Black Lake Grocery Groundwater Monitoring Results, April 2023: Data Summary Report

Environmental Assessment Program

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Abstract

Black Lake Grocery is an active convenience store and gas station situated on the northwestern corner of Black Lake in Thurston County, Washington. Petroleum hydrocarbon contamination was first discovered in the soil and groundwater at the Black Lake Grocery site in 1989, originating from leaking underground storage tanks. In 1995, these tanks were removed, and the surrounding soil was excavated. A permeable reactive barrier consisting of a sphagnum moss-filled pit was installed along Black Lake's shoreline in 2004. This treatment wall passively amends contaminated groundwater as it flows towards Black Lake.

Summit Envirosolutions conducted groundwater sampling activities of on-site monitoring wells to assess petroleum contamination between November 1993 and June 2009. In 2011, the Washington State Department of Ecology assumed responsibility for sampling at the site to monitor the efficacy of remedial actions.

This report describes water quality results from samples collected at 5 monitoring wells during the 2023 groundwater monitoring event. These samples were analyzed for benzene, toluene, ethylbenzene, xylenes (BTEX), and total petroleum hydrocarbons gasoline range (TPH-G).

Analytical results from groundwater samples collected in 2023 indicate continued contamination of the near-surface aquifer in proximity to the Black Lake Grocery site. While contaminant concentrations have decreased since initial remedial activities took place in 1995, groundwater sample contaminant concentrations continue to exceed (not meet) established cleanup levels in 4 of the site's wells. Sample concentrations downgradient of the treatment wall indicate a reduction in BTEX and TPH-G concentrations; these concentrations also suggest that petroleum contamination is migrating from the site into Black Lake.

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Background

Black Lake Grocery is an active convenience store and gas station situated on the northwestern corner of Black Lake (Figure 1). The store occupies a portion of a 5.2-acre parcel of land located approximately 100 feet (ft) upslope from the lakeshore. Subsurface investigations conducted in 1989 as part of a geotechnical study for the expansion of Black Lake Boulevard revealed gasoline-range petroleum hydrocarbon contamination of soil and groundwater at the site (Dames and Moore 1990).

Summit Envirosolutions (Summit) conducted initial cleanup activities at the site in 1995 in concurrence with the expansion project of Black Lake Boulevard. These activities took place between June and July 1995. They consisted of the removal of 7 underground storage tanks (USTs) and the excavation and off-site disposal of approximately 1,200 cubic yards of impacted soil. The footprint of the excavated soil included the area between the property boundaries at Goldsby Road and Black Lake Boulevard, and the store building itself (Figure 1). The soil excavation could not fully extend throughout the project area due to the county roads to the north and west of the site (Summit 2000). Soil excavations were completed to depths ranging from approximately 10 ft to 13 ft below ground surface (bgs) (Ecology 2002).

Analytical results from soil samples collected along the perimeter of the excavated area continued to exceed (not meet) the Model Toxics Control Act (MTCA) Method A cleanup levels in soils (WAC 173-340-740) for benzene, toluene, ethylbenzene, and xylenes (BTEX), and total petroleum hydrocarbons gasoline-range (TPH-G).

Additional site characterization was conducted in 2000 by Summit through completion of a Remedial Investigation/Feasibility Study (RI/FS). The delineation of the contaminant plume as provided by the RI/FS encompassed the subsurface near the former USTs and extended downgradient to Black Lake. A stormwater culvert located under Black Lake Boulevard was found to pass through the northeastern extent of the plume. In 1995, Summit collected a groundwater sample north of this culvert and found no impact from petroleum contamination (Summit 2000). This northeastern portion of the plume has not been sampled since 1995.

To reduce the remaining groundwater contamination from petroleum hydrocarbons, a remediation strategy utilizing both natural attenuation and an engineered passive treatment wall was selected in the Cleanup Action Plan (CAP) (Ecology 2002). This treatment wall was installed along the shore of Black Lake in November 2004. Treatment wall dimensions are approximately 120 ft long, 5 ft wide, and 12 ft deep. The treatment wall acts as a permeable reactive barrier, in which engineered sphagnum peat moss absorbs petroleum hydrocarbons and provides a catalytic surface that promotes the growth of microbes that degrade these contaminants. Natural attenuation mechanisms upgradient of the treatment wall are additionally intended to reduce groundwater contaminant concentrations.

Site cleanup objectives will be met when contamination concentrations do not exceed both MTCA Method A groundwater cleanup levels (WAC 173-340-720) and CAP cleanup levels (Ecology 2002). Cleanup levels established in the CAP for toluene, ethylbenzene, and xylenes

are lower than the MTCA Method A groundwater cleanup levels; however, the CAP cleanup levels have been erroneously cited as MTCA Method A cleanup levels (Ecology 2002).

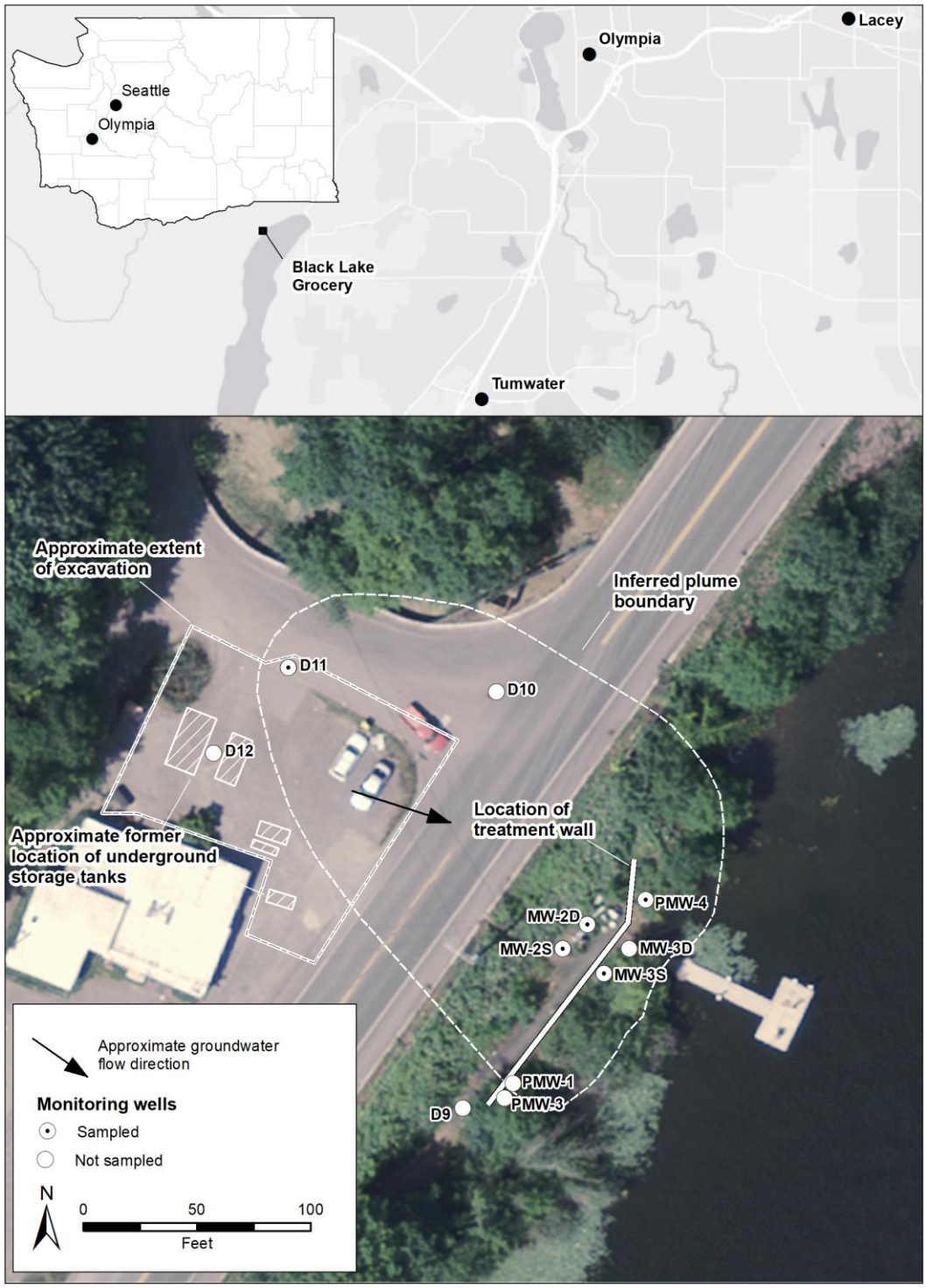

Figure 1. Black Lake Grocery Location and Site Details.
Groundwater flow direction and former underground storage tank placement based on Summit's figure and are not to scale (Summit 2004).

Groundwater monitoring activities conducted by Summit Envirosolutions between November 1993 and June 2009 indicated that concentrations of BTEX and TPH-G had decreased following both the excavation of contaminated soils and the subsequent installation of the treatment wall. While concentrations decreased throughout this period of monitoring, contaminant concentrations continued to exceed (not meet) the MTCA Method A cleanup levels for groundwater in 5 of the 11 monitoring wells onsite (Appendix A, Figures A1 – A9, Tables A1 – A11). Ecology assumed responsibility for groundwater monitoring activities in 2010 and began regularly scheduled sampling activities at the site in August 2011 to assess the efficacy of the selected remedial strategy.

In the Engineering Design Report submitted to Ecology in 2005, Summit estimated that the combination of source material excavation and biodegradation would reduce site contaminant concentrations below cleanup levels by 2020 (Summit 2005). Sampling of conventional geochemical parameters (dissolved organic carbon, total and dissolved iron, sulfate, nitrate, nitrite, and turbidity) in 2011 and 2012 indicated favorable conditions for the biodegradation of hydrocarbon contamination (Marti 2013).

This data report summarizes groundwater results from five on-site wells for April 2023. The data and historical monitoring reports for this Site are available at Ecology's Environmental Information Management (EIM) website www.ecy.wa.gov/eim/index.htm. Search Study ID, PMART007.

Methods and Results

Ecology conducted a groundwater monitoring event in April 2023 at the Black Lake Grocery site, consisting of groundwater sample collection from 5 monitoring wells (D11, MW-2S, MW-2D, MW-3S, PMW-4) (Figure 1). Previous monitoring events indicate continued exceedance of site cleanup levels in four of these wells. Groundwater monitoring well D-10 was not sampled during this event. Though contaminant concentrations at D-10 have historically been high, the well is low-yielding, and water level recovery is slow. This well is also difficult to access due to traffic along Black Lake Boulevard.

Ecology conducted this monitoring event utilizing industry-standard, low-flow sampling techniques. Low yields and slow water level recovery at the site wells necessitated the use of a peristaltic pump with dedicated tubing for purging and sampling procedures. Well purging was conducted through continuously pumping water into a flow-through cell at a rate of 0.5 liter/minute or below. Well purging was considered complete upon field parameter (pH, temperature, specific conductance, dissolved oxygen, and oxidization-reduction potential) stabilization as outlined by SOP EAP078 (Ecology 2024). Well construction information and measured water levels are provided below in Table 1. Stabilized field parameters are provided in Table 2.

Table 1. Well construction details and water levels for April 2023.

Well	Land Surface Elevation (feet, NAVD88)	Well Depth (feet bgs)	Screened Interval (feet bgs)	2023 Groundwater Elevation (feet, NAVD88)
D11	136.08	15	5 – 15	131.58
MW-2D	132.77	15	12 – 15	131.58
MW-2S	131.97	5	2 – 5	130.57
MW-3S	131.11	5	2 – 5	129.53
PMW-4	132.14	11	1 – 11	130.86

bgs: Below ground surface.
NAVD88: North American Vertical Datum of 1988

Water levels measured during the April 2023 monitoring event increased considerably compared to the October 2021 monitoring event (Table 1). Groundwater elevations rose between 2.05 ft and 4.89 ft at wells D11 and MW-2D, respectively. This increase in groundwater elevation reflects the observed trend of seasonal groundwater level variation (Figures A1 – A4).

Table 2. Field measurements from April 2023 sampling.

Well	pH (std. units)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)	Turbidity (NTU)
D11	6.4	509	0.3	-49	0.8
MW-2D	6.9	291	4.7	73	5.4
MW-2S	6.2	642	0	23	5.8
MW-3S	5.9	491 EST	0	-14	5.7
PMW-4	6.1	258	0	-46	1.1

EST: Measurement value reported is an estimate.
mV: Millivolts
NTU: Nephelometric turbidity units
mg/L: Milligrams per liter
std. units: Standard Units
µg/L: Micrograms per liter
µS/cm: Microsiemens per centimeter

Groundwater samples collected during the April 2023 monitoring event were submitted to the Manchester Environmental Laboratory under standard chain-of-custody procedures for analysis of BTEX and TPH-G. Sampling locations are chosen to assess contaminant concentrations upgradient and downgradient from the treatment wall. Analytical results for BTEX and TPH-G are summarized in Table 3 and are displayed by analyte in Figure A5. These results are compared to both the CAP cleanup levels for the site (Ecology 2002) and the MTCA Method A groundwater cleanup for comparison (WAC 173-340-720).

For quality control purposes, a duplicate sample was collected from well PMW-4 and submitted as a blind duplicate to the laboratory. Relative percent differences (RPDs) were calculated utilizing analytical results from both the parent and duplicate samples as specified in the Quality Assurance Project Plan (Marti 2011). RPDs for all analytes ranged from 3.8% to 13.1% (Table 4).

Table 3. Analytical results from the April 2023 sampling and associated cleanup levels.

Well	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	TPH-G
D11	**645**	**89.4**	**1110**	**740**	**33.9**	**14500**
MW-2D	1U	1U	1U	2U	1U	70U
MW-2S	**3450**	**894**	**1570**	**3880**	**1500**	**84700**
MW-3S	**72.2**	**3.07**	1U	**217**	**1.78**	**1480**
PMW-4	**5.58**	1U	**2.77**	**5.38**	1U	**109**
CAP cleanup levels	5	40	30	20 [a]	20 [a]	1000
MTCA cleanup levels	5	1000	700	1000 [a]	1000 [a]	800 – 1000 [b]

Note. All concentrations are in µg/L.
Bold: Analyte was detected.
Underline: Values are greater than the CAP and/or MTCA Method A cleanup levels.
U: Analyte was not detected at or above the reported value.
J: The reported result is an estimate.
CAP: Cleanup Action Plan (Ecology 2002).
MTCA: MTCA Method A Groundwater Cleanup Level (WAC 173-340-720).
[a] The cleanup limit shown for m,p-xylene and o-xylene is for total xylenes.
[b] The MTCA Method A cleanup limit for TPH-G is 800 µg/L when benzene is present, and 1000 µg/L when benzene is not present.

Table 4. Relative percent differences of duplicate results from well PMW-4.

Analyte	PMW-4 (µg/L)	PMW-4 duplicate (µg/L)	RPD (%)
Gasoline	101	109	7.62
Benzene	5.58	5.37	3.84
Toluene	1U	1U	—
Ethylbenzene	2.77	2.57	7.49
m, p-Xylene	5.38	4.72	13.1
o-Xylene	1U	1U	—

—: Indicates that RPD could not be calculated.
U: Analyte was not detected at or above the reported value.
µg/L: Micrograms per liter

All calculated RPDs were within the data quality objective (DQO) of 30% as established in the QAPP (Marti 2011). RPDs could not be calculated for toluene and o-xylene as both analytes were not detected above reporting limits in the parent and duplicate samples. Analytical results presented in this report represent the highest detected concentrations of each analyte between the parent and duplicate samples. The results of the laboratory data quality control and quality assurance indicate that the analytical performance was good. All results are considered usable as reported.

Historical data collected at the site from 1993 through 2023 are presented in Figures A1 – A4 and Tables A1 – A11.

Upper Portion of the Project Area — Well D11

Well D11 is located along Goldsby Street near the north-central extent of the excavated area. Analytical results indicate that BTEX and TPH-G concentrations in well D11 continue to exceed (not meet) the most stringent cleanup levels (Ecology 2002; WAC 173-340-740) (Table 3). Concentrations of contaminants in well D11 have generally decreased since initial sampling in the mid- to late-1990s; however, ethylbenzene concentrations remain elevated (Figure A1). BTEX and TPH-G concentrations in well D11 remain among the highest in the Black Lake Grocery project area.

In April 2023, ethylbenzene, total xylenes, and TPH-G increased compared to the October 2021 concentrations, while concentrations of benzene and toluene decreased (Figure A1, Table A3).

Groundwater Upgradient of the Treatment Wall — Wells MW-2S, MW-2D

Wells MW-2S and MW-2D are housed in a well cluster located along the base of a bluff, approximately 100 feet downgradient from the former USTs. Wells MW-2S and MW-2D are both relatively shallow, with completion depths of 5 ft bgs and 15 ft bgs, respectively.

Analytical results from MW-2S indicate that this location had the highest concentration of residual petroleum contaminants of the sampled wells. Concentrations of BTEX and TPH-G far exceeded both CAP cleanup levels and MTCA Method A cleanup levels, with the exception of toluene, which was below the MTCA Method A cleanup level (Ecology 2002; WAC-173-340-720). In April 2023, benzene, toluene, ethylbenzene, and TPH-G increased compared to the October 2021 concentrations, while concentrations of total xylenes decreased (Figure A2, Table A8).

Analytical results from the deeper well MW-2D indicate concentrations below the reporting limits for all contaminants. Samples collected at this well have had concentrations below reporting limits since 2013, having decreased substantially following interim remedial action (Table A9).

Groundwater Downgradient of the Treatment Wall — Wells MW-3S, PMW-4

Well MW-3S is located approximately 20 feet southeast of well MW-2S along the downgradient side of the treatment wall. Well MW-3S is a shallow well, with a completion depth of about 5 ft bgs.

Analytical results from MW-3S indicate that BTEX and TPH-G concentrations are considerably lower than those of MW-2S. Benzene and TPH-G concentrations in MW-3S continue to exceed (not meet) both the CAP cleanup levels and the MTCA Method A cleanup levels (Ecology 2002; WAC-173-340-720); however, concentrations of xylenes exceeded only the CAP cleanup levels (Ecology 2002) (Table 3). Concentrations of toluene were below the most stringent cleanup levels, and ethylbenzene was not detected above laboratory reporting limits.

BTEX concentrations in well MW-3S were initially similar to those found in samples collected at well MW-2S and had decreased up to 99% within 6 months of treatment wall installation in 2005 (Figure A3). Following a rapid decline, concentrations began to steadily increase, and then started to level off in 2011. Contaminant concentrations have gradually decreased at MW-3S since 2014 (Figure A3, Table A10). In April 2023, benzene, toluene, total xylenes, and TPH-G increased slightly compared to October 2021 concentrations, while ethylbenzene decreased. These increases reflect an apparent seasonal trend in concentrations of benzene, toluene, xylenes, and TPH-G. This trend shows an increase in concentration during spring sampling events and a decrease in the fall, with an overall downward trend since 2015.

Well PMW-4 is located on the northern extent of the downgradient side of the treatment wall and is completed to approximately 10 ft bgs. Analytical results indicate that concentrations of benzene at PMW-4 continue to exceed (not meet) both the CAP cleanup levels and MTCA

Method A cleanup levels (Ecology 2002; WAC-173-340-720) (Table 3). Detected concentrations of ethylbenzene, m,p-xylene, and TPH-G were below the most stringent cleanup levels, and toluene and o-xylene were not detected above laboratory reporting limits (Table 3). All analytes decreased at PMW-4 compared to the sample collected during the October 2021 monitoring event (Table A7), with the reported benzene concentration of 5.58 µg/L approaching the most stringent cleanup level of 5 µg/L (Ecology 2002; WAC-173-340-720). While TPH-G concentrations at PMW-4 were far below the most stringent cleanup levels in April 2023, this analyte has fluctuated considerably throughout monitoring events, with concentrations that typically exceed (do not meet) established cleanup levels. BTEX concentrations have generally decreased since monitoring began in 2005 (Figure A4, Table A11).

Conclusions

Analytical results from the April 2023 groundwater monitoring event confirm that the near-surface aquifer at Black Lake Grocery continues to be impacted by petroleum hydrocarbon contamination. Samples collected on both the upgradient and downgradient sides of the treatment wall continue to exceed (not meet) applicable cleanup limits in 4 of the 5 wells (D11, MW-2S, MW-3, PMW-4) (Table 3).

Following soil excavation and removal in 1995 and the installation of a treatment wall in 2004, contaminant concentrations have decreased at the Black Lake Grocery site. Since 2015, analytical results from wells MW-2S and MW-3S have shown pronounced seasonal variations in contaminant concentrations that correlate with seasonal changes in groundwater levels. BTEX and TPH-G concentrations are relatively low in the fall, when groundwater levels are lowest, and increase in the spring and summer as groundwater levels rise. This apparent trend continued as indicated by analytical results from samples collected at wells MW-2S and MW-3S during the 2023 groundwater monitoring event (Figures A2 and A3). This seasonal trend generally appears weaker in wells D11 and PMW-4 (Figures A1 and A4).

Comparison of analytical results from upgradient well MW-2S to downgradient wells MW-3S and PMW-4 demonstrates a decrease in contaminant concentrations by an order of magnitude or greater on the downgradient side of the treatment wall. This decrease suggests the treatment wall removes contaminants from groundwater. Concentrations of contaminants in downgradient wells MW-3S and PMW-4 continue to exceed (not meet) the established cleanup levels for the site, which may indicate that the treatment wall material is nearing the end of its effective lifespan. The engineered material within the treatment wall is known to have limited capacity to adsorb and react with contaminants and is currently nearing twenty years of on-site application.

While previous samples collected from near-shore sediment and the water of Black Lake did not contain reportable concentrations of BTEX and TPH-G, the continued detection of petroleum contamination in wells MW-3S and PMW-4 suggests that the contaminant plume likely extends into Black Lake (Coots 2005). Wells MW-3S and PMW-4 are located less than 10 feet from the lakeshore, and no further remedial measures extend beyond the treatment wall.

Recommendations

Analysis of the April 2023 monitoring results yields the following recommendations:

- Due to continued contaminant concentrations in excess (not meeting) of established cleanup levels, groundwater monitoring at the Black Lake Grocery site should continue. This monitoring will provide information regarding the efficacy of the treatment wall. Potential increases in contaminant concentrations downgradient of the treatment wall may occur as the sorptive or reactive capacity of the engineered material is exhausted.
- Further site characterization may provide better insight into site conditions, including the extent of the contaminant plume towards the northern edge of the site and into Black Lake, and assess the treatment wall effectiveness in comparison to alternative remedial strategies. Following a sampling protocol to collect conventional parameters at the Black Lake Grocery site may help assess the effectiveness of the treatment wall, as in a previous Ecology study (Marti 2013). Collection of samples within the lake using temporary piezometers or a push-point sampler will additionally facilitate better plume delineation.

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Appendix A. Sampling Results, 1993 – 2023

This appendix presents sampling data from Black Lake Grocery monitoring wells from 1993 through 2023.

The following qualifiers, symbols, and abbreviations are used in the tables below:

- **Bold**: Analyte was detected.
- **Underline**: Values are greater than the CAP cleanup levels.
- U: Analyte was not detected at or above the reported value.
- REJ: Sample results rejected, the presence or absence of the analyte cannot be verified.
- —: Not Sampled
- CAP CL: Cleanup Action Plan Cleanup Limit.

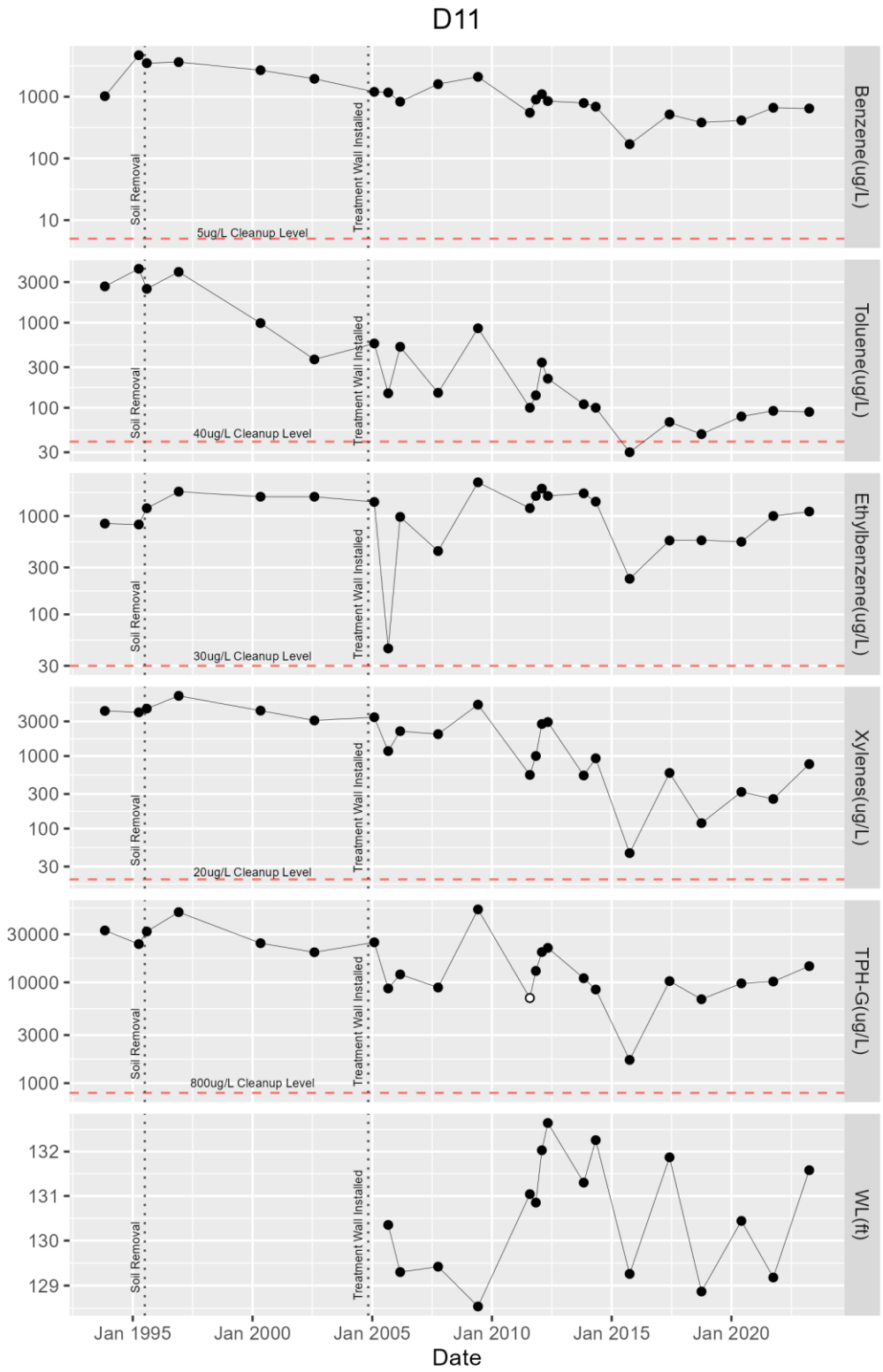

Figure A1. Contaminant concentrations (µg/L, log scale) and groundwater elevations (ft) for well D11, November 1993 to April 2023.
Open circles indicate the analyte was not detected and are plotted at one-half the reporting limit.

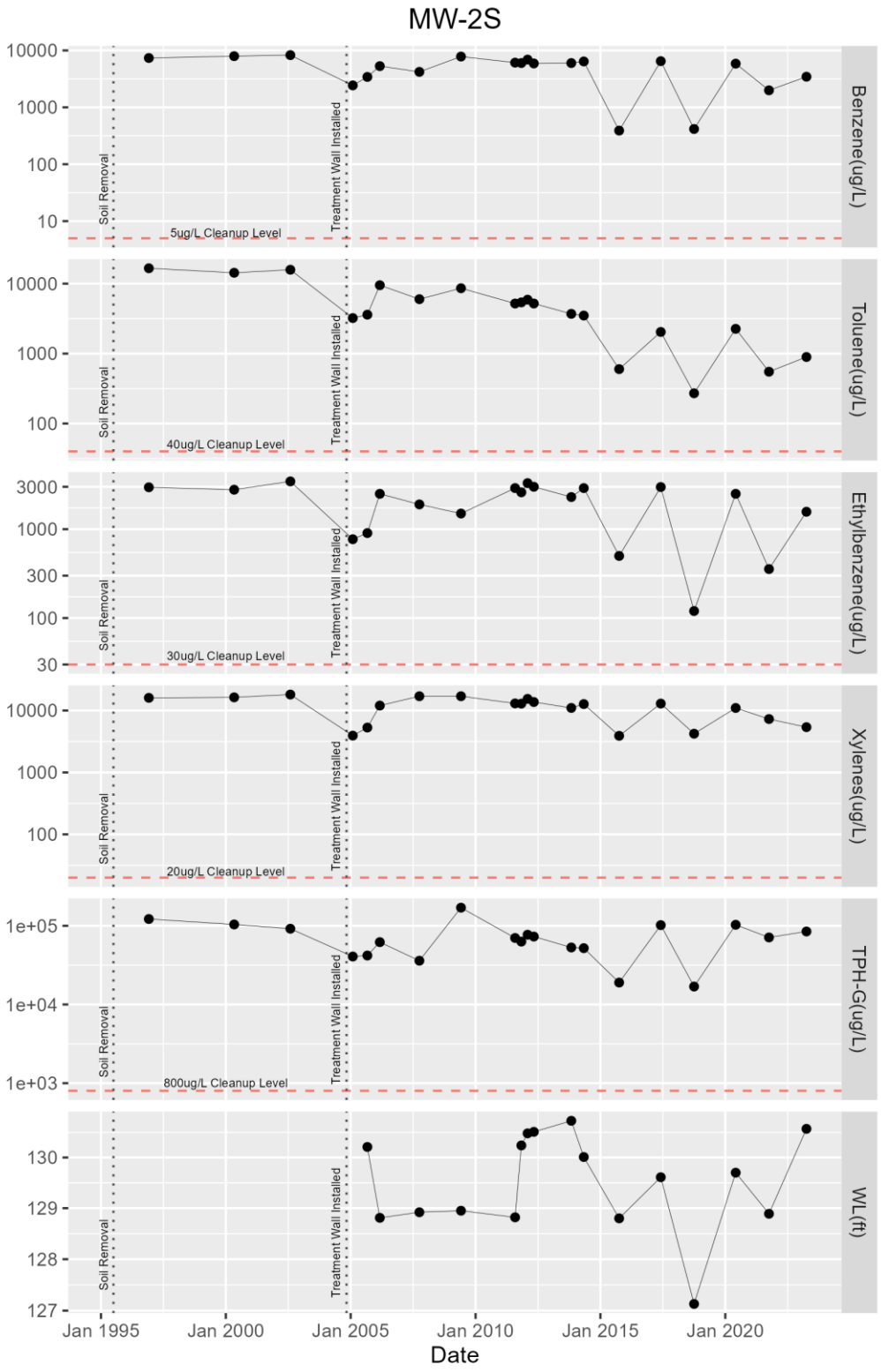

Figure A2. Contaminant concentrations (µg/L, log scale) and groundwater elevations (ft) for well MW-2S, November 1993 to April 2023.

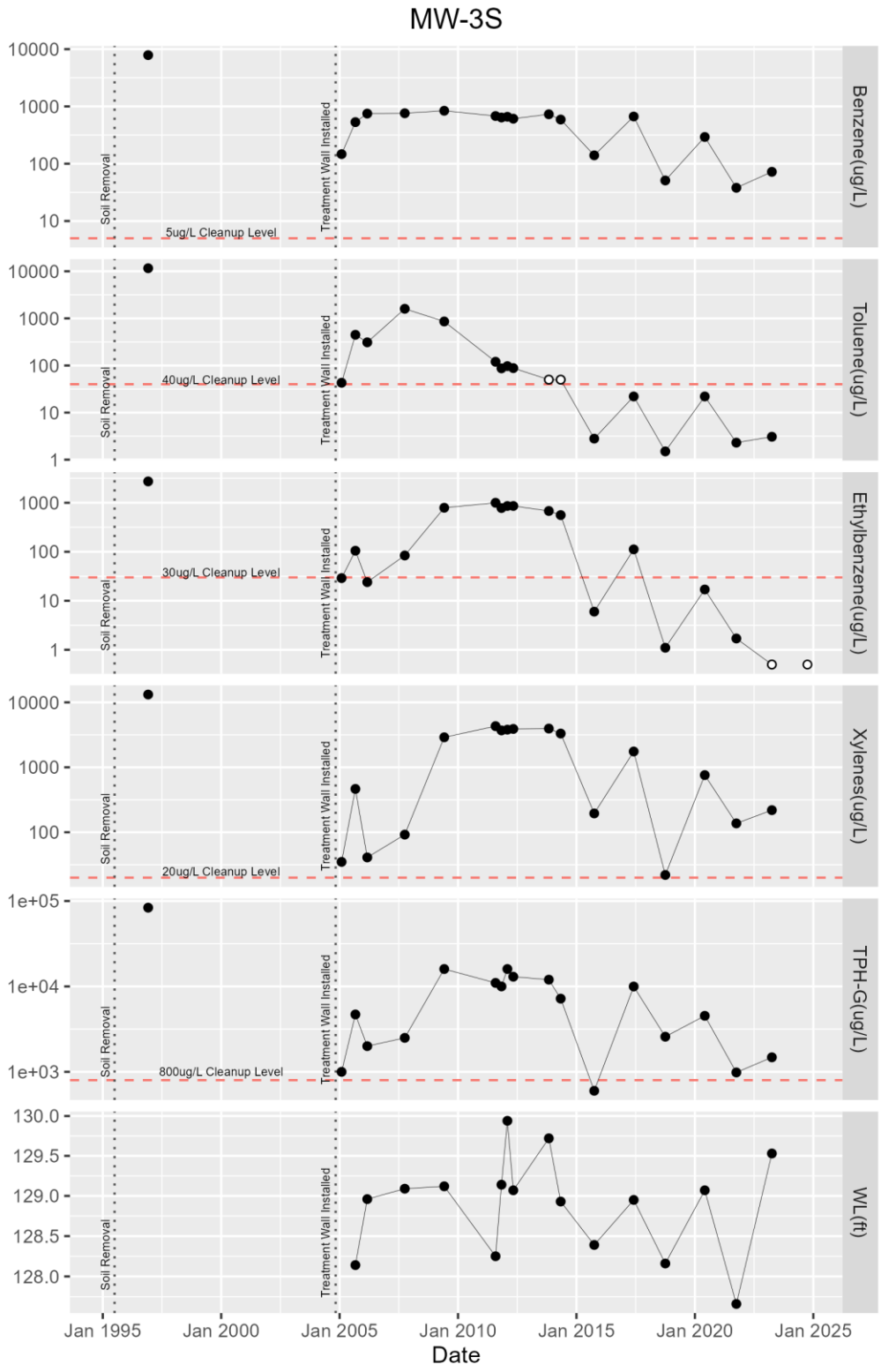

Figure A3. Contaminant concentrations (µg/L, log scale) and groundwater elevations (ft) for well MW-3S, November 1993 to April 2023.

Open circles indicate the analyte was not detected and are plotted at one-half the reporting limit.

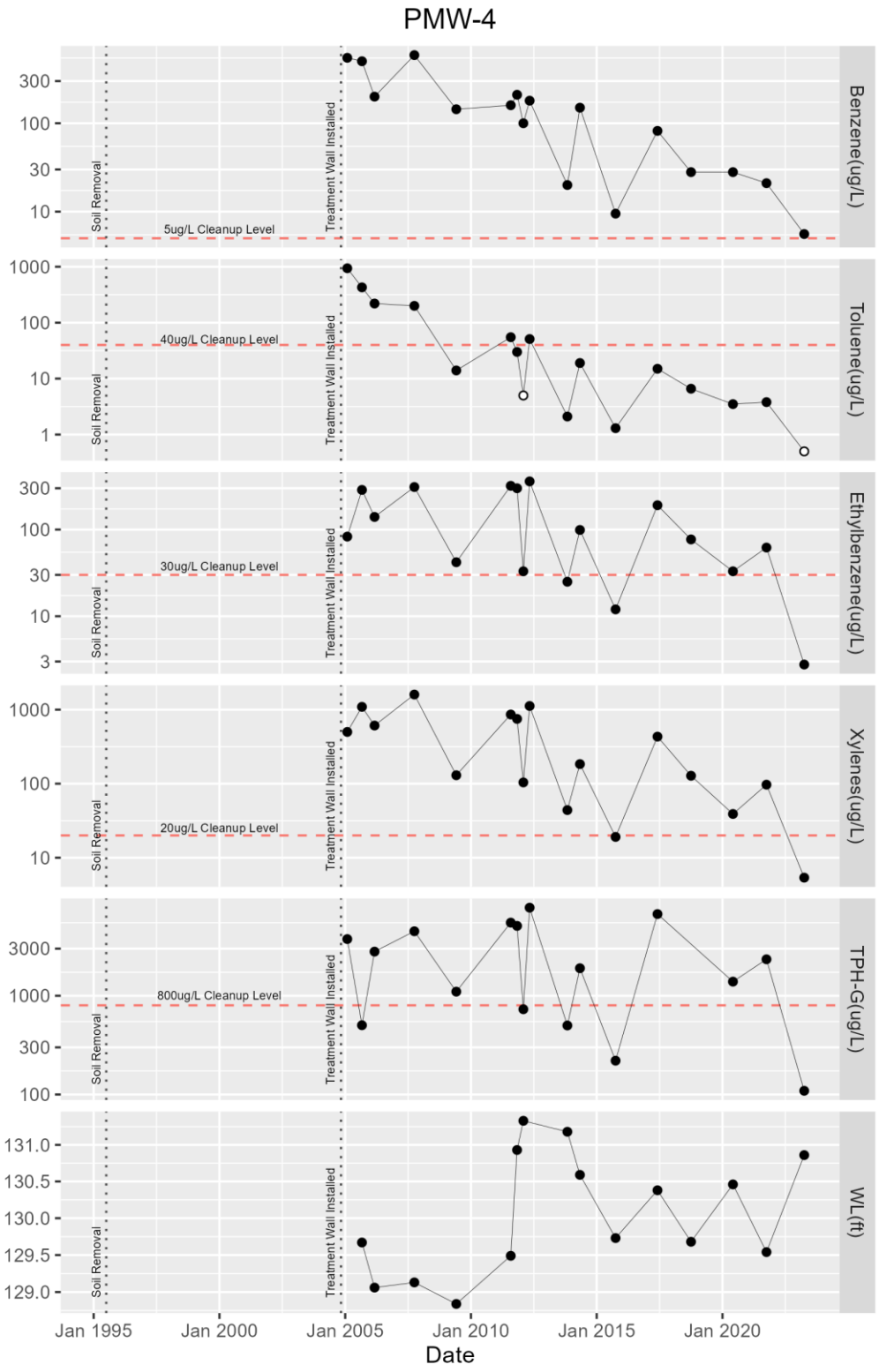

Figure A4. Contaminant concentrations (µg/L, log scale) and groundwater elevations (ft) for well PMW-4, November 1993 to April 2023.

Open circles indicate the analyte was not detected and are plotted at one-half the reporting limit

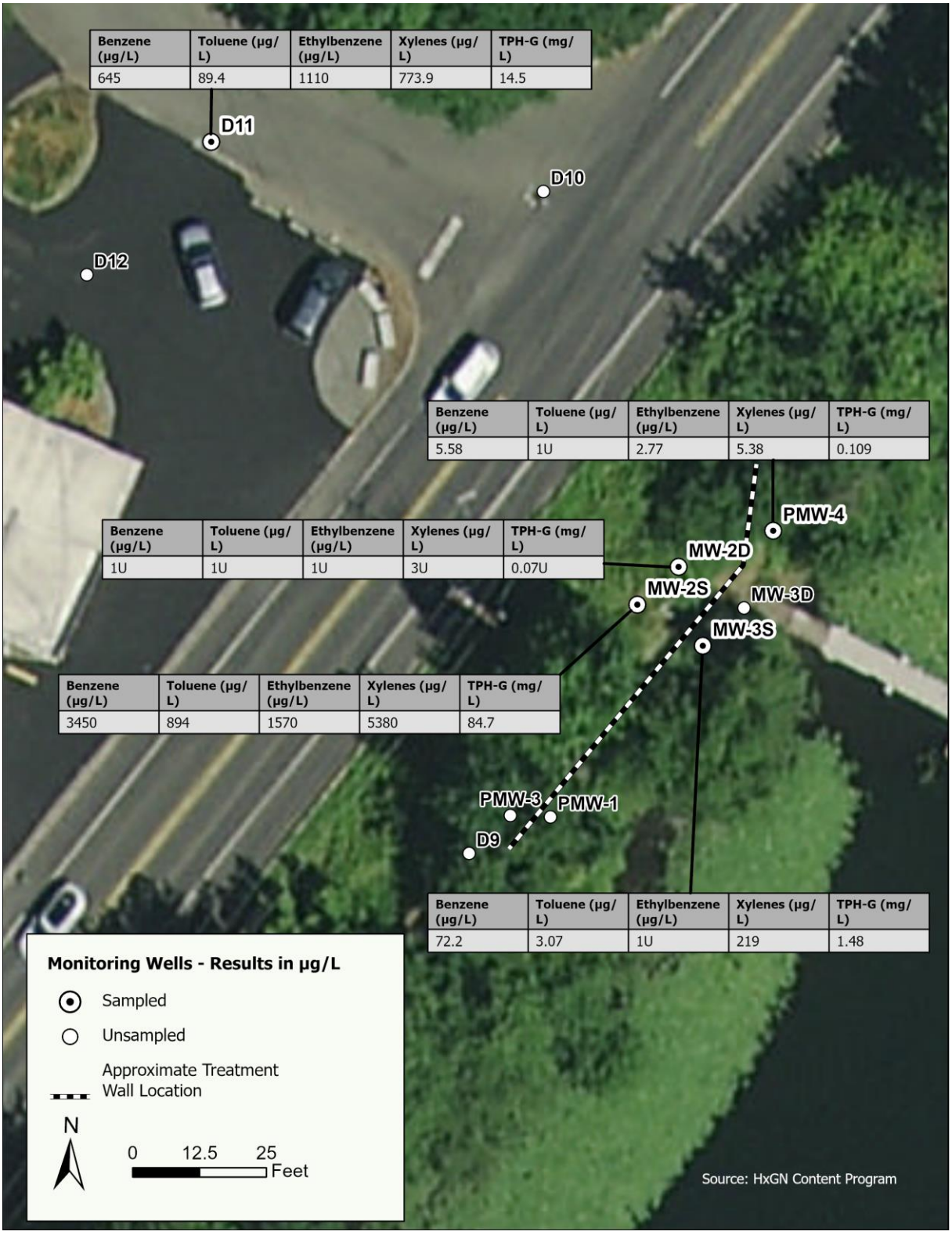

Figure A5. Benzene concentrations in µg/L for all wells sampled during April 2023.

Table A1. Analytical results from 1993 to 2014 for monitoring well D9.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Nov-93	**909**	**3520**	**1720**	**6050**	**57,570**
Apr-95	**830**	**1500**	**1300**	**2600**	**28,000**
Aug-95	**570**	**680**	**510**	**1100**	**13,000**
Dec-96	**164**	**190**	**170**	**418**	**3300**
Feb-05	1 U	**8.4**	**4.9**	**33**	**1510**
Sep-05	1 U	**17**	**3.7**	**18**	**160**
Mar-06	1 U	1 U	1 U	1 U	100 U
Oct-07	1 U	1 U	1 U	1 U	100 U
Sep-09	1 U	1 U	1 U	1 U	100 U
Aug-11	1 U	1 U	1 U	3 U	140 U
Nov-11	1 U	1 U	1 U	3 U	40 U
Feb-12	1 U	1 U	1 U	3 U	70 U
May-12	1 U	1 U	1 U	3 U	70 U
Nov-13	1 U	1 U	1 U	3 U	70 U
May-14	1 U	1 U	1 U	3 U	70 U
CAP CL	**5**	**40**	**30**	**20**	**800**

Table A2. Analytical results from 1993 to 2013 for monitoring well D10.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Nov-93	**8450**	**8670**	**1450**	**5260**	**30,680**
Dec-96	**8150**	**4830**	**2190**	**9680**	**45,500**
May-00	**5580**	**931**	**1070**	**3660**	**40,700**
Aug-02	**8270**	**674**	**1680**	**3290**	**32,100**
Feb-05	**706**	**79**	**237**	**295**	**5420**
Sep-05	**3440**	**368**	**525**	**1050**	**15,700**
Mar-06	**4000**	**150**	**570**	**290**	**9000**
Oct-07	**510**	**22**	**38**	**190**	**1300**
Sep-09	**3700**	**130**	**540**	**290**	**6800**
Aug-11	**4400**	**120**	**700**	**400**	**3300**
Nov-11	**2700**	100 U	**360**	300 U	**2300**
Feb-12	**5800**	100 U	**910**	**750**	**4700**
May-12	**2000**	**58**	**410**	**450**	**2500**
Nov-13	REJ	REJ	REJ	REJ	REJ
CAP CL	**5**	**40**	**30**	**20**	**800**

Table A3. Analytical results from 1993 to 2023 for monitoring well D11.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Nov-93	1020	2670	838	4180	32750
Apr-95	4700	4300	820	4000	24000
Aug-95	3500	2500	1200	4500	32000
Dec-96	3640	3950	1770	6740	49800
May-00	2690	988	1570	4220	24500
Aug-02	1950	370	1570	3090	19900
Feb-05	1200	570	1390	3420	25000
Sep-05	1170	148	45	1170	8710
Mar-06	830	520	980	2200	12000
Oct-07	1600	150	440	2000	8900
Sep-09	2100	860	2200	5100	53000
Aug-11	550	100	1200	550	140 U
Nov-11	900	140	1600	1000	13000
Feb-12	1100	340	1900	2760	20000
May-12	850	220	1600	2940	22000
Nov-13	790	110	1700	540	11000
May-14	690	100	1400	930	8500
Oct-15	170	30	230	46	1700
Jun-17	516	68	564	585	10300
Oct-18	382	49	566	119	6800
Jun-20	413	79	547	320J	9780
Oct-21	663	92	1000	256	10200
Apr-23	645	89.4	1110	773.9	14500
CAP CL	5	40	30	20	800

Table A4. Analytical results from 1995 to 2014 for monitoring well D12.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Aug-95	**0.5**	0.5 U	**0.7**	1 U	50 U
Dec-96	0.5 U	0.5 U	0.5 U	1 U	50 U
May-00	0.5 U	0.5 U	0.5 U	1 U	50 U
Aug-02	0.5 U	2 U	1 U	1.5 U	100 U
Feb-05	**17**	**34**	**5.8**	**31**	**360**
Sep-05	**2.2**	**1.4**	1 U	**2**	100 U
Mar-06	**1.6**	1 U	1 U	**15**	100 U
Oct-07	**9.6**	1 U	1 U	**24**	**140**
Sep-09	1 U	1 U	1 U	3 U	100 U
Aug-11	1 U	1 U	1 U	3 U	140 U
Nov-11	1 U	1 U	1 U	3 U	40 U
Feb-12	1 U	1 U	1 U	3 U	70 U
May-12	1 U	1 U	1 U	3 U	70 U
Nov-13	1 U	1 U	1 U	3 U	70 U
May-14	1 U	1 U	1 U	3 U	70 U
CAP CL	**5**	**40**	**30**	**20**	**800**

Table A5. Analytical results from 2005 to 2014 for monitoring well PMW-1.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Feb-05	1 U	1 U	1 U	1 U	100 U
Sep-05	**272**	**7.2**	**2.3**	**11**	100 U
Mar-06	1 U	**6.7**	1 U	1 U	100 U
Oct-07	1 U	1 U	1 U	1 U	100 U
Sep-09	1 U	**2.4**	1 U	3 U	100 U
Aug-11	1 U	1 U	1 U	3 U	140 U
Nov-11	**2.5**	**6.6**	**4.2**	**9.4**	**110**
Feb-12	**1.9**	**18**	**2.3**	**5.3**	**92**
May-12	**1.3**	**9.5**	**4**	**7.2**	**83**
Nov-13	**1.6**	**1.1**	**1.1**	**8.9**	70 U
May-14	**3.6**	**1.1**	**1.8**	**16**	70 U
CAP CL	**5**	**40**	**30**	**20**	**800**

Table A6. Analytical results from 2005 to 2014 for monitoring well PMW-3.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Feb-05	**1.1**	**8.7**	1 U	1 U	**125**
Sep-05	**14**	**296**	**9.7**	**33**	**523**
Mar-06	**2.7**	**320**	1 U	**16**	**480**
Oct-07	**6.1**	**340**	**27**	**34**	**480**
Sep-09	1 U	1 U	1 U	3 U	**150**
Aug-11	1 U	1 U	1 U	3 U	140 U
Nov-11	1 U	**5.4**	1 U	3 U	40 U
Feb-12	1 U	1 U	1 U	3 U	70 U
May-12	1 U	**1.5**	1 U	3 U	70 U
Nov-13	1 U	1 U	1 U	3 U	70 U
May-14	1 U	1 U	1 U	3 U	70 U
CAP CL	**5**	**40**	**30**	**20**	**800**

Table A7. Analytical results from 2005 to 2023 for monitoring well PMW-4.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Feb-05	**550**	**940**	**83**	**500**	**3750**
Sep-05	**503**	**428**	**287**	**1090**	**503**
Mar-06	**200**	**220**	**140**	**610**	**2800**
Oct-07	**590**	**200**	**310**	**1600**	**4500**
Sep-09	**144**	**14**	**42**	**130**	**1100**
Aug-11	**160**	**55**	**320**	**860**	**5500**
Nov-11	**210**	**30**	**300**	**750**	**5100**
Feb-12	**100**	10U	**33**	**104**	**730**
May-12	**180**	**51**	**360**	**1120**	**7800**
Nov-13	**20**	**2.1**	**25**	**44**	**500**
May-14	**150**	**19**	**99**	**184**	**1900**
Oct-15	**9.5J**	**1.3**	**16J**	**19.1J**	**220**
Jun-17	**82**	**15**	**191**	**432**	**6720**
Oct-18	**28**	**6.6**	**77**	**128**	**REJ**
Jun-20	**28**	**3.5J**	**33**	**39**	**1390**
Oct-21	**21J**	**3.8J**	**62J**	**97J**	**2340J**
Apr-23	**5.58**	1U	**2.77**	**5.38**	**109**
CAP CL	**5**	**40**	**30**	**20**	**800**

Table A8. Analytical results from 1996 to 2023 for monitoring well MW-2S.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Dec-96	7360	16600	2960	16000	122000
May-00	7930	14300	2780	16300	104000
Aug-02	8270	15800	3450	18100	91800
Feb-05	2430	3220	771	3930	40700
Sep-05	3420	3600	904	5300	41900
Mar-06	5300	9500	2500	12000	62000
Oct-07	4200	6000	1900	17000	36000
Sep-09	7800	8600	1500	17000	170000
Aug-11	6100	5200	2900	13000	70000
Nov-11	6000	5400	2600	12900	63000
Feb-12	6900	5900	3300	15400	77000
May-12	5900	5200	3000	13700	73000
Nov-13	6000	3700	2300	11000	53000
May-14	6400	3500	2900	12700	52000
Oct-15	390	600	500	3900	19000
Jun-17	6480	2040	2980	12930	102000
Oct-18	416J	271J	120J	4220J	16900J
Jun-20	5860	2260	2500	10980	103000
Oct-21	1990J	551J	356J	7280J	71100J
Apr-23	3450	894	1570	5380	84700
CAP CL	5	40	30	20	800

Table A9. Analytical results from 1996 to 2023 for monitoring well MW-2D.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Dec-96	**3040**	**7300**	**1830**	**10,700**	**64,000**
May-00	**787**	**29**	**42**	**13**	**425**
Aug-02	**4.2**	2 U	1 U	1.5 U	**219**
Feb-05	**47**	**105**	**23**	**139**	**1200**
Sep-05	**63**	**21**	**3.7**	**31**	**395**
Sep-09	**3.5**	1 U	1 U	3 U	100 U
Aug-11	1 U	1 U	1 U	3 U	140 U
Nov-11	**19**	1 U	1 U	3 U	40 U
Feb-12	**50**	1 U	1 U	3 U	70 U
May-12	**30**	1 U	1 U	3 U	70 U
Nov-13	**36**	1 U	1 U	3 U	70 U
May-14	1 U	1 U	1 U	3 U	70 U
Oct-15	1 U	1 U	1 U	3 U	70 U
Jun-17	1 U	1 U	1 U	3 U	70 U
Oct-18	1 U	1 U	1 U	3 U	70 U
Jun-20	1 U	1 U	1 U	3 U	70 U
Oct-21	1 U	1 U	1 U	3 U	70 U
Apr-23	1 U	1 U	1 U	3 U	70 U
CAP CL	**5**	**40**	**30**	**20**	**800**

Table A10. Analytical results from 1996 to 2023 for monitoring well MW-3S.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Dec-96	7860	11600	2730	13200	83600
Feb-05	147	43	29	35	1000
Sep-05	532	448	105	465	4700
Mar-06	750	310	24	41	2000
Oct-07	760	1600	84	92	2500
Sep-09	840	860	790	2900	16000
Aug-11	680	120	1000	4300	11000
Nov-11	640	87	780	3700	10000
Feb-12	660	97	860	3800	16000
May-12	610	88	860	3900	13000
Nov-13	730	100U	680	3950	12000
May-14	590	100U	560	3310	7200
Oct-15	140	2.8	6	195	600
Jun-17	667	22	112	1753	9980
Oct-18	51	1.5	1.1	22	2580
Jun-20	293	22	17	759J	4530
Oct-21	38	2.3	1.7	137	984
Apr-23	72.2	3.1	1 U	219	1480
CAP CL	5	40	30	20	800

Table A11. Analytical results from 1996 to 2009 for monitoring well MW-3D.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Dec-96	**132**	**138**	**21**	**1440**	**11,600**
Aug-02	0.5 U	2 U	1 U	1.5 U	100 U
Feb-05	1 U	1 U	1 U	1 U	100 U
Sep-05	**78**	**89**	**16**	**100**	**800**
Mar-06	**1.6**	1 U	1 U	1 U	100 U
Oct-07	**51**	**70**	**44**	**190**	**490**
Sep-09	1 U	**1.4**	1 U	**5**	100 U
Aug-11	1 U	1 U	1 U	3 U	140 U
Nov-11	1 U	1 U	1 U	3 U	40 U
Feb-12	1 U	1 U	1 U	3 U	70 U
May-12	1 U	1 U	1 U	3 U	70 U
Nov-13	1 U	1 U	1 U	3 U	70 U
May-14	1 U	1 U	1 U	3 U	70 U
CAP CL	**5**	**40**	**30**	**20**	**800**