Black Lake Grocery Groundwater Monitoring Results, October 2018 and June 2020: Data Summary Report

Environmental Assessment Program
Publication 21-03-018

Authored by Jacob Carnes

Published October 2021

Abstract

Black Lake Grocery is an active gas station and convenience store located on the northwest shore of Black Lake in Thurston County, Washington. In 1989, petroleum hydrocarbon contamination was discovered in soil and groundwater beneath the site. The source of the contamination was Black Lake Grocery's underground storage tanks. In 1995, these tanks and a large amount of contaminated soil were removed. In 2004, a treatment wall consisting of a trench filled with a permeable reactive material was installed along Black Lake's shoreline. The treatment wall was installed to passively treat contaminated groundwater flowing toward the lake.

From November 1993 to June 2009, Summit Envirosolutions conducted groundwater sampling of on-site monitoring wells to monitor petroleum contamination. In 2011, the Washington State Department of Ecology (Ecology) resumed sampling to characterize the groundwater contaminant concentrations.

This report describes the water quality results for groundwater samples collected during October 2018 and June 2020 from 5 monitoring wells. The samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) and total petroleum hydrocarbons as gasoline (TPH-G).

Water quality results for groundwater sampling in 2018 and 2020 continue to confirm that the near-surface aquifer at Black Lake Grocery is contaminated across the site. Since 1995, contaminant concentrations have decreased but continue to exceed (not meet) established cleanup levels in 4 of the sampled wells. BTEX and TPH-G concentrations decreased significantly after passing through the treatment wall, but the continued presence of high contaminant concentrations in wells on the downgradient side of the wall and near the shoreline suggests that petroleum constituents from the site may be migrating to Black Lake.

Publication Information

This report is available on the Department of Ecology's website at:
https://apps.ecology.wa.gov/publications/SummaryPages/2103018.html.

Data for this project are available in Ecology's EIM Database. Study ID: PMART007

The Activity Tracker Code for this study is 12-001.

Suggested Citation:
Carnes, J., 2021. Black Lake Grocery Groundwater Monitoring Results, October 2018 and June 2020: Data Summary Report. Publication 21-03-018. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2103018.html.

Water Resource Inventory Area (WRIA) and 8-digit Hydrologic Unit Code (HUC) numbers for the study area:

- WRIA: 23
- HUC number: 17100103

Contact Information

Publication Coordinator
Environmental Assessment Program
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
Phone: 360-407-6764

Washington State Department of Ecology – https://ecology.wa.gov

• Headquarters, Olympia	360-407-6000
• Northwest Regional Office, Bellevue	425-649-7000
• Southwest Regional Office, Olympia	360-407-6300
• Central Regional Office, Union Gap	509-575-2490
• Eastern Regional Office, Spokane	509-329-3400

This report was prepared under the supervision of a licensed hydrogeologist. A signed and stamped copy of the report is available upon request.

Background

Black Lake Grocery is an active gas station and convenience store located on the northwest shore of Black Lake (Figure 1). The store is situated on a 5.2-acre parcel of land about 100 feet from the lakeshore. In 1989, a geotechnical study was performed by Dames and Moore for Thurston County as part of a planned expansion of Black Lake Boulevard. That study found that soil and groundwater beneath the Black Lake Grocery site were contaminated with gasoline-range petroleum hydrocarbons (Dames and Moore, 1990).

In June and July 1995, during the Black Lake Boulevard expansion, 7 underground storage tanks and 1,200 cubic yards of petroleum-contaminated soils were removed from the site as an interim action. The excavated area was in the northeast portion of the site and encompassed the area between the grocery store and the property boundaries at Goldsby Road and Black Lake Boulevard (Figure 1). The depth of the soil excavation ranged from approximately 10 to 13 feet below ground surface.

Soil samples from the edge of the area excavated at the time of the Black Lake Boulevard expansion 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) as well as total petroleum hydrocarbons as gasoline (TPH-G). The contaminated soil beyond the excavated area could not be removed because the soil was not accessible below the adjacent county roads (Summit, 2000).

Summit (2000) completed a remedial investigation/feasibility study (RI/FS) of the Black Lake Grocery site. In the RI/FS the contaminant plume was defined as extending from the former location of the underground storage tanks downgradient to Black Lake. The northeastern edge of the plume was shown to coincide with the location of a stormwater culvert under Black Lake Boulevard. In 1995, a groundwater sample collected from north of the culvert did not contain petroleum contamination (Summit, 2000). No additional sampling has occurred northeast of the mapped plume extent since 1995.

To remediate the remaining petroleum hydrocarbon contamination in soils and groundwater, the remediation strategy selected in the Cleanup Action Plan (CAP) (Ecology, 2002) relies on natural attenuation and a passive treatment wall installed along the lake shoreline. The treatment wall, which is a trench filled with a permeable reactive material, is designed to passively remediate the contaminated groundwater flowing toward Black Lake.

In November 2004, the treatment wall was constructed along the shore of Black Lake. The wall is approximately 120 feet long, 5 feet wide, and 12 feet deep. The permeable reactive material within the wall is an engineered sphagnum peat moss. The permeable reactive material was designed to both absorb petroleum hydrocarbons and provide a catalytic surface on which microbial activity can occur. Upgradient of the treatment wall, natural attenuation mechanisms are relied upon to mitigate the groundwater contamination.

Site cleanup will be achieved when contaminant concentrations throughout the Black Lake Grocery site (point of compliance) have met the MTCA method A groundwater cleanup levels (WAC 173-340-720) and CAP cleanup levels (Ecology, 2002). The cleanup levels for toluene, ethylbenzene, and xylenes established in the CAP are more stringent than the MTCA method A groundwater cleanup levels. However, the CAP cleanup levels are cited as MTCA method A cleanup levels (Ecology, 2002).

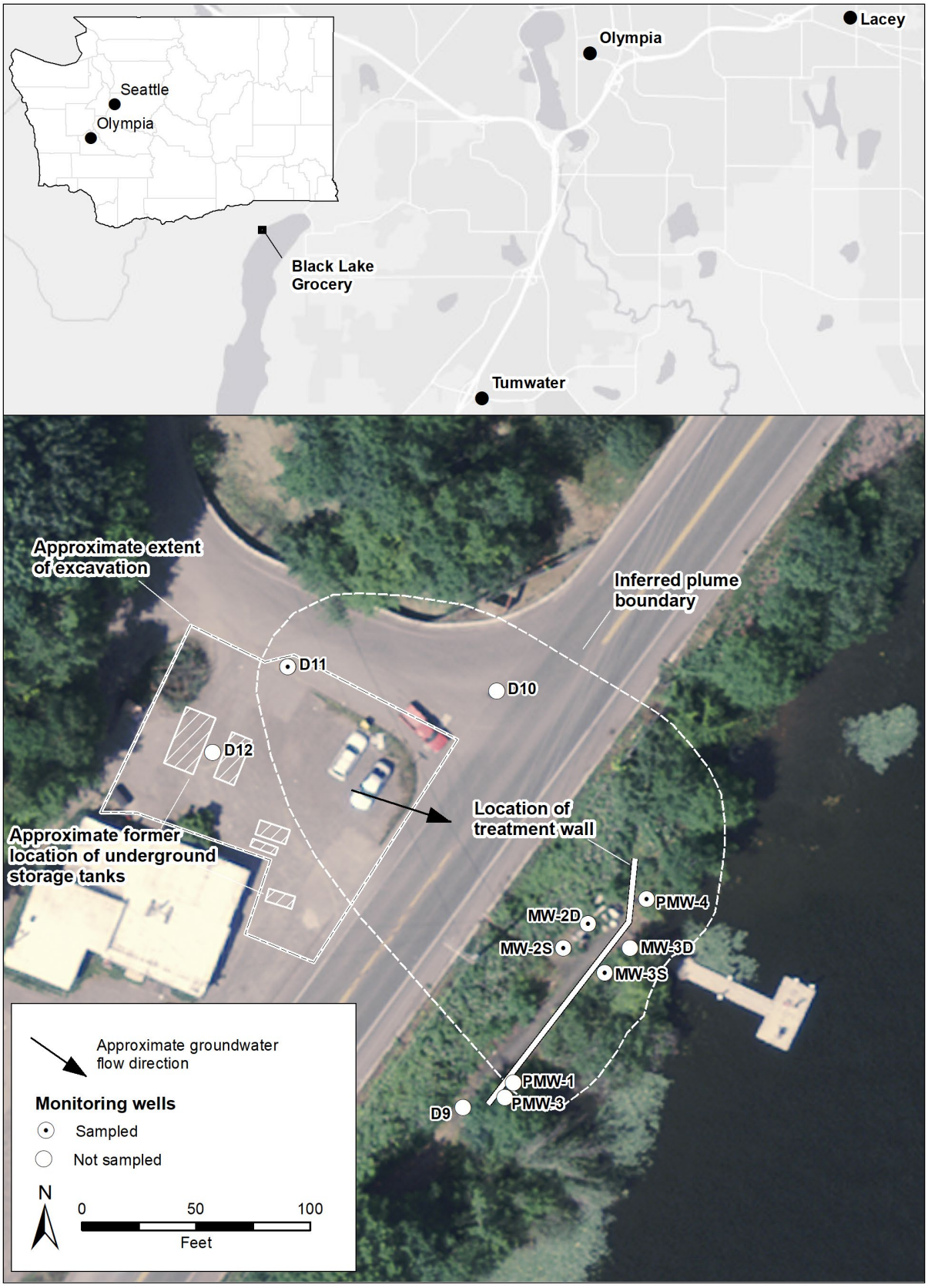

Figure 1. Black Lake Grocery Location and Site Details.

From November 1993 through June 2009, Summit Envirosolutions sampled and analyzed groundwater for petroleum constituents at the site. Concentrations of BTEX and TPH-G in groundwater decreased after the excavation of contaminated soils and installation of the treatment wall. However, contaminant concentrations still exceeded the MTCA groundwater cleanup levels (WAC 173-340-720) in 5 of the 11 monitoring wells (Figures A1-A4, Tables A1-A7). In August 2011, Ecology resumed groundwater sampling because of the continued elevated concentrations of petroleum constituents in groundwater (Marti, 2013).

Summit (2005) estimated that contaminant concentrations would fall below cleanup levels within 10 to 25 years, due to the combined effects of excavation of source material and biodegradation. In 2011 and 2012, Ecology conducted sampling to measure conventional parameters (dissolved organic carbon, total and dissolved iron, sulfate, nitrate, nitrite, and turbidity) in groundwater. The purpose of that sampling was to evaluate the potential for natural attenuation of the site. The results of this sampling indicate conditions favorable for the biodegradation of petroleum hydrocarbon contamination (Marti, 2013).

This data report summarizes groundwater results from select on-site wells for October 2018 and June 2020. The data and associated monitoring reports for this project are available at Ecology's Environmental Information Management (EIM) website www.ecy.wa.gov/eim/index.htm. Search Study ID, PMART007.

Methods and Results

In October 2018 and June 2020, Ecology collected groundwater samples from 5 monitoring wells (D11, MW-2S, MW-2D, MW-3S, PMW-4) at the Black Lake Grocery site (Figure 1). Four of the selected wells are known to have contaminant concentrations that exceed the site cleanup levels. Well D10 historically has had high petroleum concentrations (see Table A2), but was not sampled because it is difficult to access due to traffic. Also, D10 is low yielding and the water level in the well is slow to recover.

Ecology employed industry-standard low-flow sampling techniques. Because most of the wells are low yielding and slow to recover, each well was purged and sampled using a peristaltic pump with dedicated tubing. Prior to sampling, the wells were purged through a continuous flow cell at a rate of 0.5-liter/minute or less. The wells were purged until field parameters (pH, temperature, specific conductance, dissolved oxygen, and oxidation reduction potential) stabilized as specified in SOP EAP078 (Marti, 2020). Well construction information and water levels are shown in Table 1. Stabilized field measurements are presented in Tables 2 and 3.

Table 1. Well construction details and water levels for October 2018 and October 2020.

Well	Land Surface Elevation (feet, NAVD88)	Well Depth (feet bgs)	Screened Interval (feet bgs)	2018 Groundwater Elevation (feet, NAVD88)	2020 Groundwater Elevation (feet, NAVD88)
D-11	136.08	15	5 – 15	128.87	130.44
MW-2D	132.77	15	12 – 15	129.09	130.87
MW-2S	131.97	5	2 – 5	127.13	129.70
MW-3S	131.11	5	2 – 5	128.16	129.07
PMW-4	132.14	11	1 – 11	129.68	130.46

bgs: Below ground surface.

In October 2018, well MW-2S purged dry before stabilizing. Ecology returned to the site 2 days later to collect the samples from MW-2S. Because of the low water level and slow recharge, MW-2S was not purged before sampling, and field parameters were not recorded.

Table 2. Field measurements from October 2018 sampling.

Well	pH (std. units)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)
D-11	6.4	444	1.0	-102
MW-2D	6.8	277	0.6	11
MW-2S[a]	--	--	--	--
MW-3S	5.9	522	0.5	4
PMW-4[b]	--	404	1.4	-102

-- Not collected

[a] Field parameters in MW-2S were not measured due to low water level.

[b] The pH meter malfunctioned during purging of PMW-4.

Table 3. Field measurements from June 2020 sampling.

Well	pH (std. units)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)
D-11	6.3	303	0.50	25
MW-2D	6.2	667	0.0	-34
MW-2S	6.3	518	0.0	-122
MW-3S	6.0	797	0.2	-104
PMW-4	6.3	570	0.01	-86

Groundwater samples collected in October 2018 and July 2020 were submitted for analysis of BTEX and TPH-G to determine petroleum contaminant concentrations upgradient and downgradient of the treatment wall. Analytical results for BTEX and TPH-G are summarized in Tables 4 and 5. The Cleanup Action Plan (CAP) cleanup levels for the site (Ecology, 2002) and the MTCA Method A groundwater cleanup levels are also listed for comparison (WAC 173-340-720).

A blind field duplicate was collected from well PMW-4 in both 2018 and 2020. The relative percent difference (RPD) for all analyte duplicate results ranged from 7% to 89% in 2018, and 3% to 38% in 2020 (Table 6).

Table 4. Analytical results from the October 2018 sampling, and associated cleanup limits. All concentrations are in µg/L.

Well	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	TPH-G
D-11	**382**	**49.2**	**566**	**114**	**5.22**	**6,800**
MW-2D	1U	1U	1U	2U	1U	70U
MW-2S	**416J**	**271J**	**120J**	**2,070J**	**2,150J**	**16,900J**
MW-3S	**50.7**	**1.49**	**1.12**	**20.5**	**1.63**	**2,580**
PMW-4	**27.6**	**6.6J**	**77**	**118**	**9.71**	**REJ**
PMW-4 (duplicate)	**35.1**	**4.09J**	**71.7**	**111**	**8.86**	**REJ**
CAP cleanup levels	*5*	*40*	*30*	*20 [a]*	*20 [a]*	*1000*
MTCA cleanup levels	*5*	*1000*	*700*	*1000 [a]*	*1000 [a]*	*800 - 1000 [b]*

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.
REJ: Sample results rejected due to high duplicate RPD, the concentration cannot be verified.
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 5. Analytical results from the June 2020 sampling, and associated cleanup limits. All concentrations are in µg/L.

Well	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	TPH-G
D-11	**413**	**78.9**	**547**	**301**	**18.9J**	**9,780**
MW-2D	1U	1U	1U	2U	1U	70U
MW-2S	**5,860**	**2,260**	**2,500**	**7,670**	**3,310**	**103,000**
MW-3S	**293**	**22**	**17.1**	**751**	**8.05J**	**4,530**
PMW-4	**27.7**	**3.55J**	**33.1**	**33.9**	**4.96**	**1,390**
PMW-4 (duplicate)	**30.4**	**5.2J**	**31.8**	**30**	**5.11**	**1,480**
CAP cleanup levels	*5*	*40*	*30*	*20 [a]*	*20 [a]*	*1000*
MTCA cleanup levels	*5*	*1000*	*700*	*1000 [a]*	*1000 [a]*	*800 - 1000 [b]*

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: Analyte was positively identified below the reporting limit. The reported result is an estimate.
CAP: Cleanup Action Plan (Ecology, 2002).
MTCA: MTCA Method A Groundwater Cleanup Level (WAC 173-340-740).
[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 6. Relative percent differences of duplicate results from well PMW-4.

Sampling date	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	TPH-G
October 2018	23.9	47.0	7.1	6.1	9.2	88.8
June 2020	9.3	37.7	4.0	12.2	3.0	6.3

In both 2018 and 2020, toluene failed to meet the data quality objective (DQO) of 30% established in the Quality Assurance Project Plan (Marti, 2011). The results for toluene in well PMW-4 have been qualified as estimates. The 2018 results for TPH-G in PMW-4 have been rejected because the RPD far exceeded DQO of 30%. All other analyte duplicate results achieved a RPD below 30% and met the project DQO. The laboratory data quality control and quality assurance results indicate that the analytical performance was good. All results are usable as reported.

Project data collected since 1993 are presented in Figures A1-A4 and Tables A1-A7.

Upper Portion of the Project Area – Well D11

Well D11 is located on the north-central edge of the excavated area. Concentrations of BTEX and TPH-G in well D11 continue to exceed (not meet) the most stringent cleanup levels (Ecology, 2002; WAC 173-340-740) (Tables 3 and 4). Although contaminant concentrations have shown up to an 80% decrease since 1995 (Figure A1), this well continues to have some of the highest BTEX and TPH-G concentrations in the project area.

For the majority of contaminants, the October 2018 concentrations in well D11 decreased compared to the 2017 data (Figure A1). The June 2020 results indicated an increase in several contaminant concentrations compared to the 2018 results. However, the ethylbenzene concentration remained relatively consistent from 2017 to 2020.

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

Wells MW-2S and MW-2D are part of a cluster of wells located at the base of the bluff, about 100 feet downgradient of the former underground storage tanks. Well MW-2S is relatively shallow, with a total depth of about 5 feet below ground surface. Well MW-2D has a total depth of about 15 feet below ground surface.

Of all the wells sampled in 2018 and 2020, MW-2S had the highest concentrations of petroleum-related contaminants. In October 2018, BTEX and TPH-G exceeded CAP cleanup levels, and the concentrations of benzene, total xylenes, and TPH-G exceeded MTCA Method A cleanup levels (Ecology, 2002; WAC-173-340-720). The October 2018 concentrations BTEX and TPH-G are among the lowest observed since 1996 (Figure A2). In June 2020, BTEX and TPH-G concentrations exceeded both the CAP and MTCA cleanup levels (Tables 3 and 4).

None of the contaminants assessed were detected in the sample from deep well MW-2D in either 2018 or 2020. Measured contaminants were last detected in well MW-2D in 2013. BTEX concentrations decreased substantially in MW-2D following the interim action (Table A6).

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

Well MW-3S is located on the southeast side of the treatment wall and about 20 feet southeast of well MW-2S. In terms of groundwater flow, MW-3S is downgradient of the treatment wall and MW-2S. MW-3S is completed about 5 feet below ground surface.

Although BTEX and TPH-G concentrations in MW-3S decrease significantly after passing through the treatment barrier, concentrations of benzene, xylenes, and TPH-G continued to exceed the CAP cleanup levels (Ecology, 2002) in both 2018 and 2020 (Tables 3 and 4).

In December 1996, BTEX concentrations in well MW-3S (Figure A3) were similar to those detected in well MW-2S. In February 2005, 6 months after the treatment wall was installed, concentrations in MW-3S had decreased up to 99%. Concentrations then steadily increased, before leveling off in 2011.

Well PMW-4 is located downgradient of the north end of the treatment wall. This well is completed about 10 feet below ground surface. During 2018 and 2020, petroleum contaminants continued to exceed the cleanup levels established for this site (Tables 3 and 4), although concentrations of all measured contaminants decreased from 2017 to 2020. Since monitoring began in 2005, BTEX concentrations have generally decreased (Figure A4). However, TPH-G concentrations in PMW-4 have shown greater fluctuation and remain well above the established cleanup level.

Conclusions

Water quality results from the October 2018 and June 2020 groundwater sampling continue to confirm that the near-surface aquifer at Black Lake Grocery is contaminated with gasoline-range petroleum hydrocarbons both upgradient and downgradient of the treatment wall. Contaminant concentrations have decreased since excavation and removal of contaminated soils in 1995 and installation of the treatment wall in 2004. However, in 4 of the 5 monitoring wells sampled in 2018 and 2020, groundwater contaminant concentrations continue to exceed (not meet) the cleanup levels established for this site.

Starting in 2015, contaminant concentrations began to show pronounced seasonal variation that appears to coincide with changes in groundwater levels. During the fall, when water levels are low, TPH-G and BTEX concentrations in groundwater are relatively low. In the spring and summer, when water levels are higher, contaminant concentrations are relatively high. This apparent trend continued through the 2018 and 2020 sampling events (Figures A1-A4).

According to the CAP (Ecology, 2002), treatment of the remaining contaminated soils and groundwater was expected to occur through natural attenuation as well as water flow through the treatment wall installed along the lake shoreline.

Comparison of data from well MW-2S to wells MW-3S and PMW-4 shows that contaminant concentrations decrease by at least an order of magnitude on the downgradient side of the treatment wall. Yet, contaminant concentrations in MW-3S and PMW-4 still consistently exceed (not meet) the established cleanup levels for this site. The material within the treatment wall has a limited capacity to adsorb and react with contaminants. An increase in contaminant

concentrations in MW-3S and PMW-4 could indicate that the material within the treatment wall is no longer effectively treating groundwater.

BTEX and TPH-G were not detected in near-shore sediment or water samples collected by Ecology (Coots, 2005). However, continued presence of petroleum contamination in wells MW-3S and PMW-4, which are less than 10 feet from the lakeshore**,** suggests the contaminant plume may extend to Black Lake.

Recommendations

Based on the June 2018 and 2020 monitoring results, the following recommendations are provided:

- Because contaminant concentrations still exceed (do not meet) established cleanup levels, groundwater monitoring at the Black Lake Grocery site should continue on an annual to bi-annual basis as recommended in the Compliance Monitoring Plan (Summit, 2004). Continued monitoring will also provide information on the continued effectiveness of the treatment wall. A rise in contaminant concentrations downgradient of the treatment wall may indicate that the sorptive or reactive capacity of the treatment material has been exhausted.
- Summit (2005) estimated that contaminant concentrations would meet cleanup levels through natural attenuation by 2030. Another assessment of natural attenuation potential is warranted, since contaminant concentrations continue to exceed cleanup limits. Analysis of conventional parameters at the Black Lake Grocery site, similar to a previous Ecology study (Marti, 2013), will help determine if 2030 continues to be a realistic target date for when cleanup levels will be met.
- Consider options to better define the northern edge of the contaminant plume. The extent of the plume was first delineated in the RI/FS (Summit, 2000). However, the northern extent of the plume has not been confirmed since 1995. Options for delineating the northern extent of the plume include sampling shallow groundwater near the shore of Black Lake using a push-point sampler or installing one or more piezometers along the lake shore.

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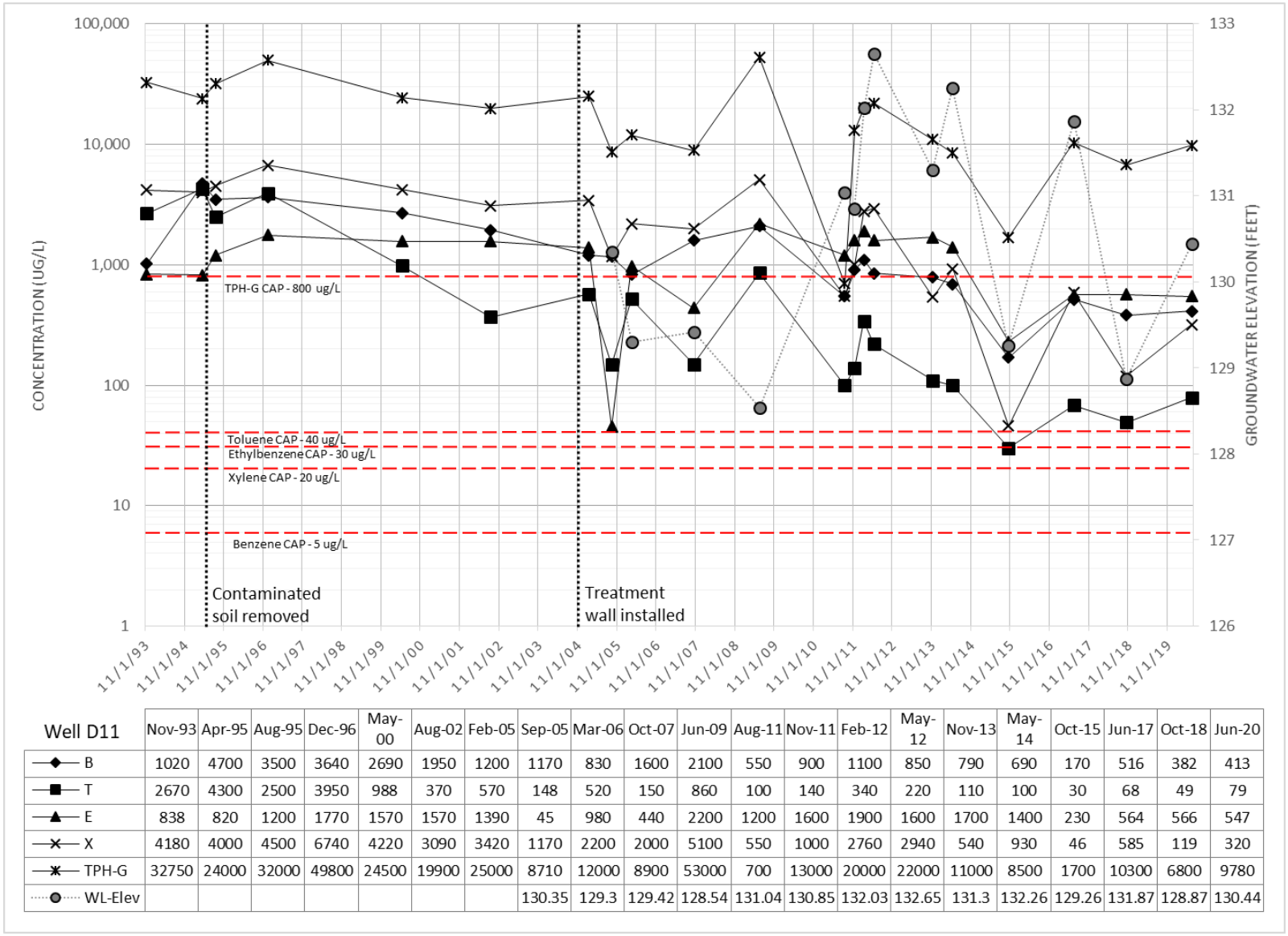
WAC 173-340-740. Unrestricted Land Use Soil Cleanup Standards. Washington State Department of Ecology, Olympia, WA.

Appendix. Sampling Results, 1993-2020.

This appendix presents sampling data from Black Lake Grocery monitoring wells from 1993 through 2020.

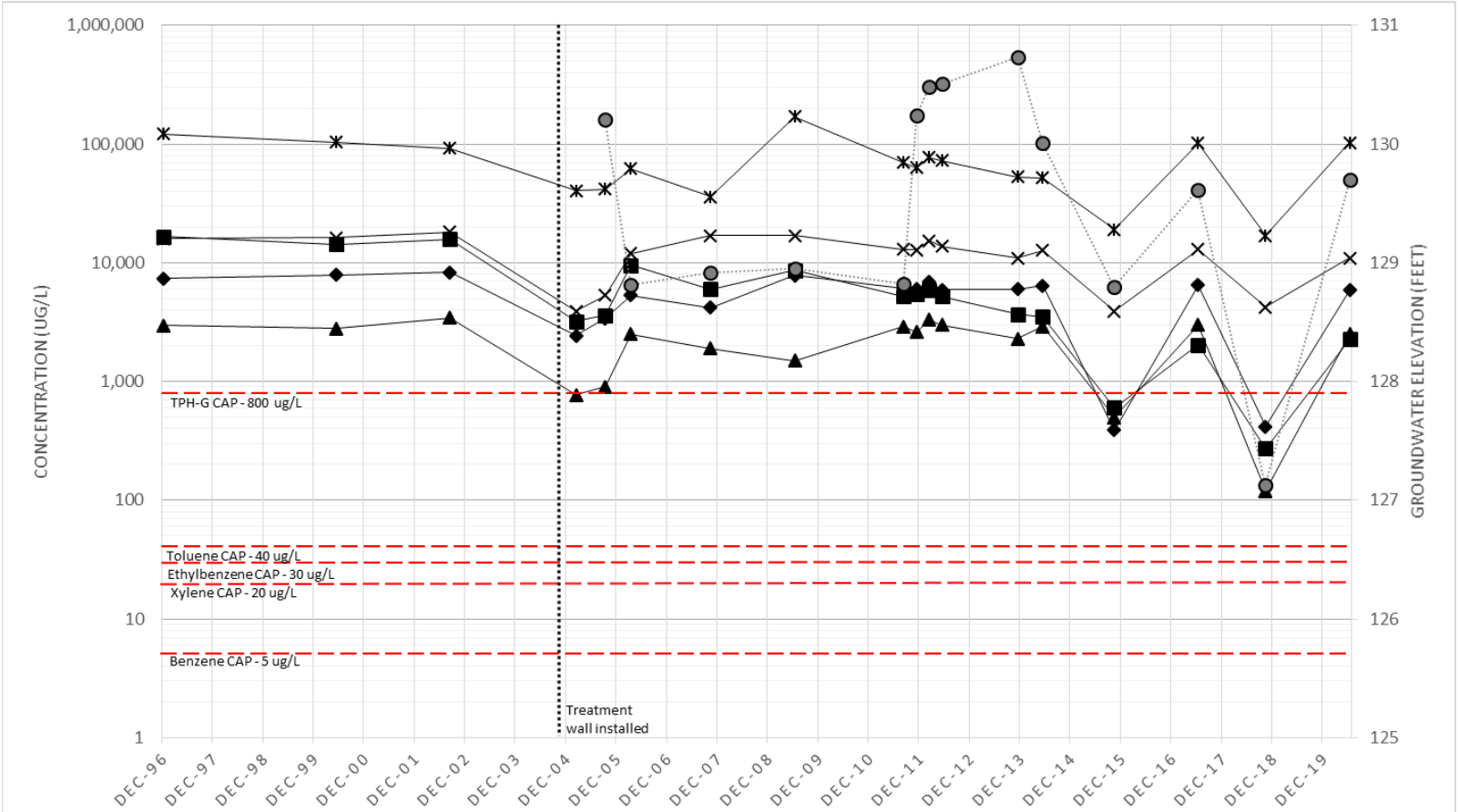
The following qualifiers, symbols, and abbreviations are used in the tables below:

- **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



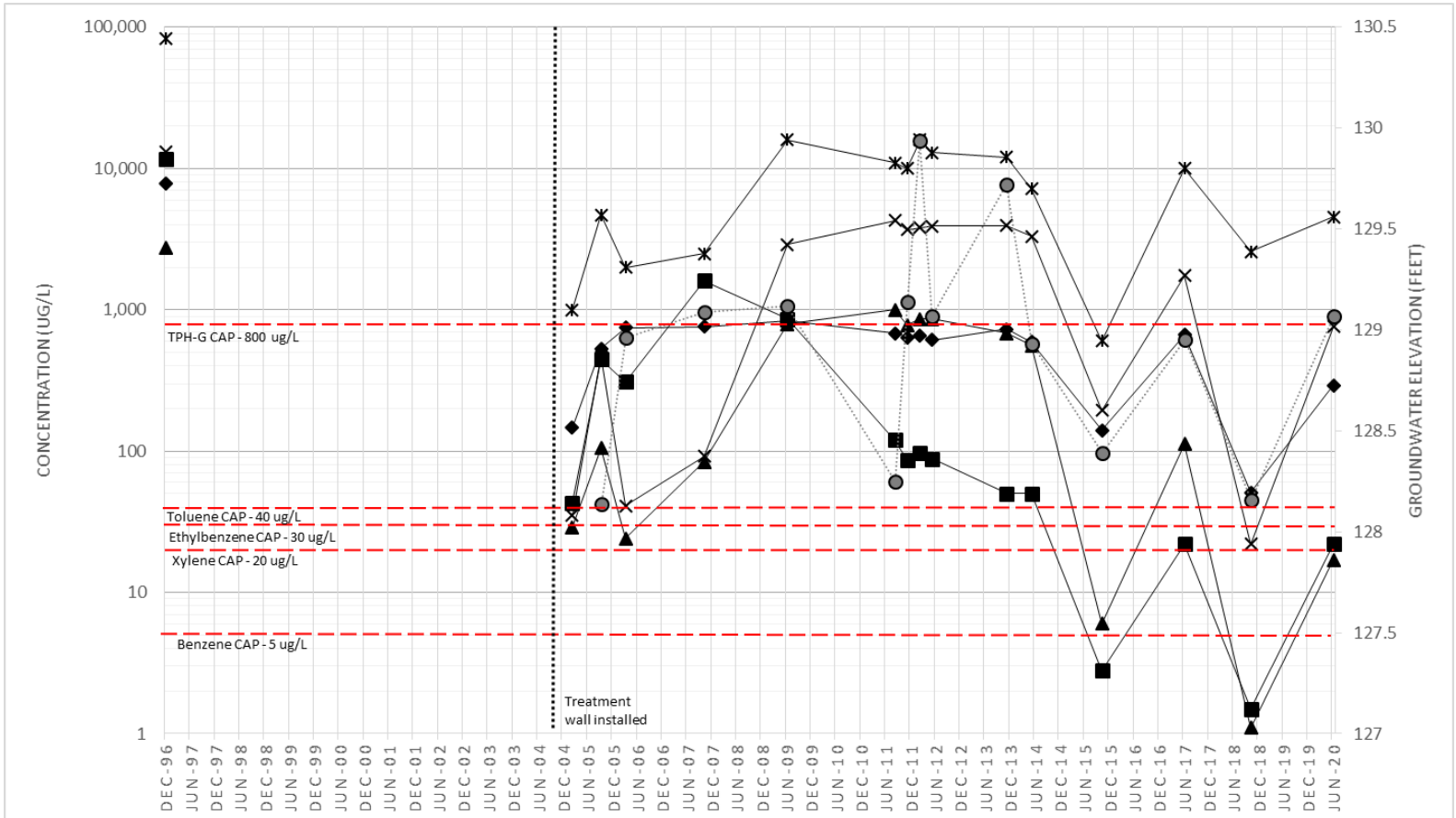
Well D11	Nov-93	Apr-95	Aug-95	Dec-96	May-00	Aug-02	Feb-05	Sep-05	Mar-06	Oct-07	Jun-09	Aug-11	Nov-11	Feb-12	May-12	Nov-13	May-14	Oct-15	Jun-17	Oct-18	Jun-20
B	1020	4700	3500	3640	2690	1950	1200	1170	830	1600	2100	550	900	1100	850	790	690	170	516	382	413
T	2670	4300	2500	3950	988	370	570	148	520	150	860	100	140	340	220	110	100	30	68	49	79
E	838	820	1200	1770	1570	1570	1390	45	980	440	2200	1200	1600	1900	1600	1700	1400	230	564	566	547
X	4180	4000	4500	6740	4220	3090	3420	1170	2200	2000	5100	550	1000	2760	2940	540	930	46	585	119	320
TPH-G	32750	24000	32000	49800	24500	19900	25000	8710	12000	8900	53000	700	13000	20000	22000	11000	8500	1700	10300	6800	9780
WL-Elev								130.35	129.3	129.42	128.54	131.04	130.85	132.03	132.65	131.3	132.26	129.26	131.87	128.87	130.44

Figure A1. BTEX and TPH-G Results (µg/L) for Well D11, November 1993 to June 2020.



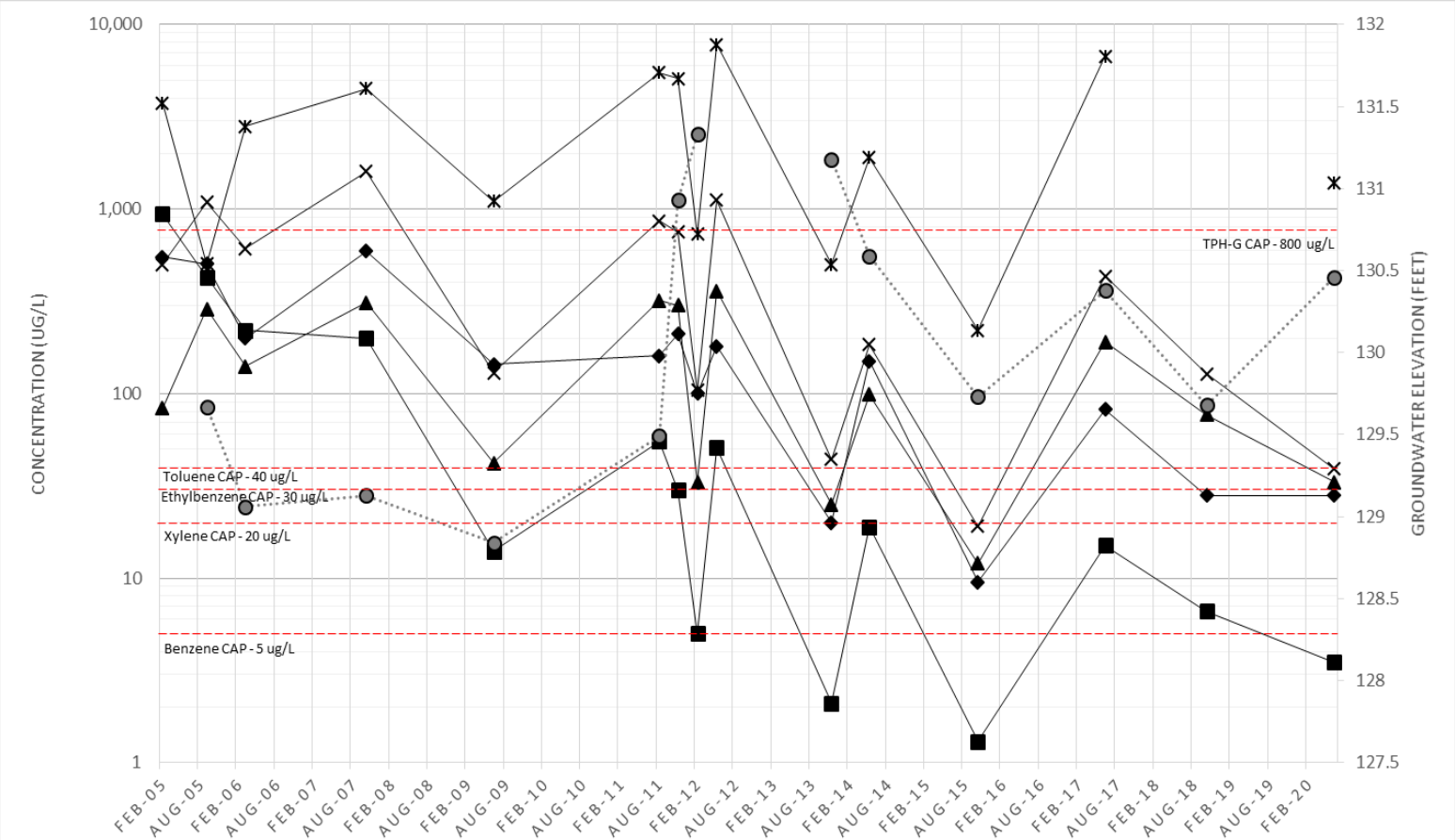
Well MW-2S	Dec-96	May-00	Aug-02	Feb-05	Sep-05	Mar-06	Oct-07	Jun-09	Aug-11	Nov-11	Feb-12	May-12	Nov-13	May-14	Oct-15	Jun-17	Oct-18	Jun-20
B	7360	7930	8270	2430	3420	5300	4200	7800	6100	6000	6900	5900	6000	6400	390	6480	416	5860
T	16600	14300	15800	3220	3600	9500	6000	8600	5200	5400	5900	5200	3700	3500	600	2040	271	2260
E	2960	2780	3450	771	904	2500	1900	1500	2900	2600	3300	3000	2300	2900	500	2980	120	2500
X	16000	16300	18100	3930	5300	12000	17000	17000	13000	12900	15400	13700	11000	12700	3900	12930	4220	10980
TPH-G	122000	104000	91800	40700	41900	62000	36000	170000	70000	63000	77000	73000	53000	52000	19000	102000	16900	103000
WL-Elev					130.21	128.81	128.92	128.95	128.82	130.24	130.48	130.51	130.73	130.01	128.8	129.61	127.13	129.7

Figure A2. BTEX and TPH-G Results (µg/L) for Well MW-2S, December 1996 to June 2020.



Well MW-3S	Dec-96	May-00	Aug-02	Feb-05	Sep-05	Mar-06	Oct-07	Jun-09	Aug-11	Nov-11	Feb-12	May-12	Nov-13	May-14	Oct-15	Jun-17	Oct-18	Jun-20
B	7860			147	532	750	760	840	680	640	660	610	730	590	140	667	51	293
T	11600			43	448	310	1600	860	120	87	97	88	50	50	2.8	22	1.5	22
E	2730			29	105	24	84	790	1000	780	860	860	680	560	6	112	1.1	17
X	13200			35	465	41	92	2900	4300	3700	3800	3900	3950	3310	195	1753	22	759
TPH-G	83600			1000	4700	2000	2500	16000	11000	10000	16000	13000	12000	7200	600	9980	2580	4530
WL-Elev					128.14	128.96	129.09	129.12	128.25	129.14	129.94	129.07	129.72	128.93	128.39	128.95	128.16	129.07

Figure A3. BTEX and TPH-G Results (µg/L) for Well MW-3S, December 1996 to June 2020.



Well PMW-4	Feb-05	Sep-05	Mar-06	Oct-07	Jun-09	Aug-11	Nov-11	Feb-12	May-12	Nov-13	May-14	Oct-15	Jun-17	Oct-18	Jun-20
B	550	503	200	590	144	160	210	100	180	20	150	9.5	82	28	28
T	940	428	220	200	14	55	30	5	51	2.1	19	1.3	15	6.6	3.5
E	83	287	140	310	42	320	300	33	360	25	99	12	191	77	33
X	500	1090	610	1600	130	860	750	104	1120	44	184	19.1	432	128	39
TPH-G	3750	503	2800	4500	1100	5500	5100	730	7800	500	1900	220	6720		1390
WL-Elev		129.67	129.06	129.13	128.84	129.49	130.93	131.33		131.18	130.59	129.73	130.38	129.68	130.46

Figure A4. BTEX and TPH-G Results (µg/L) for Well PMW-4, February 2005 to June 2020.

Table A1. Analytical results from 1993 to 2014 in 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**
May-00	--	--	--	--	--
Aug-02	--	--	--	--	--
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 in monitoring well D10.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Nov-93	**8450**	**8670**	**1450**	**5260**	**30,680**
Apr-95	--	--	--	--	--
Aug-95	--	--	--	--	--
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 1995 to 2014 in 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 A4. Analytical results from 2005 to 2014 in 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 A5. Analytical results from 2005 to 2014 in 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 A6. Analytical results from 1996 to 2020 in 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**
Mar-06	--	--	--	--	--
Oct-07	--	--	--	--	--
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
June-17	1 U	1 U	1 U	3 U	70 U
Oct-18	1 U	1 U	1 U	3 U	70 U
June-20	1 U	1 U	1 U	3 U	70 U
CAP CL	**5**	**40**	**30**	**20**	**800**

Table A7. Analytical results from 1996 to 2009 in monitoring well MW-3D.

Date	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH-G
Dec-96	**132**	**138**	**21**	**1440**	**11,600**
May-00	--	--	--	--	--
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**