DOE/RL-2015-21
Revision 3

Hanford Site Solid Waste Landfill Annual Monitoring Report October 2016 Through September 2017

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2015-21
Revision 3

Hanford Site Solid Waste Landfill Annual Monitoring Report October 2016 Through September 2017

D. Kinney
Mission Support Alliance

J. Ollero
Mission Support Alliance

Date Published
March 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

APPROVED
By Janis Aardal at 2:31 pm, Feb 21, 2018

Release Approval | Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

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

This report has been reproduced from the best available copy.

Printed in the United States of America

HANFORD SITE SOLID WASTE LANDFILL ANNUAL MONITORING REPORT OCTOBER 2016 THROUGH SEPTEMBER 2017

This report summarizes results of leachate, groundwater and soil gas monitoring performed at the Hanford Site Solid Waste Landfill, shown in Figure ES-1, for the period of October 2016 through September 2017. In March 1996, waste disposal activities at the solid waste landfill were discontinued and is in interim closure status.

Figure ES-1 Hanford Site Solid Waste Landfill

CONTENTS

1.0 INTRODUCTION 1
2.0 LEACHATE MONITORING9 4
2.1 LEACHATE GENERATION 4
2.2 LEACHATE ANALYTICAL RESULTS 6
3.0 GROUNDWATER MONITORING 8
3.1 BACKGROUND THRESHOLD VALUE EXCEEDANCES 10
3.2 GROUNDWATER QUALITY CRITERIA AND DRINKING WATER MAXIMUM CONTAMINANT LEVEL EXCEEDANCES 12
3.3 GROUNDWATER HYDROLOGY 13
3.4 CHLORINATED ORGANICS IN GROUNDWATER WELLS 13
4.0 SOIL GAS MONITORING 16
5.0 REFERENCES 20
APPENDIX A – GROUNDWATER TRENDS 22

TABLES

Table 1 Precipitation and Leachate Generation 4
Table 2 Leachate Monitoring Results - Key Constituents 7
Table 3 Monitoring Network Well Changes 8
Table 4 Constituents Sampled 11
Table 5 BTV Exceedances 11
Table 6 GWQC and Drinking Water Maximum Contaminant Level Exceedances 12
Table 7 Primary Chlorinated Hydrocarbon Groundwater Monitoring Results Downgradient Wells Compared with Upgradient Wells (Concentrations in µg/L) 15
Table 8 Solid Waste Landfill Soil Gas Monitoring Results (Constituent measured in ppmV) 18

FIGURES

Figure 1 Location of SWL (Central Landfill) on Hanford Site 2
Figure 2 Location of Solid Waste Landfill Trenches and Basin Lysimeter 3
Figure 3 Leachate Generation versus Precipitation (2016-2017) 5
Figure 4 Ten Year Leachate Generation Rates 5
Figure 5 Solid Waste Landfill Basin Lysimeter Drainage 6
Figure 6 Location of current Groundwater Monitoring Network Wells 9
Figure 7 Location of Soil Gas Monitoring Stations 16

ACRONYMS

BTV: background threshold values

CCU: Cold Creek unit

CY: Calendar Year, January 1 through December 31

DOE: U.S. Department of Energy

DOE-RL: DOE Richland Operations

Ecology: Washington State Department of Ecology

FY: Fiscal Year, October 1 through September 30

GWQC: groundwater quality criteria

MCL: maximum contaminant levels

MSA: Mission Support Alliance

NRDWL: Nonradioactive Dangerous Waste Landfill

ppmv: parts per million by volume

RCRA: Resource Conservation and Recovery Act

SWL: Solid Waste Landfill

VOC: volatile organic compound

WAC: Washington Administrative Code

1.0 INTRODUCTION

The Hanford Site Solid Waste Landfill (SWL) covers approximately 27 hectares (66 acres) and began operations in 1973. Figure 1 shows the location of the SWL (Central Landfill) on the Hanford Site.

The SWL is divided into five units, each consisting of a series of parallel trenches, as shown in Figure 2. The two oldest units make up Phase I. Phase II comprises three units: north, middle, and south. The SWL stopped receiving waste in 1996 and placed an intermediate cover over all disposal trenches. Current plans call for the placement of an engineered cover to minimize infiltration and leachate generation.

Monitoring systems at the landfill have been established and provide data for evaluating changes that could indicate increased risks to human health and the environment. Current monitoring activities include leachate, groundwater and soil gas testing and tracking. The following sections provide information from monitoring activities performed from October 2016 through September 2017.

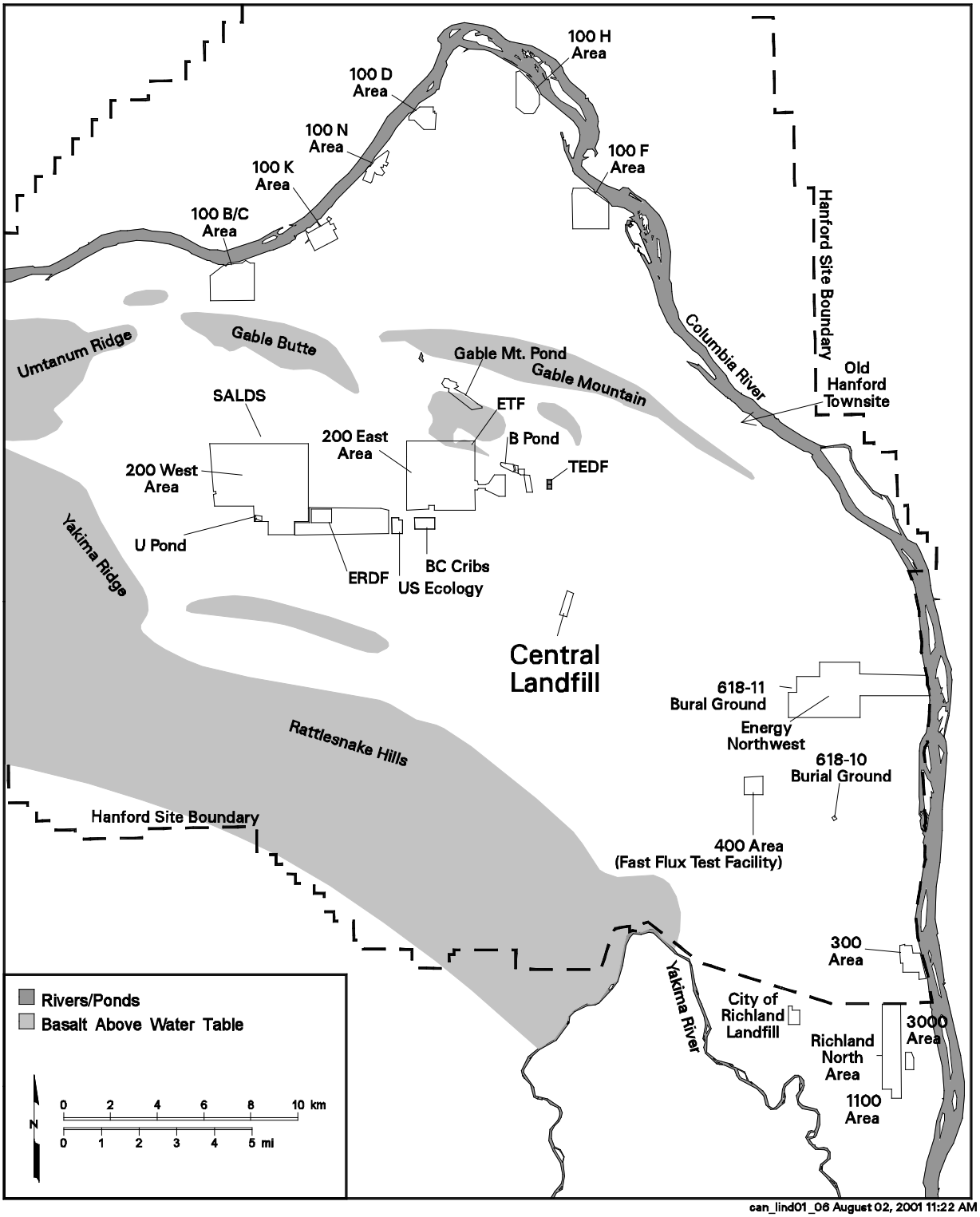

Figure 1 Location of SWL (Central Landfill) on Hanford Site

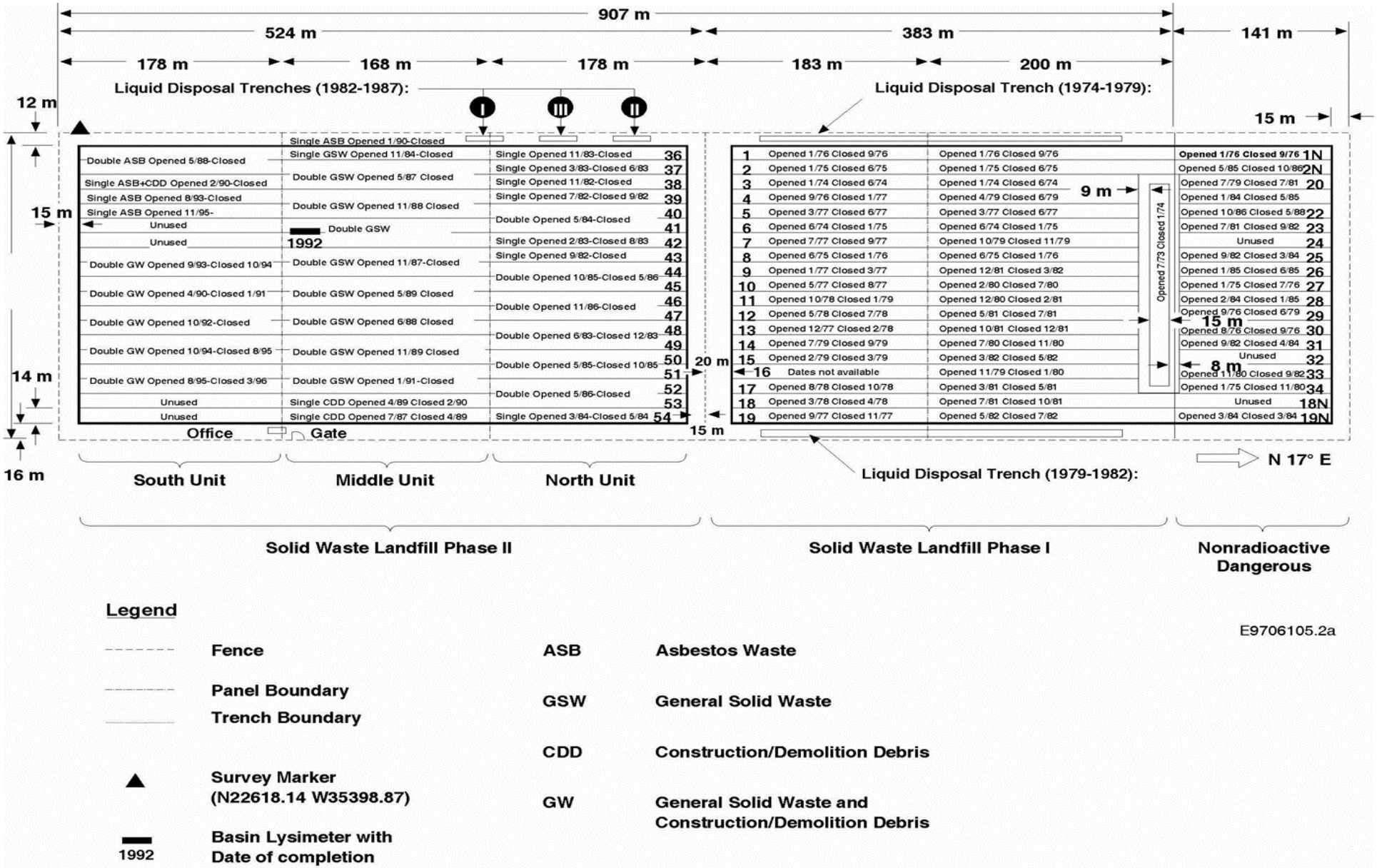

Figure 2 Location of Solid Waste Landfill Trenches and Basin Lysimeter

2.0 LEACHATE MONITORING9

One of the SWL's double trenches is equipped with a liner, allowing leachate to collect in a basin lysimeter. Leachate is generated as precipitation percolates through the SWL's contents. Figure 2 shows the location of the basin lysimeter in relation to other landfill trenches. The collected leachate is disposed of through a permitted wastewater treatment system.

Leachate monitoring provides an indication of potential impurities that may be reaching the groundwater from the unlined disposal cells. Because leachate is collected under only one double trench in the Phase II area of the SWL trenches, results are not necessarily representative of total leachate generation throughout the landfill.

Contaminants potentially leaching from trenches throughout the SWL represent a 23-year disposal period, dating from 1973, before many of the regulations restricting land disposal were enacted. In contrast, the leachate being collected is from one of the newer disposal trenches. Varying amounts of vegetation are growing over the intermediate cover affecting the volume of leachate generation. The older trenches have a thick vegetation cover, while some of the newer trenches remain essentially bare, allowing more precipitation to leach through.

2.1 LEACHATE GENERATION

Leachate is removed from an underground lysimeter collection tank every 10 to 14 days during dry months, as needed. From October 2016 through September 2017, approximately 1,372.5 gallons of leachate was collected, for a daily average of approximately 3.71 gallons. This is an increase in leachate generation from the previous year, during which the daily average leachate generation was approximately 1.51 gallons.

Table 1 and Figure 3 provide leachate volumes collected from the lysimeter, as well as monthly precipitation for the reporting period from October 2016 through September 2017. Figure 4 graphs the leachate generation rates over the previous ten years. Data in Figure 5 shows the relationship of the precipitation received at the landfill to drainage.

Table 1 Precipitation and Leachate Generation

Month	Leachate Volume (Gallons)	Precipitation (1/100th inch)
Oct-16	1.84	2.59
Nov-16	1.83	0.57
Dec-16	1.80	0.47
Jan-17	1.65	1.43
Feb-17	2.35	1.78
Mar-17	6.04	0.79
Apr-17	7.33	0.98
May-17	2.89	0.37
Jun-17	4.60	0.23
Jul-17	3.67	0.00
Aug-17	5.47	0.06
Sep-17	7.09	0.29

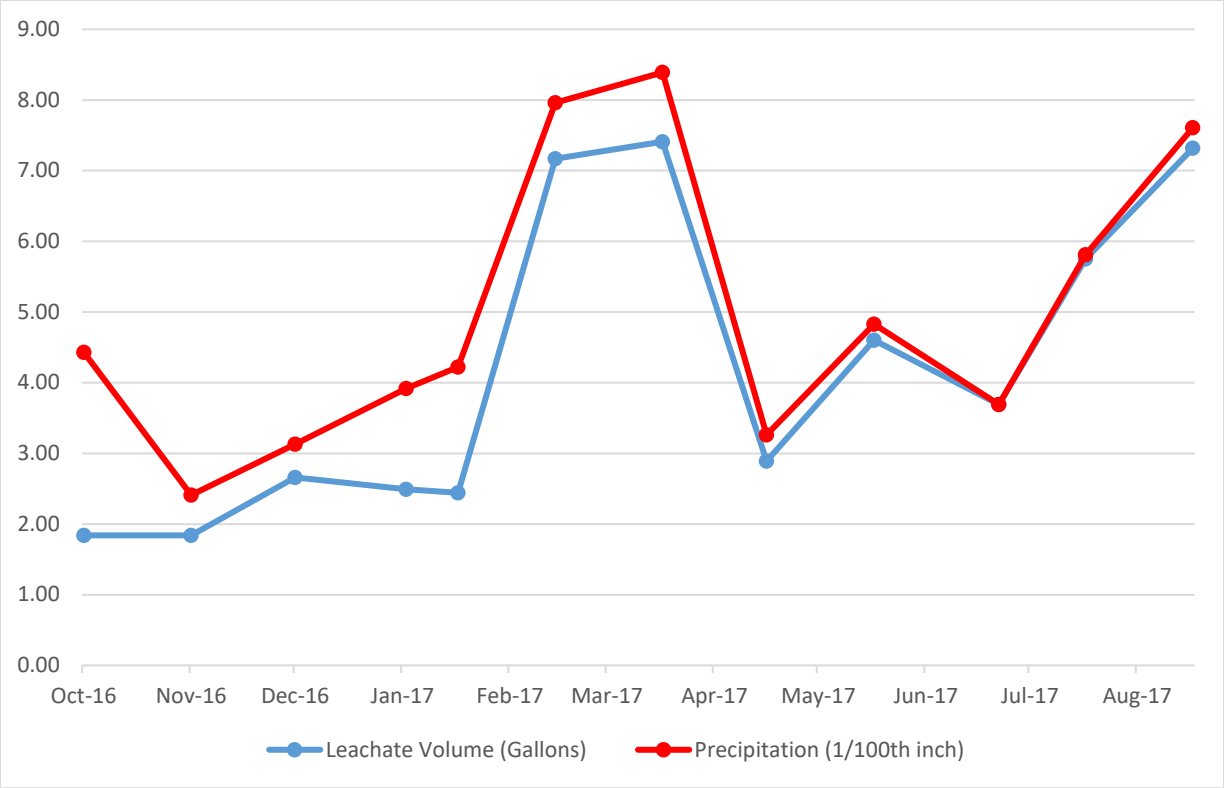

Figure 3 Leachate Generation versus Precipitation (2016-2017)

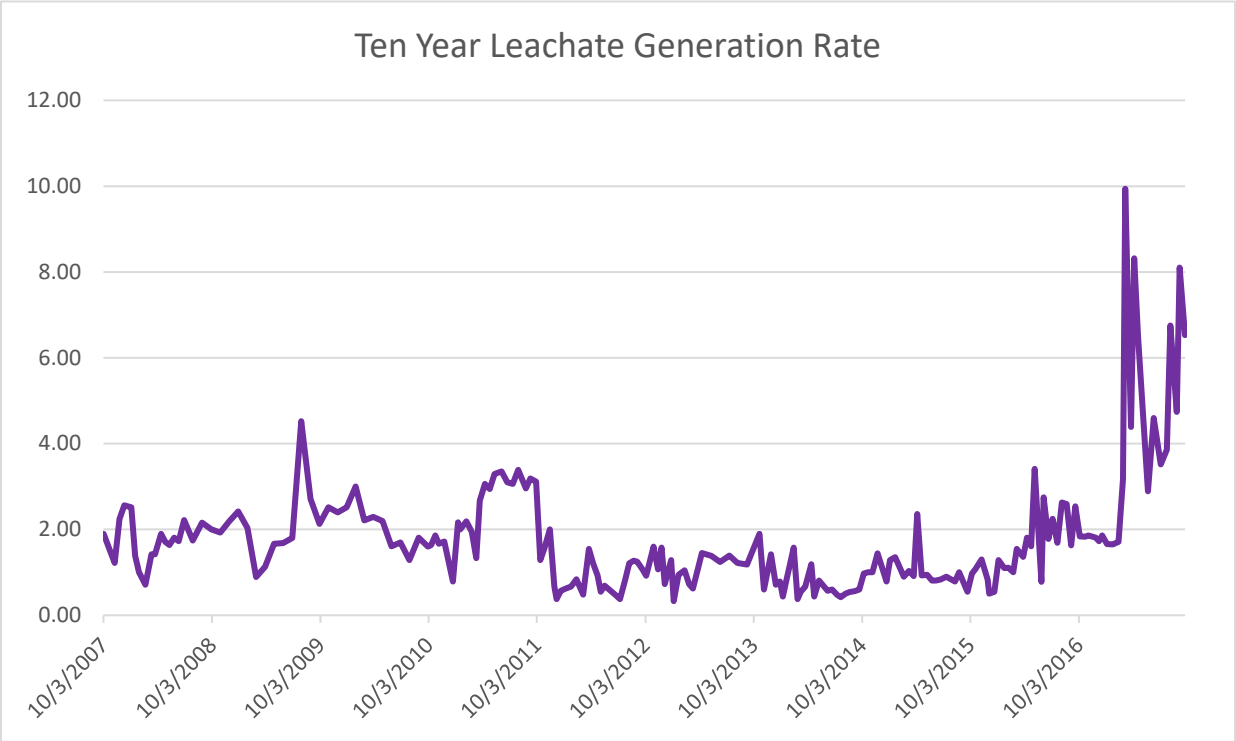

Figure 4 Ten Year Leachate Generation Rates

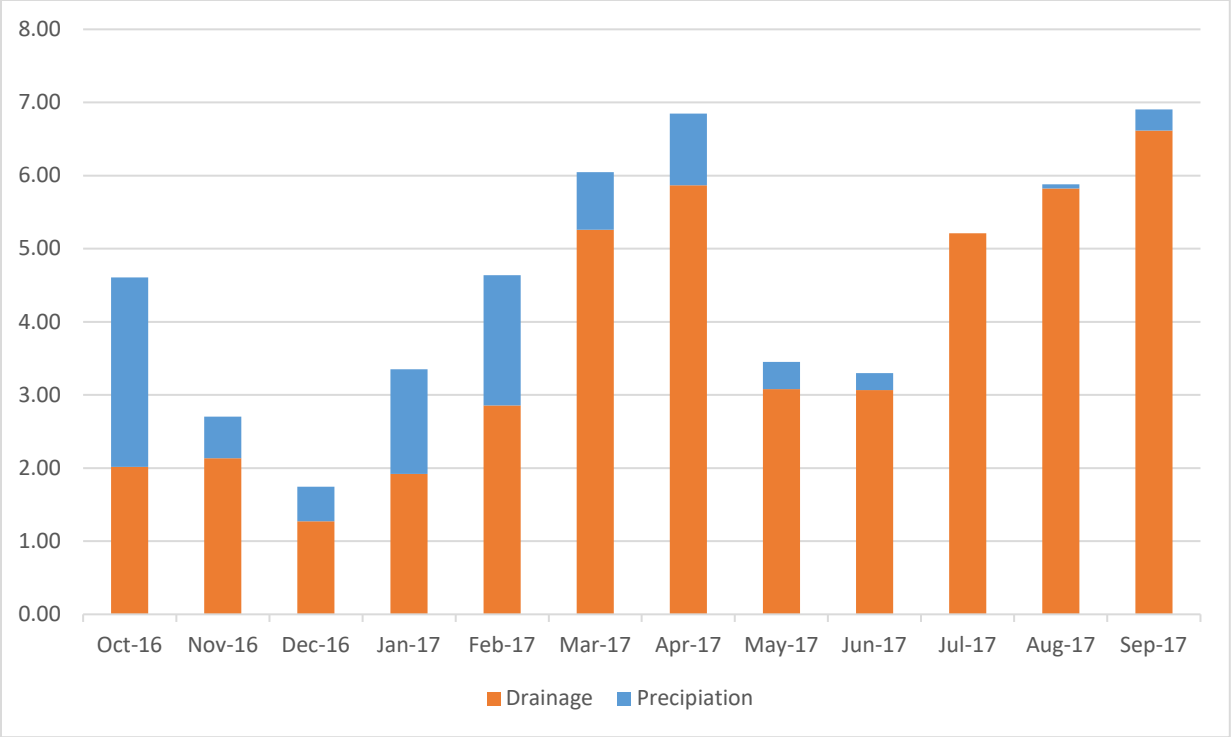

Figure 5 Solid Waste Landfill Basin Lysimeter Drainage

2.2 LEACHATE ANALYTICAL RESULTS

Table 2 shows analytical results of indicator- and site-specific parameters for the leachate. Only the indicator parameters for groundwater monitoring listed in Washington Administrative Code (WAC) 173-304-490, "Groundwater Monitoring Requirements," are monitored quarterly. The analytical results for the 2016-2017 reporting period were similar to those from previous years and did not identify any areas of concern.

As required under HNF-7173, Hanford Solid Waste Landfill Closure Plan, site-specific parameters are monitored annually and indicator parameters are monitored quarterly. As can be seen from Table 2, some parameters continue to be above WAC 173-200, "Water Quality Standards for Groundwater of the State of Washington," and groundwater quality criteria (GWQC) and/or maximum contaminant levels (MCL) for public water supplies established in WAC 246-290, "Group A Public Water Supplies". These contaminants being above compliance levels in the leachate does not necessarily mean they will be present in the same concentrations in the groundwater. Annual groundwater monitoring results are reported in Section 3.0.

Table 2 Leachate Monitoring Results - Key Constituents

Parameter[1]	**Q4 2016**	**Q1 2017**	**Q2 2017**	**Q3 2017**	**GWQC[2]**	**MCL[3]**
Indicator Parameters (Quarterly)						
Conductivity (µS /cm)	2050	2130	1990	2170	NA	700 umhos/cm
pH	7.47	7.16	7.32	6.89	6.5-8.5	NA
Alkalinity**	895	922	852	909	NA	NA
Bicarbonate**	895	922	852	909	NA	NA
Calcium**	192	182	178	195	NA	NA
Sodium**	101	122	111	103	NA	20 mg/L
Magnesium** ug/L	109	103	92.6	98.4	NA	NA
Chloride – Dissolved	150	130	110	140	250 mg/L	25.0 mg/L
Ammonia as N (mg/L)	0.678	0.688	0.786	0.42	NA	NA
Nitrate as N – Dissolved	0.036	0.07	0.047	0.082	10 mg/L	10.0
Nitrite as N – Dissolved	0.038	0.095	0.038	0.038	NA	1.0
Sulfate – Dissolved	100	160	150	160	250 mg/L	25 mg/L
Dissolved Iron	7.99	12.9	8.9	5.26	0.3 mg/L	0.3 mg/L
Dissolved Manganese	2.03	1.65	2.24	1.6	0.05 mg/L	0.05 mg/L
Dissolved Zinc	0.213	1.01	1.63	0.759	5.0 mg/L	5.0 mg/L
Chemical Oxygen Demand	165	366	130	145	NA	NA
Total Organic Carbon	49.2	36.7	35.4	47.7	NA	NA
Site-Specific Parameters (Annually)						
Total Dissolved Solids	1470	1460	1300	1350	500 mg/L	500 mg/L[4]
Total Organic Halogens (µg/L)	424	240	242	282	NA	NA
Arsenic (µg/L)	32.5	25.9	28.3	46	0.05 µg/L	0.010 mg/L
Barium (µg/L)	448	467	447	463	1.0 mg/L	2.0 mg/L
Nickel (µg/L)	57.1	52.1	46.1	45.9	NA	0.1 mg/L
1,1,1-Trichloroethane	0.30	NT	NT	NT	0.20 mg/L	0.2 mg/L
1,1-Dichloroethane	0.30	NT	NT	NT	1.0 µg/L	NA
Tetrachloroethene (µg/L)	0.30	NT	NT	NT	NA	NA
Trichloroethene (µg/L)	0.30	NT	NT	NT	NA	NA
Carbon Tetrachloride	0.30	NT	NT	NT	0.3 µg/L	0.005 mg/L
Methylene Chloride	4.64	NT	NT	NT	5 µg/L	NA
1,4-Dioxane	15	NT	NT	NT	7 µg/L	NA
1,4-Dichlorobenzene	0.30	NT	NT	NT	4 µg/L	NA
Acetone (µg/L)	3	NT	NT	NT	NA	NA
Tetrahydrofuran (µg/L)	1.5	NT	NT	NT	NA	NA
2-Butanone (µg/L)	3.0	NT	NT	NT	NA	NA
2-Pentanone (µg/L)	3.0	NT	NT	NT	NA	NA

[1]Units as provided in analytical results report.
[2]Groundwater quality criteria are from WAC 173-200.
[3]Maximum contaminant levels are from WAC 246-290.
[4]Required only when specific conductivity exceeds 700 µS/cm.
** Indicator parameters added to quarterly sampling from DOE/RL-2015-33.

3.0 GROUNDWATER MONITORING

During Fiscal Year (FY) 2017, sampling events were completed in October 2016, as well as January, April and August 2017. Sampling was conducted under monitoring plan, DOE/RL-2015-33, Groundwater Monitoring Plan for the Solid Waste Landfill, implemented in FY 2016, and designed to meet the current governing regulation WAC 173-350, "Solid Waste Handling Standards".

Table 3 provides a summary of current network wells. Figure 6 shows the SWL groundwater monitoring wells and network wells that have been replaced during the last few years.

Table 3 Monitoring Network Well Changes

Well Number	Monitoring Status
Upgradient Groundwater Monitoring Wells	
699-24-35	Active
699-24-36[a]	Active
Downgradient Groundwater Monitoring Wells	
699-22-35	Active
699-23-34B	Active
699-23-34A	Inactive – Sample Dry*
699-24-34A	Active – Going Sample Dry*
699-24-34D[b]	Active – Replaced 699-24-34A
699-24-34B	Inactive – Going Sample Dry*
699-24-34E[c]	Active – Replaced wells 699-24-34B
699-24-33 (Deep Well)	Active - Non Statistical Use Well
699-24-34C	Inactive - Sample Dry*
699-25-34C	Inactive – Sample Dry*
699-25-34E	Active – Replaced 699-24-34C and 699-25-34C

*Sample Dry = Insufficient water available in well to permit sample collection.
[a]Well implemented in FY 2016.
[b]Installed in FY 2015.
[c]Sampling initiated in FY 2015.

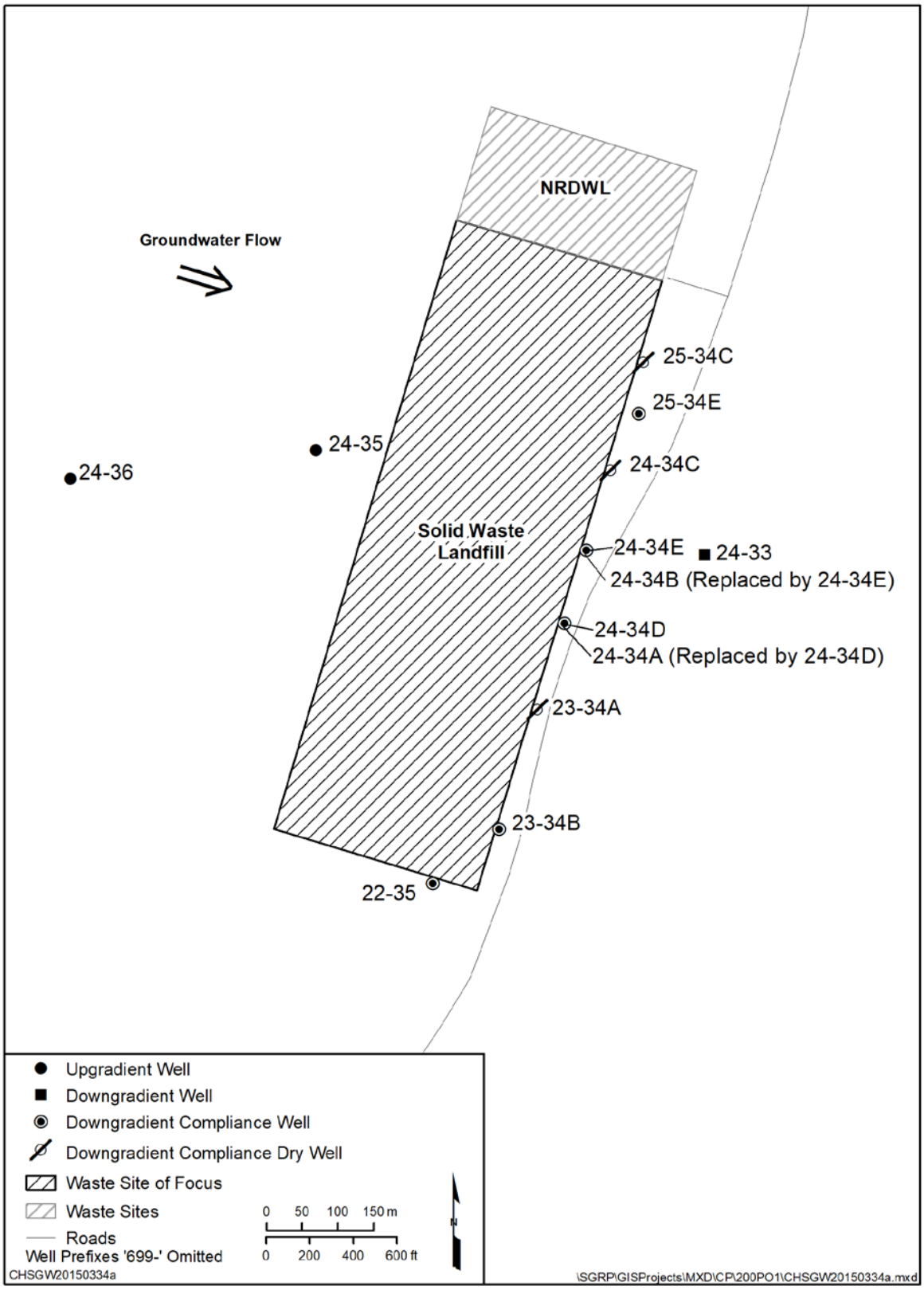

Figure 6 Location of current Groundwater Monitoring Network Wells

All groundwater network wells at the SWL were sampled successfully for this reporting period. The results of groundwater sampling are evaluated to determine whether any concentrations of the sampled constituents have increased significantly over established background threshold values (BTV), GWQC or MCL. Table 4 lists all the constituents sampled in the groundwater for the past fiscal year. Table 5 summarizes the analysis results. New wells 699-24-34D and 699-24-34E were sampled quarterly in FY 2017, representing the first full year under DOE/RL-2015-33, with August 2017 representing the last quarterly event.

3.1 BACKGROUND THRESHOLD VALUE EXCEEDANCES

Sample results for downgradient SWL groundwater monitoring wells, collected in October 2016, January 2017, April 2017 and July 2017, under DOE/RL-2015-33, are compared to BTV for groundwater constituents specified in WAC 173-350-500(5). The BTV were calculated in accordance with the requirements of DOE/RL-2015-33 and presented in ECF-200PO1-16-0144, Calculation of BTV for the SWL through CY 2016.

During the previous reporting year, BTV for chemical oxygen demand, coliform bacteria, field pH, specific conductance, sulfate, temperature, and total organic carbon were exceeded in downgradient wells. Chemical oxygen demand is not included as a monitoring constituent under DOE/RL-2015-33. During this reporting period, some wells exceeded BTV for calcium, chloride, filtered magnesium, nitrate, filtered sodium, specific conductance and temperature. Table 6 summarizes these exceedances for sampling associated with this annual reporting period. Some volatile organic compounds (VOC) were also detected in the network wells during the reporting period.

Concentrations of calcium and magnesium exceeded the derived BTV as established in ECF-200PO1-16-0144 during the April 2017 event; however, elevated calcium and magnesium concentrations are a known and previously reported site condition. BTV for the SWL were previously calculated under the prior groundwater monitoring plan, PNNL-13014, Groundwater Monitoring Plan for the Solid Waste Landfill, and included those constituents required under WAC 173-304-490, Groundwater Monitoring Requirements. Under WAC 173-304-490, calcium and magnesium were not listed as indicator parameters. Samples collected October 2016 were evaluated against published BTV calculated under PNNL-13014, GWQC or MCL consistent with the January and April 2016 events. The elevated calcium and magnesium are contributors to elevated specific conductance and are associated with a carbon dioxide vapor plume present within the vadose zone soils beneath the landfill. The carbon dioxide vapor plume is sourced from disposal of sewage which contained VOCs. The presence of elevated calcium and magnesium has been documented in detail in previous site-wide annual groundwater reports, as well as in the current groundwater monitoring plan DOE/RL-2015-33, Rev. 0. Results for the April 2017 event are on trend and consistent with historic values. Notification of exceedance of calcium and magnesium was provided to Ecology in June 2017 based on requirements in the current groundwater monitoring plan, DOE/RL-2015-33.

Elevated alkalinity, specific conductance and sulfate, potentially indicate the past disposal of sewage in the landfill. Continued detection of low levels of chlorinated hydrocarbons (tetrachloride [PCE]) is consistent with waste previously disposed of at the landfill from the 1100

Area heavy equipment garage and bus shop. Whether the detected VOC are present because of liquid waste, other than sewage, is unknown.

Due to errors in laboratory sample management systems, 1,4-dichlorobenzene was not analyzed in FY 2017. Data has been recovered for all wells and will be uploaded into HEIS as it becomes available. 1,4-dichlorobenzene is included within the groundwater monitoring constituent list in DOE/RL-2015-33, and was retained from the previous groundwater monitoring plan PNNL-13014, due to historic detections at SWL. The historic presence of chlorinated VOC is further discussed in Section 3.4. 1,4-dichlorobenzene has continued to be monitored as one of multiple chlorinated VOC. However to date, concentrations of 1,4-dichlorobenzene have not exceeded the GWQC concentration of 4 µg/L, or the default Model Toxics Control Act Method B cleanup level of 8.1 µg/L. Additionally, 1,4-dichlorobenzene was last detected at SWL in well 699-23-34B (since replaced by 699-23-34E) in February 2005 at a concentration of 0.2 µg/L. The identified errors in the laboratory management system have been corrected and 1,4-dichlorobenzene will continue to be analyzed during future SWL monitoring events.

In summary, the analytical results are typical of historical trends at the SWL and are consistent with results at the upgradient (background) wells.

Table 4 Constituents Sampled

Constituents			
1,1,1-Trichloroethane	Arsenic	Coliform Bacteria	Sodium
1,1-Dichloroethane	Bicarbonate	Iron	Specific Conductance
1,2-Dichloroethane	Calcium	Magnesium	Sulfate
1,4-Dichlorobenzene**	Carbon tetrachloride	Manganese	Temperature
1,4-Dioxane	Chloride	Nitrate	Tetrachloroethene
Alkalinity	Chloroform	pH Measurement	Trichloroethene

**Due to errors in laboratory sample management systems, 1,4-Dichlorobenzene was not analyzed in FY 2017.

Table 5 BTV Exceedances

Parameter (FY 2017 BTV)	**Maximum Previous Year (Based on FY 2016 BTV)**	**October 2016 thru September 2017**
Calcium-filtered (81,000 µg/L)	*Not Required for BTV Comparison under WAC 173-304-490*	Six downgradient wells exceeded the BTV. Maximum Value = 110,000 µg/L @ 699-22-35 and 699-23-34B
Chloride (6,100 µg/L)	One downgradient wells exceeded the BTV. Maximum value = 7,900 @ well 699-25-34E	Five downgradient wells with a maximum value of 7,800 µg/L @ new well 699-25-34E
Field Ph (6.58 - 7.76)	One downgradient wells exceeded the lower bound. Lowest value = 6.52 @ 699-24-34D	No exceedances
Iron-filtered (74.2 µg/L)	No exceedances	No exceedances

Parameter (FY 2017 BTV)	Maximum Previous Year (Based on FY 2016 BTV)	October 2016 thru September 2017
Magnesium-filtered (17,200 µg/L)	*Not Required for BTV Comparison under WAC 173-304-490*	Six downgradient wells exceeded the BTV. Maximum value = 22,100 @699-22-35
Nitrate (14,600 µg/L)	Eight downgradient wells exceeded the BTV. Maximum value = 20,400 @ 699-26-35A	Four downgradient wells exceeded the BTV. Maximum value = 18,600 @ 699-23-34B
Sodium-filtered (23,500 µg/L)	Four downgradient wells exceeded the BTV. Maximum value = 24,600 @ 699-24-34D	One downgradient well exceeded the BTV with a maximum value of 24,600 @ 699-24-34D.
Specific Conductance (576 µS/cm)	Eight downgradient wells exceeded the BTV. Maximum value = 767 @ 699-22-35	Six downgradient wells exceeded the BTV. Maximum value = 778 @ 699-22-35
Sulfate (47,400µg/L)	No exceedances	No exceedances
Temperature (19.7 °C)	Five downgradient wells exceeded the BTV. Maximum value = 21.9 @ 699-26-35A	Four downgradient wells exceeded the BTV. Maximum value = 22.1 @ 699-24-33

3.2 GROUNDWATER QUALITY CRITERIA AND DRINKING WATER MAXIMUM CONTAMINANT LEVEL EXCEEDANCES

During the previous reporting period, levels above the Washington State drinking water MCL were reported for coliform bacteria (based on FY 2016 BTV), antimony, specific conductance and sodium. In addition, levels of tetrachloroethene (PCE) reported at several wells exceeded the WAC 173-200 GWQC. Antimony is not a monitoring constituent under DOE/RL-2015-33.

During this reporting period, samples exceeded the limits for coliform bacteria, specific conductance, PCE and sodium. Table 6 summarizes the exceedances recorded from October 2016 through September 2017.

Table 6 GWQC and Drinking Water Maximum Contaminant Level Exceedances

Parameter (Limit)	Maximum Previous Year	October 2016 through September 2017
Coliform Bacteria (1 Colony/100 ml)	Five downgradient wells. Maximum 2,420 colony/100 ml @ 699-24-34E	Four downgradient network wells. Maximum 2,420 colony/100 ml @ 699-23-34B
Specific conductance (700 µS/cm)[1]	Three downgradient network wells. Maximum 753 @ 699-22-35	Three downgradient network wells. Maximum 767 @ 699-22-35
Tetrachloroethene (PCE) (0.8 µg/L)[2]	Five downgradient wells. Maximum 1.11 µg/L @ 699-24-33	Three downgradient wells. Maximum 0.89 µg/L @ 699-24-34D

Sodium (20 mg/L)[1*]	All network wells. Maximum 26.1 mg/L @ well 699-25-34E	All network wells. Maximum 24.6 mg/L @ well 699-24-34D

1Maximum contaminant levels from WAC 246-290-310, "Maximum contaminant levels (MCL) and maximum residual disinfectant levels (MRDL)," Washington Administrative Code, as amended, Olympia, Washington.
2Groundwater quality criteria from WAC 173-200-040, "Criteria," Washington Administrative Code, as amended, Olympia, Washington.
*No MCL, but identified as level of concern.

Results remain consistent with the type of waste disposed to the landfill which included sewage and chlorinated hydrocarbons from the 1100 Area heavy equipment garage and bus shop. Arsenic concentrations detected at SWL wells were reported at or below 5.51 µg/L during this reporting period and are typical of the Hanford Site background values (11.8 µg/L) identified in DOE/RL-96-61, Hanford Site Background: Part 3, Groundwater Background (95th percentile, as corrected).

3.3 GROUNDWATER HYDROLOGY

The water table beneath SWL is near the top of a silty sand unit in the lower portion of the Hanford formation or in the upper portion of the Cold Creek Unit (CCU). The uppermost aquifer is unconfined and comprises saturated Hanford sediments and the CCU. The saturated Hanford and CCU sediments are gravelly sand to sandy gravel, approximately 18 m (59 ft.) thick. Historically, the direction and flow of groundwater beneath the SWL has been difficult to determine from water table maps because of the extremely low hydraulic gradient. However, groundwater is known to flow southeast between the 200 East Area and the SWL.

The groundwater flow rate was estimated for the adjacent NRDWL in ECF-HANFORD-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017*. In 2017, the calculated average groundwater velocity estimate was 0.014 meters per day.

From 2012 through 2017, measured water table elevations in wells declined on average 1.9 cm/yr (0.7 in./yr).

3.4 CHLORINATED ORGANICS IN GROUNDWATER WELLS

Based on past monitoring of the groundwater wells in the SWL groundwater monitoring program, six primary organic compounds were identified in the groundwater below the SWL for inclusion in this report:

- 1,1-dichloroethane
- 1,1,1-trichloroethane
- Chloroform
- Carbon tetrachloride
- Tetrachloroethene
- Trichloroethylene

Some of these chlorinated hydrocarbons are detected in both upgradient and downgradient wells, although concentrations for most constituents are slightly higher in the downgradient wells. Three wells historically have shown the highest levels of organic compounds (699-22-35, 699-23-34A, 699-24-34C). These three downgradient wells have been referred to as the 'target wells'. Well 699-22-35 is located outside the south perimeter fence of the SWL. Well 699-23-34A is located outside the east perimeter fence near the southeast corner. This well went sample dry in the first quarter of FY 2014. Well 699-24-34C, which went sample dry in FY 2011, is located outside the east perimeter fence just north of the SWL's mid-point. Table 8 shows the results of analyses for the six primary organic compounds in downgradient wells, in addition to comparison data from upgradient wells 699-24-35, 699-24-36 and 699-26-35A sampled between October 2016 and September 2017. Table 8 presents all wells sampled during FY 2017.

Appendix A, Figures A-1 through A-6, show the historical concentration trending for these organic chemical compounds in groundwater for the network wells since January 2000. As indicated in the trend plots, the low-level concentrations over the past 10 years have generally been stable or slightly decreasing. Carbon tetrachloride is generally not detected. Except for tetrachloroethene, the chlorinated organic constituents shown in the figures had levels below the WAC 246-290 GWQC.

Table 7 Primary Chlorinated Hydrocarbon Groundwater Monitoring Results
Downgradient Wells Compared with Upgradient Wells (Concentrations in µg/L)

FY 2017 Quarters	22-35	23-34B	24-33	24-34D	24-34E	25-34E	24-35 (upgradient)	24-36 (upgradient)
	Concentrations are in µg/L (Well numbers begin with 699-)							
1,1,1 trichloroethane (GWQC of 200 µg/L)**								
Oct –Dec ‘16	0.41J	0.27J	0.32J	0.45J	0.35J	0.24J	0.34J	0.3U
Jan – Mar ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U
Apr – Jun ‘17	0.3U	0.27J	0.3U	0.3U	0.3U	0.2J	0.24J	0.3U
Jul – Sep ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U
1,1 dichloroethane (GWQC of 1 µg/L)**								
Oct –Dec ‘16	0.3U	0.07U	0.3U	0.3U	0.3U	0.07U	0.22U	0.3U
Jan – Mar ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U
Apr – Jun ‘17	0.3U	0.07U	0.3U	0.3U	0.3U	0.07U	0.07U	0.3U
Jul – Sep ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U
Carbon tetrachloride (GWQC of 0.3 µg/L)**								
Oct –Dec ‘16	0.3U	0.18U	0.3U	0.3U	0.3U	0.18U	0.19U	0.3U
Jan – Mar ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U
Apr – Jun ‘17	0.3U	0.18U	0.3U	0.3U	0.3U	0.18U	0.18U	0.3U
Jul – Sep ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U
Chloroform (GWQC of 7 µg/L)**								
Oct –Dec ‘16	0.3U	0.1U	0.3U	0.3U	0.3U	0.13J	0.16U	0.3U
Jan – Mar ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U
Apr – Jun ‘17	0.3U	0.1U	0.3U	0.3U	0.3U	0.1U	0.1U	0.3U
Jul – Sep ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U
Tetrachloroethene (GWQC of 0.8 µg/L)**								
Oct –Dec ‘16	0.45J	0.41J	1.11J	0.89J	1.04J	0.77J	0.5J	0.3U
Jan – Mar ‘17	NA	NA	NA	0.81J	0.67J	NA	NA	0.3U
Apr – Jun ‘17	0.39J	0.35J	0.83J	0.68J	0.68J	0.68J	0.39J	0.3U
Jul – Sep ‘17	NA	NA	NA	0.61J	0.72J	NA	NA	0.3U
Trichloroethene (GWQC of 3 µg/L)**								
Oct –Dec ‘16	0.4J	0.34J	0.54J	0.36J	0.41J	0.42J	0.25J	0.3U
Jan – Mar ‘17	NA	NA	NA	0.32J	0.33J	NA	NA	0.3U
Apr – Jun ‘17	0.31J	0.38J	0.39J	0.35J	0.3U	0.38J	0.25U	0.3U
Jul – Sep ‘17	NA	NA	NA	0.3U	0.3U	NA	NA	0.3U

**Groundwater Quality Criteria from WAC 173-200, “Water Quality Standards for Groundwaters of the State of Washington,” Washington Administrative Code, as amended, Olympia, Washington.
u = Non-detect or below the MDL.
J = Estimated value (actual value is between the MDL and the practical quantitation limits).
NA = Not Sampled.

4.0 SOIL GAS MONITORING

The soil gas monitoring network consists of eight shallow monitoring stations located around the perimeter of the SWL. Each monitoring station consists of two dedicated soil-gas probes driven to depths of approximately 9 and 15 ft (2.7 m and 4.6 m), respectively. The gas is monitored quarterly to determine concentrations of carbon dioxide and methane. The soil gas is also analyzed for several key volatile organic constituents (i.e., methylene chloride, 1,1 dichloroethane, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, trichloroethylene, 1,1,2-trichloroethane, and tetrachloroethene). See Figure 7 for the locations of soil gas monitoring stations. (NOTE: Soil gas monitoring station DE-1, shown in Figure 7, was damaged by fire and is no longer used.)

In addition to the eight monitoring stations in the SWL soil gas monitoring network, soil gas monitoring station DW-2, located along the border with the NRDWL, is sampled routinely.

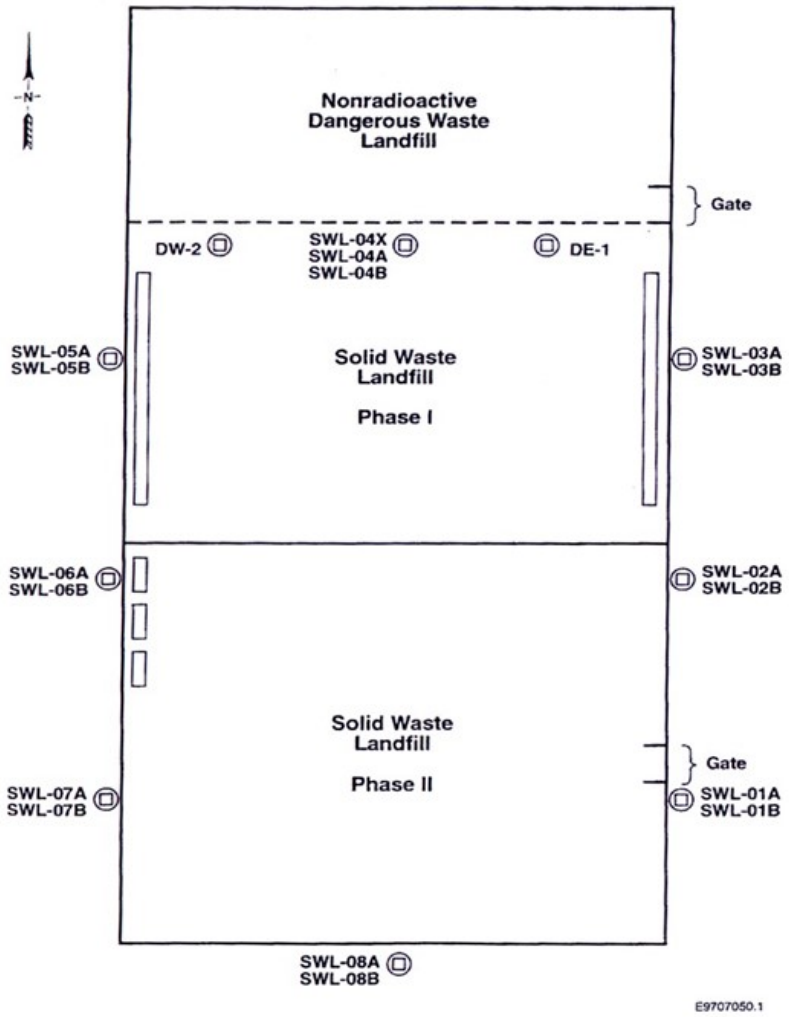

Figure 7 Location of Soil Gas Monitoring Stations

Table 8 summarizes the soil gas monitoring results which are consistent with the results of previous monitoring. The concentrations for the volatile organic constituents were at or below the detection limits. Methane concentrations remain low or, for the most part, are not detected. Carbon dioxide concentrations continue to be consistent with data provided in previous reports.

Table 8 Solid Waste Landfill Soil Gas Monitoring Results
(Constituent measured in ppmV)

Constituent/ Sample Month	Sample Station																	
	01-A	**01-B**	**02-A**	**02-B**	**03-A**	**03-B**	**04-A**	**04-B**	**04-X**	**DW-2**	**05-A**	**05-B**	**06-A**	**06-B**	**07-A**	**07-B**	**08-A**	**08-B**
Methane (CH4)																		
Nov 2016	< DL	0.5	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	0.2	0.2	0.5	1	< DL	< DL	< DL	< DL
Feb 2017	0.3	0.5	< DL	< DL	2.4	2.1	< DL	< DL	< DL	< DL	0.2	< DL	0.5	0.7	0.5	0.3	< DL	< DL
May 2017	0.1	0.1	< DL	< DL	0.5	0.6	< DL	< DL	< DL	< DL	< DL	< DL	0.5	< DL	0.5	0.4	0.1	< DL
Aug 2017	< DL	< DL	0.3	< DL	0.3	0.2	< DL	< DL	< DL	< DL	< DL	< DL	3.8	7.3	7.7	< DL	< DL	< DL
Carbon Dioxide (CO2)																		
Nov 2016	14	1	2	1	64	2	2129	1498	151	3	12	7	162	201	26	17	381	422
Feb 2017	1	5	2	2	3	3	3	1	313	3	31	38	5	11	10	14	8	13
May 2017	6	8	3	2	44	56	5024	8170	348	228	81	98	259	101	4	5	98	4
Aug 2017	131	139	5	45	1	6	492	1915	250	118	28	42	75	63	1	5	10	11
Methylene Chloride (DCM)																		
Nov 2016	18.5	17.5	< DL	< DL	0.5	0.9	< DL	< DL	< DL	0.8	0.8	1.1	8.6	7.7	7.5	8.2	8.8	9.8
Feb 2017	0.6	< DL	27.4	27.6	< DL	< DL	< DL	2.8	6	< DL	9.2	8.3	< DL	0.7	1.2	< DL	< DL	1.6
May 2017	0.5	< DL	4	3.9	< DL	< DL	3.7	< DL	5.9	35.4	< DL	< DL	< DL	< DL	< DL	< DL	1.1	< DL
Aug 2017	0.6	1	5.8	4.9	29.1	28.8	4.2	< DL	0.7	< DL	9.5	8.9	1	2.3	8	7.7	< DL	0.6
1,1 - Dichloroethane (1,1 - DCA)																		
Nov 2016	< DL	< DL	< DL	< DL	< DL	< DL	0.3	0.4	< DL	< DL	< DL	< DL	< DL	0.2	< DL	< DL	< DL	< DL
Feb 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	0.2	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
May 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Aug 2017	< DL	0.3	< DL	< DL	< DL	< DL	0.3	0.2	< DL	< DL	< DL	0.2	0.8	0.4	< DL	< DL	< DL	< DL
Chloroform (TCM)																		
Nov 2016	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Feb 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
May 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Aug 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL

Table 8 Solid Waste Landfill Soil Gas Monitoring Results
(Constituent measured in ppmV)

Constituent/ Sample Month	Sample Station																	
	01-A	01-B	02-A	02-B	03-A	03-B	04-A	04-B	04-X	DW-2	05-A	05-B	06-A	06-B	07-A	07-B	08-A	08-B
1,1,1 - Trichloroethane (1,1,1 - TCA)																		
Nov 2016	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	>DL	< DL	< DL	< DL	< DL	>DL
Feb 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	>DL
May 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	>DL
Aug 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	0.2	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	>DL
Carbon Tetrachloride (CCI4)																		
Nov 2016	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Feb 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
May 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Aug 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Trichloroethylene (TCE)																		
Nov 2016	15	14	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	1	< DL	32	33	35	34	34	31
Feb 2017	1	1	37	37	< DL	< DL	< DL	< DL	< DL	< DL	8	8	< DL	< DL	< DL	< DL	< DL	1
May 2017	< DL	< DL	2	2	< DL	< DL	< DL	< DL	< DL	29	31	31	< DL	< DL	1	< DL	< DL	< DL
Aug 2017	3	< DL	1	1	19	20	< DL	1	< DL	3	2	2	2	1	4	5	1	1
1,1,2 - Trichloroethane (1,1,2 - TCA)																		
Nov 2016	< DL	< DL	< DL	< DL	< DL	< DL	0.2	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Feb 2017	< DL	< DL	< DL	< DL	0.2	< DL	7.5	4.5	1.1	0.4	0.2	0.2	< DL	< DL	< DL	< DL	0.5	< DL
May 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Aug 2017	< DL	0.1	< DL	< DL	0.2	0.3	10	6.2	0.9	0.5	0.2	< DL	0.7	2.4	< DL	< DL	2.7	2.7
Tetrachloroethene (PCE)																		
Nov 2016	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Feb 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
May 2017	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL
Aug 2017	< DL	< DL	< DL	0.1	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL	< DL

5.0 REFERENCES

DOE/RL-96-61, 1997, *Hanford Site Background: Part 3, Groundwater Background, Rev. 0*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2010-28, 2010, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill, Rev. 1*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2014-32, 2014, *Hanford Site Groundwater Monitoring Report for 2013, Rev. 0*, CH2M HILL, Plateau Remediation Company, Richland, Washington.

DOE/RL-2015-33, *Groundwater Monitoring Plan for the Solid Waste Landfill*, CH2M Hill, Plateau Remediation Company, Richland, Washington.

ECF-HANFORD-16-0013, Rev. 0, Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2015, CH2M Hill, Plateau Remediation Company, Richland, Washington.

ECF-Hanford-17-0241, 2018, Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

HNF-7173, 2000, *Hanford Solid Waste Landfill Closure Plan*, DynCorp Tri-Cities Services, Inc., Richland, Washington.

PNNL-13014, 2000, *Groundwater Monitoring Plan for the Solid Waste Landfill*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-16346, 2007, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-SA-49780, *The 2002-2003 Fluctuation of the Water-Table Elevation in the 200 East Area and Vicinity: Evaluation of Potential Causes*, Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976, Public Law 94-580.

SGW-54165, 2014, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site, Rev. 0*, CH2M HILL, Plateau Remediation Company, Richland, Washington.

WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Permit Modification Number. 8c2015.Q4, Washington State Department of Ecology, Olympia, Washington.

WAC 173-200, "Water Quality Standards for Groundwater of the State of Washington," *Washington Administrative Code*, as amended, Olympia, Washington.

WAC 173-200-040, "Criteria," *Washington Administrative Code*, as amended, Olympia, Washington.

WAC 173-304, "Minimum Functional Standards for Solid Waste Handling," *Washington Administrative Code*, as amended, Olympia, Washington.

WAC 173-304-490, "Groundwater monitoring requirements," *Washington Administrative Code*, as amended, Olympia, Washington.

WAC 246-290, "Group A Public Water Supplies," *Washington Administrative Code*, as amended, Olympia, Washington.

WAC 246-290-310, "Maximum contaminant levels (MCL) and maximum residual disinfectant levels (MRDL)," *Washington Administrative Code*, as amended, Olympia, Washington.

APPENDIX A – GROUNDWATER TRENDS

The plots in Figures A-1 through A-6 show the concentration trends of 1,1,1,-trichloroethane, 1,1-dichloroethane, carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene, respectively, for this reporting period.

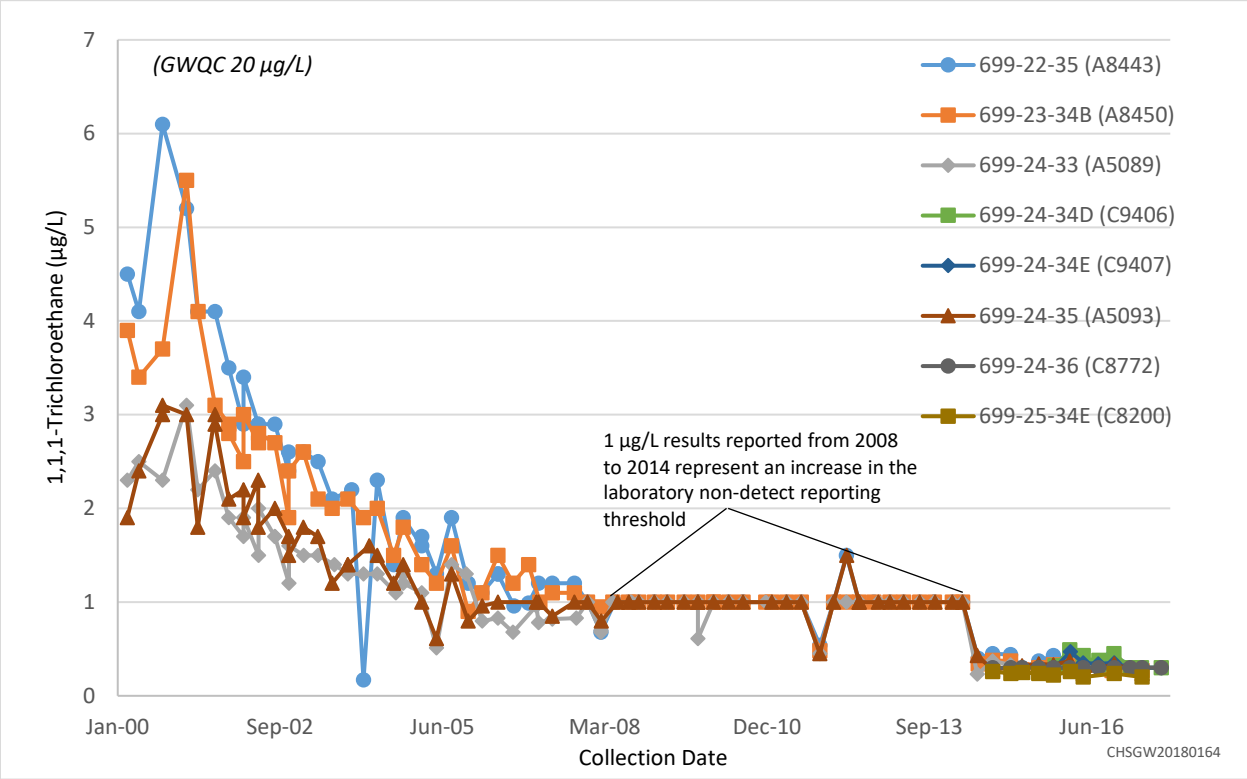

Figure A-1. 1,1,1-Trichloroethane Trend

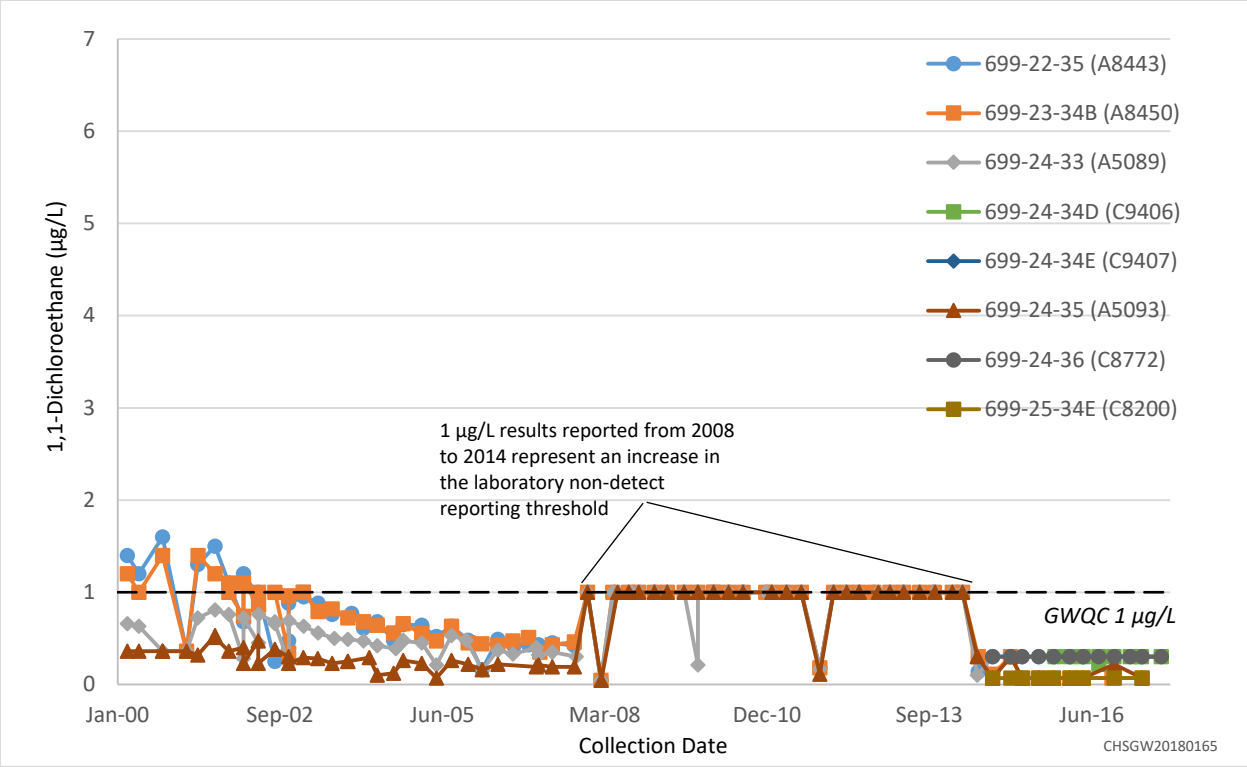

Figure A-2. 1,1-Dichloroethane Trend

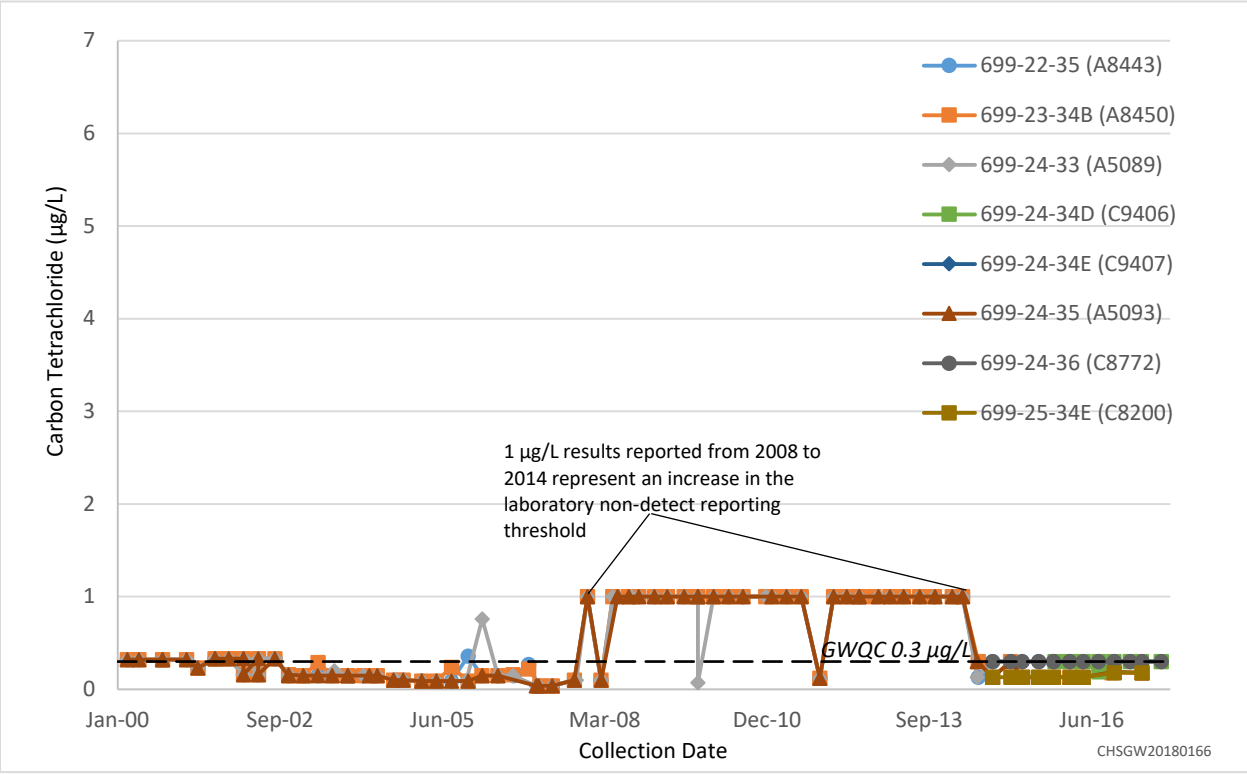

Figure A-3. Carbon Tetrachloride Trend

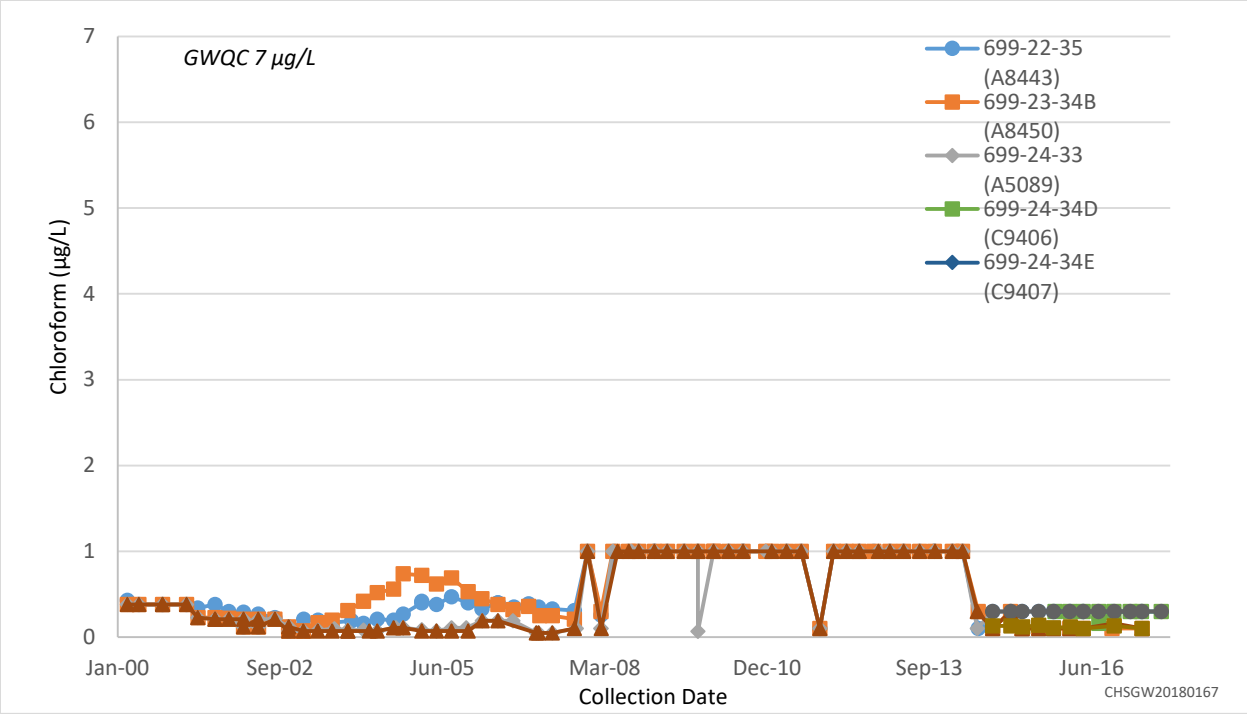

Figure A-4. Chloroform Trend

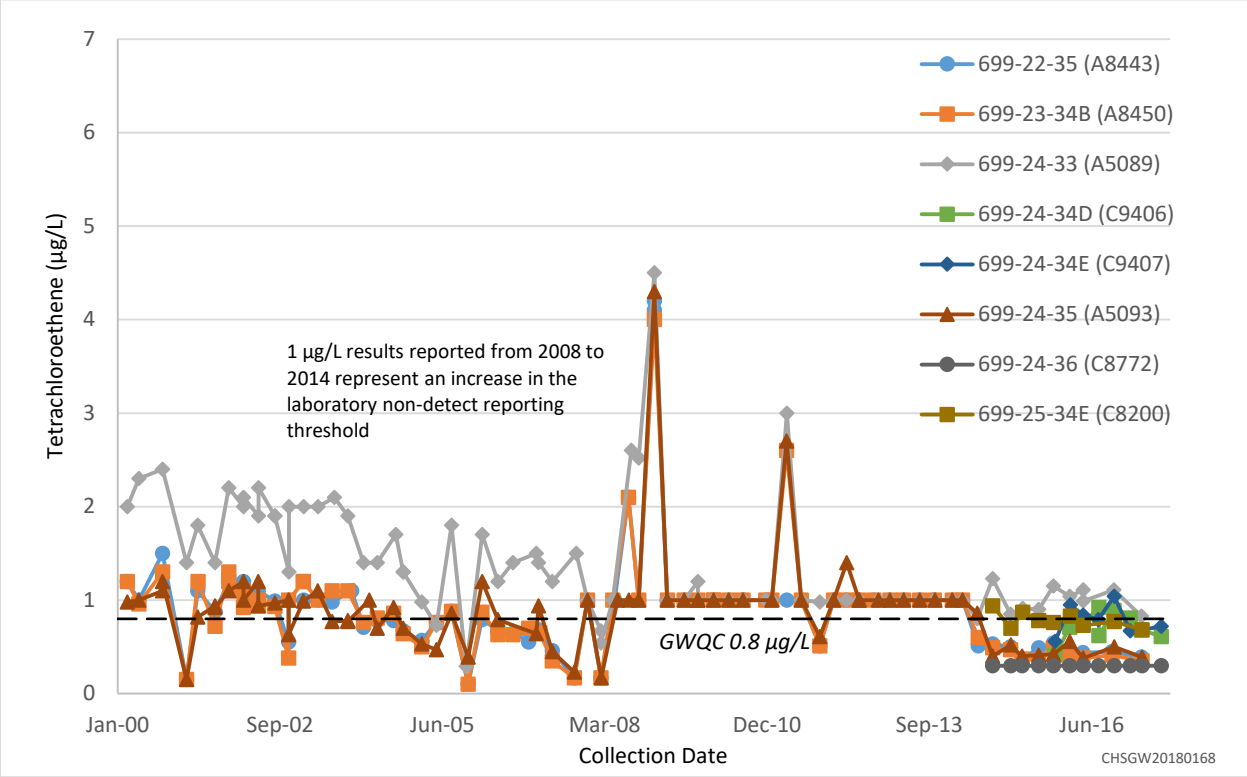

Figure A-5. Tetrachloroethene Trend

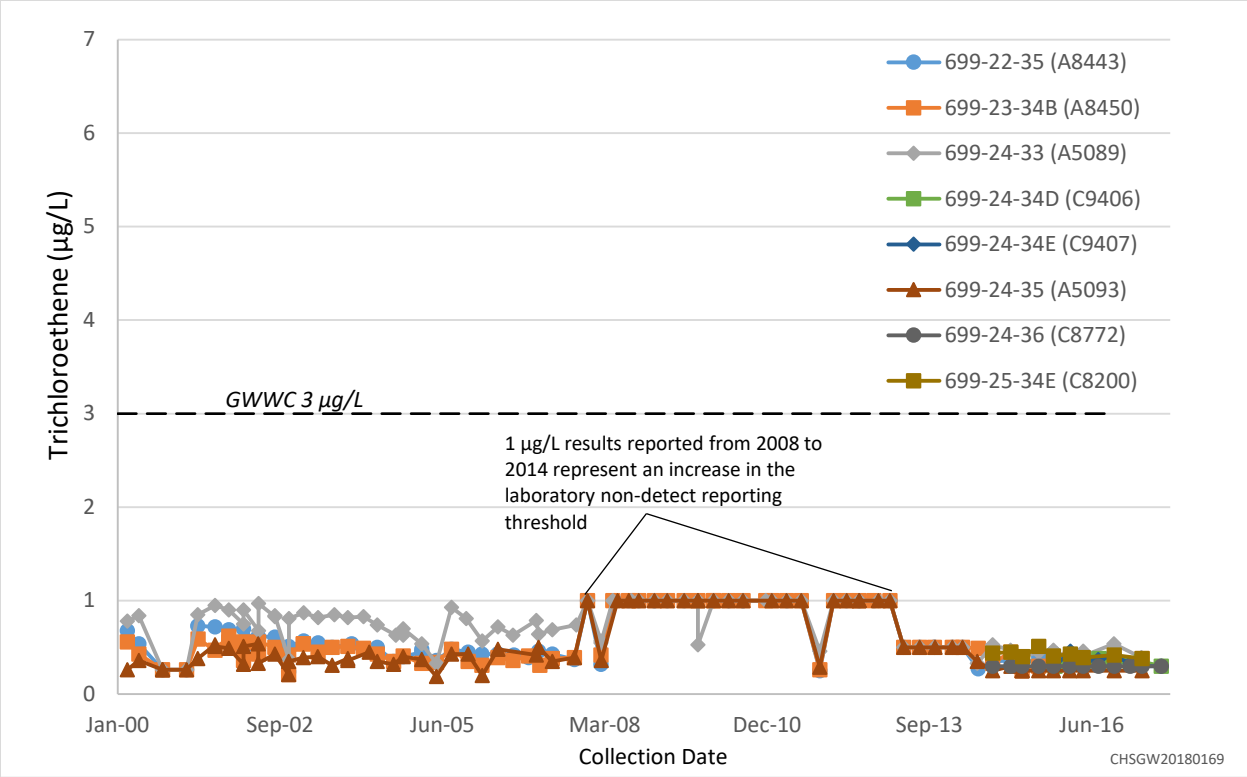

Figure A-6. Trichloroethene Trend