of PNNL-11810, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas S-SX at the Hanford Site*). Monitoring is currently performed under DOE/RL-2009-73, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area S-SX*. The objective of RCRA monitoring at WMA S-SX is to assess the rate and extent of migration and the concentration of the dangerous waste constituent chromium in the groundwater.

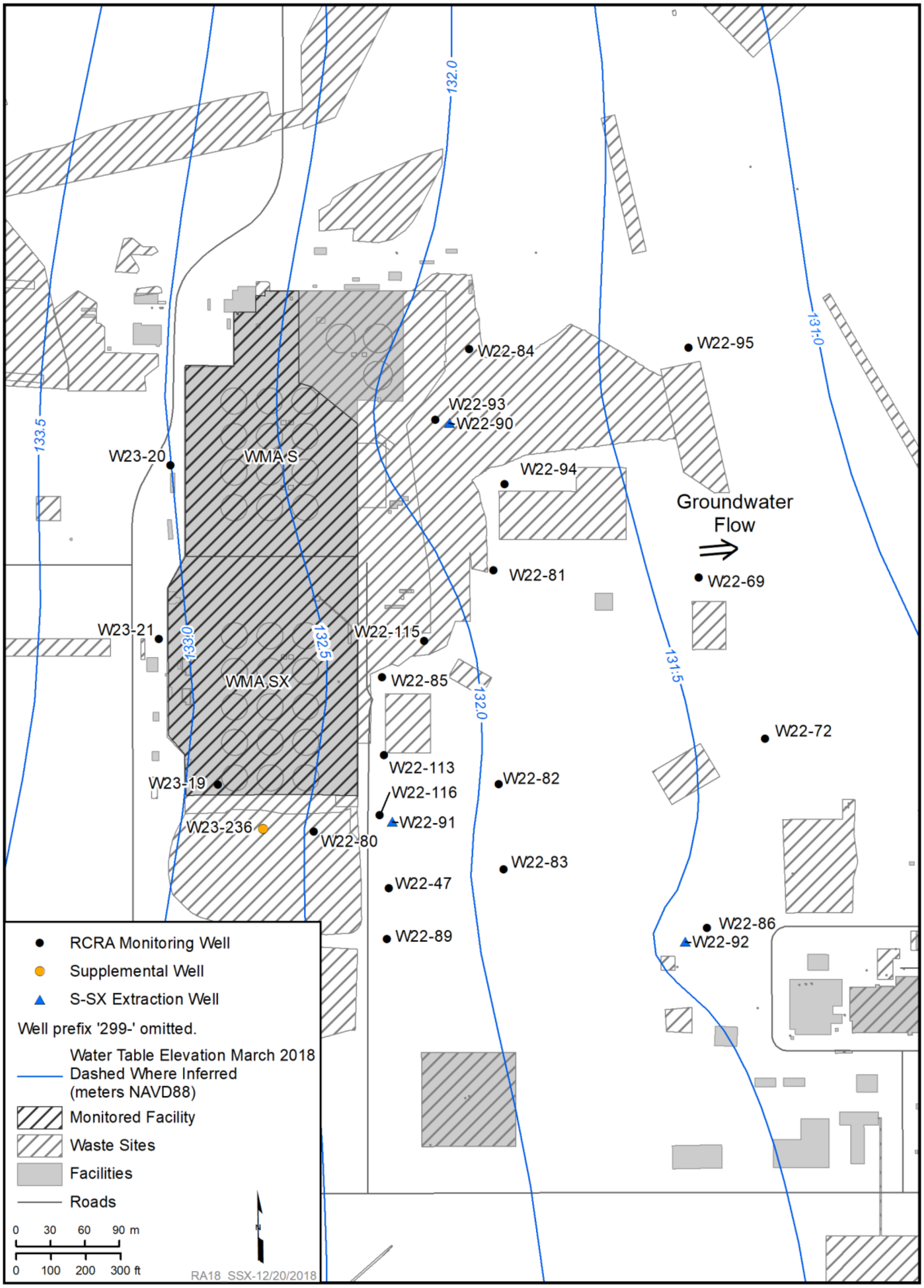
Table 3-10 lists the monitoring wells for WMA S-SX. Based on the well distribution compared to the extent of contamination, the current well network is capable of monitoring the contaminant distribution at WMA S-SX. All wells were sampled as required during 2018, and the WMA remains in interim status groundwater quality assessment monitoring in 2019. A revised monitoring network was recommended by SGW-60577, *Engineering Evaluation Report for Single-Shell Tank Waste Management Area S-SX Groundwater Monitoring*.

Water levels in the wells declined an average of 18 cm (8.7 in.) during 2018. This was less than in 2017, when the decline was 22 cm (7.1 in.). The groundwater extraction system operating at WMA S-SX and the 200 West P&T system had lower average pumping rates during 2018, which may have contributed to the lower average decline in the local water level. Trend surface analysis performed on water-level measurements collected during March 2018 resulted in an estimated hydraulic gradient of 3.4×10^{-3} m/m toward the east (82 degrees azimuth). The estimated groundwater flow rate in 2018 was 0.17 m/d (0.56 ft/d) (Table 3-11), consistent with the 2017 value of 0.15 m/d (0.49 ft/d).

Table 3-12 summarizes the assessment data. Groundwater beneath WMA S-SX is contaminated with the dangerous waste constituent chromium at levels above the DWS. The chromium is attributed to a 91,000 L (24,000 gal) overfill event from tank S-104 in the S Tank Farm (Sections 3.7.2 and 4.6 in RPP-RPT-48589, *Hanford 241-S Farm Leak Assessment Report*) and a 190,000 L (51,000 gal) leak from tank SX-115 during 1965 in the SX Tank Farm (Section 4.3 and Table ES-1 of RPP-ENV-39658, *Hanford SX-Farm Leak Assessments Report*). The Cr(VI) analysis is not required by the monitoring plan, but available data show concentrations about the same as total chromium. Because dissolved chromium is highly mobile in the aquifer, it migrates to the east at the same average flow rate as groundwater (0.17 m/d [0.56 ft/d]). Depth-discrete sampling while drilling well 299-W22-47 indicated that chromium was present within the upper 20 m (65 ft) of the aquifer.

Groundwater extraction wells (Figure 3-4) have altered chromium plume migration. Instead of moving eastward, some of the chromium is drawn into the extraction wells. The groundwater extraction system has caused chromium concentrations to decline in several network wells. Of the six wells that had baseline chromium concentrations above the 48 μg/L 200-UP-1 OU cleanup level prior to P&T, concentrations decreased in wells 299-W22-47, 299-W22-83, 299-W22-86, 299-W22-93, and 299-W22-116. The chromium concentration in well 299-W22-95 increased between 2013 and 2016 and then leveled off in 2017 and 2018 (34 to 44 μg/L in filtered and unfiltered 2018 samples). The increase in concentrations is consistent with downgradient migration of the S Tank Farm portion of the plume. At well 299-W23-19 inside the SX Tank Farm, the chromium concentration increased from 190 μg/L in December 2017 to 338 μg/L in December 2018 (Figure 3-5). The increase in well 299-W23-19 indicates that chromium is migrating downward through the vadose zone as a continuing source. At well 299-W22-93, directly downgradient of the S Tank Farm, the chromium concentration has been steady over the past few years (124 μg/L in December 2018), consistent with a continuing source.

Seven wells had nitrate concentrations above the DWS due to a regional contaminant plume (Table 3-12). Iron and manganese are not required analyses under the groundwater assessment plan, but data are available along with required metals. Sample turbidity, iron, and manganese (unfiltered) were elevated in well 299-W22-81 in 2018. The well is scheduled to be cleaned in early 2019.



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

Figure 3-4. Waste Management Area S-SX

Table 3-10. WMA S-SX Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W22-47	DG	2005 (C)	135.8	445.6	125.2	410.6	132.14	433.54	9/11/2018	7.0	22.9	Q	1, 3, 6, 9, 12
299-W22-69	DG	2006 (C)	134.7	442.0	124.0	406.9	131.34	430.90	9/11/2018	7.3	24.0	A	1, 3, 6, 9, 12
299-W22-72	DG	2006 (C)	135.1	443.3	124.4	408.3	131.29	430.75	9/11/2018	6.9	22.5	A	1, 3, 6, 9, 12
299-W22-80	DG	2000 (C)	137.5	451.1	126.8	416.0	132.41	434.42	9/10/2018	5.6	18.4	A	3, 6, 9, 12 (missed January)
299-W22-81	DG	2001 (C)	136.8	448.8	126.1	413.9	131.86	432.60	9/11/2018	5.7	18.7	A	1, 3, 6, 9, 12
299-W22-82	DG	2001 (C)	137.2	450.2	126.5	415.1	131.92	432.81	9/11/2018	5.4	17.7	A	1, 3, 6, 9, 12
299-W22-83	DG	2001 (C)	137.4	450.7	126.7	415.7	131.87	432.65	9/12/2018	5.2	17.0	A	1, 3, 6, 9, 12
299-W22-84	DG	2001 (C)	137.1	449.7	126.4	414.7	131.85	432.59	9/10/2018	5.4	17.8	A	2, 3, 6, 9, 12
299-W22-85	DG	2001 (C)	137.5	451.1	126.9	416.2	132.31	434.09	9/11/2018	5.4	17.8	A	1, 3, 6, 9, 12
299-W22-86	DG	2006 (C)	135.2	443.5	124.5	408.4	131.29	430.75	9/12/2018	6.8	22.4	A	1, 3, 6, 9, 12
299-W22-89	DG	2006 (C)	135.1	443.3	124.4	408.2	132.17	433.62	9/12/2018	7.8	25.4	A	1, 3, 6, 9, 12
299-W22-93 (replacement for 299-W22-44)[b]	DG	2015 (C)	132.3	434.1	121.6	399.1	131.70	432.07	9/10/2018	10.1	33.0	Q	2, 3, 6, 9, 12
299-W22-94 (replacement for 299-W22-48)[b]	DG	2013 (C)	133.2	436.9	122.5	401.9	131.76	432.29	9/12/2018	9.3	30.4	S	1, 3, 6, 9, 12
299-W22-95 (replacement for 299-W22-26)[b]	DG	2013 (C)	132.1	433.3	119.9	393.3	131.37	430.99	9/12/2018	11.5	37.7	S	1, 3, 6, 9, 12
299-W22-113 (replacement for 299-W22-49)[b]	DG	2014 (C)	132.7	435.5	123.6	405.4	132.19	433.70	9/10/2018	8.6	28.3	S	1, 3, 6, 9, 12
299-W22-115 (replacement for 299-W22-45)[b]	DG	2015 (C)	133.3	437.2	122.6	402.1	132.14	433.54	9/10/2018	9.6	31.4	S	2, 3, 6, 9, 12

Table 3-10. WMA S-SX Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W22-116 (replacement for 299-W22-50)[b]	DG	2015 (C)	132.5	434.8	121.9	399.8	132.17	433.63	9/11/2018	10.3	33.8	A	1, 3, 6, 9, 12
299-W23-19[c]	DG	1999 (C)	138.3	453.6	128.9	423.0	132.87	435.93	9/11/2018	3.9	12.9	Q	3, 6, 9, 12 (missed January)
299-W23-20	UG	2000 (C)	138.3	453.8	126.7	415.8	133.02	436.43	9/11/2018	6.3	20.6	A	1, 3, 6, 9, 12
299-W23-21	UG	2000 (C)	137.8	452.0	126.5	414.9	133.13	436.79	9/11/2018	6.7	21.8	A	1, 3, 6, 9, 12
299-W23-236	DG	2015 (C)	132.9	436.0	122.2	401.0	132.67	435.27	9/11/2018	10.4	34.3	A	Not included in DOE/RL-2009-73, but sampled 3, 6, 9, 12 (missed January)

Note: Requirements from Table 3-2 of DOE/RL-2009-73, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area S-SX*. An additional well listed in DOE/RL-2009-73, 299-W23-15, has not been sampled in recent years due to a lack of access inside the tank farms.

a. Listed frequency is as required under the monitoring plan. Quarterly sampling was conducted in all wells for all constituents in 2018 in anticipation of a monitoring plan revision. Sampled in January 2018 because some samples from December 2017 missed holding times.

b. Wells formerly monitored for WMA S-SX (listed in DOE/RL-2009-73) went dry and were replaced.

c. Water-level measurements are not possible from well 299-W23-19 because it is located within the tank farm fence line and is sampled remotely from outside the fence. The water level was estimated as 0.2 m higher than at nearby well 299-W23-236.

A = annually

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

Q = quarterly

S = semiannually

UG = upgradient

WMA = waste management area

Table 3-11. Groundwater Velocity at WMA S-SX

Flow Direction	82 degrees (east)
Flow Rate (m/d)	0.17
Hydraulic Conductivity (m/d) (Source)	5 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	3.4×10^{-3}
Comments	Gradient and direction determined by trend surface analysis using March 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-12. WMA S-SX Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	78	116	—	
Calcium (unfiltered)	µg/L	18,800	74,000	—	
Calcium (filtered)	µg/L	18,200	71,700	—	
Chloride	mg/L	3.6	21	250[b]	Range excludes “Y”-flagged data
Chromium (unfiltered)	µg/L	<1.3	367	100[c]	299-W22-116, 299-W22-81, 299-W22-93, 299-W23-19
Chromium (filtered)	µg/L	<1.3	373	100[c]	299-W22-116, 299-W22-93, 299-W23-19
Magnesium (unfiltered)	µg/L	6,250	25,000	—	
Magnesium (filtered)	µg/L	6,030	24,200	—	
Nitrate	mg/L	5.75	270	45[d]	299-W22-115, 299-W22-116, 299-W22-72, 299-W22-85, 299-W22-93, 299-W22-95, 299-W23-19
pH Measurement		6.87	8.5	6.5 – 8.5[b]	
Potassium (unfiltered)	µg/L	2,770	4,850	—	
Potassium (filtered)	µg/L	2,670	4,730	—	
Sodium (unfiltered)	µg/L	12,000	33,500	—	
Sodium (filtered)	µg/L	12,000	33,200	—	
Specific conductance	µS/cm	242	752	—	
Sulfate	mg/L	11	35	250[b]	Range excludes “Y”-flagged data
Temperature	ºC	13.5	24.6	—	

Table 3-12. WMA S-SX Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Turbidity	NTU	0.23	1,000	—	

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

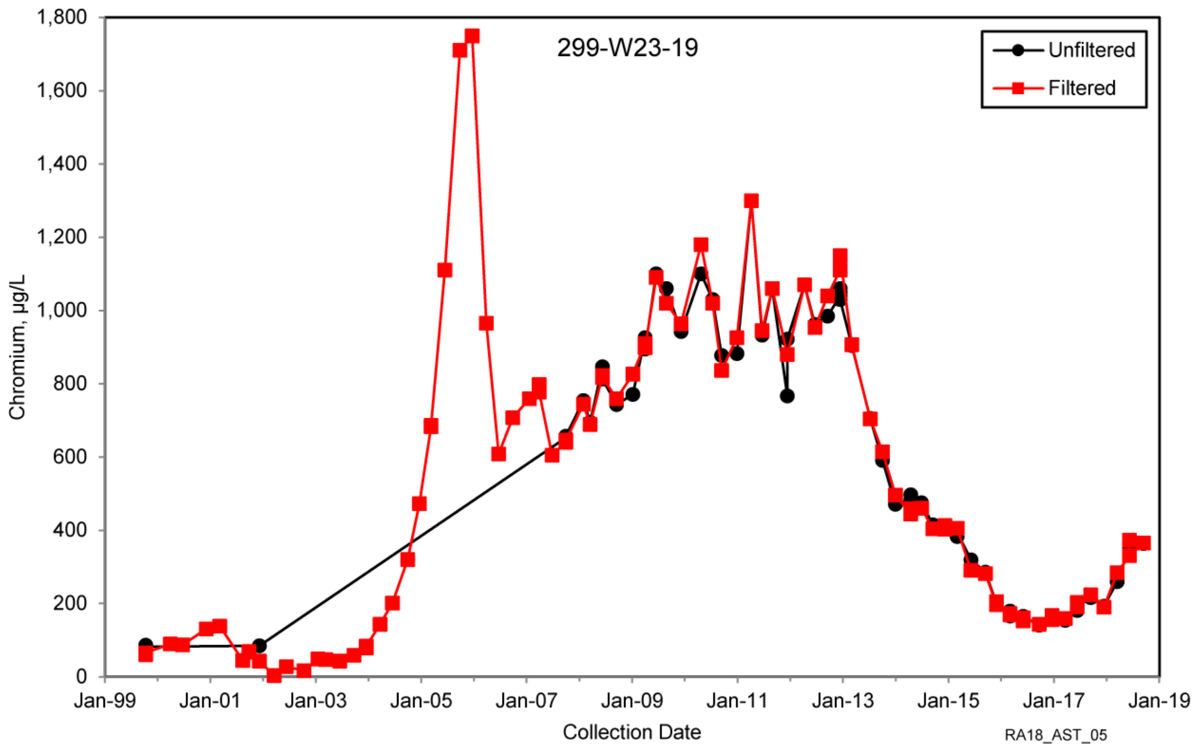


Figure 3-5. Chromium Concentration in Well 299-W23-19 at WMA S-SX

3.5 Waste Management Area T

WMA T (Figure 3-6), which includes the T Tank Farm, is located in the northern portion of the 200 West Area. WMA T contains 16 underground SSTs constructed in 1943 and 1944. Tanks T-101 through T-112 have capacities of 2,000,000 L (528,000 gal), and tanks T-201 through T-204 have capacities of 208,000 L (55,000 gal). WMA T also includes diversion boxes, ancillary pumps, valves, and pipes.

The tanks in WMA T began receiving waste in 1944 and were in almost continual use until 1980, when all tanks in this WMA were removed from service. The SSTs received transuranic, high-level metal, and first-cycle waste from chemical processing of uranium-bearing, irradiated reactor fuel rods. Lesser amounts of other waste also were stored in the WMA T tanks. WHC-MR-0132, *A History of the 200 Area Tank Farms*; WRPS-55779-FP, *Hanford Tank Waste to WIPP – Maximizing the Value of our National Repository Asset – 14230*; and RPP-7218, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*, provide more detailed information on WMA T waste inventory. Most of the drainable liquid in each tank has been removed, and the tanks have been interim stabilized. As interim corrective action, berms were constructed around the tank farms in 2001 to stop run-on of natural precipitation, and all known water lines were tested or cut off. Interim surface barriers were placed over tanks in WMA T in 2008 to inhibit precipitation infiltration.

WMA T was placed in assessment in 1993 due to elevated specific conductance. Cr(VI) is a dangerous waste constituent monitored under the RCRA assessment program. From 1944 to 1980, the WMA received metal and first-cycle waste from chemical processing, including the bismuth phosphate, tributyl phosphate, and REDOX processes. Past leaks from SSTs and waste pipelines within the WMA are the sources of Cr(VI) contamination, described in DOE/RL-2009-66, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area T.*

Table 3-13 lists wells sampled in 2018. Assessment well 299-W10-23 is used to help distinguish other contaminant plumes impinging on WMA T. Wells monitor the upper portion of the unconfined aquifer. The 200 West P&T system caused water levels in WMA T wells to decline from the 1990s until 2016, when the decline ceased. The WMA monitoring wells have sufficient water for sampling (Table 3-13) and are not expected to go dry. A revised monitoring network, including three new wells, was recommended by SGW-60575, *Engineering Evaluation Report for Single-Shell Tank Waste Management Area T Groundwater Monitoring.* The Tri-Parties negotiate replacement wells annually in accordance with Tri-Party Agreement Milestone M-24-00.

Extraction wells east of the WMA affect local groundwater flow (Figure 3-6). Groundwater flows to the east-southeast under a gradient of 7.1×10^{-3} m/m. The estimated groundwater and contaminant flow rate beneath WMA T is 0.36 m/d (1.2 ft/d) (Table 3-14). The direction of groundwater flow is not expected to change with continued operation of the 200 West P&T.

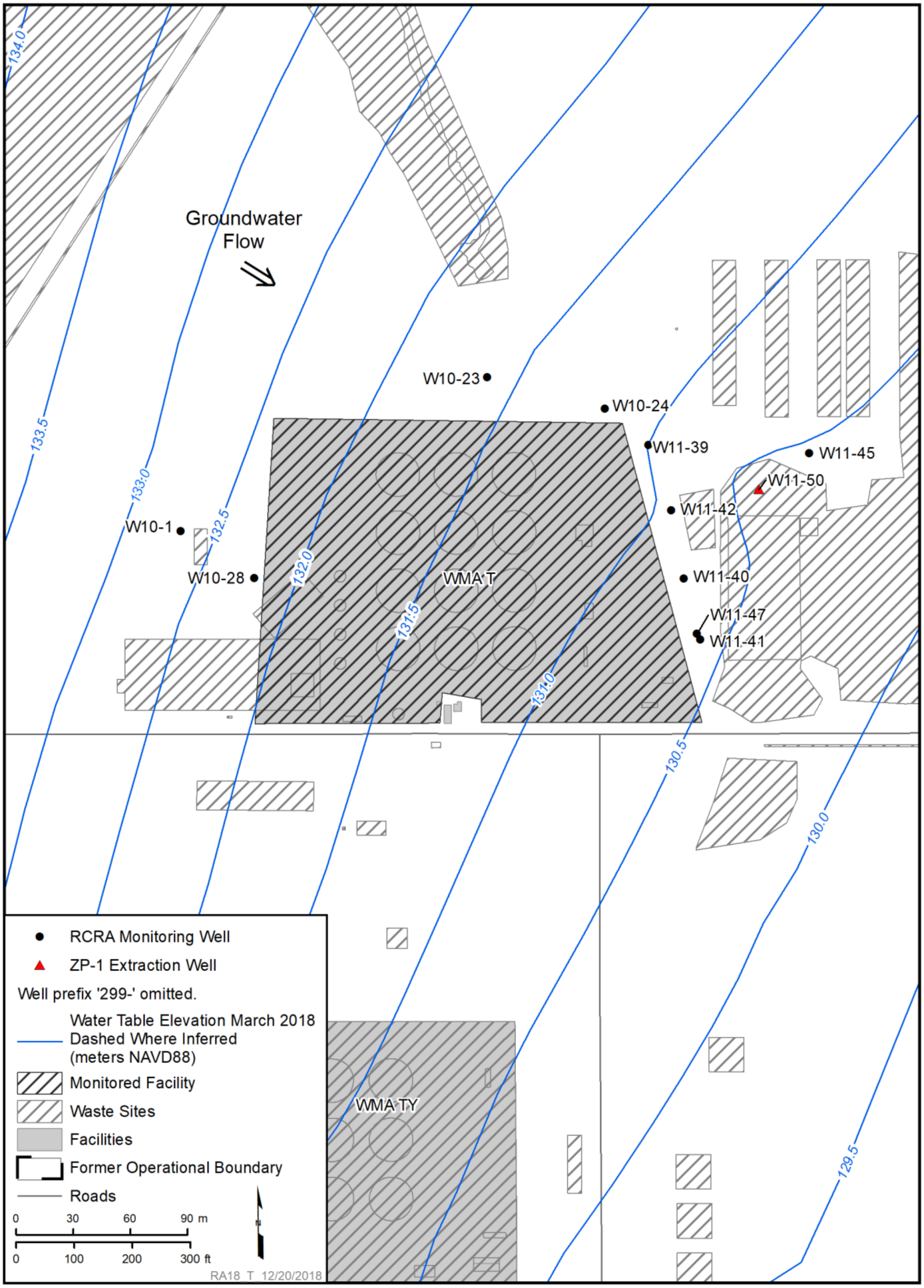
Table 3-13 lists the wells monitored for WMA T. Well 299-W11-41 was sampled more frequently than required in 2018 to provide information on cyanide contamination, which is not currently required under DOE/RL-2009-66.

Table 3-15 summarizes the monitoring results for 2018. The concentration of the dangerous waste constituent Cr(VI) was 120 µg/L in well 299-W10-28 in 2018, which was the same as 2017 and above the MTCA standard (WAC 173-340). Concentrations of total chromium were about the same as Cr(VI).

Nitrate is also found in groundwater beneath the WMA and is from the same source as the Cr(VI). The nitrate plume beneath WMA T is within a regional nitrate plume and did not change significantly between 2017 and 2018; however, the maximum concentrations for the network increased. The highest nitrate levels in 2018 were in upgradient well 299-W10-28 (531 mg/L) and downgradient well 299-W11-41 (270 mg/L). While WMA T is a source of nitrate, other upgradient sources are larger contributors.

In 2018, fluoride concentrations were above the primary DWS in wells 299-W10-23, 299-W10-24, and 299-W11-39, which is consistent with previous results.

Monthly sampling for total cyanide and free cyanide was initiated at well 299-W11-41 in February 2017. There were no detections during 2018, except one free cyanide result that was flagged as suspect.



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

Figure 3-6. Waste Management Area T

Table 3-13. WMA T Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W10-1	UG	1947 (P)	148.6	487.6	124.2	407.6	132.94	436.16	11/15/2018	8.7	28.5	A	2, 5, 8, 11
299-W10-4	ASMT	1952 (P)	147.3	483.4	130.6	428.4	—	—	—	—	—	—	Dry since 2014
299-W10-8	DG	1973 (P)	143.2	469.8	131.0	429.8	—	—	—	—	—	—	Dry since 2015
299-W10-23	ASMT	1998 (C)	137.8	452.1	127.1	417.1	131.60	431.77	11/14/2018	4.5	14.6	B	2, 5, 8, 11
299-W10-24	DG	1998 (C)	138.0	452.6	127.3	417.6	131.23	430.55	11/14/2018	3.9	12.9	A	2, 5, 8, 11
299-W10-28	UG	2001 (C)	137.5	451.2	126.9	416.2	132.76	435.56	11/15/2018	5.9	19.4	A	2, 5, 8, 11
299-W11-39	DG	2000 (C)	137.0	449.6	126.4	414.6	131.04	429.92	11/14/2018	4.7	15.3	A	2, 5, 8, 11
299-W11-40	DG	2000 (C)	137.2	450.0	126.5	415.0	130.88	429.38	11/14/2018	4.4	14.4	Q	2, 5, 8, 11
299-W11-41	DG	2000 (C)	137.4	450.9	126.8	415.9	130.75	428.98	11/14/2018	4.0	13.1	Q	Monthly[b]
299-W11-42	DG	2000 (C)	137.9	452.6	127.3	417.6	131.08	430.06	11/15/2018	3.8	12.5	Q	2, 5, 8, 11
299-W11-45	Far-field	2006 (C)	127.2	417.4	122.7	402.4	130.45	427.99	11/15/2018	7.8	25.6	S	2, 5, 8, 11
299-W11-47	DG	2006 (C)	126.1	413.8	116.7	382.8	130.66	428.67	11/15/2018	14.0	45.8	Q	2, 5, 8, 11

Note: Requirements from Table 3-2 of DOE/RL-2009-66, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area T*.

a. Listed frequency is as required under the monitoring plan. Quarterly sampling was performed in 2018 in anticipation of a monitoring plan revision.

b. Well 299-W11-41 was sampled monthly for cyanide in 2018; not required under DOE/RL-2009-66.

— = no information (dry wells)
A = annually
ASMT = assessment of plume
B = biennial (every other year)
C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"
DG = downgradient
P = constructed prior to *Washington Administrative Code* requirements
Q = quarterly
S = semiannually
UG = upgradient

Table 3-14. Groundwater Velocity at WMA T

Flow Direction	107 degrees (east-southeast)
Flow Rate (m/d)	0.36
Hydraulic Conductivity (m/d) (Source)	5 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	7.1×10^{-3}
Comments	Gradient and direction determined by trend surface analysis using March 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-15. WMA T Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	107	141	—	
Calcium (unfiltered)	µg/L	3,880	128,000	—	
Chloride	mg/L	12.2	25	250[b]	
Chromium (unfiltered)	µg/L	10.2	238	100[c]	299-W10-28, 299-W11-39
Cr(VI) (unfiltered)	µg/L	<1.5	120	48[d]	299-W10-28
Dissolved oxygen	mg/L	6.22	10.08	—	
Fluoride	mg/L	0.29	5.6	4[c]	299-W10-23, 299-W10-24, 299-W11-39
Magnesium (unfiltered)	µg/L	1,140	39,600	—	
Nitrate	mg/L	33.8	531	45[e]	All except 299-W10-1; minimum value excludes suspect data points
pH		7.68	9.23	—	
Potassium (unfiltered)	µg/L	1,750	6,140	—	
Sodium (unfiltered)	µg/L	10,300	149,000	—	
Specific conductance	µS/cm	416	1,216	—	
Sulfate	mg/L	26	58.2	250[b]	
Temperature	°C	13.4	23.2	—	
Turbidity	NTU	0.47	48.5	—	

Note: Minimum and maximum are based on quarterly sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, “National Secondary Drinking Water Regulations,” “Secondary Maximum Contaminant Levels.”

Table 3-15. WMA T Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

e. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

3.6 Waste Management Area TX-TY

WMA TX-TY (Figure 3-7), which includes the TX and TY Tank Farms, is located in the northern portion of the 200 West Area. The WMA contains 24 underground 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). In addition to the tanks, six diversion boxes and ancillary pumps, valves, and pipes are included in the Hanford RCRA Permit Part A Form for the SSTs in the TX-TY Tank Farms system.

The tanks in WMA TX-TY began receiving waste in 1949, with the tanks in both farms used to support the bismuth phosphate process and the uranium-recovery program. Some of the tanks also received waste from REDOX and PUREX Plant operations. Detailed information on WMA TX-TY is provided in DOE/RL-2009-67, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY*. Most of the drainable liquid in the tanks has been removed, and the tanks have been interim stabilized. As interim corrective action, berms were constructed around the tank farms in 2001 to stop run-on of natural precipitation. Water lines were pressure tested and, if needed, were repaired. Lines no longer needed were cut and capped. Interim surface barriers were placed over tanks in the TY Tank Farm in 2011 to inhibit precipitation infiltration.

The WMA is regulated under RCRA and its implementing requirements as described in DOE/RL-2009-67. WMA TX-TY is monitored under an interim status assessment program because of elevated specific conductance in two downgradient wells in 1993. The dangerous waste constituent Cr(VI) was monitored under the WMA TX-TY RCRA assessment program during the reporting period. Table 3-16 lists the current monitoring network for WMA TX-TY. Wells monitor the upper portion of the unconfined aquifer. A revised monitoring network, including two new wells, was recommended in SGW-60576, *Engineering Evaluation Report for Single-Shell Tank Waste Management Area TX-TY Groundwater Monitoring*. The Tri-Parties negotiate replacement wells annually in accordance with Tri-Party Agreement Milestone M-24-00.

The 200 West P&T extraction wells on the east, west, and south sides of the WMA alter the groundwater flow direction and hydraulic gradients (Figure 3-7). Based on March 2018 water-level data, the overall flow direction is toward the east, but local directions vary from southeast to east-northeast. The hydraulic gradient averaged 9.5×10^{-3} m/m, and the groundwater and contaminant flow rate was estimated at 0.48 m/d (1.6 ft/d) (Table 3-17). Between 2017 and 2018, monitoring well water levels increased an average of 0.64 m (2.1 ft).

In 2018, the sampling frequency was increased to quarterly. Five wells continued to be scheduled for monthly sampling to provide information on cyanide, which is not required under the monitoring plan. All of the WMA TX-TY wells scheduled for sampling in February were sampled in March 2018 due to PFP radiological controlled area restrictions.

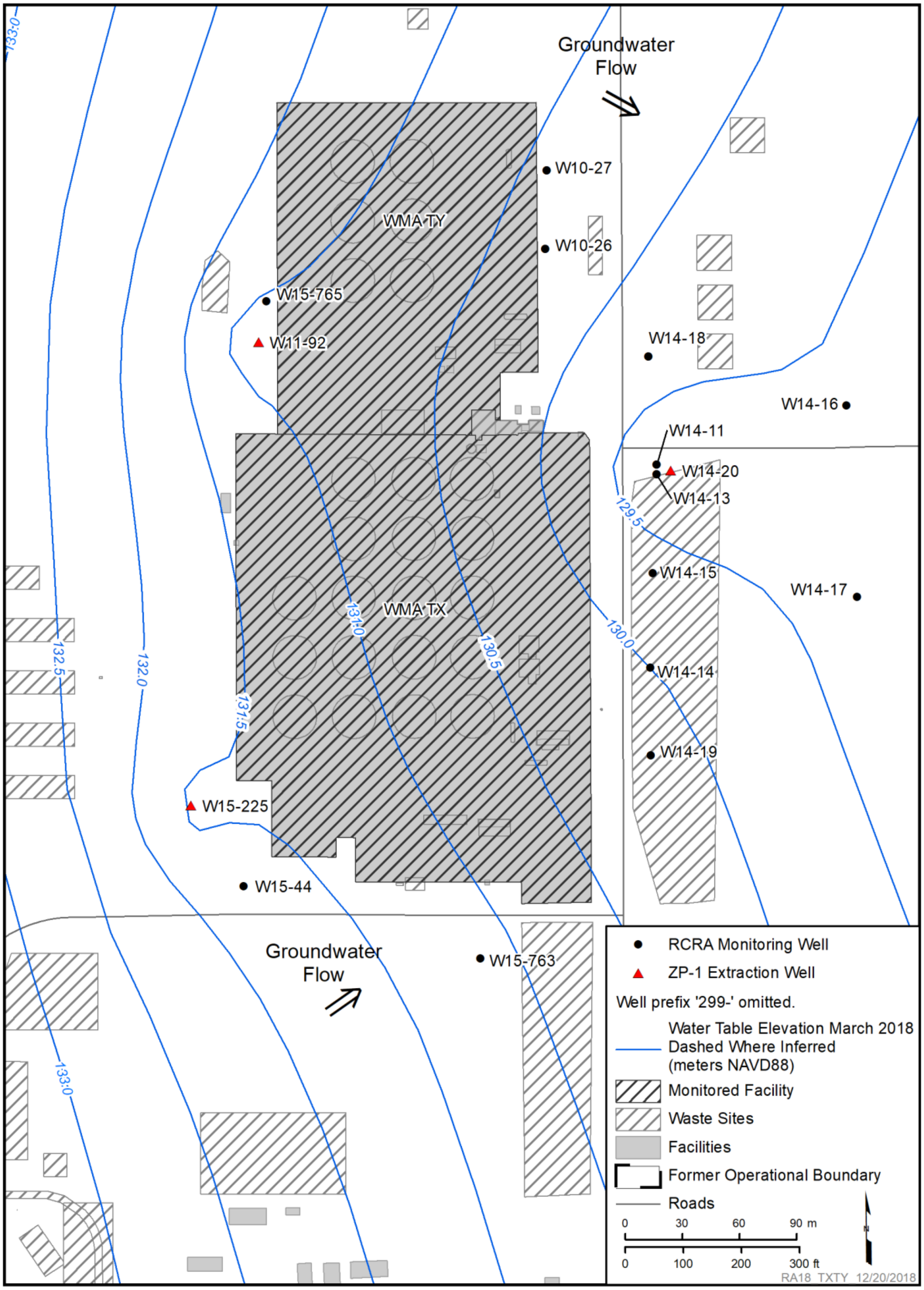
Table 3-18 summarizes the monitoring results for 2018. Cr(VI) was above the 48 µg/L MTCA standard (WAC 173-340) in wells 299-W10-26 and 299-W14-16. The 2018 maximum Cr(VI) was 140 µg/L in well 299-W14-16 in March 2018, higher than the 2017 maximum (97.0 µg/L in November 2017). Concentrations declined in March, August, and November 2018. In 2018, the highest concentration in well 299-W10-26 was 54 µg/L in August. The source for the Cr(VI) was past leaks from tanks and pipelines at WMA TX-TY.

Total chromium is analyzed only in unfiltered samples. The maximum concentration in 2018 was 257 µg/L in well 299-W14-16. This was higher than the Cr(VI) concentration, indicating the presence of undissolved trivalent chromium. Aluminum is elevated in unfiltered samples from 10 wells, most likely due to particulate matter from aquifer sediments.

During 2018, nitrate remained above the DWS in all network wells. Nitrate concentrations have declined in WMA TX-TY monitoring wells from a maximum of 3,600 mg/L at well 299-W14-11 in 2005 to 531 mg/L at well 299-W14-16 in 2018. Most of the nitrate contamination is attributed to PFP operations, as well as past-practice disposal to cribs and trenches in the area.

Monthly sampling for total and free cyanide continued at wells 299-W10-26, 299-W10-27, 299-W14-11, 299-W14-13, and 299-W14-18 in 2018, although not required by the monitoring plan. As discussed in Section 3.1, cyanide is regulated as free cyanide, and total cyanide concentrations in groundwater are typically much higher than free cyanide concentrations.

Total cyanide concentrations were >200 µg/L in wells 299-W10-26 and 299-W14-18 (Figure 3-8). In well 299-W14-11, total cyanide concentrations reached a maximum of 220 µg/L in March 2018 but decreased to 49.2 µg/L in October 2018. The highest free cyanide concentration was 26.0 µg/L in well 299-W10-26 (greater than the 4.8 µg/L MTCA standard [WAC 173-340]).



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

Figure 3-7. Waste Management Area TX-TY

Table 3-16. WMA TX-TY Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W10-26	DG	1998 (C)	138.5	454.5	127.9	419.5	130.84	429.26	8/14/2018	3.0	9.8	Q	Monthly, except February
299-W10-27	DG	2001 (C)	137.5	451.2	126.9	416.2	130.87	429.36	8/14/2018	4.0	13.1	Q	Monthly, except February
299-W14-11	DG	2005 (C)	124.5	408.5	121.5	398.5	129.29	424.19	8/17/2018	7.8	25.6	S	Monthly, except February
299-W14-13	DG	1998 (C)	138.2	453.4	127.5	418.4	129.37	424.45	8/14/2018	1.8	6.0	Q	Monthly, except February
299-W14-14	DG	1998 (C)	138.5	454.3	127.8	419.3	130.24	427.30	5/17/2018[b]	2.4	8.0	S	3, 5, 8, 11
299-W14-15	DG	2000 (C)	137.5	451.2	126.9	416.2	130.23	427.27	8/15/2018	3.4	11.1	Q	3, 5, 8, 11
299-W14-16	FF	2000 (C)	137.4	450.8	126.7	415.8	129.84	426.00	8/15/2018	3.1	10.2	A	3, 5, 8, 11
299-W14-17	FF	2000 (C)	137.4	450.8	126.7	415.8	129.81	425.88	8/15/2018	3.1	10.1	A	3, 5, 8, 11
299-W14-18	DG	2000 (C)	137.8	452.2	127.1	417.2	130.10	426.85	8/15/2018	3.0	9.7	Q	Monthly, except February
299-W14-19	DG	2002 (C)	136.6	448.2	126.0	413.2	130.51	428.20	8/16/2018	4.6	15.0	S	3, 5, 8, 11
299-W15-44	DG[c]	2002 (C)	138.3	453.8	127.7	418.8	132.38	434.32	8/16/2018	4.7	15.5	S	3, 5, 8, 11
299-W15-763	DG[c]	2001 (C)	137.6	451.3	126.9	416.3	131.77	432.33	8/16/2018	4.9	16.0	S	3, 5, 8, 11
299-W15-765	UG	2001 (C)	137.4	450.9	126.8	415.9	131.58	431.69	8/16/2018	4.8	15.7	S	3, 5, 8, 11

Table 3-16. WMA TX-TY Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		

Note: Requirements from Table 3-2 of DOE/RL-2009-67, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY*.

a. Listed frequency as required under DOE/RL-2009-67; however, the wells were sampled at least quarterly in 2018.

b. August water-level measurement in well 299-W14-14 was erroneous.

c. Designated downgradient in the groundwater monitoring plan; currently cross gradient.

A = annually

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

FF = far field

Q = quarterly

S = semiannual

UG = upgradient

Table 3-17. Groundwater Velocity at WMA TX-TY

Flow Direction	86 degrees (east)
Flow Rate (m/d)	0.48
Hydraulic Conductivity (m/d) (Source)	5 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	9.5×10^{-3}
Comments	Reflects general gradient and flow directions across WMA and adjacent area. Gradient and direction determined by trend surface analysis of data collected in March 2018 from monitoring wells not adjacent to extraction wells. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-18. WMA TX-TY Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	95.8	133	—	
Aluminum (unfiltered)	µg/L	<15	1,240	50[b]	299-W10-26, 299-W10-27, 299-W14-13, 299-W14-14, 299-W14-16, 299-W14-17, 299-W14-18, 299-W14-19, 299-W15-44, 299-W15-763
Calcium (unfiltered)	µg/L	37,100	142,000	—	
Chloride	mg/L	18	39	250[b]	
Chromium (unfiltered)	µg/L	4.15	257	100[c]	299-W14-16, 299-W15-763
Cr(VI) (unfiltered)	µg/L	3.6	140	48[d]	299-W10-26, 299-W14-16
Dissolved oxygen	mg/L	4.42	9.64	—	
Fluoride	mg/L	0.21	1.7	4[c]	
Magnesium (unfiltered)	µg/L	12,400	47,300	—	
Nitrate	mg/L	36.3	531	45[e]	All
pH	—	7.46	8.37	—	
Potassium (unfiltered)	µg/L	3,870	7,830	—	
Sodium (unfiltered)	µg/L	11,300	145,000	—	
Specific conductance	µS/cm	447	1,394	—	
Sulfate	mg/L	32	68	250[b]	
Temperature	ºC	16	23.3	—	
Turbidity	NTU	0.19	28	—	

Table 3-18. WMA TX-TY Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value

Note: Minimum and maximum are based on sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. WAC 173-340-705, "Model Toxics Control Act—Cleanup," "Use of Method B."

e. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

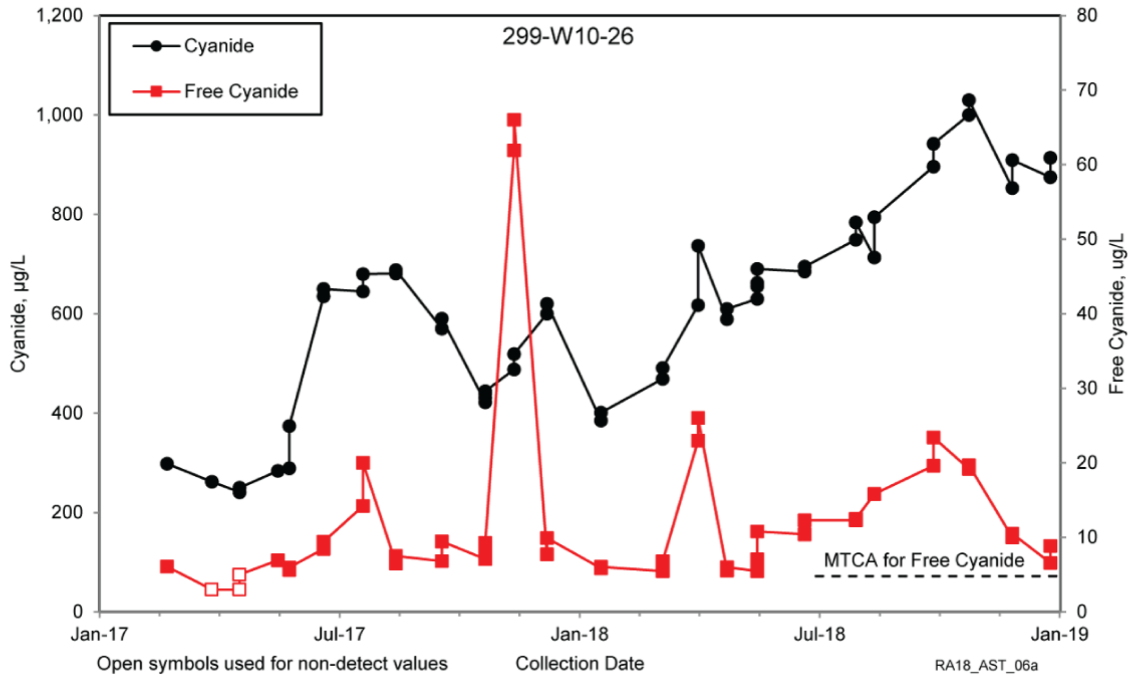
< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*



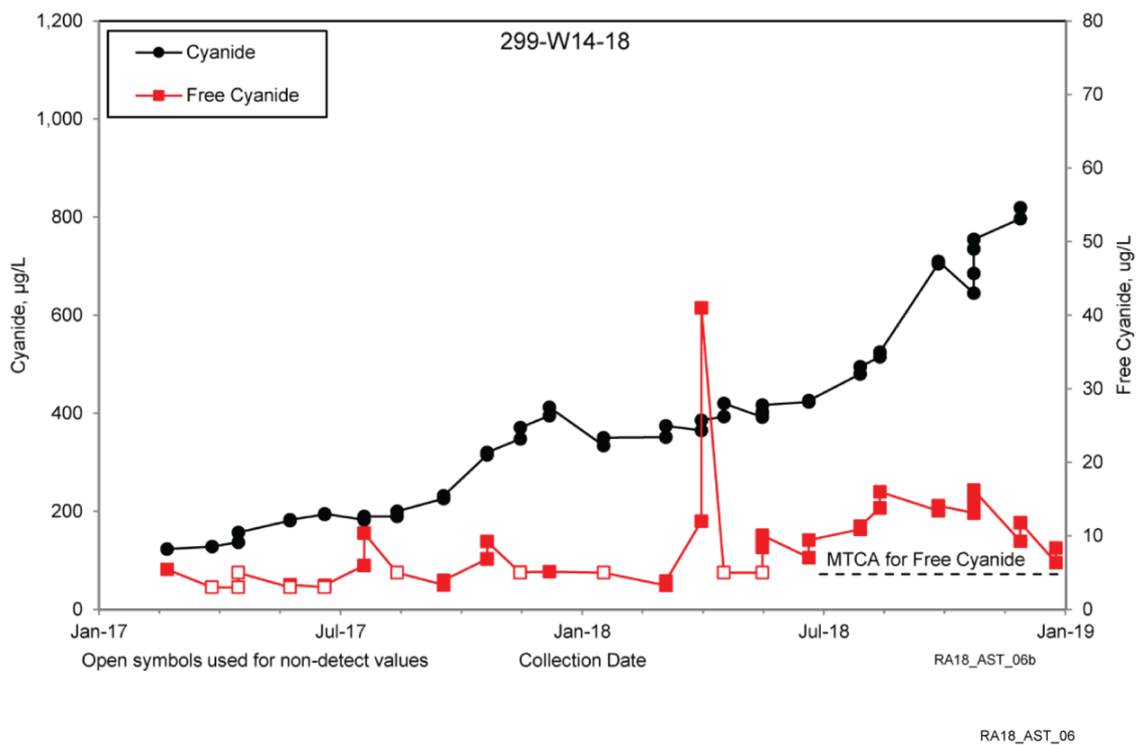


Figure 3-8. Total and Free Cyanide in Wells 299-W10-26 and 299-W14-18 at WMA TX-TY

3.7 Waste Management Area U

WMA U (Figures 1-1 and 3-9) contains 16 underground SSTs constructed between 1943 and 1944. Twelve SSTs have 2 million L (535,000 gal) capacities, and four have 210,000 L (55,000 gal) capacities (Section 1.2 of RPP-35485, *Field Investigation Report for Waste Management Area U*). The WMA also has a variety of ancillary equipment, including six diversion boxes; the 271-UR control house; the 244-UR process vault; the 244-U double-contained receiver tank; and waste transfer lines, pits, and junction boxes.

WMA U received waste from the bismuth phosphate process between 1946 and 1948 and from the REDOX process between 1954 and 1957 (WHC-MR-0132). In 1952, some waste was retrieved and pumped to the 242T evaporator and, between 1952 and 1957, the metal waste stored in nine of the 2 million L (535,000 gal) capacity tanks was transferred to U Plant for uranium recovery. To minimize the probability and severity of future leaks, most of the drainable liquid in each tank has been removed and transferred to DSTs.

WMA U was placed into assessment status in 2000 when specific conductance in downgradient monitoring wells exceeded upgradient levels. An assessment of that finding in 2000 determined that the WMA had affected groundwater quality based on elevated nitrate and possibly chromium in downgradient wells (Chapter 6.0 of PNNL-13282, *Groundwater Quality Assessment Plan for Waste Management Area U: First Determination*). However, these contaminants were below their respective DWSs, and the affected area was limited to the southeastern corner of the WMA.

Groundwater at WMA U is currently monitored under DOE/RL-2009-74, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area U*. The objective of RCRA monitoring at WMA U is to assess the rate and extent of migration and the concentrations of the dangerous waste constituent chromium in the groundwater. Table 3-19 lists the wells monitored for WMA U, as well as the screen intervals and water-level information.

Groundwater flow beneath WMA U is affected by the 200 West P&T system. Trend surface analysis was performed on March 2018 water-level measurements at WMA U, and the hydraulic gradient magnitude was 6.2×10^{-3} m/m (Table 3-20), which is lower than the 2017 average of 7.1×10^{-3} m/m. Extraction well 299-W17-3 is located 150 m (490 ft) north-northeast of the WMA. Flow rates in this well decreased from an average of 492 to 322 L/min (130 to 85 gal/min) during the 4 months prior to March 2018, and the resulting decrease in drawdown may account for the decreased gradient at WMA U. In response to pumping in this well, the flow direction beneath the WMA was expected to turn toward the northeast, but the average 2018 direction was similar to previous years (east at 85 degrees azimuth). The estimated 2018 flow rate of 0.31 m/d (1.0 ft/d) is lower than the 2017 rate of 0.35 m/d (1.1 ft/d) due to the decreased hydraulic gradient magnitude.

Water levels in the monitoring wells increased an average of 45 cm (18 in.) in 2018. A revised monitoring network, including one new well, was recommended by SGW-60578, *Engineering Evaluation Report for Single-Shell Tank Waste Management Area U Groundwater Monitoring*. The Tri-Parties negotiate replacement wells annually in accordance with Tri-Party Agreement Milestone M-24-00.

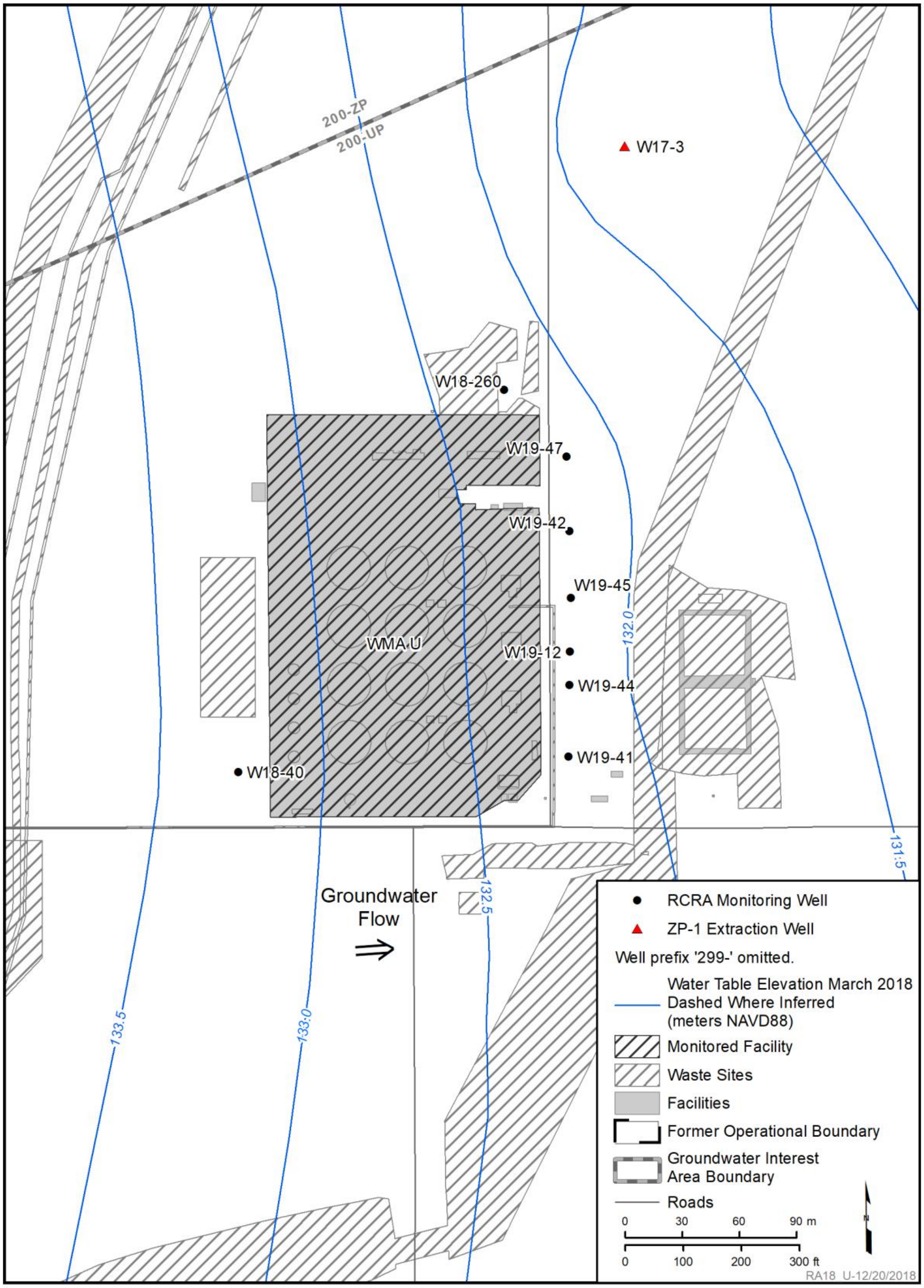
Table 3-19 provides a list of the wells monitored at WMA U. All required sampling was performed successfully during 2018. Table 3-21 summarizes the sampling results.

The dangerous waste constituent chromium is present in groundwater at WMA U. During 2018, the highest chromium concentration (185 µg/L) was in an unfiltered sample from well 299-W19-12. The highest concentration in a filtered sample was 23.0 µg/L in well 299-W19-45. The filtered concentration in upgradient well 299-W18-40 was 9.2 µg/L. The WMA U is the source of groundwater contamination limited to the downgradient (east) side of the tank farm (Chapter 6.0 of PNNL-13282).

Chromium may be present at WMA U as a groundwater contaminant and as a result of stainless-steel well screen corrosion. Many of the network wells have elevated iron, manganese, and nickel, which (along with chromium) are the primary components of 304 stainless steel used to construct the network wells. In particular, nickel is a good indicator of stainless-steel corrosion because its natural concentration in Hanford Site groundwater is very low (90^{th} percentile background is 1.56 µg/L [DOE/RL-96-61]). In wells 299-W19-45 and 299-W19-47, nickel is not routinely detected. Chromium concentrations ranged from 17.0 to 23.0 µg/L in well 299-W19-45 and from 6.2 to 10.9 µg/L in well 299-W19-47. The lack of nickel in these wells indicates that the chromium is from groundwater contamination and not screen corrosion.

While dissolved chromium is highly mobile in the aquifer, it can migrate more slowly than the movement of moisture in the vadose zone beneath the tank farms (at least initially) following release from a tank. This has been attributed to a reduction process where tank fluids dissolve divalent iron minerals in the sediment. The iron then reacts with the soluble Cr(VI), reducing it to trivalent chromium, which precipitates as an insoluble iron chromium hydroxide (Zachara et al., 2007, “Geochemical Processes Controlling Migration of Tank Wastes in Hanford’s Vadose Zone”). This reaction may explain the current low concentrations of chromium in the filtered groundwater samples. In the aquifer, dissolved chromium migrates to the east at the calculated groundwater flow rate of 0.31 m/d (1.0 ft/d).

Concentrations of the nondangerous constituent nitrate are >45 mg/L and are steadily increasing in network wells, including the upgradient well. The upgradient nitrate source is treated water injected into wells formerly used for the 200-ZP-1 OU interim action P&T system. The injected water was treated for volatile organic compounds but still contained nitrate (Section 3.3.5 of DOE/RL-2011-118). Because nitrate in some downgradient wells is higher than the upgradient well, it is likely that WMA U is also a source of nitrate to the groundwater.



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

Figure 3-9. Waste Management Area U

Table 3-19. WMA U Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W18-40	UG	2001 (C)	136.2	446.8	125.5	411.8	133.14	436.82	10/22/2018	7.6	25.0	A	3[b], 4, 6[c], 10
299-W18-260 (replacement for 299-W18-30[d])	DG	2014 (C)	132.0	432.9	122.8	402.9	132.58	434.98	10/19/2018	9.8	32.0	S	1, 4, 6[c], 10
299-W19-12	DG	1983 (P)	141.7	464.8	130.4	427.8	132.49	434.66	10/19/2018	2.1	6.8	S	1, 4, 6[c], 10
299-W19-41	DG	1998 (C)	138.7	455.0	128.0	420.0	132.54	434.84	10/22/2018	4.5	14.8	S	1, 4, 6[c], 10
299-W19-42	DG	1998 (C)	138.4	453.9	127.7	418.8	132.29	434.04	10/19/2018	4.6	15.2	S	1, 4, 6[c], 10
299-W19-44	DG	2001 (C)	136.4	447.7	125.8	412.7	132.45	434.55	10/19/2018	6.7	21.9	S	1, 4, 6[c], 10
299-W19-45	DG	2001 (C)	137.4	450.6	126.7	415.7	132.49	434.67	10/19/2018	5.8	18.9	S	1, 4, 6[c], 10
299-W19-47	DG	2004 (C)	136.3	447.3	125.7	412.4	132.54	434.84	10/19/2018	6.8	22.5	S	1, 4, 6[c], 10

Note: Requirements from Table 3-2 of DOE/RL-2009-74, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area U*.

a. Listed frequency is as required under the monitoring plan. However, quarterly sampling was initiated in October 2017 in anticipation of a monitoring plan revision.

b. Sample scheduled for January delayed until March.

c. Sample scheduled for July collected in June.

d. Well 299-W18-30 went dry in 2013 and was replaced.

A = annually

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

S = semiannually

UG = upgradient

Table 3-20. Groundwater Velocity at WMA U

Flow Direction	85 degrees (east)
Flow Rate (m/d)	0.31
Hydraulic Conductivity (m/d) (Source)	5.0 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	6.2×10^{-3}
Comments	Gradient and direction determined by trend surface analysis using March 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-21. WMA U Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value
Alkalinity	mg/L	73.8	99.7	—	
Calcium (unfiltered)	µg/L	31,900	61,600	—	
Calcium (filtered)	µg/L	32,300	62,900	—	
Chloride	mg/L	13	25	250[b]	
Chromium (unfiltered)	µg/L	5.99	185	100[c]	299-W9-12
Chromium (filtered)	µg/L	5.3	23	100[c]	
Magnesium (unfiltered)	µg/L	11,300	20,300	—	
Magnesium (filtered)	µg/L	11,300	20,900	—	
Nitrate	mg/L	66.4	195	45[d]	All
pH Measurement	None	7.71	9.14	6.5 – 8.5[b]	299-W19-44
Potassium (unfiltered)	µg/L	3,600	5,110	—	
Potassium (filtered)	µg/L	3,730	5,050	—	
Sodium (unfiltered)	µg/L	18,500	26,600	—	
Sodium (filtered)	µg/L	19,000	27,300	—	
Specific conductance	µS/cm	375	680	—	
Sulfate	mg/L	17	41	250[b]	
Temperature	ºC	14.6	22.1	—	
Turbidity	NTU	1.25	45.1	—	

Note: Minimum and maximum are based on quarterly sample results collected specifically for this RCRA unit. Appendix A presents the full data set for 2018.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 143.3, “National Secondary Drinking Water Regulations,” “Secondary Maximum Contaminant Levels.”

Table 3-21. WMA U Sampling Summary for 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison Value

c. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

d. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

— = no comparison value

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

3.8 216-A-29 Ditch

The 216-A-29 Ditch is located just east of the 200 East Area fence line (Figures 1-1 and 3-10). DOE submitted an updated closure plan (DOE/RL-2008-53, *216-A-29 Ditch Closure Plan (D-2-3)*) to Ecology in 2014. The site is designated as a surface impoundment in accordance with WAC 173-303-040, "Definitions."

The 216-A-29 Ditch was placed into service in November 1955. It received continuous discharge of corrosive waste and potentially hazardous spilled chemical materials from the PUREX Plant. The most significant chemical discharges included acidic and caustic effluents from backwashing during demineralizer column regeneration. From 1955 to 1986, daily discharges of sodium hydroxide and sulfuric acid solutions occurred. Treatment of this waste involved the successive addition of acidic and caustic waste, which neutralized waste in the ditch. The ditch also received spills from the PUREX Plant chemical sewer (low-level contamination). Flow from the chemical sewer was continuous, with an average volume of 3,700 L/min (970 gal/min). After 1986, dangerous waste was no longer discharged to the chemical sewer. A complete estimated inventory of materials discharged to the 216-A-29 Ditch is provided in Appendix A of WHC-SD-EN-AP-045, *Ground Water Monitoring Plan for the 216-A-29 Ditch*.

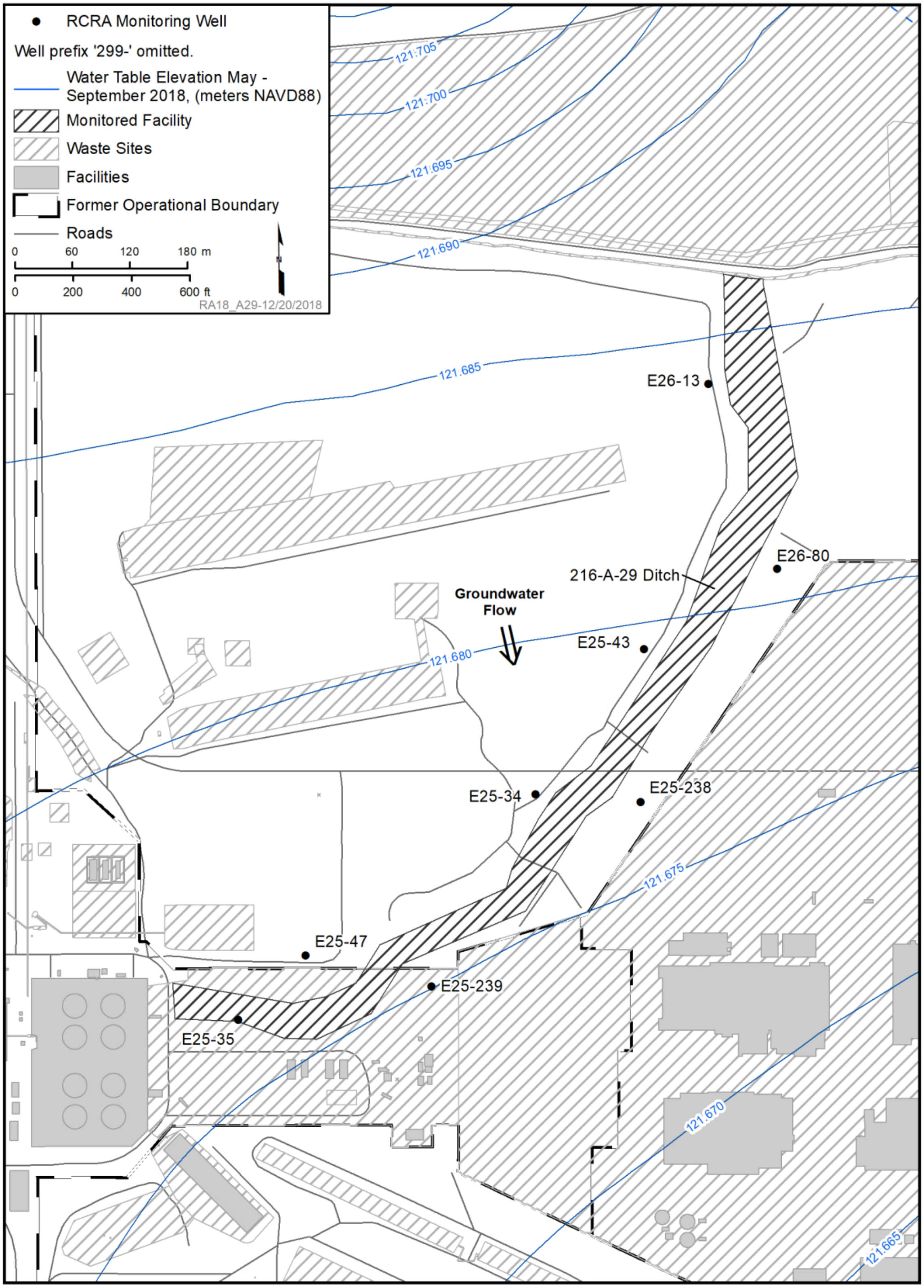
The 216-A-29 Ditch was removed from service in 1991, partly backfilled with material from the ditch sides, and the portion of the ditch inside the 200 East Area security fence was brought to grade with clean fill material. The ditch outside of the 200 East Area security fence was topped with clean fill material in a series of 11 terraces progressing down the length of the ditch. Both areas were revegetated and posted as underground radioactive material areas.

In January 2016, the 216-A-29 Ditch was placed into a groundwater assessment program because specific conductance in wells 299-E25-32P, 299-E25-35, and 299-E25-48 exceeded the critical mean value in 2015. DOE/RL-2016-23, *216-A-29 Ditch Interim Status Groundwater Quality Assessment Monitoring Plan*, is the current groundwater quality assessment monitoring plan. Network groundwater wells all have adequate water columns in the screened interval for representative sampling over the next decade.

In 2018, the hydraulic gradient dipped to the south-southeast (Figure 3-10; Table 3-23). The gradient magnitude was 1.9×10^{-5} m/m, and the calculated average flow velocity was 1.6 m/d (5.2 ft/d).

In 2018, the network was sampled quarterly to assess whether dangerous waste or dangerous waste constituents are present in the groundwater and their rate and extent of migration (Table 3-22). The 216-A-29 Ditch assessment monitoring plan (DOE/RL-2016-23) states that after two sampling events, further actions may be needed, including reconfiguring the well network for proper alignment with the groundwater flow direction and/or determining the full extent of dangerous waste or dangerous waste constituents in groundwater. However, it was found that additional data were needed to properly evaluate the potential dangerous waste impacts to groundwater. Additional data (forwarded to Ecology after each sampling event) have been collected, and an evaluation of these results is in progress. Upon completion of the evaluation, the results will be included in a first determination report (40 CFR 265.93 (d)(5)). Wells were sampled as required in 2018, with the exception that ammonia was not analyzed in well 299-E26-13 in July due to a sample preservation error.

Table 3-24 summarizes the results for constituents required by the monitoring plan and detected in 2018. Arsenic concentrations were above the DWS in upgradient wells 299-E25-34 and 299-E25-47 and in downgradient well 299-E25-35. The maximum concentration, 11.9 µg/L in an October 2018 sample from well 299-E25-34, was only slightly higher than the Hanford Site background concentration of 11.8 µg/L (DOE/RL-96-61).



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

Figure 3-10. 216-A-29 Ditch

Table 3-22. 216-A-29 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E25-238	DG	2017 (C)	122.3	401.3	113.2	371.3	121.65	399.10	10/9/2018	8.5	27.8	Q	1, 4, 7, 10
299-E25-239	DG	2017 (C)	122.8	402.7	113.6	372.7	121.63	399.06	10/9/2018	8.0	26.3	Q	1, 4, 7, 10
299-E25-34[a]	UG	1988 (C)	125.8	412.6	119.7	392.6	121.68	399.22	10/9/2018	2.0	6.6	Q	1, 4, 7, 10
299-E25-35[a]	DG	1988 (C)	126.2	414.0	119.9	393.5	121.69	399.25	10/8/2018	1.7	5.7	Q	1, 4, 7, 10
299-E25-43	UG	1991 (C)	125.5	411.6	119.1	390.6	121.66	399.13	10/8/2018	2.6	8.5	Q	1, 4, 7, 10
299-E25-47	UG	1992 (C)	125.2	410.7	119.1	390.8	121.69	399.23	10/8/2018	2.6	8.4	Q	1, 4, 7, 10
299-E26-13[a]	UG	1991 (C)	126.0	413.2	119.7	392.6	121.69	399.25	10/8/2018	2.0	6.6	Q	1, 4, 7[b], 10
299-E26-80	DG	2017 (C)	122.5	402.0	113.4	372.0	121.65	399.12	10/10/2018	8.3	27.1	Q	1, 4, 7, 10

Note: Requirements from Table 3-2 of DOE/RL-2016-23, *216-A-29 Ditch Interim Status Groundwater Quality Assessment Monitoring Plan*.

a. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

b. Ammonia was not analyzed in well 299-E26-13 in July due to a sample preservation error.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

Q = quarterly

UG = upgradient

Table 3-23. Groundwater Velocity at the 216-A-29 Ditch

Flow Direction	154 degrees (south-southeast)
Flow Rate (m/d)	1.6
Hydraulic Conductivity (m/d) (Source)	Hanford formation and Cold Creek gravels: 17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	1.9×10^{-5}
Comments	Gradient and flow direction based on low-gradient water table map prepared by applying the Tikhonov regularized inverse method to the average of May through September 2018 data (ECF-200E-18-0085, *Water Level Mapping and Hydraulic Gradient Calculations for 200 East Area RCRA Sites, 2018*). Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-24. 216-A-29 Sampling Summary: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison; Comments
Acetone	µg/L	U	4.48	—	
Alkalinity	mg/L	85	115	—	
Ammonia	µg/L	U	382	—	
Antimony, unfiltered	µg/L	U	2.0	6[b]	All <PQL
Antimony, filtered	µg/L	U	2.0	6[b]	All <PQL
Arsenic, unfiltered	µg/L	4.9	11.9	10[b]	299-E25-34, 299-E25-35, 299-E25-47
Arsenic, filtered	µg/L	4.7	11.9	10[b]	299-E25-34, 299-E25-35
Barium, unfiltered	µg/L	17.6	51.8	2,000[b]	
Barium, filtered	µg/L	18.2	51.8	2,000[b]	
Beryllium, unfiltered	µg/L	U	0.47	4[b]	
Beryllium, filtered	µg/L	U	0.2	4[b]	
Calcium, unfiltered	µg/L	24,400	59,900	—	Excludes outlier
Calcium, filtered	µg/L	24,500	58,600	—	Excludes outlier
Chloride	mg/L	30	30	250[c]	
Chloroform	µg/L	U	0.31	80[d]	All <PQL
Chromium, unfiltered	µg/L	U	44	100[b]	
Chromium, filtered	µg/L	U	6.16	100[b]	
Cobalt, unfiltered	µg/L	U	0.9	—	All <PQL
Cobalt, filtered	µg/L	U	1.9	—	

Table 3-24. 216-A-29 Sampling Summary: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison; Comments
Coliform bacteria[e]	MPN	U	39.5	TC+	299-E25-238, 299-E26-80; excludes "Y"-flagged data point
Copper, unfiltered	µg/L	U	4.4	1,000[c]	
Copper, filtered	µg/L	U	2.0	1,000[c]	
Cyanide, total	µg/L	U	9.7	—	
Fluoride[e]	mg/L	0.11	0.43	4[b]	
Gross alpha[e]	pCi/L	U	5.76	15[f]	
Gross beta[e]	pCi/L	3.9	19.6	50[f]	
Iron, unfiltered	µg/L	U	270	300[c]	Excludes outlier
Iron, filtered	µg/L	U	79	300[c]	Excludes outlier
Lead, unfiltered	µg/L	U	1.1	15[g]	All <PQL
Lead, filtered	µg/L	U	1.1	15[g]	
Magnesium, unfiltered	µg/L	6,760	17,100	—	Excludes outlier
Magnesium, filtered	µg/L	6,800	15,800	—	Excludes outlier
Manganese, unfiltered	µg/L	U	5.5	50[c]	
Manganese, filtered	µg/L	U	2.3	50[c]	
Mercury, unfiltered	µg/L	U	U	2[b]	All <PQL
Mercury, filtered	µg/L	U	0.085	2[b]	All <PQL
Nickel, unfiltered	µg/L	U	21	—	
Nickel, filtered	µg/L	U	6.2	—	
Nitrate	mg/L	2.3	18.1	45[h]	
pH Measurement	None	7.9	8.52	6.5 – 8.5[c]	299-E25-47
Potassium, unfiltered	µg/L	4,310	8,180	—	Excludes outlier
Potassium, filtered	µg/L	4,500	8,070	—	Excludes outlier
Radium-226[e]	pCi/L	U	1.42	5[i]	
Radium-228[e]	pCi/L	U	0.889		
Selenium, unfiltered	µg/L	U	6.06	50[b]	
Selenium, filtered	µg/L	U	5.9	50[b]	
Silver, unfiltered	µg/L	U	0.9	100[c]	All <PQL
Silver, filtered	µg/L	U	0.9	100[c]	All <PQL
Sodium, unfiltered	µg/L	9,890	29,800	—	Excludes outlier
Sodium, filtered	µg/L	9,620	29,600	—	Excludes outlier
Specific conductance	µS/cm	238	546	—	

Table 3-24. 216-A-29 Sampling Summary: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison; Comments
Sulfate	mg/L	17	160	250[c]	
Sulfide	mg/L	U	18.9	—	
Temperature	°C	16.3	20.2	—	
Thallium, unfiltered	µg/L	U	0.9	2[b]	All <PQL
Thallium, filtered	µg/L	U	0.9	2[b]	All <PQL
Tin, unfiltered	µg/L	U	5.6	—	All <PQL
Tin, filtered	µg/L	U	3.1	—	All <PQL
Total organic carbon	µg/L	U	962	—	
Total organic halides	µg/L	U	10.3	—	
Turbidity	NTU	0.2	4.78	—	
Vanadium, unfiltered	µg/L	11.8	612	—	
Vanadium, filtered	µg/L	17.3	646	—	
Zinc, unfiltered	µg/L	U	19.8	5,000[c]	
Zinc, filtered	µg/L	U	20	5,000[c]	

Note: Samples were analyzed for all constituents listed in Tables 3-1, 3-2, and 3-3 of DOE/RL-2016-23, *216-A-29 Ditch Interim Status Groundwater Quality Assessment Monitoring Plan*. Only detected constituents are listed here.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

c. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

d. The 40 CFR 141 standard is for total trihalomethanes.

e. These constituents only in wells 299-E25-43, 299-E25-47, 299-E25-238, 299-E25-239, and 299-E26-80 (Table 3-3 of DOE/RL-2016-23).

f. Gross alpha standard excludes uranium and radium (40 CFR 141.15, "Maximum Contaminant Levels for Radium-226, Radium-228, and Gross Alpha Particle Radioactivity in Community Water Systems"). Gross beta standard is a concentration assumed to yield a dose equivalent of 4 mrem/yr (40 CFR 141.16, "Maximum Contaminant Levels for Beta Particle and Photon Radioactivity from Man-Made Radionuclides in Community Water Systems").

g. Action level (40 CFR 141, Subpart I, "Control of Lead and Copper").

h. The federal drinking water standards for nitrate is 10 mg/L expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

i. Combined radium-226 and radium-228 not to exceed 5 pCi/L (40 CFR 141.15).

— = no comparison value
NTU = nephelometric turbidity unit
PQL = practical quantitation limit
RCRA = *Resource Conservation and Recovery Act of 1976*
TC+ = positive for total coliform (EPA 815-B-13-001, *Revised Total Coliform Rule: A Quick Reference Guide*)
U = below the detection limit

3.9 Nonradioactive Dangerous Waste Landfill

The NRDWL is located southeast of the 200 East Area, next to the Solid Waste Landfill (SWL) (Figures 1-1 and 3-11). This landfill encompasses an area of 0.045 km^2 (0.017 mi^2) and consists of 19 parallel unlined trenches, each about 122 m (400 ft) long, 4.9 m (16 ft) wide at the base, and 4.6 m (15 ft) deep. The landfill received chemical, asbestos, and nonhazardous waste from 1975 to 1985.

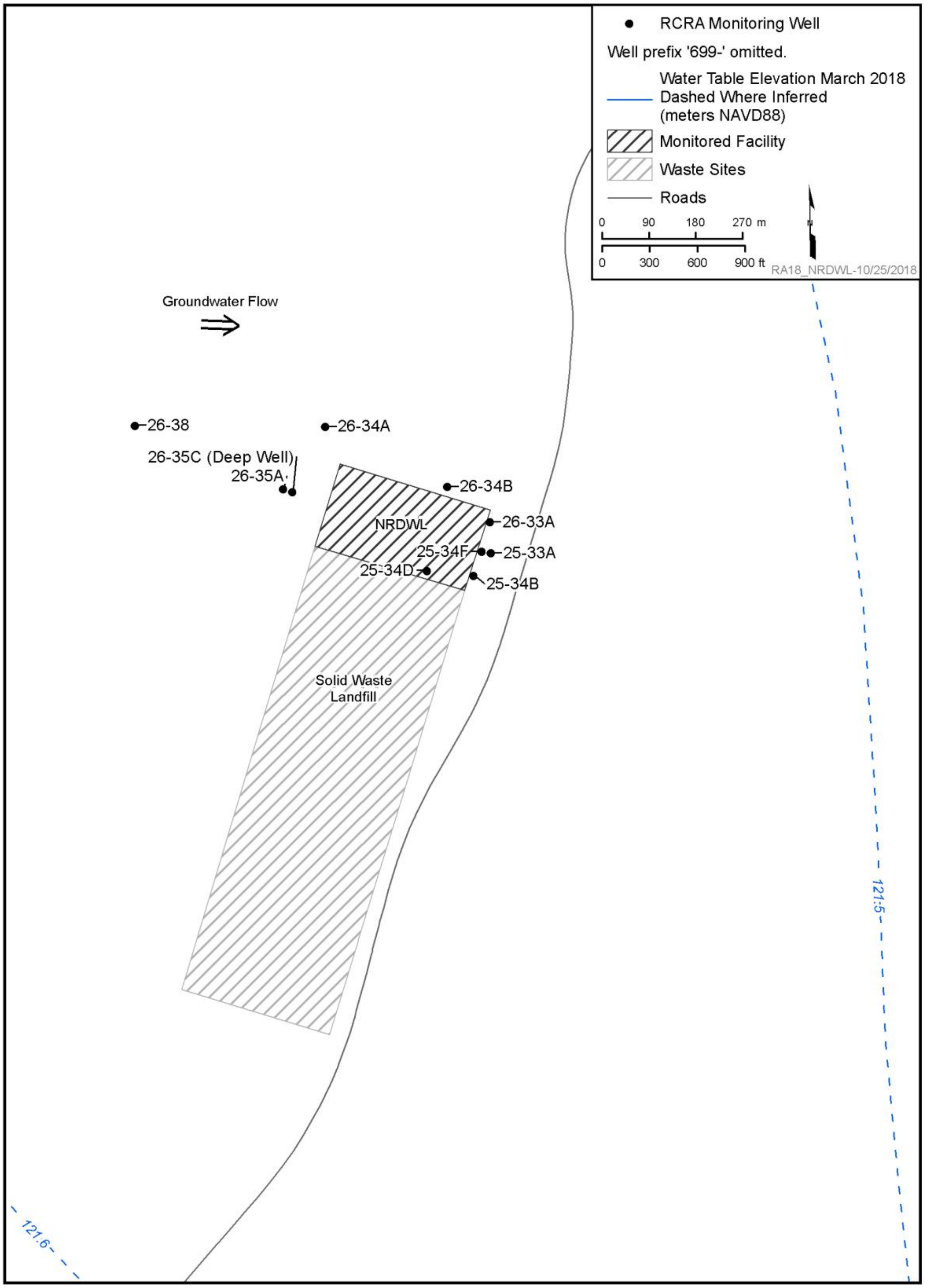
NRDWL entered a groundwater quality assessment monitoring program in 2017, which continued in 2018 under DOE/RL-2017-19, *Groundwater Quality Assessment Plan for the Nonradioactive Dangerous Waste Landfill, Hanford Site*. Quarterly assessment sampling began in April 2017. Table 3-25 lists the current monitoring well network. Wells were sampled as planned in 2018.

Between 2013 and 2018, water levels declined an average of 2.1 cm/yr (1.7 in./yr). Data compiled in 2018 and used for trend surface analysis indicate an eastward flow direction and a hydraulic gradient of 6.1×10^{-5} m/m (Table 3-26). A southeast flow direction is inferred from historical plume migration in this area and hydraulic head differences in the NRDWL/SWL area compared to the 200 East Area. The average groundwater flow rate was 0.033 m/d (0.11 ft/d).

The monitoring network was sampled quarterly in 2018 to assess whether dangerous waste or dangerous waste constituents are present in the groundwater, rate and extent of migration, and concentration. Samples were analyzed for an extensive list of constituents (Tables 3-1 through 3-3 in DOE/RL-2017-19). Table 3-27 lists the detected results for 2018.

Iron concentrations in unfiltered samples from well 699-25-34B were above the 300 µg/L secondary DWS in April. The concentrations in filtered samples from the same well were <30 µg/L.

Low-level detections of several organic compounds were noted in 2018 (Table 3-27). All results were below practical quantitation limits, except for acetone and bis(2-ethylhexyl) phthalate. Acetone is a common laboratory contaminant. It was detected above the practical quantitation limit in five samples, with a maximum concentration of 4.8 µg/L. Bis(2-ethylhexyl)phthalate was detected in just one sample at 1 µg/L. When the assessment is completed, the results will be presented in a first determination report (40 CFR 265.93(d)(5)).



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

Figure 3-11. Nonradioactive Dangerous Waste Landfill

Table 3-25. NRDWL Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
699-25-33A*	DG deep	1987 (C)	103.4	339.1	100.3	329.1	121.51	398.66	10/11/2018	21.2	69.5	Q	1, 4, 7, 10
699-25-34B	DG	1986 (C)	125.7	412.4	119.6	392.4	121.45	398.44	10/11/2018	1.8	6.1	Q	1, 4, 7, 10
699-25-34D	CG/DG	1992 (C)	125.3	411.0	114.7	376.5	121.52	398.68	10/16/2018	6.8	22.2	Q	1, 4, 7, 10
699-25-34F	DG	2015 (C)	122.6	402.2	113.4	372.2	121.52	398.69	10/11/2018	8.1	26.5	Q	1, 4, 7, 10
699-26-33A	DG	2015 (C)	122.7	402.6	112.0	367.6	121.91	399.97	10/11/2018	9.9	32.4	Q	1, 4, 7, 10
699-26-34A	UG	1986 (C)	125.7	412.5	119.6	392.5	121.51	398.67	10/11/2018	1.9	6.2	Q	1, 4, 7, 10
699-26-34B	CG/DG	1992 (C)	125.4	411.4	114.7	376.5	121.51	398.65	10/11/2018	6.8	22.2	Q	1, 4, 7, 10
699-26-35A	UG	1986 (C)	125.9	413.2	119.8	393.2	121.52	398.68	10/11/2018	1.7	5.5	Q	1, 4, 7, 10
699-26-35C*	UG deep	1987 (C)	103.9	341.0	100.9	331.0	121.50	398.62	10/11/2018	20.6	67.7	Q	1, 4, 7, 10
699-26-38	UG	2014 (C)	123.1	403.9	114.0	373.9	121.52	398.69	10/16/2018	7.6	24.8	Q	1, 4, 7, 10

Note: Requirements from Table 3-2 of DOE/RL-2017-19, *Groundwater Quality Assessment Plan for the Nonradioactive Dangerous Waste Landfill, Hanford Site*.

*Hydraulic head data for these wells were not corrected for borehole deviation from vertical, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

CG = cross gradient

DG = downgradient

Q = quarterly

UG = upgradient

Table 3-26. NRDWL Groundwater Velocity

Flow Direction	84 degrees (east)
Flow Rate (m/d)	0.033
Hydraulic Conductivity (m/d) (Source)	109 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	6.1×10^{-5}
Comments	Gradient and direction determined by trend surface analysis using March 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 3-27. NRDWL Sampling Summary: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison; Comments
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	µg/L	U	1.24E-05	—	All <PQL
1,4-Dioxane	µg/L	U	8.72	—	All <PQL
Acetone	µg/L	U	9.08	—	
Alkalinity	mg/L	128	244	—	
Antimony, unfiltered	µg/L	U	2.00	6[b]	All <PQL
Antimony, filtered	µg/L	U	2.00	6[b]	All <PQL
Arsenic, unfiltered	µg/L	U	5.07	10[b]	
Arsenic, filtered	µg/L	U	4.87	10[b]	
Barium, unfiltered	µg/L	34.9	70.3	2,000[b]	
Barium, filtered	µg/L	34.8	66.9	2,000[b]	
Beryllium, unfiltered	µg/L	U	U	4[b]	All <PQL
Beryllium, filtered	µg/L	U	0.31	4[b]	All <PQL
Bis(2-ethylhexyl) phthalate	µg/L	U	4.60	—	
Cadmium, unfiltered	µg/L	U	0.30	5[b]	All <PQL
Cadmium, filtered	µg/L	U	0.30	5[b]	All <PQL
Calcium, unfiltered	µg/L	34,800	76,100	—	
Calcium, filtered	µg/L	33,200	74,600	—	
Chloride	mg/L	6.6	14	250[c]	
Chloroform	µg/L	U	0.50	80[d]	All <PQL
Chromium, unfiltered	µg/L	U	31.9	100[b]	
Chromium, filtered	µg/L	U	28.2	100[b]	

Table 3-27. NRDWL Sampling Summary: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison; Comments
Cobalt, unfiltered	µg/L	U	0.978	—	All <PQL
Cobalt, filtered	µg/L	U	0.90	—	All <PQL
Copper, unfiltered	µg/L	U	1.9	1,000[c]	All <PQL
Copper, filtered	µg/L	U	1.9	1,000[c]	All <PQL
Cyanide	µg/L	U	5.0	—	All <PQL
Diethylphthalate	µg/L	U	5.9	—	All <PQL
Heptachlorodibenzo-p-dioxins	µg/L	U	1.24E-05	—	All <PQL
Hexachlorodibenzo-p-dioxin	µg/L	U	1.24E-05	—	All <PQL
Iron, unfiltered	µg/L	U	319	300[c]	699-25-34B
Iron, filtered	µg/L	U	58	300[c]	
Lead, unfiltered	µg/L	U	1.0	15[e]	All <PQL
Lead, filtered	µg/L	U	1.0	15[e]	All <PQL
Magnesium, unfiltered	µg/L	8,920	19,200	—	
Magnesium, filtered	µg/L	8,570	19,000	—	
Manganese, unfiltered	µg/L	U	6.60	50[c]	
Manganese, filtered	µg/L	U	2.74	50[c]	
Mercury, unfiltered	µg/L	U	0.077	2[b]	All <PQL
Mercury, filtered	µg/L	U	0.1	2[b]	All <PQL
Methylene chloride	µg/L	U	9.9	—	All <PQL
Nickel, unfiltered	µg/L	U	12.4	—	
Nickel, filtered	µg/L	U	4.62	—	
Nitrate	mg/L	6.64	35.4	45[f]	
Octachlorodibenzofuran	µg/L	U	2.48E-05	—	All <PQL
Octachlorodibenzo-p-dioxin	µg/L	U	2.48E-05	—	All <PQL
Pentachlorodibenzo-p-dioxins	µg/L	U	1.24E-05	—	All <PQL
pH Measurement	None	7.12	8.49	6.5 – 8.5[c]	
Potassium, unfiltered	µg/L	4,910	8,700	—	
Potassium, filtered	µg/L	4,980	8,610	—	
Selenium, unfiltered	µg/L	U	6.0	50[b]	All <PQL
Selenium, filtered	µg/L	U	4.4	50[b]	All <PQL
Silver, unfiltered	µg/L	U	0.9	100[c]	All <PQL
Silver, filtered	µg/L	U	0.9	100[c]	All <PQL
Sodium, unfiltered	µg/L	16,000	33,400	—	

Table 3-27. NRDWL Sampling Summary: Constituents Detected in 2018

Constituent	Units	Minimum	Maximum	Comparison Value[a]	Wells Above Comparison; Comments
Sodium, filtered	µg/L	16,100	32,900	—	
Specific conductance	µS/cm	317	692	—	
Sulfate	mg/L	27	69.0	250[c]	
Sulfide	mg/L	U	20.4	—	
Temperature	°C	17.6	21.8	—	
Tetrachlorodibenzo-p-dioxins	µg/L	U	4.95E-06	—	All <PQL
Tetrachloroethene	µg/L	U	0.81	5[b]	All <PQL
Thallium, unfiltered	µg/L	U	U	2[b]	All <PQL
Thallium, filtered	µg/L	U	0.90	2[b]	All <PQL
Tin, unfiltered	µg/L	U	1.2	—	All <PQL
Tin, filtered	µg/L	U	1.2	—	All <PQL
Total organic carbon	µg/L	155	2,300	—	Range excludes suspect value
Total organic halides	µg/L	U	10.7	—	
trans-1,3-Dichloropropene	µg/L	U	0.35	—	All <PQL
Trichloroethene	µg/L	U	0.44	5[b]	All <PQL
Trichloromonofluoromethane	µg/L	U	0.53	—	All <PQL
Turbidity	NTU	0.23	4.99	—	
Vanadium, unfiltered	µg/L	7.3	23.0	—	
Vanadium, filtered	µg/L	7	18.1	—	
Zinc, unfiltered	µg/L	U	25.9	5,000[c]	
Zinc, filtered	µg/L	U	15.8	5,000[c]	

Note: Samples were analyzed for all constituents listed in Tables 3-1, 3-2, and 3-3 of DOE/RL-2017-19, *Groundwater Quality Assessment Plan for the Nonradioactive Dangerous Waste Landfill, Hanford Site*. Only detected constituents are listed here.

a. Comparison values are provided for information only and are not used to determine RCRA groundwater monitoring exceedances.

b. 40 CFR 141, Subpart G, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

c. 40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

d. The 40 CFR 141 standard is for total trihalomethanes.

e. Action level (40 CFR 141, Subpart I, "Control of Lead and Copper").

f. The federal drinking water standards for nitrate is 10 mg/L, expressed as nitrogen (40 CFR 141, Subpart G). This equates to 45 mg/L when expressed as NO_3.

— = no comparison value

NTU = nephelometric turbidity unit

PQL = practical quantitation limit

RCRA = *Resource Conservation and Recovery Act of 1976*

U = below the detection limit

4 Corrective Action Monitoring

Two RCRA units that affected groundwater quality are monitored under final status corrective action programs. Remediation of groundwater contaminated by these units and other waste sites in the OUs is in progress under the CERCLA program.

4.1 183-H Solar Evaporation Basins

The 183-H Solar Evaporation Basins (116-H-6 waste site) (Figures 1-1 and 4-1) consisted of four basins in the 100-H Area. The basins were originally part of the larger 183-H water treatment facility, which had 12 additional basins. Following decommissioning of the water treatment facility, the four remaining basins were used to evaporate various liquid waste streams, including neutralized spent acid etch solutions from the 300 Area fuel fabrication facilities. The waste solutions contained various contaminants, including chromium, uranium, and nitrate. The basins were used for waste evaporation from July 1973 until November 1985 and were demolished in 1995. The contaminated soil was removed to a depth of 4.6 m (15 ft) below Basin 1 in 1996 (DOE/RL-97-48, *183-H Solar Evaporation Basins Postclosure Plan*).

Groundwater protection was demonstrated through modeling, and Ecology approved a modified RCRA closure in May 1997 (Soper, 1997, "Re: Acceptance of "Closure Certification for the 183-H Solar Evaporation Basins (T-1-4)," 96-EAP-246). Clean closure of the site was not achieved because fluoride and nitrate levels in soil below the 4.6 m (15 ft) deep excavation exceeded the MTCA Method B cleanup levels (WAC 173-340) for groundwater protection. Therefore, the 183-H Solar Evaporation Basins were closed in place under the modified closure provisions of the Hanford RCRA Permit with specified measures for post-closure care.

Groundwater monitoring to meet RCRA requirements is conducted in accordance with the Hanford RCRA Permit (WA7890008967, Part VI, Post-Closure Unit 2 (PCU-2), Chapter 3.0, "Groundwater Monitoring"), which incorporated DOE/RL-2015-28, *Final Status Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*, on May 24, 2017. The plan monitors total chromium (collected as a filtered sample) and nitrate as dangerous waste constituents identified for corrective action monitoring.

The 183-H Solar Evaporation Basins monitoring wells (Table 4-1) are sampled semiannually for total chromium (filtered), nitrate, and field parameters. Wells 199-H4-88 and 199-H4-89 were drilled in 2016, and the revised permit requires the wells to be sampled quarterly for 2 years to ensure sufficient samples to support statistical evaluation. The quarterly monitoring requirement was initiated following the permit revision in May 2017, beginning in the third quarter of 2017 and continuing through the second quarter of 2019. At the end of 2 years of quarterly sampling, the sampling frequency will be reduced to semiannual, consistent with the other wells in the network.

The results for 183-H Solar Evaporation Basins groundwater monitoring are reported semiannually. DOE prepared two semiannual reports for 2018 (SGW-62519, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: January – June 2018*; and SGW-62854, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: July – December 2018* [in publication]).

The unconfined aquifer is very thin below the former 183-H Solar Evaporation Basins, and most of the wells are screened across the entire aquifer. The saturated aquifer thickness varies from <1 m (3 ft) in the fall during low river stage to 3 m (10 ft) in the spring and early summer during high river stage.

The CERCLA P&T extraction and injection wells influence groundwater flow near the 183-H Solar Evaporation Basins. The March 2018 water table showed a local groundwater depression created by the extraction wells (Figure 4-1). Under natural, non-pumping conditions, groundwater flow would be toward the river (east to northeast) during low river stage and west to southwest during high river stage. However, groundwater flow direction and gradients are highly variable due to the influence of the nearby extraction and injection wells. Therefore, a groundwater velocity table is not provided for the 183-H Solar Evaporation Basins in this chapter.

Table 4-2 summarizes results from the 2018 RCRA sampling events for the 183-H Solar Evaporation Basins. Total chromium (filtered sample) remained below the permit concentration limit of 48 µg/L in each of the five wells in the monitoring network during RCRA sampling. The maximum concentration observed in the network during the RCRA sampling events in 2018 was 32 µg/L in well 199-H4-88 (located within the footprint of Basin 4).

CERCLA sampling was also conducted during 2018 in wells within the RCRA network at a higher sampling frequency. Total chromium (filtered) results in well 199-H4-84 were as high as 83.9 µg/L (in a February 2018 CERCLA sample). This was the highest total chromium value reported during the year from the RCRA well network. Concentrations in well 199-H4-84 were >48 µg/L during both January and February, when water levels had begun to increase. The period of elevated total chromium did not coincide with the RCRA sampling events in May or November. Table 4-3 presents a summary of the data for the RCRA well network, collected under both the CERCLA and RCRA programs.

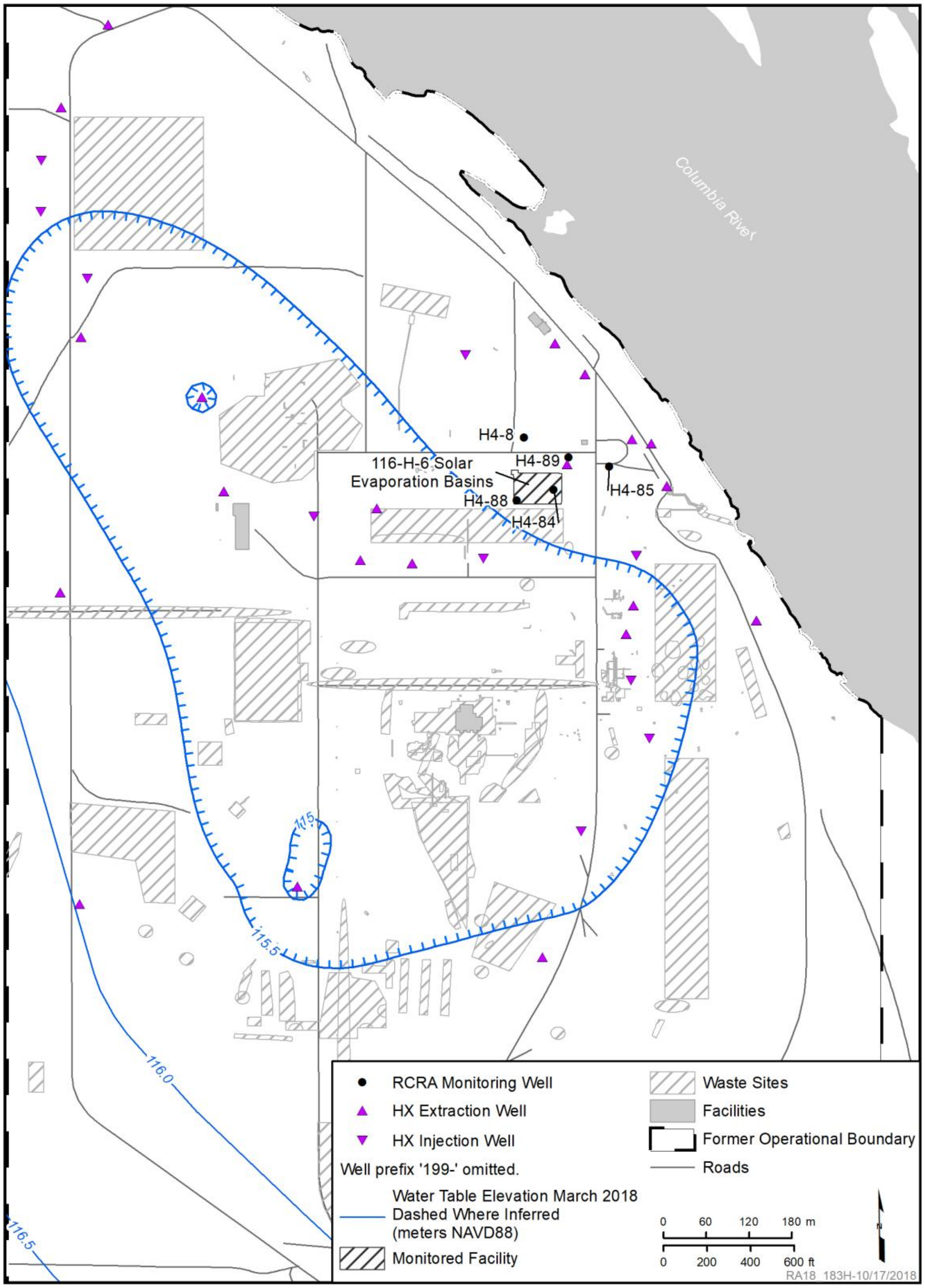
Nitrate exceeded the Hanford RCRA Permit concentration limit of 45 mg/L in wells 199-H4-84, 199-H4-88, and 199-H4-89 during 2018 (Tables 4-2 and 4-3). Well 199-H4-88 exhibited elevated nitrate levels throughout the year, with the RCRA sample results ranging from 53.1 to 93.0 mg/L. The lowest result in well 199-H4-88 was collected during a CERCLA sampling event, with a result of 44.3 mg/L (January 2018). Nitrate concentrations are directly related to water-level elevations in well 199-H4-88, with increased water levels corresponding to increased concentrations, which is typical of areas with a continuing source. Since well 199-H4-88 is located within the former basins, this is not unexpected.

Chromium and nitrate concentrations in well 199-H4-84 generally rise as river levels increase. This occurs when contamination remains in the lower vadose zone and the water table rises high enough to encounter the periodically rewetted zone, releasing the contaminants into the water column. However, when river levels are extremely high (as occurred in May 2018), river water mixes sufficiently with the groundwater and dilutes contaminant concentrations. This is confirmed by the specific conductance results, which declined during the May sampling event, when nitrate concentrations dropped to 25.2 mg/L. The CERCLA sampling results indicate nitrate concentrations in well 199-H4-84 as high as 137 mg/L (Figure 4-2). Well 199-H4-84 had nitrate levels above the concentration limits during the November 2018 RCRA sampling, with a concentration of 70.8 mg/L.

In well 199-H4-89, nitrate concentrations are inversely correlated to water level, with higher concentrations present during low river stage. This is typical of an area downgradient of a source area and influenced by mixing with river water. Concentrations in this well exceeded the concentration limits during November 2018 (at 57.5 mg/L) but not during any other sampling event during the year.

The objective of the corrective action monitoring program is to evaluate the effectiveness of the correction action. A statistical evaluation is conducted from wells when eight independent samples are available for the upper confidence limit (UCL) of the mean, or 95% UCL, calculation. Results collected for CERCLA may be included in the data set until a sufficient number of RCRA samples (eight) are collected. When sample results in the data set are less than the concentration limit, a nonstatistial or visual analysis of the data is conducted. In these cases, each result in the data set (8 to 10 samples) must be less than the concentration limit. In addition, the practical quantitation limit for each sample in the data set must not exceed the concentration limit established in the Hanford RCRA Permit.

The statistical evaluation is conducted semiannually (SGW-62519; SGW-62854). The 95% UCL values exceeded the concentration limit for filtered total chromium at well 199-H4-84 and for nitrate at wells 199-H4-84 and 199-H4-88 (Table 4-4). Both of the wells with 95% UCL values exceeding the concentrations limits are located within the footprint of the 183-H Solar Evaporation Basins, which indicates the presence of a secondary source at that location.



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

Figure 4-1. 183-H Solar Evaporation Basins (116-H-6 Waste Site)

Table 4-1. 183-H Groundwater Monitoring Network

Well Name	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
		m	ft	m	ft	m	ft		m	ft		
199-H4-8	1986 (C)	117.0	383.9	114.0	373.9	114.82	376.69	11/13/2018	0.8	2.8	S	
199-H4-84	2011 (C)	117.2	384.4	114.1	374.4	114.89	376.92	11/13/2018	0.8	2.5	S	
199-H4-85	2013 (C)	119.7	392.6	113.6	372.7	115.11	377.67	11/13/2018	1.5	4.9	S	
199-H4-88	2016 (C)	119.3	391.5	113.2	371.5	114.90	376.98	11/13/2018	1.7	5.5	Q/S	
199-H4-89	2016 (C)	118.6	389.2	114.1	374.2	115.35	378.44	8/16/2018	1.3	4.2	Q/S	Depth to water was not measured during the November sampling

Note: Requirements from WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part VI, Post-Closure Unit 2 (PCU-2), Chapter 3.0, "Groundwater Monitoring Plan."

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

Q/S = quarterly for first 2 years beginning the third quarter of 2017 through the second quarter of 2019, and semiannually thereafter

RCRA = *Resource Conservation and Recovery Act of 1976*

S = semiannually

Table 4-2. 183-H Solar Evaporation Basins RCRA Sampling Results, 2018

Well	Sample Date	Chromium (Filtered) (µg/L)	Nitrate (mg/L)	Dissolved Oxygen (mg/L)	pH	Specific Conductance (µS/cm)	Temperature (ºC)	Turbidity (NTU)
Permit Concentration Limit		**48**	**45**	—	—	—	—	—
199-H4-8	5/17/2018	4.2 BC	11.1 D	9.44	7.69	356	18.8	1.45
	11/13/2018	3.6	13.3 D	8.38	7.81	486	15.9	4.78
199-H4-84	5/17/2018	8.0 BC	25.2 D	8.16	7.64	613	19.4	1.35
	11/13/2018	20.0	70.8 D	8.97	7.58	777	17.6	4.76

Table 4-2. 183-H Solar Evaporation Basins RCRA Sampling Results, 2018

Well	Sample Date	Chromium (Filtered) (µg/L)	Nitrate (mg/L)	Dissolved Oxygen (mg/L)	pH	Specific Conductance (µS/cm)	Temperature (°C)	Turbidity (NTU)
Permit Concentration Limit		**48**	**45**	—	—	—	—	—
199-H4-85	5/17/2018	5.8 BC	10.2 D	10.79	7.81	228	18.2	1.04
	11/13/2018	6.6 B	28.8 D	9.25	7.75	453	18.1	1.55
199-H4-88	2/12/2018	26	73.0 D	7.58	7.57	803	17.1	1.92
	5/17/2018	32	93.0 D	8.57	7.50	805	19.2	0.46
	8/16/2018	17	79.7 D	7.68	7.44	773	20.3	0.76
	11/13/2018	12.1	53.1 D	8.92	7.42	887	12.2	3.94
199-H4-89	2/12/2018	3.6 B	22.5 DXH	6.42	7.32	566	18.2	5.83
	5/17/2018	3.9 BC	19.9 D	7.33	7.27	501	19.1	1.17
	8/16/2018	3.8 B	22.1 D	7.72	7.43	470	25.5	4.58
	11/13/2018	7.1 BD	57.5 D	10.66	7.93	993	13.4	4.59

Notes:

Sample results were collected for this RCRA unit. Appendix A presents the full data set for 2018.

Yellow-highlighted cells indicate concentrations greater than the concentration limit identified in the Hanford RCRA Permit (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part VI, Post-Closure Unit 2 (PCU-2), Chapter 3.0, "Groundwater Monitoring Plan").

Concentration limits in accordance with Part VI, Chapter 3.0 of the Hanford RCRA Permit.

— = no permit concentration limit

B = detected at less than the contract-required detection limit but greater than the method detection limit

C = detected in both the sample and the associated quality control blank

D = reported at a secondary dilution factor

H = exceeded holding time

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

X = other specific flags and notes required to properly qualify the result are described in the hardcopy sample data summary package and/or case narrative

Table 4-3. 183-H Solar Evaporation Basins Sampling Summary, 2018

Well	Ranges for All 2018 Samples (CERCLA and RCRA)			
	Minimum Chromium (µg/L)	Maximum Chromium (µg/L)	Minimum Nitrate (mg/L)	Maximum Nitrate (mg/L)
199-H4-8	2.8	4.2 BC	11.1 D	13.3 D
199-H4-84	8 BC	83.9 D	25.2 D	137 D
199-H4-85	4.4 B	6.6 B	9.9	28.8 D
199-H4-88	5.9 B	32.0	44.3 D	93.0 D
199-H4-89	3.6 B	3.8 B	19.9 D	57.5 D

Notes:

All chromium results presented are filtered.

Yellow-highlighted cells indicate concentrations greater than the concentration limit identified in WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part VI, Post-Closure Unit 2 (PCU-2), Chapter 3.0, "Groundwater Monitoring Plan."

B = detected at less than the contract-required detection limit but greater than the method detection limit

C = detected in both the sample and the associated quality control blank

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

D = reported at a secondary dilution factor

RCRA = *Resource Conservation and Recovery Act of 1976*

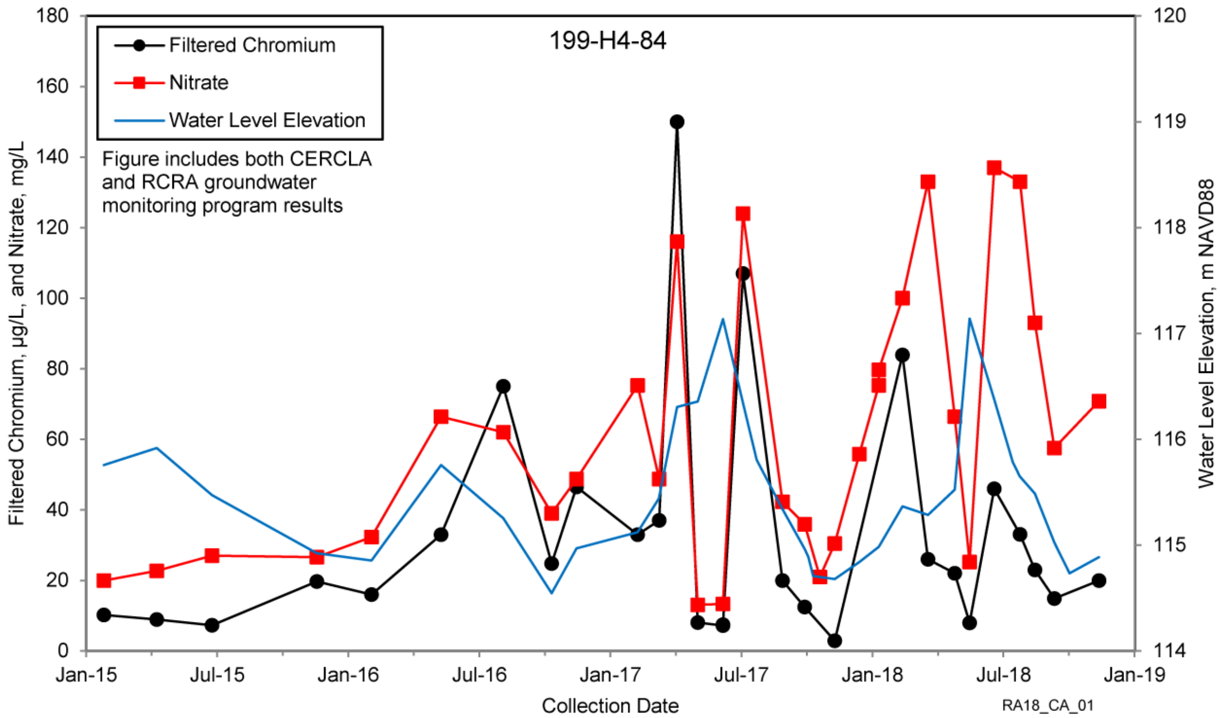


Figure 4-2. Nitrate, Filtered Chromium, and Water Level in Well 199-H4-84 at the 183-H Solar Evaporation Basins

Table 4-4. Statistical Evaluation of 183-H Solar Evaporation Basins Dangerous Waste Constituents, 2018

Well	Semiannual Period	Chromium (Filtered) (Permit Concentration Limit 48 µg/L)	Nitrate (Permit Concentration Limit 45 mg/L)
		95% UCL	95% UCL
199-H4-8	January – June	N/A[a]	N/A[a]
	July – December	N/A[a]	N/A[a]
199-H4-84	January – June	69.35[b]	93.22[b]
	July – December	41.37[b]	110.8[b]
199-H4-85	January – June	N/A[a,b]	N/A[a,b]
	July – December	N/A[a,b]	N/A[a,b]
199-H4-88	January – June	N/A[a,b]	71.88[b]
	July – December	N/A[a,b]	80.11[b]
199-H4-89	January – June	N/A[a,c]	32.91[b]
	July – December	N/A[a,b]	37.54[b]

Sources:

SGW-62519, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: January – June 2018*.

SGW-62854, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: July – December 2018*.

Note: Yellow-highlighted cells indicate that the UCL exceeded a concentration limit identified in WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part VI, Post-Closure Unit 2 (PCU-2), Chapter 3.0, "Groundwater Monitoring."

a. None of the results in the data set exceeded the concentration limit; therefore, no UCL was calculated.

b. Samples collected for *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* monitoring.

c. Fewer than eight samples have been collected (*Resource Conservation and Recovery Act of 1976* and *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* combined).

N/A = not applicable

UCL = upper confidence limit

4.2 300 Area Process Trenches

The 300 Area Process Trenches (also known as the 316-5 waste site) (Figures 1-1 and 4-3) received mixed waste effluent discharges from fuel fabrication and nuclear research laboratories in the 300 Area Industrial Complex from 1975 to 1987, followed by continued discharge of cooling water with small quantities of nonhazardous maintenance and process waste until December 1994. A comprehensive description, including a history of operations, is provided in Section 3.1.1 of the final status groundwater monitoring plan for the 300 Area Process Trenches in the Hanford RCRA Permit (WA7890008967, Part VI, Post-Closure Unit 1 (PCU-1), Chapter 3.0, "Groundwater Monitoring Plan") (hereinafter referred to as the PCU-1 groundwater monitoring plan). The PCU-1 groundwater monitoring plan was incorporated into Part VI of the Hanford RCRA Permit, Revision 8c, on May 24, 2017.[10]

DOE remediated the 300 Area Process Trenches in 1991 under a CERCLA expedited response action by excavating contaminated soil and transporting the excavated soil to the north end of the trenches (Section 2.4 of DOE/RL-92-32, *Expedited Response Action Assessment for 316-5 Process Trenches*). Additional removal actions were performed in 1997 and 1998, followed by backfilling and surface restoration in 2004 (Chapter 3 of DOE/RL-2004-74, *300-FF-1 Operable Unit Remedial Action Report*). The 300 Area Process Trenches were closed in 1998 under a modified closure with requirements for continued corrective action groundwater monitoring. Corrective action was deferred to the CERCLA program for the 300-FF-5 Groundwater OU (Executive Summary of the PCU-1 groundwater monitoring plan in the Hanford RCRA Permit).

The RCRA post-closure groundwater monitoring under the WAC 173-303-645 corrective action program uses wells at four locations: one upgradient (northwest) and three downgradient (east, southeast, and south) of the former 300 Area Process Trenches (Figure 4-3; Table 4-5). The most distant downgradient location is about 200 m (660 ft) to the southeast, along the dominant groundwater flow path from the trenches. Two wells are at each of the four locations. Well numbers ending in “A” are screened near the water table, and well numbers ending in “B” are screened in the lower portion of the unconfined aquifer.

The water table near the former trenches is not declining and is directly affected by the Columbia River stage. Dry well conditions are unlikely in the future (Section 3.2.5 of the PCU-1 groundwater monitoring plan in the Hanford RCRA Permit). Groundwater flows generally toward the south-southeast beneath the former trenches. In February 2018, the gradient sloped to the southeast at 3.4×10^{-4}, and the estimated groundwater flow rate was 18 m/d (59 ft/d) (Table 4-6).

The sampling schedule for the monitoring wells is designed to accommodate two sampling events each year, with collection scheduled during high river stage (typically May through June) and low river stage (typically September to November). This annual report for 2018 includes *cis*-1,2-dichloroethene (*cis*-1,2-DCE) and trichloroethene (TCE) results for samples collected in June and September. In 2018, sampling was performed as planned (Table 4-5).

The Hanford RCRA Permit concentration limits for *cis*-1,2-DCE and TCE are 16 µg/L and 4 µg/L, respectively, consistent with the cleanup levels in the CERCLA Record of Decision (EPA and DOE, 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*). DOE reports the results of 300 Area Process Trenches groundwater monitoring semiannually (SGW-62454, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: January – June 2018*; and SGW-62881, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: July – December 2018* [in publication]).

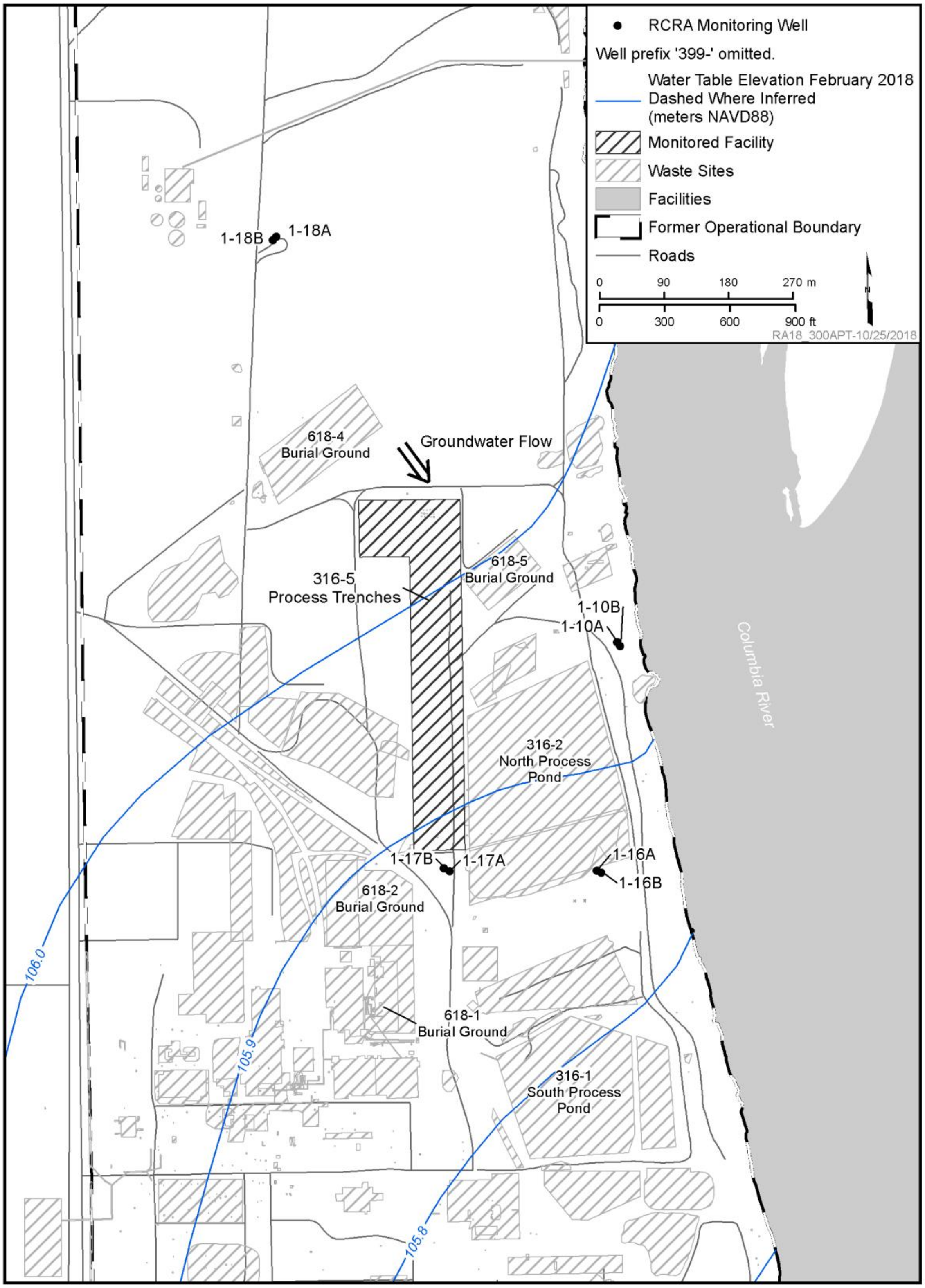
During 2018, TCE concentrations were below the Hanford RCRA Permit concentration limit and were mostly below the analytical detection limit (Table 4-7). Low-level detections of TCE in well 399-1-16B may be from the former 300 Area Process Trenches or the former 316-2 North Process Pond.

[10] Minor formatting modifications were made to the groundwater monitoring plan on March 15, 2018.

In samples from well 399-1-16B, *cis*-1,2-DCE continued to exceed the Hanford RCRA Permit concentration limit, with concentrations ranging from 130 to 140 µg/L. Lower levels of *cis*-1,2-DCE were detected in well 399-1-17B, with a maximum of 1.0 µg/L.

In accordance with Section 3.3.2 of the PCU-1 groundwater monitoring plan in the Hanford RCRA Permit, a statistical evaluation was performed to compare the dangerous waste constituent results to the Hanford RCRA Permit concentration limits. The evaluation applies to results at individual point-of-compliance (downgradient) wells. The 95% UCL on the mean is used for results that exceed concentration limits. A nonstatistical analysis is used for results that are less than concentration limits.

The statistical evaluation is conducted semiannually (SGW-62454; SGW-62881). The only 95% UCL that exceeded the Hanford RCRA Permit concentration limit in a downgradient well was for *cis*-1,2-DCE in well 399-1-16B (Table 4-8).



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

Figure 4-3. 300 Area Process Trenches (316-5 Waste Site)

Table 4-5. 300 Area Process Trenches Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
399-1-10A	DG	1986 (C)	106.9	350.8	102.3	335.8	105.15	344.96	9/5/2018	2.8	9.2	S	None
399-1-10B	DG deep	1991 (C)	82.7	271.3	79.6	261.3	105.12	344.88	9/5/2018	25.5	83.6	S	None
399-1-16A	DG	1986 (C)	107.0	351.0	102.4	336.0	105.08	344.75	9/6/2018	2.7	8.7	S	None
399-1-16B	DG deep	1987 (C)	84.8	278.4	81.8	268.4	105.12	344.87	9/6/2018	23.3	76.5	S	None
399-1-17A	DG	1986 (C)	107.7	353.5	103.2	338.5	105.11	344.85	9/5/2018	1.9	6.4	S	None
399-1-17B	DG deep	1986 (C)	85.0	278.8	81.9	268.8	105.15	344.99	9/6/2018	23.2	76.2	S	None
399-1-18A	UG	1986 (C)	107.3	352.1	102.8	337.1	105.53	346.23	9/5/2018	2.8	9.1	S	None
399-1-18B	UG deep	1987 (C)	86.0	282.1	82.9	272.1	105.59	346.42	9/5/2018	22.7	74.3	S	None

Note: Requirements from WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part VI, Post-Closure Unit 1 (PCU-1), Chapter 3.0, "Groundwater Monitoring Plan."

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

UG = upgradient

S = semiannually

Table 4-6. Groundwater Velocity at 300 Area Process Trenches

Flow Direction	Southeast
Flow Rate (m/d)	18
Hydraulic Conductivity (m/d) (Source)	9,000 (ECF-300FF5-11-0151, *Groundwater Flow and Uranium Transport Modeling in Support of the 300 Area FF-5 RI/FS*)
Effective Porosity	0.17
Gradient (m/m)	3.4×10^{-4}
Comments	Gradient and direction determined by trend surface analysis using late February 2018 data. Velocity calculated using the Darcy equation (ECF-Hanford-18-0049, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2018*).

Table 4-7. 300 Area Process Trenches RCRA Sampling Results, 2018

Well Name	RCRA Sample Date	*cis*-1,2-DCE (µg/L)	TCE (µg/L)	pH	Spec Cond (µS/cm)	Temperature (°C)	Turbidity (NTU)
Permit Concentration Limit		**16**	**4.0**	—	—	—	—
399-1-10A	6/6/2018	0.10 U	0.25 U	7.41	179.5	14.7	0.25
399-1-10A	9/5/2018	0.10 U	0.25 U	7.78	457.0	17.1	0.41
399-1-10B	6/6/2018	0.15 U	0.16 U	7.51	320.0	15.6	4.51
399-1-10B	9/5/2018	0.10 U	0.25 U	7.57	307.0	17.2	4.53
399-1-16A	6/6/2018	0.10 U	0.35 J	7.54	224.0	14.8	0.89
399-1-16A	9/6/2018	0.10 U	0.25 U	7.63	426.0	15.8	1.24
399-1-16B	6/6/2018	130 D	1.50	7.93	318.0	16.0	0.34
399-1-16B	9/6/2018	140 D	1.30	8.19	324.0	17.0	2.25

Table 4-7. 300 Area Process Trenches RCRA Sampling Results, 2018

<table>
<tr><th>Well
Name</th><th>RCRA Sample
Date</th><th>cis-1,2-DCE
(µg/L)</th><th>TCE
(µg/L)</th><th>pH</th><th>Spec Cond
(µS/cm)</th><th>Temperature
(°C)</th><th>Turbidity
(NTU)</th></tr>
<tr><td>399-1-17A</td><td>6/6/2018</td><td>0.30 U</td><td>0.30 U</td><td>7.42</td><td>392.0</td><td>17.1</td><td>1.03</td></tr>
<tr><td>399-1-17A</td><td>9/4/2018</td><td>0.30 U</td><td>0.30 U</td><td rowspan="2">7.44</td><td rowspan="2">512.0</td><td rowspan="2">18.3</td><td rowspan="2">0.37</td></tr>
<tr><td>399-1-17A</td><td>9/4/2018</td><td>0.30 U</td><td>0.30 U</td></tr>
<tr><td>399-1-17B</td><td>6/6/2018</td><td>1.00</td><td>0.16 U</td><td>7.55</td><td>351.0</td><td>17.4</td><td>4.82</td></tr>
<tr><td>399-1-17B</td><td>9/6/2018</td><td>0.82 J</td><td>0.25 U</td><td>7.81</td><td>354.0</td><td>17.9</td><td>3.04</td></tr>
<tr><td>399-1-18A</td><td>6/6/2018</td><td>0.15 U</td><td>0.16 U</td><td>7.67</td><td>463.0</td><td>17.4</td><td>0.44</td></tr>
<tr><td>399-1-18A</td><td>9/5/2018</td><td>0.15 UZTH</td><td>0.16 UZTH</td><td>8.06</td><td>476.0</td><td>18.1</td><td>1.39</td></tr>
<tr><td>399-1-18B</td><td>6/6/2018</td><td>0.30 U</td><td>0.30 U</td><td>6.89</td><td>364.0</td><td>17.5</td><td>0.48</td></tr>
<tr><td>399-1-18B</td><td>9/5/2018</td><td>0.30 U</td><td>0.30 U</td><td>7.65</td><td>372.0</td><td>27.1 F</td><td>1.23</td></tr>
</table>

Notes:

Yellow-highlighted cells indicate exceedances of the concentration limit defined in WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part VI, Post-Closure Unit 1 (PUC-1), Chapter 3.0, “Groundwater Monitoring Plan.”

Sample results were collected for this RCRA unit. Appendix A presents the full data set.

cis-1,2 DCE = *cis*-1,2-dichloroethene

D = analyte was reported at a secondary dilution factor

F = result under review

H = laboratory holding time exceeded before the sample was analyzed

J = estimated value; constituent detected at a level less than the required detection limit and greater than or equal to the method detection limit

NTU = nephelometric turbidity unit

RCRA = *Resource Conservation and Recovery Act of 1976*

T = spike and/or spike duplicate sample recovery is outside control limits

TCE = trichloroethene

U = undetected

Z = miscellaneous circumstances exist

Table 4-8. Statistical Evaluation of 300 Area Process Trenches Dangerous Waste Constituents, 2018

Well	Semiannual Period	*cis*-1,2 DCE (Permit Concentration Limit = 16 µg/L)	TCE (Permit Concentration Limit = 4 µg/L)
		95% UCL	95% UCL
399-1-10A	January – June	N/A*	N/A*
399-1-10A	July – December	N/A*	N/A*
399-1-10B	January – June	N/A*	N/A*
399-1-10B	July – December	N/A*	N/A*
399-1-16A	January – June	N/A*	N/A*
399-1-16A	July – December	N/A*	N/A*
399-1-16B	January – June	178.7	N/A*
399-1-16B	July – December	175.7	N/A*
399-1-17A	January – June	N/A*	N/A*
399-1-17A	July – December	N/A*	N/A*
399-1-17B	January – June	N/A*	N/A*
399-1-17B	July – December	N/A*	N/A*

Sources:

SGW-62454, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: January – June 2018*.

SGW-62881, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: July – December 2018*.

Note: Yellow-highlighted cells indicate that the UCL exceeded concentration limits defined in WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Part VI, Post-Closure Unit 1 (PCU-1), Chapter 3.0, "Groundwater Monitoring Plan."

*None of the results in the data set exceeded the concentration limit; therefore, the UCL was not calculated.

cis-1,2 DCE = *cis*-1,2-dichloroethene

N/A = not applicable

RCRA = *Resource Conservation and Recovery Act of 1976*

TCE = trichloroethene

UCL = upper confidence limit

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Appendix A

2018 Groundwater Data for Hanford Site RCRA Monitoring Wells

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A Monitoring Data for 2018

This appendix consists of a compilation of groundwater data, including laboratory analytical results, field measurements, and water-level measurements, collected at the *Resource Conservation and Recovery Act of 1976* (RCRA)[1] dangerous waste management units discussed in this report. The data are organized by site. The data for each site are tabulated in two Microsoft® Excel® files provided electronically with paper copies of this report. Only the well networks, constituents, and sampling events identified in the current RCRA monitoring plans are used for RCRA groundwater monitoring compliance. For informational purposes, this appendix includes data from other groundwater monitoring programs.

Online users may find groundwater data via the Environmental Dashboard Application at https://ehs.hanford.gov/eda.

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[1] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

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