A Department of Ecology Report

Black Lake Grocery Groundwater Monitoring Results, November 2013 and May 2014: Data Summary Report

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, soil and groundwater beneath the site were found to be contaminated with gasoline-range petroleum hydrocarbons. The source of the contamination was leaking underground storage tanks. These tanks were removed in June 1995, along with a large amount of contaminated soil. In 2004, a treatment wall was installed along Black Lake's shoreline to passively remediate contaminated groundwater flowing toward the lake.

Groundwater from on-site monitoring wells were sampled and analyzed for petroleum constituents from November 1993 to June 2009. The Washington State Department of Ecology (Ecology) resumed the sampling in 2011 to characterize the current groundwater contaminant concentrations. This report summarizes data from November 2013 and May 2014, when samples were collected from 11 monitoring wells and analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) and total petroleum hydrocarbons as gasoline (TPH-G).

Water quality results for the 2013-2014 monitoring continue to confirm that the near surface aquifer at Black Lake Grocery is contaminated in both the upper and lower portions of the site. Concentrations have decreased since 1995 but continue to exceed (not meet) established cleanup levels in several of the sampled wells. Although BTEX and TPH-G concentrations decreased significantly after passing through the treatment wall, the presence of high contaminant concentrations in wells on the downgradient side and near the shoreline suggests that petroleum constituents from the site may be migrating to Black Lake.

Because the sorptive and reactive capacity of treatment barriers is limited, groundwater monitoring downgradient of the treatment wall should continue to determine if the reactive materials in the wall remain effective in remediating the contaminated groundwater.

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Ecology's Activity Tracker Code for this study is 12-001.

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- WRIA: 23
- HUC number: 17100103

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This report was prepared by 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 approximately 100 feet from the lakeshore. In 1989, during a geotechnical study performed for Thurston County as part of a planned expansion of Black Lake Boulevard, soil and groundwater beneath the site were found to be contaminated with gasoline-range petroleum hydrocarbons (Dames and Moore, 1990).

In June and July 1995, at the time of the Black Lake Boulevard expansion, seven underground storage tanks and 1200 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 to the property boundaries at Goldsby Road and Black Lake Boulevard (Figure 1). The depth of the excavation ranged from approximately 10 to 13 feet below ground surface. Soils from the edge of the excavated area were still found to exceed (not meet) the Model Toxics Control Act Method-A cleanup levels for benzene, toluene, ethylbenzene, and xylenes (BTEX) and total petroleum hydrocarbons (TPH). The contaminated soil beyond the excavated area could not be removed because it was not accessible below the adjacent county roads (Summit, 2000).

A remedial investigation/feasibility study was completed in 2001. The contaminant plume was defined as extending from the site's tank area downgradient to Black Lake. To remediate the remaining groundwater contamination, the selected remedial alternative was installation of a treatment wall at the downgradient end of the contaminant plume, along the shore of Black Lake. The treatment wall was intended to passively remediate the contaminated groundwater flowing toward the lake. Constructed in November 2004, it is approximately 120 feet long, 5 feet wide, 12 feet deep, and composed of a permeable reactive material (an engineered sphagnum peat moss) that is designed to both absorb petroleum hydrocarbons and provide a catalytic surface on which microbial activity can occur. Natural attenuation mechanisms are relied upon to mitigate the groundwater plume upgradient of the wall. Site cleanup will be achieved when contaminant concentrations throughout the site (point of compliance) have met the established cleanup levels.

Groundwater at the site was sampled and analyzed for petroleum constituents between November 1993 and June 2009. Overall, concentrations decreased after the excavation and removal of contaminated soils and installation of the treatment wall. However, concentrations still exceeded the Model Toxics Control Act (MTCA) cleanup levels in several of the sampled wells. In August 2011, Ecology resumed groundwater sampling because of the continued elevated concentrations of petroleum constituents (Marti, 2013). This data report discusses groundwater results from the on-site wells in November 2013 and May 2014.

The data and associated annual 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.

Results

Ecology collected groundwater samples from 11 monitoring wells in November 2013 and May 2014. All wells were sampled in accordance with Ecology's SOP EAP078 (Marti, 2014).

Samples were submitted for analysis of BTEX and TPH to determine current petroleum contaminant concentrations. Analytical results are summarized in Tables 1 and 2.

Blind field duplicates were collected from well PMW-4 in November and May. The relative percent difference (RPD) for the BTEX and TPH-G duplicate results ranged from 0% to 7% as shown in Table 1.

Table 1. Relative Percent Difference (RPD) of Duplicate Sample Results (ug/L), November 2013 and May 2014.

Sample ID:	RPD Target	PMW-4	PMW-4A	RPD (%)	PMW -4	PMW-4A	RPD (%)
		November 2013			May 2014		
Benzene	30%	20	21	5	150	150	0
Toluene	30%	2.1	2.2	5	19	20	5
Ethylbenzene	30%	25	26	4	99	100	1
m,p-Xylene	30%	31	33	6	140	140	0
o-Xylene	30%	13	14	7	44	45	2
TPH-G	40%	500	510	2	1900	1900	0

PMW-4A: The replicate sample identification.

The BTEX and TPH-G duplicate data from well PMW-4 met the measurement quality objectives established in the Quality Assurance Project Plan (Marti, 2011). The laboratory data quality control and quality assurance results indicate that the analytical performance was good and that the results are usable as qualified.

High concentrations of petroleum contaminants in wells D11 and MW-3S caused the practical quantitation limits for the BTEX analysis to increase, resulting in some analytes not being detected.

The November 2013 analytical data for well D10 have been rejected. The data for this monitoring period were considerably lower than previous data collected from this well. The low results are attributed to an insufficient volume of water while sampling this well. Because of this, the data are considered to be unrepresentative of the true site conditions.

Analytical results for BTEX and TPH-G are summarized in Table 2 and are compared to both the site's Cleanup Action Plan (CAP) cleanup levels and the MTCA Method A cleanup levels. For ease of discussion, project results have been grouped by the monitoring wells location within different areas of the contaminant plume.

Table 2. Sampling Results for Black Lake Grocery, November 2013 and May 2014.

Well ID	Sample Date	Well Depth (TOC)	Ground Water Elevation (feet msl)	Field Measurements: pH (Std. Units)	Conductivity (uS/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Laboratory Analysis: Benzene	Toluene	Ethyl benzene	m,p-Xylene	o-Xylene	TPH-G
								CAP: 5 ug/L	40 ug/L	30 ug/L	20 ug/L		1000 ug/L
								MTCA: 5 ug/L	1000 ug/L	700 ug/L	1000 ug/L		800 ug/L (1000*)
Upper portion of the plume													
D10	11/13	11.4	131.56	6.9	694	0.5	-11	REJ	REJ	REJ	REJ	REJ	REJ
	5/14		--	--	--	--	--	--	--	--	--	--	--
D11	11/13	13.92	131.30	6.4	558	0.2	-51	**790**	**110**	**1700**	**540**	100 U	**11,000**
	5/14		132.26	6.8	565	0.2	-53	**690**	**100**	**1400**	**930**	100 U	**8500**
D12	11/13	9.06	135.28	6.0	135	5.2	226	1 U	1 U	1 U	2 U	1 U	70 U
	5/14		135.18	6.4	117	7.4	215	1 U	1 U	1 U	2 U	1 U	70 U
Shallow and deep groundwater immediately upgradient of the treatment wall													
D9	11/13	15.05	130.76	6.0	280	0.4	108	1 U	1 U	1 U	2 U	1 U	70 U
	5/14		129.95	5.4	259	0.5	111	1 U	1 U	1 U	2 U	1 U	70 U
MW-2S	11/13	7.07	130.73	6.3	587	0.3	31	**6000**	**3700**	**2300**	**7600**	**3400**	**53,000**
	5/14		130.01	5.9	624	0.3	28	**6400**	**3500**	**2900**	**9000**	**3700**	**52,000**
MW-2D	11/13	17.12	131.90	6.8	351	0.9	53	**36**	1 U	1 U	2 U	1 U	70 U
	5/14		131.10	6.0	309	0.4	44	1 U	1 U	1 U	2 U	1 U	70 U
Groundwater within the treatment wall													
PMW-1	11/13	11.47	129.46	5.5	261	0.2	-96	**1.6**	**1.1**	**1.1**	**7**	**1.9**	70 U
	5/14		128.97	5.0	278	0.6	-38	**3.6**	**1.1**	**1.8**	**12**	**3.9**	70 U
Shallow and deep groundwater immediately downgradient of the treatment wall													
PMW-3	11/13	12.15	130.80	6.0	419	0.4	-65	1 U	1 U	1 U	2 U	1 U	70 U
	5/14		129.77	5.4	358	0.3	-59	1 U	1 U	1 U	2 U	1 U	70 U
PMW-4	11/13	10.42	131.18	6.3	274	0.1	-68	**20**	**2.1**	**25**	**31**	**13**	**500**
	5/14		130.59	5.9	572	0.1	-115	**150**	**19**	**99**	**140**	**44**	**1900**
MW-3S	11/13	5.80	129.72	5.8	725	0.3	-64	**730**	100 U	**680**	**3000**	**950**	**12,000**
	5/14		128.93	5.6	746	0.3	-44	**590**	100 U	**560**	**2500**	**810**	**7200**
MW-3D	11/13	13.37	129.05	6.9	313	0.4	48	1 U	1 U	1 U	2 U	1 U	70 U
	5/14		129.02	6.2	311	0.5	66	1 U	1 U	1 U	2 U	1 U	70 U

CAP: Cleanup Action Plan.
MTCA: MTCA Method A Cleanup Level.
Bold: Analyte was detected.
Shade: Values are greater than the CAP cleanup levels.
REJ: Analytical results are considered unrepresentative of site conditions and have therefore been rejected.
U: Analyte was not detected at or above the reported value.

Upper Portion of the Plume – Wells D10, D11, D12

Well D11, located in the upper portion of the project area, continues to have BTEX and TPH-G concentrations that exceed the CAP and MTCA Method A cleanup levels (Table 2). This well is located on the northern edge of the excavated area. Concentrations have decreased since 1995 (Figure 2), such as benzene with up to an 80% reduction. However, this well still has some of the highest BTEX and TPH-G concentrations in the project area.

Although the November 2013 data for well D10 have been rejected, this well typically has some of the highest contaminant concentrations. Well D10 is located in the portion of the plume that was beyond the area of contaminated soil removal. Contaminant concentrations showed a significant decrease in this well beginning in 2005 (Figure 3).

Even though petroleum hydrocarbon concentrations in wells D10 and D11 remain high, decreasing concentrations – in conjunction with continued low dissolved oxygen (DO) and oxidation reduction potential (ORP) – indicate that biodegradation is occurring in this portion of the site through anaerobic or reducing conditions. In general, concentrations of DO less than 0.5 mg/L and ORP levels less than 0 millivolts are desired to stimulate anaerobic degradation processes. Low nitrate and sulfate concentrations detected in these wells in 2011-2012 also provide evidence of biodegradation (Marti, 2013).

Well D12, which is located within the excavated and backfilled area, continues to have no detectable concentrations of BTEX or TPH-G (Tables 2 and 3). DO measurements in this well indicate aerobic conditions in this portion of the site.

Shallow and Deep Groundwater Upgradient of the Treatment Wall – Wells D9, MW-2S, MW-2D

Well MW-2S had the highest concentrations of petroleum-related contaminants of all the sampled wells. BTEX and TPH-G concentrations exceeded both the CAP and MTCA cleanup levels during both sample rounds (Table 2). Well MW-2S is located at the base of the bluff, about 100 feet downgradient of the former tank area, and is approximately 5 feet below ground surface. BTEX concentrations in well MW-2S had an initial decrease soon after the treatment wall was installed (Figure 4). However, concentrations quickly rebounded. Benzene concentrations in this well continue to be high and fairly stable, decreasing about 15% since monitoring began in 1996.

In contrast, only benzene was detected in the November 2013 sample from deep well MW-2D. BTEX concentrations have decreased substantially in well MW-2D since samples were first collected in 1996 (Table 3). This well, approximately 15 feet below ground surface, is part of a well cluster immediately upgradient of the treatment wall. For this monitoring period, the average benzene concentration in shallow well MW-2S was 6200 ug/L, decreasing to 36 ug/L in well MW-2D. Benzene is the only contaminant that has been detected in this well since June 2009.

BTEX and TPH-G were not detected in well D9 (Table 2). This well is located at the southern end of the treatment wall. Petroleum compounds were last detected in well D9 in 2005 (Table 3).

Overall, DO measurements in these three wells were below 0.5 mg/L, suggesting biodegradation through anaerobic conditions in this portion of the site.

Groundwater within the Treatment Wall – Well PMW-1

Well PMW-1 is located within the treatment wall. BTEX and TPH-G continue to be detected in this well but at concentrations below both the CAP and MTCA cleanup levels (Tables 2 and 3).

Shallow and Deep Groundwater Downgradient of the Treatment Wall – Wells PMW-3, PMW-4, MW-3S, MW-3D

Of the four wells (MW-3S, MW-3D, PMW-3, PMW-4) sampled downgradient of the treatment wall, elevated concentrations of petroleum-related contaminants were detected in monitoring wells MW-3S and PMW-4.

Well MW-3S is also a paired shallow well located on the downgradient side of the treatment wall, about 20 feet southeast of well MW-2S. Although BTEX and TPH-G concentrations decreased significantly after passing through the treatment barrier, concentrations still far exceed the established cleanup levels for this well (Table 2). In December 1996, BTEX concentrations in well MW-3S were similar to those detected in well MW-2S (Figure 5). In February 2005, six months after the treatment wall was installed, concentrations in this well had decreased up to 99%. Concentrations then steadily increased, before leveling off in 2011 to concentrations similar to those detected during this 2013-2014 monitoring period.

Well MW-3D is a deeper well (approximately 14 feet) paired with well MW-3S. For this monitoring period, the average benzene concentration in shallow well MW-3S was 660 ug/L, decreasing to below the detection limit of 1 ug/L in well MW-3D (Table 2). Petroleum compounds were last detected in well MW-3D in 2009 (Table 3).

Well PMW-4 is located downgradient of the north end of the treatment wall. Petroleum contaminants continue to exceed the cleanup levels established for this site (Table 2). But overall, concentrations have been steadily decreasing since monitoring began in 2005 (Figure 6).

BTEX and TPH-G were not detected in PMW-3 (Tables 2 and 3).

Contaminant concentrations remain elevated downgradient of the source area in wells D10, D11, MW2S, MW-3S, and PMW-4. Estimated benzene concentration contours in the shallow groundwater for the 2013-2014 monitoring period are shown in Figure 1.

Conclusions

Water quality results from the 2013-2014 monitoring continue to confirm that the near surface aquifer at Black Lake Grocery is contaminated with gasoline-range petroleum hydrocarbons in both the upper and lower portions of the site. Concentrations have decreased since excavation and removal of contaminated soils in 1995 and installation of the treatment wall in 2004. However, groundwater contaminant concentrations continue to exceed (not meet) the cleanup levels established for this site in several of the site's monitoring wells.

According to the Cleanup Action Plan (CAP), treatment of the remaining contaminated soils and groundwater was expected to occur through natural attenuation and the passive treatment barrier installed along the lake shoreline.

During the remediation design, it was predicted that concentrations of the petroleum contaminants would decrease naturally with time due to removal of most of the source material and natural biodegradation processes. Conventional parameters were measured in 2011-2012 to evaluate natural attenuation properties of the site. The site was characterized by low dissolved oxygen, oxidation reduction potential, nitrate and sulfate, with elevated concentrations of iron (Marti, 2013). Under these conditions, the petroleum hydrocarbons should be subject to a variety of biodegradation processes such as iron or sulfate reduction. Project data seem to indicate that biodegradation of the contaminants is occurring. The effects of biodegradation were expected to be most noticeable at the limits of the excavated area and proceed downgradient over time. BTEX concentrations in well D9 decreased substantially between 1993 and 1996, and have not been detected in this well since 2005. Benzene concentrations have also decreased, most notably in wells D11 and D10. It was estimated that contaminant concentrations would be below cleanup levels within 10-25 years (Summit, 2005).

The second part of the remediation is the treatment wall that was installed in fall of 2004 to act as a passive barrier that remediates the contaminated groundwater as it flows toward Black Lake. Data from wells PMW-4 and MW-3S confirm that contaminant concentrations decrease on the downgradient side of the treatment wall; however, concentrations in these wells still consistently exceed the established cleanup levels for this site. Because the sorptive and reactive capacity of treatment barriers is limited, contaminant concentrations in these two wells should continue to be monitored. If concentrations begin to increase, it could indicate that the treatment wall is losing its sorptive or reactive capacity.

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

Recommendations

Based on the results of the 2013-2014 monitoring, the following recommendations are provided:

- Groundwater monitoring downgradient of the treatment wall should continue annually as recommended in the Compliance Monitoring Plan (Summit, 2004) to determine if the contaminant

removal capability of the reactive materials remains effective in remediating the contaminated groundwater. If the treatment wall materials are no longer effective, they may need to be replaced.

- Using the data collected in 2011-2012 the natural attenuation properties of the Black Lake Grocery site should be evaluated to determine if site cleanup levels will be reached in a timely manner. It was estimated that contaminant concentrations would be below cleanup levels within 10-25 years (Summit, 2005).
- In the 2005 Ecology study, BTEX and TPH-G were not detected in the near-shore sediment and surface water samples (Coots, 2005). In order to capture and monitor groundwater as it discharges to the lake, consider installation of shallow in-water, near-shore piezometers which could provide more accurate data to determine if groundwater contaminants from the site are reaching Black Lake.

References

Coots, R., 2005. Investigation of Petroleum Products in Black Lake Sediment and Surface Water Adjacent to an Underground Storage Tank Site. Washington State Department of Ecology, Olympia, WA. Publication No. 05-03-030.
https://fortress.wa.gov/ecy/publications/SummaryPages/0503030.html

Dames and Moore, 1990. Addendum Report of Geotechnical Services, Black Lake Boulevard Expansion for Thurston County Department of Public Works, Thurston County, Washington, Job No. 8538-003-016. Prepared by Dames and Moore, Seattle, WA.

Marti, P., 2011. Quality Assurance Project Plan: Black Lake Grocery Groundwater Confirmational Monitoring. Washington State Department of Ecology, Olympia, WA. Publication No. 11-03-114.
https://fortress.wa.gov/ecy/publications/SummaryPages/1103114.html

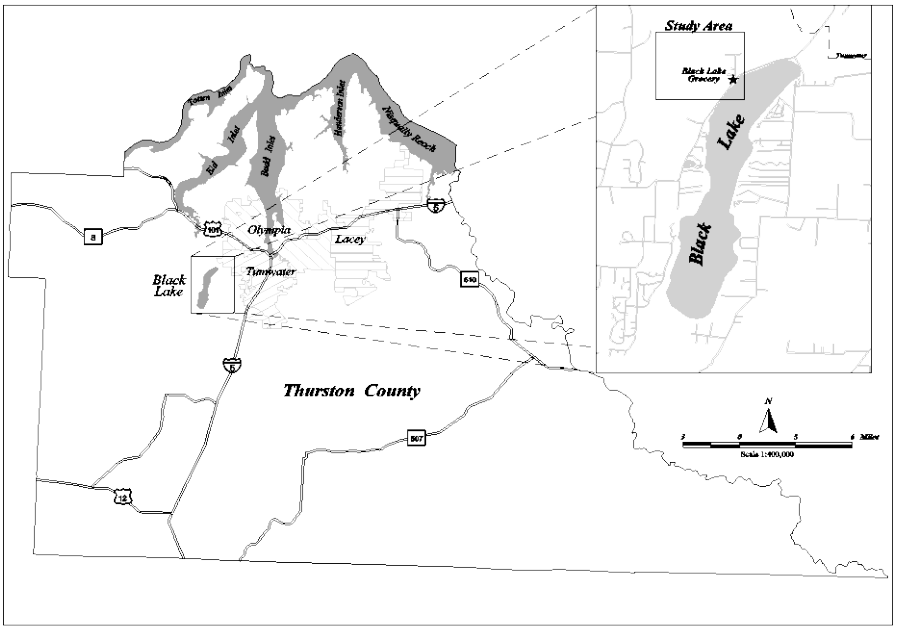
Marti, P., 2013. Black Lake Grocery Groundwater Confirmational Monitoring, August 2011 to May 2012. Washington State Department of Ecology, Olympia, WA. Publication No. 13-03-008.
https://fortress.wa.gov/ecy/publications/SummaryPages/1303008.html

Marti, P., 2014. Standard operating procedure for purging and sampling monitoring wells plus guidance on collecting samples for volatiles and other organic compounds. Washington State Department of Ecology, Environmental Assessment Program, SOP EAP078, Version 2.0.
www.ecy.wa.gov/programs/eap/quality.html

Summit, 2000. Final Remedial Investigation and Feasibility Study, Black Lake Grocery, Olympia, Washington. Prepared by Summit Envirosolutions, Inc. for Man K. Pak. August, 2000.

Summit, 2004. Compliance Monitoring Report, Black Lake Grocery, Olympia, Washington. Project Number 0551-002. Prepared by Summit Envirosolutions, Inc. for Man K. Pak. July 2004.

Summit, 2005. Engineering Design Report, Black Lake Grocery, Olympia, Washington. Project Number 0551-002. Prepared by Summit Envirosolutions, Inc. for Man K. Pak. March 2005.



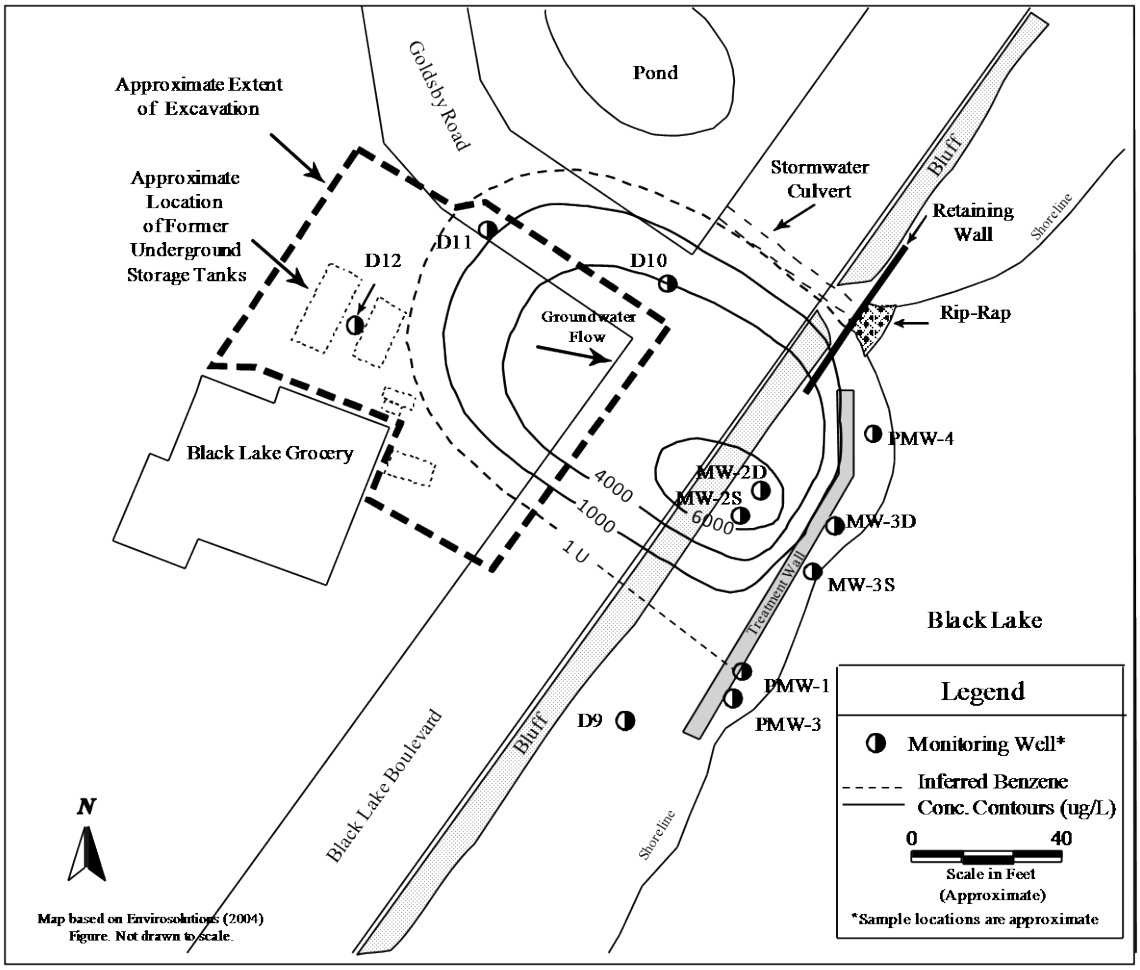
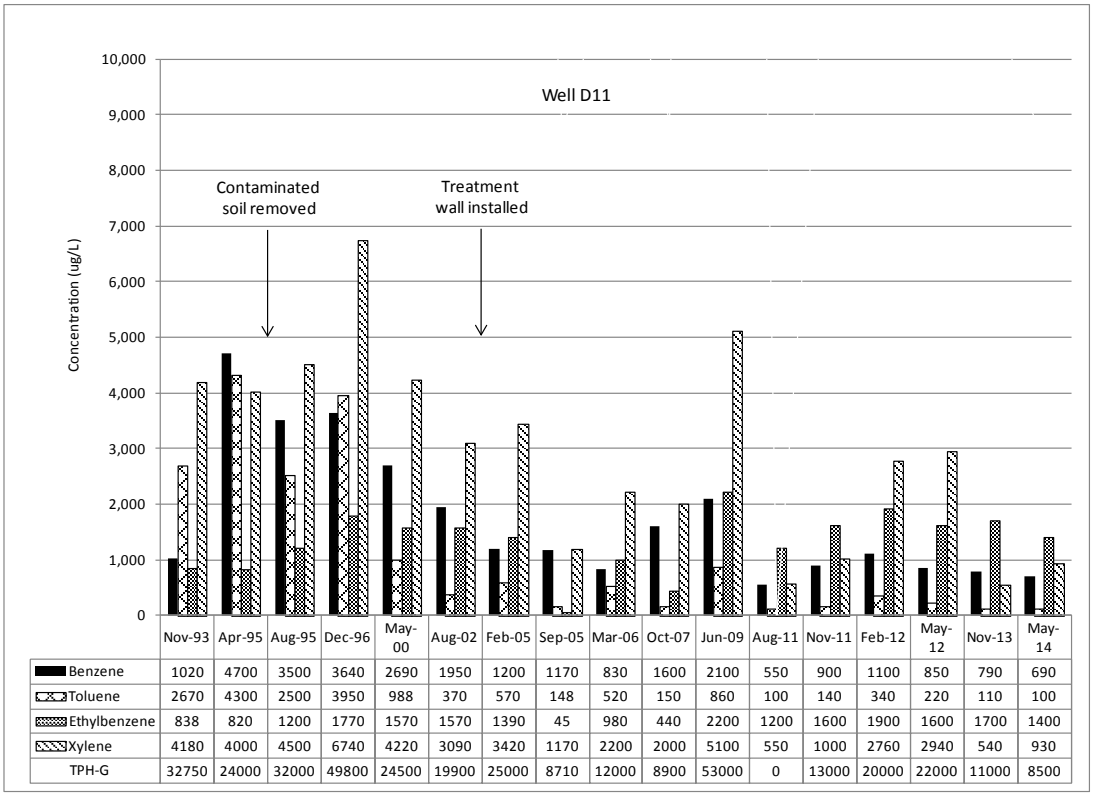
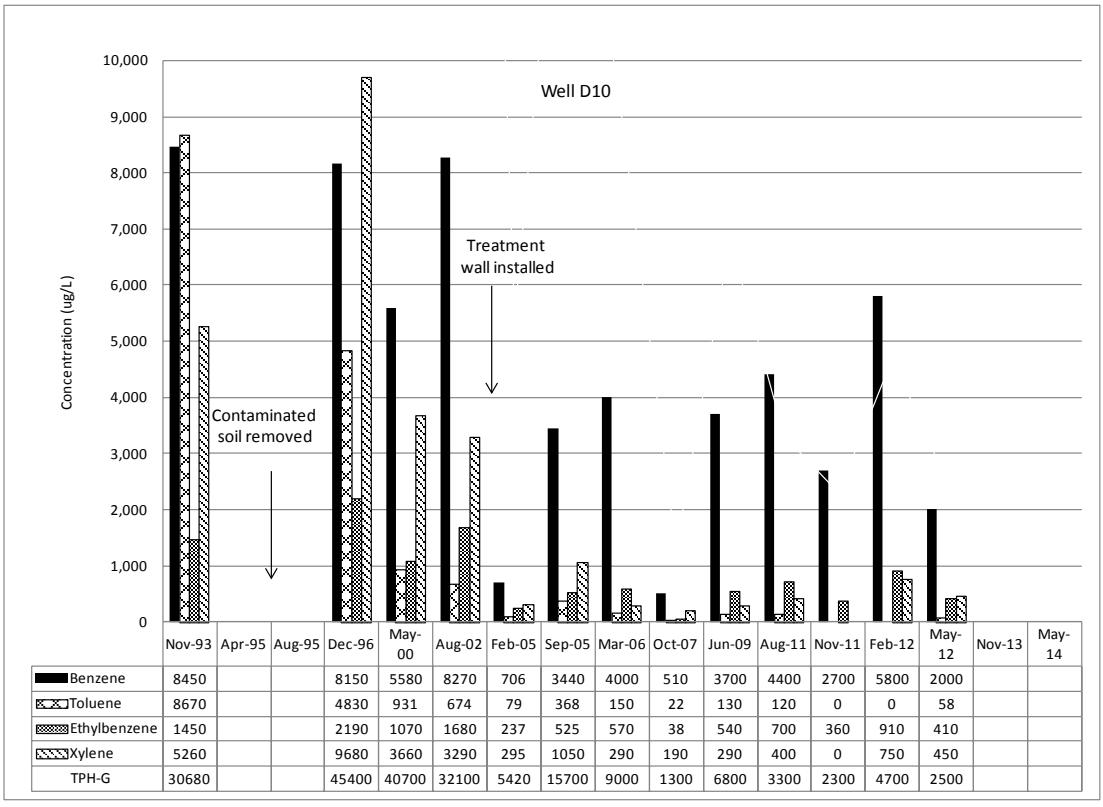


Figure 1. Black Lake Grocery Location and Site Details.



	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
Benzene	1020	4700	3500	3640	2690	1950	1200	1170	830	1600	2100	550	900	1100	850	790	690
Toluene	2670	4300	2500	3950	988	370	570	148	520	150	860	100	140	340	220	110	100
Ethylbenzene	838	820	1200	1770	1570	1570	1390	45	980	440	2200	1200	1600	1900	1600	1700	1400
Xylene	4180	4000	4500	6740	4220	3090	3420	1170	2200	2000	5100	550	1000	2760	2940	540	930
TPH-G	32750	24000	32000	49800	24500	19900	25000	8710	12000	8900	53000	0	13000	20000	22000	11000	8500

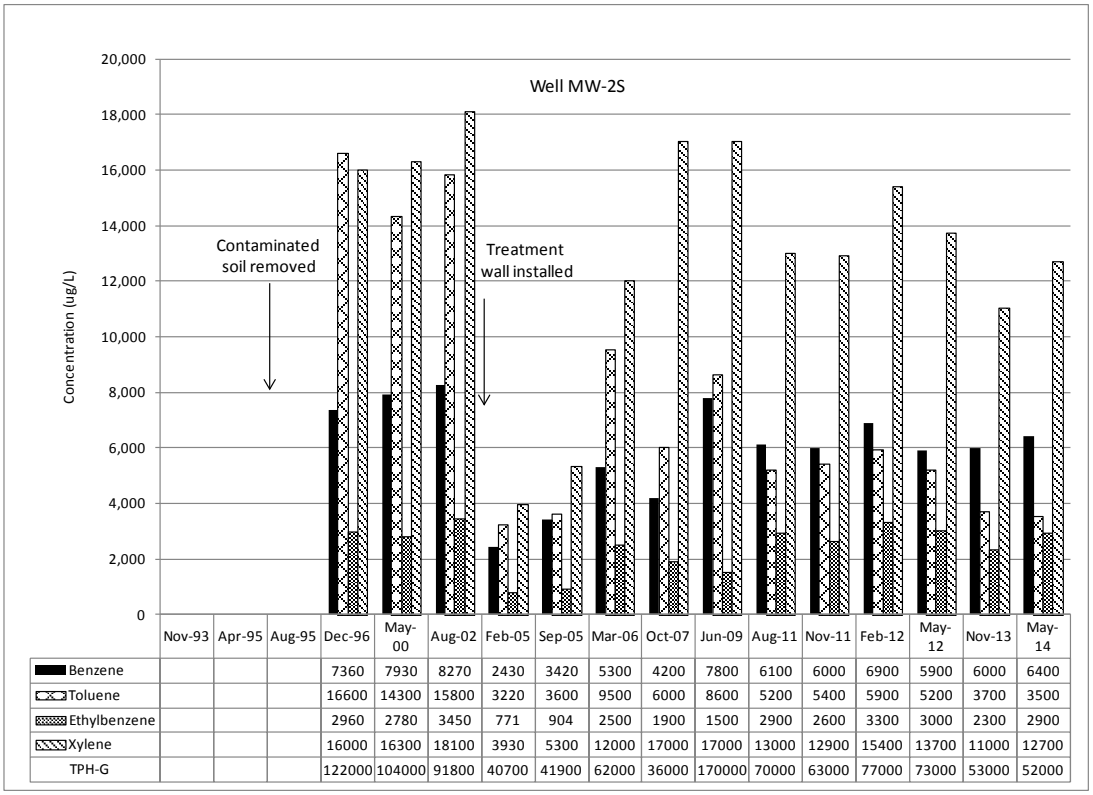
Figure 2. BTEX and TPH-G Results (ug/L) for Well D11, November 1993 to May 2014.



	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
Benzene	8450			8150	5580	8270	706	3440	4000	510	3700	4400	2700	5800	2000		
Toluene	8670			4830	931	674	79	368	150	22	130	120	0	0	58		
Ethylbenzene	1450			2190	1070	1680	237	525	570	38	540	700	360	910	410		
Xylene	5260			9680	3660	3290	295	1050	290	190	290	400	0	750	450		
TPH-G	30680			45400	40700	32100	5420	15700	9000	1300	6800	3300	2300	4700	2500		

0: Analyte was not detected at or above the laboratory reporting value. Blank: not sampled.

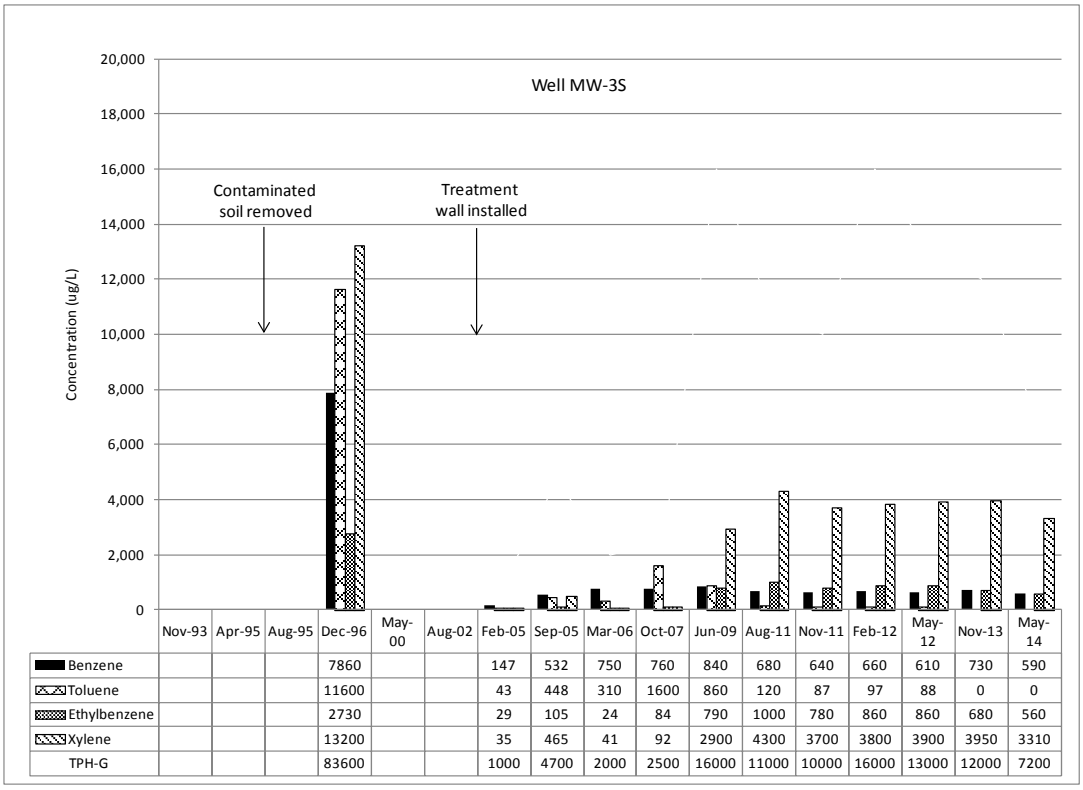
Figure 3. BTEX and TPH-G Results (ug/L) for Well D10, November 1993 to May 2014.



	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
Benzene				7360	7930	8270	2430	3420	5300	4200	7800	6100	6000	6900	5900	6000	6400
Toluene				16600	14300	15800	3220	3600	9500	6000	8600	5200	5400	5900	5200	3700	3500
Ethylbenzene				2960	2780	3450	771	904	2500	1900	1500	2900	2600	3300	3000	2300	2900
Xylene				16000	16300	18100	3930	5300	12000	17000	17000	13000	12900	15400	13700	11000	12700
TPH-G				122000	104000	91800	40700	41900	62000	36000	170000	70000	63000	77000	73000	53000	52000

Blank: not sampled, well installed in December 1996.

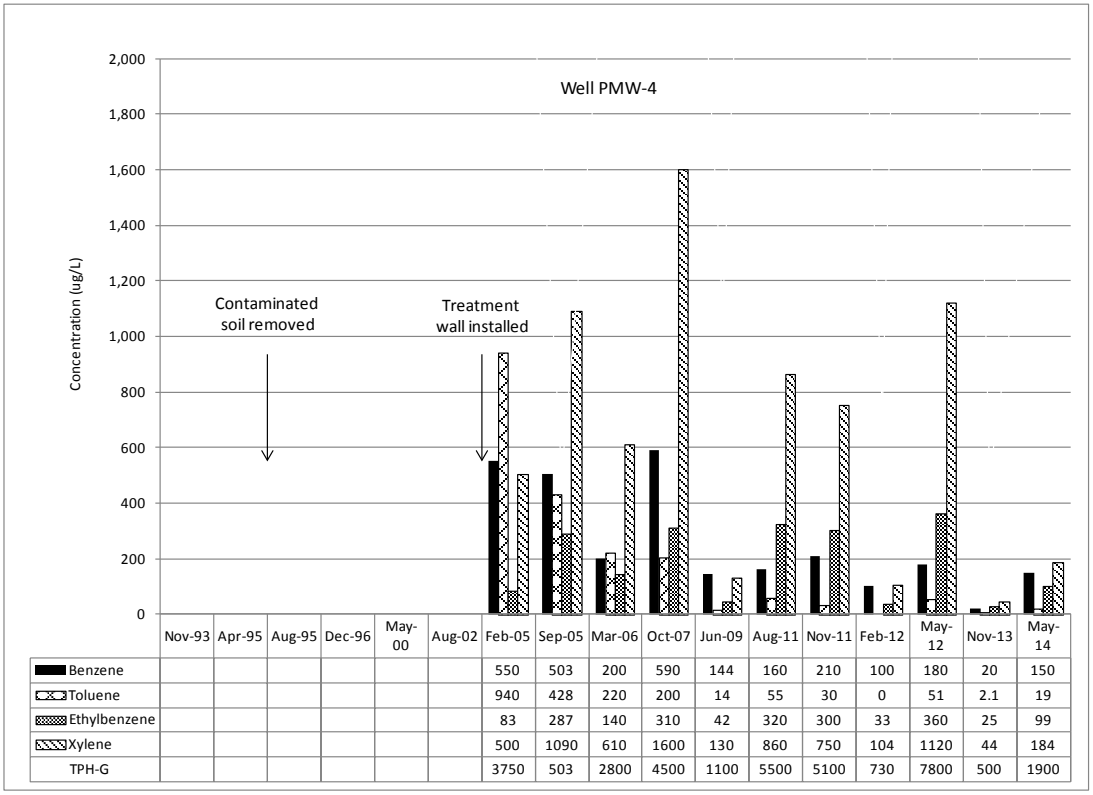
Figure 4. BTEX and TPH-G Results (ug/L) for Well MW-2S, November 1993 to May 2014.



	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
Benzene				7860			147	532	750	760	840	680	640	660	610	730	590
Toluene				11600			43	448	310	1600	860	120	87	97	88	0	0
Ethylbenzene				2730			29	105	24	84	790	1000	780	860	860	680	560
Xylene				13200			35	465	41	92	2900	4300	3700	3800	3900	3950	3310
TPH-G				83600			1000	4700	2000	2500	16000	11000	10000	16000	13000	12000	7200

0: Analyte was not detected at or above the laboratory reporting value. Blank: not sampled, well installed in December 1996.

Figure 5. BTEX and TPH-G Results (ug/L) for Well MW-3S, November 1993 to May 2014.



	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
Benzene							550	503	200	590	144	160	210	100	180	20	150
Toluene							940	428	220	200	14	55	30	0	51	2.1	19
Ethylbenzene							83	287	140	310	42	320	300	33	360	25	99
Xylene							500	1090	610	1600	130	860	750	104	1120	44	184
TPH-G							3750	503	2800	4500	1100	5500	5100	730	7800	500	1900

Blank: not sampled, well installed in November 2004.

Figure 6. BTEX and TPH-G Results (ug/L) for Well PMW-4, November 1993 to May 2014.

Table 3. BTEX and TPH-G Groundwater Results (ug/L), November 1993 through May 2014.

Well ID	Analyte	Ecology																
		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
D12	B	Well Installed June 1995		**0.5**	0.5 U	0.5 U	0.5 U	**17**	**2.2**	**1.6**	**9.6**	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	T			0.5 U	0.5 U	0.5 U	2 U	**34**	**1.4**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	E			**0.7**	0.5 U	0.5 U	1 U	**5.8**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	X			1 U	1 U	1 U	1.5 U	**31**	**2**	**15**	**24**	3 U	3 U	3 U	3 U	3 U	3 U	3 U
	TPH-G			50 U	50 U	50 U	100 U	**360**	100 U	100 U	**140**	100 U	140 U	40 U	70 U	70 U	70 U	70 U
D9	B	**909**	**830**	**570**	**164**	--	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	T	**3520**	**1500**	**680**	**190**	--	--	**8.4**	**16.8**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	E	**1720**	**1300**	**510**	**170**	--	--	**4.9**	**3.7**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	X	**6050**	**2600**	**1100**	**418**	--	--	**33**	**18.4**	1 U	1 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
	TPH-G	**57,570**	**28,000**	**13,000**	**3300**	--	--	**1510**	**160**	100 U	100 U	100 U	140 U	40 U	70 U	70 U	70 U	70 U
MW-2D	B	Well Installed December 1996			**3040**	**787**	**4.2**	**47**	**63**	--	--	**3.5**	1 U	**19**	**50**	**30**	**36**	1 U
	T				**7300**	**28.9**	2 U	**105**	**21**	--	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	E				**1830**	**41.6**	1 U	**23**	**3.7**	--	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	X				**10,700**	**13.4**	1.5 U	**139**	**31**	--	--	3 U	3 U	3 U	3 U	3 U	3 U	3 U
	TPH-G				**64,000**	**425**	**219**	**1200**	**395**	--	--	100 U	140 U	40 U	70 U	70 U	70 U	70 U
PMW-1	B	Well Installed November 2004						1 U	**272**	1 U	1 U	1 U	1 U	**2.5**	**1.9**	**1.3**	**1.6**	**3.6**
	T							1 U	**7.2**	**6.7**	1 U	**2.4**	1 U	**6.6**	**18**	**9.5**	**1.1**	**1.1**
	E							1 U	**2.3**	1 U	1 U	1 U	1 U	**4.2**	**2.3**	**4**	**1.1**	**1.8**
	X							1 U	**10.7**	1 U	1 U	3 U	3 U	**9.4**	**5.3**	**7.2**	**8.9**	**15.9**
	TPH-G							100 U	100 U	100 U	100 U	100 U	140 U	**110**	**92**	**83**	70 U	70 U
PMW-3	B	Well Installed November 2004						**1.1**	**13.9**	**2.7**	**6.1**	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	T							**8.7**	**296**	**320**	**340**	1 U	1 U	**5.4**	1 U	**1.5**	1 U	1 U
	E							1 U	**9.7**	1 U	**27**	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	X							1 U	**32.6**	**16**	**34**	3 U	3 U	3 U	3 U	3 U	3 U	3 U
	TPH-G							**125**	**523**	**480**	**480**	**150**	140 U	40 U	70 U	70 U	70 U	70 U
MW-3D	B	Well Installed December 1996			**132**	--	0.5 U	1 U	**78**	**1.6**	**51**	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	T				**138**	--	2 U	1 U	**89**	1 U	**70**	**1.4**	1 U	1 U	1 U	1 U	1 U	1 U
	E				**20.8**	--	1 U	1 U	**15.5**	1 U	**44**	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	X				**1440**	--	1.5 U	1 U	**100**	1 U	**190**	**5**	3 U	3 U	3 U	3 U	3 U	3 U
	TPH-G				**11,600**	--	100 U	100 U	**800**	100 U	**490**	100 U	140 U	40 U	70 U	70 U	70 U	70 U

U: Analyte was not detected at or above the reported value.
Bold: Analyte was detected.
Shade: Value is greater than the CAP and MTCA cleanup levels.