



Black Lake Grocery Groundwater Monitoring Results, October 2015: 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 was sampled and analyzed for petroleum constituents from November 1993 to June 2009. The Washington State Department of Ecology (Ecology) resumed sampling in 2011 to characterize the groundwater contaminant concentrations. This report describes the water quality results for groundwater samples collected in October 2015 from 5 monitoring wells that were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) and total petroleum hydrocarbons as gasoline (TPH-G).

Water quality results for 2015 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 4 of the site 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 and near the shoreline suggests that petroleum constituents from the site may be migrating to Black Lake.

Groundwater monitoring downgradient of the treatment wall should continue, so Ecology can determine if the reactive materials in the wall remain effective in remediating the contaminated groundwater.

Publication Information

This report is available on the Department of Ecology's website at <https://fortress.wa.gov/ecy/publications/SummaryPages/1603014.html>

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.

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

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

- 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.

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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 (Summit, 2000). 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 installing 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, the wall is approximately 120 feet long, 5 feet wide, 12 feet deep. It is 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. 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 5 of the 11 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 select on-site wells for October 2015.

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.

Method and Results

Ecology collected groundwater samples from five monitoring wells in October 2015. Wells selected for monitoring were known to have contaminant concentrations that exceeded the site cleanup levels. All wells were sampled in accordance with Ecology's SOP EAP078 (Marti, 2014).

Samples were submitted for analysis of BTEX and TPH-G to determine petroleum contaminant concentrations upgradient and downgradient of the treatment wall. Analytical results are summarized in Table 1.

A blind field duplicate was collected from well PMW-4. The relative percent difference (RPD) for the BTEX duplicate results ranged from 15% to 40%. Benzene and toluene met the data quality objectives of 30% established in the Quality Assurance Project Plan (Marti, 2011). Ethylbenzene and xylene did not meet the DQOs. The lab reported that the sample set collected from well PMW-4 was not homogenous. The lack of homogeneity likely contributed to the higher RPDs in both the field duplicate and the laboratory quality control samples. The associated data are reported as estimates. The TPH-G duplicate data from well PMW-4 had an RPD of 9% which met the DQOs. The laboratory data quality control and quality assurance results indicate that the analytical performance was good for the remainder of the analyses. All results are usable as qualified.

Table 1: Sample Results for Black Lake Grocery, October 2015.

Field Measurements							Laboratory Analysis					
Well ID	Well Depth (feet)	Ground Water Elevation (feet)	pH (Std. Units)	SC (uS/cm)	DO (mg/L)	ORP (mV)	Benzene	Toluene	Ethyl benzene	m,p-Xylene	o-Xylene	TPH-G
							CAP/MTCA Cleanup Levels					
							5 ug/L	40/1000 ug/L	30/700 ug/L	20/1000 ug/L		800 ug/L
Upper portion of plume							170	30	230	46	1 U	1700
Shallow/deep groundwater immediately upgradient of treatment wall							390	600	500	2500	1400	19,000
MW-2S	7.07	128.80	6.7	291	0.6	61	1 U	1 U	1 U	2 U	1 U	70 U
MW-2D	17.12	128.95	6.8	300	2.8	54						
Shallow/deep groundwater immediately downgradient of treatment wall							11 J	1.8	18 J	25 J	3.2	240
PMW-4	10.42	129.73	6.8	469	0.62	-46	9.5	1.3	12 J	17 J	2.1	220
PMW-4 (dup)	--	--	--	--	--	--	140	2.8	6	120	75	600
MW-3S	5.80	128.39	6.6	823	0.47	44						

SC: Specific Conductance

DO: Dissolved Oxygen

ORP: Oxidation Reduction Potential

CAP: Cleanup Action Plan.

MTCA: MTCA Method A Cleanup Level.

Bold: Analyte was detected.

Shade: Values are greater than the CAP cleanup levels.

U: Analyte was not detected at or above the reported value.

J: Analyte was positively identified. The associated numerical result is an estimate

Analytical results for BTEX and TPH-G are summarized in Table 1 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 well location relative to the contaminant plume.

Project data collected since 1993 are presented in Table 2 and Figures 2-6.

Upper Portion of the Plume – Well D11

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 1). This well is located on the northern edge of the excavated area. Although contaminant concentrations have shown more than an 80% decrease since 1995 (Figure 2), this well continues to have some of the highest BTEX and TPH-G concentrations in the project area. The October 2015 concentrations decreased significantly compared to 2013 and 2014. This is possibly related to the low water levels encountered during this monitoring period.

Although well D10 is known to have high petroleum concentrations, it was not sampled in October 2015. This well is located in the portion of the plume that was beyond the area of contaminated soil removal. Because the well is located in the center of an intersection, has a low water volume and slow recovery rate, it has not been sampled since May 2012. BTEX and TPH-G concentrations from 1993 to 2012 are shown in Figure 3. Contaminant concentrations decreased significantly in this well after 2002.

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

Well MW-2S had the highest concentrations of petroleum-related contaminants of all the sampled wells in 2015. BTEX and TPH-G concentrations exceeded both the CAP and MTCA cleanup levels (Table 1). 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. Contaminant concentrations in this well initially decreased after the treatment wall was installed (Figure 4). However, concentrations quickly rebounded. The October 2015 data indicate the first significant decrease in concentrations in well MW-2S since 2005.

No contaminants were detected in the sample from deep well MW-2D. BTEX concentrations have decreased substantially in well MW-2D since samples were first collected in 1996 (Table 2). This well, approximately 15 feet below ground surface, is part of a well cluster with MW-2S.

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

Well MW-3S is 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 (Table 1). In December 1996, BTEX concentrations in well MW-3S (Figure 5) were similar to those detected in well MW-2S. In February 2005, six 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. Similar to other wells sampled in 2015, contaminant concentrations in MW-3S decreased significantly from the 2013-2014 monitoring period.

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 1). But overall, concentrations have been steadily decreasing since monitoring began in 2005 (Figure 6).

Discussion and Conclusions

Water quality results from the 2015 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 4 of the monitoring wells sampled in 2015. An approximate plume boundary for the shallow groundwater is shown in Figure 1.

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. The effects of biodegradation were expected to be most noticeable at the limits of the excavated area and proceed downgradient over time. It was estimated that contaminant concentrations would be below cleanup levels within 10-25 years (Summit, 2005). Conventional parameters were measured in 2011-2012 to evaluate natural attenuation properties of the site. The site was characterized by low levels of dissolved oxygen, oxidation reduction potential, nitrate and sulfate, with elevated iron 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 indicate that biodegradation of the contaminants is occurring. Petroleum hydrocarbon concentrations are decreasing in conjunction with anaerobic or reducing conditions, indicating that biodegradation is occurring in the shallow groundwater throughout the site.

The second part of the remediation is the treatment wall that was installed in fall of 2004 as a passive barrier that remediates the contaminated groundwater as it flows toward Black Lake. Data from wells MW-3S and PMW-4 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.

BTEX and TPH-G were not detected in near-shore sediment or water samples collected by Ecology (Coots, 2005). However, the presence of high contaminant concentrations 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 October 2015 monitoring results, the following recommendations are provided:

- Groundwater monitoring downgradient of the treatment wall should continue on an annual to bi-annual basis 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 lose their sorptive or reactive effectiveness, they may need to be replaced.
- 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).

References

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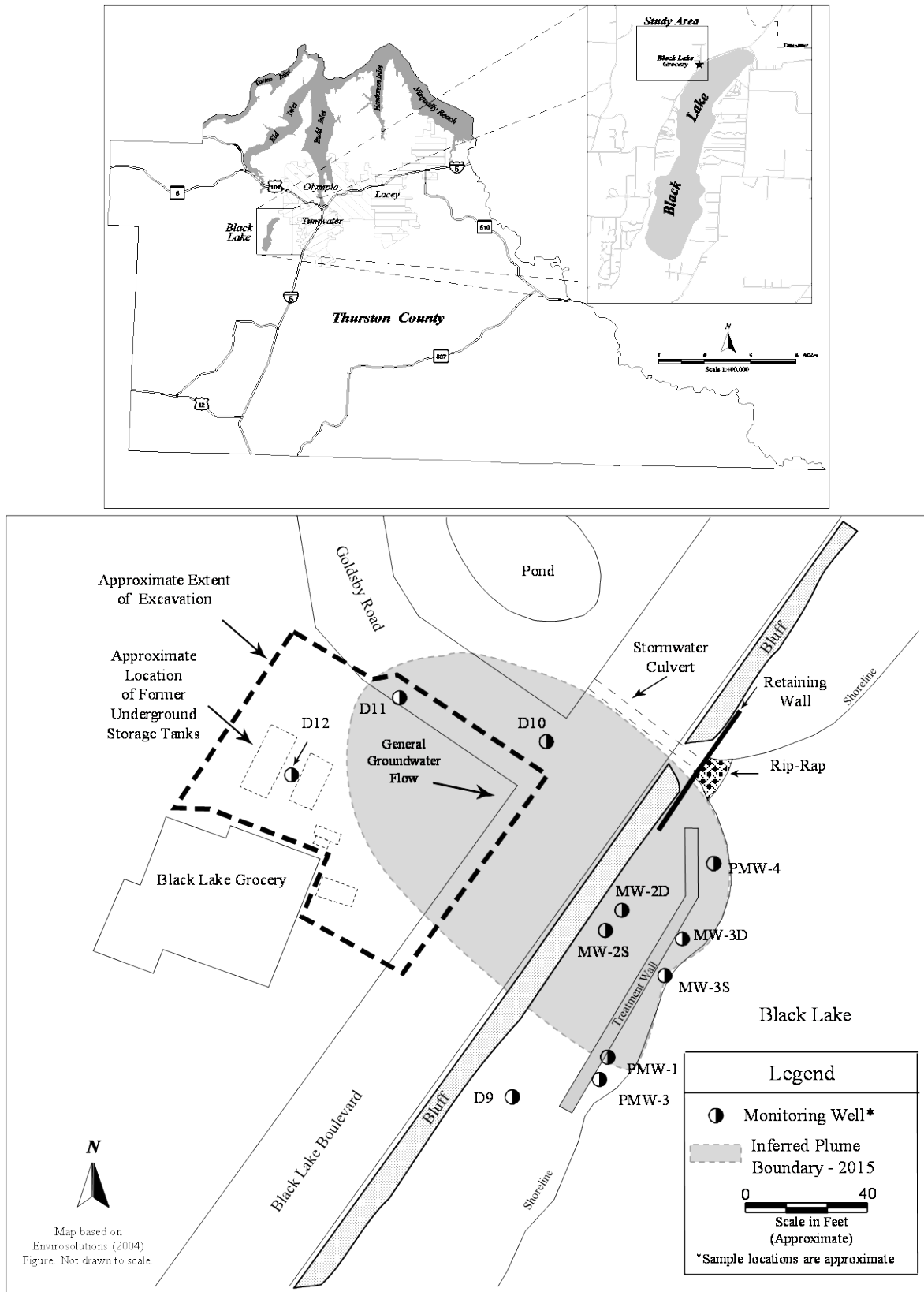


Figure 1. Black Lake Grocery Location and Site Details.

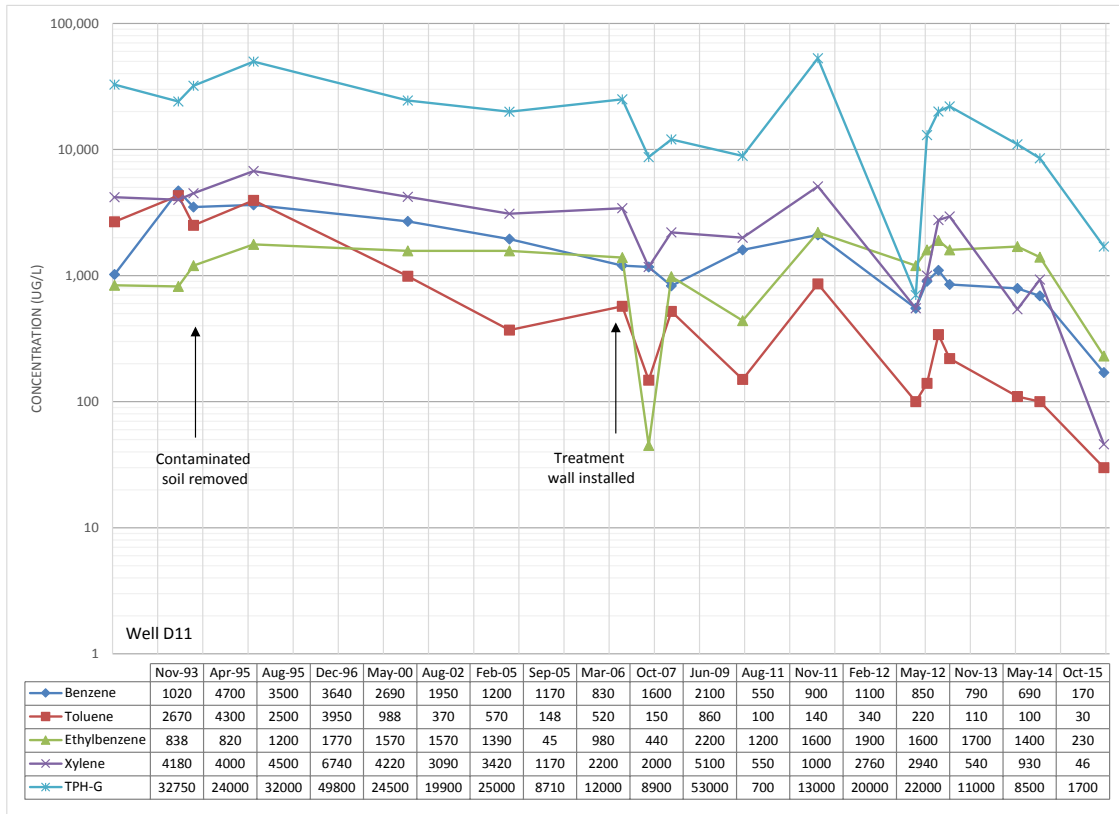


Figure 2. BTEX and TPH-G Results (ug/L) for Well D11, November 1993 to October 2015.

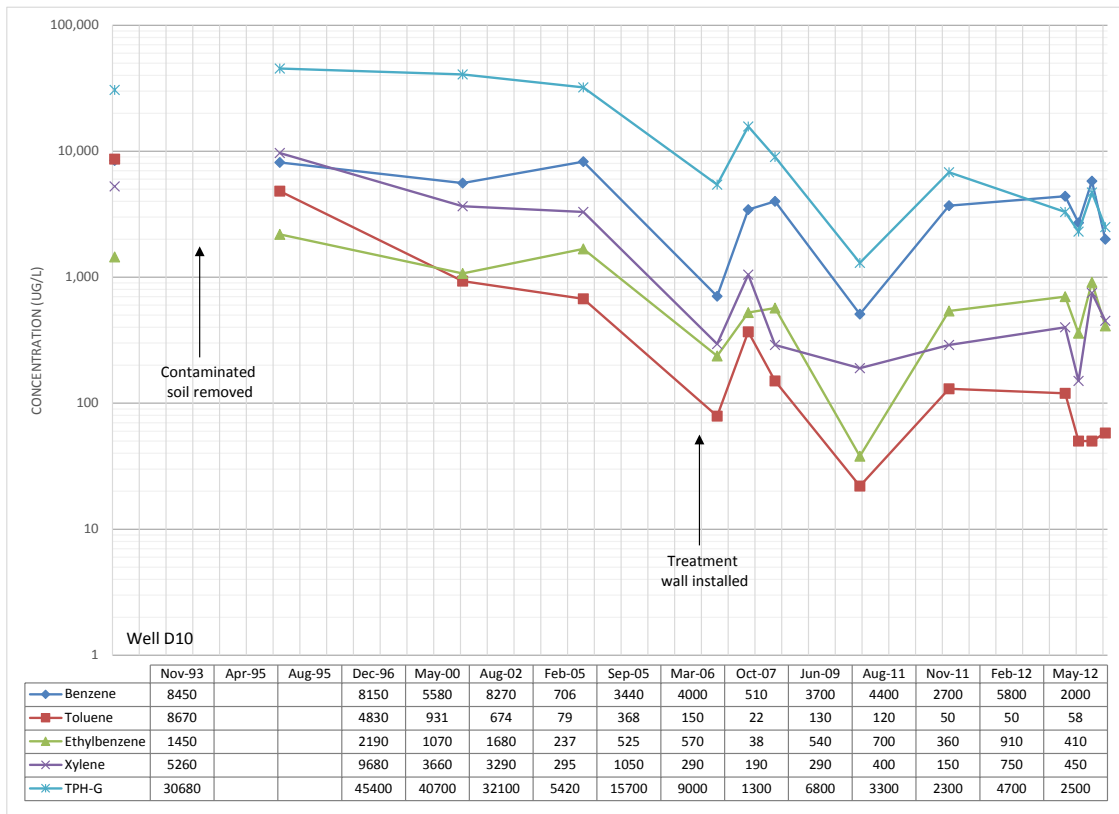


Figure 3. BTEX and TPH-G Results (ug/L) for Well D10, November 1993 to May 2012.

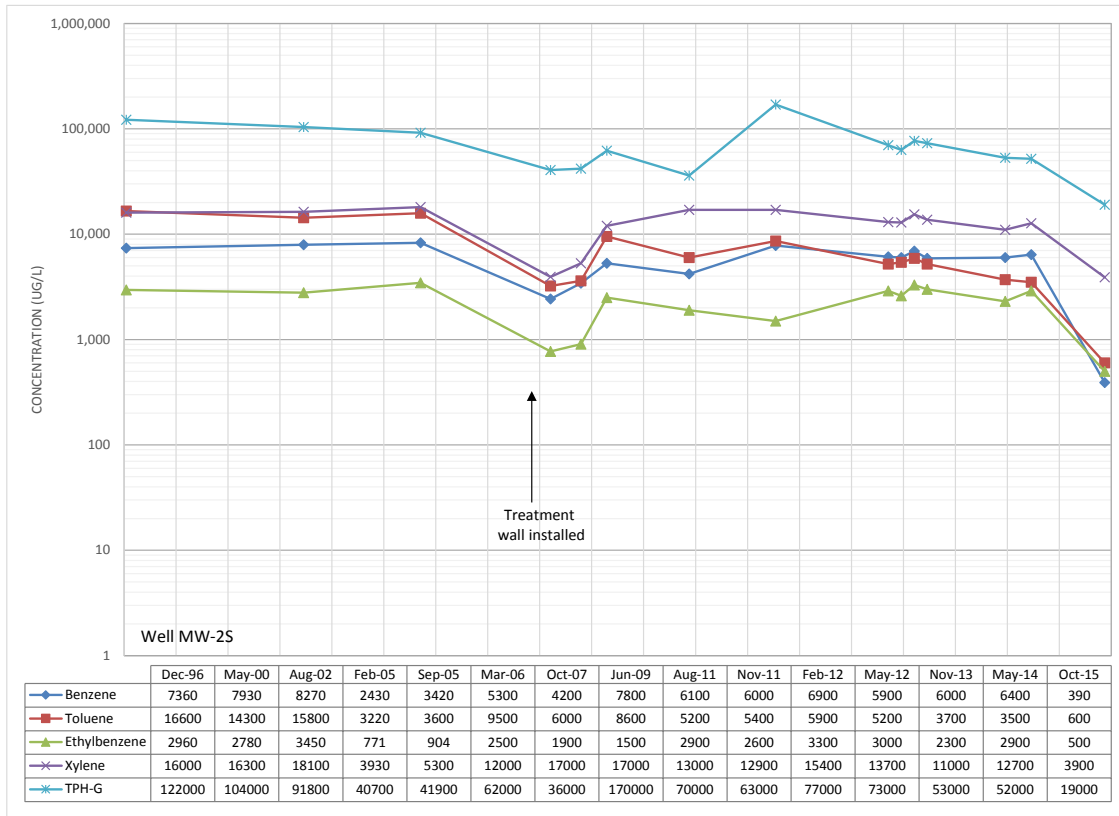


Figure 4. BTEX and TPH-G Results (ug/L) for Well MW-2S, December 1996 to October 2015.

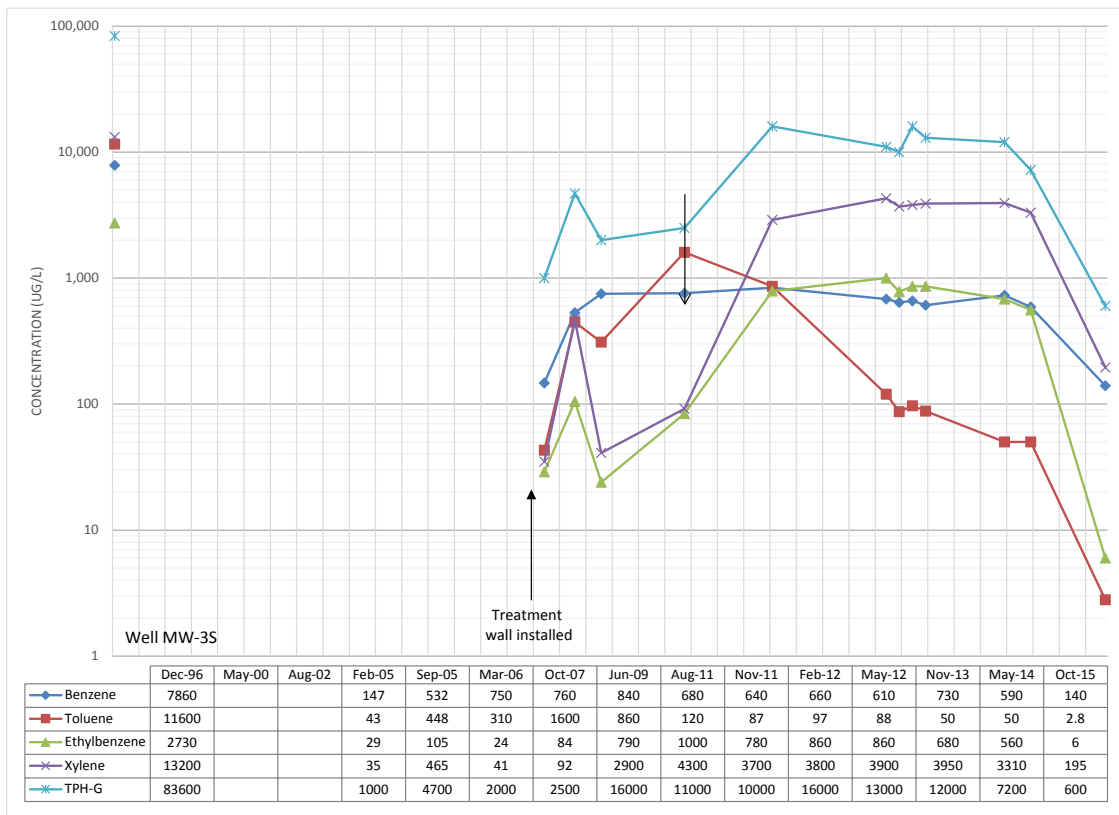


Figure 5. BTEX and TPH-G Results (ug/L) for Well MW-3S, December 1996 to October 2015.

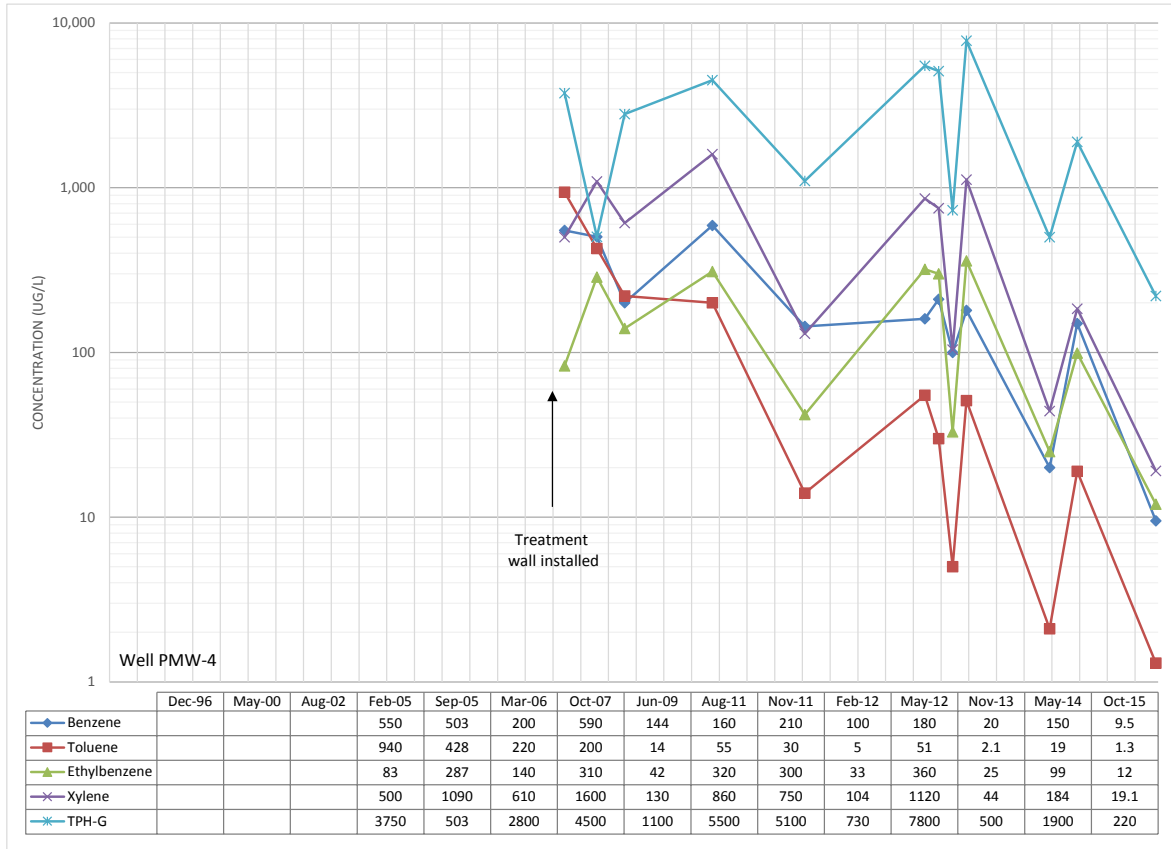


Figure 6. BTEX and TPH-G Results (ug/L) for Well PMW-4, February 2005 to October 2015.

Table 2. BTEX and TPH-G Groundwater Results (ug/L), November 1993 through May 2014.

Well ID	Analyte	Summit Envirosolutions						AEG		Stemen Env.			Dept. of 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	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	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	3 U	
	TPH-G			50 U	50 U	50 U	100 U	360	100 U	100 U	140	100 U	140 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	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	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	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	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	4.2	2.3	4	1.1	1.8			
	X							1 U	10.7	1 U	1 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	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	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	3 U	
	TPH-G				11,600	--	100 U	100 U	800	100 U	490	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.

AEG: Associated Environmental Group