A Department of Ecology Report

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Shelton Laundry and Cleaners, August 2006 through May 2007 Groundwater Monitoring Results

Abstract

PCE contamination of the shallow groundwater underlying Shelton Laundry and Cleaners was discovered in 1997. The source of contamination was assumed to be a 1993 spill outside the dry cleaners. Monitoring of four shallow site wells in 1998 detected PCE in one well (4W) at a concentration of 280 µg/L.

In 2002 Ecology installed four deep wells and began monitoring the groundwater quality of all eight wells. From 2002 to 2005, PCE concentrations in well 4W ranged from 10 to 25 µg/L. PCE was not detected in the four deep wells.

To remediate the remaining contaminants, in June 2005 Ecology had a hydrogen release compound (HRC®) injected into the groundwater around well 4W. Groundwater monitoring continued to assess the concentrations and distribution of the contaminants. Five months following the HRC injection, PCE and TCE concentrations decreased and cis-DCE concentrations increased, indicating that enhanced degradation may have been occurring.

Between August 2006 and May 2007, groundwater samples were collected quarterly from five of the wells. PCE was detected in well 4W with concentrations ranging from 3.2 to 10 µg/L. The Model Toxic Control Act (MTCA) Method A cleanup level for PCE is 5 µg/L. TCE and cis-DCE were also detected in well 4W but at concentrations near or below the practical quantitation limit of 1 µg/L. PCE was not detected in the two deeper wells.

Since August 2006, contaminant concentrations have been steadily increasing. Parallel increases in PCE, TCE, and cis-DCE concentrations may suggest the HRC is past its effectiveness in reducing the contaminant concentrations. As of May 2007, it has been 23 months since the HRC injection. HRC typically has an effective longevity of 12 to 18 months.

Groundwater monitoring should continue in the five wells on a quarterly basis because PCE concentrations in monitoring well 4W continue to exceed the 5 µg/L cleanup level.

This site may benefit from a second injection of a hydrogen release compound.

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by Pamela B. Marti and Tanya Roberts

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Background

Tetrachloroethylene (PCE) contamination of shallow groundwater was discovered in 1997 during an environmental site assessment of a property in Shelton, Washington (Building Analytics, 1997) (Figure 1). PCE was detected at a concentration of 130 µg/L in groundwater collected from a shallow boring approximately 11 feet deep. The Model Toxic Control Act (MTCA) Method A cleanup level for PCE in groundwater is 5 µg/L.

The Washington State Department of Ecology (Ecology) was notified of the contamination when it received copies of the Environmental Site Assessment Reports in June 1997 (Building Analytics, 1997). Based on these reports, Shelton Laundry and Cleaners was listed on Ecology's *Confirmed and Suspected Contaminated Sites List* in December 1997, and ranked under the Washington Ranking System.

The most likely source of the contamination was identified as the dry cleaning facility, Shelton Laundry and Cleaners, which is located adjacent to the property where the site assessment was conducted. A commerical laundry and dry cleaning facility has been in operation at this site since 1935. In 1993, a new dry cleaning machine was installed. As the old cleaning machine was removed, a small quantity of dry cleaning solvent, assumed to be PCE, was reportedly spilled and infiltrated through the broken asphalt in the alley behind the building. This spill event is assumed to be the source of the groundwater contamination.

Several environmental investigations were conducted at the Shelton Laundry and Cleaners site during 1997 and 1998. During these investigations, several shallow borings were drilled to collect both soil and groundwater samples. In July 1998, four shallow (15 feet deep) monitoring wells were installed (1W, 4W, 7W, and 8W) (Figure 2). Groundwater was sampled from these wells four times between July 1998 and September 2000. PCE contamination was primarily detected in the well (4W) located nearest to where the spill was reported to have occurred, with concentrations ranging from 280 µg/L (July 1998) to 25 µg/L (September 2000).

Ecology conducted a follow-up investigation in 2002 to determine the status of the PCE groundwater contamination. As part of the invesitgation, four additional monitoring wells (MW-5 through MW-8) were installed to gain a better understanding of contaminant concentrations at greater depths. Three of the wells were installed adjacent to existing shallow wells to a depth of 45 feet. The fourth well was installed south of the site to a depth of 60 feet. PCE was not detected in any of the four deeper wells during the 2002 monitoring (Marti, 2003).

Because PCE concentrations exceeded the MTCA cleanup standard in well 4W, Ecology continued to monitor the groundwater quality in both the shallow and deep wells. From July 2002 to April 2005, PCE concentrations in well 4W have ranged from approximately 10 to 25 µg/L. In an effort to remediate the remaining contaminants, in June 2005, 1,050 pounds of a hydrogen release compound (HRC®) was injected into the shallow groundwater between wells 4W and 7W. The HRC was injected at depths of 5 to 20 feet below the ground surface at 16 locations which were spaced at 8-foot intervals and covered an area of about 60 feet by 15 feet (Balaraju, 2005).

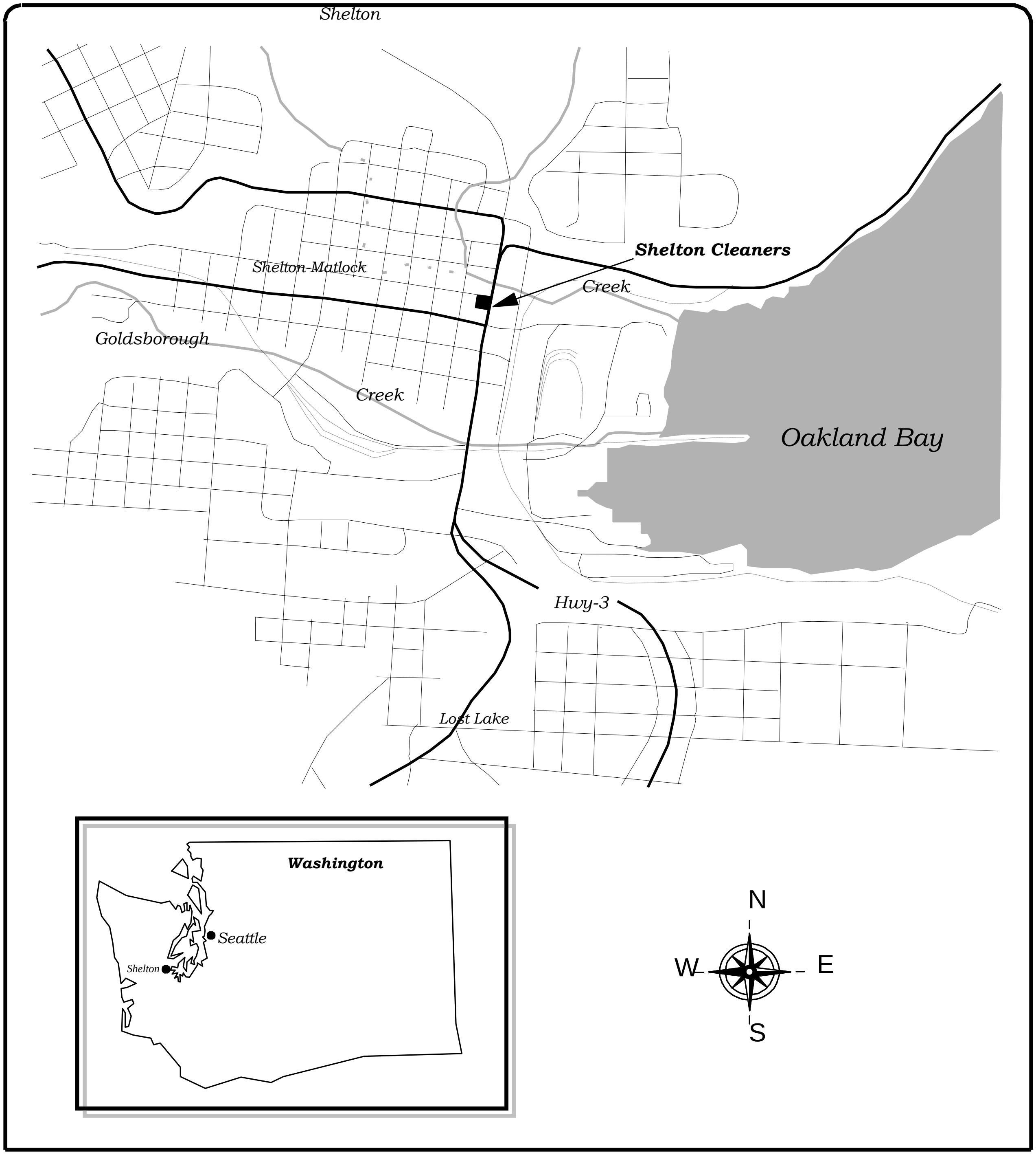
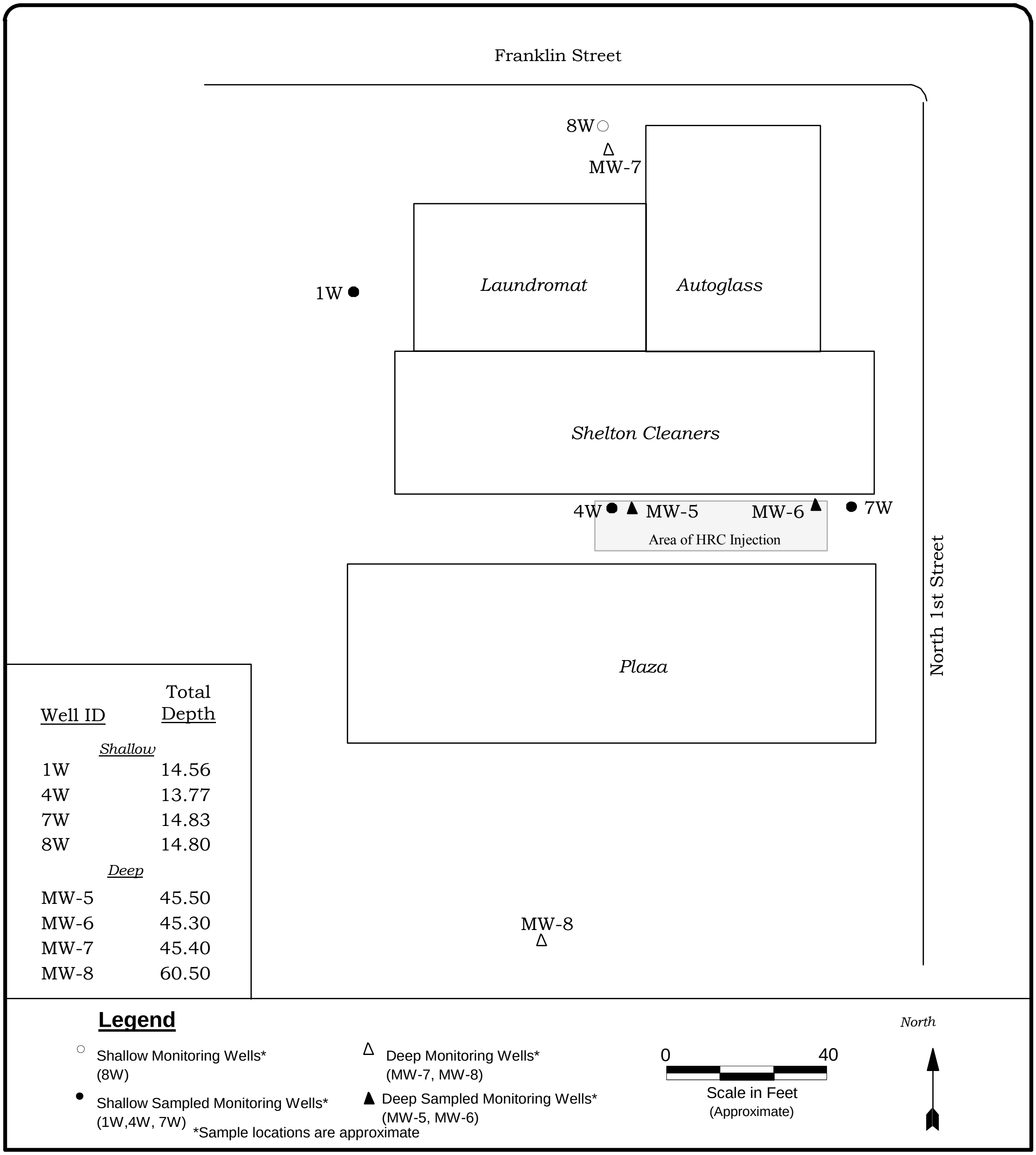


Figure 1: Shelton Laundry & Cleaners Site Location



Well ID	Total Depth
Shallow	
1W	14.56
4W	13.77
7W	14.83
8W	14.80
Deep	
MW-5	45.50
MW-6	45.30
MW-7	45.40
MW-8	60.50

Figure 2: Shelton Laundry & Cleaners Sample Locations

In general, site well logs indicate the site is covered with a thin layer of fill and two to six feet of silty sand, which is underlain by an undetermined thickness of gravely sands with some sand interbeds. The well log for 4W shows the upper silty sand layer which grades to a silty, fine gravel with some fine to coarse sand from six to 14 feet below ground surface. Soils from split spoon samples collected in June 2005 indicate the presence of a thin silt layer at approximately four feet below the ground surface in the area of well 4W.

The gravely sands in which all eight monitoring wells are screened is part of the Vashon recessional outwash deposits which underlay the western outwash plain between Shelton and the Skokomish Valley to the north. Deeper production well logs near the site indicate that the recessional deposits can attain a thickness of more than 100 feet in the area of Oakland Bay.

The depth to the water table on the project site ranged from about three to six feet over the 1997 – 2006 study period. Regionally, groundwater flow is described as being southward in the loose sand and gravel toward the Shelton Valley and Oakland Bay (Molenaar and Noble, 1970). Groundwater flow patterns determined from site water levels appear to be southward, with flow to the southwest and southeast across the site.

Methods

Groundwater Sampling

Groundwater samples were collected in August and December 2006 and in February and May 2007 from three shallow and two deep monitoring wells (Figure 2). Samples were submitted for analysis of volatile organic compounds (VOCs) to determine if the June 2005 HRC injection has been effective in remediating the remaining PCE concentrations in the vicinity of well 4W.

The three shallow wells installed in 1998 (1W, 4W, and 7W) were constructed of 1-inch diameter PVC to a depth of about 15 feet with 10-foot screens. The two deep wells installed in 2002 (MW-5 and MW-6) were constructed of 2-inch diameter PVC to a depth of about 45 feet, with the screened interval from 35-45 feet below ground surface (bgs).

Static water levels were measured in all wells, prior to well purging and sampling, using a Solinst water level meter with a ¼-inch diameter probe. Measurements were recorded to 0.01 foot and are accurate to ±0.03 foot. The probe was rinsed with deionized water between measurements.

Because of the small diameter (1 inch) of wells 1W, 4W, and 7W, as well as the presence of an unidentified substance in well 4W since May 2006, these wells were purged and sampled with a stainless steel mechanical bladder pump. The mechanical bladder pump, which has a mesh screen intake, prevented clumps of the unidentified material, which may be remnants of the HRC or the resulting microbial growth, from entering the samples from well 4W. These wells were pumped at a rate of 0.1 to 0.5-liter/minute. Wells were purged until pH, specific conductivity, and temperature readings collected from grab samples stabilized. At the completion of purging, samples were collected directly from each of the monitoring well's dedicated pump discharge tubing into laboratory supplied containers.

Monitoring wells MW-5 and MW-6 were purged and sampled using a stainless steel submersible pump, at a pump rate of 1-liter/minute. These wells were purged through a continuous flow cell until the field parameter readings stabilized. At the completion of purging, the flow cell was disconnected and the samples were collected directly from both of the well's dedicated pump discharge tubing into the sample containers.

VOC samples were collected free of headspace in three 40-mL glass vials with Teflon-lined septa lids and preserved with 1:1 hydrochloric acid. Upon sample collection and proper labeling, all samples were stored in an ice-filled cooler. Samples were transported to Ecology's Operation Center in Lacey. Samples were kept in the walk-in cooler until picked up by the courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Environmental Laboratory protocol (Ecology, 2005).

Both pumps were decontaminated after each well was sampled by circulating a laboratory-grade detergent and water mixture through the pump, followed by a clean water rinse. Purge water from all the wells was collected and stored on-site in a 55-gallon drum. The purge water was transported and disposed of in accordance with Washington State Dangerous Waste Regulations (Chapter 173-303 WAC).

Laboratory

Analytes, analytical methods, and detection limits for both field and laboratory parameters are listed in Table 1. All groundwater samples were analyzed for volatile organics (VOCs) by the Ecology/EPA Manchester Environmental Laboratory.

Table 1. Field and Laboratory Methods.

Analytes	Method	Reference	Reporting Limit
Field			
Water Level	Solinst Water Level Meter	NA	±0.03 feet
pH	Orion 25A Field Meter	NA	0.1 std. units
Temperature	YSI 3510 Temperature Probe	NA	0.1 ºC
Specific Conductance	YSI 3520 Conductivity Cell	NA	10 umhos/cm
Laboratory			
VOCs	EPA SW-846 Method 8260B	EPA 1996	1-5 µg/L

Data Quality

Quality control samples collected in the field consisted of blind field duplicates. Field duplicates were collected by splitting the pump discharge between two sets of sample bottles, which provides a measure of the overall sampling and analytical precision. Precision estimates are influenced not only by the random error introduced by collection and measurement procedures, but are also influenced by the natural variability of the concentrations in the media being sampled. Field duplicates were collected from well 4W during all sample rounds.

Table 2 shows the results of the duplicate samples and the relative percent difference (RPD). RPD is calculated as the difference between sample results, divided by the mean and expressed as a percent.

Table 2. Relative Percent Difference (RPD) of PCE Duplicate Sample Results (µg/L) from August 2006 through May 2007.

Well Sample ID	August 2006	December 2006	February 2007	May 2007
4W	3.2 J	6.3	10	9.3
4W-A	3.2 J	6.4	10	9.7
RPD (%)	-- %	2%	0%	4%

Between December 2006 and May 2007, the RPD for duplicate samples from monitoring well 4W ranged from 0% to 4%. PCE results for August 2006 were slightly outside the criteria for the initial calibration; therefore, the sample results are qualified “J” as an estimate. The RPD was not calculated for these duplicate results. All data met the measurement quality objectives established in the Quality Assurance Project Plan (Marti, 2002).

Overall, a review of the data quality control and quality assurance from laboratory case narratives indicates analytical performance was good. The reviews include descriptions of analytical methods, holding times, instrument calibration checks, blank results, surrogate recoveries, and laboratory control samples. No problems were reported that compromised the usefulness or validity of the sample results. No data were rejected, and all results were usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

All field measurements and analytical result data are available in electronic format from Ecology’s Environmental Information Management (EIM) database: www.ecy.wa.gov/eim/index.htm at study ID, PMART001.

Results

Field Observations

Total depth of each monitoring well, as well as the range of depth-to-water, temperature, pH, and specific conductance readings, at the time of sampling are listed in Table 3. All field data are presented in Appendix A.

Table 3. Summary of Field Parameter Results for August 2006 through May 2007.

Well	Total Depth (feet)[1]	Depth to Water (feet)[1]		Temperature (°C)		pH (standard units)		Specific Conductance (umhos/cm)	
		Range	Difference	Range	Difference	Range	Mean	Range	Mean
Shallow									
1W	14.56	4.06 - 5.16	1.10	9.7 - 13.2	3.5	6.5 - 7.4	6.8	116 - 252	196
4W	13.77	4.04 - 5.09	1.05	9.2 - 14.2	5.0	6.5 - 7.2	6.8	113 - 216	143
7W	14.83	3.67 - 4.73	1.06	10.0 - 12.0	2.0	6.7 - 7.3	6.9	109 – 264	174
Deep									
MW-5	45.5	4.01 - 5.08	1.07	10.7 - 13.3	2.6	6.6 - 7.1	6.9	212 – 216	214
MW-6	45.3	3.66 - 4.72	1.06	10.7 - 12.1	1.4	6.6 - 7.1	6.9	176 - 221	209

[1] Measured from top of PVC casing.

Completion depths for the five monitoring wells ranged from 13.77 to 45.5 feet, with depth-to-water ranging from 3.66 to 5.16 feet below the measuring point. Water levels fluctuated approximately one foot during the monitoring period. Hydrographs showing water-level elevations for each well from May 2002 to May 2007 are in Figure 3. Data for the hydrographs are presented in Appendix B. The hydrographs show that, overall, the seasonal fluctuation is small throughout the year (about one foot), and the groundwater gradient is fairly flat. Water level elevations in February 2006 and February 2007 were higher than in previous years which are probably the results of long rainfall periods prior to those sample events, as shown in Figure 3.

A typical groundwater flow pattern for the site is shown in Figure 4. This figure is based on water levels measured in December 2006. The location of the water-table contours was determined using a kriging algorithm in the Surfer software program. The groundwater flow direction is approximately perpendicular to the contours. The overall flow direction appears to be southward, which corresponds to the regional flow direction with flow toward the southwest and southeast.

Field parameters were within expected ranges for the sampled monitoring wells. Groundwater temperatures were measured from grab samples from the 1” wells and in a flow cell from the 2” wells, which makes them subject to ambient air temperatures. Temperatures ranged from 9.2ºC to 14.2ºC, with a fluctuation of 1.4 to 5.0°C. The lowest groundwater temperatures were measured in February 2007 and the highest in August 2006. The pH of groundwater had an average of 6.9. The specific conductivity measurements had a mean range of 143 to 214 umhos/cm.

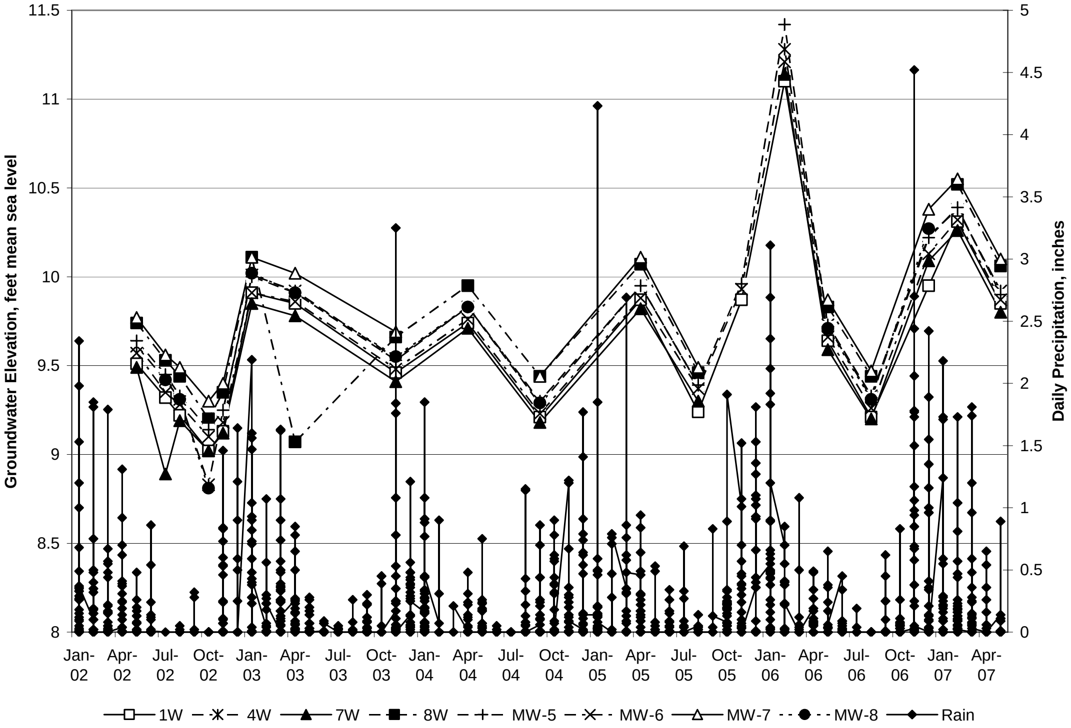


Figure 3: Shelton Laundry and Cleaners - Hydrographs, May 2002 to May 2007

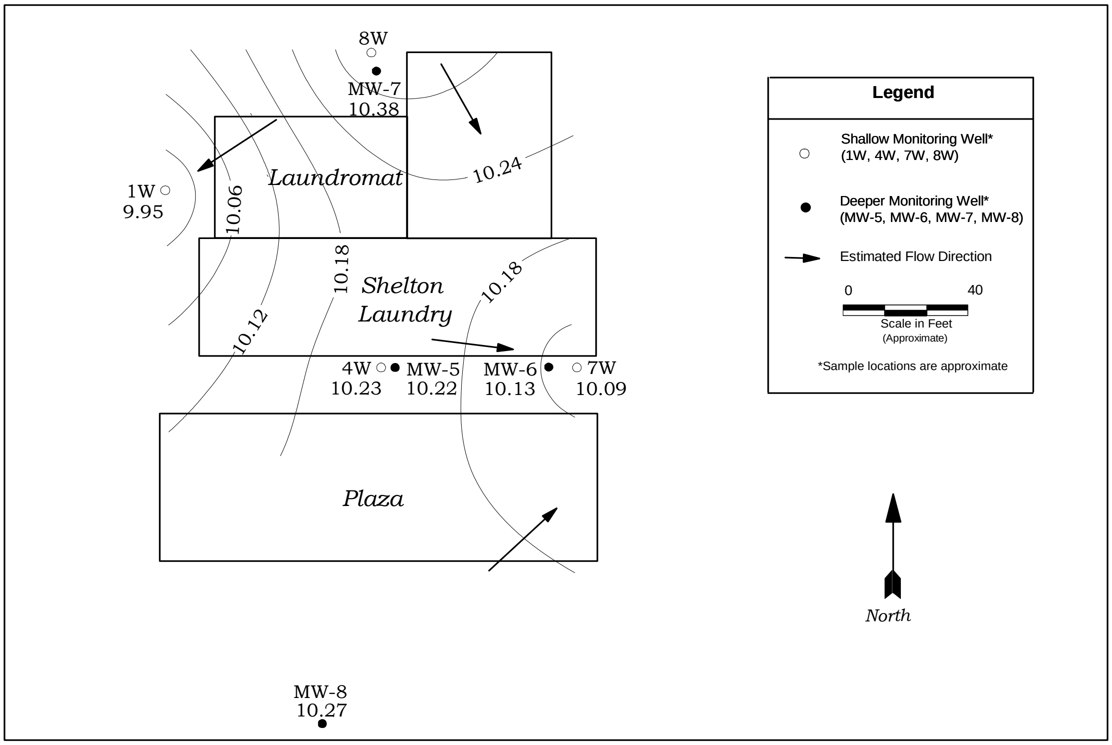


Figure 4: Shelton Laundry and Cleaners - Water Table Elevation, December 2006

Analytical Results

Analytical results for volatile organics that were detected are summarized in Table 4. For comparison, a summary of historical data for this project is presented in Appendix C.

Table 4. Summary of Analytical Results (µg/L) for August 2006 through May 2007.

Well ID	Tetrachloroethylene (PCE)				Trichloroethylene (TCE)				Cis-1,2-Dichloroethylene (cis-DCE)			
	8/06	12/06	2/07	5/07	8/06	12/06	2/07	5/07	8/06	12/06	2/07	5/07
Shallow												
1W	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4W	**3.2 J**	**6.3**	**10**	**9.3**	**0.60 J**	**1.7**	**3.2**	**2**	**0.19 J**	**0.47 J**	**1**	**0.75 J**
7W	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Deep												
MW-5	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-6	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

U – Analyte was not detected at or above the reported value.
J – Analyte was positively identified. The associated numerical result is an estimate.
UJ – Analyte was not detected above the approximate reported sample quantitation limit.
Bold – Analyte was detected.

PCE, trichloroethylene (TCE), and cis-1,2-dichloroethylene (cis-DCE) were detected in well 4W during all four rounds of sampling. PCE concentrations in this well ranged from an estimated 3.2 µg/L in August 2006 to 10 µg/L in February 2007. TCE and cis-DCE concentrations in well 4W were near or below the practical quantitation limit of 1 µg/L.

PCE, TCE, and cis-DCE have not been detected in the deep wells since they were installed in July 2002.

Discussion

PCE, TCE, and cis-DCE concentrations in well 4W have fluctuated since the injection of the HRC in June 2005 (Figure 5). Prior to its injection, the average PCE and TCE concentrations in this well were 15 µg/L and 1.6 µg/L, respectively. In November 2005, five months following the HRC injection, PCE and TCE concentrations decreased to 6.8 µg/L and 0.52 µg/L. At the same time, the cis-DCE concentration increased from a pre-HRC average of 0.62 µg/L to 1.8 µg/L, which could be an indication that enhanced degradation was occurring due to the HRC injection. PCE concentrations increased during the next two sample quarters to 17.5 µg/L (February 2006) and a high of 324 µg/L in May 2006. Concentrations of TCE and cis-DCE also increased to a high of 13 µg/L and 16 µg/L, respectively. Hansen et al. (2000) have noted that there can be temporary increases in aqueous contaminant concentrations in the treatment area as biosurfactants (microbial surface active agents) produced by stimulating microbial growth in the subsurface, solubilize volatile organics that are absorbed to the aquifer media.

Between August 2005 and May 2006, 2-butanone, also known as methyl ethyl ketone (MEK), was also detected in wells 4W and 7W. MEK concentrations in well 4W ranged from a high of 222 µg/L in August 2005 to a low of 2 µg/L in May 2006. MEK was detected in well 7W in August and November 2005 at concentrations of 9.8 µg/L and 3.8 µg/L, respectively. MEK had not been detected at this site prior to the HRC injection.

Based on information provided by the HRC® manufacturer, MEK can be produced by soil bacteria through fermentation of a wide range of organic carbon compounds, either native to the site or introduced during engineered bioremediation. The production of MEK at other HRC sites has not appeared to be significant or long-lasting (Biondolillo, 2006). MEK has not been detected in any of the wells since May 2006.

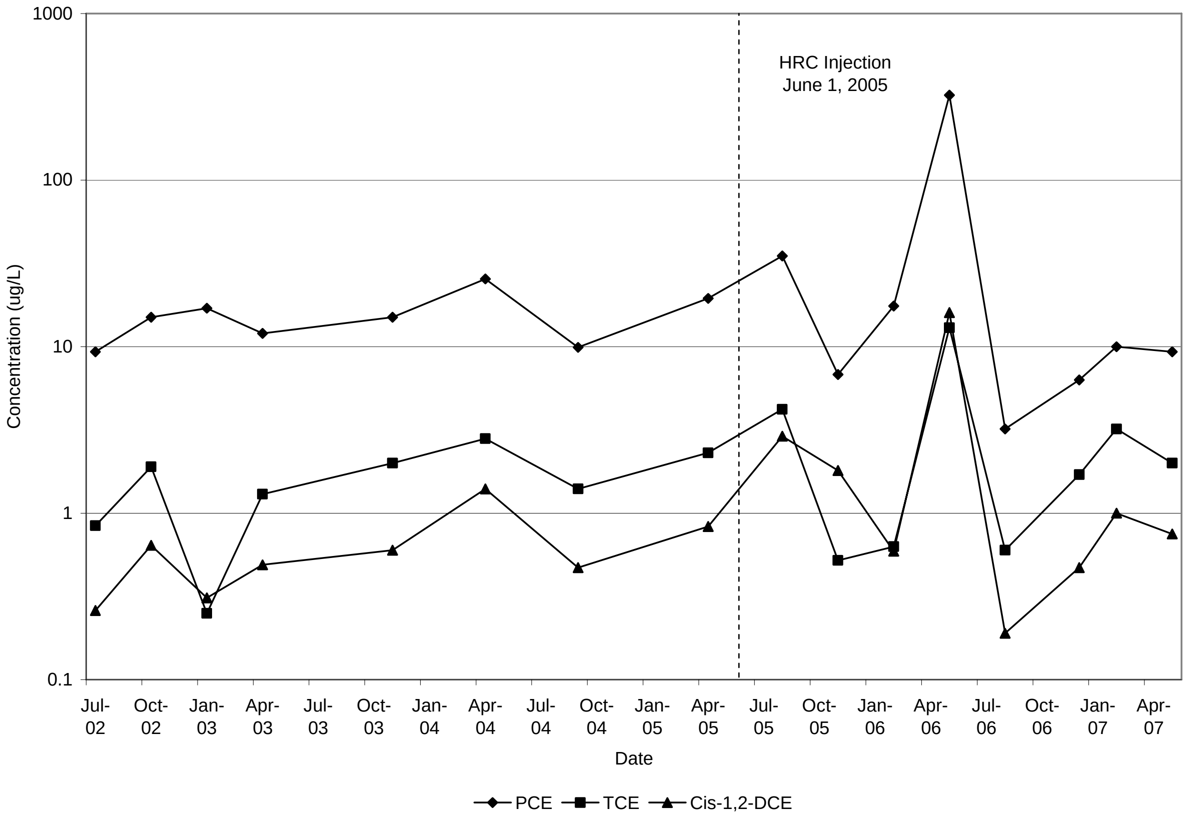


Figure 5: PCE, TCE, and cis-DCE Concentrations (µg/L – log scale) in well 4W,
July 2002 through May 2007.

In August 2006, 15 months following the HRC injection, PCE (3.2 µg/L), TCE (0.6 µg/L), and cis-DCE (0.19 µg/L) had decreased to some of their lowest concentrations. This was the first occurrence of PCE concentrations being below the MTCA Method A cleanup level of 5 µg/L since monitoring began in 2002. Since the August 2006 sampling, PCE, TCE, and cis-DCE concentrations have been steadily increasing. The average PCE concentration is now 7 µg/L.

The parallel increases of PCE, TCE, and cis-DCE concentrations suggest that the HRC is past its effectiveness. In a review of HCR® case histories, Willett et al. (2004) found that the effective longevity of HRC is about 12 to 18 months. As of May 2007, when the last samples were collected, it has been 23 months since the HRC injection in June 2005.

Conclusions

PCE concentrations in well 4W during the past year of monitoring (August 2006 to May 2007) have increased from a low 3.2 J µg/L in August 2006 to 10 µg/L in February 2007. PCE concentrations detected in well 4W continue to exceed the Model Toxic Control Act (MTCA) Method A cleanup level of 5 µg/L.

TCE and cis-DCE concentrations also increased in well 4W, but remained near or below the practical quantitation limit of 1 µg/L. TCE and cis-DCE are typically associated with the breakdown of PCE. TCE and cis-DCE concentrations were below their respective cleanup levels of 5 µg/L and 70 µg/L.

Even with the injection of the hydrogen release compound (HRC®) in June 2005 to remediate the site, results of this study indicate that the groundwater underlying the Shelton Laundry and Cleaners site continues to be contaminated in the area of well 4W.

Results from the first year of monitoring following the HRC injection seem to indicate that enhanced degradation was occurring. Even though there was a spike of contaminant concentrations in May 2006, PCE and TCE concentrations decreased while cis-DCE concentrations increased.

The contaminant concentrations were at their lowest in August 2006, 15 months following the HRC injection, but have been steadily increasing during this past year of sampling. The parallel increase in PCE, TCE, and cis-DCE concentrations may suggest that the HRC is no longer being effective in reducing the contaminant concentrations. As of May 2007, it has been 23 months since the injection of the HRC. HRC typically has an effective longevity of about 12 to 18 months.

Recommendation

Groundwater monitoring should continue in the three shallow wells (1W, 4W, and 7W) and the two deep wells (MW-5 and MW-6) on a quarterly basis for the next year because PCE concentrations in monitoring well 4W continue to exceed the MTCA Method A cleanup level of 5 µg/L.

This site may benefit from a second injection of a hydrogen release compound. However, a longer lasting formula such as HRC-X® should be considered. HRC-X is an extended release formula designed to treat source areas with residual dense nonaqueous phase liquid (DNAPL) and has an anticipated lifetime of three to five years (Regenesis.com).

If a second HRC injection does occur, the five wells should be monitored quarterly. Samples should also be collected and analyzed for total organic carbon (TOC), dissolved iron, sulfate, and chloride from the four wells within the treatment area. These additional parameters will help indicate if reductive dechlorination is occurring. It has been observed at other sites where HRC has been injected and successful at creating reducing conditions, that TOC, chloride, and dissolved iron concentrations increase, and sulfate concentrations decrease.

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Appendix A. Field Parameters

Table A-1. Field Parameter Results for August & December 2006 and February & May 2007.

Well ID	Date	Total Depth (feet)[1]	Depth to Water (feet)[1]	Temperature (°C)	pH (standard units)	Specific Conductance (umhos/cm)	Purge Volume (gallons)
1W	8/22/06	14.56	5.16	13.2	6.6	116	1.5
1W	12/1/06		4.42	9.7	6.5	252	2.25
1W	2/15/07		4.06	9.8	6.7	197	2
1W	5/14/07		4.52	11.6	7.4	218	1.75
4W	8/22/06	13.77	5.09	14.2	6.9	113	2
4W	12/1/06		4.19	10.8	6.5	216	2
4W	2/15/07		4.04	9.2	6.5	127	1.75
4W	5/14/07		4.50	12.2	7.2	114	1.5
7W	8/22/06	14.83	4.73	12.0	6.7	117	1.5
7W	12/1/06		3.84	10.5	6.7	264	2
7W	2/15/07		3.67	10.0	7.2	205	1.5
7W	5/14/07		4.13	11.8	7.3	109	1.75
MW-5	8/22/06	45.50	5.08	13.3	7.1	215	8
MW-5	12/1/06		4.18	11.8	6.6	213	9
MW-5	2/15/07		4.01	10.7	6.6	216	10
MW-5	5/14/07		4.50	12.1	7.1	212	7
MW-6	8/22/06	45.30	4.72	12.1	6.9	221	9
MW-6	12/1/06		3.85	11.2	6.8	176	10
MW-6	2/15/07		3.66	10.7	6.6	220	9
MW-6	5/14/07		4.11	11.5	7.1	220	7

[1] Measured from top of PVC casing.

Appendix B. Hydrograph Data

Table B-1. Groundwater Elevations (feet above mean sea level), May 2002 through May 2007.

Well ID:	1W	4W	7W	8W	MW-5	MW-6	MW-7	MW-8
5/13/02	9.51	9.61	9.49	9.74	9.64	9.57	9.77	--
7/16/02	9.32	9.42	8.89	9.53	9.45	9.35	9.56	9.42
8/20/02	9.22	9.31	9.19	9.44	9.33	9.28	9.49	9.31
10/2/02	9.02	8.83	9.02	9.2	9.14	9.1	9.3	8.81
11/26/02	9.13	9.25	9.12	9.35	9.25	9.18	9.5	--
1/21/03	9.91	10.01	9.85	10.11	10	9.91	10.11	10.02
4/2/03	9.85	9.92	9.78	9.07	9.91	9.86	10.02	9.91
11/5/03	9.46	9.54	9.41	9.66	9.53	9.48	9.69	9.55
4/1/04	9.74	9.83	9.71	9.95	9.83	9.76	--	9.83
9/23/04	9.21	9.3	9.18	9.44	9.28	9.23	9.44	9.29
4/20/05	9.87	9.95	9.82	10.07	9.95	9.88	10.11	--
8/19/05	9.24	9.39	9.30	9.46	9.39	9.37	9.49	--
11/3/05	9.87	--	--	--	9.96	9.93	--	--
2/1/06	11.1	11.28	11.14	--	11.42	11.21	--	--
5/3/06	9.64	9.73	9.59	9.83	9.72	9.66	9.87	9.71
8/22/06	9.21	9.33	9.2	9.44	9.32	9.26	9.47	9.31
12/1/06	9.95	10.23	10.09	--	10.22	10.13	10.38	10.27
2/15/07	10.31	10.38	10.26	10.52	10.39	10.32	10.55	--
5/14/07	9.85	9.92	9.8	10.06	9.9	9.87	10.1	--

Depth-to-water measured from top of PVC casing.
-- Not measured.

Appendix C. Historical Data

Table C-1. PCE, TCE, and cis-DCE Groundwater Results (µg/L), May 1997 through May 2007.

Well ID	Building Analytics	AA Enviro Assessment	GeoEngineers			
	5/21/97	3/3/98	7/24/98	11/18/98	7/12/99	9/6/00
1W						
PCE	--	--	<1.0	<1.0	<1.0	NS
TCE	--	--	<1.0	<1.0	<1.0	NS
4W						
PCE	**130**[1]	**1510**[2]	**280**	**130**	**39**	**25**
TCE	NR	NR	**4.7**	<1.0	<1.0	<1.0
Cis-DCE	NR	NR	**33**	<1.0	<1.0	<1.0
7W						
PCE	--	--	**4.3**	**3**	<1.0	**1.2**
TCE	--	--	<1.0	<1.0	<1.0	<1.0
Cis-DCE	--	--	**6.4**	<1.0	<1.0	<1.0
8W						
PCE	--	--	<1.0	<1.0	<1.0	NS
TCE	--	--	<1.0	<1.0	<1.0	NS

PCE = tetrachloroethylene.
TCE = trichloroethylene.
DCE = cis-1,2-dichloroethylene.

NS = not sampled .
NR = not reported.

<1.0 = Analyte was not detected at a concentration above the value shown.

[1] = Concentration reported by Building Analytics is from an approximate location of well 4W.
[2] = Concentration reported by AA Enviro Assessment is from an approximate location of well 4W.

Bold = Analyte was detected.

Table C-1 (continued). PCE, TCE, and DCE Groundwater Results (µg/L), May 1997 through May 2007.

Well ID	Ecology															
	7/17/02	10/3/02	1/22/03	4/3/03	11/5/03	4/1/04	9/23/04	4/20/05	8/19/05	11/3/05	2/1/06	5/3/06	8/22/06	12/1/06	2/15/07	5/14/07
1W																
PCE	1 U	1 U	1 U	1 U	--	--	--	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TCE	1 U	2 U	1 U	1 U	--	--	--	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4W																
PCE	**9.3**	**15**	**17**	**12**	**15**	**26***	**9.9**	**20***	**35***	**6.8**	**18***	**324**	**3.2 J**	**6.3**	**10**	**9.3**
TCE	**0.84 J**	**1.9 J**	**0.25 J**	**1.3**	**2**	**2.8***	**1.4**	**2.3**	**4.2***	**0.52 J**	**0.63 J**	**13**	**0.60 J**	**1.7**	**3.2**	**2**
DCE	**0.26 J**	**0.64 J**	**0.31 J**	**0.49 J**	**0.60 J**	**1.4**	**0.47 J**	**0.83 J**	**2.9***	**1.8**	**0.59 J**	**16**	**0.19 J**	**0.47 J**	**1**	**0.75 J**
7W																
PCE	1 U	**0.19 J**	1 U	1 U	1 U	**1.7**	**0.47 J**	**0.15 J**	**0.38 J**	1 U	**0.53 J**	1 U	1 U	1 U	1 U	1 U
TCE	1 U	2 U	1 U	1 U	1 U	1 U	**0.26 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
DCE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
8W																
PCE	1 U	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
TCE	1 U	2 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
MW-5																
PCE	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
TCE	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-6																
PCE	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
TCE	1 U	2 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-7																
PCE	1 U	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
TCE	1 U	2 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
MW-8																
PCE	1 U	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
TCE	1 U	2 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--

PCE = tetrachloroethylene. TCE = trichloroethylene. DCE = cis-1,2-dichloroethylene.

U = Analyte was not detected at or above the reported value.
J = Analyte was positively identified. The associated numerical result is an estimate.
UJ = Analyte was not detected at or above the reported estimated result.
* = Average concentration of duplicate samples.
Bold = Analyte was detected.