DOE/RL-2015-21
Revision 6

Hanford Site Solid Waste Landfill Annual Monitoring Report October 2019 to September 2020

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

Contractor for the U.S. Department of Energy
under Contract 89303320DEM000031

P.O. Box 650
Richland, Washington 99352

Approved for Public Release;
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Hanford Mission Integration Solutions (HMIS)

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HANFORD SITE SOLID WASTE LANDFILL ANNUAL MONITORING REPORT OCTOBER 2019 THROUGH SEPTEMBER 2020

This report summarizes results of leachate, groundwater and soil gas monitoring performed at the Hanford Site Solid Waste Landfill (SWL), shown in Figure ES-1, for the period of October 2019 through September 2020. In March 1996, disposal activities stopped. The SWL is now in interim closure status.

Figure ES-1 Hanford Site Solid Waste Landfill

CONTENTS

TABLES

FIGURES

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
HMIS:	Hanford Mission Integration Solutions
MCL:	maximum contaminant levels
MSA:	Mission Support Alliance
NT:	Not Tested
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) began operations in 1973 and covers approximately 27 hectares, or 66 acres. Figure 1 shows the location of the SWL (Central Landfill) on the Hanford Site.

The SWL has five units, as shown in Figure 2, each consisting of a series of parallel trenches. The two oldest units form Phase I. Phase II encompasses three units: north, middle and south. The SWL stopped receiving waste in 1996 and placed an intermediate cover over all disposal trenches. Current plans for final closure show placement of an engineered cover minimizing infiltration and leachate generation.

In February 2017, repairs to the interim cover over Phases I and II were initiated to eliminate subsidence features and erosion. The repairs were completed in September 2018.

Established monitoring systems at the SWL provide data for evaluating changes indicating increased risks to the environment and human health. Current monitoring activities include leachate, groundwater and soil gas testing and tracking. The following sections provide information from monitoring activities performed from October 2019 through September 2020.

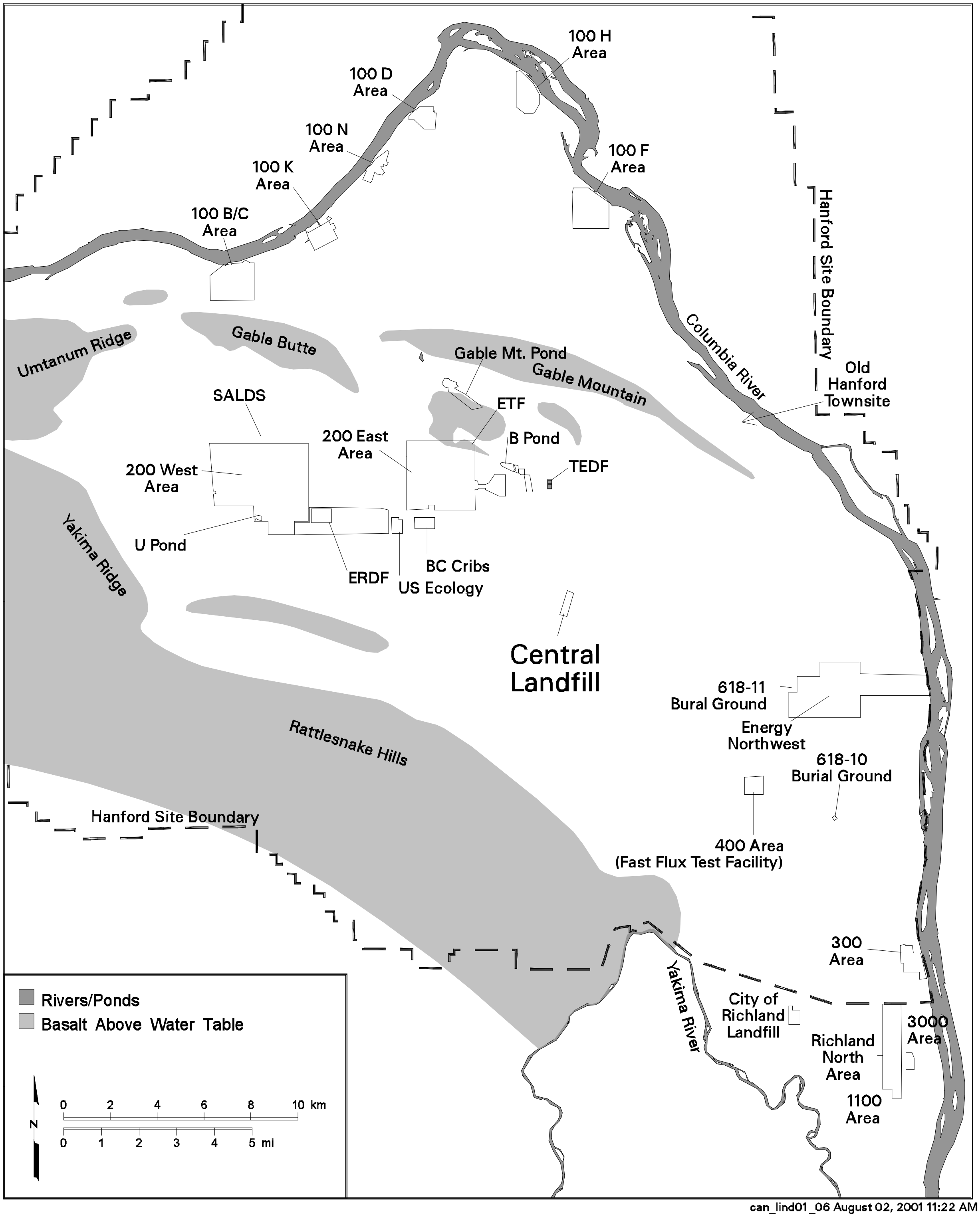

Figure 1. Location of SWL (Central Landfill) on Hanford Site

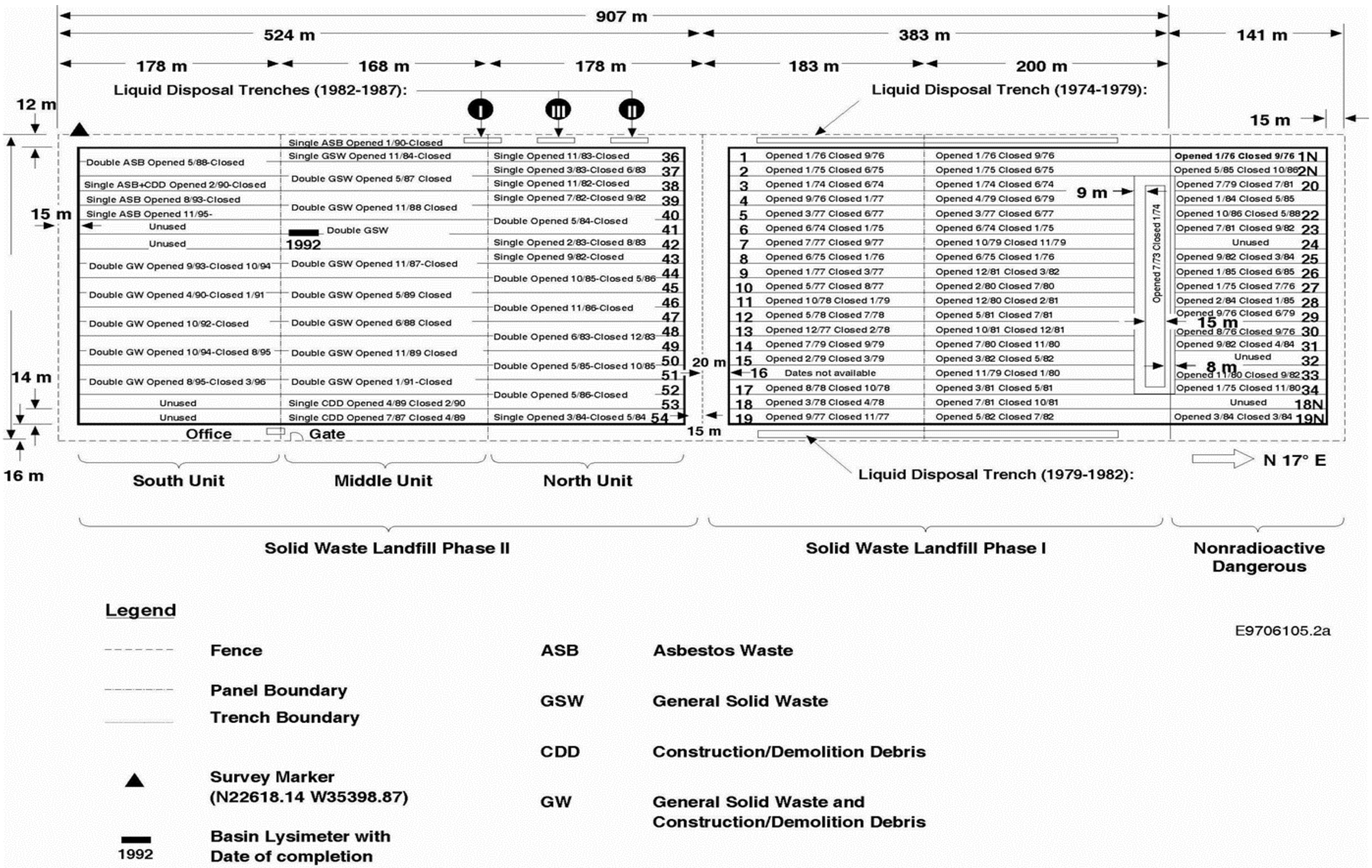

Figure 2. Location of Solid Waste Landfill Trenches and Basin Lysimeter

2.0 LEACHATE MONITORING

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 contents of the SWL. Figure 2 shows the location of the basin lysimeter in relation to other SWL trenches. The collected leachate is disposed of through a permitted wastewater treatment system.

Leachate monitoring provides an indication of potential impurities possibly reaching the groundwater from the unlined disposal cells. Leachate is collected under one double trench in Phase II of the SWL trenches and is not representative of the total leachate generation throughout the SWL.

Contaminants potentially leaching from trenches throughout the SWL represent a 23-year disposal period, dating from 1973, before enactment of the regulations restricting disposal on land. Construction activities on the phase I and II interim cover of the SWL has removed much of the variability in vegetative cover between trenches. Transpiration rates should equalize allowing uniform percolation into the soil from precipitation events.

2.1 LEACHATE GENERATION

Removal of leachate from an underground lysimeter collection tank occurs every 10 to 14 days during the dry months. The daily leachate collection rate was 4.54 gallons, from October 2019 through September 2020, totaling 1,656 gallons for the year. Leachate generation is equivalent to the previous year, which averaged 4.50 gallons per day. It is only until recently as of June 2020 that leachate generation rates appear to have stabilized to representative averages measured before the 2017/2018 phase II/I SWL interim cover repairs. These repairs involved the addition of 96,510 cubic yards of soil/gravel to fill depressions and increase the depth of the protective interim cover of soil/gravel. Heavy equipment personnel applied copious amounts of water during construction activities for dust control abatement. The resulting leachate generation rates fluctuated and remained elevated. Figure 4 represents this description best. Continued monitoring of leachate through 2021 may show a return to the pre-construction 10 year equilibrium of approximately 1.6 gallons per day.

Table 1 and Figure 3 provide leachate volumes collected from the lysimeter, as well as precipitation for the reporting period of October 2019 through September 2020. Figure 4 graphs the leachate generation rates for the past ten years. Data in Figure 5 shows the relationship of drainage to precipitation at the SWL.

Table 1. Precipitation and Leachate Generation

Month-Year	Leachate Volume (Gallons)	Precipitation (1/100th inch)
October – 2019	6.14	0.50
November – 2019	4.68	0.09
December – 2019	5.14	0.55
January – 2020	5.56	0.99
February – 2020	5.67	0.09
March – 2020	7.60	0.52
April – 2020	5.41	0.03
May – 2020	4.70	0.50
June – 2020	3.00	0.49
July – 2020	2.46	0.00
August – 2020	2.25	0.01
September – 2020	2.37	0.18

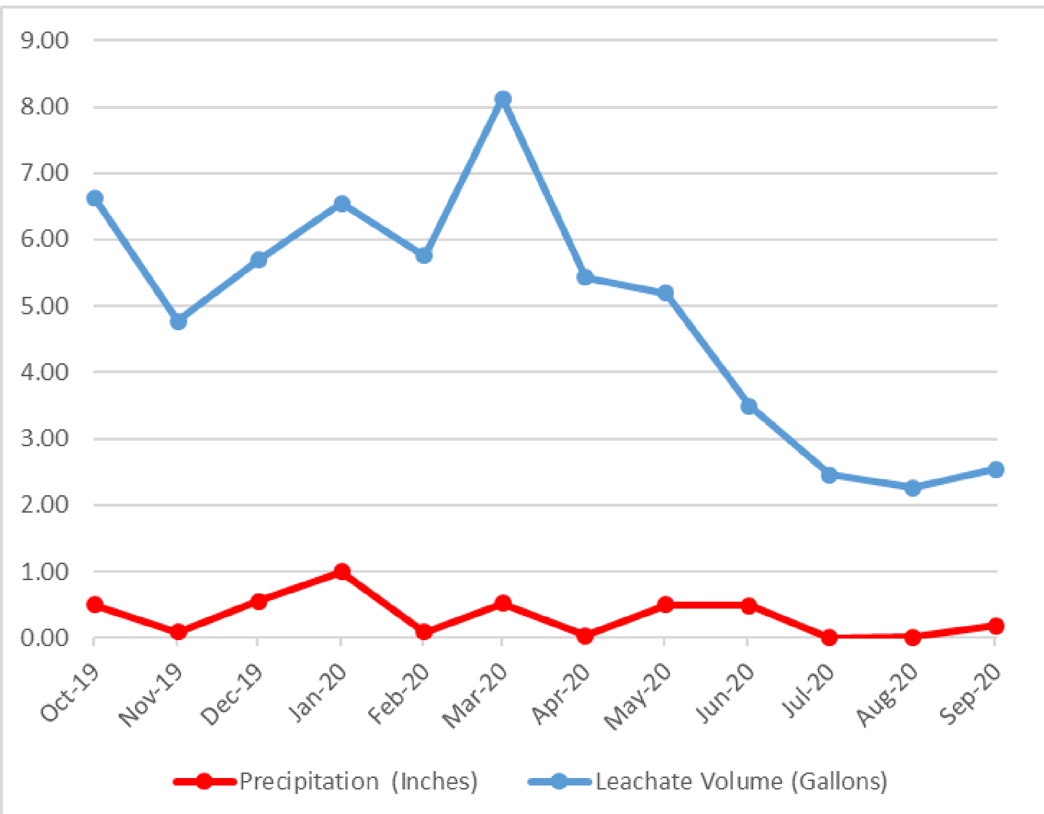

Figure 3. Leachate Generation versus Precipitation

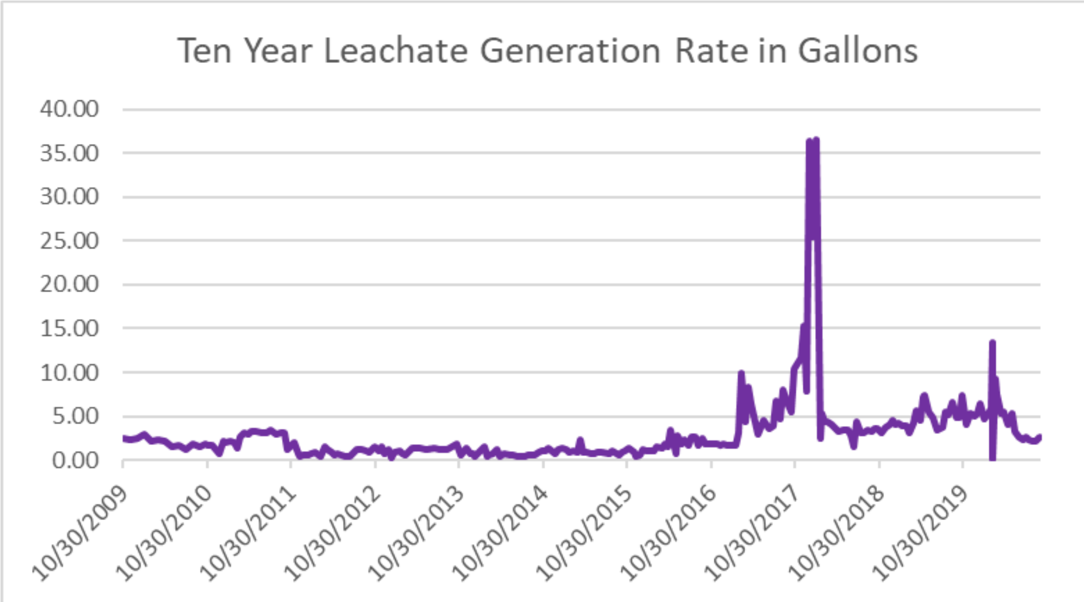

Figure 4. Ten-Year Leachate Generation Rates

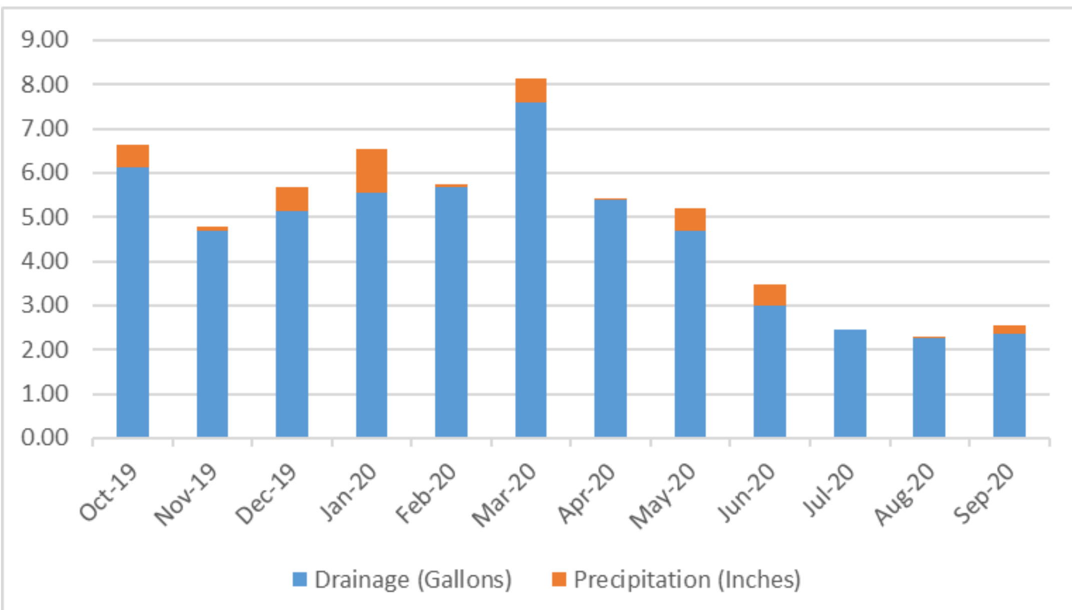

Figure 5. SWL Basin Lysimeter Drainage

2.2 LEACHATE ANALYTICAL RESULTS

Table 2 shows analytical results of indicator and site-specific parameters for the leachate. Quarterly groundwater monitoring requirements and parameters are in the Washington Administrative Code (WAC) 173-304-490, "Groundwater Monitoring Requirements".

The analytical results for the 2019-2020 reporting period were similar to those from previous years and did not identify any areas of concern.

Per HNF-7173, Hanford Solid Waste Landfill Closure Plan, site-specific parameter monitoring is annual and indicator parameter monitoring is 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,” 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 2019	Q1 2020	Q2 2020	Q3 2020	GWQC[2]	MCL[3]
Indicator Parameters (Quarterly)						
Conductivity (µS/cm)	2180	2000	2300	2480	NA	700 umhos/cm
pH	7.11	7.28	7.57	7.93	6.5-8.5	NA
Alkalinity** (mg/L)	975	933	976	954	NA	NA
Bicarbonate** (mg/L)	975	933	976	954	NA	NA
Calcium** (mg/L)	225	201	229	218	NA	NA
Sodium** (mg/L)	121	111	127	131	NA	20 mg/L
Magnesium** (mg/L)	123	112	138	139	NA	NA
Diluted Chloride (mg/L)	88	115	123	128	250 mg/L	25.0 mg/L
Ammonia as N	522	360	258	353	NA	NA
Nitrate as N - Dissolved	33.0	33.0	33.0	1770	10 mg/L	10.0
Nitrite as N - Dissolved	33.0	33.0	33.0	660	NA	1.0
Diluted Sulfate (mg/L)	185	165	199	220	250 mg/L	25 mg/L
Iron (mg/L)	5.19	4.78	1.39	.506	0.3 mg/L	0.3 mg/L
Diluted Manganese (mg/L)	3.86	3.86	1.66	1.03	0.05 mg/L	0.05 mg/L
Zinc	775	1140	480	176	5.0 mg/L	5.0 mg/L
Chemical Oxygen Demand (mg/L)	98.5	155	140	131	NA	NA
Diluted Total Organic Carbon (mg/L)	29.9	29.7	42.6	44.2	NA	NA
Site-Specific Parameters (Annually)						
Total Dissolved Solids (mg/L)	1490	1540	1560	1580	500 mg/L	500 mg/L[4]
Total Organic Halogens	260	266	408	415	NA	NA
Arsenic	13.4	15.1	11.0	9.53	0.05 µg/L	0.010 mg/L
Barium	421	408	343	309	1.0 mg/L	2.0 mg/L
Nickel	33.9	42.9	100	121	NA	0.1 mg/L
1,1,1-Trichloroethane	0.33	NT	NT	NT	0.20 mg/L	0.2 mg/L
1,1-Dichloroethane	0.33	NT	NT	NT	1.0 µg/L	NA
1,1,1,2-Tetrachloroethane	0.33	NT	NT	NT	NA	NA
Trichloroethene	0.33	NT	NT	NT	NA	NA
Carbon Tetrachloride	0.33	NT	NT	NT	0.3 µg/L	0.005 mg/L
Methylene Chloride	1.67	NT	NT	NT	5 µg/L	NA
1,4-Dioxane	16.7	NT	NT	NT	7 µg/L	NA
1,4-Dichlorobenzene	6.02	NT	NT	NT	4 µg/L	NA
Acetone	5.53	NT	NT	NT	NA	NA
Tetrahydrofuran	1.67	NT	NT	NT	NA	NA
2-Butanone	1.67	NT	NT	NT	NA	NA
2-Pentanone	3.33	NT	NT	NT	NA	NA

[1]Units measured in µg/L unless otherwise noted.
[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

This section discusses the groundwater hydrology, the SWL groundwater monitoring network, fiscal year (FY) 2020 sampling events, and sampling results, and summarizes the groundwater sampling events.

3.1 GROUNDWATER HYDROLOGY

The water table occurs within the gravel-dominated sequence of the Hanford formation and the gravel-dominated Cold Creek Unit (CCUg), at an elevation of 121.5 m (398.6 ft). Based on the maximum surface elevations at SWL, the unsaturated thickness of the vadose zone is approximately 43.9 m (144 ft) thick. The uppermost aquifer is unconfined and comprises the saturated Hanford formation sediments, CCUg, sandy silt, sand, and gravelly sand of the Ringold Formation member of Taylor Flat, and sand, silt, and gravel of the Ringold Formation member of Wooded Island unit E. The base of the unconfined aquifer is the top of the fine-grained Ringold Formation member of Wooded Island lower mud unit, which is expected to be encountered at 118 m (387 ft) below ground surface.

Historically, the direction and flow of groundwater beneath SWL has been difficult to determine from water table maps because of the extremely low hydraulic gradient. ECF- HANFORD-20-0078, *Preparation of the Hanford Site Water Table Map for January to March 2020*, calculated the groundwater gradient and flow rates at the adjacent NRDWL which are applicable to SWL. In 2020, the calculated hydraulic gradient was 1.5×10-5 m/m, with a flow direction to the southeast. The average groundwater flow rate was 1.0 m/d (3.3 ft/d).

3.2 GROUNDWATER MONITORING NETWORK

Table 3 provides a summary of current SWL monitoring network wells. Figure 6 shows the locations of the SWL groundwater monitoring wells. Well 699-24-33 is a deep well and is not constructed to the standard in WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells,” sample results from this well are used for informational purposes only and are not included in upgradient versus downgradient comparisons.

Table 3. Monitoring Network Wells

Well Number	Completion Date	Location
699-24-35	1987	Upgradient
699-24-36[a]	2014	Upgradient
699-22-35	1993	Downgradient
699-23-34B	1993	Downgradient
699-24-34D[b]	2015	Downgradient
699-24-34E[c]	2015	Downgradient
699-24-33[d] (Deep Well)	1948	Downgradient - Non Statistical Use Well
699-25-34E	2014	Downgradient

a. Well installed in 2014.
b. Well installed in 2015.
c. Sampling initiated in FY 2015.
d. Results from well 699-24-33 are used for supporting information only.

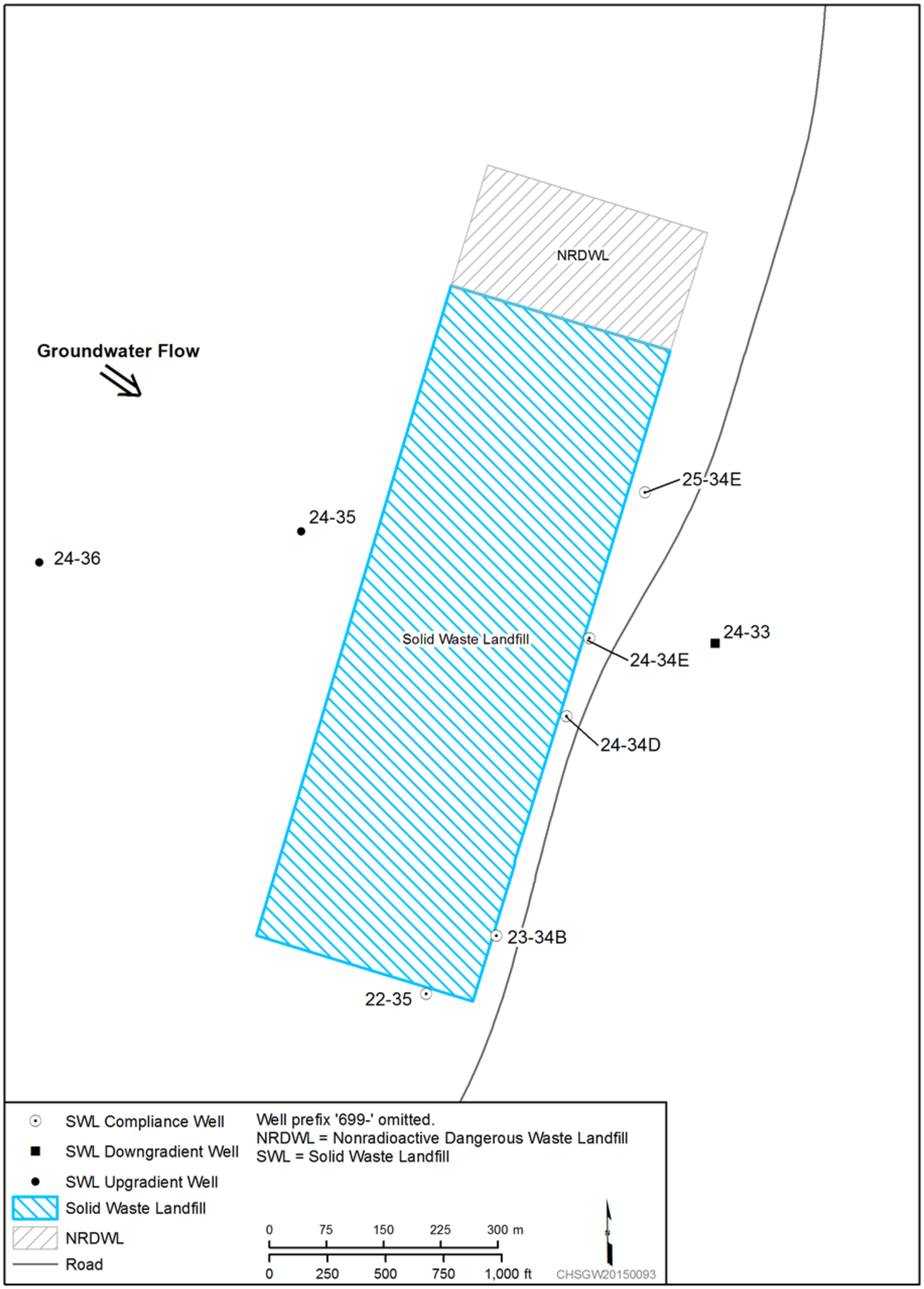

Figure 6. SWL Groundwater Monitoring Network

3.3 GROUNDWATER SAMPLING

FY 2020 sampling events at SWL were performed in October 2019 and September 2020. The second semiannual sampling event, originally scheduled for April 2020, was delayed until September due to the adoption of minimum-safe operations during the COVID-19 national health emergency. However, SWL was sampled in the appropriate semi-annual period. Sampling was conducted under DOE/RL-2015-33, *Groundwater Monitoring Plan for the Solid Waste Landfill*, which was implemented in FY 2016 to meet the governing regulation WAC 173-350, "Solid Waste Handling Standards."

Sampling occurred on all SWL groundwater monitoring network wells for this reporting period. The sampling results are evaluated as to whether concentrations of the sampled constituents have increased significantly over established background threshold values (BTVs), groundwater quality criteria (GWQC), or maximum contaminant levels (MCLs).

3.3.1 CONSTITUENTS MONITORED AND RESULTS SUMMARY

All of the specified monitoring parameters, as listed in Table 3-1 of DOE/RL-2015-33, were collected as required with one exception. The closure of the TestAmerica Richland Laboratory in January 2019 removed the availability for coliform analysis to be performed within the required 6-hour holding time. The lack of laboratory capability for the coliform analysis was documented in Section 10.11 of DOE/RL-2019-66, *Hanford Site Groundwater Monitoring Report for 2019*. The Soil and Groundwater Remediation Project continues to assess local laboratory capabilities for this analysis. Table 4 lists the constituents monitored in the groundwater.

Table 4. Constituents Monitored

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

Notes:

Sampling requirements are identified in Table 3-1 in DOE/RL-2015-33, *Groundwater Monitoring Plan for the Solid Waste Landfill*

Total coliform is identified as a site-specific constituent for Solid Waste Landfill; however, samples were not collected due to the closure of the analytical laboratory used for analysis.

3.3.2 VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER WELLS

The current SWL groundwater monitoring plan, DOE/RL-2015-33, requires monitoring for volatile organic compounds. The required organic compounds are 1,1-dichloroethane; 1,2-dichloroethane; 1,4-dichlorobenzene; 1,1,1-trichloroethane; 1,4-dioxane; carbon tetrachloride, chloroform; tetrachloroethene; and trichloroethene.

Volatile organic compounds (VOCs) were detected in some network wells during FY2020; however, the reported concentrations were less than analyte specific practical quantitation limits (PQL). Continued detection of low levels of VOCs (Table 5) is consistent with waste previously disposed of at the landfill from the 1100 Area heavy equipment garage and bus shop. It is likely that the low-level VOC detections are from vapor-phase dissolution into groundwater at the air/water table interface (Section 3.1 in DOE /RL-2019-22, *Groundwater Assessment First Determination Report for the Nonradioactive Dangerous Waste Landfill*).

Appendix A, Figures A-1 through A-9, shows the historical concentration trending for these organic chemical compounds since January 2000. The low-level concentrations over the past 20 years are generally stable, or decreasing, as indicated in the trend plots. None of the monitored organic constituents were detected above regulatory limits.

Table 5. Required Volatile Organic Compound Groundwater Monitoring Results

FY 2020 Sample	22-35	23-34B	24-33[a]	24-34D	24-34E	25-34E	24-35 (Upgradient)	24-36 (Upgradient)
	Concentrations are reported in µg/L							
1,1-Dichloroethane (GWQC of 1.0 µg/L)[b]								
Oct 2019	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.25 U	0.3 U	0.3 U
Sept 2020	0.333 U	0.25 U	0.333 U	0.333 U	0.32 U	0.25 U	0.333 U	0.333 U
1,2-Dichloroethane (GWQC of 0.5 µg/L)[b]								
Oct 2019	0.3 U	0.15 U	0.3 U	0.3 U	0.15 U	0.23 UT	0.3 U	0.3 U
Sept 2020	0.333 U	0.23 U	0.333 U	0.333 U	0.41 U	0.23 U	0.333 U	0.333 U
1,4-Dichlorobenzene (GWQC of 4 µg/L)[b]								
Oct 2019	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U	0.3 U	0.45 U
Sept 2020	0.333 U	0.45 U	0.333 U	0.333 U	0.3 U	0.45 U	0.333 U	0.45 U
1,1,1-Trichloroethane (MCL of 200 µg/L)[c]								
Oct 2019	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.25 U	0.3 U	0.3 U
Sept 2020	0.33 U	0.25 U	0.333 U	0.333 U	0.36 U	0.25 U	0.333 U	0.333 U
1,4-Dioxane (GWQC of 7.0 µg/L)[b]								
Oct 2019	3.09 U	3.04 U	3 U	3.06 U	3.07 U	3.06 U	3.01 U	3.09 U
Sept 2020	2.83 U	2.83 U	3 U	2.86 U	2.83 U	2.86 U	2.8 U	2.83 U
Carbon tetrachloride (GWQC of 0.3 µg/L)[b]								
Oct 2019	0.3 U	0.15 U	0.3 U	0.3 U	0.15 U	0.19 U	0.3 U	0.3 U
Sept 2020	0.333 U	0.19 U	0.333 U	0.333 U	0.38 U	0.19 U	0.333 U	0.333 U

Table 5. Required Volatile Organic Compound Groundwater Monitoring Results

FY 2020 Sample	22-35	23-34B	24-33[a]	24-34D	24-34E	25-34E	24-35 (Upgradient)	24-36 (Upgradient)
	Concentrations are reported in µg/L							
Chloroform (GWQC of 7 µg/L)[b]								
Oct 2019	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.24 U	0.3 U	0.3 U
Sept 2020	0.333 U	0.24 U	0.333 U	0.333 U	0.31 U	0.24 U	0.333 U	0.333 U
Tetrachloroethene (GWQC of 0.8 µg/L)[b]								
Oct 2019	0.33 J	0.355 J	0.65 J	0.47 J	0.67 J	0.69 J	0.3 U	0.3 U
Sept 2020	0.333 U	0.31 U	0.68 J	0.46 J	0.5 J	0.59 JT	0.34 J	0.333 U
Trichloroethene (GWQC of 3 µg/L)[b]								
Oct 2019	0.3 U	0. 5 U	0.36 J	0.3 U	0.5 U	0.42 J	0.3 U	0.3 U
Sept 2020	0.333 U	0.32 J	0.35 J	0.333 U	0.5 U	0.43 J	0.333 U	0.333 U

Note: Well numbers begin with 699-.

a. Well 699-24-33 is a deep well and is used for information only.

b. Groundwater Quality Criteria from WAC 173-200-040, "Water Quality Standards for Groundwaters of the State of Washington," Washington Administrative Code, as amended, Olympia, Washington.

c. Groundwater MCLs from WAC 246-290-310(7)(b), "Maximum contaminant levels (MCLs) and maximum residual disinfectant levels (MRDLs)," Washington Administrative Code, as amended, Olympia, Washington.

U = non-detect or measured below the MDL

J = estimated value (actual value is between the MDL and the practical quantitation limit)

T = laboratory spike and/or duplicate recovery was outside of control limits

MDL = method detection limit

3.3.3 BACKGROUND THRESHOLD VALUE EXCEEDANCES

Sample results for downgradient SWL groundwater monitoring wells, collected in FY2020, under DOE/RL-2015-33, Rev. 0, are compared against BTVs for the constituents specified in WAC 173-350-500(4)(h)(i) and (ii). An updated BTV calculation was prepared that incorporated sample results collected through calendar year 2020 (ECF-200PO1-21-0002, *Calculation of Background Threshold Values (BTVs) for the Solid Waste Landfill (SWL) for CYs 2017, 2018, 2019, and 2020*). Samples collected at SWL wells in FY2020 are compared to the BTVs calculated for the previous CY (CY2019) (Table 10 in ECF-200PO1-21-0002).

Constituents in downgradient wells exceeding BTVs during the previous reporting year included filtered calcium, chloride, unfiltered iron, filtered magnesium, nitrate, specific conductance, and temperature.

Constituents in downgradient wells exceeding the BTVs, summarized in Table 5, included alkalinity, filtered and unfiltered calcium, chloride, filtered and unfiltered magnesium, nitrate, pH, filtered (dissolved) potassium[1], specific conductance, and temperature. Constituents exceeding the BTVs are discussed below.

Total alkalinity and bicarbonate alkalinity exceeded the BTVs in all downgradient network wells. Because there was an insufficient number of usable samples in the previous dataset used for BTV calculation (Table 8 in ECF-200PO1-16-0144, *Calculation of Background Threshold Values (BTVs) for the Solid Waste Landfill (SWL) through CY 2016*), 2020 is the first year where a BTV was available for comparison for these constituents. Section 2.6.3 in DOE/RL-2015-33, documents the increased alkalinity concentrations due to the continuing breakdown of sewage disposed into the landfill and resulting increasing carbon dioxide concentrations in the vadose zone. Observed concentration of total and bicarbonate alkalinity are in agreement with historical trends and generally appear to be decreasing.

Concentrations of calcium and magnesium exceeded the calculated BTVs during FY2020. Elevated calcium and magnesium concentrations are a known and previously reported site condition. 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. As noted previously, disposal of sewage is the source of the carbon dioxide vapor plume. Previous site-wide annual groundwater reports, as well as the current groundwater monitoring plan, document the presence of elevated calcium and magnesium. Ecology received the required notice of exceedance of calcium and magnesium in June 2017. Observed concentrations of these constituents are in agreement with historical trends and exhibit a strong downward trend. The well with the maximum concentration for both calcium and magnesium, downgradient well 699-22-35, is the same as was observed during FY2019.

Chloride concentrations were observed above the BTV in all downgradient wells and in one upgradient well (699-24-36). The current groundwater monitoring plan documents historical and continued BTV exceedances of chloride at SWL (Section 2.5 in DOE/RL-2015-33). Observed concentrations in FY2020 for chloride are in agreement with historical concentrations and demonstrate an overall downward trend. This observation is largely unchanged from what was measured in FY2019.

Nitrate was observed above the BTV in four downgradient wells. Section 2.5 in DOE/RL-2015-33 discusses the routine detection of nitrate above calculated BTVs at SWL. Observed nitrate concentrations at SWL in FY2020 are in agreement with historical trends and except for well 699-24-34D exhibit a slight increasing trend.

Measurements for pH indicated that three downgradient wells exceeded the lower pH BTV of 6.82 pH units. pH is a monitoring parameter that is routinely observed above calculated the BTVs at SWL. The BTV range for pH decreased in the current calculation (ECF-200PO1-21-0002) relative to the BTV used in previous comparisons. In the previous calculation (ECF-PO1-2016-0144), the lower pH BTV was 6.58 pH units; had the previous BTV used for comparison, only one well (699-23-34B) would have exceeded the lower BTV with a measured

[1] Potassium is not a required constituent in the groundwater monitoring plan (DOE/RL-2015-33). Monitoring for dissolved potassium was added in WAC 173-350-500 after issuance of DOE/RL-2015-33 and is included in this report for completeness.

value of 6.57 pH units. Current pH values are in agreement with historical trends and overall appear flat.

Dissolved potassium was measured above the BTV at two downgradient wells. Dissolved potassium was not a required monitoring constituent under WAC 173-350-500 when the SWL groundwater monitoring plan (DOE/RL-2015-33) was issued in 2016; however, a BTV was calculated for dissolved potassium in ECF-200PO1-21-0002 and a comparison is presented for completeness. A revision to the SWL groundwater monitoring plan will be prepared and include monitoring for dissolved potassium. Observed concentrations of dissolved potassium in SWL monitoring wells in FY 2020 are exhibiting a long-term downward trend.

Specific conductance measurements exceeded the BTV (544 µS/cm) in all downgradient network wells. Section 2.6.3 in DOE/RL-2015-33, documents continued exceedance of specific conductance BTVs at SWL. As discussed under the sampling results for alkalinity, calcium, and magnesium, the cause of increasing specific conductance values is attributed to the breakdown of sewage disposed into the landfill and resulting increasing carbon dioxide concentrations in the vadose zone. Observed values for specific conductance measurements are in agreement with historical trends and are exhibiting a long-term decrease.

Groundwater temperature measurements were above the calculated BTV in one downgradient well (699-25-34E) during FY2020. The sample was collected during the September sampling event. Section 2.5 in DOE/RL-2015-33 documents historical exceedance for temperature measurements at SWL. Temperature measurements in groundwater at SWL in FY2020 are not out of trend and are generally stable; not increasing or decreasing. Table 6 summarizes the analysis results.

Table 6. Comparison of Analytical Results to BTVs

Constituent	Units	Maximum value (well)	BTV[a]	Wells above BTV
Alkalinity	mg/L	370 (699-22-35)	240	All downgradient wells
Arsenic, filtered	µg/L	14 U (699-23-34B)	7.281	None
Arsenic, unfiltered	µg/L	14 U (699-23-34B)	8.095	None
Bicarbonate	mg/L	370 (699-22-35)	240	All downgradient wells
Calcium, filtered	µg/L	113,000 (699-22-35)	98,000	699-22-35, 699-23-34B
Calcium, unfiltered	µg/L	115,000 (699-22-35)	97,000	699-22-35, 699-23-34B
Chloride	mg/L	9.3 (699-22-35)	6.073	All except 699-24-35
Iron, filtered	µg/L	53 U (699-22-35)	43.98	None
Iron, unfiltered	µg/L	140 (699-23-34B)	149.4	None
Magnesium, filtered	µg/L	20,900 (699-22-35)	19,000	699-22-35, 699-24-33[b]
Magnesium, unfiltered	µg/L	21,200 (699-22-35)	19,000	699-22-35, 699-24-33[b]

Constituent	Units	Maximum value (well)	BTV[a]	Wells above BTV
Manganese, filtered	µg/L	4 U	2.357	None (all results U or B qualified)
Manganese, unfiltered	µg/L	4 U	4.746	None (all results U or B qualified)
Nitrate	mg/L	21.2 (699-22-35)	15.006	699-22-35, 699-23-34B, 699-24-33[b], 699-25-34E
pH	unitless	7.67 (699-24-36)	7.85	None above 7.85
		6.57 (699-23-34B)	6.81	699-23-34B, 699-24-34D, 699 24-34E (below 6.81 pH units)
Potassium, filtered[c]	µg/L	9,800 (699-23-34B)	8,189	699-22-35, 699-23-34B
Sodium, filtered	µg/L	22,400 (699-25-34E)	23,983	None
Sodium, unfiltered	µg/L	22,000 (699-23-34B)	24,089	None
Specific Conductance	µS/cm	771 (699-22-35)	553	All downgradient wells
Sulfate	mg/L	44.4 (699-22-35)	47.396	None
Temperature	Deg C	19.9 (699-25-34E)	19.64	699-25-34E

Note: Complete references are provided in Chapter 5.

a. BTVs from Table 10 in ECF-200PO1-21-0002, *Calculation of Background Threshold Values (BTVs) for the Solid Waste Landfill (SWL) for CYs 2017, 2018, 2019, and 2020.*

b. Well 699-24-33 is a deep well for information only.

c. Potassium is not a required constituent in the groundwater monitoring plan (DOE/RL-2015-33). Monitoring for dissolved potassium was added in WAC 173-350-500 after issuance of DOE/RL-2015-33 and is included in this report for completeness.

BTV = background threshold value

PQL = practical quantitation limit

U = non-detect value

3.3.4 GROUNDWATER QUALITY CRITERIA AND DRINKING WATER MAXIMUM CONTAMINANT LEVEL EXCEEDANCES

A comparison to the groundwater quality criteria (GWQC) or the drinking water maximum contaminant levels (MCL) for wells where the BTV is exceeded is presented in Table 7. During this reporting period, no sample results exceeded either the associated GWQC or MCL. Many of the constituents monitored at SWL that exceeded BTVs do not have formalized GWQCs or MCLs.

Table 7. GWQCs and MCLs Comparisons for SWL Monitoring Constituents that Exceed BTVs

Constituent	Units	BTV[a]	Wells above BTV (Maximum Sample Result)	GWQC[b]	MCL[c]
Alkalinity	mg/L	240	All downgradient wells (370 mg/L at 699-22-35)	NA	NA
Bicarbonate	mg/L	240	All downgradient wells (370 mg/L at 699-22-35)	NA	NA
Calcium	µg/L	97,000	699-22-35 and 699-23-34B (115,000 µg/L at 699-22-35)	NA	NA
Chloride	mg/L	6.094	All wells except 699-24-35 (9.30 mg/L at 699-22-35)	250	250
Magnesium	µg/L	19,000	699-22-35 and 699-24-33[d] (21,200 µg/L at 699-22-35)	NA	NA
Nitrate	mg/L	15.097	699-22-35, 699-23-34B, 699-24-33[d], and 699-25-34E (21.2_mg/L at 699-22-35)	45[e]	45[e]
pH	unitless	6.82 - 7.85	699-23-34B, 699-24-34D, and 699-24-34E (minimum 6.57)	6.5 – 8.5	6.5 – 8.5
Potassium (dissolved)	µg/L	8,334	699-23-34B (9,800 µg/L at 699-25-34E)	NA	NA
Specific conductance	µS/cm	544	All downgradient wells (771 µS/cm at 699-22-35)	NA	700 µmhos/cm[f]
Temperature	Deg C	19.72	699-25-34E (19.9° C)	NA	NA

a. When both a filtered and non-filtered BTV were calculated, the more restrictive value is listed.
b. GWQC values obtained from WAC 173-200-040, "Water Quality Standards for Groundwaters of the State of Washington," Washington Administrative Code, as amended, Olympia, Washington.
c. MCL values obtained from WAC 246-290-310(3), "Maximum contaminant levels (MCL) and maximum residual disinfectant levels (MRDL)," Washington Administrative Code, as amended, Olympia, Washington.
d. Well 699-24-33 is a deep well used for information only.
e. GWQC and MCL values for nitrate are based on the 10 mg/L nitrogen in nitrate limit, which equates to 45 mg/L as nitrate.
f. The MCL for specific conductance is expressed in the older unit micromho/cm (umhos) which is equivalent to µS/cm (microSiemens/cm)

BTV = background threshold value
GWQC = groundwater quality criteria
MCL = maximum contaminant level
NA = not applicable, no established regulatory limit

3.4 SUMMARY OF GROUNDWATER MONITORING RESULTS AT SWL FOR FY 2020

The monitoring results of the groundwater beneath SWL are consistent with the type of waste disposed to SWL. Waste types include sewage and chlorinated hydrocarbons from the 1100 Area heavy equipment garage and bus shop. For this monitoring period, FY2020, observed concentrations of constituents monitored under DOE/RL-2015-33 and field measurements are consistent with historical trends. Overall, concentrations of monitored constituents are slowly decreasing.

Dissolved potassium was not a required monitoring constituent under WAC 173-350-500 when the SWL groundwater monitoring plan (DOE/RL-2015-33) was issued in 2016; however, a BTV was calculated for dissolved potassium in ECF-200PO1-21-0002 and a comparison is presented for completeness. A revision to the SWL groundwater monitoring plan is being prepared and include monitoring for dissolved potassium.

4.0 SOIL GAS MONITORING

Soil gas monitoring 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). Quarterly soil gas monitoring determines concentrations of carbon dioxide and methane. The soil gas monitoring also analyzes 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). Figure 7 lists the soil gas monitoring station locations. (NOTE: Soil gas monitoring station DE-1 is fire damaged and no longer used.)

Station DW-2 was sampled in addition to the eight previously mentioned stations. Station DW-2 is located along the border with the NRDWL.

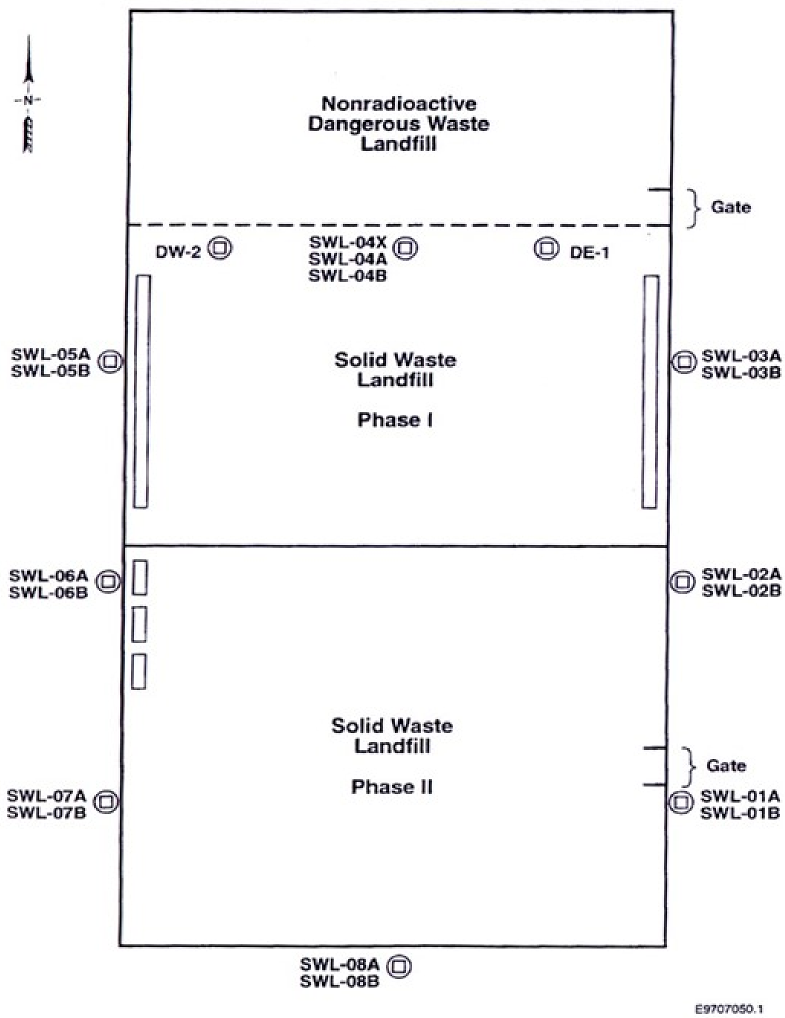

Figure 7. Soil Gas Monitoring Station Locations

Table 8 summarizes the results of the soil gas monitoring, which are consistent with the results of previous monitoring. The concentrations for the volatile organic constituents were at or below detection limits. Methane concentrations remain low or 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 2019	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.6	<DL	0.7	0.6	<DL	<DL	<DL	<DL	<DL	<DL
Feb 2020	0.6	0.8	0.1	<DL	<DL	0.1	<DL	<DL	1.5	0.9	0.3	0.4	8.4	5.6	0.6	<DL	<DL	<DL
May 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Aug 2020	0.2	0.3	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.3	<DL	<DL	0.6	0.5	0.8	1.1	<DL	<DL
Carbon Dioxide (CO2)																		
Nov 2019	<DL	<DL	1	6	4	4	20	2015	138	55	12	98	1	2	<DL	1	75	120
Feb 2020	9	6	8	8	10	19	2471	3714	69	21	33	65	35	38	527	530	12	121
May 2020	5	2	3	0	39	66	4838	1826	340	2428	3	4	276	502	6	2	242	5
Aug 2020	15	21	4	6	9	3	1875	2754	215	43	12	10	374	816	4	2	354	815
Methylene Chloride (DCM)																		
Nov 2019	<DL	<DL	<DL	<DL	11	11.7	<DL	1.5	2.7	<DL	<DL	<DL	<DL	<DL	<DL	0.5	0.8	0.8
Feb 2020	<DL	<DL	<DL	<DL	<DL	<DL	3.9	3.3	3.8	3.7	2	1.7	1	1.2	<DL	<DL	<DL	<DL
May 2020	<DL	<DL	3.9	3.7	11.7	11.5	0.9	<DL	<DL	0.8	<DL	<DL	0.8	<DL	<DL	0.6	<DL	<DL
Aug 2020	<DL	<DL	2.7	2.4	<DL	<DL	8	7.1	<DL	2.5	<DL	<DL	0.6	<DL	1	1.7	<DL	1.5
1,1 - Dichloroethane (1,1 - DCA)																		
Nov 2019	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.6	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Feb 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
May 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.2	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Aug 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.2	<DL	<DL	<DL	<DL	<DL
Chloroform (TCM)																		
Nov 2019	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Feb 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
May 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Aug 2020	<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 2019	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Feb 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
May 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Aug 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.3	0.3	<DL	<DL	<DL	<DL
Carbon Tetrachloride (CCI4)																		
Nov 2019	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Feb 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
May 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Aug 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Trichloroethylene (TCE)																		
Nov 2019	<DL	<DL	<DL	<DL	9	9	5	5	<DL	<DL	<DL	<DL	<DL	<DL	<DL	1	<DL	<DL
Feb 2020	<DL	<DL	<DL	<DL	<DL	<DL	2	<DL	3	1	1	1	<DL	<DL	<DL	<DL	<DL	1
May 2020	<DL	<DL	1	2	9	8	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Aug 2020	<DL	<DL	1	1	<DL	<DL	2	2	<DL	2	<DL	<DL	<DL	<DL	<DL	1	1	1
1,1,2 - Trichloroethane (1,1,2 - TCA)																		
Nov 2019	<DL	<DL	<DL	<DL	0.2	0.1	2.3	3.1	1.2	0.3	0.2	0.3	1	1.4	<DL	<DL	<DL	0.1
Feb 2020	<DL	<DL	<DL	<DL	0.3	>DL	14.8	11.4	<DL	0.2	<DL	<DL	<DL	<DL	<DL	<DL	0.4	<DL
May 2020	<DL	<DL	<DL	<DL	0.1	0.1	12.2	3.1	0.5	<DL	<DL	<DL	<DL	<DL	<DL	<DL	2.2	4.2
Aug 2020	<DL	<DL	<DL	<DL	0.4	0.5	3.8	5.4	0.6	13.4	<DL	<DL	1.7	3.1	<DL	<DL	0.8	0.6
Tetrachloroethene (PCE)																		
Nov 2019	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Feb 2020	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
May 2020	<DL	<DL	0.5	0.4	<DL	<DL	0.4	<DL	0.1	<DL	<DL	<DL	0.2	0.1	<DL	<DL	<DL	0.1
Aug 2020	<DL	<DL	<DL	<DL	<DL	<DL	0.1	0.1	<DL	<DL	<DL	<DL	0.2	<DL	<DL	<DL	<DL	<DL

5.0 REFERENCES

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WAC 173-200-040, "Criteria," *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.

WAC 173-350, “Solid Waste Handling Standards,” *Washington Administrative Code*, as amended, Olympia, Washington.

APPENDIX A – GROUNDWATER TRENDS

The plots in Figures A-1 through A-9 show the concentration trends of 1,1-dichloroethane; 1,2-dichloroethane; 1,4-dichlorobenzene; 1,1,1-trichloroethane; 1,4-dioxane; carbon tetrachloride, chloroform; tetrachloroethene; and trichloroethene, respectively, for this reporting period.

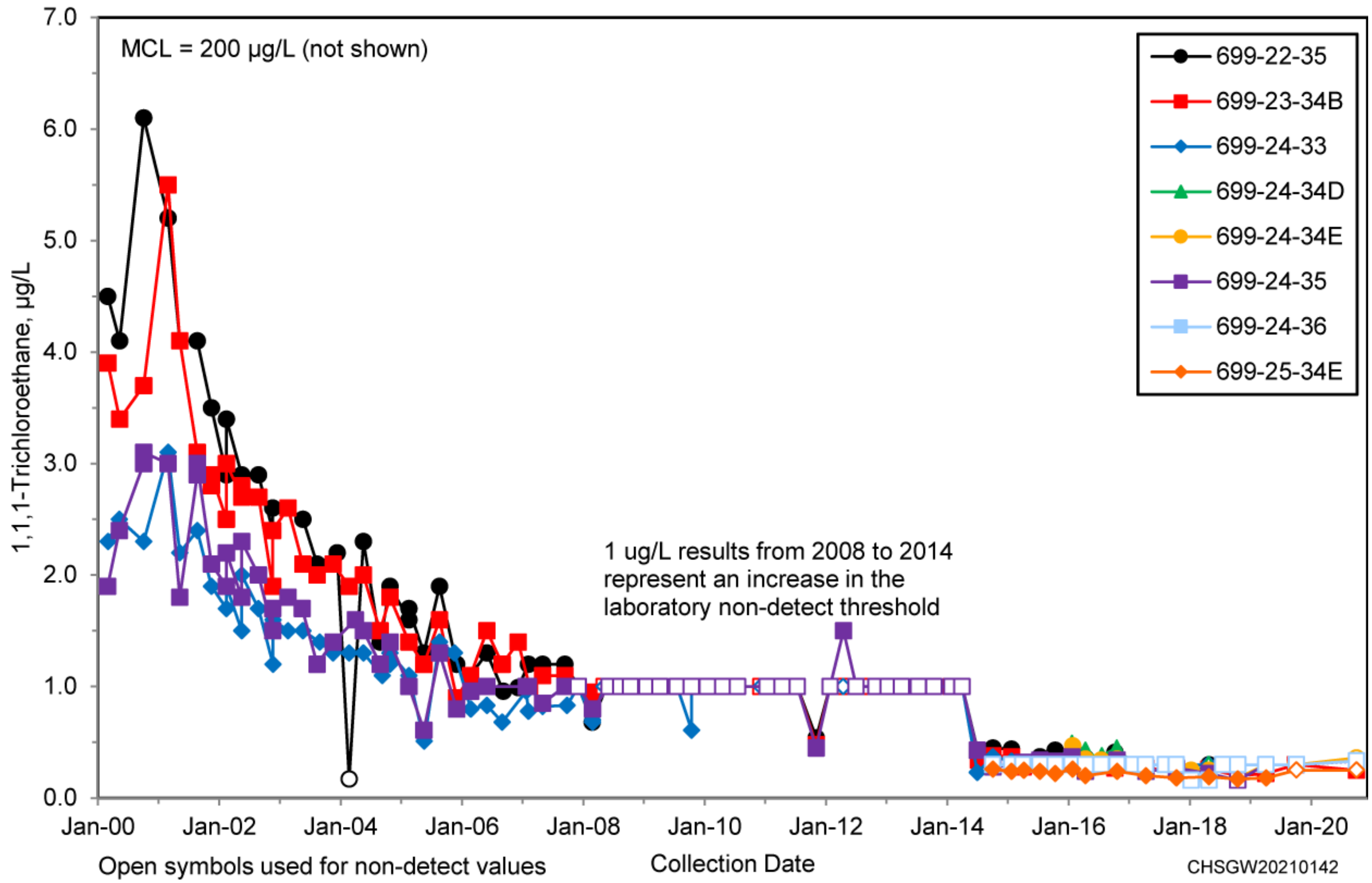

Figure A-1, 1,1,1-Trichloroethane trend in groundwater at SWL

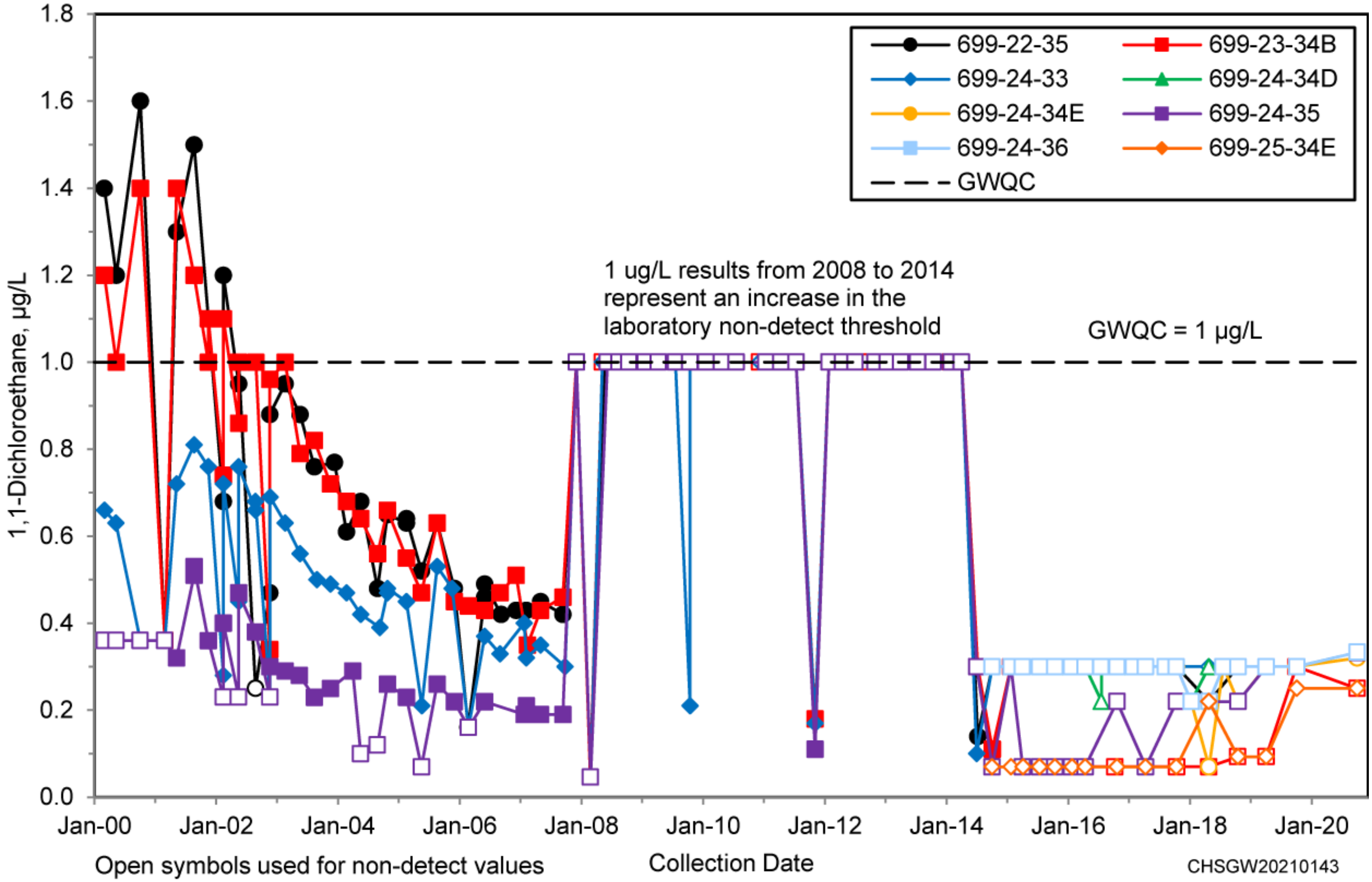

Figure A-2, 1,1-Dichloroethane trend in groundwater at SWL

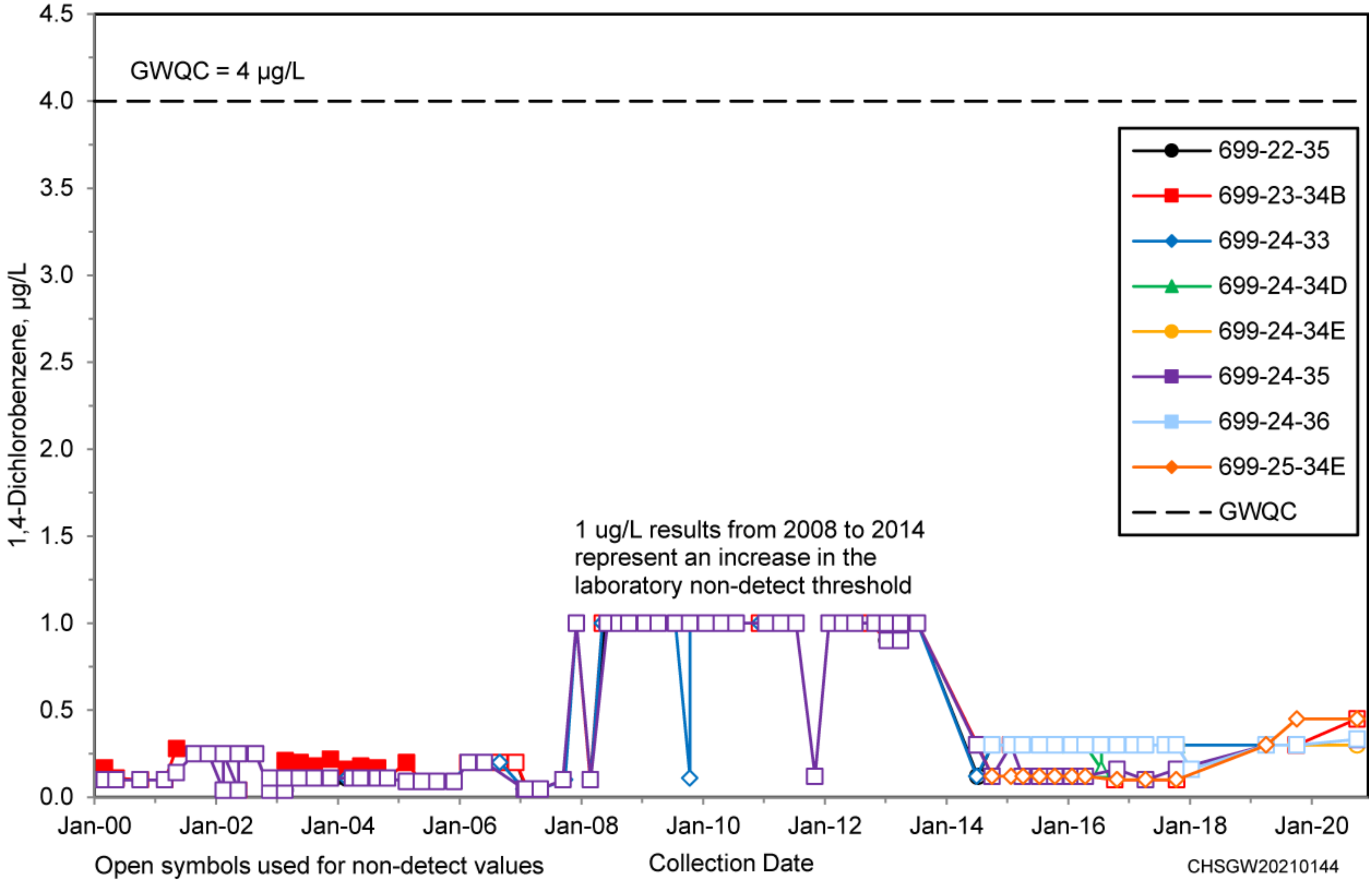

Figure A-3, 1,4-Dichlorobenzene trend in groundwater at SWL

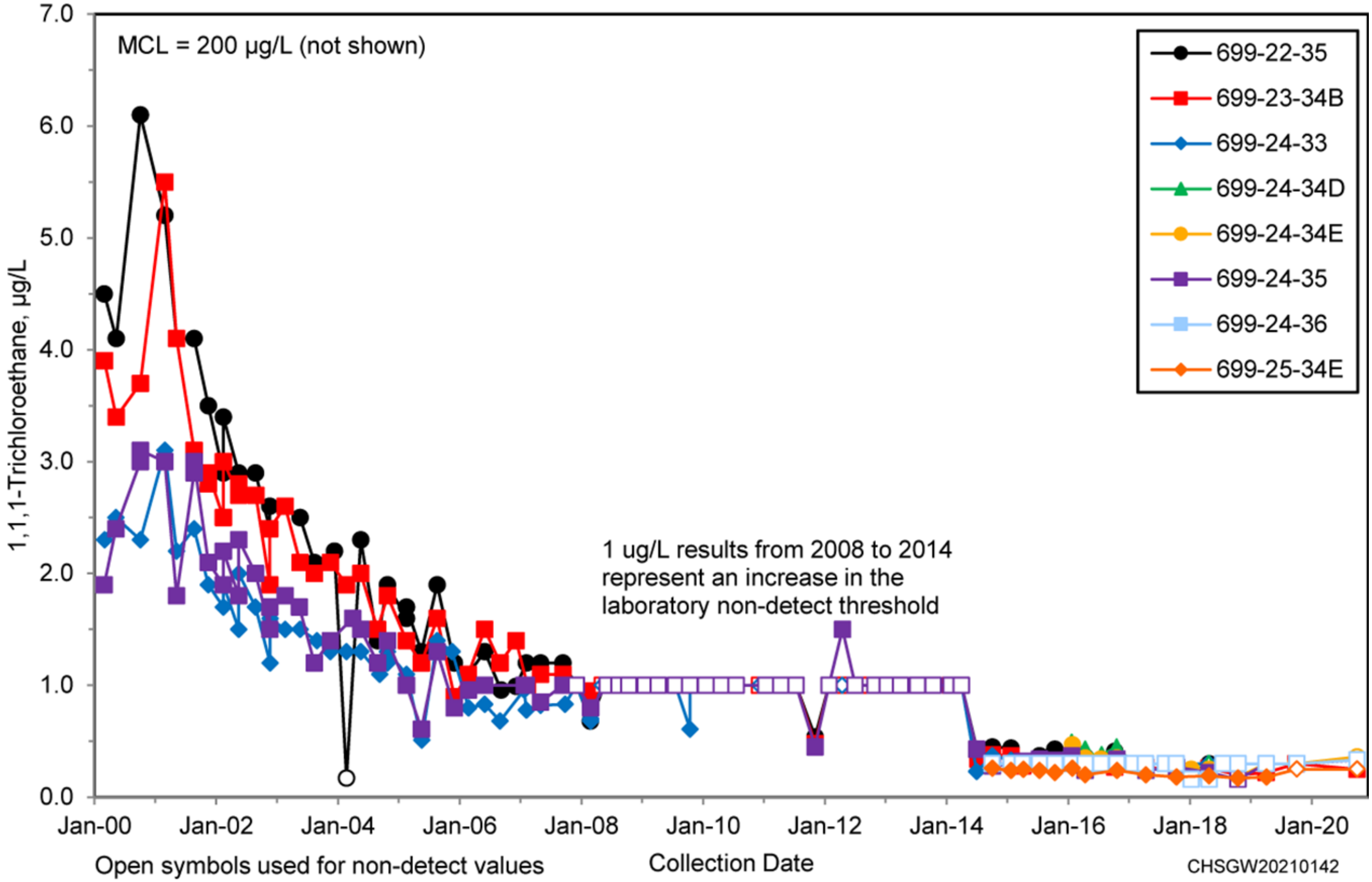

Figure A-4, 1,1,1-Trichloroethane trend in groundwater at SWL

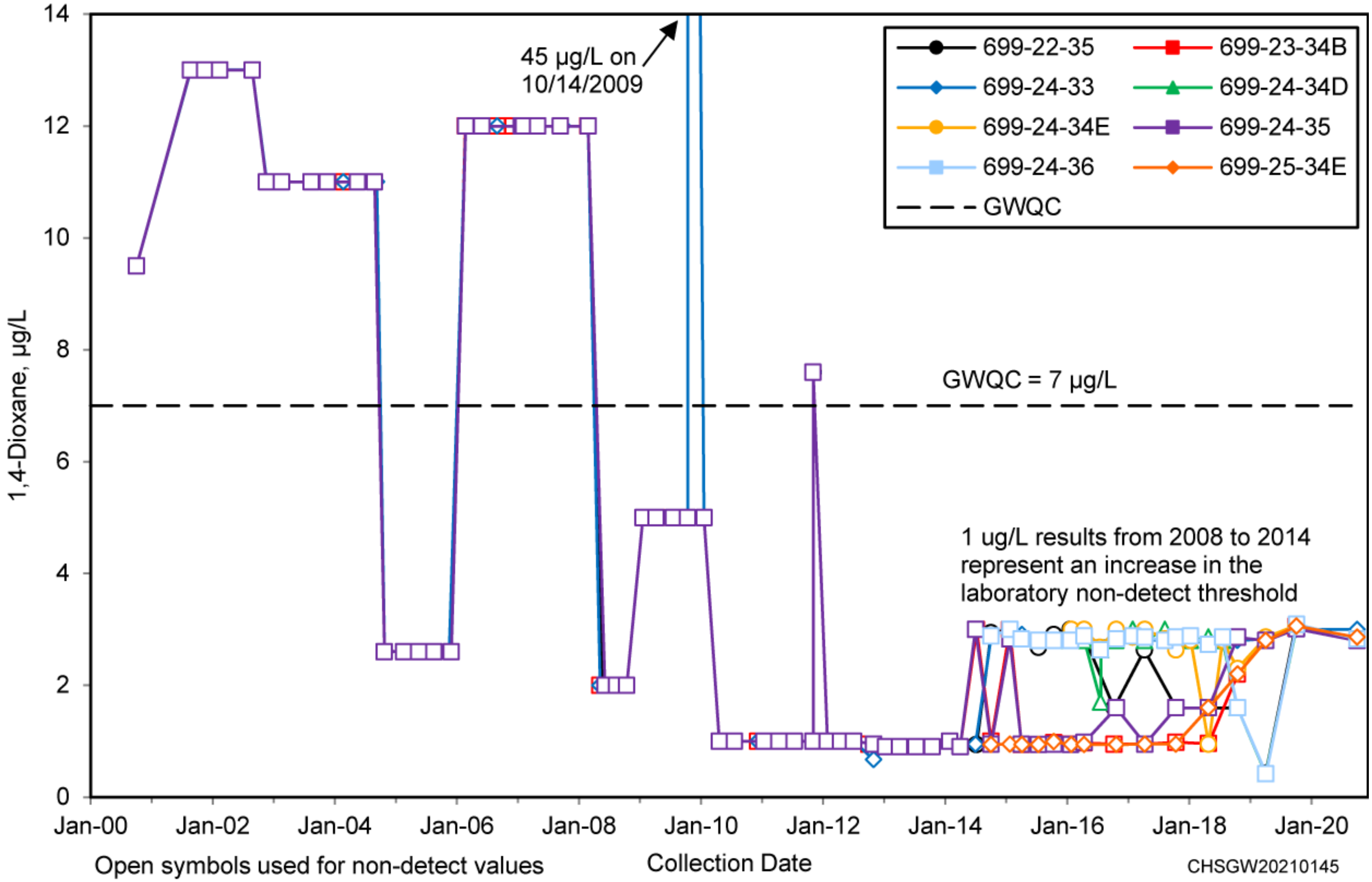

Figure A-5, 1,4-Dioxane trend in groundwater at SW

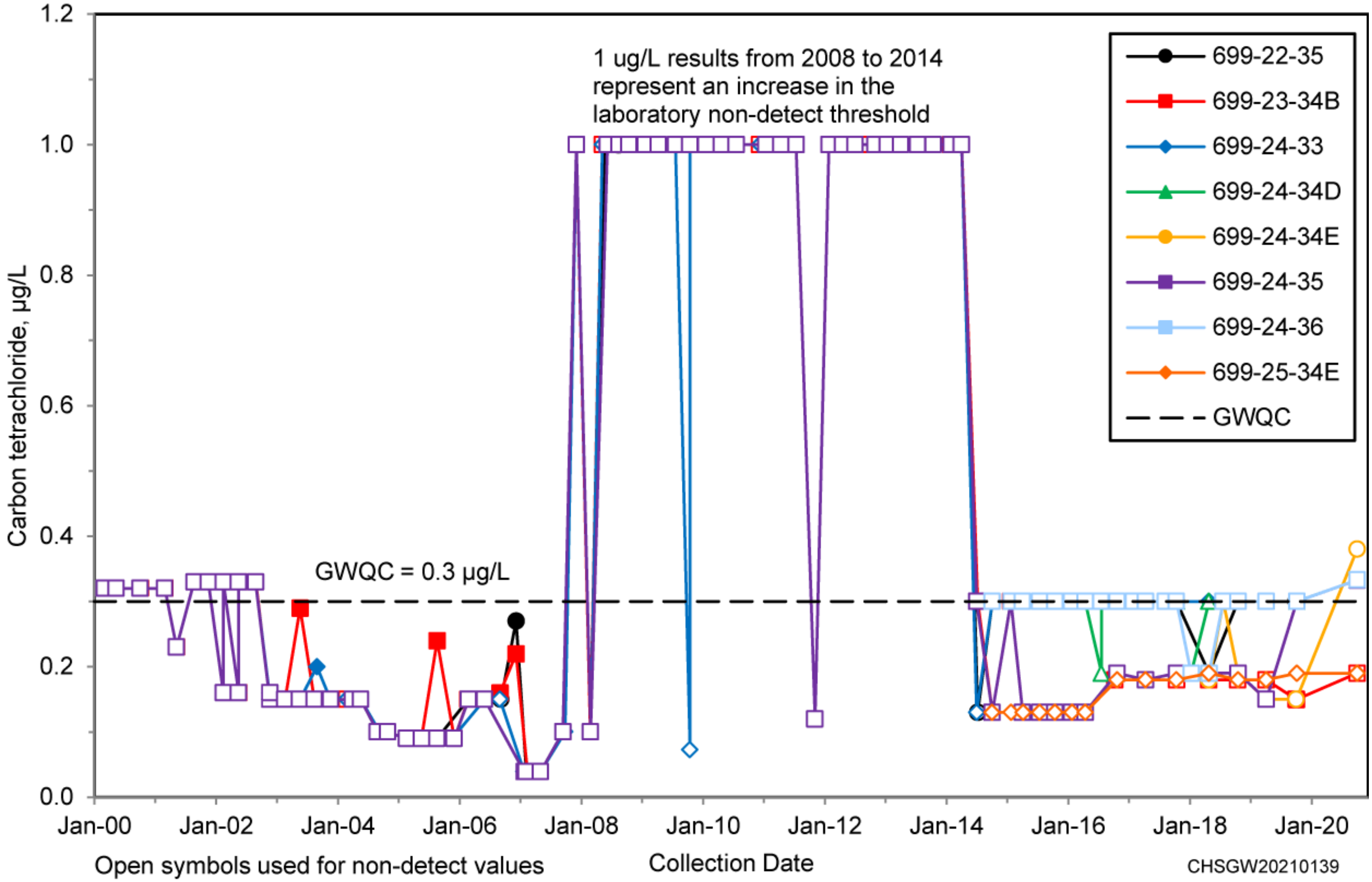

Figure A-6, Carbon tetrachloride trend in groundwater at SWL

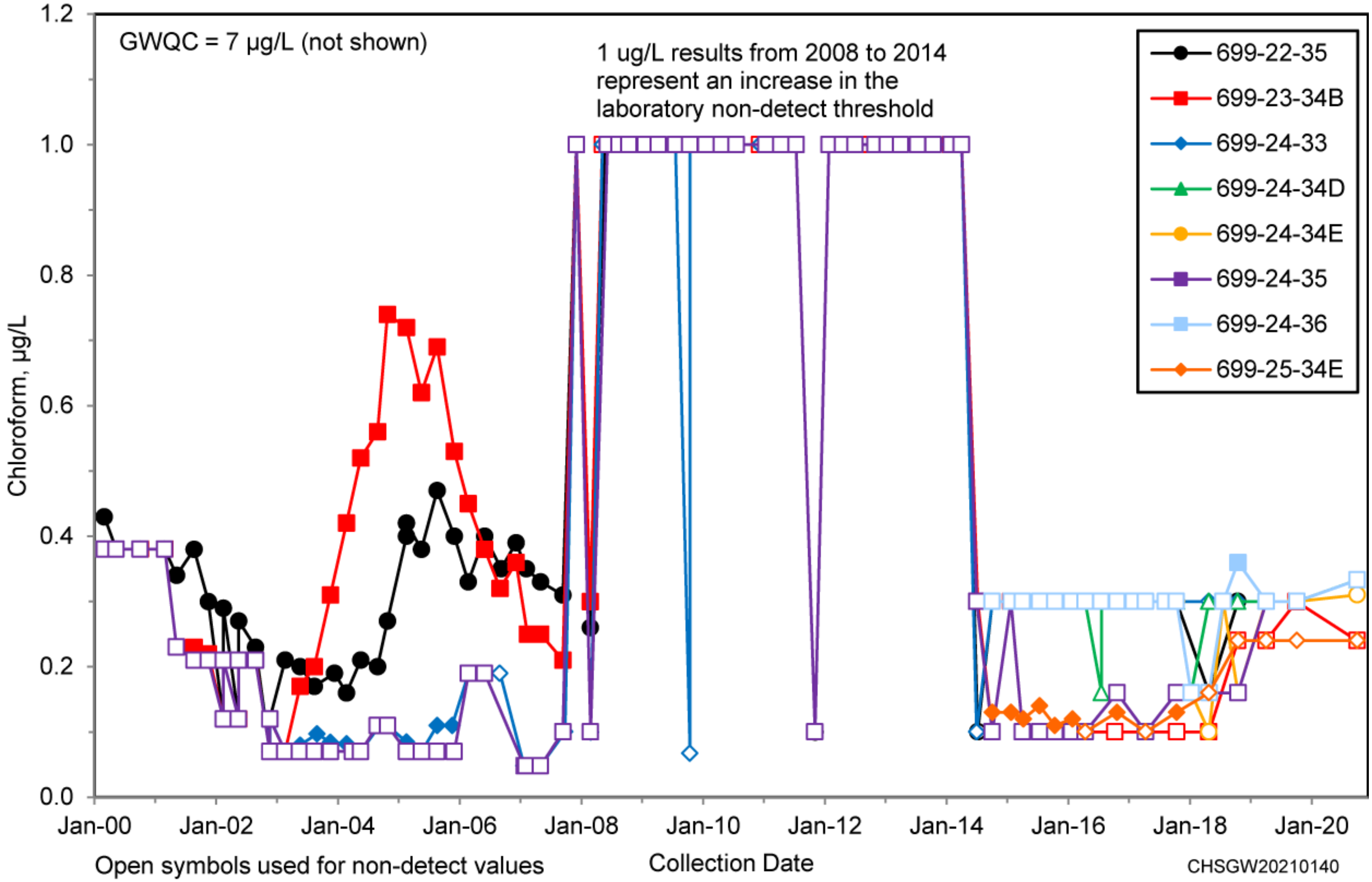

Figure A-7, Chloroform trend in groundwater at SWL

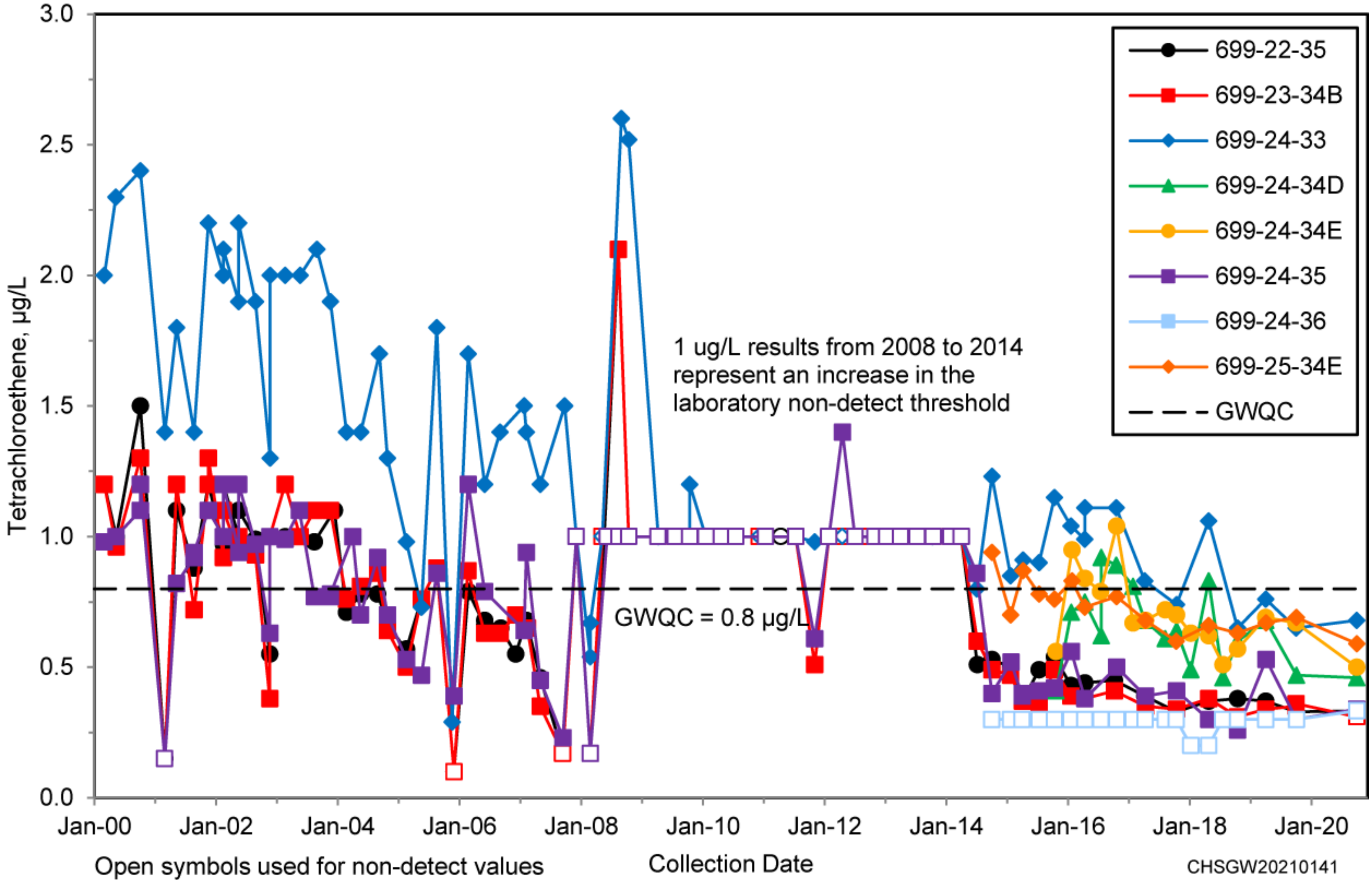

Figure A-8, Tetrachloroethene trend in groundwater at SWL

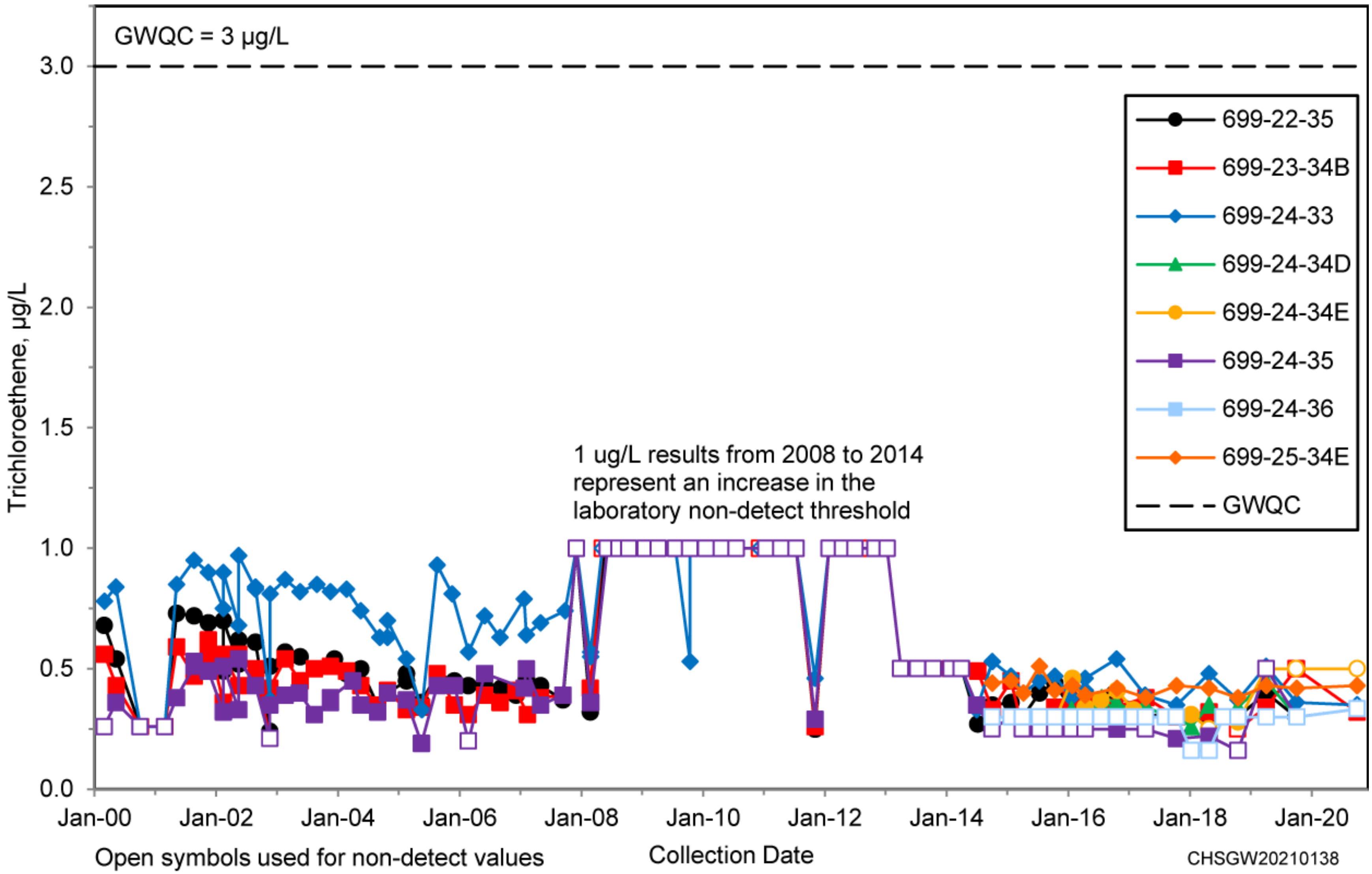

Figure A-9, Trichloroethene trend in groundwater at SWL