Five-Year Review Report

Fifth Five-Year Review Report

for

Lakewood/Ponders Corner Superfund Site

Lakewood, Washington

September 2012

PREPARED BY

United States Army Corps of Engineers

Seattle District

Seattle, Washington

Approved by: **Date:**

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Executive Summary

The Lakewood/Ponders Corner Superfund site is located in the city of Lakewood in Pierce County, Washington. In 1981, the U. S. Environmental Protection Agency (EPA) sampled the Lakewood Water District drinking water supply wells H1 and H2. The tests indicated that wells H1 and H2 were contaminated with volatile organic compounds (VOC), i.e., tetrachloroethylene (PCE), trichloroethylene (TCE) and cis-1,2 dichloroethylene (cis-1,2 DCE). The source of contamination was identified as Plaza Cleaners, a dry cleaning and laundry facility.

The Lakewood/Ponders Corner Superfund site was listed on the National Priorities List (NPL) on December 30, 1982. A Record of Decision (ROD) was signed on June 1, 1984 to include the installation of the air strippers to treat contaminated groundwater. A remedial investigation and feasibility studies were completed during August 1984 through July 1985. Selected remedies to address soil contamination at Plaza Cleaners include the excavation of contaminated soils, removal of contaminated sludge and off-site disposal. A ROD was signed on September 30, 1985 and amended in November 14, 1986 to include the installation of a soil vapor extraction system (SVES) for treating a small portion of contaminated soil in the vadose zone. An Explanation of Significant Difference was signed in 1992 to excavate additional soil and sludge in the septic field. The soil remediation was completed in 1993 and EPA announced in the Federal Register the partial deletion of the Lakewood site “Soil Unit” from the NPL, effective November 27, 1996.

The selected remedy for the groundwater is a well head treatment system. By November 1984, two air strippers were constructed at Lakewood Water District production wells H1 and H2 and began operating to treat the contaminated groundwater. The treated groundwater meets Safe Drinking Water Act Maximum Contaminant Levels standards (after air stripping). The groundwater treatment system is still in operation, since the groundwater cleanup levels have not been achieved throughout the site.

On September 15, 1992, an Explanation of Significant Difference (ESD) was issued to establish site-specific cleanup levels for contaminants in soil and groundwater, excavate soils, and revise the institutional control requirements at the site. The success of the final soil remedial action eliminated the need for institutional controls (as called for in the original ROD) on land use. Since initiation of the groundwater treatment program, EPA has utilized public outreach and education to implement administrative restrictions on the installation and use of drinking water wells within the contaminated area.

EPA conducted five-year reviews in 1992, 1997 and 2007. Washington Department of Ecology (Ecology) conducted a five-year review in 2002. This fifth five-year review was conducted by the U.S. Army Corps of Engineers (USACE) for EPA.

The production wells and air stripper operation and maintenance are conducted by the Lakewood Water District. Groundwater monitoring is performed by the Washington State Department of Ecology.

The remedy is functioning to the extent that extracted groundwater is suitably treated for public consumption. The remedy is not performing as expected from a long-term protectiveness perspective towards the attainment of groundwater cleanup levels throughout the entire plume in the period of time anticipated in the Record of Decision. However, the Responsiveness Summary of the ROD acknowledged that the 10-15 year estimate in the ROD was the minimal amount of time estimated to reach cleanup goals. The pump and treat system does appear to capture the contaminated groundwater in the Advanced outwash unit.

The continuing migration of contaminants from lower permeability soils is the likely cause for ongoing impacts to groundwater, and represents one of the major physical barriers to attaining groundwater cleanup levels throughout the entire plume. This is evidenced by the lack of decreasing concentration trends in MW-16A. This is consistent with the conceptual site model for the Site. It is acknowledged that continued leaching of PCE from the till unit will likely require the indefinite operation of the air strippers on the public water supply wells. The pumping of production wells H1 and H2 does produce a capture zone in the Advance outwash sand but it does not directly impact the above till unit. MW-20B which is screened in the till unit does have a downward vertical hydraulic gradient and the water quality data does show increasing PCE concentrations in MW-16A. This is evidence that pumping of H1 and H2 does have a positive impact on controlling the plume coming from the till unit to the advance outwash towards the pumping center of H1 and H2.

The treatment system (air strippers) is currently working as designed. It is unknown whether the design of the strippers considered seismic requirements. In the event of an earthquake, damage to the air strippers may impact the supply of potable water to area residents.

Standards that have changed within the last five years do not affect the protectiveness of the remedy. Exposure pathways described in the ROD have not changed. The vapor intrusion pathway was not evaluated during the ROD. Changes in toxicity values have changed for PCE and TCE in the last five years. These changes do not affect the protectiveness of the remedy; the MCLs (the cleanup goals for this site) are currently being met in the treated water. However, the MCLs may change in the future due to the changes in toxicity values and it is recommended that subsequent five-year reviews check for any changes to the MCLs.

The remedy at the Lakewood/Ponders Corner Superfund Site is considered protective of human health and the environment in the short-term because exposure pathways that could result in unacceptable risks are being controlled through the treatment of groundwater to concentrations below MCLs for public consumption and the Tacoma-Pierce County Health Departments Environmental Health Code Chapter 3(6)(c)(13) Drinking Water Board of Health Resolution 2010-4223, prohibitsthe installation of new water wells within the Urban Growth Boundary. The site is within the Urban Growth Boundary of Lakewood.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name (from WasteLAN): Lakewood/Ponders Corner Superfund Site		
EPA ID (from WasteLan): WAD050075662		
Region: 10	**State: WA**	**City/County: Tacoma/Pierce**

SITE STATUS	
NPL Status: Final, Deleted (Soil Unit only)	
Multiple OUs? No	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:** Click here to enter text.
Author name (Federal or State Project Manager): Christopher Cora
Author affiliation: US EPA
Review period: October 2007 – January 2012
Date of site inspection: April 16, 2012
Type of review: Statutory
Review number: 5
Triggering action date (from WasteLan): 9/24/2007
Due date *(five years after triggering action date)*: 9/24/2012

Five-Year Review Summary Form (continued)

Issues/Recommendations				
OU(s) without Issues/Recommendations Identified in the Five-Year Review:				
NA				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): Ground water	**Issue Category: Remedy Performance**			
	Issue: Determine the current capture zone in the advance outwash sands for H1 and H2 at the current pumping rates.			
	Recommendation: Develop a target capture zone based on the current monitoring well network and PCE concentrations. Use the six steps for systematic evaluation of capture zones, EPA 600/R-08/003 January 2008.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA/State	September 2013
OU(s): Ground water	**Issue Category: Remedy Performance**			
	Issue: LPMW-2 has low concentrations of PCE screened in the Steilacoom gravels near the original source zone. A determination of the fate and transport of this dissolved PCE concentration in this monitoring well is needed to determine whether it is significant			
	Recommendation: Evaluate existing information on groundwater flow direction in the Steilacoom gravels at LPMW-2. Install a down gradient Monitoring well from LPMW-2 and sample for VOCs.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA/State	September 2013
OU(s): Ground water	**Issue Category: Remedy Performance**			
	Issue: Aging air stripper system with significant expenditures for repairs and replacement, and seismic design need to be evaluated			
	Recommendation: Evaluate optimization of the treatment facility to operating one air stripper at a time, and reducing blower airflow rates with smaller units or variable speed motors. Check air stripper design for seismic stress.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA/State	EPA/State	September 2014
OU(s): Ground water	**Issue Category: Remedy Performance**			
	Issue: Time for restoration of the aquifer (greater than 100 years) is anticipated to exceed the ROD estimates, due to leaching of PCE from the Vashon Till unit.			
	Recommendation: Evaluate restoration time frame for the aquifer and alternatives to accelerate restoration if necessary.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	September 2017

Protectiveness Statement(s)		
Operable Unit: **Sitewide**	***Protectiveness Determination:*** **Short-term Protective**	***Addendum Due Date (if applicable):*** **Click here to enter date.**
Protectiveness Statement: The remedy at the Lakewood/Ponders Corner Superfund Site is considered protective of human health and the environment in the short-term because exposure pathways that could result in unacceptable risks are being controlled through the treatment of groundwater to concentrations below MCLs for public consumption and the locality maintains restrictions prohibiting the installation of new water wells within this area. In order to optimize the remedy and ensure it is protective in the long-term, an evaluation is required to determine pump and treat system capture zone, the full extent of the contaminant plume in the till layer, and if additional treatment would facilitate accelerating the restoration of the aquifer. The results of this evaluation would determine whether additional actions are required.		

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List of Abbreviations

ACGIH	American Conference of Govermental Industrial Hygenists
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2 DCE	cis-1,2 dichloroethylene
Ecology	Washington Department of Ecology
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Difference
FFS	Focused Feasibility Study
FS	Feasibility Study
FYR	Five Year Review
g	Unit of acceleration
HQ	Hazard quotient
IDLH	Immediately Dangerous to Life and Health
IRIS	Integrated Risk Information System
IRM	Initial Remedial Action
IUR	Inhalation unit risk
MAROS	Monitoring and Remediation Optimization System
MCL	Maximum Contaminant Level
MTCA	Washington Model Toxics Control Act
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
ppb	parts per billion
PCE	Tetrachloroethylene
PRGs	Preliminary Remediation Goals
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RfC	Reference concentration
RfD	Reference dose
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager

RSL	Regional screening level
SARA	Superfund Amendments and Reauthorization Act
SF	Slope factor
SVES	soil vapor extraction system
Tbc	To-be-considered
TCE	Trichloroethylene
TLV	Threshold Limit Value
TWA	Time-Weighted Average
USACE	United States Army Corps of Engineers
VOC	Volatile Organic Compound

1. Introduction

This is the fifth five-year review (FYR) for the Lakewood/Ponders Corner Superfund site (Site) in Tacoma, Washington. The 1986 Record of Decision (ROD) amendment triggered the first five-year review. The triggering action for this review is the previous five-year review report dated September 24, 2007. The five-year review is required because hazardous substances, pollutants, or contaminants remain at the site above the levels that allow for unlimited use and unrestricted exposure. Although the selected remedy will not leave contaminants on site above unlimited use and unrestricted exposure levels when completed, this review is required by U.S. Environmental Protection Agency (EPA) policy because it will take more than five years to reach groundwater cleanup goals.

The EPA conducted this five-year review of the remedy implemented at the site. This review is required by EPA policy. This review was conducted by the EPA Project Manager for the period from September 2007 through September 2012. This report documents the results of the review.

1.1. Purpose

The purpose of the five-year review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

1.2. Authority

The Agency is preparing this five-year review pursuant to Comprehensive Environemtal Response Compensation and Liability Act (CERCLA) §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

This review was conducted from April 2012 through June 2012. This report documents the results of the review. The triggering action for this review is the date September 24, 2007.

2. Site Chronology

Table 1 Chronology of Site Events

Event	Date
Lakewood Water District drinking water production wells (H1 and H2) were sampled by EPA and revealed contamination of tetrachloroethylene (PCE), trichloroethylene (TCE) and cis-1,2 dichloroethylene (cis-1,2 DCE)	July 1981
Lakewood Water District wells H1 and H2 were temporarily taken out of service while monitoring wells were installed	August 1981
Source of contamination is suspected to be Plaza Cleaners located approximately 800 feet north (upgradient) of the Lakewood Water District production wells	1981
Final listing on EPA National Priorities List (NPL)	December 30, 1982
Stipulated agreement for remedial action reached between Ecology and Plaza Cleaners	September 1983
Cleanup of site soils, removal of drummed sludge, liquid and contaminated solids from septic tanks	1983-1987
EPA completed a focused feasibility study (FFS) identifying an Initial Remedial Action (IRM)	May 1984
Record of Decision (ROD) selecting the air stripping remedy for contaminated groundwater is signed	June 1, 1984
Remedial Investigation conducted by EPA contractor	August 1984 – July 1985
Two air strippers installed at Lakewood Water District production wells H1 and H2 to treat contaminated groundwater	November 1984
EPA confirmed source of soil and groundwater contamination to be effluent discharges from septic tanks behind the Plaza Cleaners building and sludge disposal on the ground surface	1985
Feasibility Study made available to public	July 1985
ROD selecting continued operation of the air strippers, additional groundwater monitoring wells, excavation of septic tanks and drainfield, and the placement of administrative restrictions on the wells and excavation of contaminated soils is signed	September 30, 1985
Amended ROD is signed for modifications to the soils unit cleanup, i.e. installation of a soil vapor extraction system (SVES) for treatment of soils in place, reduction in the amount of septic tank contents to be removed and treated off-site, and continued soil and vapor testing until soil treatment was deemed complete	November 14, 1986
Soil excavation alternative implemented	June 1992 – July 1992
Explanation of Significant Differences (ESD) issued by EPA, primarily to (1) establish site-specific cleanup levels for contaminants in soil and groundwater; (2) eliminate the requirement to implement institutional controls on land and ground water use; and (3) document revisions to the remedial action necessary to remove the source of contamination at the site	September 15, 1992
First five-year review report prepared by EPA	September 1992
Preliminary Close-out Report signed.	September 29, 1992
Certification of completion for the Soils Unit Cleanup	May 6, 1993

Event	Date
EPA announced, in the Federal Register, the partial deletion of the Lakewood site “Soil Unit” from the NPL	November 27, 1996
EPA sent letter to residences, realtors, and well drillers regarding administrative control restrictions	February 24, 1997
Operation & Maintenance (O & M) responsibility was transferred to the state (Ecology) as a part of the on-going long term response action	July 1997
Second five-year review report prepared by EPA	September 1997
Third five-year review report prepared by WA state Department of Ecology	September 2002
EPA sent letter to residences, realtors, and well drillers regarding administrative control restrictions. Notices were sent to trade magazines (for well drillers), and realtors.	March 2007
Fourth five-year review report prepared by EPA	September 2007
EPA sent letters to realtors and well drillers regarding administrative control restrictions.	March 2008
EPA sent out fact sheets notifying homeowners, realtors, and well drillers regarding administrative control restrictions and site information	May 2012
Washington Department of Ecology decommissioned three monitoring wells	July 2012

3. Background

3.1. Physical Characteristics

The Lakewood/Ponders Corner site is located in Pierce County, Washington, south of the city of Tacoma on Pacific Highway Southwest. It includes the property upon which Plaza Cleaners had operated a dry cleaning business for many years. The dry cleaner no longer operates at the property. The former Plaza Cleaners property is located at 12509 Pacific Highway Southwest in Tacoma and is bounded by Interstate 5 to the south, and surrounded on the remaining three sides by a commercial/light industrial area. Approximately one-tenth of a mile farther north of the former Plaza Cleaners is a predominantly residential area. Lakewood Water District has two of its production wells (H1 and H2) within a fenced area south of the former Plaza Cleaners, across Interstate 5. The production wells H1 and H2 serve approximately 150 homes. Residential property lies to the east and McChord Air Force Base to the southeast of these wells. Figure 1 shows the location of the site. The production wells are operated in rotation. Well H1 is pumped at 1400 gallons per minute (gpm) during the summer months; and H2 is pumped at 1100 gpm for the rest of the year.

The Lakewood/Ponders Corner Site is situated on an upland drift plain that slopes gently to the northwest, terminating at Puget Sound. The area around Ponders Corner has a maritime climate with cool, wet winters and warm, dry summers. Average annual precipitation is 40 inches, 85 percent of which falls during the months of September through April. Mean lake evaporation is about 23 inches per year. Most of the evaporation occurs during the months with lowest precipitation, indicating a strong seasonal trend for groundwater recharge and surface runoff. Local annual recharge for the open area immediately behind Plaza Cleaners is estimated to be about 17 inches, or about 40 percent of the total precipitation. Recharge in areas adjacent to Plaza Cleaners will be less because much of the area is paved and drained to storm sewers.

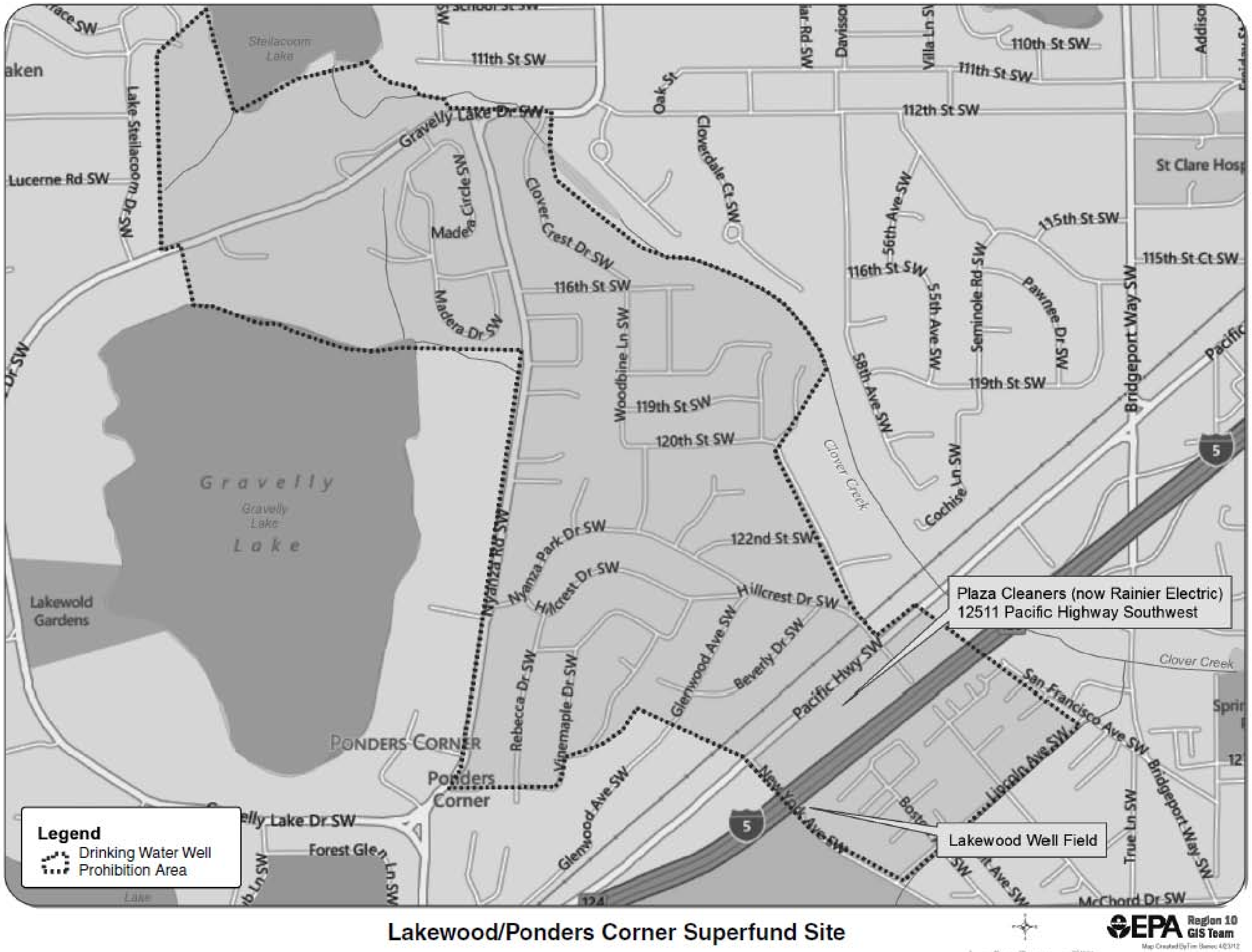

Figure 1. Site Location Map

The four hydrogeological units of interest which underlie the Ponders Corner area are shown in Figure 2 and as follows:

- The permeable sands and gravels of the recessional outwash deposits, known as the Steilacoom gravels. This unit typically ranges from 0 to 30 feet below ground surface (bgs).
- The semi-confining silt and clay-rich Vashon till that contains lenses of clean gravel in places. This unit typically ranges from 30 to 75 feet bgs.
- The highly stratified, yet permeable, Advance outwash deposits that form the primary aquifer. This unit typically ranges from 75 to 110 feet bgs.
- The generally less permeable Colvos sand that grades to a clayey sand or blue clay at its base. This unit is typically observed beyond 110 feet bgs.

The Steilacoom gravels are typically unsaturated, except in an area east of the former Plaza Cleaners and near wells Hl and H2. In these areas perched, saturated zones several feet thick can exist. These zones are capable of yielding several tens of gallons per minute.

The underlying Vashon till is highly variable in thickness. It is thickest to the north and west of the former Plaza Cleaners and becomes quite thin, and possibly discontinuous, southeast of wells Hl and H2. At least one of the gravel layers is present over a fairly large area, including the Plaza Cleaners. This permeable interval appears to be hydraulically interconnected with the Steilacoom gravels. While the upper portion of the till is generally unsaturated, saturated zones can be found elsewhere, particularly near the bottom of the till and in gravel lenses found in this zone. Little is known about the hydrologic properties of the Vashon till.

Underneath the Vashon till are highly permeable sands and gravels of the Advance outwash. Most monitoring wells are screened in this aquifer, most in the basal portion at depths of 80 to 120 feet, bgs. This basal portion tends to be the most permeable part. Horizontal hydraulic conductivities vary from 400 to 2000 feet per day. Linear flow velocities range from 2.7 ft/day to 100 ft/day.

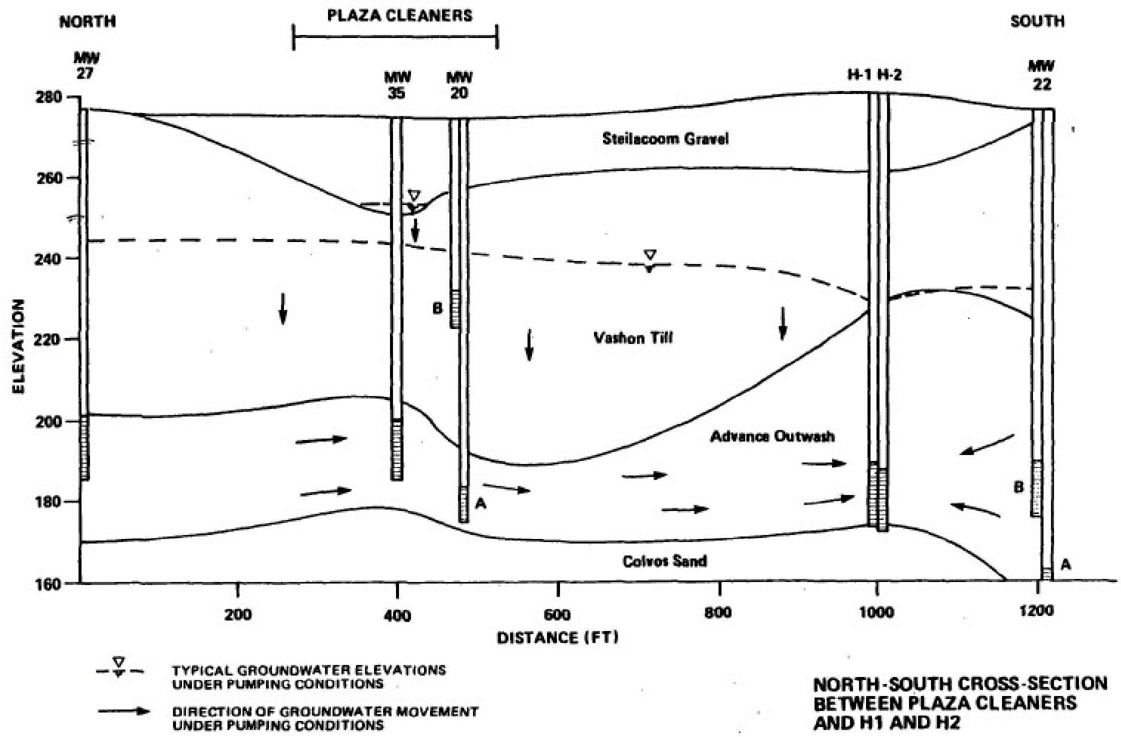

Figure 2. Geological Cross Section of Site

3.2. Land and Resource Use

The former location of Plaza Cleaners is currently occupied by Rainier Lighting and Electric Supply. The current land use for the surrounding area is residential and commercial. The Lakewood Water District wells (H1 and H2) are located approximately 800 feet downgradient of the former Plaza Cleaners facility, on the other side of Interstate 5, a 6 lane divided highway. It is anticipated that a mix of land uses similar to that described will continue into the future. Soil remediation has been completed at the former Plaza Cleaners facility.

The groundwater aquifer underlying the site is currently used as a drinking water source. Treatment of groundwater continues via air stripping at the Lakewood Water District production wells (H1 and H2). Treated water discharged to the distribution system consistently meets the drinking water system discharge criteria. The Site is within the Urban Growth Boundary of the City of Lakewood. Pursuant to Tacoma-Pierce County Health Departments Environmental Health Code Chapter 3(6)(c)(13) Drinking Water Board of Health Resolution 2010-4223, the installation of new water wells within the Urban Growth Boundary is prohibited.

3.3. History of Contamination

In July 1981, EPA sampled drinking water wells in the Tacoma area for contamination by volatile organic compounds (VOCs). The sample results indicated that the Lakewood Water District's production wells H1 and H2 were contaminated with trichloroethylene (TCE), tetrachloroethylene (PCE) and cis-1, 2 dichloroethylene (cis-1, 2 DCE). In August 1981, H1 and H2 were temporarily taken out of service. The source of the contamination was determined to be Plaza Cleaners, a dry cleaning and laundry business, located approximately 800 feet north of the Lakewood Water District production wells H1 and H2.

During August 1981, the Washington Department of Ecology (Ecology) inspected several businesses near the production wells for potential sources of contamination. Plaza Cleaners, across the freeway and about 800 feet away-from-the production wells, was the only business identified as a major potential source of contamination. Plaza C1eaners operated a dry cleaning and laundry business with three dry cleaning machines, two reclaimers (dryers), and five commercial washing machines. Some solvent used in the dry c1eaning process was discharged into the cleaner's septic tank system. Other wastes containing solvent were deposited on the ground outside the building.

The Lakewood/Ponders Corner Site was added to the National Priorities List (NPL) on December 30, 1982.

3.4. Initial response

In April 1983 it was confirmed that contamination had resulted from the dumping of PCE into three on-site bottomless septic tanks behind Plaza Cleaners, causing contamination of the soils. It was also confirmed that sludge was disposed of on the ground surface.

An agreement for remedial action was reached between Ecology and Plaza Cleaners in September 1983. Plaza Cleaners agreed to discontinue their prior solvent disposal practices, install a system for reclaiming cleaning solvents, send stored drummed waste water and contaminated soil to a suitable off-site disposal facility, and cooperate in the immediate cleanup of the sludge disposal areas. Plaza Cleaners successfully fulfilled the terms of the agreement.

In May 1984, EPA completed a focused feasibility study (FFS) identifying an Initial Remedial Measure (IRM) needed to address those contaminant problems posing the most immediate threat at the site.
A Record of Decision (ROD) was signed June 1, 1984 prescribing the use of air strippers to treat the contaminated groundwater used by the Lakewood Water District as the IRM. By November 15, 1984, two air strippers had been installed and were operating to treat wells H1 and H2. The Puget Sound Air Pollution Control Agency (now the Puget Sound Clean Air Agency) issued a permit (subsequently cancelled because CERCLA remedial actions do not require permits) for the H1 and H2 air stripping towers treatment facility. The stack emissions from the air stripping towers at the extraction wells met all technical requirements and ambient air quality standards for discharge.

3.5. Basis for Taking Remedial Actions

From August 1984 to July 1985, a Remedial Investigation (RI) was conducted to further determine the extent of groundwater contamination at the site, test the soil at Plaza Cleaners for remaining contaminants, and determine whether other sources were contributing to the groundwater problem.

The RI indicated that PCE contamination in soils was highest where the solvent-contaminated wastes were intentionally disposed on the ground surface. Most of the PCE from the soil borings and test pit was located in the upper 12 to 13 feet of soil in the immediate vicinity of the dry cleaner's septic tanks and drain field. PCE concentrations in soil ranged from 11 parts per billion (ppb) to 3,800 ppb. Maximum TCE and cis-1,2-DCE concentrations in soil were 5 ppb and 4 ppb, respectively.

Effluent discharge from the drain field provided a significant driving force for contaminant migration. The effluent discharge flow rate of was calculated to be 20,000 gallons per day, about 40 times greater than the estimated recharge rate of 17 inches per year for the area immediately behind plaza cleaners. Based on the available soils and geologic data, it appears that the effluent migrated vertically through the Steilacoom gravels. Upon reaching the surface of the Vashon till, it may have migrated laterally along the surface of the till until it reached a conduit into the till. Possible conduits through the till include the gravel lenses known to exist in the vicinity of plaza cleaners, discontinuities in the till where it thins to the southeast, or the suspected but never substantiated presence of dry well(s). The contamination then worked its way vertically and laterally through the till into the Advance outwash. Once in the Advance outwash, the contamination moved laterally towards well H1 and H2 (figure 2) due to the reversal of groundwater flow direction in the Advanced outwash because of the capture zone created by wells H1 and H2.

During the time when wells H1 and H2 were taken out of service, contaminant migration in the Advance outwash was mainly to the northwest in response to the regional flow gradient. During this time some contamination may have migrated beyond the zone of capture for wells H1 and H2.

The rate of contaminant migration in the Steilacoom gravels and Vashon till has probably decreased substantially following the cessation of discharges from the Plaza Cleaner's septic tanks in July of 1983. Contaminant migration in these zones is now controlled by local natural recharge.

The RI also indicated that the PCE concentration in the two production wells (H1 and H2) ranged from 100 ppb to 500 ppb prior to initiating the groundwater treatment. Contaminant concentrations decreased rapidly after several days of pumping, and continued to decrease. The maximum and mean concentrations in other groundwater monitoring wells prior to treatment were: PCE at 922 ppb and 16 ppb, respectively, and TCE at 57 ppb and 3 ppb, respectively. The only detected concentration for cis-1, 2-DCE was 85 ppb in a monitoring well upgradient of the production wells. The treated groundwater meets MCLs.

The basis for taking remedial action is to protect human health and the environment from contaminants found in soils and ground water at the Lakewood/Ponders Corner Superfund site. If remedial action was not conducted, unacceptable risk from contaminants could increase the risk to individuals in the area. Thus, remedies were put in place to reduce possible risk and insure that exposure to contaminants would be limited, if not eliminated.

4. Remedial Actions

4.1. Regulatory actions

The Lakewood/Ponders Corner Superfund site was listed on the NPL on December 30, 1982. The Remedial Investigation and Feasibility Studies were completed during August 1984 through July 1985. A Record of Decision was signed June 1, 1984 and on September 30, 1985. An amended ROD was signed on November 14, 1986. An Explanation of Significant Difference (ESD) was signed on September 15, 1992.The soil remediation was completed in 1993, and EPA announced in the Federal Register the partial deletion of the Lakewood site "Soil Unit" from the NPL, effective November 27, 1996.

4.2. Remedial action objectives

The remedial action objectives (RAOs) of the 1984 ROD were to:

- Restrict the spread of contamination within the aquifer
- Restore normal water service to the area; and
- Initiate groundwater treatment as quickly as possible.

The RAOs in the 1985 ROD consisted of the following:

- Evaluate the potential health risks associated with the no-action alternative which assumes continued stripping towers operation
- Reduce potential health risks associated with on-site excavation and use of contaminated groundwater below those for no-action alternative
- Meet requirements of other environmental regulations
- Increase the efficiency of the existing IRM, to reduce energy requirements and thereby reduce costs.

These RAOs are retained in the 1986 ROD amendment and the 1992 ESD.

4.3. Remedy description

The selected remedy components in the 1984 ROD consisted of the installation of two air stripping towers.

The selected remedy components in the 1985 ROD consisted of the following:

- Continued operation of the H1 and H2 production wells treatment system to clean up the aquifer.
- Installation of higher efficiency equipment or modification of existing equipment used in the treatment system.
- Installation of additional monitoring wells, upgrade existing wells, and continuation of routine sampling and analysis of the aquifer to monitor progress and provide early warning of potential new contaminants.
- Excavation and removal of contaminated septic tanks and drain field piping on the Plaza Cleaners property to avoid the possible spread of contamination via uncontrolled excavation (i.e. future property development).
- Placement of administrative restrictions on the installation and use of groundwater wells and on excavation into the contaminated soils to minimize the potential for use of contaminated groundwater and reduce the risks associated with uncontrolled excavation.

The 1986 ROD amendment provided changes to the selected remedy in the 1985 ROD related to the contaminated soil. These changes are as follows:

- Cleanout the three existing septic tanks
- Construct a soil vapor extraction system (SVES) concentrated along the drain field lines.
- Continue soil and vapor analysis until soil treatment is complete.

The 1992 ESD provided additional changes to the 1985 ROD and 1986 ROD amendment. These changes are as follows:

- Excavate remaining PCE-contaminated sludge
- Establish cleanup goals for soil and groundwater
- Eliminate Land Use Restrictions

- Maintenance of current groundwater use restrictions
- Elimination of future groundwater use restrictions

4.4. Remedy implementation

The fiberglass air strippers were installed by November 1984 and have continued to operate since.

Table 2 lists the current list of wells sampled, depth to groundwater, and their sampling frequency. Ecology has been sampling the monitoring and the production wells since 1992. Figure 3 shows the location of these wells.

Table 2. Current Monitoring Wells

Monitored wells	Stratigraphic Unit of well screen	Depth to Groundwater (feet below top of well)	Sampling Frequency
MW-16A	Advanced outwash	37.76[1]	Semi-annually
MW-19A	Advanced outwash	38.41[1]	Once every 2 years
MW-20A	Advanced outwash	32.57[1]	Semi-annually
MW-20B	Vashon till	33.18[1]	Semi-annually
MW-27	Advanced outwash	31.58[1]	Semi-annually[5]
MW-31	Advanced outwash	38.05[1]	Once every 2 years
MW-32	Advanced outwash	57.93[2]	Once every 5 years
MW-33	Advanced outwash	34.83[1]	Annually
MW-40	Advanced outwash	35.95[1]	Once every 5 years[5]
MW-41	Advanced outwash	26.69[2]	Once every 5 years[5]
LPMW-1[3]	Steilacoom gravels	--	Annually (not installed by Ecology or EPA)
LPMW-2	Steilacoom gravels	20.07[4]	Annually (not installed by Ecology or EPA)
LPMW-3[3]	Vashon till	--	Annually (not installed by Ecology or EPA)
H1/H2[6]	Advanced outwash	--	One or the other semi-annually, depending on which is running.

1 – Water levels from October 2011
2 – Water levels from June 2010
3 – These wells were removed from the monitoring program in May 2008 because of access restrictions and no PCE detected
4 – Water level from June 2011
5- These wells were decommissioned in July 2012
6 – Dedicated pump obstructed water-level measurement
A – deep well (Advance outwash)
B – shallow well (Vashon till)

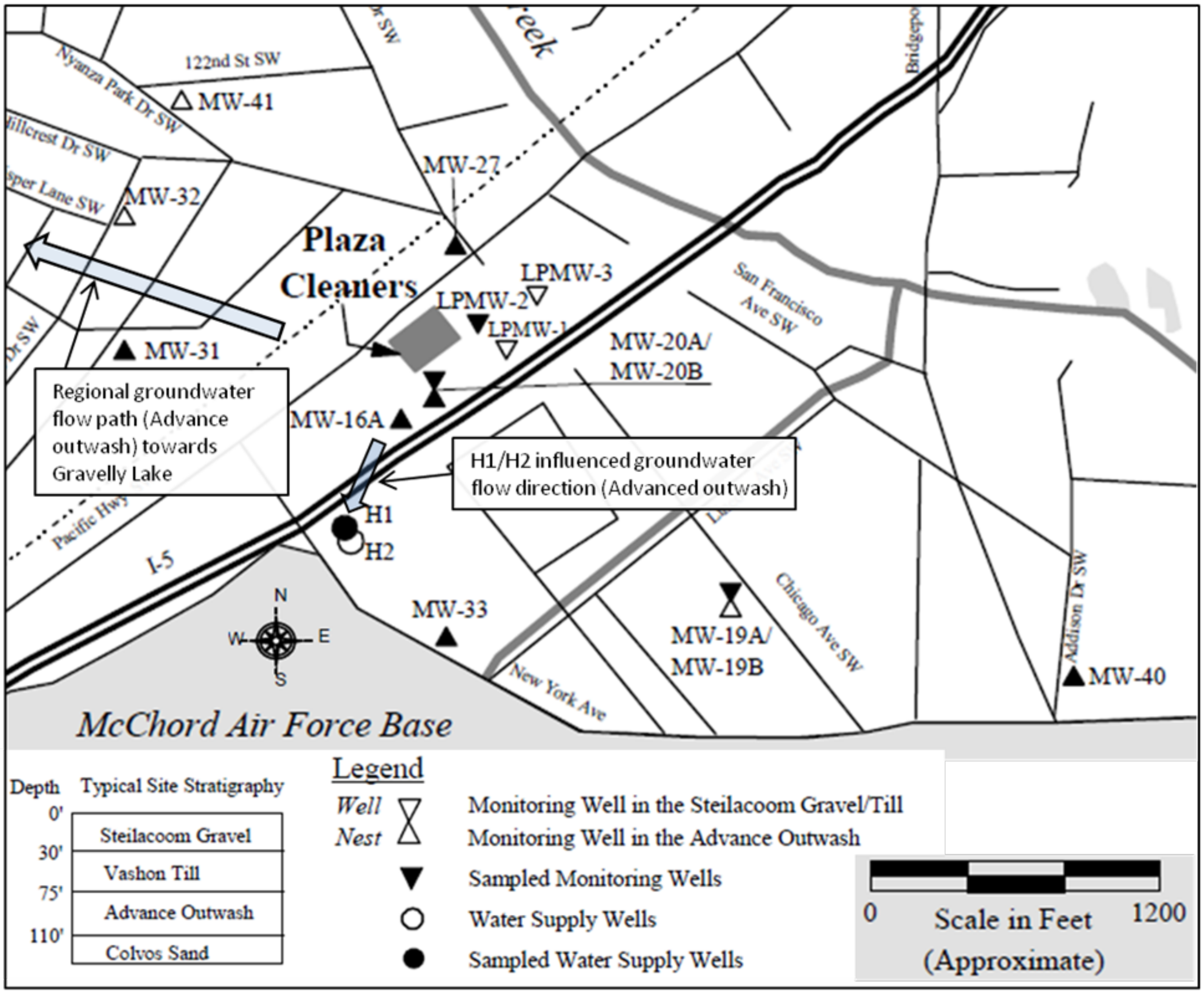

Figure 3. Monitoring Well Location Map

In 1987, EPA successfully removed contaminated solids and any water from three on-site septic tanks (which were used for disposal of dry cleaning wastes) and disposed of the contaminated material off-site. The remainder of the contaminated soil within the septic tanks and around the historical drain field was treated using a SVES.

The SVES was installed in 1987 operating intermittently between 1988 and 1989. Follow-up soil sampling conducted in October 1990 indicated elevated PCE concentrations at approximately 10 to 12 feet below ground surface remained. EPA decided to excavate the contaminated sludge and soil for off-site disposal. The SVES was then decommissioned and dismantled.

July 1992, EPA completed final remediation of this area by excavating the contaminated sludge which was transported to an approved off-site disposal facility for incineration. Contaminated soil from above and around the contaminated sludge was also excavated during the final remedial action. All contaminated waste was removed from the site by the end of September 1992. The soil unit was removed from NPL in 1996.

Soil and groundwater cleanup levels were established as part of the 1992 ESD. The following table presents these cleanup levels.

Table 3. 1992 Soil and Groundwater Cleanup Levels

Contaminant	Cleanup Level (ppb)
Soil	
PCE	500[1]
Groundwater	
PCE	5[2]
TCE	5[2]
1,2-DCE	70[2]

1 – Model Toxics Control Act (MTCA) Method A
2 – Federal maximum contaminant level (MCL)

The institutional controls established in the 1992 ESD include the following.

- Eliminate the land use restrictions established in the 1985 ROD because of the successful soil remediation
- Maintain current groundwater use restrictions by public outreach and education. This includes notifying homeowners within the plume, well drillers, and realtors of the potential risks associated with contaminated groundwater use.
- Eliminate future groundwater use restrictions established in the 1985 ROD because of public outreach and education.

4.5. Systems operations/Operations & Maintenance

In October 1985, the Lakewood Water District assumed all the O&M costs associated with the stripping towers at wells H1 and H2. This includes inlet/outlet water sampling and analysis for the contaminants of concern, pump maintenance and inspection, general equipment observations, and maintaining data records. Ecology assumed operation and maintenance responsibilities related to groundwater monitoring in 1992. In July 1997, EPA sent a letter to Ecology clarifying the operation and maintenance responsibilities that the state must provide or otherwise assure for the long term response actions at the site. Ecology's O&M responsibilities for long term response action at the site include:

- Activities involving O&M of the air stripping facility and existing groundwater monitoring wells;
- Compliance monitoring of the air stripping facility;
- Decommissioning, dismantling, and disposing of the air strippers and associated equipment after restoration goals for groundwater are met; and,
- Abandonment and decommissioning of existing groundwater monitoring wells after the plume has withdrawn and certain wells are no longer needed.

To date, the routine O&M of the groundwater treatment system (air strippers) is being performed by the Lakewood Water District and the routine (see Table 2) groundwater monitoring is being conducted by Ecology. No significant problems regarding the routine O&M of the treatment system has been reported to Ecology by the Lakewood Water District.

In December 2004, three test/observation wells were installed by the owner of the property adjacent to the former Plaza Cleaners location as part of a state voluntary cleanup action. According to Ecology staff, these wells were installed for monitoring purposes and not to serve as drinking water wells. In May 2006, Ecology obtained permission to sample these wells (LPMW-1, LPMW-2, and LPMW-3; Figure 2) to add to the data collected for the Lakewood/Ponders Corner Site. Currently, only LPMW-2 is being actively sampled. LPMW-1 and LPMW-3 were removed from the groundwater monitoring program in 2008 due to access restrictions and no detections of PCE.

In a September 11, 2007 letter from Ecology, EPA was further informed that anyone seeking permission from the Tacoma Pierce County Health Department to install a drinking water well in the vicinity of the site would be denied because the groundwater is contaminated and the site is in the urban growth area. Private drinking water wells are prohibited in the urban growth area. Figure 1 shows the area where private drinking water wells, if installed, could be impacted by PCE contamination in the Advanced Outwash Aquifer.

Currently, the production wells are operating on a 6 month alternating cycle; i.e. Well H1 operates for six months, and then Well H2 operates for six months. Also the wells are not operated continuously. In the winter, the wells may only operate 3 to 4 hours per day. In the summer, the wells may operate 14 to 18 hours per day. The maximum flow rates for Wells H1 and H2 are 1,400 gpm and 1,100, respectively.

4.5.1. Summary of costs of system operations

The average annual cost for the O&M of production well treatment which includes electrical power is approximately $5,300.

The annual costs to conduct groundwater monitoring, analytical testing, and producing a monitoring report is approximately $10,300.

5. Progress since the Last Five-Year Review

5.1. Protectiveness statements from last review

The protectiveness statement from the last FYR is as follows:

"The remedy at the Lakewood/Ponders Corner Superfund Site currently protects human health and the environment because contaminants in soils and sludges that were sources to groundwater have been addressed through removal and off-site disposal, an air stripping system has been implemented to treat contaminated groundwater used for drinking, and institutional controls are in place to prevent new drinking water wells in the plume. However, in order to ensure the remedy remains protective in the long-term the following actions need to be taken:

- evaluate the pump and treat system capture zone to ensure the system is adequate to achieve the cleanup goals throughout the contaminant plume in a reasonable time frame and if not, determine what additional actions are needed, and
- increase the frequency of the public outreach and education program to restrict installation and use of drinking water wells, determine whether that is sufficient to ensure the remedy remains protective until cleanup goals are met, and if not, implement additional administrative restrictions (institutional controls)."

5.2. Status of recommendations and follow-up actions from last review

The status of recommendations and follow-up actions from the last FYR are presented in Table 4.

Table 4. Actions Taken Since the Last Five-Year Review

Issues from Previous Review	Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
The need for Ecology and EPA to discuss the existing monitoring wells and determine whether any of these wells can be decommissioned.	Schedule and conduct discussions between Ecology and EPA to determine the appropriateness of decommissioning any of the monitoring wells.	Ecology	June 2008	Discussions have occurred within the last five years. Three wells (MW-27, MW-40, and MW-41) were decommissioned.	July 2, 2012.

Issues from Previous Review	Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
The need to update the institutional control plan for this site to ensure that updated information on the groundwater plume is sent frequently enough to residences, realtors, and well drillers. As part of developing the plan, EPA and Ecology need to evaluate whether increasing the frequency will be adequate to meet the remedial action objective to restrict installation and use of drinking water wells to ensure the remedy remains protective until cleanup goals are met or whether additional institutional controls are needed.	Schedule and conduct discussions to develop an updated institutional control plan for this site to ensure that residences, realtors, and well drillers are updated frequently enough about the groundwater plume, clarify who has the O&M responsibility for doing so, determine whether that is sufficient to restrict installation and use of drinking water wells to ensure the remedy remains protective until cleanup goals are met, and if not, implement additional administrative restrictions (institutional controls).	Ecology and EPA	June 2008	Letters were sent in 2008 to inform realtors and drillers about the contaminated groundwater underlying private properties. In 2012, EPA published a fact sheet with updates to the site.	March 2008/ May 2012

Issues from Previous Review	Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
The need for Ecology and EPA to discuss whether Tacoma Pierce County Health Department's denying of applications for private well installation should be documented as part of the remedy through an ESD.	Schedule and conduct discussions to determine whether the Health Department's denying of applications for private well installation should be documented as part of the remedy through an ESD.	Ecology and EPA	June 2008	No specific discussions have occurred regarding the preparation of an ESD. The value of this action is debatable as it is attempting to "prove a negative" and there is no incentive for homeowners to install a drinking water well in the Advanced outwash unit of the aquifer when municipal water is provided in the area.	NA
Uncertainty whether the capture and treatment of contaminated groundwater by wells H1 and H2 which is making drinking water safe is also adequate to achieve the cleanup goals throughout the contaminant plume in a reasonable time frame.	Schedule and conduct discussions to evaluate the pump and treat system capture zone to ensure the system is adequate to achieve the cleanup goals throughout the contaminant plume in a reasonable time frame, and if not, will determine what additional actions are needed.	Ecology and EPA	September 2008	No discussions regarding the capture zone and the achievement of the cleanup goals within a reasonable time frame. This issue is retained as an issue warranting follow up in this Five Year Review.	NA

6. Five-Year Review Process

6.1. Administrative Components

EPA Region 10 initiated the FYR in March 2012 and scheduled its completion for September 2012. The EPA Lakewood/ Ponders Corner review team was led by Christopher Cora, EPA Remedial Project Manager (RPM) for the Lakewood/Ponders Corner Site and included USACE Seattle District personnel Marlowe Laubach (chemical engineer), Rick Garrison (geologist), and Blair Kinser (environmental engineer). In March 2012, EPA held a scoping call with the review team to discuss the Site and items of interest as they related to the protectiveness of the remedy currently in place. A review schedule was established that consisted of the following:

- Community notification;
- Document review;
- Data collection and review;
- Site inspection;
- Local interviews; and
- Five-Year Review Report and development and review.

6.2. Community Involvement

On May 16, 2012, a public notice was published in the Tacoma News Tribune announcing the commencement of the Five-Year Review process for the Lakewood/Ponders Corner Site, providing the contact information for EPA RPM, Christopher Cora, and inviting community participation. No person has contacted EPA as a result of this advertisement.

In addition to the public notice, a fact sheet was published in May 2012 and sent to interested parties (homeowners, well drillers, realtors) announcing the Five-Year Review, identifying restrictions on drinking water wells within the Urban Growth Boundary, and inviting comments or information about the Lakewood/Ponders Corner Site. The public notice and fact sheet are presented in Appendix E.

The Five-Year Review report will be made available to the public once it has been finalized. Copies of this document will be placed on the EPA and Ecology websites for the Lakewood/Ponders Corner Site, the Ecology document repository at 300 Desmond Dr Southeast, Lacey, Washington and the EPA Superfund Record Center at 1200 Sixth Avenue, Suite 900, Seattle, WA and website (http://go.usa.gov/y3). Upon completion of the FYR, a public notice will be placed in the Tacoma News Tribune to announce the availability of the final FYR report in the Site document repository.

6.3. Document review

This FYR included a review of relevant, site-related documents including the ROD(s) and recent monitoring data. A complete list of the documents reviewed can be found in Appendix A.

6.3.1. Data Review

Groundwater Levels and Gradients

An assessment of groundwater levels, flow directions, and gradients is based on data from five wells that represent zone A (Advance outwash stratigraphic unit). However, an assessment of the groundwater in zone B (Vashon till) and the near surface Steilacoom gravels is based on only one well screen in each of those units. The data indicate strong seasonal variations with similar trends between the glacial till soils (zone B) and the more permeable glacial outwash soils (zone A) as shown in Figure 4. Groundwater elevations are 3 to 10 feet lower in the fall than in the spring and may reflect natural rainfall patterns, a higher pumping rate during the summer months, or a combination of both. Larger scale variations appear to reflect broader rainfall totals, with no long-term trend for the period of 1998 to 2011. There is insufficient data to evaluate groundwater flow with confidence, but it suggests that the gradient is low in zone A and generally toward the extraction wells H1 and H2. There is only one well in zone B (MW-20B) that is routinely monitored, and thus, impractical to evaluate horizontal groundwater flow in this unit. Previous wells in zone B were dry wells, and it is presumed that the Vashon Till unit has very low hydraulic conductivity and water bearing potential. Similarly, there is very few data about the Colvos sand unit, underlying the Advance outwash, to evaluate flow and gradient characteristics.

The previous FYR reported a downward vertical gradient. However, data for this FYR period indicates reversing vertical gradients according to the seasons. This may be an artifact of surveying data inaccuracies. Well MW-20B in the low permeable till soils show greater seasonal groundwater changes than in the highly permeable MW-20A soils. Groundwater data is presented in Appendix F.

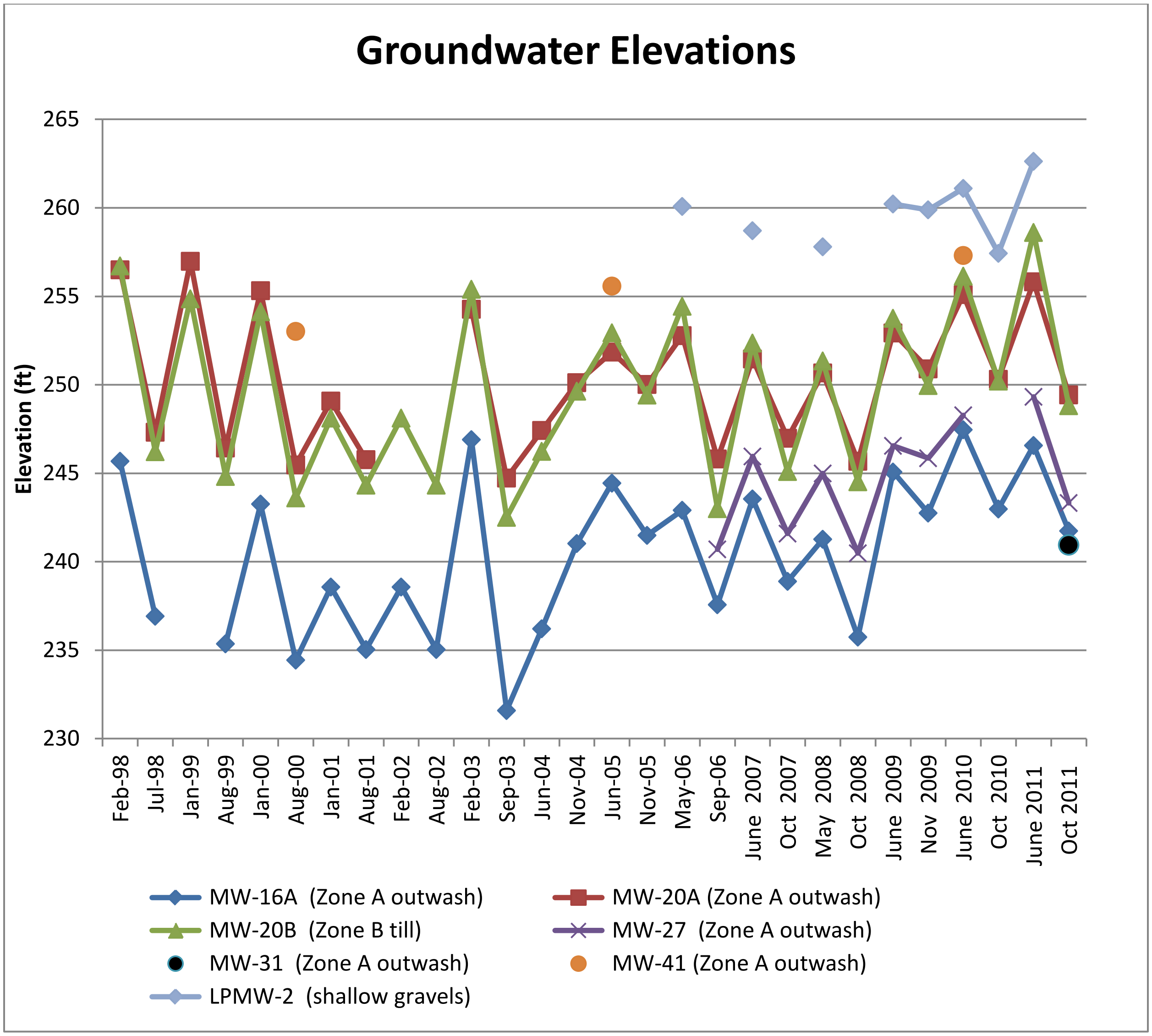

Figure 4. Groundwater Elevations

<u>Groundwater Chemistry</u>

Chemical data collected from the 16 wells in the current groundwater monitoring network (Tables 2 and 5) since the fourth FYR up to October 2011 were analyzed and compared against the performance criteria provided in the groundwater ROD, as amended by the ESD, for the remediation goals. The groundwater was collected using a low-flow sampling method.

Table 5 shows groundwater MCL or action level exceedances, and all detections of PCE and TCE, in all monitoring wells regardless of water-bearing zone during the fifth FYR period.

The groundwater monitoring data shows that monitoring wells MW-16A, MW-20B, and LPMW-2, as well as the Lakewood Water District Production wells H1/H2, continue to have PCE concentrations exceeding the federally established maximum contaminant level (MCL) of 5 µg/L. Monitoring well MW-20B had the highest contaminant concentrations during each sampling event (Table 5). Groundwater sample results for the other monitoring wells have been either non-detect or below cleanup levels. This includes three upgradient wells in the A zone and two A zone wells, downgradient of the extraction wells. Well MW-20B is the only well in the Vashon till unit, and appears to be screened within the gravel lense.

Table 5. Average Annual PCE and TCE Concentrations (µg/L) for Wells that Exceed the MCLs for Groundwater.

Year	MW-20B		MW-16A	H1/H2	LPMW-2
	PCE	TCE	PCE	PCE	PCE
	MCL: 5 ppb	MCL: 5 ppb	MCL: 5 ppb	MCL: 5 ppb	MCL: 5 ppb
2007	**348**	**6**	**54**	4.5	4.8
2008	**201**	**5**	**43**	**7.4**	2.5
2009	**205**	4.4	**48**	**6.8**	**7.6**
2010	**325**	4.8	**73**	4.3	4.7
2011	**460**	4.2	**79**	3.7	3.2

Figure 5 presents the average annual PCE concentrations for wells MW-20B and MW-16A, 1991 through 2011. Contaminant concentrations in well MW-16A appear to be gradually increasing over time and the contaminant concentrations in well MW-20B appear to exhibit no long-term trend.

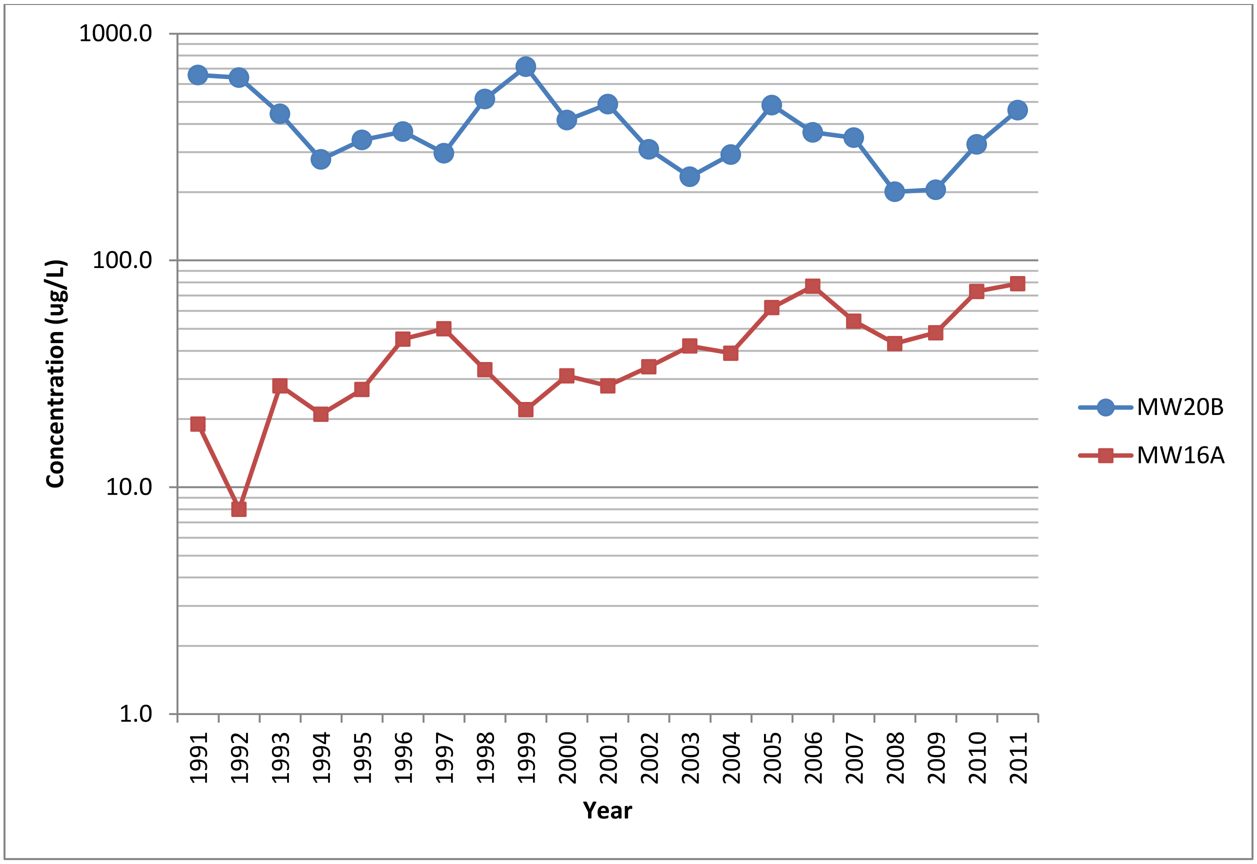

Figure 5. Average Annual PCE Concentrations for MW-20B and MW-16A from 1991 through 2011

Statistical trend analyses were performed for PCE and TCE at MW-20B, and for PCE at MW-16A using data from 2000 through 2011. The Monitoring and Remediation Optimization System (MAROS) was used to apply the Kendall Mann nonparametric test for trend, commonly used for environmental time-series data. The MAROS freeware program was developed for the Air Force Center for Environmental Excellence that can assist users with groundwater data trend analysis. The test was utilized to assess groundwater contaminant data in several wells, including MW-20B and MW-16A. The statistical results are presented in Table 6. The trend analysis suggests that the contaminant PCE in well MW-16A is increasing, while it is stable in well MW-20B, exhibiting no long-term trend. The trend in MW-20B has fluctuated over time and has been increasing during the last 4 sampling events, but within the historic range.

Table 6. Mann Kendall Trend Analysis Results

Well	COV	MK (S)	Confidence in Trend	Concentration Trend
H1/H2	0.31	-35	99%	Decreasing
LPMW-2	0.55	-52	100%	Decreasing
MW16A	0.36	44	100%	Increasing
MW20B	0.30	-12	77%	Stable

COV - The Coefficient of Variation: a statistical measure of how the individual data points vary about the mean value MK (S) -The Mann-Kendall Statistic measures the trend in the data. Confidence in Trend is the statistical confidence that the constituent concentration is increasing (S>0) or decreasing (S<0).

The Mann-Kendall statistic (S) measures the trend in the data. Positive values indicate an increase in constituent concentrations over time, whereas negative values indicate a decrease in constituent concentrations over time. The strength of the trend is proportional to the magnitude of the Mann-Kendall Statistic (i.e., large magnitudes indicate a strong trend). The Coefficient of Variation (COV) is a statistical measure of how the individual data points vary about the mean value. The coefficient of variation, defined as the standard deviation divided by the average. Values less than or near 1.00 indicate that the data form a relatively close group about the mean value. Values larger than 1.00 indicate that the data show a greater degree of scatter about the mean.

6.3.2. Site Inspection

A site inspection was conducted on April 16, 2012. Personnel from EPA, USACE, Ecology, and the Lakewood Water District attended. Details of the site inspection and photos are presented in Appendix B. The inspection checklist is presented in Appendix C.

All remedy components are working as intended. One concern of Lakewood Water District was length of time to operate the strippers as prescribed in the ROD has been surpassed. One concern from the Ecology was that wells H1 and H2 are currently only operated intermittently affecting the capture zone as well as the overall timeframe for treatment.

6.4. Interviews

Questionnaires were sent to Ecology and the Lakewood Water District personnel. The purpose of the interviews was to document the perceived status of the Site and any perceived problems or successes with the remedy components implemented to date. Common themes and more important issues raised are summarized below. The full questionnaire responses are presented in Appendix D.

In general, both the Lakewood Water District and Ecology felt informed of the progress at the Site. A comment from the Lakewood Water District presented the impracticality for the Water District to operate either production wells on a continuous basis (24 hours a day per week) because of the need to maintain proper chlorine residual and adequate turnover in area reservoir tanks. A concern from Ecology was that the degree of hydraulic containment and the groundwater cleanup timeframe is uncertain because the extraction system is operated according to the needs of the Lakewood Water District. Ecology also suggested the need for additional source investigation to determine whether additional source area cleanup is necessary.

7. Technical Assessment

7.1. Question A

Is the remedy functioning as intended by the decision documents?

Remedial action performance
The remedy is functioning to the extent that extracted groundwater is suitably treated for public consumption. The expectation based on the long-term trend data is that groundwater cleanup levels may not be met throughout the entire plume because of characteristics of the Vashon till unit and pumping rates. Groundwater elevations suggest that the extraction wells draw only part of the groundwater flow in zone A towards the pump and treat system (that is, production wells H1 and H2). There is insufficient groundwater data to show flow directions in zone B. The only paired wells (MW-20A and MW-20B, located near the former source) appear to show vertical flows reversing based on the seasons. This would indicate a weak response to the production well. However, PCE contaminants in lower outwash unit (MW-16A and H1/H2) along with little or no detections in MW-20A, suggest that groundwater flow is carrying the contaminants down and towards the treatment system. This would support the conceptual site model, described in Section 3.5, where the contaminant pathway is through the Steilacoom gravel unit, into the Vashon till - more specifically, a gravel lense within the till unit - and then into the Advance outwash. Once in the outwash, the contamination moves laterally towards well H1 and H2. The remedial design apparently assumed that both production wells would be operating simultaneously and continuously year round. That only one operates at a time might result in weak hydraulic control of groundwater in the zone A and B aquifers.

In the ROD, it was estimated that the pump and treat operation would clean up the groundwater in 10 to 15 years. However, the Responsiveness Summary of the ROD indicated that "The estimated times were found to be unrealistically short and, at best, can only be used as absolute minimum cleanup times."

After 27 years of operation, the concentration of PCE in the till unit (MW-20B) shows no increasing or decreasing trend, though there is an increasing trend in PCE concentration in the lower Advance outwash unit (MW-16A). The increasing trend may be attributed to 1) slow migration of PCE from the low-permeable glacial till sediments into the permeable lower aquifer; 2) immobilized source area residual contaminant mass that may still reside within the saturated zone and/or lower permeability soil types not addressed by the soil treatment component of the remedy that continues to contribute to long-term groundwater impacts [i.e., contaminants that originally migrated from the vadose zone and impacted the lower aquifer]; and 3) inadequate characterization and monitoring of groundwater flow paths and influence of the current municipal well pumping system.

Emphasis needs to be placed on defining the capture zone of the public water supply wells, H1 and H2, and ensuring plume containment is achieved regardless of pumping rates. Such actions should include: 1) an evaluation of existing or new wells in the area to determine flow gradients in all three aquifer units and the capture zone of the H1/H2 wells. Water levels should be routinely obtained from available wells, at least semi-annually, and especially when H1 and H2 are not pumping; and 2) evaluation of additional treatment measures within the source area (till unit included) to accelerate PCE migration and allow eventual shutdown of the air stripper system.

System operations/O&M
The air stripper system is currently working as designed. All treated groundwater meets MCLs. The groundwater monitoring of the plume is being conducted on a regular basis.

The air strippers have been in operation since 1984 with no major repairs or upgrades. The media was replaced in 2000 and the blowers were installed in 1999/2000. Continued operation of the air strippers would require replacement of either the air stripper media or the strippers themselves incurring a large cost.

Cost of system operations/O&M
The costs from the last five years reflect the minimal O&M for this site. Continued treatment will incur more costs when either the air stripper media or the air strippers themselves require replacement. The average annual cost for the O&M of production well treatment, which includes electrical power, is approximately $5,300.

Opportunities for optimization
According to the Lakewood Water District, optimization of the treatment system was conducted in past years. However, in light of the current operating conditions, additional optimization opportunities are present. These include using only one air stripper at a time to lengthen stripper media life and reducing the blower airflow rates to achieve effluent objectives through either replacing blowers with smaller capacity units or installing variable speed motors.

Implementation of institutional controls
The public notifications and education have been successful in making local residents and businesses aware of contaminated groundwater associated with the site. The need for proprietary land and groundwater use restrictions was removed in the 1992 ESD. Also, because local requirements prohibit the installation of private drinking water wells within urban areas, additional groundwater use restrictions are not required. The objectives of the institutional controls remain the same and there is no indication there have been any failures with the Tacoma/Pierce County installation of drinking water well restriction.

Early indicators of potential issues
The current production well operation of alternate six months with seasonal flow variations (lower in the winter; higher in the summer) may affect the groundwater control at the site. It is unknown if the current production well operation affects the contaminant migration such that groundwater is no longer under control.

7.2. Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in standards

Table 7 presents the standards in each ROD. Some changes in regulatory and to-be-considered (TBC) standards have occurred since the RODs and ESD were signed.

There have been no changes to the MCLs since the 1992 ESD which established groundwater cleanup goals. The MCLs for PCE and TCE may change in the future because of recent changes in toxicity values. Future FYRs should check for changes in the PCE and TCE MCLs. The soil cleanup level for PCE presented in the 1992 ESD changed from 500 ppb to 50 ppb (MTCA Method A soil cleanup levels) in 2007. Per the NCP and FYR Guidance, the change in the MTCA soil cleanup standard was evaluated to determine whether it calls into question the protectiveness of the remedy such that a modification is warranted. Since MTCA Method A cleanup levels are based on 1E-6 risk, and the change in the standard was one order of magnitude (from 500 down to 50) it follows that the estimated risk also changed one order of magnitude, from 1E-6 to 1E-5. Since 1E-5 is still within the Superfund acceptable risk range, the change does not call into question the protectiveness of the selected remedy and no change in the cleanup levels selected for this Site are warranted.

Table 7. ARAR Analysis

ROD	Medium / Authority	ARAR / Citation	ARAR Determination	Standard Applied in ROD	Current Use / Changes
1986 ROD amendment	Air/Occupational Safety and Health Administration	8 hr ground level air standards[1]	Applicable	Air emissions from the volatilization of contaminants during the air stripping process.	The air strippers are still in operation. Therefore, this requirement is still applicable. Any changes to this requirement do not affect the protectiveness of the remedy.
1985 ROD 1986 ROD amendment	Air/Clean Air Act/Puget Sound Clean Air Agency (PSCAA)	Air discharge requirements[1]	Applicable	Air emissions from the air stripper are regulated under the Puget Sound Clean Air Agency (then known as the Puget Sound Air Pollution Control Agency). Design of the air strippers would ensure compliance with this requirement. This also was applicable to the SVES installed to remediate contaminated soils.	The air strippers are still in operation. No permit is required for Superfund and, according to PSCAA, no monitoring requirements are required because this is not within a non-attainment area. The soil portion of the site has been remediated and was removed from the NPL in 1996. The SVES was disassembled in the early 1990's.
1985 ROD 1992 ESD	Hazardous Waste/Resource Conservation and Recovery Act (RCRA)	No specific citations were provided n the ROD.	Applicable	Identifies how to determine if waste is hazardous Provides requirements for the treatment of hazardous wastes Identifies land disposal restrictions These requirements apply to excavated contaminated soils.	The soil portion of the site has been remediated and was removed from the NPL in 1996. Any changes to this requirement do not affect the protectiveness of the remedy.
1985 ROD	Hazardous Waste/Resource Conservation and Recovery Act (RCRA)	40 CFR 264 Subpart F	Applicable	Provides requirement for site closure including the removal/treatment/stabilization of all hazardous waste. The requirements would be applicable to the contaminated soils.	Soil cleanup levels were established in the 1992 ESD. The soil portion of the site has been remediated and was removed from the NPL in 1996. Any changes to this requirement do not affect the protectiveness of the remedy.

ROD	Medium / Authority	ARAR / Citation	ARAR Determination	Standard Applied in ROD	Current Use / Changes
1985 ROD 1992 ESD	Groundwater/Safe Drinking Water Act	No specifc citations were provided in the 1985 ROD. The 1992 ESD cites the Federal MCLs.	Applicable	The 1985 ROD describes drinking water health advisories established by EPA Office of Drinking Water (now known as the Office of Water) and the Tacoma-Pierce County Health Department. The 1992 ESD established groundwater cleanup levels for PCE, TCE, and 1,2-DCE applicable throughout the contaminated groundwater plume	Contaminated groundwater is currently being treated using the air strippers. Federal MCLs were established as the groundwater cleanup levels in the 1992 ESD. No changes in the MCLs have occurred since the 1992 ESD.
1986 ROD Amendment	Soil/CERCLA/SARA	Section 121	Applicable	Provides cleanup standard requirements for the contaminated soil.	The cleanup level for soil was established in the 1992 ESD. The soil portion of the site has been remediated and removed from the NPL in 1996. Any changes to this requirement do not affect the protectiveness of the remedy.
1992 ESD	Soil/MTCA	Soil cleanup levels[1]	Applicable	Establishes soil cleanup levels. The 1992 ESD established PCE cleanup levels for soil.	The cleanup level established in 1992 ESD was 500 ppb for PCE. MCTA changed this requirement in 2007 to 50 ppb. The soil portion of the site has been remediated and was removed from the NPL in 1996. However, residual soil concentrations exceed the current MTCA value, but remain protective.

1 – No specific citation was provided in the ROD.

Changes in toxicity

EPA's Integrated Risk Information System (IRIS) updates toxicity values used by the Agency in risk assessment when newer scientific information becomes available. In the past five years, there have been a number of changes to the toxicity values for all contaminants of concern at the Site. Revisions to the toxicity values for PCE, TCE, and cis-1,2-DCE indicate a higher risk from exposure to these chemicals than previously considered. Table 10 lists the new toxicity values.

Table 8. Toxicity Value Changes

Contaminant	Toxicity values in ROD[1]	Changes in Toxicity Values[2]
PCE	Oral SF: 5.4E-1/mg/kg-day Oral/Inhalation RfD: 1E-2 mg/kg-day Inhalation SF: 2.1E-2/mg/kg-day	Oral SF: 2.1E-3/mg/kg-day IUR: 2.6E-7/µg/m3 Oral RfD: 6E-3 mg/kg-day Inhalation RfC: 4E-2 mg/m3
TCE	Oral/Inhalation SF: 4E-1/mg/kg-day Oral RfD: 3E-4 mg/kg-day Inhalation RfD: 1E-2 mg/kg-day	Oral SF: 4.6E-2/mg/kg-day IUR: 4.1E-6/ug/m3 Oral RfD: 5E-4 mg/kg-day Inhalation RfC: 2E-3 mg/m3
Cis-1,2-DCE	Oral/Inhalation RfD: 1E-2 mg/kg-day	Oral RfD: 2E-3 mg/kg-day

1 – Toxicity values were not provided in the RODs. Therefore, this evaluation uses the 2004 Preliminary Remedial Goals (PRGs) from EPA Region 9.

2 – New toxicity values are from the April 2012 EPA RSLs which reflect the most recent EPA IRIS toxicity values; different units for inhalation toxicity values have been published, as EPA no longer uses inhalation reference doses or inhalation cancer slope factors, but rather inhalation reference concentrations and inhalation unit risks. MTCA equations continue to use the older units. These toxicity values are used to determine all screening and cleanup levels.

PRG – preliminary remediation goal
RSL – regional screening level
SF – slope factor
RfD – reference dose
RfC – reference concentration
IUR – inhalation unit risk

Groundwater results are frequently compared to EPA Regional Screening Levels (RSLs) as a first step in determining whether response actions may be needed to address potential human health exposures. The RSLs are chemical-specific concentrations that correspond to an excess cancer risk level of 1E-6 (or a Hazard Quotient (HQ) of 1 for noncarcinogens) developed for standard exposure scenarios (e.g., residential and commercial/industrial). RSLs are not de facto cleanup standards for a Superfund site, but they do provide a good indication of whether actions may be needed.

In September 2010, EPA completed a review of the cis-1,2-DCE toxicity literature and posted on IRIS non-cancer toxicity values which resulted in lower RSLs for cis-1,2-DCE. EPA's 2010 Toxicological Review for DCE also developed safe levels that include at least a 10 fold margin of safety for health effects other than cancer. Any concentration below the non-cancer RSL indicates that no adverse health effect from exposure is expected. Concentrations significantly above the RSL may indicate an increased potential of non-cancer effects. The non-cancer screening value for cis-1,2 DCE is 28 µg/L, while the maximum cleanup level (MCL) is 70 µg/L. There are no current cancer or noncancer inhalation toxicity values available for cis-1,2-DCE.

In September 2011, EPA completed a review of the TCE toxicity literature and posted on IRIS both cancer and non-cancer toxicity values which resulted in lower RSLs for TCE. The multipathway tapwater screening level for chronic exposure for cancer excess risk level of 1E-6 is 0.44 µg/L. EPA uses an excess cancer risk range between 1E-4 and 1E-6 for assessing potential exposures, which means a TCE groundwater concentration between 0.44 and 44 µg/L is within the acceptable excess cancer risk range. The current MCL for TCE of 5 µg/L is within the revised protective carcinogenic risk range. However, care must be taken to not assume that the entire cancer risk range is protective for noncancer effects. EPA's 2011 Toxicological Review for TCE also developed noncancer toxicity values. Any concentration below the non-cancer RSL indicates that no adverse health effect from exposure is expected. Concentrations above the RSL may indicate an increased potential for adverse non-cancer effects. The non-cancer tapwater screening level for TCE is 2.6 µg/L. EPA’s 2011 toxicity evaluation of TCE’s noncancer effects include a subchronic outcome of fetal cardiac malformations that may occur during exposure to the mother during a nonspecific 21-day period of time in the first trimester of pregnancy, according to the IRIS Toxicological Review for TCE [http://epa.gov/iris/supdocs/0199index.html]. Accordingly, EPA Region 10 recommends limiting TCE exposures for adult human females of reproductive age so that the average dose or concentration over any 3-week period is less than or equal to the TCE RfD or RfC. This exposure would be likely to be without an appreciable risk of deleterious non-cancer effects, including those due to developmental toxicity.

EPA also recently reassessed PCE toxicity literature for both cancer and non-cancer affects and released the toxicological review in February 2012, posted on IRIS. The reassessment determined that risk for cancer excess of 1E-6 was less stringent than previously assumed, and has raised the multipathway tapwater cancer RSL for PCE to 9.7 µg/L. The non-cancer RSL was also revised based on adverse neurological effects and resulted in a multipathway tapwater non-cancer risk RSL of 35 µg/L. The PCE MCL of 5 µg/L remains protective for both carcinogenic and non-cancer effects; however, as with TCE, it should not be assumed that the entire cancer risk range of 1E-4 to 1E-6 (9.7 µg/L to 970 µg/L for tapwater) is protective for noncancer outcomes for PCE.

Changes in exposure pathways

The following table presents the exposure pathways evaluated in the 1984 ROD, the 1985 ROD, and the 1992 ESD. No additional risk evaluation was presented in the 1986 ROD amendment.

Table 9. Exposure Pathways

Exposure Pathway	Increased risk
Drinking and cooking using treated well water	7E-8
Gases from stripping towers	NS
Gases from bathing water using treated well water	NS
Dermal exposure to bathing water using treated well water	1E-8
Drinking and cooking of untreated well water	9E-6
Gases from bathing water using untreated well water	NS
Dermal exposure to untreated well water used as bathing water using untreated well water	9E-6
Ingestion of surface soil	NS
Ingestion of subsurface soil	6E-9 to 4E-8
Inhalation of surface dust	NS
Dermal contact to surface soil	NS
Dermal contact to subsurface soil	NQ
Inhalation of gases during excavation	26 times ACGIH TLV-TWA (still air) 2.5 times IDLH (still air) 0.006 times ACGIH TLV-TWA (0.25 mph wind speed)

NS – not substantial
NQ – not quantifiable
ACGIH TLV-TWA – American Conference of Governmental Industrial Hygienists Threshold Limit Value-Time Weighted Average
IDLH: Immediately Dangerous to Life and Health

The exposure pathways for groundwater presented in the 1985 ROD have not changed. Treated well water is still available for use by Lakewood residents. There are no known private drinking water wells within the contaminated aquifer and local restrictions have been put in place to prevent the installation of private drinking water wells within the area depicted on Figure 1. Therefore, there are no effects to the protectiveness of the remedy.

The exposure pathways for soil presented in the 1985 ROD are no longer valid since soil remediation has effectively reduced soil contamination below cleanup levels. The soil portion of this site was removed from the NPL in 1996.

EPA's understanding of contaminant migration from soil gas and/or groundwater into buildings has evolved over the past few years, leading to the conclusion that vapor intrusion may have a greater potential for posing risk to human health than assumed when the ROD(s) were prepared. Contaminated groundwater underlies at least one business.

Table 10. Comparison of Concentrations Protective of Indoor Air

PCE				
Highest Groundwater Concentration (µg/L)				720[1]
ROD cleanup levels (µg/L)				5
EPA RSLs and concentrations in groundwater protective of indoor air[3]				
	Residential		Industrial	
	Cancer	Noncancer	Cancer	Noncancer
Tapwater RSL(µg/L)	9.7	35	NA	NA
Soil RSL (mg/kg)	22	86	110	410
Air RSL (µg/m3)	9.4	42	47	180
Groundwater concentration protective of indoor air (µg/L)	24.5	109.4	122.4	468.8
MTCA screening levels and concentrations protective of indoor air[3]				
	Method B		Method C	
	Cancer	Noncancer	Cancer	Noncancer
Groundwater SL (µg/L)	20.8	48	208.3	105
Soil SL (mg/kg)	476.2	480	62,500	21,000
Air SL(µg/m3)	9.6	17.6	96.2	38.5
Soil concentration protective of GW (mg/kg)	0.21		1.05	
Groundwater concentration protective of indoor air (µg/L)	25		100.3	
TCE				
Highest Groundwater Concentration (µg/L)				7.5[2]

<table>
<tr><td colspan="4">ROD cleanup levels (μg/L)</td><td>5</td></tr>
<tr><td colspan="5">EPA RSLs and concentrations protective of indoor air[3]</td></tr>
<tr><td rowspan="2"></td><td colspan="2">Residential</td><td colspan="2">Industrial</td></tr>
<tr><td>Cancer</td><td>Noncancer/
Subchronic noncancer</td><td>Cancer</td><td>Noncancer/
Subchronic noncancer</td></tr>
<tr><td>Tapwater RSL (μg/L)</td><td>0.44</td><td>2.6/3.4</td><td>NA</td><td>NA</td></tr>
<tr><td>Soil RSL (mg/kg)</td><td>0.91</td><td>4.4/4.7</td><td>6.4</td><td>20/20</td></tr>
<tr><td>Air RSL (μg/m3)</td><td>0.43</td><td>2.1/2</td><td>3</td><td>8.8/8.4</td></tr>
<tr><td>Groundwater concentration protective of indoor air (μg/L)</td><td>1.9</td><td>9.2/8.7</td><td>13.1</td><td>38.4/36.7</td></tr>
<tr><td colspan="5">MTCA screening levels and concentrations protective of indoor air[3]</td></tr>
<tr><td rowspan="2"></td><td colspan="2">Method B</td><td colspan="2">Method C</td></tr>
<tr><td>Cancer</td><td>Noncancer</td><td>Cancer</td><td>Noncancer</td></tr>
<tr><td>Groundwater screening level (μg/L)</td><td>0.54</td><td>4</td><td>9.4</td><td>8.7</td></tr>
<tr><td>Soil screening level (mg/kg)</td><td>11.5</td><td>40</td><td>2,853.3</td><td>1750</td></tr>
<tr><td>Air screening level (μg/m3)</td><td>0.37</td><td>0.9</td><td>6.3</td><td>2</td></tr>
<tr><td>Soil concentration protective of groundwater (mg/kg)</td><td colspan="2">0.03</td><td colspan="2">0.05</td></tr>
<tr><td>Groundwater concentration protective of indoor air (μg/L)</td><td colspan="2">1.6</td><td colspan="2">8.7</td></tr>
</table>

1 – From MW-20B in October 2011 2-– From MW-20B in October 2007

3 - Both the EPA RSL and MTCA SL are based on Henry's Law constants (unitless) at a temperature of 13.7 C and assume an attenuation factor of 0.001 from groundwater to indoor air. EPA and MTCA chronic cancer and noncancer screening levels are different because air concentrations, exposure assumptions, and calculations differ between the two agencies.

RSL – remedial screening level SL – Screening level

No screening levels for cis-1,2-DCE are presented because cancer or noncancer inhalation values are unavailable.

Table 10 compares the highest contaminant concentrations from the last five years to the groundwater screening levels for vapor intrusion potential from the draft EPA guidance (USEPA, 2002) and the

Washington State guidance (Ecology, 2009). The highest PCE concentration, 720 μg/L in MW-20B, is greater than both state and federal screening levels. The highest TCE concentration is within EPA's cancer and non-cancer risk, however, MW-20B is screened within the Vashon Till unit, which is not considered the shallowest groundwater zone and therefore not appropriate for assessing the potential for vapor intrusion. MW-20B is screened approximately 50 feet below the ground surface. Monitoring well LPMW-2 is screened in the Steilacoom gravel unit and is within 20 feet of the ground surface and closer to the building. PCE concentrations in LPMW-2 have never exceeded 11 ug/L. Based on the concentrations in LPMW-2, vapor intrusion is not expected to pose an unacceptable risk to workers in buildings above or adjacent to the plume. In addition to comparing PCE and TCE concentrations to EPA and Ecology screening values, EPA conducted a comparison of PCE concentrations in groundwater to the Vapor Intrusion Screening Level (VISL) Calculator (USEPA March 2012) to evaluate potential vapor intrusion risks. Based on the results, vapor intrusion is unlikely to pose an unacceptable risk for workers in buildings above the plume.

The degradation of PCE results in formation of several compounds. These include TCE, 1,2-DCE (cis- and trans) and vinyl chloride. TCE and cis-1,2-DCE have been detected at low concentrations. Vinyl chloride has not been detected since 1991. This indicates natural attenuation is not a significant process for reducing the contaminant concentrations in the aquifer.

Changes in land use
Current land use has not changed since the ROD(s). In the area of the former cleaners land use is commercial/industrial. The current land use around the area of the production wells and air strippers is residential and military base. No changes in land use are anticipated in the future near the former cleaners and the production wells.

Progress towards meeting RAOs
A risk assessment performed as part of the 1985 ROD showed the health risks associated with the use of treated water were below the 1E-6 to 1E-4 acceptable cancer risk. Soil excavation and treatment ceased in 1996 because all soil remediation conducted was completed. Public notices are sent approximately twice every 5 years describing the contamination within the Lakewood/Ponders Corner Superfund Site and the potential effects of using contaminated (untreated) groundwater. Environmental regulations related to all remediation work were followed. Upgrades to the treatment system in recent years have increased efficiency and reduced energy requirements as evidenced by the relatively low annual operating costs. Therefore, the remedy is currently meeting the RAOs described in the ROD.

7.3. Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

The following information could call into question the protectiveness of the remedy.

- Western Washington is in a high seismic region. Seismic hazard maps, developed by the U.S. Geological Survey, show that the Lakewood area can be subjected to ground motions of about 0.4 g (a unit of acceleration; 1 g equals 32. feet/second) from an earthquake along the Tacoma Fault or within the deep subduction zone slab. In comparison, the ground motion from the 2001 Nisqually earthquake was 0.1 g, in the Lakewood area. The air stripping structures could be subject to seismic damage, unless the design accounted for this level of shaking.

Ecological risks have not been evaluated for this site. The site is within an area of mixed industrial, commercial, and residential use. Interstate 5 is located between the former source area and the water treatment facility. Therefore, ecological risks are not anticipated due to lack of suitable habitat.

7.4. Technical Assessment Summary

The remedy is functioning to the extent that extracted groundwater is suitably treated for public consumption. H1 and H2 may not capture all the contaminated groundwater. However, there are no indications that contaminants are migrating away from the public water supply wells, as evidenced by very low (less than 2µg/L since 1992) PCE detections in MW-31 and MW-32, which are in the Advanced Outwash unit and outside the anticipated capture zone of H1/H2.

The migration of contaminants from the Vashon Till unit is the likely cause of continuing impacts to groundwater, and lack of a decreasing trend in concentrations at MW-16A. This is consistent with the Conceptual Site Model and should be expected. It is acknowledged that the continued seepage of PCE from the Vashon Till unit will require continued treatment of groundwater for distribution into the indefinite future. Recommendations include additional investigations to assess the effective capture zone of H1/H2 and potential migration of PCE within the Steilacoom Gravel unit.

The air strippers are currently working as designed. It is unknown whether the design of the air strippers considered seismic requirements. In the event of an earthquake, damage to the air strippers may impact the supply of potable water to area residents.

Standards that have changed since the RODs and ESD were signed do not affect the protectiveness of the remedy. Exposure pathways described in the ROD have not changed. The vapor intrusion pathway was not evaluated during the ROD. An evaluation during this Five Year Review indicates vapor intrusion is unlikely to pose an unacceptable risk to receptors overlying the groundwater. Changes in toxicity values have occurred for PCE, TCE, and cis-1,2-DCE in the last five years. These changes do not affect the protectiveness of the remedy because the MCL-based cleanup goals for the Site remain within EPA's acceptable risk range and the MCLs are currently being met for treated water.

8. Issues

Issues that affect the protectiveness of the remedy are shown in Table 11.

Table 11. Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
1. Determine the current capture zone in the advance outwash sands for H1 and H2 at the current pumping rates.	N	Y
2. LPMW-2 has low concentrations of PCE screened in the Steilacoom gravels near the original source zone a determination of the fate & transport of this dissolved PCE concentration in this monitoring well is needed to determine whether it is significant.	N	Y
3. Aging stripper system with significant expenditures for repairs and replacement, and seismic design need to be evaluated.	N	Y
4. Time for restoration of the aquifer (greater than 100 years) is anticipated to exceed the ROD estimates, due to leaching of PCE from the Vashon Till unit.	N	Y

9. Recommendations and Follow-up Actions

Table 12 below provides recommendations to the issues presented above.

Table 12. Recommendations and Followup Actions

Recommendations and Follow up Actions	**Party Responsible**	**Oversite agency**	**Mile-Stone Date**	**Affects Protectiveness (Y/N)**	
				Current	**Future**
1. Develop a target capture zone based on the current monitoring well network and PCE concentrations. Use the six steps for systematic evaluation of capture zones, EPA 600/R-08/003 January 2008	Ecology/EPA	EPA	09/2013	N	Y
2. Evaluate existing information on groundwater flow direction in the Steilacoom gravels at	EPA	EPA/Ecology	09/2013	N	Y

LPMW-2. Install a down gradient Monitoring well from LPMW-2 and sample for VOCs.					
3. Evaluate optimization of operations of the treatment facility to operating one air stripper at a time, and reducing blower airflow rates with smaller units or variable speed motors. Check air stripper design for seismic stress.	Lakewood Water District / Ecology	EPA	09/2014	N	Y
4. Evaluate restoration time frame for the aquifer and alternatives to accelerate restoration if necessary.	Ecology/EPA	EPA	09/2017	N	Y

10. Protectiveness Statements

The remedy at the Lakewood/Ponders Corner Superfund Site is considered protective of human health and the environment in the short-term because exposure pathways that could result in unacceptable risks are being controlled through the treatment of groundwater to concentrations below MCLs for public consumption and the locality maintains restrictions prohibiting the installation of new water wells within this area. In order to optimize the remedy and ensure it is protective in the long-term, an evaluation is required to determine pump and treat system capture zone, the full extent of the contaminant plume in the till layer, and if additional treatment would facilitate accelerating the restoration of the aquifer. The results of this evaluation would determine whether additional actions are required.

11. Next Review

The next five year review for the Lakewood/Ponders Corner Superfund Site is required five years from the date of this review in 2017.

12. References

Environmental Protection Agency (EPA) 2001. Comprehensive Five-Year Review Guidance. June 2001.

EPA 2002. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), November 2002.

Washington State Department of Ecology (WSDOE) 2009. Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action, October 2009.

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Appendix A: Documents Reviewed

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Documents Reviewed

Ecology 2008, Washington Department of Ecology, Lakewood Plaza Cleaners, June and October 2007, Groundwater Monitoring Results. April 2008

Ecology 2009, Washington Department of Ecology, Lakewood Plaza Cleaners, Groundwater Monitoring Results, May and October 2008. March 2009.

Ecology 2010, Washington Department of Ecology, Lakewood Plaza Cleaners, Groundwater Monitoring Results, June and November 2009. February 2010.

Ecology 2011, Washington Department of Ecology, Lakewood Plaza Cleaners, Groundwater Monitoring Results, June and October 2010. January 2011.

Ecology 2012, Washington Department of Ecology, Lakewood Plaza Cleaners, Groundwater Monitoring Results, June and October 2011. January 2012.

EPA 1984, Environmental Protection Agency (EPA) Record of Decision, Lakewood EPA ID: WAD050075662 OU OO, Lakewood, Washington. September 1984

EPA 1985, EPA Record of Decision, Lakewood EPA ID: WAD050075662 OU OO, Lakewood, Washington. September 1985.

EPA 1986, EPA Record of Decision Amendment, Lakewood EPA ID: WAD050075662 OU 01, Lakewood, Washington. November 1986.

EPA 1992, EPA Explanation of Significant Differences, Lakewood EPA ID: QAD050075662 OU OO, Lakewood, Washington. September 1992

EPA 2007, EPA Five Year Review Report, Fourth Five-Year Review Report for Lakewood/Ponders Corner Superfund Site, Tacoma, Pierce County, Washington. September 2007

Zavala 2010, Bernie Zavala, Memorandum, Review of current groundwater data from the Lakewood Ponders Corner Superfund Site. August 2010.

Appendix B: Site Inspection Trip Report

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TRIP REPORT
LAKEWOOD/PONDERS CORNER SUPERFUND SITE
(EPAID: WAD050075662)

Attendees

USACE:

Marlowe Laubach	USACE Seattle District Chemical Engineer	(206) 764-4480
Richard Garrison	USACE Seattle District Geologist	(206) 764-3312

USEPA:

Christopher Cora	USEPA Region 10 Remedial Project Manager (RPM)	(206) 553-1478

WDOE:

Guy Barrett	Hydrogeologist, Dept. of Ecology, Toxics Cleanup Program	(360) 407-7115

Lakewood Water District:

Dave Hall	Groundwater Treatment Plant Operator

Purpose

Lakewood/Ponders Corner is a USEPA-led CERCLA site in which a five-year review is being conducted. A site visit was conducted to provide information about the site's status and to visually inspect and document the conditions of the remedy, the site, and the surrounding area for inclusion into the fifth five-year review site inspection checklist and report.

Report

On 16 April 2012, Ms. Laubach and Mr. Garrison drove from the Seattle District office to the Lakewood/Ponders Corner Superfund site, located at 12509 Pacific Hwy SW in Lakewood, Washington arriving at approximately 1000 hrs, the arranged meeting time. The weather was cool and cloudy. The site is located in a commercial/light industrial area, adjacent to Interstate 5.

The USACE team met with Mr. Cora and Mr. Barrett at the former dry cleaning site. Mr. Barrett conducted the tour. We were shown that the former dry cleaning building is now an electrical supply store.

We were also taken to see the locations of monitoring wells MW- 20, MW-16, and LPMW-2 though without opening any of the well casings for inspection. Groundwater contamination at these three wells continues to be high. The wells are sampled every six months. We found the well casings to be in good condition and secured with locks. MW-16 is located within a self-storage facility south of the former dry cleaner that is accessible through an electronic key pad gate. MW-20 is enclosed in a storage area behind the electronics store; however, the fence along the freeway side is bent down. The employee, who let us into the enclosure, explained that they are subject to break-ins and thefts. LPMW-2 is a flush mounted well that is easily accessible from the street. We did not open the lid for inspection. We did not inspect any other monitoring wells, but Mr. Barrett states that he has been to all of them within the past year or two and finds that all are in good condition and secure. Groundwater contamination in the other wells are below maximum contaminant levels (MCL) or non-detect and are sampled at much wider frequency. Two other monitoring wells were observed north and within 100 yards of the source site. Mr. Barrett said that both wells are not monitored anymore: one is dry and the other has been non-detect for a long time. Both wells are on vacant land that he says will be leased to a landscaping business.

About 1100 hours, this group drove about 0.5 mile to the Lakewood Water District's water supply wells H1 and H2 located across and adjacent to the freeway. We met with and were given a tour of the site by Mr. Hall. He showed and explained to us the air strippers, constructed in 1984, to treat the groundwater from both water supply wells. We were also shown the wet well collector and distribution room, and the two wells. Discussions included questions that helped Ms. Laubach complete the Site Inspection Checklist. The wells are operated alternately and for about 14 to 18 hours per day during the summer months and about 3 to 4 hours per day for the rest of the year. The water is treated by the air stripper, then into a wet well for distribution into the District's water system. Though the wells are alternately in use, the air stripper system is designed to handle simultaneous flows from both wells. Well maintenance occurs as needed such as when a pump fails. The pump in Well H2 was replaced four years ago, and 6 or 7 years ago in Well H1. In both cases, the water district took the opportunity to inspect the well screens and found both to be in good condition with no rehabilitation required. The grounds and the fencing appeared in good condition. The structures and machinery appeared to be generally well-maintained. Mr. Hall pointed out that a rubber sleeve in the air stripper system is getting brittle and will need replacement. The stripper media were replaced in 2000. Mr. Hall expressed his concern of continuing the air stripper operation beyond the initial treatment timeframe of 10 to 12 years presented in the 1985 ROD.

The site visit concluded at approximately 1100 hrs and the Corps of Engineers' team drove back to the district office.

Building once used as dry cleaning shop, now an electrical supply store.

Monitoring well MW-16. Two wells clustered within the protective casing. Located approximately 400 feet SW of the source site.

Monitoring well MW-20.

Treatment System

Inside treatment building with chlorination system

Appendix C: Site Inspection Checklist

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Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Lakewood/Ponders Corner	**Date of inspection: 16 April 2012**
Location: Tacoma, WA	**EPA ID: WAD050075662**
Agency, office, or company leading the five-year review: EPA Region 10	**Weather/temperature: Cloudy, wind, 50 F**
Remedy Includes: (Check all that apply) ☐ Landfill cover/containment ☐ Access controls ☐ Institutional controls ☒ Groundwater pump and treatment ☐ Surface water collection and treatment ☐ Other: ______	☐ Monitored natural attenuation ☐ Groundwater containment ☐ Vertical barrier walls
Attachments: ☐ Inspection team roster attached	☐ Site map attached
II. INTERVIEWS (Check all that apply) *Interviews will be provided separately.*	
1. **O&M site manager** ______ ______ ______ Name Title Date Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______ Problems, suggestions; ☐ Report attached ______	
2. **O&M staff** ______ ______ ______ Name Title Date Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______ Problems, suggestions; ☐ Report attached ______	

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency:
Contact: ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual ☒ Readily available ☐ Up to date ☐ N/A
   - ☐ As-built drawings ☒ Readily available ☐ Up to date ☐ N/A
   - ☐ Maintenance logs ☒ Readily available ☐ Up to date ☐ N/A

   Remarks______________________________

2. **Site-Specific Health and Safety Plan** ☒ Readily available ☐ Up to date ☐ N/A
   - ☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☐ N/A

   Remarks______________________________

3. **O&M and OSHA Training Records** ☒ Readily available ☐ Up to date ☐ N/A

   Remarks______________________________

4. **Permits and Service Agreements**
   - ☐ Air discharge permit ☐ Readily available ☐ Up to date ☒ N/A
   - ☐ Effluent discharge ☐ Readily available ☐ Up to date ☒ N/A
   - ☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ☒ N/A
   - ☐ Other permits______________________ ☐ Readily available ☐ Up to date ☒ N/A

   Remarks: Air effluent from the strippers are vented to the atmosphere. No monitoring is conducted. Effluent discharge from the air strippers enter the Lakewood Water District water distribution system. Effluent meets drinking water quality standards.

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A

   Remarks______________________________

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A

   Remarks______________________________

7. **Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A

   Remarks______________________________

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A

   Remarks______________________________

9. **Discharge Compliance Records**
   - ☐ Air ☐ Readily available ☐ Up to date ☒ N/A
   - ☐ Water (effluent) ☐ Readily available ☐ Up to date ☒ N/A

   Remarks______________________________

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☒ N/A

    Remarks______________________________

IV. O&M COSTS

1. **O&M Organization**

☒ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☒ Other: Lakewood Water District in charge of day-to-day maintenance of the air strippers. Ecology handles the larger maintenance requirements and samples the monitoring wells semi-annually.

2. **O&M Cost Records**

☒ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: None described during the site visit. Future anticipated costs include the upgrade of the air strippers.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks: The former site of the Plaza Cleaners is now Rainier Light &Electric. Two monitoring wells immediately adjacent to this business are within fenced and locked areas. The fence on the southeast end of the property appears to be damaged.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A

Remarks:

C. Institutional Controls (ICs) *Institutional controls in the form of deed restriction is not part of the remedy.*

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☒ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☒ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ____________________
Frequency ____________________
Responsible party/agency ____________________
Contact ____________________ ____________________ __________ __________

Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A
Violations have been reported ☐ Yes ☐ No ☒ N/A
Other problems or suggestions: ☐ Report attached

The 1992 ESD removes land use and future groundwater use restrictions. Only maintaining current groundwater restrictions in the form of periodic information to residents, realtors, and drillers to not drill within the contaminated groundwater plume is mentioned.

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks: Source of groundwater contamination has been removed and all residents within this area use city water. The likelihood of a private owner installing a drinking water well is small.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks: For the areas near the former Plaza Cleaners no vandalism is evident (with respect to the monitoring wells). For the area near the water supply wells and air strippers, according to Dan Hall (Lakewood Water District) no vandalism has occurred in the area of the treatment facility.

2. **Land use changes on site** ☐ N/A

Remarks: The land use of the former Plaza Cleaners (now Rainier Light and Electric) remains commercial.

3. **Land use changes off site** ☐ N/A

Remarks: North of the Rainier Light and Electric, the adjacent property owner will be leasing the adjacent property to a landscaping business. The adjacent property is currently a vacant lot.

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☐ N/A

Remarks____________________
____

B. Other Site Conditions
Remarks ______________________________
VII. LANDFILL COVERS ☐ Applicable ☒ N/A
VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

The groundwater treatment in the ROD required the installation of air strippers to treat the water supply wells used by the Lakewood Water District. The ROD assumed that these air strippers would not only provide clean (below MCLs for PCE, TCE, and DCE) but also contribute to the remediation of the contaminated aquifer.

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance G N/A
Remarks___

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks___

3. **Spare Parts and Equipment**
☒ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks___

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. **Collection Structures, Pumps, and Electrical**
☐ Good condition ☐ Needs Maintenance
Remarks___

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition ☐ Needs Maintenance
Remarks___

3. **Spare Parts and Equipment**
☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks___

C. Treatment System ☒ Applicable ☐ N/A	
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☒ Air stripping ☐ Carbon adsorbers ☐ Filters___ ☐ Additive (*e.g.*, chelation agent, flocculent)___ ☐ Others___ ☒ Good condition ☐ Needs Maintenance ☒ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually___ ☐ Quantity of surface water treated annually___ Remarks: The treatment system consists of 2 pump houses for each production well and 2 air strippers that are run in series. The stripper media consists of 2-inch balls. The stripper effluent flows into a wet well in the treatment building. Chlorination occurs in-line prior to entering the wet well. Water in the wet well is then pumped into the Lakewood Water District distribution system. Typical influent concentrations are: TCE and DCE non-detect; PCE slightly above the MCL.
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☒ Good condition ☐ Needs Maintenance Remarks___
3.	**Tanks, Vaults, Storage Vessels** ☒ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks___
4.	**Discharge Structure and Appurtenances** ☐ N/A ☒ Good condition ☐ Needs Maintenance Remarks___
5.	**Treatment Building(s)** ☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair ☒ Chemicals and equipment properly stored Remarks: Chlorination of treated water occurs within the treatment building. Hypochlorite is added to the treated water at a rate that provides adequate free chlorine content in the water to achieve and maintain disinfection.
6.	**Monitoring Wells** (pump and treatment remedy) ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks___
D. Monitoring Data	
1.	Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality

2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining From the annual reports, the data suggests that PCE concentrations are decreasing in MW-20B (shallow) and increasing MW-16A (deep) and steady concentrations of PCE near the MCL in the production wells H1 and H2.

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☒ N/A

Remarks____
____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

<u>The air strippers are functioning to treat contaminated groundwater. They provide water that meets drinking water standards for the Lakewood Water District. As a means to provide control of the groundwater plume, the water wells do not operate 24 hours, 7 days a week. In the winter they may operate 3-4 hours per day, in the summer 14-18 hours per day. Each production well is operated one at a time alternating every 6 months.</u>

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

<u>The Lakewood Water District provides O&M of the strippers to ensure they are working properly to remove contaminants. The O&M of the strippers are continual and routine with no issues to note. The production wells H1 and H2 are operating well. However, the operation of these wells is not 24 hours, 7 days a week as assumed in the 1984 ROD; the well operation varies by the season (lower in the winter, higher in the summer.) Also the operation of the wells is limited because of the strippers in terms of head. Due to the loss of head within the strippers, only one well can be operated at a time and requires the use of the wet well. The affect on groundwater cleanup is unclear with the reduced pump rates. The groundwater monitoring wells (most of them) are sampled on a semi-annual basis. These monitoring wells are functioning well with no issues to note. Continual operation of the strippers ensures that contaminated groundwater is not being distributed with the Lakewood drinking water system.</u>

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. The reduced pumping for the production wells at H1 and H2 affects the timeframe for treatment and the potential of loss of hydraulic control. The strippers are nearing their useful life. The 1984 ROD stated the expected treatment was for 10 -12 years. It has now been 28 years; approximately 16 years longer than initial estimates. Replacement of these strippers will involve system downtime and a decrease in hydraulic control.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Determining the optimal pump rates for production well extraction so that it meets Lakewood Water District needs but still effectively controls contaminant migration would be beneficial. Potential opportunities for optimization include the use of one stripper instead of both especially since the strippers were designed to handle the total flow of both production wells.

Appendix D: Interview Records

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Interview Records

Questionnaire Responses from Dave Hall (Lakewood Water District)

1. What is your overall impression of the Lakewood/Ponders Corner Superfund Site (general sentiment)?
To date, the site has worked very well in terms of mitigating the contamination of the H-1 and H-2 wells. The District has been afforded the continual use of both wells throughout the history of the site. The SCADA and software upgrade completed in the mid-1990s, was instrumental in allowing the District to maximize the operational potential of the site. However, the basic site mechanical devices are aging and will need to be upgraded/repaired or replaced if continued use of the site remains an integral part of a long term mitigation strategy.
2. What is your current role and your agency's role with respect to the site?
Lakewood Water District (LWD) Department Head overseeing site maintenance and operation.
3. Have there been routine communications or activities (for example site visits, inspections, etc.) conducted by your office regarding the site? If so, please give purpose and results.
Routine maintenance activities include weekly visits to the site by a variety of LWD technicians.
4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
No particular problems outside the scope of routine maintenance.
5. Do you feel well informed about the site's activities and progress?
Yes.
6. Are you aware of any changes in State/County/Local laws and regulations that may impact the protectiveness of the site?
No.
7. Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?
In order to optimize the operational viability of the distribution system specific to maintaining the proper Chlorine residual and adequate turnover in the area tanks, it is not practical to operate one of the wells on a continuous basis (24 hour/day/week). Even though continuous operation would best mitigate the remaining contaminant, continuous operation is not practical for District operations.
8. What are the operational costs for your organizations involvement for the Site?
The District's average operation and maintenance budget for the last five (5) years including electric power costs is $26,500.00.

Questionnaire Responses from Guy Barrett (Washington State Department of Ecology)

1. What is your overall impression of the Lakewood/Ponders Corner Superfund Site (general sentiment)?
The remedy at this Site remains protective of human health and the environment as exposure pathways are incomplete. The groundwater pump and treat system is being well maintained by the Lakewood Water District. However there is a lack of certainty regarding the degree of hydraulic containment since the Lakewood Water District operates the groundwater extraction system independently and according to their needs. The restoration timeframe is therefore very hard to predict and appears to be quite lengthy. Expensive future equipment repairs and replacement costs are a big concern to the State.
2. What is your current role and your agency's role with respect to the site?
I am Ecology's Site Manager and my role is to ensure we meet our Operation and Maintenance responsibilities. These responsibilities include periodic groundwater monitoring, annual reporting, and decommissioning, dismantling, and disposing of the air strippers and associated equipment, as well as abandoning and decommissioning of existing ground water monitoring wells. Ecology is also responsible for major equipment replacement costs.
3. Have there been routine communications or activities (for example site visits, inspections, etc.) conducted by your office regarding the site? If so, please give purpose and results.
Yes, Ecology has performed routine periodic groundwater monitoring with annual reporting at this Site.
4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
No, not to my knowledge.
5. Do you feel well informed about the site's activities and progress?
Yes.
6. Are you aware of any changes in State/County/Local laws and regulations that may impact the protectiveness of the site?
No.
7. Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?
An effort should be made to better accommodate the Lakewood Water District's drinking water needs with EPA and Ecology's hydraulic containment and cleanup goals, possibly through an interagency agreement. Ecology recommends groundwater modeling with updated input variables to provide a more accurate restoration timeframe and confirm hydraulic containment, etc. A large data gap exists between the source and the extraction wells making it difficult in the future to ever definitively say the entire plume has met cleanup goals, and this should be discussed. Ecology recommends additional source area investigation to better characterize remaining contaminant concentrations to assist in determining if additional source area cleanup is necessary.
8. What are the operational costs for your organizations involvement for the Site?
Ecology's annual operational costs include labor for groundwater monitoring and report writing/review, as well as analytical costs at Manchester Laboratory. These costs total approximately $10,300 annually.

Appendix E: Public Notices

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Soldiers will get in parks for free

$80 GIFT: Perk starts Saturday, Armed Forces Day

BY MICHAEL MUSKAL
Los Angeles Times

LOS ANGELES - The Obama administration is stepping up its courtship of active-duty military personnel and their families by offering them a free pass to any national park, officials announced Tuesday.

The annual passes will be made available to members of the military free of charge beginning Saturday, Armed Forces Day. The pass, which usually costs $80, allows entrance to more than 2,000 national parks, wildlife refuges and other public lands.

The plan was announced Tuesday during a ceremony at Colonial National Historical Park in Yorktown, Va., where Secretary of the Interior Ken Salazar, director of the National Park Service Jonathan B. Jarvis and assistant Secretary of the Army (Civil Works) Jo-Ellen Darcy distributed the first passes to one member from each of the military's five branches.

"Our nation owes a debt of gratitude to our servicemen and women who make great sacrifices and put their lives on the line to protect our country and preserve our freedom," Salazar said. "In recognition of their contributions and service, we are putting out a welcome mat for these brave men and women and their families at America's most beautiful and storied sites."

The National Park Service estimated that giving away the passes will cost between $2 million and $6 million in lost revenue a year.

Army formalizes combat jobs for women

TEST: 9 brigades will try the new policy first

BY KRISTIN M. HALL
The Associated Press

FORT CAMPBELL, KY. - Female soldiers this week are moving into new jobs in once all-male units as the Army breaks down formal barriers in recognition of what has already happened in wars in Iraq and Afghanistan.

The policy change announced earlier this year is being tested at nine brigades, including one at Fort Campbell, before going Armywide. It opens thousands of jobs to female soldiers by loosening restrictions meant to keep them away from the battlefield. Experience on the ground in the past decade showed women were fighting and dying alongside male soldiers anyway.

Joint Base Lewis-McChord, south of Tacoma, is not one of the testing sites.

Col. Val Keaveny Jr., commander of the 4th Brigade Combat Team that is among units piloting the change, told The Associated Press that for the last decade it has been common to have women temporarily attached to the combat units and serve alongside them.

"Women have served in our Army since the Revolutionary War, and they have done phenomenal work and continue to do so today," he said. "There is great talent, and now we can have it in the headquarters of infantry, armor and cavalry."

Under the new policy, female officers and noncommissioned officers will be assigned to combat units below the brigade level. The change will open up about 14,000 new jobs for women in the military, but more than 250,000 jobs remain closed.

The new jobs within combat battalions are in personnel, intelligence, logistics, signal corps, medical and chaplaincy. The Army is also opening jobs that were once entirely closed to women, such as mechanics for tanks and artillery and rocket launcher crew members.

The 4th Brigade draws its lineage from the 506th Parachute Infantry Regiment, whose World War II heroics led to books and a TV miniseries called "Band of Brothers." But these days, Keaveny said there are more than 350 women already serving in the brigade, and they will be opening 36 new jobs to women in the battalions.

"For the last 10 years, we have been fighting alongside women. In my experience I have seen that the Band of Brothers quickly integrate their sisters and they are a family," he said.

Capt. Elizabeth Evans, a 44-year-old mother of five, is one of the first women assigned to the combat battalions. She will serve as a battalion S1, whose job is to oversee personnel issues within the battalion, including awards, casualties, human resources and other administrative responsibilities. She said there is a lot of pride associated with serving in an infantry unit.

"I think there's a rich history in the 101st and especially the 4th Brigade Combat Team," she said.

Evans, who has deployed to Afghanistan, noted that women have been serving in dangerous jobs in Iraq and Afghanistan for 10 years.

"With the fluidity of the battlefield and how there are no front lines, it just makes more sense to me to allow women to come into those roles, those noncombat staff roles," she said.

Kayla Williams, author of "Love My Rifle More Than You: Young and Female in the US Army," served with the 3rd Brigade Combat Team under the 101st Airborne Division during the initial invasion of Iraq as an enlisted soldier in military intelligence. Early in the war, she wasn't even issued plates for her ballistic vest "because females can't serve in combat," she said.

She said she was temporarily attached to an infantry battalion at Fort Campbell that had no female latrines.

As an Arabic translator, she was attached to infantry units rather than assigned, but doing the same things as her male infantry counterparts, including going on foot patrols and living in remote combat outposts.

"Women have been serving in very forward deployed roles, and women have been serving side-by-side with combat arms personnel, just not in a formalized assigned method," said Williams, who is a fellow at the Truman National Security Project.

United States Environmental Protection Agency
Region 10

EPA Prepares for Lakewood /Ponders Corner Superfund Site 5-Year Review

Comments must be submitted by June 30, 2012

Lakewood, WA May 2012

Groundwater monitoring near Plaza Cleaners
Washington State Dept. of Ecology Photo

The U.S. Environmental Protection Agency (EPA) will soon prepare the fifth in a series of Five-Year Reviews for the Lakewood Superfund Site (commonly referred to as Lakewood/Ponders Corner). The 5-Year Review process determines whether current cleanup efforts at the site still protect people and the environment. If EPA finds any problems with the cleanup during the 5-Year Review, it will recommend actions to fix them.

The Lakewood Superfund Site is located south of Tacoma in Pierce County, Washington. It sits east of New York Avenue and south of Pacific Highway South in Lakewood. The contamination at the site originally came from a local dry cleaning and laundry business. The site is now occupied by an electrical supply and lighting business.

EPA invites you to submit comments or information that we can use during the 5-Year Review. Comments must be submitted by June 30. Comment information is on Page 2 of this fact sheet. For more information about the Site, go to the EPA website at: http://i.usa.gov/yf3
or to the Washington State Department of Ecology website at: http://1.usa.gov/Lakewood_study

Site Background and History

In 1981, EPA sampled two Lakewood Water District drinking water wells (H1 and H2). Tests showed tetrachloroethylene and other volatile organic contamination in the wells. The contaminated wells were temporarily taken out of service. Later that year, EPA removed contaminated soils and sludges from the Plaza Cleaners property.

EPA listed the Lakewood site on the National Priorities List (NPL) in 1983. The NPL includes the most hazardous sites across the United States that need to be cleaned up.

At every NPL site, EPA looks at the danger to people and the environment. We then decide the best way to deal with the threat. At the Lakewood site, we chose a method of cleanup that:

- Removed contaminated soils and sludge for offsite treatment and disposal,
- Used soil vapor extraction, and
- Installed air stripping towers on the Lakewood Water District supply wells to remove contaminants.

In 1996, EPA declared the soils at the site cleaned up and we removed the soil portion of the site from the NPL.

Continued next page

Timeline

1983	1984-85	May 1986	Nov 1986	Sept 1992	1992 ➡	2007
Listed to NPL	*Completed Investigation & Studies*	*Started First Cleanup*	*Chose Final Plan*	*Completed Construction*	*Ongoing Monitoring*	*Fourth 5-Yr Review*

What Current Residents Should Know

Although EPA has removed the site from the NPL, contaminants remain in the groundwater. As a result, the Lakewood Water District still operates the system to treat groundwater at the site and the Department of Ecology monitors groundwater for contamination.

The treatment is successful, with no detectable tetrachloroethylene or other volatile contaminants in the treated water. However, the untreated groundwater still contains some contaminants because the remedy only treats water intended for consumption.

Exposure to contaminated groundwater is prevented by prohibiting the installation of drinking water wells in the area. Use of drinking wells is prohibited in the area depicted on the adjacent map. ⇨
We ask all current landowners, drillers, and realtors to take note of the restriction. EPA asks owners of property **within** the outlined area on the map to continue with this restriction. Installation of private drinking water wells is prohibited within the Lakewood Urban Growth Boundary.

Comments and Information

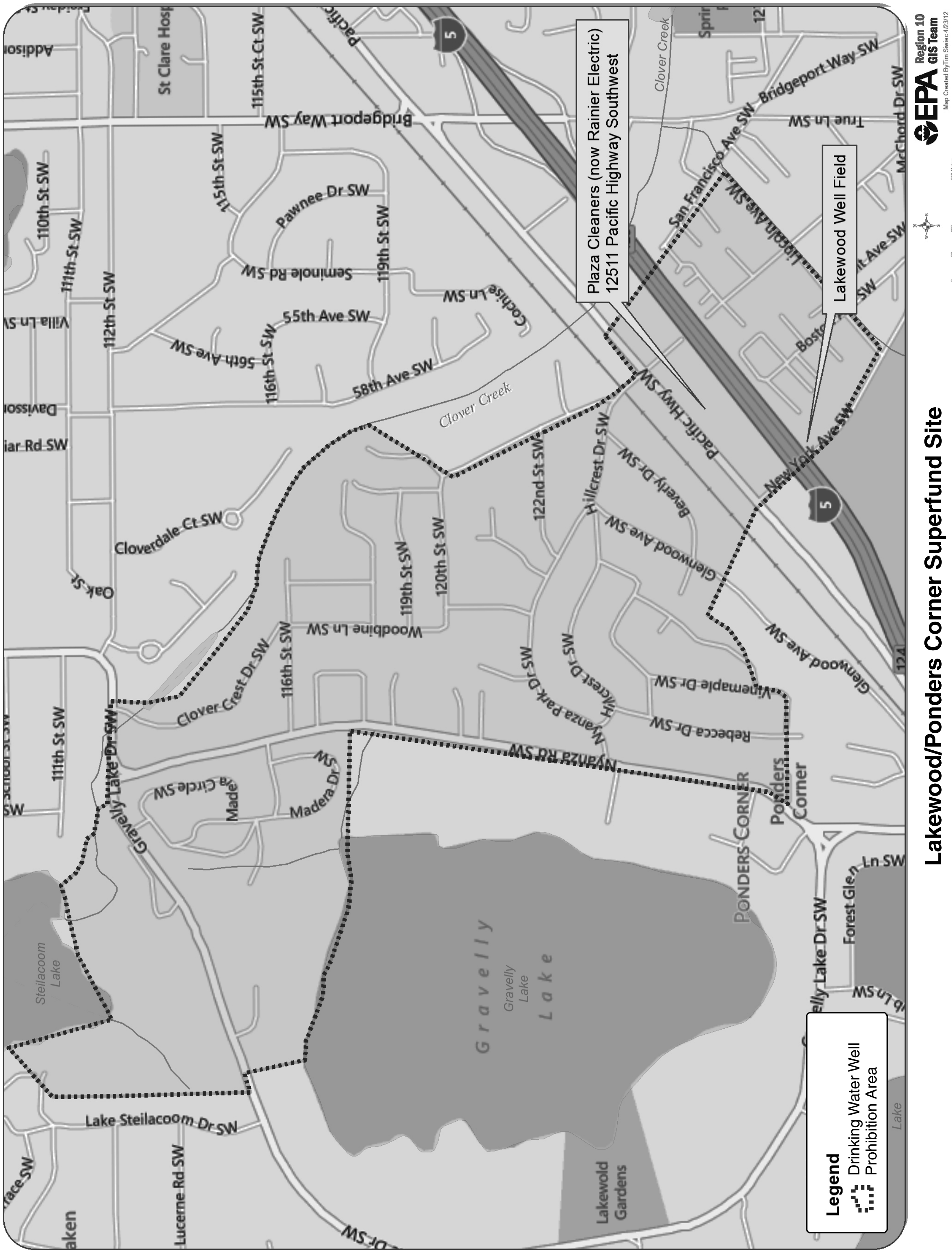
How to Submit Comments:

EPA welcomes comments that could be helpful in our evaluation of this site. Please send your comments by mail or email to

Christopher Cora
U.S. EPA, 1200 Sixth Ave, ECL-115
Seattle, WA 98101
Cora.Christopher@epa.gov

All comments must be submitted **no later than June 30, 2012.**

TDD users may call the Federal Relay Service at 800-877-8839 and give the operator Christopher Cora's phone number—206-553-1478


Lakewood/Ponders Corner Superfund Site
Plaza Cleaners (now Rainier Electric)
12511 Pacific Highway Southwest
Lakewood Well Field
Legend
Drinking Water Well Prohibition Area
Gravelly Lake
Steilacoom Lake
Ponders Corner
Clover Creek
Pacific Hwy SW
Bridgeport Way SW
Nyanza Rd SW
Gravelly Lake Dr SW
Lake Steilacoom Dr SW
Lakewold Gardens
EPA Region 10 GIS Team

United States Environmental Protection Agency
Region 10

1200 Sixth Avenue, Suite 900, ETPA-081
Seattle, Washington 98101-3140

May 2012

Pre-Sorted Standard
Postage and Fees Paid
U.S. EPA
Permit No. G-35
Seattle, WA

EPA Prepares for Lakewood/ Ponders Corner Superfund Site 5-Year Review

Read inside for details

EPA Prepares for Lakewood/Ponders Corner Superfund Site 5-Year Review

Look Inside for

- *What Current Residents Should Know*
- *Site Background and History*
- *How to Comment and Get Information*

Appendix F: Groundwater Data

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Lakewood Plaza Cleaners, June and October 2007 Groundwater Monitoring Results

Abstract

This progress report is one in a series describing results of long-term groundwater sampling at the former Lakewood Plaza Cleaners site south of Tacoma. The report includes results of volatile organics in samples collected from nine monitoring wells and one municipal well in June 2007, and four monitoring wells and one municipal well in October 2007.

- Monitoring wells MW-20B and MW-16A, as well as municipal well H1, continue to have tetrachloroethene (PCE) concentrations higher than the Model Toxic Control Act (MTCA) cleanup level of 5 µg/L. PCE concentrations in these wells during June and October were: MW-20B (204 and 491 µg/L), MW-16A (83 and 24 µg/L), and H1 (5.2 and 3.8 µg/L).

- PCE was also detected in well LPMW-2 at a concentration of 4.8 µg/L. This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

- Trichloroethene (TCE) was detected in MW-20B at concentrations of 4.4 and 7.5 µg/L, the latter of which exceeds the MTCA cleanup level for TCE of 5 µg/L.

- Cis-1,2-dichloroethene (cis-1,2-DCE) was detected in wells MW-20B (7.8 and 15 µg/L) and MW-16A (2.5 and an estimated 0.64 J µg/L). The federal maximum contaminant level for cis-1,2-DCE is 70 µg/L.

Most concentrations remain within the range of those reported in previous samplings conducted since 1991. However, PCE concentrations in well MW-16A appear to be steadily rising. Average PCE concentrations have increased from 8 µg/L in 1992 to 77 µg/L in 2006. The average PCE concentration in well MW-16A in 2007 was 54 µg/L. PCE concentrations in municipal well H1 remain near the MTCA cleanup level.

April 2008
Publication No. 08-03-010
Waterbody No. WA-12-1115

by Pam Marti and Tanya Roberts

Publication Information

This report is available on the Department of Ecology website at
www.ecy.wa.gov/biblio/0803010.html

Data for this project are available at Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search User Study ID, LAKEWOOD.

Ecology's Project Tracker Code for this study is 99-001-05.

For more information contact:

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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

In 1981, the U.S. Environmental Protection Agency (EPA) confirmed that the Lakewood Water District production wells H1 and H2 (Pierce County, Washington) were contaminated with tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dicloroethene (cis-1,2-DCE). The source of the contamination was identified as the Lakewood Plaza Cleaners (EPA, 1983).

In 1991, the Washington State Department of Ecology (Ecology) began semi-annual, long-term groundwater monitoring at the site. The objective of this sampling is to collect groundwater quality data for Ecology's Toxics Cleanup Program. The Toxics Cleanup Program will use this data to evaluate the effectiveness of Lakewood water supply wells H1 and H2 to contain and remove groundwater contaminated by Plaza Cleaners.

In 1996, the monitoring program was evaluated. Based on data collected from 1986 to 1996, it was decided to decommission half of the remaining wells and reduce the monitoring program to wells in the immediate vicinity of Plaza Cleaners. The monitoring program was evaluated again in August 2002. The current monitoring program was determined to be sufficient to meet project objectives (Ecology, 2002).

Three wells (LPMW-1, LPMW-2, and LPMW-3) were added to the monitoring program in May 2006. These wells are located on a property adjoining the former Plaza Cleaners property. PCE was detected in these wells during their installation in December 2004.

Methods

In June 2007, groundwater samples were collected from monitoring wells MW-16A, MW-19A, MW-20A, MW-20B, MW-27, MW-31, MW-33, LPMW-2, LPMW-3 and municipal well H1 (Figure 1). Well LPMW-1 was not sampled because it was dry.

In October 2007, groundwater samples were collected from wells MW-16A, MW-20A, MW-20B, MW-27, and municipal well H1. The three new wells were not sampled in October because the access gate to LPMW-1 and LPMW-3 was locked, and LPMW-2, located outside the gate, lacked enough water for the selected sampling method.

Wells MW-16A, MW-19A, MW-20A, MW-27, MW-31, and MW-33 are screened in the Advanced Outwash deposits, the primary water-supply aquifer for the area. Groundwater flow direction in the Advanced Outwash is west-northwest when municipal water-supply wells H1 and H2 are not in use. When in use, these two wells create a large cone of depression (EPA, 1985). Well MW-20B is screened in the Vashon Till, which forms an aquitard over most of the site. The new wells (LPMW-1, LPMW-2, and LPMW-3), which range in depth from 28-32 feet, are screened in the Steilacoom Gravel, which generally contains perched water above the impermeable Vashon Till and regional water table.

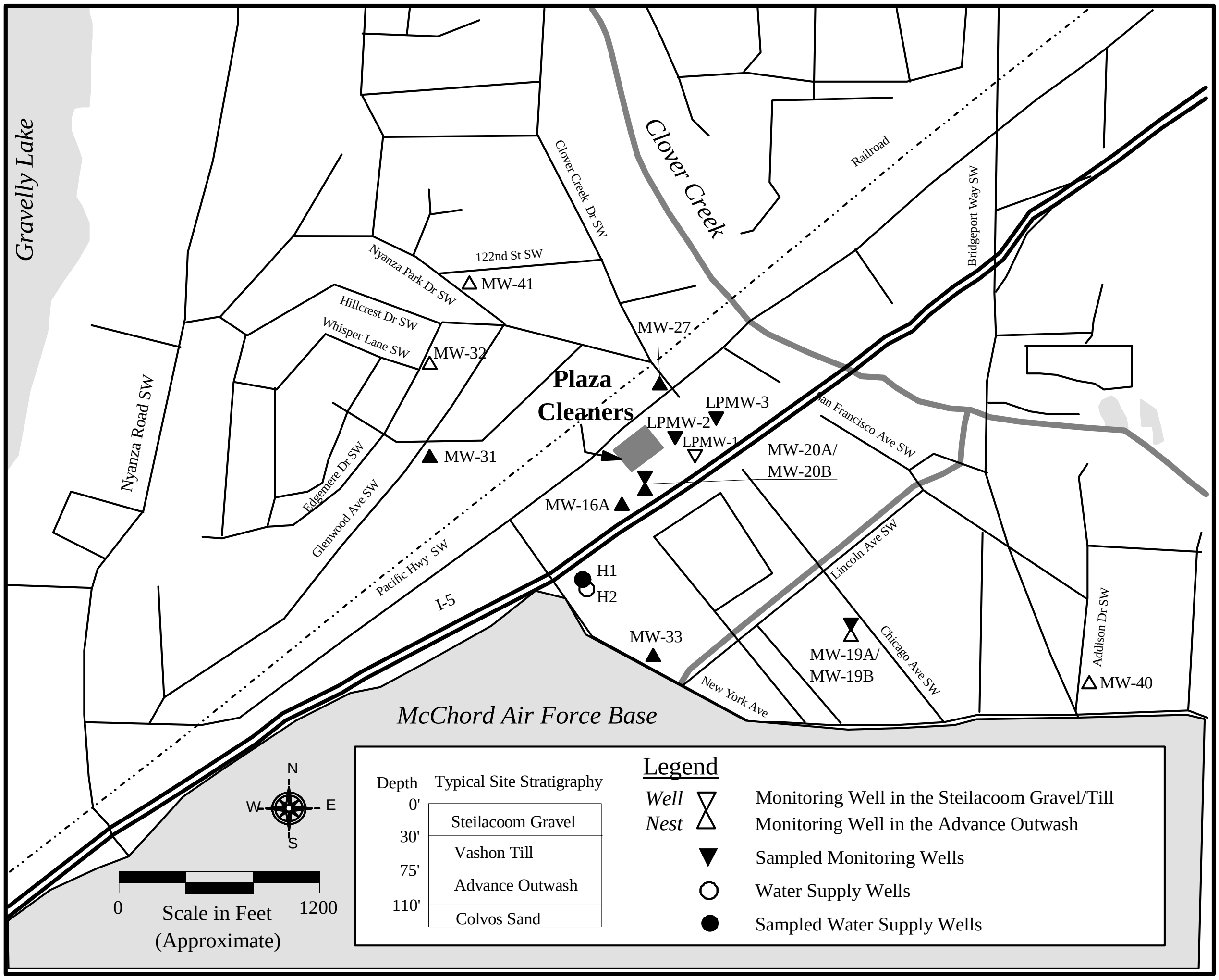

Figure 1. Lakewood Plaza Cleaners Sampling Locations.

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

Monitoring wells MW-16A, MW-19A, MW-20A, MW-31, and MW-33 were purged and sampled using dedicated bladder pumps.

Wells MW-20B, MW-27, LPMW-2, and LPMW-3 were purged and sampled with a stainless-steel submersible pump with dedicated tubing using low-flow sampling techniques. The submersible pump was decontaminated between wells by circulating laboratory grade detergent/water through the pump followed by a clean water rinse, with each cycle lasting five minutes.

The monitoring wells were purged until pH, temperature, and specific conductance readings stabilized or three well volumes of water had been removed. Purge water from the monitoring wells was collected and stored in 55-gallon drums. The purge water waste was transported and disposed of in accordance with State of Washington regulations (Chapter 173-340-400 WAC). At the completion of purging, samples were collected from the monitoring wells directly from the dedicated pump discharge tubing into laboratory supplied containers. Municipal well H1, which pumps continuously, was sampled from the tap nearest the well.

Volatile organics 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 Operations Center in Lacey. Samples were kept in the walk-in cooler until taken by the courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Laboratory protocol (Ecology, 2003).

Analysis

Table 1 lists analytes, analytical methods, and detection limits for both field and laboratory parameters. All groundwater samples were analyzed for volatile organics.

Table 1. Field and Laboratory Methods for June and October 2007 Samples.

Field Measurements	Instrument Type	Method	Accuracy
Water Level pH Temperature Specific Conductance	Solinst Water Level Meter Orion 25A Field Meter Orion 25A Field Meter YSI 3520 Conductivity Cell	Ecology SOP EPA 150.1 Ecology SOP EPA 120.1	±0.03 feet ±0.1 std. units ±0.1 ºC ±10 µmhos/cm
Laboratory Analytes	Reference	Method	Reporting Limit
Volatile Organic Analysis	EPA 1996	EPA SW-846 Method 8260B	1-5 µg/L

SOP = Standard operating procedure.

The quality of the data is acceptable. Quality control samples collected in the field consisted of blind field duplicates obtained from well MW-16A. 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 also by the natural variability of the concentrations in the media being sampled.

The numeric comparison of duplicate results is expressed as the relative percent difference (RPD). The RPD is calculated as the difference between sample results, divided by the mean and expressed as a percent. Table 2 shows the results of the duplicate samples and their relative percent difference (RPD). The RPD for the June data ranged from 4% to 9%, and the RPD for PCE in October was 22%.

Table 2. Relative Percent Difference (RPD) of Duplicate Sample Results (µg/L) from June and October 2007.

Well	PCE		TCE		cis-1,2-DCE	
	6/07	10/07	6/07	10/07	6/07	10/07
MW-16A	83	24	1.2	1 U	2.5	0.64 J
MW-16B	80	30	1.1	1 U	2.4	0.70 J
RPD (%)	4%	22%	9%	--	4%	--

A review of the data quality control and quality assurance from laboratory case narratives indicates that 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 major problems were reported that compromised the usefulness or validity of the sample results; therefore, all results are usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

Results

Field

Depth-to-water measurements and purge volume, as well as pH, specific conductance, and temperature readings, at the time of sampling are listed in Table 3.

Table 3. Summary of Field Parameters Results for June 13-14 and October 4, 2007.

Well	Total Depth (feet)[1]	Depth to Water (feet)[1]	pH (standard units)	Specific Conductance (µmhos/cm)	Temperature (°C)	Purge Volume (gallons)
June						
MW-16A	109	35.95	7.1	251	13.5	54
MW-19A	97.5	++	7.0	207	11.9	30
MW-20A	97.3	30.54	7.7	225	12.7	23
MW-20B	50.4	29.64	6.5	423	13.8	7
MW-27	96.4	28.95	6.7	186	13.7	15
MW-31	93	++	6.9	189	12.0	28
MW-33	99.3	++	7.2	220	11.5	27
LPMW-2	29	23.99	6.2	184	14.2	3
LPMW-3	31.45	23.03	6.6	281	17.9	2.5
H1	110	++	6.6	184	12.5	>1000
October						
MW-16A	109	40.61	7.1	212	12.4	66
MW-20A	97.3	35.02	7.6	224	12.5	16
MW-20B	50.4	36.9	6.4	407	13.8	6
MW-27	96.4	33.31	6.7	188	14.0	18
H1	110	++	--	177	11.9	>1000

[1] Measured from top of PVC casing.
++ Dedicated pump obstructed water-level measurement.
-- Not measured.

All field parameters were within expected ranges. The specific conductance in wells MW-20B (407-423 µmhos/cm) and LPMW-3 (281 µmhos/cm) was greater than the other wells. Well MW-20B is screened in a fine-grained till unit. LPMW-3 is screened in a very dense, gravelly, sandy silt. Specific conductance readings are typically higher for water from fine-grained units.

Analytical

Analytical results for volatile organics of interest are summarized in Table 4 and presented in Figure 2.

All field measurements and analytical results data are available in electronic format from Ecology's EIM data management system: www.ecy.wa.gov/eim/index.htm at study ID LAKEWOOD.

Table 4. Results (µg/L) of Volatile Organics of Interest for June 13-14 and October 4, 2007.

Well	Tetrachloroethene (PCE)	Trichloroethene (TCE)	Cis-1,2-Dichloroethene (cis-1,2-DCE)
June			
MW-16A	**83**	**1.2**	**2.5**
MW-19A	2 U	**1.2 J**	2 U
MW-20A	2 U	2 U	2 U
MW-20B	**204**	**4.4**	**7.8**
MW-27	2 U	2 U	2 U
MW-31	**1.6 J**	2 U	2 U
MW-33	2 U	2 U	2 U
LPMW-2	**4.8**	1 U	1 U
LPMW-3	2 U	1 U	1 U
H1	**5.2**	2 U	2 U
October			
MW-16A	**24**	1 U	**0.64 J**
MW-20A	2 U	1 U	1 U
MW-20B	**491**	**7.5**	**15**
MW-27	2 U	1 U	1 U
H1	**3.8**	1 U	1 U

Bold: Analyte detected.
U: Analyte was not detected at or above the reported value.
J: Analyte was positively identified. The associated numerical result is an estimate.

In June, PCE, TCE, and cis-1,2-DCE concentrations in well MW-20B were 204 µg/L, 4.4 µg/L, and 7.8 µg/L, respectively. PCE, TCE, and cis-1,2-DCE were also detected in monitoring well MW-16A at concentrations of 83 µg/L, 1.2 µg/L and 2.5 µg/L, respectively. PCE was detected in municipal well H1 at a concentration of 5.2 µg/L. PCE was also detected in well LPMW-2 at a concentration of 4.8 µg/L. This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

In October, PCE, TCE, and cis-1,2-DCE concentrations in well MW-20B were 491 µg/L, 7.5 µg/L, and 15 µg/L, respectively. PCE was also detected in wells MW-16A and H1 at concentrations of 24 µg/L and 3.8 µg/L, respectively. MW-16A also contained cis-1,2-DCE at a concentration below the practical quantitation limit of 1 µg/L.

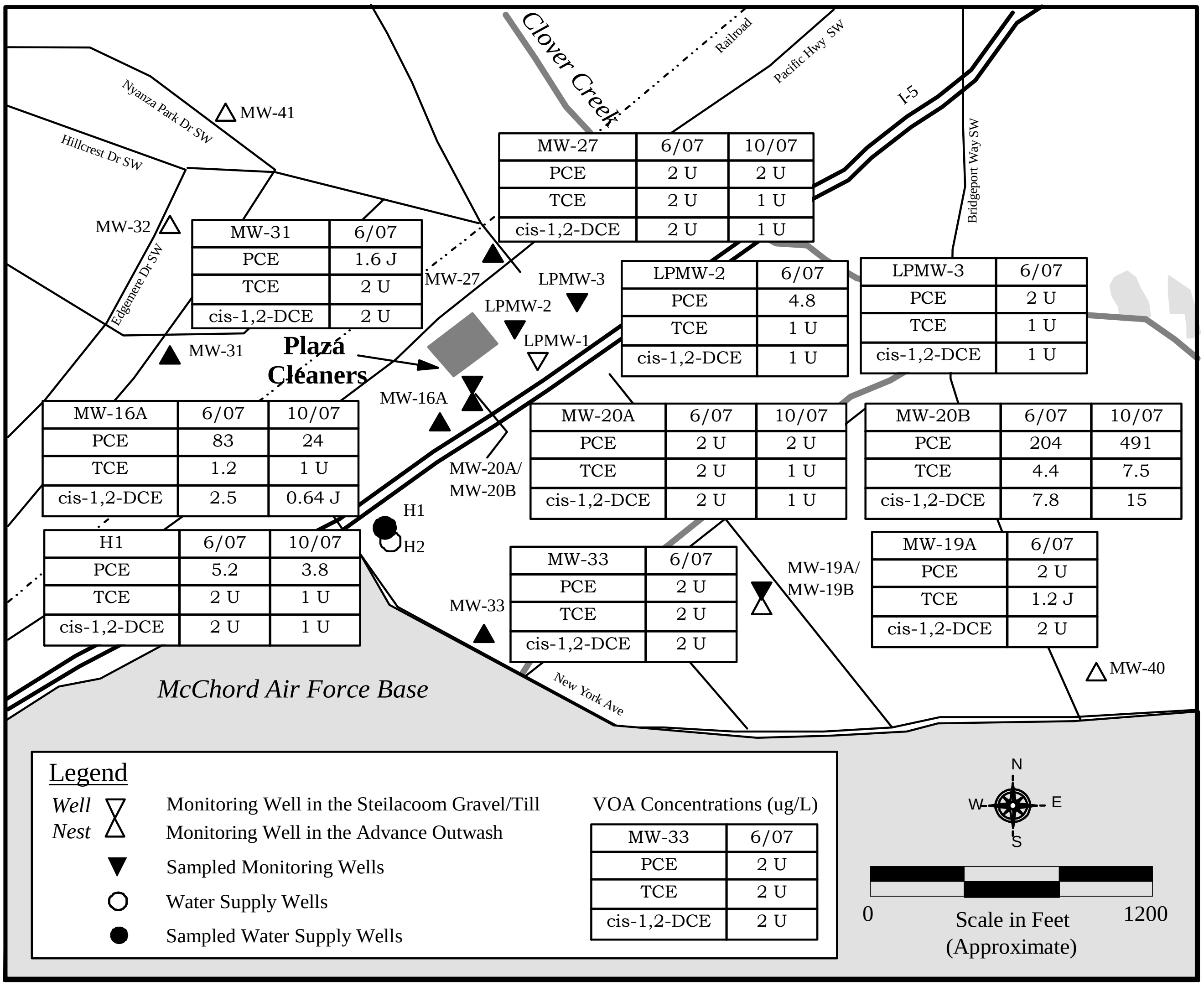

Figure 2. Lakewood Plaza Cleaners PCE, TCE, and Cis-1,2-DCE Concentrations (μg/L), June and October 2007.

Table 5 shows average PCE and TCE concentrations that have exceeded the MTCA cleanup level of 5 µg/L during the sample period. All PCE, TCE, and cis-1,2-DCE concentrations from January 1991 through October 2007 are presented in the Appendix.

Table 5. Average Annual PCE and TCE Concentrations (µg/L) that Exceeded the MTCA Method A Cleanup Level for Groundwater of 5 µg/L.

Year	MW-20B		MW-16A	H1/H2
	PCE	TCE	PCE	PCE
1991	657	12	19	---
1992	640	14	8	---
1993	443	12	28	---
1994	279	8.6	21	---
1995	340[a]	8.4[a]	27[a]	9[a]
1996	370	7	45	4
1997	297	4	50	13
1998	515	8	33	10
1999	715	7	22[a]	3
2000	416	6	31	9
2001	489	7	28	9
2002	309	8.5	34	9
2003	234	5.4	42	6.4
2004	293	6.6	39	5.3
2005	484	6.5	62	10.2
2006	367	4.9	77	6.1
2007	348	6	54	4.5

--: Not tested.
a: Single annual result.

Figures 3 and 4 show the average annual PCE concentrations for MW-20B and MW-16A from 1985 to 2007. PCE concentrations in both wells have varied substantially.

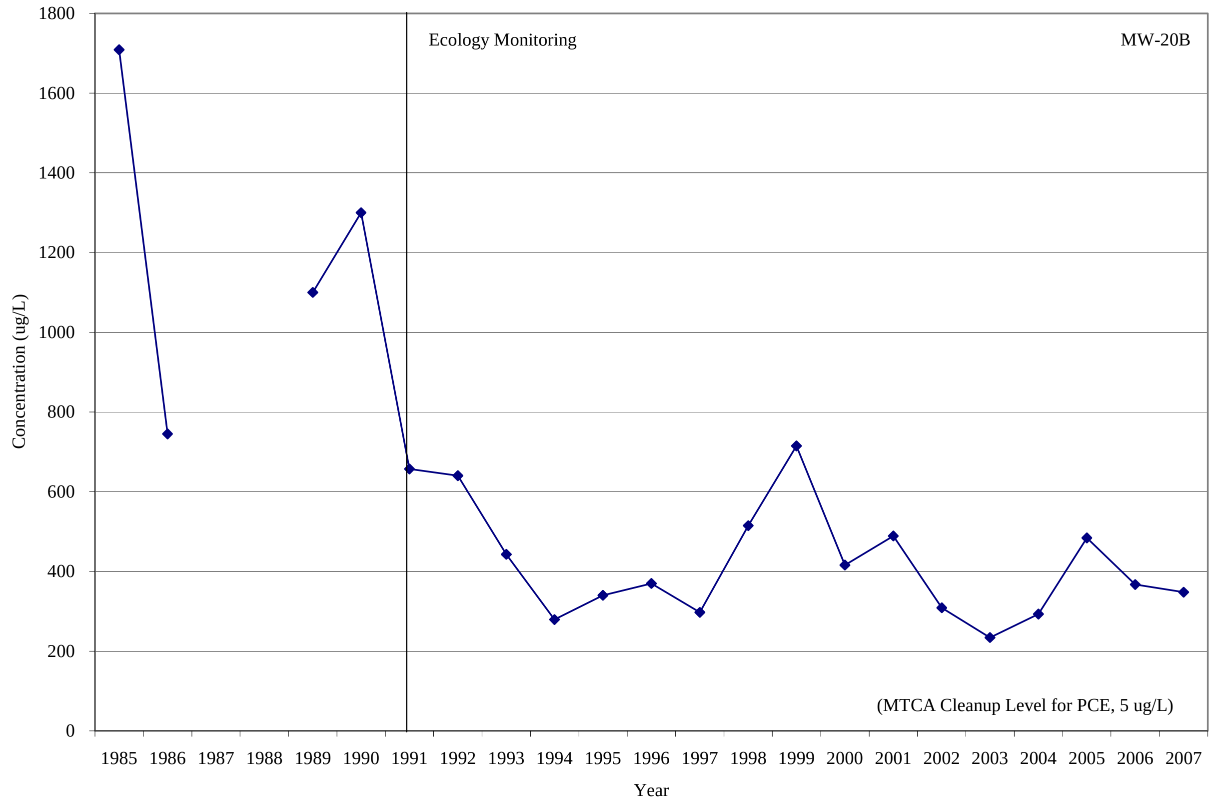

Figure 3. Average Annual PCE Concentrations for Well MW-20B from 1985 to 2007.

PCE concentrations decreased initially in MW-20B from 4850 µg/L in March 1985 to 570 µg/L in May 1985. The average PCE concentration for 1985 was 1700 µg/L. Well MW-20B was sampled annually in 1986, 1989, and 1990 and had a PCE concentration range of 745 to 1300 µg/L.

In 1991, Ecology began long-term groundwater monitoring of the site.

From 1991 to 1994, samples were collected in the spring and fall which corresponded to the high-water/low-water seasons. PCE concentrations decreased from a 1991 average of 657 µg/L to 279 µg/L in 1994.

In 1995, the sampling routine changed to a winter/summer schedule. Seasonal fluctuations in concentrations which occurred from 1991 to 1994 leveled off with the change in the sample schedule. In 1995 average PCE concentrations were 340 µg/L. Average concentrations then increased to a high of 715 µg/L in 1999, before decreasing to a low of 234 µg/L in 2003.

In the fall of 2003, sampling returned to the spring/fall schedule, which led to a corresponding return to seasonal variations in concentrations. Average annual PCE concentrations have since ranged from 234 μg/L in 2003, increasing to 484 μg/L in 2005, and then decreasing to 348 μg/L in 2007.

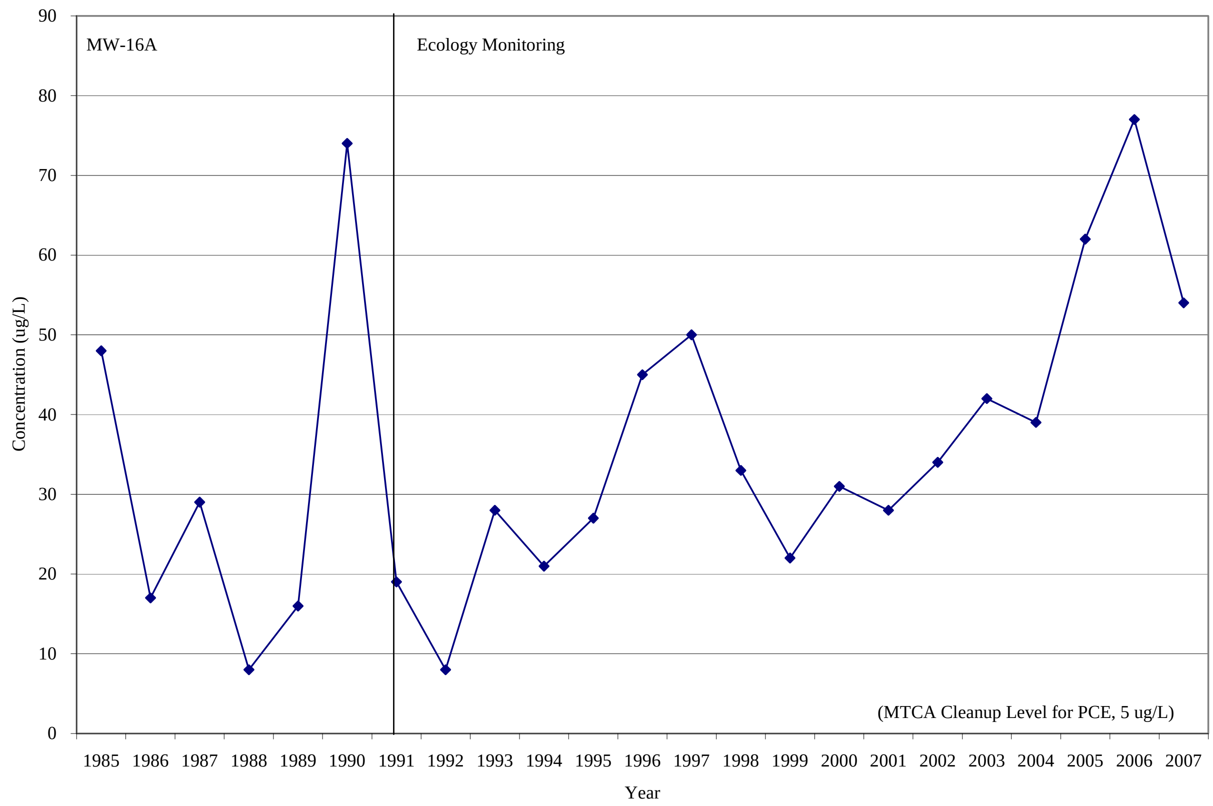

Figure 4. Average Annual PCE Concentrations for Well MW-16A from 1985 to 2007

PCE concentrations also initially decreased in well MW-16A, dropping from 110 μg/L in March 1985 to 12 μg/L in August 1985, with an average annual PCE concentration of 48 μg/L. From 1986 to 1990, PCE concentrations of individual samples ranged from 8 μg/L, increasing to 74 μg/L in 1990. Since Ecology began monitoring in 1991, average annual PCE concentrations have ranged from 8 μg/L in 1992, increasing to 50 μg/L in 1997, and decreasing to 22 μg/L in 1999. Since 1999, average annual concentrations have been steadily increasing to 77 μg/L in 2006. Average PCE concentrations in 2007 were 54 μg/L.

PCE concentrations continue to be elevated in wells MW-20B and MW-16A. Municipal wells H1 and H2, which were added to the monitoring program in 1995, also have PCE concentrations above the MTCA cleanup level.

Conclusions

Monitoring was conducted in June 2007 at nine monitoring wells and one municipal well and in October 2007 at four monitoring wells and one municipal well, to evaluate volatile organics in groundwater at the Lakewood Plaza Cleaners site.

- Monitoring wells MW-20B and MW-16A, as well as municipal well H1, continue to have PCE concentrations exceeding the MTCA cleanup level of 5 µg/L.

- Monitoring well MW-20B continues to have TCE concentrations exceeding the MTCA cleanup level of 5 µg/L.

- PCE concentrations in well LPMW-2 have been above or near the cleanup level of 5 µg/L. This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

Concentrations of PCE have decreased from their original levels, but continue to remain elevated. Average PCE concentrations in wells MW-20B and MW-16A have decreased since their 1985 concentrations of 4850 µg/L and 110 µg/L, respectively. Since Ecology began sampling in 1991, average PCE concentrations in well MW-20B have ranged from a high of 715 µg/L in 1999 to a low of 234 µg/L in 2003. Although PCE concentrations have been slightly higher during the last four years of monitoring, concentrations are still within the range of those reported in previous samplings. The average PCE concentration for well MW-20B in 2007 was 348 µg/L.

PCE concentrations in well MW-16A appear to be steadily increasing. Average PCE concentrations in 1992 were 8 µg/L, increasing to 77 µg/L in 2006. The average PCE concentrations in 2007 were 54 µg/L.

Citations

Ecology, 2002. Five-Year Review Report. Third Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, WA – October 2002. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

Ecology, 2005. Manchester Environmental Laboratory - Laboratory Users Manual. 8th edition. Washington State Department of Ecology, Manchester, WA.

Ecology, 2006. Standard Operating Procedures Field Manual for Groundwater Assessment Program Studies. Draft. Washington State Department of Ecology, Olympia, WA.

EPA, 1979. EPA-600/4-79-020 Methods for Chemical Analysis of Water and Wastes. U.S. Environmental Protection Agency.

EPA, 1983. Report of the Groundwater Investigation – Lakewood, Washington, October 1981 to February 1983. U.S. Environmental Protection Agency.

EPA, 1985. Final Draft Remedial Investigation Report – Ponders Corner, Washington. U.S. Environmental Protection Agency. EPA 112-0L22.

EPA, 1996. Test Methods for Evaluating Solid Waste, SW-846. Office of Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

References

CH2M HILL, 1990a. Sampling and Analysis Plan Remedial Action - Lakewood.

CH2M HILL, 1990b. Technical Memorandum from Lisa Dally Wilson to Ann Williamson RE: Groundwater Sampling at Lakewood (April 1990). Project No. SEA69018RA.FQ.

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round I - January 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e34. www.ecy.wa.gov/biblio/91e34.html

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round II - June 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e35. www.ecy.wa.gov/biblio/91e35.html

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round III - November 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e43. www.ecy.wa.gov/biblio/92e43.html

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round IV - June 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e44. www.ecy.wa.gov/biblio/92e44.html

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round V - December 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e38. www.ecy.wa.gov/biblio/93e38.html

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round VI - June 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e39. www.ecy.wa.gov/biblio/93e39.html

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VII - December 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 94-131. www.ecy.wa.gov/biblio/94131.html

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VIII - April 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 94-198. www.ecy.wa.gov/biblio/94198.html

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring Round IX - November 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 95-340. www.ecy.wa.gov/biblio/95340.html

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring - July 11, 12 & 14, 1995. Washington State Department of Ecology, Olympia, WA. Publication No. 95-359. www.ecy.wa.gov/biblio/95359.html

Marti, P., 1996. Lakewood/Plaza Cleaners Monitoring - January 17-18, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 96-317. www.ecy.wa.gov/biblio/96317.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 31, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 97-312. www.ecy.wa.gov/biblio/97312.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - January 9, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-324a. www.ecy.wa.gov/biblio/97324a.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 23-24, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-339. www.ecy.wa.gov/biblio/97339.html

Marti, P., 1998. Lakewood/Plaza Cleaners Monitoring - February 2, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 98-325. www.ecy.wa.gov/biblio/98325.html

Marti, P., 1999. Lakewood/Plaza Cleaners Monitoring - July 15, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 99-312. www.ecy.wa.gov/biblio/99312.html

Marti, P., 1999. Lakewood/Plaza Cleaners Long-term Monitoring, January and August, 1999. Washington State Department of Ecology, Olympia, WA. Publication No. 99-344. www.ecy.wa.gov/biblio/99344.html

Marti, P., 2000. Lakewood/Plaza Cleaners, January and August 2000 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 00-03-046. www.ecy.wa.gov/biblio/0003046.html

Marti, P., 2001. Lakewood/Plaza Cleaners, January and August 2001 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 01-03-032. www.ecy.wa.gov/biblio/0103032.html

Marti, P., 2002. Lakewood Plaza Cleaners, February and August 2002 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-007. www.ecy.wa.gov/biblio/0303007.html

Marti, P., 2003. Lakewood Plaza Cleaners, February and October 2003 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-050. www.ecy.wa.gov/biblio/0303050.html

Marti, P., 2004. Lakewood Plaza Cleaners, June and November 2004 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-054. www.ecy.wa.gov/biblio/0403054.html

Marti, P., 2005. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html

Marti, P., 2006. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html

Marti, P., 2007. Lakewood Plaza Cleaners, May and September 2006 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 07-03-013. www.ecy.wa.gov/biblio/0703013.html

Appendix. Summary of Results

Table A-1. Summary of Sample Results (ug/L) from January 1991 to October 2007.

Well	January 1991			May 1991			November 1991			May 1992			December 1992		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**28**	**1 J**	**2.4 J**	**26**	**0.6 J**	**2**	**2.7 J**	1 U	**0.6 J**	**7**	1 U	**1**	**9 J**	**0.3 J**	**0.8 J**
MW-20A	1 U	1 U	1 U	**0.4 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.5 J**	1 U	1 U	**0.8 J**	1 UJ	1 UJ
MW-20B	**1100 D**	**18**	**33**	**752**	**16**	**30**	**120**	**2.6 J**	**6.7**	**940**	**13**	**32**	**340 J**	**14 J**	**20 J**
MW-21	**2.1 J**	1 U	**1 J**	**2**	1 U	**0.7 J**	**2.2 J**	1 U	**1.0 J**	**2**	1 U	**0.6 J**	**2**	**0.2 J**	**0.3 J**
MW-27	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 UJ	1 UJ	1 UJ
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-31	**1 J**	1 U	**1.9 J**	**0.6 J**	1 U	**2**	**0.9 J**	1 U	**2.2 J**	**0.8 J**	1 U	**1**	**0.5 J**	1 UJ	**0.9 J**
MW-32	**1 J**	1 U	**1.1 J**	**1**	1 U	**2**	**0.6 J**	1 U	**0.6 J**	**0.7 J**	1 U	**1**	**0.7 J**	1 UJ	**0.5 J**
MW-41	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 UJ	1 UJ	1 UJ
MW-19A	--	--	--	--	--	--	1 U	**0.5 J**	1 U	--	--	--	1 UJ	1 UJ	1 UJ
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-40	1 U	1 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--	1 UJ	1 UJ	1 UJ
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well	May 1993			December 1993			April 1994			November 1994			July 1995		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**44**	10 U	**2 J**	**13**	**0.3 J**	**0.7 J**	**33**	**0.6**	**1.4**	**9.7**	**0.3 J**	**0.5 J**	**27**	**0.5 J**	**0.8 J**
MW-20A	10 U	10 U	10 U	**0.3 J**	1 U	1 U	**0.4**	0.2 U	0.2 U	**0.3 J**	1 U	1 U	**0.4 J**	1 U	1 U
MW-20B	**700 D**	**12**	**21**	**187**	50 U	**8.2 J**	**472**	**8.6 J**	**12.6**	**86**	50 U	**3 J**	**340 D**	**8.4**	**17**
MW-21	**1 J**	10 U	10 U	**1.6**	1 U	**0.4 J**	**1.5**	**0.2 J**	**0.3**	**1.8**	**0.2 J**	**0.3 J**	--	--	--
MW-27	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-31	10 U	10 U	10 U	**0.8 J**	1 U	**1.2 J**	**0.7**	0.2 U	**1.0**	**0.8 J**	1 U	**1**	**0.6 J**	1 U	**0.5 J**
MW-32	10 U	10 U	10 U	**0.7 J**	1 U	**0.6 J**	**0.7**	0.2 U	**0.6**	**0.6 J**	1 U	**0.5 J**	**0.7 J**	1 U	**0.5 J**
MW-41	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-19A	--	--	--	1 U	**0.4**	1 U	0.2 U	**0.5**	0.2 U	--	--	--	1 U	**0.4 J**	1 U
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	--	--	--	1 U	1 U	1 U
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	**9**	**0.3 J**	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2007.

Well	January 1996			July 1996			January 1997			July 1997			February 1998		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**47 E**	**0.8 J**	**1.5**	**43**	**0.7 J**	**1.9**	**54**	**1.1**	**3.1**	**47**	**0.7 J**	**2.5**	**36**	**0.7 J**	**2 J**
MW-20A	**0.2 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.3 J**	1 U	2 U	**0.4 J**	1 U	1 U
MW-20B	**353**	**7.2**	**15**	**387**	**7.6**	**15**	**373**	100 U	**6.4 J**	**222**	**4**	**6.4**	**456**	**7 J**	**12**
MW-21	--	--	--	Well Decommissioned											
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
MW-28A	1 U	1 U	1 U	Well Decommissioned											
MW-31	**0.6 J**	1 U	**0.7 J**	--	--	--	--	--	--	**0.9 J**	1 U	**0.9 J**	--	--	--
MW-32	**0.8 J**	1 U	**0.6 J**	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	--	--	--	1 U	**0.3 J**	2 U	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--	1 U	1 U	2 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	**8.4**	**0.2 J**	**0.2 J**	**0.14 J**	1 U	1 U	**18**	**0.4 J**	**0.4 J**	**8.8**	**0.3 J**	**0.6 J**	**11**	**0.4 J**	**0.3 J**

Well	July 1998			January 1999			August 1999			January 2000			August 2000		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**30**	1 U	**1.5 J**	--	--	--	**22**	**0.4 J**	**1.1**	**40**	**0.7 J**	**1.9**	**22**	**0.3 J**	**0.7**
MW-20A	**0.6 J**	1 U	1 U	1 U	2 U	1 U	**0.8 J**	2 U	1 U	**0.2 J**	2 U	1 U	**0.1 J**	2 U	1 U
MW-20B	**575 D**	**10**	**23**	**708**	**5.2**	**12**	**722**	**8.4 J**	**16 J**	**184**	**6**	**13**	**648**	200 U	100 U
MW-27	**0.05 J**	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U
MW-31	--	--	--	--	--	--	**0.9 J**	2 U	**0.4 J**	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	**0.8 J**	2 U	1 U
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
MW-19A	--	--	--	--	--	--	1 U	**0.4 J**	1 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	1 U	2 U	1 U	--	--	--	1 U	2 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
H1/H2	**10**	1 U	**0.1 J**	**1.5**	1 U	1 U	**5.2**	**0.2 J**	1 U	**10**	1 U	1 U	**8.7**	**0.03 J**	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2007.

Well Number	January 2001			August 2001			February 2002			August 2002			February 2003		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.4 J**	**1**	**25**	**0.3 J**	**0.7 J**	**47**	**0.8 J**	**2.3**	**22**	**0.3 J**	**0.8 J**	**59 J**	**0.2 J**	**2.4**
MW-20A	**0.2 J**	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U
MW-20B	**493**	**6.6 J**	**12**	**486**	**8.2**	**18**	**248**	200 U	100 U	**371**	**8.5**	**16**	**230**	100 U	100 U
MW-27	1 U	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	**0.4 J**	2 U	**0.3 J**	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	1 U	**0.3 J**	1 U	--	--	--	--	--	--	--	--	--
MW-33	--	--	--	1 U	2 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	**11**	**0.2 J**	1 U	**6.8**	**0.2 J**	1 U	**12**	**0.2 J**	**0.2 J**	**6.1**	1 U	1 U	**1.3**	1 U	1 U

Well Number	September 2003			June 2004			November 2004			June 2005			November 2005		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**26**	**0.3 J**	**0.5 J**	**30**	**0.4 J**	**0.8 J**	**48**	1 U	**1.4**	**80.3**	**1.3**	**2.8**	**43**	**0.69 J**	**1.0 J**
MW-20A	**0.1 J**	1 U	1 U	**0.2 J**	1 U	1 U	**0.3 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**239**	**5.4 J**	**12**	**344**	**6.5 J**	**15**	**241**	**6.7**	**13**	**413**	**6.6**	**12**	**555**	**6.4**	**11**
MW-27	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
MW-31	**0.5 J**	1 U	**0.1 NJ**	--	--	--	--	--	--	**0.53 J**	1 U	1 U	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	**1.4**	1 U	1 U	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-19A	1 U	**0.4 NJ**	1 U	--	--	--	--	--	--	1 U	**0.57 J**	1 U	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
H1/H2	**6.4**	**0.2 NJ**	1 U	**7.9**	**0.24 J**	**0.1 J**	**2.6**	1 U	1 U	**14**	**0.31 J**	1 U	**6.4**	1 U	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2007.

Well Number	May 2006			September 2006			June 2007			October 2007		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**124**	**1.8**	**4.6**	**29**	**0.3 J**	**0.48 J**	**83**	**1.2**	**2.5**	**24**	1 U	**0.64 J**
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U
MW-20B	**216**	**4.2**	**6.6**	**518**	**5.6**	**11**	**204**	**4.4**	**7.8**	**491**	**7.5**	**15**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U
MW-31	--	--	--	--	--	--	**1.6 J**	2 U	2 U	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	2 U	**1.2 J**	2 U	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	2 U	2 U	2 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	**7.3**	**0.22 J**	1 U	**4.8**	1 U	1 U	**5.2**	2 U	2 U	**3.8**	1 U	1 U

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
D = Analysis performed at secondary dilution.
E = The concentration of the associated value exceeds the known calibration range.
-- = Not tested
Bold = The analyte was positively identified.

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State of Washington

Lakewood Plaza Cleaners Groundwater Monitoring Results

May and October 2008

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

Lakewood Plaza Cleaners, Groundwater Monitoring Results

May and October 2008

by
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Abstract

This progress report is one in a series describing results of long-term groundwater sampling at the former Lakewood Plaza Cleaners site south of Tacoma. The report includes results of volatile organics in samples collected from project monitoring wells and Lakewood Water District municipal wells in May and October 2008.

- Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have tetrachloroethene (PCE) concentrations higher than the Model Toxic Control Act (MTCA) cleanup level of 5 µg/L. PCE concentrations in these wells during May and October were: MW-20B (143 and 258 µg/L), MW-16A (55 and 31 µg/L), H2 (9.6 µg/L in May), and H1 (5.1 µg/L in October).

- PCE was also detected in well LPMW-2 in May at a concentration of 2.5 µg/L. This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

- Trichloroethene (TCE) was detected in MW-20B during May and October at concentrations of 5.5 and 4.5 µg/L. The May result exceeds the MTCA cleanup level for TCE of 5 µg/L.

- Cis-1,2-dichloroethene (cis-1,2-DCE) was detected in wells MW-20B (12 and 9 µg/L) and MW-16A (2.8 and an estimated 0.6 J µg/L). The federal maximum contaminant level for cis-1,2-DCE is 70 µg/L.

Most concentrations remain within the range of those reported in previous samplings conducted by the Washington State Department of Ecology since 1991. However, PCE concentrations in well MW-16A appear to be steadily rising. Average PCE concentrations rose from 8 µg/L in 1992 to 77 µg/L in 2006. The average PCE concentration in well MW-16A in 2008 was 43 µg/L.

Compliance with the groundwater cleanup goals have not been met for this project. The project should be evaluated to determine what follow-up actions are needed for this site to meet the cleanup goals in a reasonable timeframe.

Introduction

In 1981, the U.S. Environmental Protection Agency (EPA) confirmed that the Lakewood Water District production wells H1 and H2 were contaminated with tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE). Lakewood is south of Tacoma in Pierce County. The source of the contamination was identified as the Lakewood Plaza Cleaners (EPA, 1983). Remedial activities were conducted between 1984 to 1993.

In 1991, the Washington State Department of Ecology (Ecology) began semi-annual, long-term groundwater monitoring at the site. The objective of this sampling is to collect groundwater quality data for Ecology's Toxics Cleanup Program. The Toxics Cleanup Program will use this data to evaluate the effectiveness of Lakewood water supply wells H1 and H2 to contain, remove, and treat groundwater contaminated by Plaza Cleaners.

In 1996, the monitoring program was evaluated. Based on data collected from 1986 to 1996, it was decided to decommission half of the remaining wells and reduce the monitoring program to wells in the immediate vicinity of Plaza Cleaners. The monitoring program is evaluated every five years. The most recent evaluations occurred in 2002 and 2007. The current monitoring program was determined to be sufficient to meet project objectives (EPA, 2007).

Three wells (LPMW-1, LPMW-2, and LPMW-3) were added to the monitoring program in May 2006. These wells are located on a property adjoining the former Plaza Cleaners property. PCE was detected in these wells during their installation in December 2004. In May 2008, wells LPMW-1 and LPMW-3 were removed from the monitoring program because Ecology had not detected PCE in the wells and access to the wells had been restricted. Ecology continues to sample well LPMW-2.

Methods

In May 2008, groundwater samples were collected from monitoring wells MW-16A, MW-20A, MW-20B, MW-27, MW-33, LPMW-2 and municipal well H2 (Figure 1).

In October 2008, groundwater samples were collected from wells MW-16A, MW-20A, MW-20B, MW-27 and municipal well H1. Well LPMW-2 was not sampled because it was dry.

Wells MW-16A, MW-20A, MW-27, and MW-33 are screened in the Advanced Outwash deposits, the primary water-supply aquifer for the area. Groundwater flow direction in the Advanced Outwash is west-northwest when municipal water-supply wells H1 and H2 are not in use. When in use, these two wells create a large cone of depression (EPA, 1985).

Well MW-20B is screened in the Vashon Till, which forms an aquitard over most of the site. Wells LPMW-1, LPMW-2, and LPMW-3 range in depth from 28-32 feet and are screened in the Steilacoom Gravel, which generally contains perched water above the impermeable Vashon Till and regional water table.

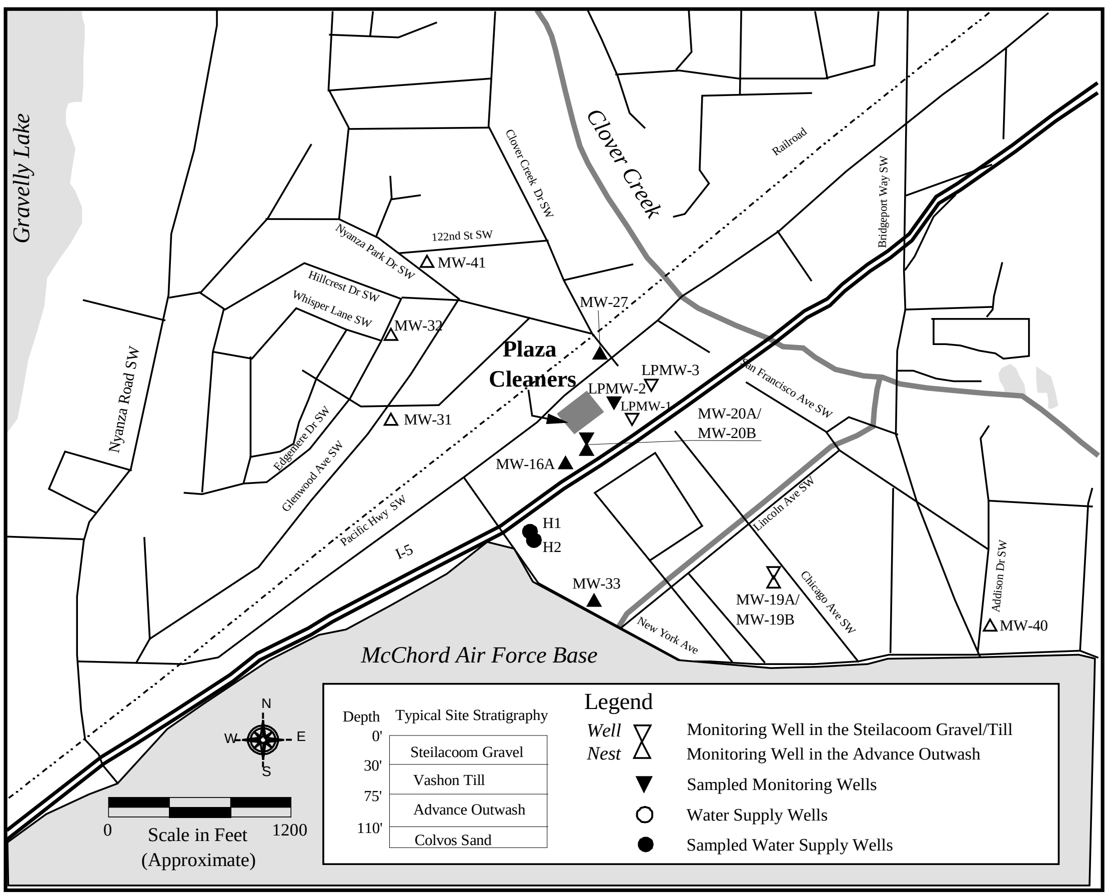


Figure 1. Lakewood Plaza Cleaners Sampling Locations.

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

Monitoring wells MW-16A, MW-20A, and MW-33 were purged and sampled using dedicated bladder pumps.

Wells MW-20B, MW-27, and LPMW-2 were purged and sampled with a stainless-steel submersible pump with dedicated tubing using low-flow sampling techniques. The submersible pump was decontaminated between wells by circulating laboratory-grade detergent/water through the pump followed by a clean water rinse, with each cycle lasting five minutes.

The monitoring wells were purged until pH, temperature, and specific conductance readings stabilized or three well volumes of water had been removed. Purge water from the monitoring wells was collected and stored in 55-gallon drums. The purge water waste was transported and disposed of in accordance with Washington State regulations (Chapter 173-340-400 WAC).
At the completion of purging, samples were collected from the monitoring wells directly from the dedicated pump discharge tubing into laboratory-supplied containers. Municipal wells H1 and H2, which pump continuously, were sampled from the tap nearest the wells.

Volatile organics 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 Operations Center in Lacey. Samples were kept in the walk-in cooler until taken by the courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Laboratory protocol (Ecology, 2003).

Results

Analysis

Table 1 lists analytes, analytical methods, and detection limits for both field and laboratory parameters. All groundwater samples were analyzed for volatile organics.

Table 1. Field and Laboratory Methods, May and October 2008.

Field Measurements	Instrument Type	Method	Accuracy
Water Level pH Temperature Specific Conductance	Solinst Water Level Meter Orion 25A Field Meter Orion 25A Field Meter YSI 3520 Conductivity Cell	SOP EAP052 EPA 150.1 EPA 150.1 EPA 120.1	±0.03 feet ±0.1 std. units ±0.1 ºC ±10 µmhos/cm
Laboratory Analytes	**Reference**	**Method**	**Reporting Limit**
Volatile Organics	EPA 1996	EPA SW-846 Method 8260B	1-5 µg/L

SOP = Standard Operating Procedure.

The quality of the data is acceptable. Quality control samples collected in the field consisted of blind field duplicates obtained from well MW-16A. 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 also by the natural variability of the concentrations in the media (e.g., groundwater) being sampled.

The numeric comparison of duplicate results is expressed as the relative percent difference (RPD). The RPD is calculated as the difference between sample results, divided by the mean and expressed as a percent. Table 2 shows the results of the duplicate samples and their RPD. The RPD for the May data ranged from 11% to 18%, and in October the RPD for PCE was 6%.

Table 2. Relative Percent Difference (RPD) of Duplicate Sample Results (µg/L), May and October 2008.

Well	PCE		TCE		cis-1,2-DCE	
	5/08	10/08	5/08	10/08	5/08	10/08
MW-16A	55	31	1.2	0.45 J	2.8	0.6 J
MW-16B	48	33	1	0.45 J	2.5	0.62 J
RPD (%)	14%	6%	18%	--	11%	--

A review of the data quality control and quality assurance from laboratory case narratives indicates that 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 major problems were reported that compromised the usefulness or validity of the sample results; therefore, all results are usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

Field

Depth-to-water measurements and purge volume, as well as pH, specific conductance, and temperature readings, at the time of sampling are listed in Table 3.

Table 3. Summary of Field Parameter Results, May 28 and October 23, 2008.

Well	Total Depth (feet)[1]	Depth to Water (feet)[1]	pH (standard units)	Specific Conductance (μmhos/cm)	Temperature (°C)	Purge Volume (gallons)
May						
MW-16A	109	38.23	7.1	207	13.2	62
MW-20A	97.3	31.33	8.1	123	13.3	20
MW-20B	50.4	30.65	6.7	451	14.2	6
MW-27	96.4	29.91	6.8	181	14.6	15
MW-33	99.3	++	7.0	--	11.7	24
LPMW-2	29	24.9	6.4	170	15.2	2.5
H2	110	++	6.3	257	12.8	>1000
October						
MW-16A	109	43.76	7.0	206	12.5	54
MW-20A	97.3	36.32	7.6	206	12.1	17
MW-20B	50.4	37.48	6.5	346	14.1	8
MW-27	96.4	34.42	--	176	13.6	21
H1	110	++	6.9	166	11.5	>1000

[1] Measured from top of PVC casing.
++ Dedicated pump obstructed water-level measurement.
-- Not measured.

All field parameters were within expected ranges. The specific conductance in well MW-20B (346-451 μmhos/cm) was greater than the other wells. Well MW-20B is screened in a fine-grained till unit. Specific conductance readings are typically higher for water from fine-grained units.

Analytical

May and October 2008 analytical results for volatile organics of interest are summarized in Table 4 and presented in Figure 2.

All field measurements and analytical results data are available in electronic format from Ecology's EIM data management system: www.ecy.wa.gov/eim/index.htm. Search study ID LAKEWOOD.

Table 4. Results (µg/L) of Volatile Organics of Interest, May 28 and October 23, 2008.

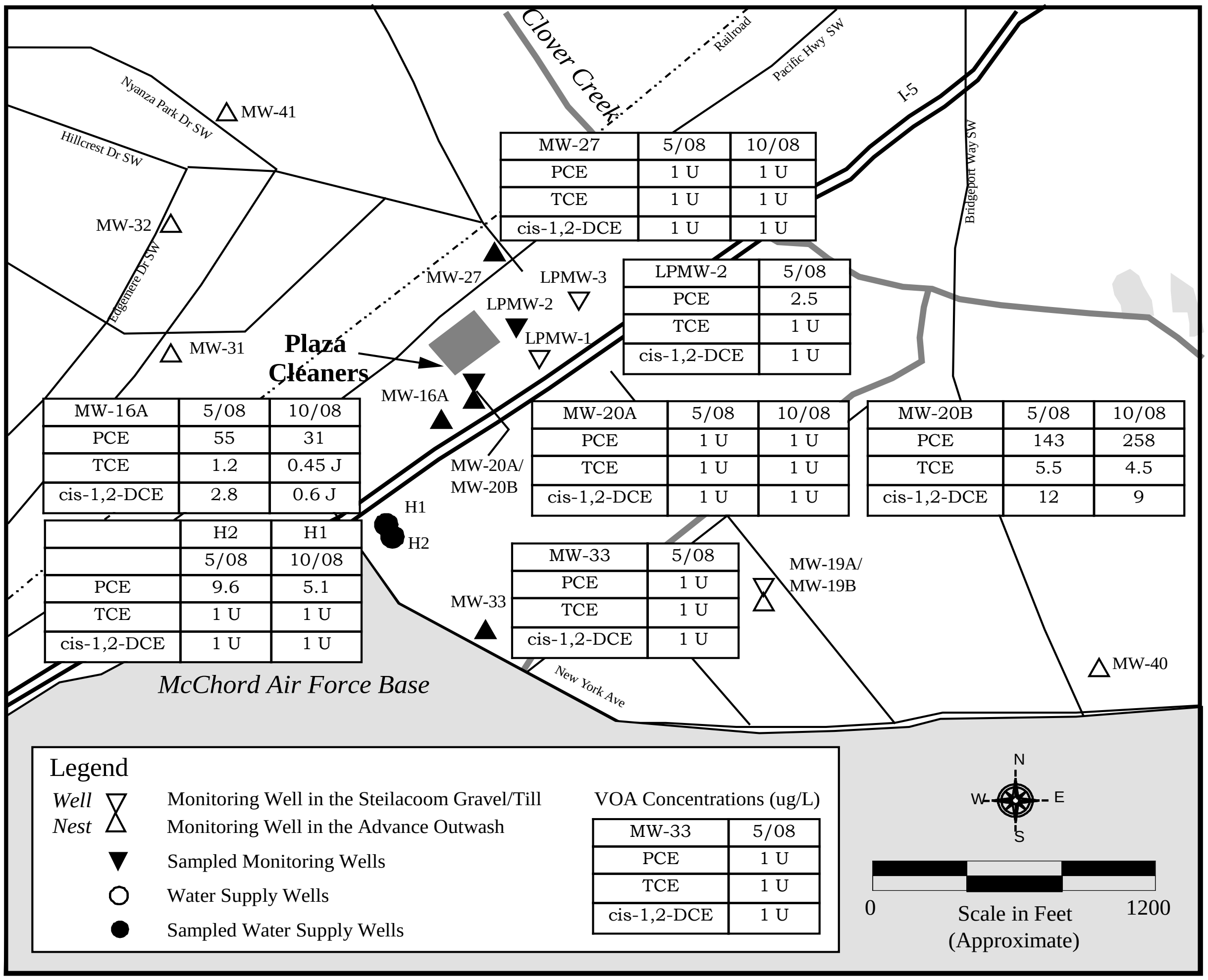
Well	Tetrachloroethene (PCE)	Trichloroethene (TCE)	Cis-1,2-Dichloroethene (cis-1,2-DCE)
May			
MW-16A	**55**	**1.2**	**2.8**
MW-20A	1 U	1 U	1 U
MW-20B	**143**	**5.5**	**12**
MW-27	1 U	1 U	1 U
MW-33	1 U	1 U	1 U
LPMW-2	**2.5**	1 U	1 U
H2	**9.6**	1 U	1 U
October			
MW-16A	**31**	**0.45 J**	**0.6 J**
MW-20A	1 U	1 U	1 U
MW-20B	**258**	**4.5**	**9**
MW-27	1 U	1 U	1 U
H1	**5.1**	1 U	1 U

Bold: Analyte detected.
U: Analyte was not detected at or above the reported value.
J: Analyte was positively identified. The associated numerical result is an estimate.

In May, PCE, TCE, and cis-1,2-DCE concentrations in well MW-20B were 143 µg/L, 5.5 µg/L, and 12 µg/L, respectively. These analytes were also detected in well MW-16A at concentrations of 55 µg/L (PCE), 1.2 µg/L (TCE), and 2.8 µg/L (cis-1,2-DCE). PCE was detected in municipal well H2 at a concentration of 9.6 µg/L. PCE was also detected in well LPMW-2 at a concentration of 2.5 µg/L. This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

In October, PCE, TCE, and cis-1,2-DCE concentrations in well MW-20B were 258 µg/L, 4.5 µg/L, and 9 µg/L, respectively. PCE was also detected in wells MW-16A and H1 at concentrations of 31 µg/L and 5.1 µg/L, respectively. MW-16A also contained TCE and cis-1,2-DCE at concentrations below the practical quantitation limit of 1 µg/L.

Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have PCE concentrations exceeding the MTCA cleanup level of 5 µg/L. Well MW-20B also continues to have TCE concentrations near the MTCA cleanup level of 5 µg/L



MW-27	5/08	10/08
PCE	1 U	1 U
TCE	1 U	1 U
cis-1,2-DCE	1 U	1 U

LPMW-2	5/08
PCE	2.5
TCE	1 U
cis-1,2-DCE	1 U

MW-16A	5/08	10/08
PCE	55	31
TCE	1.2	0.45 J
cis-1,2-DCE	2.8	0.6 J

MW-20A	5/08	10/08
PCE	1 U	1 U
TCE	1 U	1 U
cis-1,2-DCE	1 U	1 U

MW-20B	5/08	10/08
PCE	143	258
TCE	5.5	4.5
cis-1,2-DCE	12	9

	H2	H1
	5/08	10/08
PCE	9.6	5.1
TCE	1 U	1 U
cis-1,2-DCE	1 U	1 U

MW-33	5/08
PCE	1 U
TCE	1 U
cis-1,2-DCE	1 U

MW-33	5/08
PCE	1 U
TCE	1 U
cis-1,2-DCE	1 U

Figure 2. Lakewood Plaza Cleaners PCE, TCE, and Cis-1,2-DCE Concentrations (µg/L), May and October 2008.

Discussion

In 1991, Ecology assumed long-term groundwater monitoring of the site with the goal of collecting groundwater data to evaluate the effectiveness of municipal wells H1 and H2 to contain and remove the contaminated groundwater. Contaminant concentrations were projected to meet cleanup standards by the mid-1990s (EPA, 1992).

Table 5 shows average PCE and TCE concentrations that have exceeded the MTCA cleanup level of 5 μg/L during Ecology's sample period of 1991 to 2008. All PCE, TCE, and cis-1,2-DCE concentrations from January 1991 through October 2008 are presented in Appendix A. PCE concentrations for wells MW-20B and MW-16A for the same time period are also presented as graphs in Appendix A.

Table 5. Average Annual PCE and TCE Concentrations (μg/L) for Wells that Exceed MTCA Method A Cleanup Level for Groundwater of 5 μg/L.

Year	MW-20B		MW-16A	H1/H2
	PCE	TCE	PCE	PCE
1991	657	12	19	---
1992	640	14	8	---
1993	443	12	28	---
1994	279	8.6	21	---
1995	340[a]	8.4[a]	27[a]	9[a]
1996	370	7	45	4
1997	297	4	50	13
1998	515	8	33	10
1999	715	7	22[a]	3
2000	416	6	31	9
2001	489	7	28	9
2002	309	8.5	34	9
2003	234	5.4	42	6.4
2004	293	6.6	39	5.3
2005	484	6.5	62	10.2
2006	367	4.9	77	6.1
2007	348	6	54	4.5
2008	201	5	43	7.4

--: Not tested.
a: Single annual result.

Figures 3 and 4 show the average annual PCE concentrations for MW-20B and MW-16A from 1985 through 2008. PCE concentrations in both wells have varied substantially.

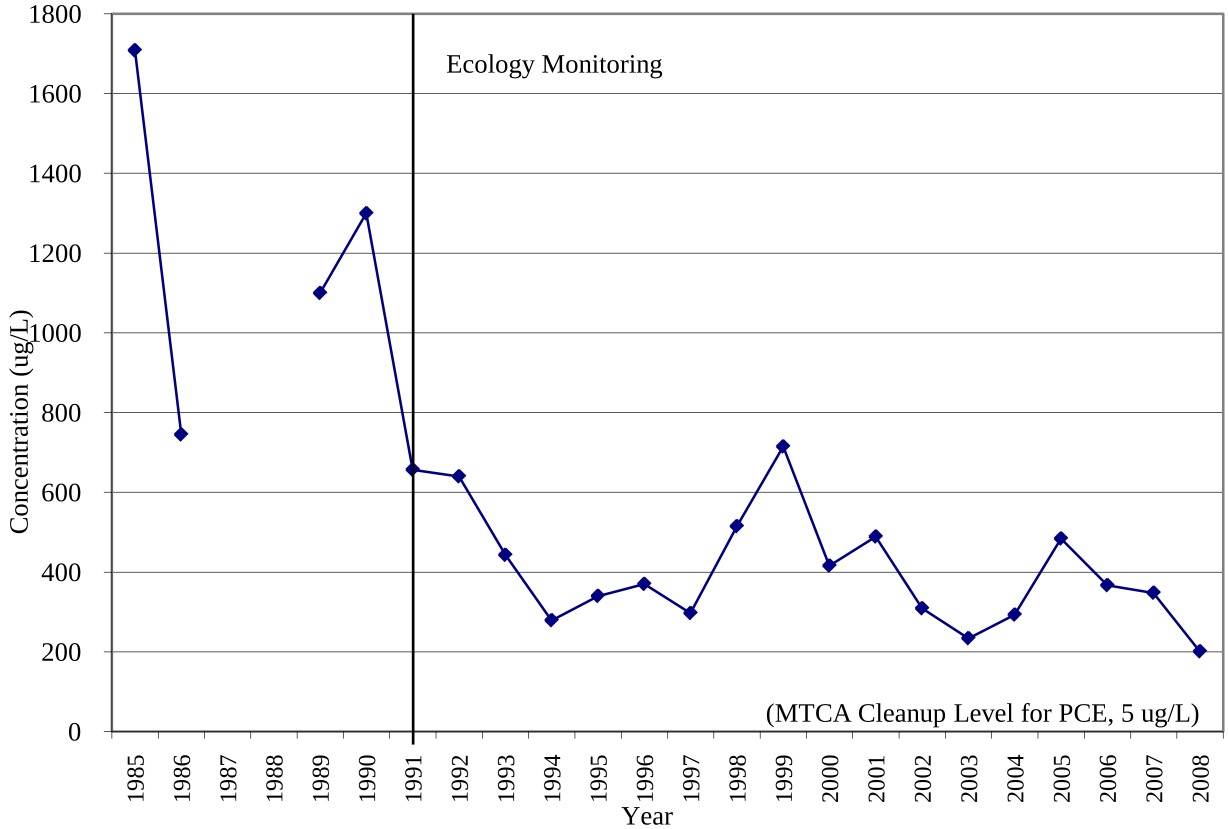


Figure 3. Average Annual PCE Concentrations for Well MW-20B, 1985 through 2008.

PCE concentrations decreased initially in MW-20B from 4850 µg/L in March 1985 to 570 µg/L in May 1985. The average PCE concentration for 1985 was 1700 µg/L. Well MW-20B was sampled annually in 1986, 1989, and 1990 and had a PCE concentration range of 745 to 1300 µg/L.

From 1991 to 1994, Ecology collected samples in the spring and fall which corresponded to the high-water/low-water seasons. In well MW-20B, PCE concentrations decreased from a 1991 average of 657 to 279 µg/L in 1994.

In 1995, the sampling routine changed to a winter/summer schedule. Seasonal fluctuations in concentrations which occurred from 1991 to 1994 leveled off with the change in the sample schedule (Figure A1). In 1995, average PCE concentrations were 340 µg/L. Average concentrations then increased to a high of 715 µg/L in 1999, before decreasing to 234 µg/L in 2003.

In the fall of 2003, sampling returned to the spring/fall schedule, which led to a corresponding return to seasonal variations in concentrations. Average annual PCE concentrations have since ranged from 234 μg/L in 2003, to 484 μg/L in 2005, and then decreased to 201 μg/L in 2008.

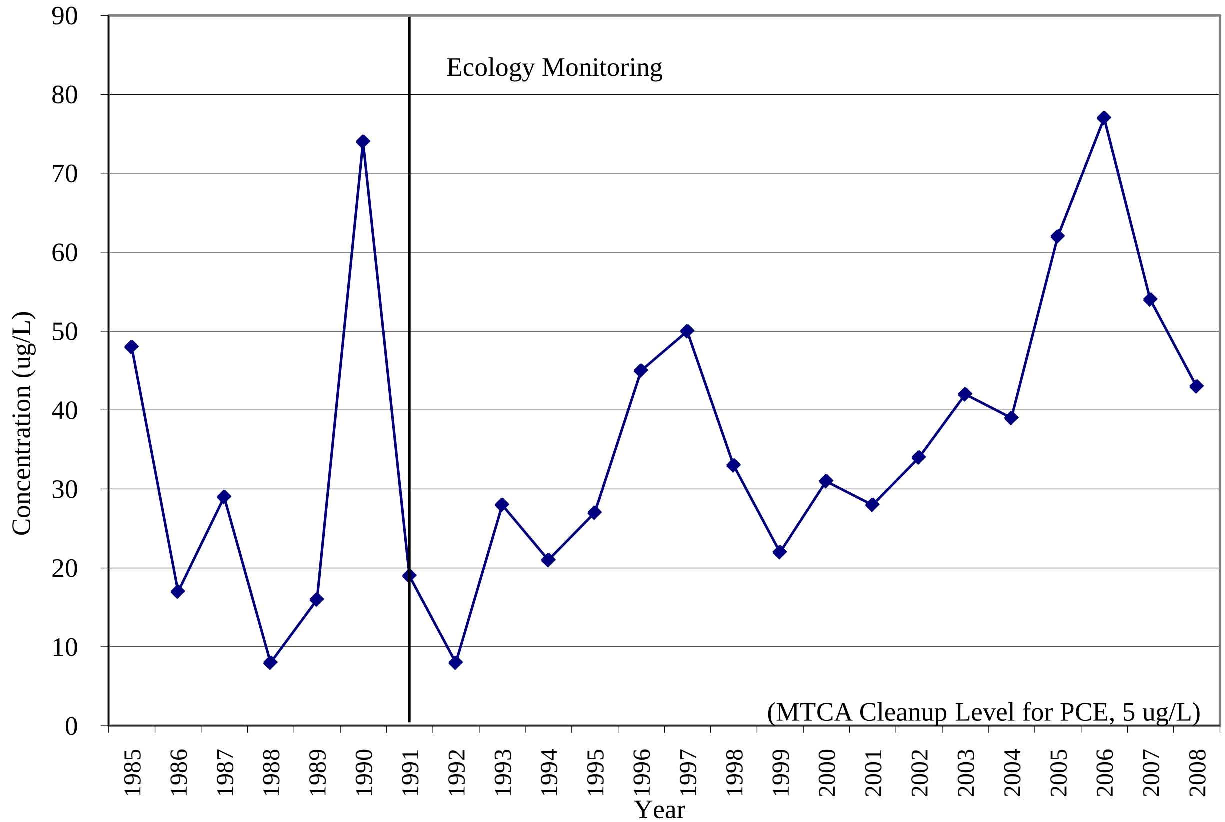


Figure 4. Average Annual PCE Concentrations for Well MW-16A, 1985 through 2008.

In 1985, PCE concentrations also initially decreased in well MW-16A, dropping from 110 μg/L in March to 12 μg/L in August, with an average annual PCE concentration of 48 μg/L. From 1986 to 1990, PCE concentrations of individual samples ranged from 8 to 74 μg/L.

Since Ecology began monitoring in 1991, average annual PCE concentrations have gone from 8 μg/L in 1992 to 50 μg/L in 1997, decreasing to 22 μg/L in 1999, then steadily increasing to 77 μg/L in 2006. Average PCE concentrations in 2008 were 43 μg/L. PCE concentrations for well MW-16A from 1991 to 2008 (Ecology sampling) are presented in Figure A-2.

PCE concentrations continue to exceed the MTCA cleanup level of 5 μg/L in monitoring wells MW-20B and MW-16A. Samples collected from municipal wells H1 and H2 prior to treatment also have PCE concentrations above the MTCA cleanup level. Compliance with the groundwater cleanup goals have not been met for this project.

Conclusions

Monitoring was conducted in May 2008 at six monitoring wells and one municipal well, and in October 2008 at four monitoring wells and one municipal well, to evaluate volatile organics in groundwater at the Lakewood Plaza Cleaners site.

- Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have PCE concentrations higher than the MTCA cleanup level of 5 µg/L.
- Monitoring well MW-20B continues to have TCE concentrations near the MTCA cleanup level of 5 µg/L.
- PCE concentrations in well LPMW-2 have been above or near the cleanup level of 5 µg/L in past samplings, but was below the cleanup level in May (2.5 µg/L). This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

Concentrations of PCE have decreased from their original 1985 levels, but continue to remain elevated. Average annual PCE concentrations in wells MW-20B and MW-16A have decreased since their 1985 concentrations of 4850 µg/L and 110 µg/L, respectively. Since Ecology began sampling in 1991, average annual PCE concentrations in well MW-20B have ranged from a high of 715 µg/L in 1999 to a low of 201 µg/L in 2008. Although PCE concentrations were lower during the 2008 sampling, concentrations continue to be within the range of those reported during previous monitoring.

PCE concentrations in well MW-16A appear to be steadily increasing. Average annual PCE concentrations in 1992 were 8 µg/L, increasing to 77 µg/L in 2006. The average PCE concentrations in 2008 were 43 µg/L. Although average annual concentrations have decreased during 2007 and 2008 (54 µg/L and 43 µg/L), overall PCE concentrations in wells MW-16A appear to be steadily rising.

Since 1984, municipal wells H1 and H2 have been used to contain and remove contaminated groundwater associated with the Lakewood Plaza Cleaners site. Based on early monitoring results, it was projected that compliance with cleanup goals of 5 ug/L for PCE and TCE would be achieved throughout the contaminated plume by the mid-1990s. PCE concentrations in monitoring wells MW-20B, MW-16A, and municipal wells H1 and H2 continue to exceed the cleanup levels. At this time, it is unknown when compliance with the cleanup goals will be reached.

Recommendations

Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have PCE concentrations higher than the MTCA cleanup level and the site cleanup goal of 5 µg/L. Most concentrations remain within the range of those reported in previous samplings conducted by Ecology since 1991. However, PCE concentrations in well MW-16A appear to be steadily rising. Municipal wells H1 and H2 have been used to contain, remove, and treat the groundwater contaminated by the Lakewood Plaza Cleaners site. Compliance with the project goals has not been achieved within the projected timeframe.

Project data should be evaluated to determine what follow-up actions are needed for this project to meet the cleanup goals in a reasonable timeframe.

References

References Cited

Ecology, 2005. Manchester Environmental Laboratory - Lab Users Manual. 8th edition. Washington State Department of Ecology, Manchester, WA.

Ecology, 2006. Standard Operating Procedures Field Manual for Groundwater Assessment Program Studies. Draft. Washington State Department of Ecology, Olympia, WA.

EPA, 1979. EPA-600/4-79-020 Methods for Chemical Analysis of Water and Wastes. U.S. Environmental Protection Agency.

EPA, 1983. Report of the Groundwater Investigation – Lakewood, Washington, October 1981 to February 1983. U.S. Environmental Protection Agency.

EPA, 1985. Final Draft Remedial Investigation Report – Ponders Corner, Washington. U.S. Environmental Protection Agency. EPA 112-0L22.

EPA, 1992. Lakewood/Ponders Corner Superfund Site - Five Year Review Report. U.S. Environmental Protection Agency.

EPA, 1996. Test Methods for Evaluating Solid Waste, SW-846. Office of Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

EPA, 2007. Five-Year Review Report. Fourth Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, Pierce County, WA – September 2007. U.S. Environmental Protection Agency.

Other References

CH2M HILL, 1990a. Sampling and Analysis Plan Remedial Action - Lakewood.

CH2M HILL, 1990b. Technical Memorandum from Lisa Dally Wilson to Ann Williamson RE: Groundwater Sampling at Lakewood (April 1990). Project No. SEA69018RA.FQ.

Ecology, 2002. Five-Year Review Report. Third Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, WA – October 2002. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round I - January 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e34. www.ecy.wa.gov/biblio/91e34.html

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round II - June 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e35. www.ecy.wa.gov/biblio/91e35.html

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round III - November 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e43. www.ecy.wa.gov/biblio/92e43.html

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round IV - June 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e44. www.ecy.wa.gov/biblio/92e44.html

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round V - December 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e38. www.ecy.wa.gov/biblio/93e38.html

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round VI - June 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e39. www.ecy.wa.gov/biblio/93e39.html

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VII - December 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 94-131. www.ecy.wa.gov/biblio/94131.html

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VIII - April 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 94-198. www.ecy.wa.gov/biblio/94198.html

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring Round IX - November 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 95-340. www.ecy.wa.gov/biblio/95340.html

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring - July 11, 12 & 14, 1995. Washington State Department of Ecology, Olympia, WA. Publication No. 95-359. www.ecy.wa.gov/biblio/95359.html

Marti, P., 1996. Lakewood/Plaza Cleaners Monitoring - January 17-18, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 96-317. www.ecy.wa.gov/biblio/96317.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 31, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 97-312. www.ecy.wa.gov/biblio/97312.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - January 9, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-324a. www.ecy.wa.gov/biblio/97324a.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 23-24, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-339. www.ecy.wa.gov/biblio/97339.html

Marti, P., 1998. Lakewood/Plaza Cleaners Monitoring - February 2, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 98-325. www.ecy.wa.gov/biblio/98325.html

Marti, P., 1999. Lakewood/Plaza Cleaners Monitoring - July 15, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 99-312. www.ecy.wa.gov/biblio/99312.html

Marti, P., 1999. Lakewood/Plaza Cleaners Long-term Monitoring, January and August, 1999. Washington State Department of Ecology, Olympia, WA. Publication No. 99-344. www.ecy.wa.gov/biblio/99344.html

Marti, P., 2000. Lakewood/Plaza Cleaners, January and August 2000 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 00-03-046. www.ecy.wa.gov/biblio/0003046.html

Marti, P., 2001. Lakewood/Plaza Cleaners, January and August 2001 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 01-03-032. www.ecy.wa.gov/biblio/0103032.html

Marti, P., 2002. Lakewood Plaza Cleaners, February and August 2002 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-007. www.ecy.wa.gov/biblio/0303007.html

Marti, P., 2003. Lakewood Plaza Cleaners, February and October 2003 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-050. www.ecy.wa.gov/biblio/0303050.html

Marti, P., 2004. Lakewood Plaza Cleaners, June and November 2004 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-054. www.ecy.wa.gov/biblio/0403054.html

Marti, P., 2005. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html

Marti, P., 2006. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html

Marti, P., 2007. Lakewood Plaza Cleaners, May and September 2006 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 07-03-013. www.ecy.wa.gov/biblio/0703013.html

Marti, P., 2008. Lakewood Plaza Cleaners, June and October 2007 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 08-03-010. www.ecy.wa.gov/biblio/0803010.html

Appendix A. Summary of Results

Table A-1. Summary of Sample Results (ug/L), January 1991 to October 2008.

Well	January 1991			May 1991			November 1991			May 1992			December 1992		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**28**	**1 J**	**2.4 J**	**26**	**0.6 J**	**2**	**2.7 J**	1 U	**0.6 J**	**7**	1 U	**1**	**9 J**	**0.3 J**	**0.8 J**
MW-20A	1 U	1 U	1 U	**0.4 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.5 J**	1 U	1 U	**0.8 J**	1 UJ	1 UJ
MW-20B	**1100 D**	**18**	**33**	**752**	**16**	**30**	**120**	**2.6 J**	**6.7**	**940**	**13**	**32**	**340 J**	**14 J**	**20 J**
MW-21	**2.1 J**	1 U	**1 J**	**2**	1 U	**0.7 J**	**2.2 J**	1 U	**1.0 J**	**2**	1 U	**0.6 J**	**2**	**0.2 J**	**0.3 J**
MW-27	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 UJ	1 UJ	1 UJ
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-31	**1 J**	1 U	**1.9 J**	**0.6 J**	1 U	**2**	**0.9 J**	1 U	**2.2 J**	**0.8 J**	1 U	**1**	**0.5 J**	1 UJ	**0.9 J**
MW-32	**1 J**	1 U	**1.1 J**	**1**	1 U	**2**	**0.6 J**	1 U	**0.6 J**	**0.7 J**	1 U	**1**	**0.7 J**	1 UJ	**0.5 J**
MW-41	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 UJ	1 UJ	1 UJ
MW-19A	--	--	--	--	--	--	1 U	**0.5 J**	1 U	--	--	--	1 UJ	1 UJ	1 UJ
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-40	1 U	1 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--	1 UJ	1 UJ	1 UJ
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well	May 1993			December 1993			April 1994			November 1994			July 1995		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**44**	10 U	**2 J**	**13**	**0.3 J**	**0.7 J**	**33**	**0.6**	**1.4**	**9.7**	**0.3 J**	**0.5 J**	**27**	**0.5 J**	**0.8 J**
MW-20A	10 U	10 U	10 U	**0.3 J**	1 U	1 U	**0.4**	0.2 U	0.2 U	**0.3 J**	1 U	1 U	**0.4 J**	1 U	1 U
MW-20B	**700 D**	**12**	**21**	**187**	50 U	**8.2 J**	**472**	**8.6 J**	**12.6**	**86**	50 U	**3 J**	**340 D**	**8.4**	**17**
MW-21	**1 J**	10 U	10 U	**1.6**	1 U	**0.4 J**	**1.5**	**0.2 J**	**0.3**	**1.8**	**0.2 J**	**0.3 J**	--	--	--
MW-27	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-31	10 U	10 U	10 U	**0.8 J**	1 U	**1.2 J**	**0.7**	0.2 U	**1.0**	**0.8 J**	1 U	**1**	**0.6 J**	1 U	**0.5 J**
MW-32	10 U	10 U	10 U	**0.7 J**	1 U	**0.6 J**	**0.7**	0.2 U	**0.6**	**0.6 J**	1 U	**0.5 J**	**0.7 J**	1 U	**0.5 J**
MW-41	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-19A	--	--	--	1 U	**0.4**	1 U	0.2 U	**0.5**	0.2 U	--	--	--	1 U	**0.4 J**	1 U
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	--	--	--	1 U	1 U	1 U
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	**9**	**0.3 J**	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2008.

Well	January 1996			July 1996			January 1997			July 1997			February 1998		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	47 E	0.8 J	1.5	43	0.7 J	1.9	54	1.1	3.1	47	0.7 J	2.5	36	0.7 J	2 J
MW-20A	0.2 J	1 U	1 U	0.4 J	1 U	1 U	0.4 J	1 U	1 U	0.3 J	1 U	2 U	0.4 J	1 U	1 U
MW-20B	353	7.2	15	387	7.6	15	373	100 U	6.4 J	222	4	6.4	456	7 J	12
MW-21	--	--	--	Well Decommissioned											
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
MW-28A	1 U	1 U	1 U	Well Decommissioned											
MW-31	0.6 J	1 U	0.7 J	--	--	--	--	--	--	0.9 J	1 U	0.9 J	--	--	--
MW-32	0.8 J	1 U	0.6 J	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	--	--	--	1 U	0.3 J	2 U	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--	1 U	1 U	2 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	8.4	0.2 J	0.2 J	0.1 J	1 U	1 U	18	0.4 J	0.4 J	8.8	0.3 J	0.6 J	11	0.4 J	0.3 J

Well	July 1998			January 1999			August 1999			January 2000			August 2000		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	30	1 U	1.5 J	--	--	--	22	0.4 J	1.1	40	0.7 J	1.9	22	0.3 J	0.7
MW-20A	0.6 J	1 U	1 U	1 U	2 U	1 U	0.8 J	2 U	1 U	0.2 J	2 U	1 U	0.1 J	2 U	1 U
MW-20B	575 D	10	23	708	5.2	12	722	8.4 J	16 J	184	6	13	648	200 U	100 U
MW-27	0.05 J	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U
MW-31	--	--	--	--	--	--	0.9 J	2 U	0.4 J	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	0.8 J	2 U	1 U
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
MW-19A	--	--	--	--	--	--	1 U	0.4 J	1 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	1 U	2 U	1 U	--	--	--	1 U	2 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
H1/H2	10	1 U	0.1 J	1.5	1 U	1 U	5.2	0.2 J	1 U	10	1 U	1 U	8.7	0.03 J	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2008.

Well Number	January 2001			August 2001			February 2002			August 2002			February 2003		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	31	0.4 J	1	25	0.3 J	0.7 J	47	0.8 J	2.3	22	0.3 J	0.8 J	59 J	0.2 J	2.4
MW-20A	0.2 J	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U
MW-20B	493	6.6 J	12	486	8.2	18	248	200 U	100 U	371	8.5	16	230	100 U	100 U
MW-27	1 U	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	0.4 J	2 U	0.3 J	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	1 U	0.3 J	1 U	--	--	--	--	--	--	--	--	--
MW-33	--	--	--	1 U	2 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	11	0.2 J	1 U	6.8	0.2 J	1 U	12	0.2 J	0.2 J	6.1	1 U	1 U	1.3	1 U	1 U

Well Number	September 2003			June 2004			November 2004			June 2005			November 2005		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	26	0.3 J	0.5 J	30	0.4 J	0.8 J	48	1 U	1.4	80	1.3	2.8	43	0.7 J	1.0 J
MW-20A	0.1 J	1 U	1 U	0.2 J	1 U	1 U	0.3 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-20B	239	5.4 J	12	344	6.5 J	15	241	6.7	13	413	6.6	12	555	6.4	11
MW-27	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
MW-31	0.5 J	1 U	0.1 NJ	--	--	--	--	--	--	0.5 J	1 U	1 U	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	1.4	1 U	1 U	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-19A	1 U	0.4 NJ	1 U	--	--	--	--	--	--	1 U	0.6 J	1 U	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
H1/H2	6.4	0.2 NJ	1 U	7.9	0.2 J	0.1 J	2.6	1 U	1 U	14	0.3 J	1 U	6.4	1 U	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2008.

Well	May 2006			September 2006			June 2007			October 2007			May 2008		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**124**	**1.8**	**4.6**	**29**	**0.3 J**	**0.48 J**	**83**	**1.2**	**2.5**	**24**	1 U	**0.64 J**	**55**	**1.2**	**2.8**
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**216**	**4.2**	**6.6**	**518**	**5.6**	**11**	**204**	**4.4**	**7.8**	**491**	**7.5**	**15**	**143**	**5.5**	**12**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	--	--	--	**1.6 J**	2 U	2 U	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	2 U	**1.2 J**	2 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	2 U	2 U	2 U	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LPMW-2	**9.9**	1 U	1 U	--	--	--	**4.8**	1 U	1 U	--	--	--	**2.5**	1 U	1 U
LPMW-3	1 U	1 U	1 U	--	--	--	2 U	1 U	1 U	--	--	--	--	--	--
H1/H2	**7.3**	**0.2 J**	1 U	**4.8**	1 U	1 U	**5.2**	2 U	2 U	**3.8**	1 U	1 U	**9.6**	1 U	1 U

Well	October 2008		
Number	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.45 J**	**0.6 J**
MW-20A	1 U	1 U	1 U
MW-20B	**258**	**4.5**	**9**
MW-27	1 U	1 U	1 U
MW-31	--	--	--
MW-32	--	--	--
MW-41	--	--	--
MW-19A	--	--	--
MW-33	--	--	--
MW-40	--	--	--
LPMW-2	--	--	--
H1/H2	**5.1**	1 U	1 U

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
D = Analysis performed at secondary dilution.
E = The concentration of the associated value exceeds the known calibration range.
-- = Not tested
Bold = The analyte was positively identified.

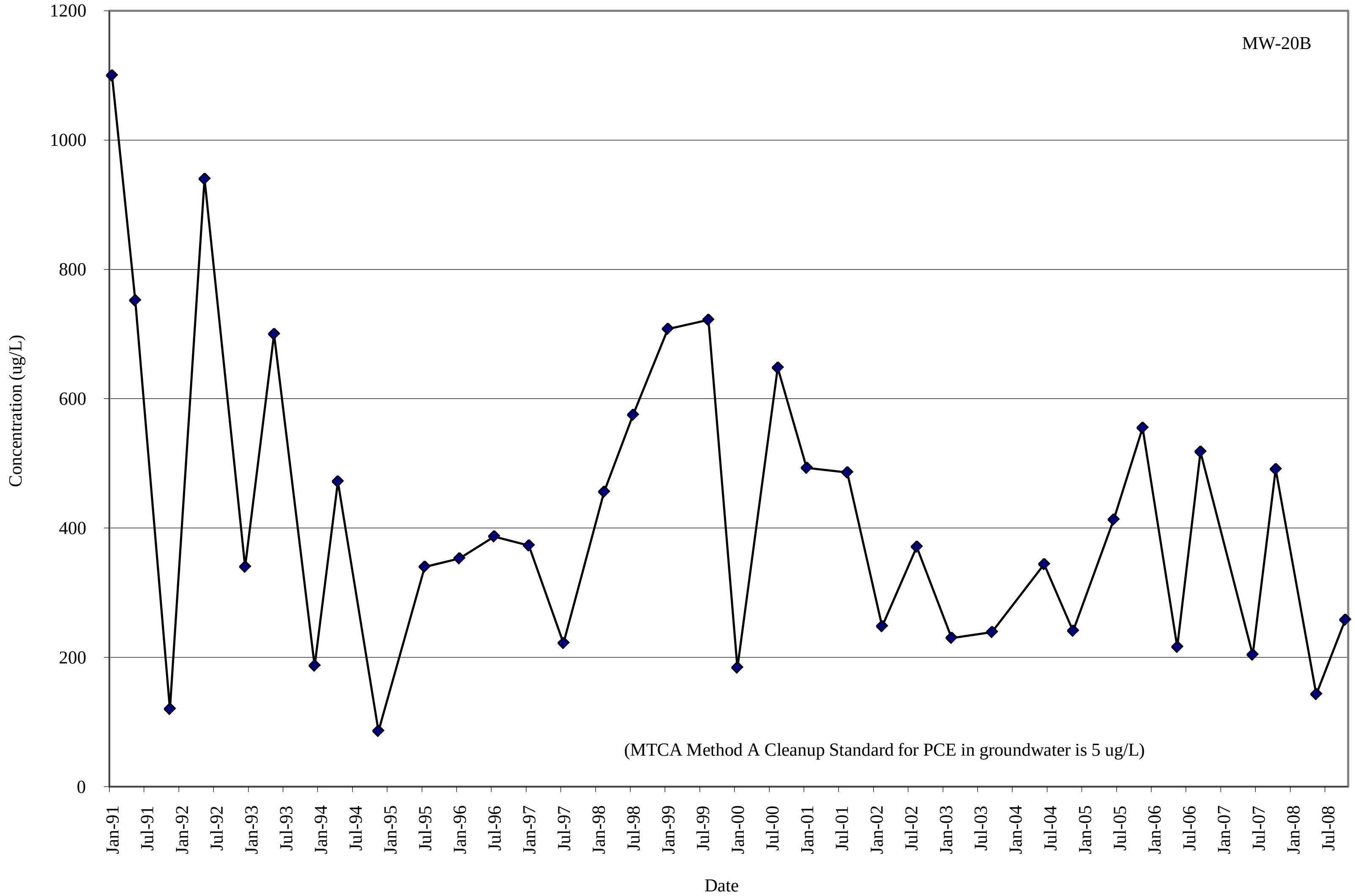


Figure A-1. PCE Concentrations for Well MW-20B, January 1991 to October 2008.

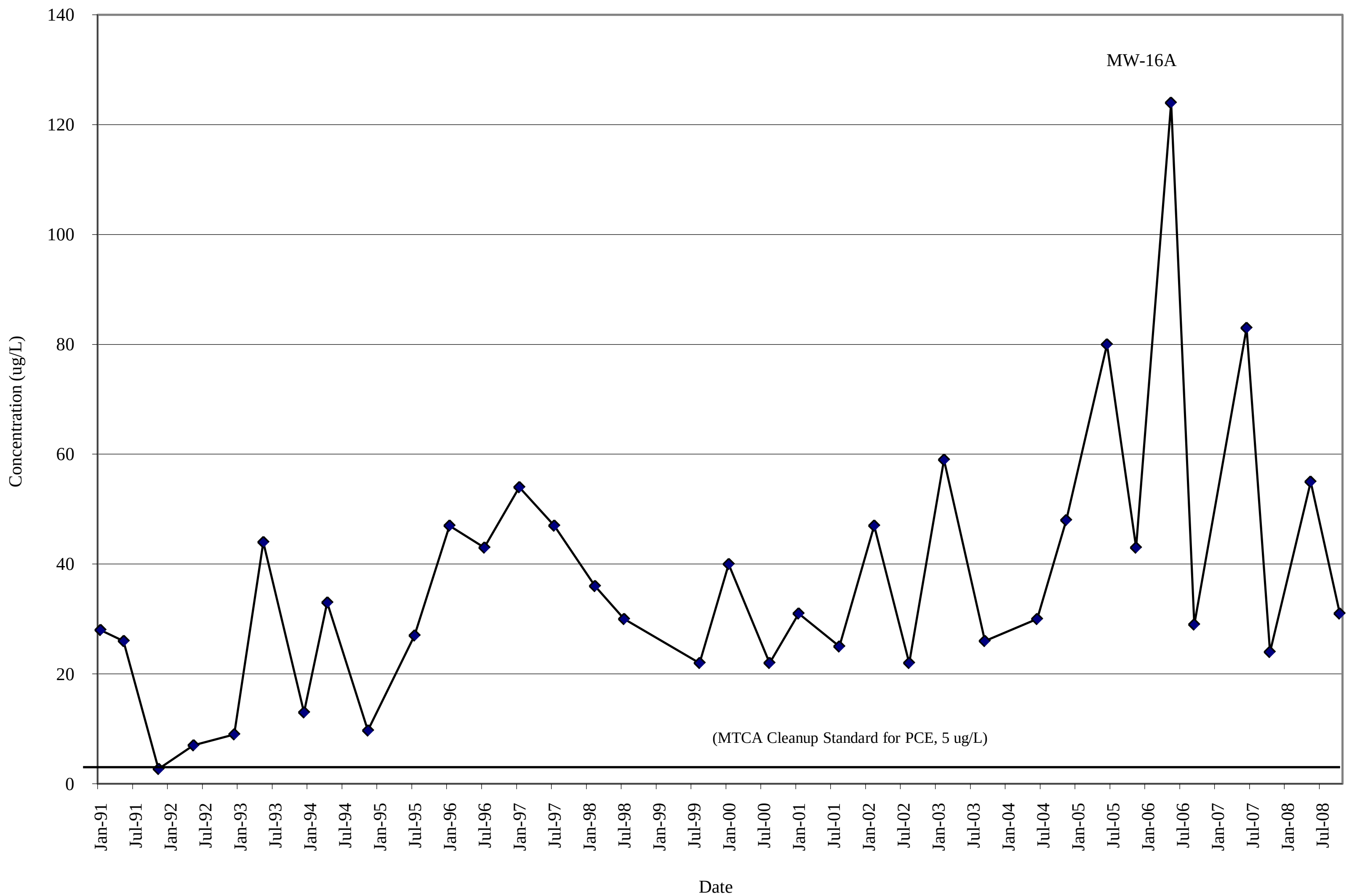


Figure A-2. PCE Concentrations for Well MW-16A, January 1991 to October 2008.

Appendix B. Acronyms and Abbreviations

Cis-1,2-DCE	Cis-1,2-dichloroethene
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	Environmental Protection Agency
MTCA	Model Toxic Control Act
PCE	Tetrachloroethene
RPD	Relative Percent Difference
TCE	Trichloroethene
VOA	Volatile Organics Analysis
WAC	Washington Administrative Code

Lakewood Plaza Cleaners Groundwater Monitoring Results

June and November 2009

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Lakewood Plaza Cleaners, Groundwater Monitoring Results

June and November 2009

by
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Washington State Department of Ecology
Olympia, Washington 98504-7710

Waterbody Number: WA-12-1115

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Abstract

This progress report is one in a series describing results of long-term groundwater monitoring at the former Lakewood Plaza Cleaners site south of Tacoma. The Washington State Department of Ecology (Ecology) assumed collecting groundwater data at the site in 1991. The goal was to evaluate the effectiveness of municipal wells H1 and H2 to contain and remove the contaminated groundwater.

This report discusses volatile organic results of samples collected from project monitoring wells and Lakewood Water District municipal wells in June and November 2009.

Tetrachloroethene (PCE) concentrations continue to not meet (exceed) the MTCA cleanup level of 5 μg/L in monitoring wells MW-20B (160 and 250 μg/L) and MW-16A (67 and 28 μg/L). Since Ecology began sampling, PCE concentrations have varied, but overall trends indicate that concentrations in well MW-20B are decreasing while concentrations in well MW-16A are increasing. The average annual PCE concentration in well MW-20B in 1991 was 657 μg/L, decreasing to 205 μg/L in 2009. The average annual PCE concentration in well MW-16A in 1991 was 19 μg/L, increasing to 48 μg/L in 2009.

Samples collected from municipal wells H1 and H2 prior to treatment continue to have PCE concentrations near the MTCA cleanup level.

PCE was also detected in well LPMW-2 (4.1 and 11 μg/L). This well is located near the former septic system of Lakewood Plaza Cleaners which was identified as a source of the contamination.

The use of municipal wells H1 and H2 to treat contaminated groundwater associated with the Lakewood Plaza Cleaners site continues since the cleanup goals have not been achieved. Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals.

Further evaluation is needed to determine what additional actions are needed for this project to meet the final cleanup goals in a reasonable timeframe.

Introduction

In 1981, the U.S. Environmental Protection Agency (EPA) confirmed that the Lakewood Water District production wells H1 and H2 were contaminated with tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE). Lakewood is south of Tacoma in Pierce County. The source of the contamination was identified as the former Lakewood Plaza Cleaners (EPA, 1983). Contamination had resulted from the dumping of PCE into on-site septic tanks and the disposal of sludge on the ground surface.

Remedial activities at the site began in 1984 and ended in 1993. They included the operation of wells H1 and H2 to pump and treat contaminated groundwater, the removal of contaminated soils and sludges from the source area, and treatment of remaining septic field contaminated soils with vapor extraction. Early monitoring results projected that compliance with cleanup goals of 5 µg/L for PCE and TCE would be achieved throughout the contaminated plume by the mid-1990s.

In 1991, the Washington State Department of Ecology (Ecology) began semi-annual, long-term groundwater monitoring at the site. The objective of this sampling is to collect groundwater quality data for Ecology's Toxics Cleanup Program. The Toxics Cleanup Program will use this data to evaluate the effectiveness of Lakewood water supply wells H1 and H2 to contain, remove, and treat the groundwater contaminated by Plaza Cleaners.

In 1996, the monitoring program was evaluated. Based on data collected from 1986 to 1996, EPA and Ecology decided to decommission half of the remaining wells and reduce the monitoring program to wells in the immediate vicinity of Plaza Cleaners. The monitoring program is evaluated every five years. The most recent evaluation occurred in 2007.

Remediation of the groundwater is ongoing under a long-term response action as cleanup goals have not yet been achieved (EPA, 2007). The current monitoring program was determined to be sufficient to assess the progress of the cleanup action. Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals. Further evaluation is needed to determine what additional actions are needed for this project to meet the final cleanup goals.

Methods

Groundwater Sampling

In June 2009, Ecology collected groundwater samples from monitoring wells MW-16A, MW-19A, MW-20A, MW-20B, MW-27, MW-33, and LPMW-2 and municipal well H2 (Figure 1).

In November 2009, Ecology collected groundwater samples from wells MW-16A, MW-20A, MW-20B, MW-27 and LPMW-2.

Wells MW-16A, MW-19A, MW-20A, MW-27, MW-33 and municipal wells H1 and H2 are screened in the Advance Outwash deposits, the primary water-supply aquifer for the area.

Well MW-20B is screened in the Vashon Till, typically a very low permeable layer which forms an aquitard of unsaturated and saturated sediment separating the Steilacoom Gravel above and Advance Outwash below. Well MW-20B is the only well screened in the Vashon Till where contamination had been detected.

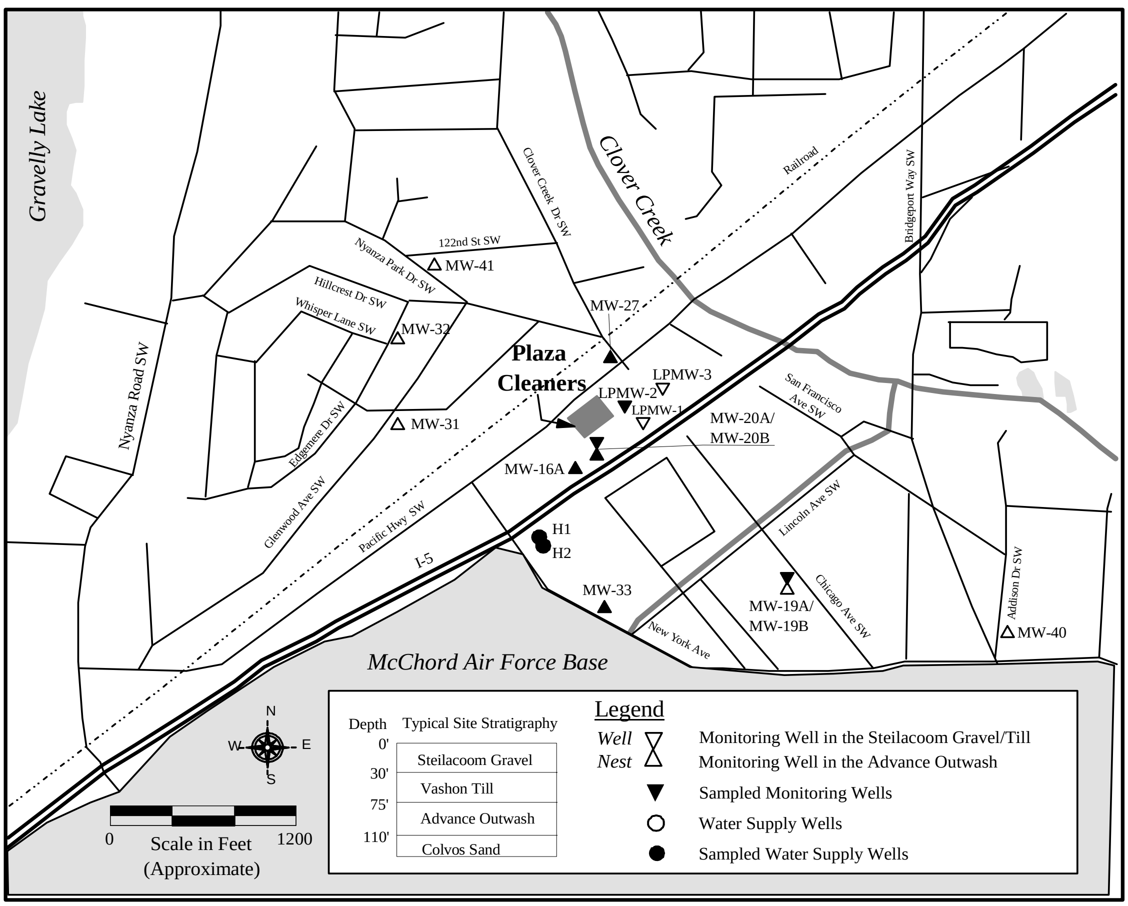

Figure 1. Lakewood Plaza Cleaners Sampling Locations.

Well LPMW-2, along with wells LPMW-1 and LPMW-3, are screened in the Steilacoom Gravel, which generally contains areas of perched water above the Vashon Till and regional water table. These wells, installed in 2004, are located on property adjoining the former Plaza Cleaners property. Ecology added the wells to the monitoring program in 2006. Wells LPMW-1 and LPMW-3 were removed from the monitoring program in 2008 because access to the wells had been restricted and PCE had not been detected.

Ecology continues to sample well LPMW-2 because PCE is detected in samples from this well. This well is located near the former septic system of Plaza Cleaners which was identified as a source of the contamination.

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

Monitoring wells MW-16A, MW-19A, MW-20A, and MW-33 were purged and sampled using dedicated bladder pumps.

Wells MW-20B, MW-27, and LPMW-2 were purged and sampled with a stainless-steel submersible pump with dedicated tubing using low-flow sampling techniques. The submersible pump was decontaminated between wells by circulating laboratory-grade detergent/water through the pump followed by a clean water rinse, with each cycle lasting five minutes.

The monitoring wells were purged until pH, temperature, and specific conductance readings stabilized or three well volumes of water had been removed. Purge water from the monitoring wells was collected and stored in 55-gallon drums. The purge water waste was transported and disposed of in accordance with Washington State regulations (Chapter 173-340-400 WAC).
At the completion of purging, samples were collected from the monitoring wells directly from the dedicated pump discharge tubing into laboratory-supplied containers. Municipal well H2, which pumps continuously, was sampled from the tap nearest the well.

Volatile organics samples were collected free of headspace in three 40-mL glass vials with Teflon-lined septa lids and preserved with 1:1 hydrochloric acid. After labeling, all samples were stored in an ice-filled cooler. Samples were transported to Ecology’s Operations Center in Lacey. Samples were kept in the walk-in cooler until taken by the courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Laboratory protocol (Ecology, 2008).

Laboratory

Table 1 lists analytes, analytical methods, and detection limits for both field and laboratory parameters. All groundwater samples were analyzed for volatile organics.

Table 1. Field and Laboratory Methods, May and October 2008.

Field Measurements	Instrument Type	Method	Accuracy
Water Level	Solinst Water Level Meter	SOP EAP052	±0.03 feet
pH	Sentix® 41-3 probe[1]	EPA 150.1	±0.1 std. units
Temperature	Sentix® 41-3 probe[1]	EPA 150.1	±0.1 ºC
Specific Conductance	Tetracon® 325 probe[1]	EPA 120.1	±10 µmhos/cm
Laboratory Analytes	**Reference**	**Method**	**Reporting Limit**
Volatile Organics	EPA 1996	EPA SW-846 Method 8260B	1-5 µg/L

SOP = Standard Operating Procedure.
EAP = Environmental Assessment Program, Ecology.
EPA = U.S. Environmental Protection Agency.
[1] Probe used with a WTW multiline P4 meter.

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Data Quality

Quality control samples collected in the field consisted of blind field duplicates obtained from well MW-16A. 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 also by the natural variability of the concentrations in the media (e.g., groundwater) being sampled.

The numeric comparison of duplicate results is expressed as the relative percent difference (RPD). The RPD is calculated as: the difference between sample results, divided by the mean, and expressed as a percent.

Table 2 shows the results of the duplicate samples and their RPD. The RPD for the June data ranged from 4% to 6%. In November the RPD for PCE was 7%. The quality of the data for this progress report is acceptable.

Table 2. Relative Percent Difference (RPD) of Duplicate Sample Results (µg/L), June and November 2009.

Well Sample ID	Tetrachloroethylene (PCE)		Trichloroethylene (TCE)		Cis-1,2-Dichloroethylene (cis-DCE)	
	6/09	11/09	6/09	11/09	6/09	11/09
MW-16A	67	28	0.94 J	0.52 J	2.2	0.83 J
MW-16B	71	26	1.1	1 U	2.3	0.77 J
RPD[1] (%)	6%	7%	--	--	4%	--

[1] : RPD target ±30%.
J : Analyte was positively identified. The associated numerical result is an estimate.
U: Analyte was not detected at or above the reported value.

A review of the data quality control and quality assurance from laboratory case narratives indicates that 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; therefore, all results are usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

Results

Field Observations

Depth-to-water measurements and purge volume, as well as pH, specific conductance, and temperature readings, at the time of sampling are listed in Table 3.

Table 3. Summary of Field Parameter Results, June 4 and November 19, 2009.

Well	Total Depth (feet)[1]	Depth to Water (feet)[1]	pH (standard units)	Specific Conductance (µmhos/cm)	Temperature (°C)	Purge Volume (gallons)
June						
MW-16A	109	34.43	7.2	233	13.0	54
MW-19A	97.5	34.59	6.8	195	12.0	18
MW-20A	97.3	29.07	7.8	206	12.7	24
MW-20B	50.4	28.24	6.9	419	14.5	5
MW-27	93	28.35	6.8	181	14.6	17
MW-33	99.3	++	7.1	203	12.0	24
LPMW-2	29	22.48	6.8	174	14.1	4
H2	110	++	6.5	179	13.1	>1000
November						
MW-16A	109	36.75	7.3	234	12.6	46
MW-20A	97.3	31.10	7.9	230	12.5	16
MW-20B	50.4	32.04	6.7	469	15.0	9
MW-27	93	29.05	7.0	191	13.8	18
LPMW-2	29	22.81	6.8	170	14.3	4

[1] Measured from top of PVC casing.

++ Dedicated pump obstructed water-level measurement.

Most of the sampled wells are screened in the Advance Outwash deposits (MW-16A, MW-19A, MW-20A, MW-27, MW-33, and H1/H2). Depth to water in the advanced outwash ranged from 28.35- 34.59 ft. in June and 29.05-36.75 ft. in November. A pump test conducted in 1981 in which municipal wells H1/H2 were shut down determined that the natural groundwater flow direction in the Advance Outwash is west-northwest toward Gravelly Lake. When in use, these wells create a large cone of depression which influences groundwater flow directions. Previous studies showed that drawdowns occur in shallow monitoring wells drilled in the Steilacoom gravel when H1 and H2 are pumping (EPA, 1985). This indicates possible hydraulic interconnection between the Steilacoom gravel and the Advance Outwash.

Well MW-20B is screened in the Vashon Till. Depth to water was 28.24 ft. in June and 32.04 ft. in November. The Vashon Till forms an aquitard when composed of silt and clay-rich gravels. The Vashon Till also contains thin layers of sandy gravel, one of which appears to be large in lateral extent, covering the area including Plaza Cleaners. This lens is saturated and appears to be hydraulically interconnected with the Steilacoom gravel (EPA, 1985). Well LPMW-2 is screened in the Steilacoom Gravel. Depth to water in this well ranged from 22.48-22.81 ft. over the monitoring period.

Field parameters (pH, specific conductance, and temperature) were within expected ranges. The specific conductance in well MW-20B (419-469 µmhos/cm) was greater than the other wells. Well MW-20B is screened in the fine-grained till unit. Specific conductance readings are typically higher for water from fine-grained units.

Analytical Results

June and November 2009 analytical results for volatile organics of interest are summarized in Table 4 and presented in Figure 2.

All field measurements and analytical results data are available in electronic format from Ecology's EIM data management system: www.ecy.wa.gov/eim/index.htm. Search study ID LAKEWOOD.

Table 4. Results (µg/L) of Volatile Organics of Interest, June 4 and November 19, 2009.

Well	Tetrachloroethene (PCE)	Trichloroethene (TCE)	Cis-1,2-Dichloroethene (cis-1,2-DCE)
June			
MW-16A	**67**	**0.94 J**	**2.2**
MW-19A	1 U	1 U	1 U
MW-20A	1 U	1 U	1 U
MW-20B	**160**	**4.1**	**7.4**
MW-27	1 U	1 U	1 U
MW-33	1 U	1 U	1 U
LPMW-2	**4.1**	1 U	1 U
H2	**6.8**	1 U	1 U
November			
MW-16A	**28**	**0.52 J**	**0.83 J**
MW-20A	**0.64 J**	1 U	1 U
MW-20B	**250**	**4.7**	**9.6**
MW-27	1 U	1 U	1 U
LPMW-2	**11**	1 U	1 U

Bold: Analyte detected.
U: Analyte was not detected at or above the reported value.
J: Analyte was positively identified. The associated numerical result is an estimate.

Chlorinated solvents continue to be detected in monitoring wells MW-20B, MW-16A, and LPMW-2 as well as municipal wells H1 and H2.

Well LPMW-2 is typically dry during the fall sample round. Because of the late fall sample date during this monitoring period and heavy precipitation, water was available to sample in November. PCE was detected at a concentration of 11 µg/L. Well LPMW-2 is located near the former septic system of Plaza Cleaners which was identified as a source of the contamination.

Monitoring wells MW-20B and MW-16A, and municipal wells H1 and H2, continue to have PCE concentrations not meeting (exceeding) the MTCA cleanup level of 5 µg/L.

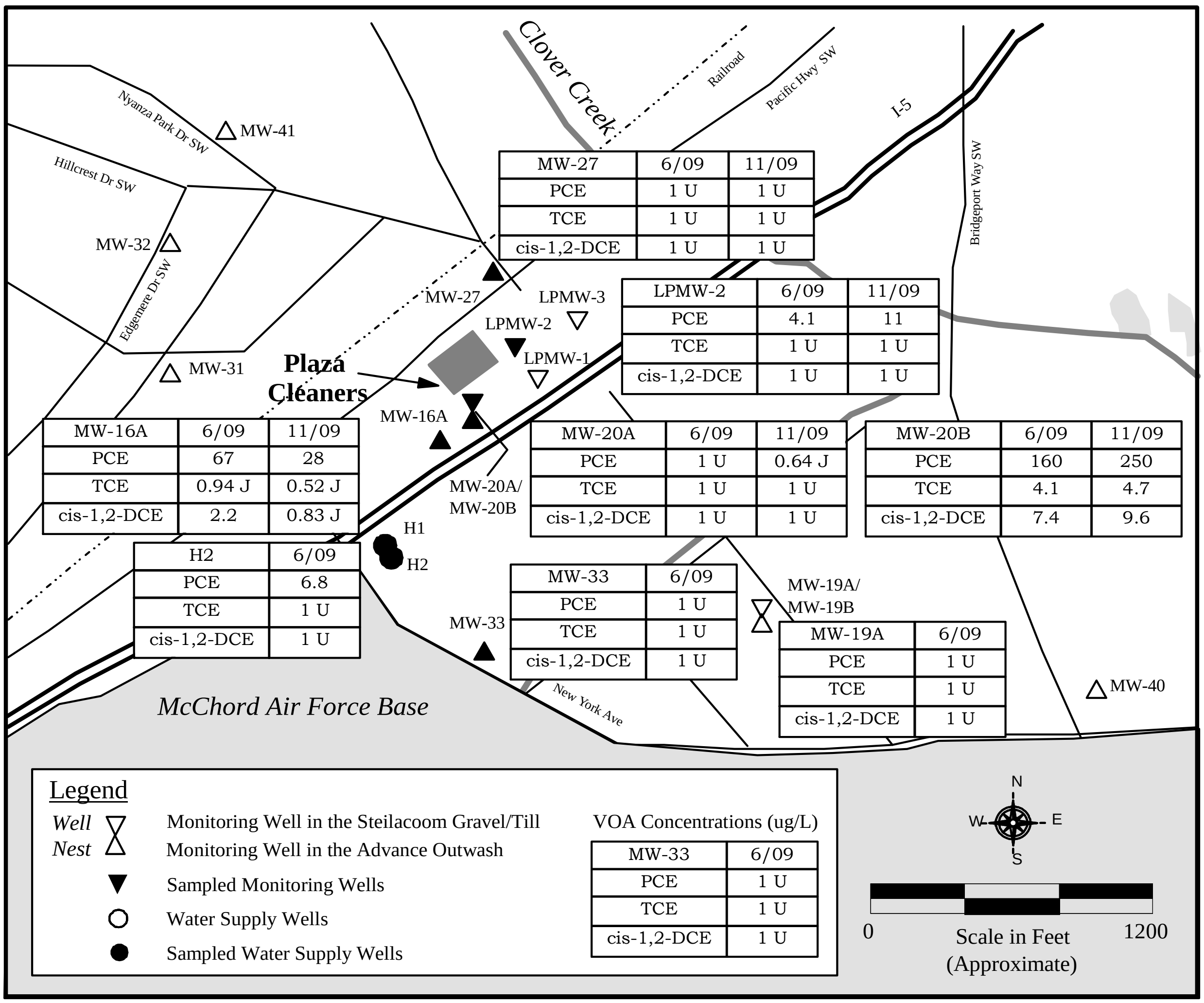

Figure 2. Lakewood Plaza Cleaners PCE, TCE, and Cis-1,2-DCE Concentrations (µg/L), June and November 2009.

Discussion

In 1991, Ecology assumed long-term groundwater monitoring of the former Lakewood Plaza Cleaners site with the goal of collecting data to evaluate the effectiveness of municipal wells H1 and H2 to contain and remove the contaminated groundwater.

Table 5 shows average PCE and TCE concentrations that have exceeded the MTCA cleanup level of 5 µg/L during Ecology's sample period of 1991 to 2009. All PCE, TCE, and cis-1,2-DCE concentrations from January 1991 through November 2009 are presented in Appendix A. PCE concentrations for wells MW-20B and MW-16A for the same time period are also presented as graphs in Appendix A.

Table 5. Average Annual PCE and TCE Concentrations (µg/L) for Wells that Exceed the MTCA Method A Cleanup Level for Groundwater of 5 µg/L.

Year	MW-20B		MW-16A	H1/H2	LPMW-2
	PCE	TCE	PCE	PCE	PCE
1991	657	12	19	---	---
1992	640	14	8	---	---
1993	443	12	28	---	---
1994	279	8.6	21	---	---
1995	340[a]	8.4[a]	27[a]	9[a]	---
1996	370	7	45	4	---
1997	297	4	50	13	---
1998	515	8	33	10	---
1999	715	7	22[a]	3	---
2000	416	6	31	9	---
2001	489	7	28	9	---
2002	309	8.5	34	9	---
2003	234	5.4	42	6.4	---
2004	293	6.6	39	5.3	---
2005	484	6.5	62	10.2	---
2006	367	4.9	77	6.1	9.9[a]
2007	348	6	54	4.5	4.8[a]
2008	201	5	43	7.4	2.5[a]
2009	205	4.4	48	6.8[a]	7.6

--: Not tested.
a: Single annual result.

Figures 3 and 4 show the average annual PCE concentrations for MW-20B and MW-16A from 1985 through 2009. PCE concentrations in both wells have varied substantially.

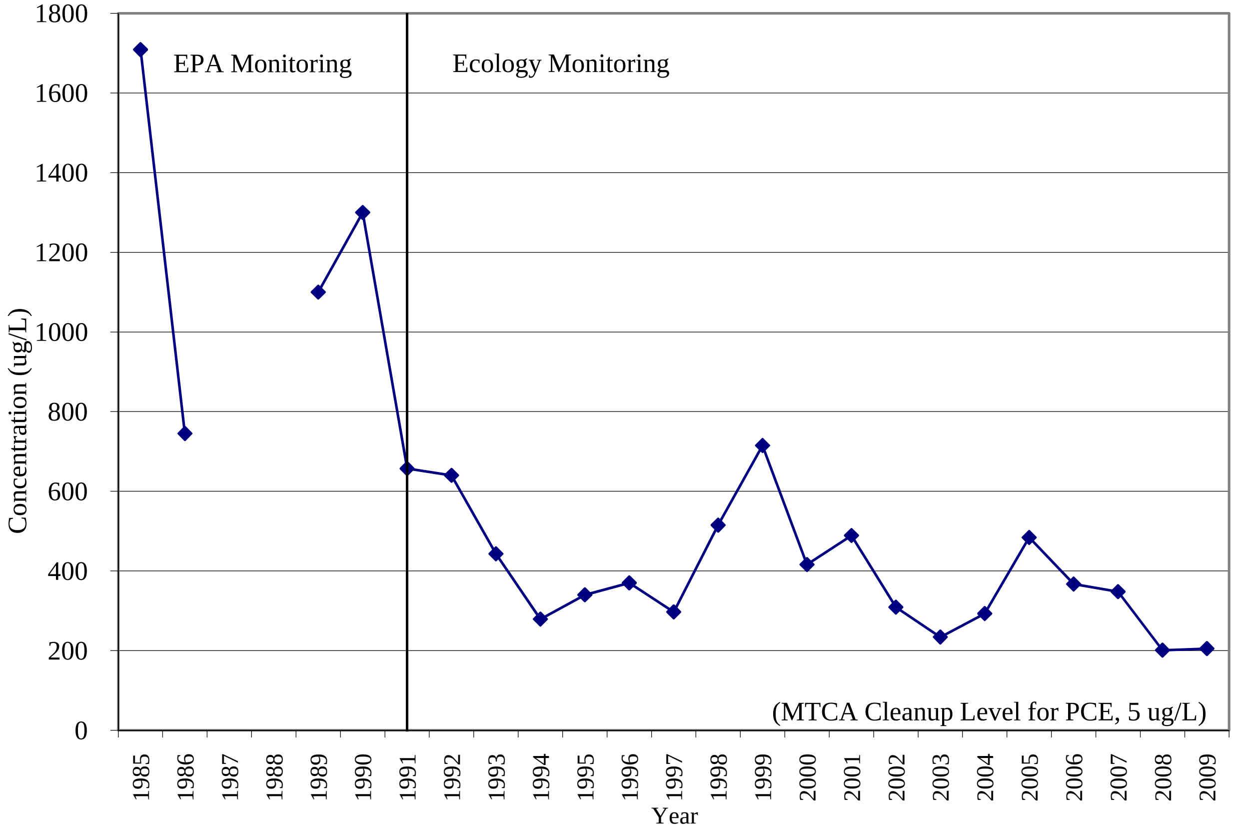

Figure 3. Average Annual PCE Concentrations for Well MW-20B, 1985 through 2009.

PCE concentrations decreased in well MW-20B during the 1980s with the implementation of remedial activities. In 1991, Ecology began semi-annual, long-term groundwater monitoring at the site. Although PCE concentrations have varied, primarily due to seasonal fluctuations, the overall trend indicates that concentrations in well MW-20B are decreasing (Figure A1). The average annual PCE concentration in 1991 was 657 µg/L, and in 2009 it was 205 µg/L.

PCE concentrations also initially decreased in well MW-16A. As with well MW-20B, concentrations have varied over the monitoring period. However, the overall trend indicates that PCE concentrations in well MW-16A are increasing (Figure A2). The average annual PCE concentration in 1991 was 19 µg/L, and in 2009 it was 48 µg/L.

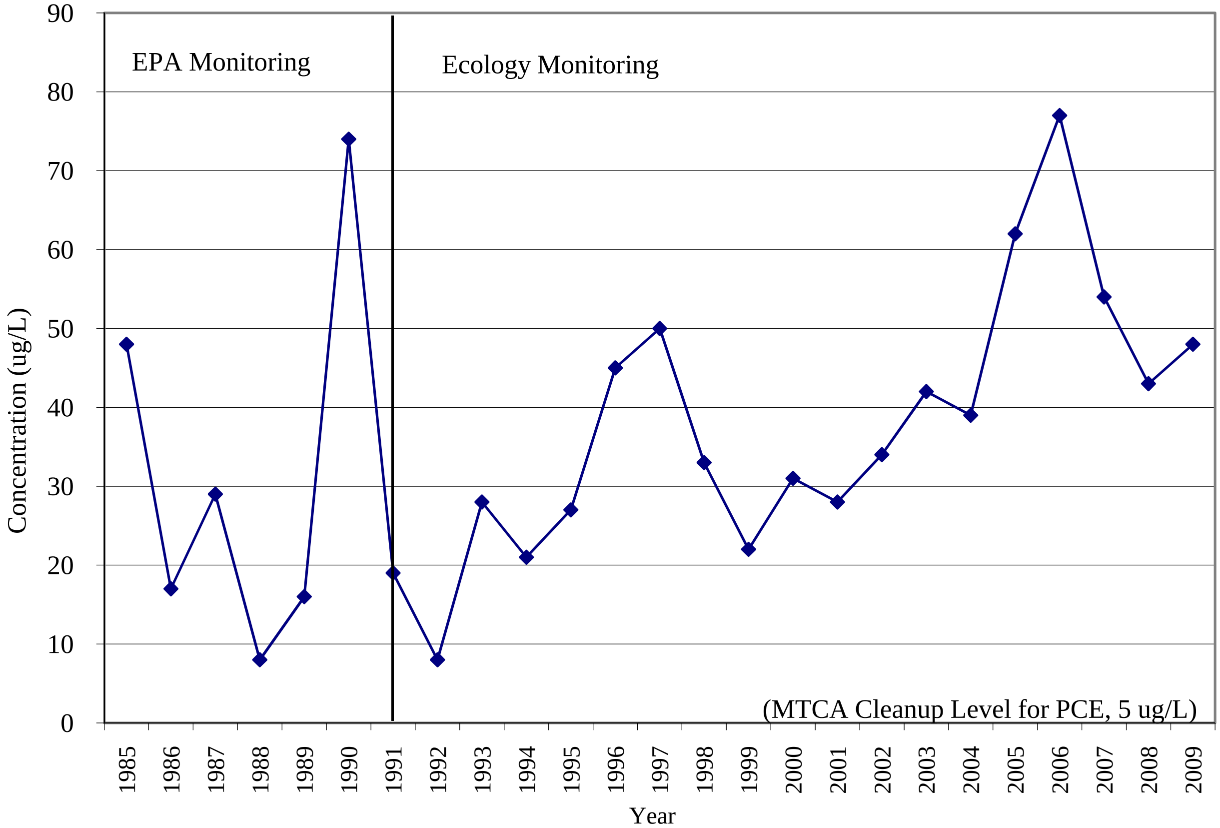

Figure 4. Average Annual PCE Concentrations for Well MW-16A, 1985 through 2009.

As shown in Figures 3 and 4, PCE concentrations continue to exceed the MTCA cleanup level of 5 µg/L in monitoring wells MW-20B and MW-16A. In addition, contaminant concentrations in well MW-16A appear to be gradually increasing over time.

Samples collected from municipal wells H1 and H2 prior to treatment also have PCE concentrations above the MTCA cleanup level (Table 5).

Compliance with the groundwater cleanup goals have not been met for this project. Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals.

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Conclusions and Recommendations

Ecology conducted groundwater monitoring in June 2009 at seven monitoring wells and one municipal well, and in November 2009 at five monitoring wells, to evaluate volatile organics in groundwater at the former Lakewood Plaza Cleaners site.

- Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have PCE concentrations not meeting (higher than) the MTCA cleanup level of 5 µg/L.
- PCE concentrations in well LPMW-2 are typically near the cleanup level of 5 µg/L.

Concentrations of PCE have decreased from their 1980s levels, but continue to not meet the project cleanup goals of 5 µg/L. Since Ecology began sampling in 1991, PCE concentrations have varied, but overall trends indicate that concentrations in well MW-20B are decreasing while concentrations in well MW-16A are increasing. The average annual PCE concentration in well MW-20B in 1991 was 657 µg/L, decreasing to 205 µg/L in 2009. The average annual PCE concentration in well MW-16A in 1991 was 19 µg/L, increasing to 48 µg/L in 2009.

The use of municipal wells H1 and H2 to contain, remove, and treat contaminated groundwater associated with the Lakewood Plaza Cleaners site continues since the cleanup goals have not yet been achieved. Project data indicates that it will take much longer than the projected timeframe to meet the cleanup goals.

Further evaluation is needed to determine what additional actions are needed for this project to meet the final cleanup goals in a reasonable timeframe.

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References

References Cited

Ecology, 2008. Manchester Environmental Laboratory - Lab Users Manual. 9th edition. Washington State Department of Ecology, Manchester, WA.

Ecology, 2006. Standard Operating Procedures Field Manual for Groundwater Assessment Program Studies. Draft. Washington State Department of Ecology, Olympia, WA.

EPA, 1979. EPA-600/4-79-020 Methods for Chemical Analysis of Water and Wastes. U.S. Environmental Protection Agency.

EPA, 1983. Report of the Groundwater Investigation – Lakewood, Washington, October 1981 to February 1983. U.S. Environmental Protection Agency.

EPA, 1985. Final Draft Remedial Investigation Report – Ponders Corner, Washington. U.S. Environmental Protection Agency. EPA 112-0L22.

EPA, 1992. Lakewood/Ponders Corner Superfund Site - Five Year Review Report. U.S. Environmental Protection Agency.

EPA, 1996. Test Methods for Evaluating Solid Waste, SW-846. Office of Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

EPA, 2007. Five-Year Review Report. Fourth Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, Pierce County, WA – September 2007. U.S. Environmental Protection Agency.

Other References

CH2M HILL, 1990a. Sampling and Analysis Plan Remedial Action - Lakewood.

CH2M HILL, 1990b. Technical Memorandum from Lisa Dally Wilson to Ann Williamson RE: Groundwater Sampling at Lakewood (April 1990). Project No. SEA69018RA.FQ.

Ecology, 2002. Five-Year Review Report. Third Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, WA – October 2002. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round I - January 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e34. www.ecy.wa.gov/biblio/91e34.html.

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round II - June 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e35. www.ecy.wa.gov/biblio/91e35.html.

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round III - November 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e43. www.ecy.wa.gov/biblio/92e43.html.

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round IV - June 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e44. www.ecy.wa.gov/biblio/92e44.html.

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round V - December 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e38. www.ecy.wa.gov/biblio/93e38.html.

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round VI - June 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e39. www.ecy.wa.gov/biblio/93e39.html.

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VII - December 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 94-131. www.ecy.wa.gov/biblio/94131.html.

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VIII - April 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 94-198. www.ecy.wa.gov/biblio/94198.html.

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring Round IX - November 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 95-340. www.ecy.wa.gov/biblio/95340.html.

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring - July 11, 12 & 14, 1995. Washington State Department of Ecology, Olympia, WA. Publication No. 95-359. www.ecy.wa.gov/biblio/95359.html.

Marti, P., 1996. Lakewood/Plaza Cleaners Monitoring - January 17-18, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 96-317. www.ecy.wa.gov/biblio/96317.html.

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 31, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 97-312. www.ecy.wa.gov/biblio/97312.html.

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - January 9, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-324a. www.ecy.wa.gov/biblio/97324a.html.

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 23-24, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-339. www.ecy.wa.gov/biblio/97339.html.

Marti, P., 1998. Lakewood/Plaza Cleaners Monitoring - February 2, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 98-325. www.ecy.wa.gov/biblio/98325.html.

Marti, P., 1999. Lakewood/Plaza Cleaners Monitoring - July 15, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 99-312. www.ecy.wa.gov/biblio/99312.html.

Marti, P., 1999. Lakewood/Plaza Cleaners Long-term Monitoring, January and August, 1999. Washington State Department of Ecology, Olympia, WA. Publication No. 99-344. www.ecy.wa.gov/biblio/99344.html.

Marti, P., 2000. Lakewood/Plaza Cleaners, January and August 2000 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 00-03-046. www.ecy.wa.gov/biblio/0003046.html.

Marti, P., 2001. Lakewood/Plaza Cleaners, January and August 2001 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 01-03-032. www.ecy.wa.gov/biblio/0103032.html.

Marti, P., 2002. Lakewood Plaza Cleaners, February and August 2002 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-007. www.ecy.wa.gov/biblio/0303007.html.

Marti, P., 2003. Lakewood Plaza Cleaners, February and October 2003 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-050. www.ecy.wa.gov/biblio/0303050.html.

Marti, P., 2004. Lakewood Plaza Cleaners, June and November 2004 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-054. www.ecy.wa.gov/biblio/0403054.html.

Marti, P., 2005. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html.

Marti, P., 2006. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html.

Marti, P., 2007. Lakewood Plaza Cleaners, May and September 2006 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 07-03-013. www.ecy.wa.gov/biblio/0703013.html.

Marti, P., 2008. Lakewood Plaza Cleaners, June and October 2007 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 08-03-010. www.ecy.wa.gov/biblio/0803010.html.

Marti, P., 2009. Lakewood Plaza Cleaners Groundwater Monitoring Results, May and October 2008. Washington State Department of Ecology, Olympia, WA. Publication No. 09-03-012. www.ecy.wa.gov/biblio/0903012.html.

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Appendices

Appendix A. Summary of Results

Table A-1. Summary of Sample Results (ug/L), January 1991 to November 2009.

Well	January 1991			May 1991			November 1991			May 1992			December 1992		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	28	1 J	2.4 J	26	0.6 J	2	2.7 J	1 U	0.6 J	7	1 U	1	9 J	0.3 J	0.8 J
MW-20A	1 U	1 U	1 U	0.4 J	1 U	1 U	0.4 J	1 U	1 U	0.5 J	1 U	1 U	0.8 J	1 UJ	1 UJ
MW-20B	1100 D	18	33	752	16	30	120	2.6 J	6.7	940	13	32	340 J	14 J	20 J
MW-21	2.1 J	1 U	1 J	2	1 U	0.7 J	2.2 J	1 U	1.0 J	2	1 U	0.6 J	2	0.2 J	0.3 J
MW-27	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 UJ	1 UJ	1 UJ
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-31	1 J	1 U	1.9 J	0.6 J	1 U	2	0.9 J	1 U	2.2 J	0.8 J	1 U	1	0.5 J	1 UJ	0.9 J
MW-32	1 J	1 U	1.1 J	1	1 U	2	0.6 J	1 U	0.6 J	0.7 J	1 U	1	0.7 J	1 UJ	0.5 J
MW-41	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 UJ	1 UJ	1 UJ
MW-19A	--	--	--	--	--	--	1 U	0.5 J	1 U	--	--	--	1 UJ	1 UJ	1 UJ
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-40	1 U	1 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--	1 UJ	1 UJ	1 UJ
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well	May 1993			December 1993			April 1994			November 1994			July 1995		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	44	10 U	2 J	13	0.3 J	0.7 J	33	0.6	1.4	9.7	0.3 J	0.5 J	27	0.5 J	0.8 J
MW-20A	10 U	10 U	10 U	0.3 J	1 U	1 U	0.4	0.2 U	0.2 U	0.3 J	1 U	1 U	0.4 J	1 U	1 U
MW-20B	700 D	12	21	187	50 U	8.2 J	472	8.6 J	12.6	86	50 U	3 J	340 D	8.4	17
MW-21	1 J	10 U	10 U	1.6	1 U	0.4 J	1.5	0.2 J	0.3	1.8	0.2 J	0.3 J	--	--	--
MW-27	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-31	10 U	10 U	10 U	0.8 J	1 U	1.2 J	0.7	0.2 U	1.0	0.8 J	1 U	1	0.6 J	1 U	0.5 J
MW-32	10 U	10 U	10 U	0.7 J	1 U	0.6 J	0.7	0.2 U	0.6	0.6 J	1 U	0.5 J	0.7 J	1 U	0.5 J
MW-41	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-19A	--	--	--	1 U	0.4	1 U	0.2 U	0.5	0.2 U	--	--	--	1 U	0.4 J	1 U
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	--	--	--	1 U	1 U	1 U
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	9	0.3 J	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to November 2009.

Well	January 1996			July 1996			January 1997			July 1997			February 1998		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	47 E	0.8 J	1.5	43	0.7 J	1.9	54	1.1	3.1	47	0.7 J	2.5	36	0.7 J	2 J
MW-20A	0.2 J	1 U	1 U	0.4 J	1 U	1 U	0.4 J	1 U	1 U	0.3 J	1 U	2 U	0.4 J	1 U	1 U
MW-20B	353	7.2	15	387	7.6	15	373	100 U	6.4 J	222	4	6.4	456	7 J	12
MW-21	--	--	--	Well Decommissioned											
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
MW-28A	1 U	1 U	1 U	Well Decommissioned											
MW-31	0.6 J	1 U	0.7 J	--	--	--	--	--	--	0.9 J	1 U	0.9 J	--	--	--
MW-32	0.8 J	1 U	0.6 J	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	--	--	--	1 U	0.3 J	2 U	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--	1 U	1 U	2 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	8.4	0.2 J	0.2 J	0.1 J	1 U	1 U	18	0.4 J	0.4 J	8.8	0.3 J	0.6 J	11	0.4 J	0.3 J

Well	July 1998			January 1999			August 1999			January 2000			August 2000		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	30	1 U	1.5 J	--	--	--	22	0.4 J	1.1	40	0.7 J	1.9	22	0.3 J	0.7
MW-20A	0.6 J	1 U	1 U	1 U	2 U	1 U	0.8 J	2 U	1 U	0.2 J	2 U	1 U	0.1 J	2 U	1 U
MW-20B	575 D	10	23	708	5.2	12	722	8.4 J	16 J	184	6	13	648	200 U	100 U
MW-27	0.05 J	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U
MW-31	--	--	--	--	--	--	0.9 J	2 U	0.4 J	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	0.8 J	2 U	1 U
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
MW-19A	--	--	--	--	--	--	1 U	0.4 J	1 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	1 U	2 U	1 U	--	--	--	1 U	2 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
H1/H2	10	1 U	0.1 J	1.5	1 U	1 U	5.2	0.2 J	1 U	10	1 U	1 U	8.7	0.03 J	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to November 2009.

Well	January 2001			August 2001			February 2002			August 2002			February 2003		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.4 J**	**1**	**25**	**0.3 J**	**0.7 J**	**47**	**0.8 J**	**2.3**	**22**	**0.3 J**	**0.8 J**	**59 J**	**0.2 J**	**2.4**
MW-20A	**0.2 J**	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U
MW-20B	**493**	**6.6 J**	**12**	**486**	**8.2**	**18**	**248**	200 U	100 U	**371**	**8.5**	**16**	**230**	100 U	100 U
MW-27	1 U	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	**0.4 J**	2 U	**0.3 J**	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	1 U	**0.3 J**	1 U	--	--	--	--	--	--	--	--	--
MW-33	--	--	--	1 U	2 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	**11**	**0.2 J**	1 U	**6.8**	**0.2 J**	1 U	**12**	**0.2 J**	**0.2 J**	**6.1**	1 U	1 U	**1.3**	1 U	1 U

Well	September 2003			June 2004			November 2004			June 2005			November 2005		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**26**	**0.3 J**	**0.5 J**	**30**	**0.4 J**	**0.8 J**	**48**	1 U	**1.4**	**80**	**1.3**	**2.8**	**43**	**0.7 J**	**1.0 J**
MW-20A	**0.1 J**	1 U	1 U	**0.2 J**	1 U	1 U	**0.3 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**239**	**5.4 J**	**12**	**344**	**6.5 J**	**15**	**241**	**6.7**	**13**	**413**	**6.6**	**12**	**555**	**6.4**	**11**
MW-27	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
MW-31	**0.5 J**	1 U	**0.1 NJ**	--	--	--	--	--	--	**0.5 J**	1 U	1 U	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	**1.4**	1 U	1 U	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-19A	1 U	**0.4 NJ**	1 U	--	--	--	--	--	--	1 U	**0.6 J**	1 U	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
H1/H2	**6.4**	**0.2 NJ**	1 U	**7.9**	**0.2 J**	**0.1 J**	**2.6**	1 U	1 U	**14**	**0.3 J**	1 U	**6.4**	1 U	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to November 2009.

Well	May 2006			September 2006			June 2007			October 2007			May 2008		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**124**	**1.8**	**4.6**	**29**	**0.3** J	**0.48** J	**83**	**1.2**	**2.5**	**24**	1 U	**0.64** J	**55**	**1.2**	**2.8**
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**216**	**4.2**	**6.6**	**518**	**5.6**	**11**	**204**	**4.4**	**7.8**	**491**	**7.5**	**15**	**143**	**5.5**	**12**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	--	--	--	**1.6** J	2 U	2 U	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	2 U	**1.2** J	2 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	2 U	2 U	2 U	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LPMW-2	**9.9**	1 U	1 U	--	--	--	**4.8**	1 U	1 U	--	--	--	**2.5**	1 U	1 U
LPMW-3	1 U	1 U	1 U	--	--	--	2 U	1 U	1 U	--	--	--	--	--	--
H1/H2	**7.3**	**0.2** J	1 U	**4.8**	1 U	1 U	**5.2**	2 U	2 U	**3.8**	1 U	1 U	**9.6**	1 U	1 U

Well	October 2008			June 2009			November 2009		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.45** J	**0.6** J	**67**	**0.94** J	**2.2**	**28**	**0.52** J	**0.83** J
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	**0.64** J	1 U	1 U
MW-20B	**258**	**4.5**	**9**	**160**	**4.1**	**7.4**	**250**	**4.7**	**9.6**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	1 U	1 U	1 U	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--
LPMW-2	--	--	--	**4.1**	1 U	1 U	**11**	1 U	1 U
H1/H2	**5.1**	1 U	1 U	**6.8**	1 U	1 U	--	--	--

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
D = Analysis performed at secondary dilution.
E = The concentration of the associated value exceeds the known calibration range.
-- = Not tested
Bold = The analyte was positively identified.

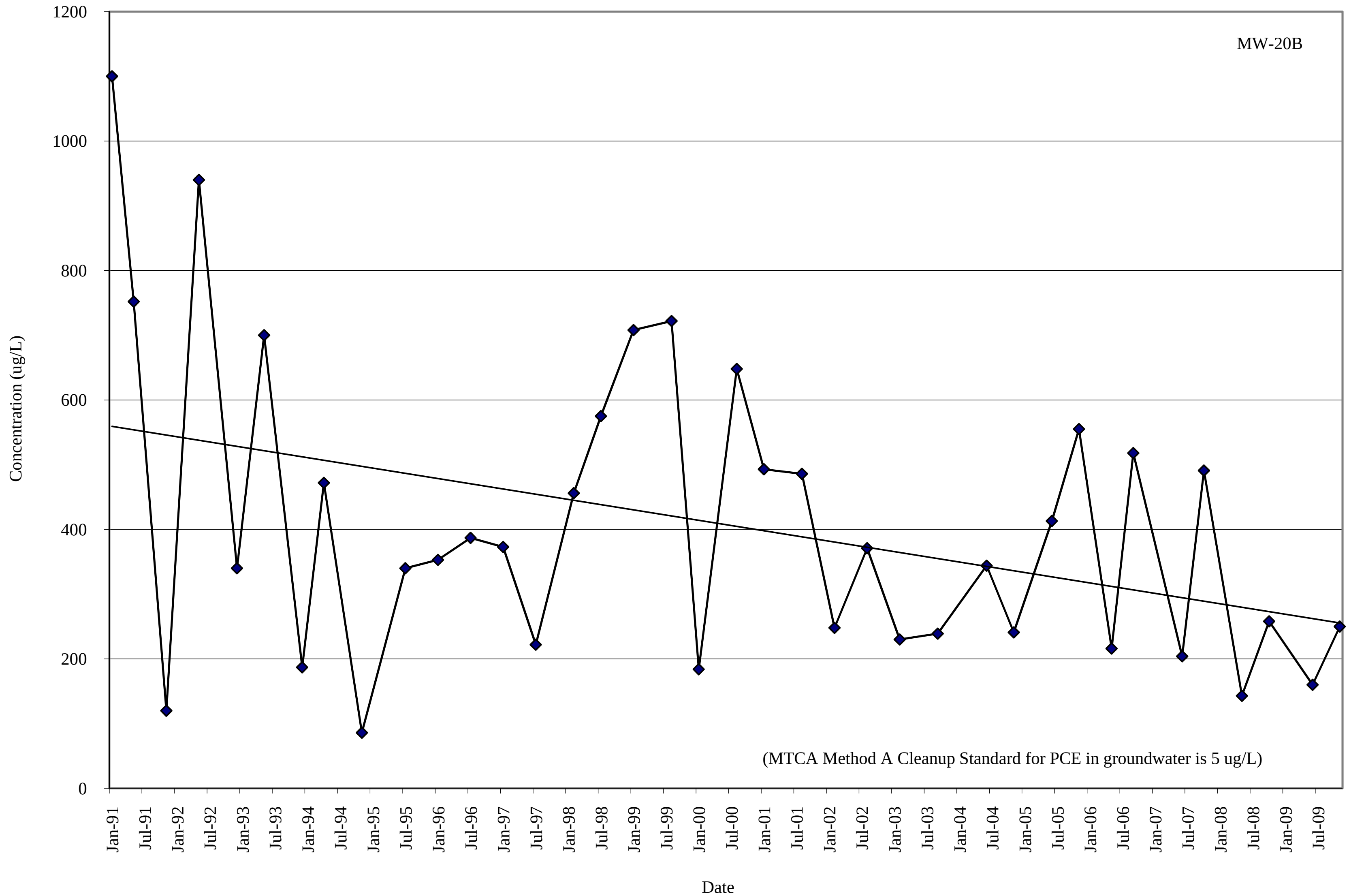

Figure A-1. PCE Concentrations for Well MW-20B, January 1991 to November 2009.

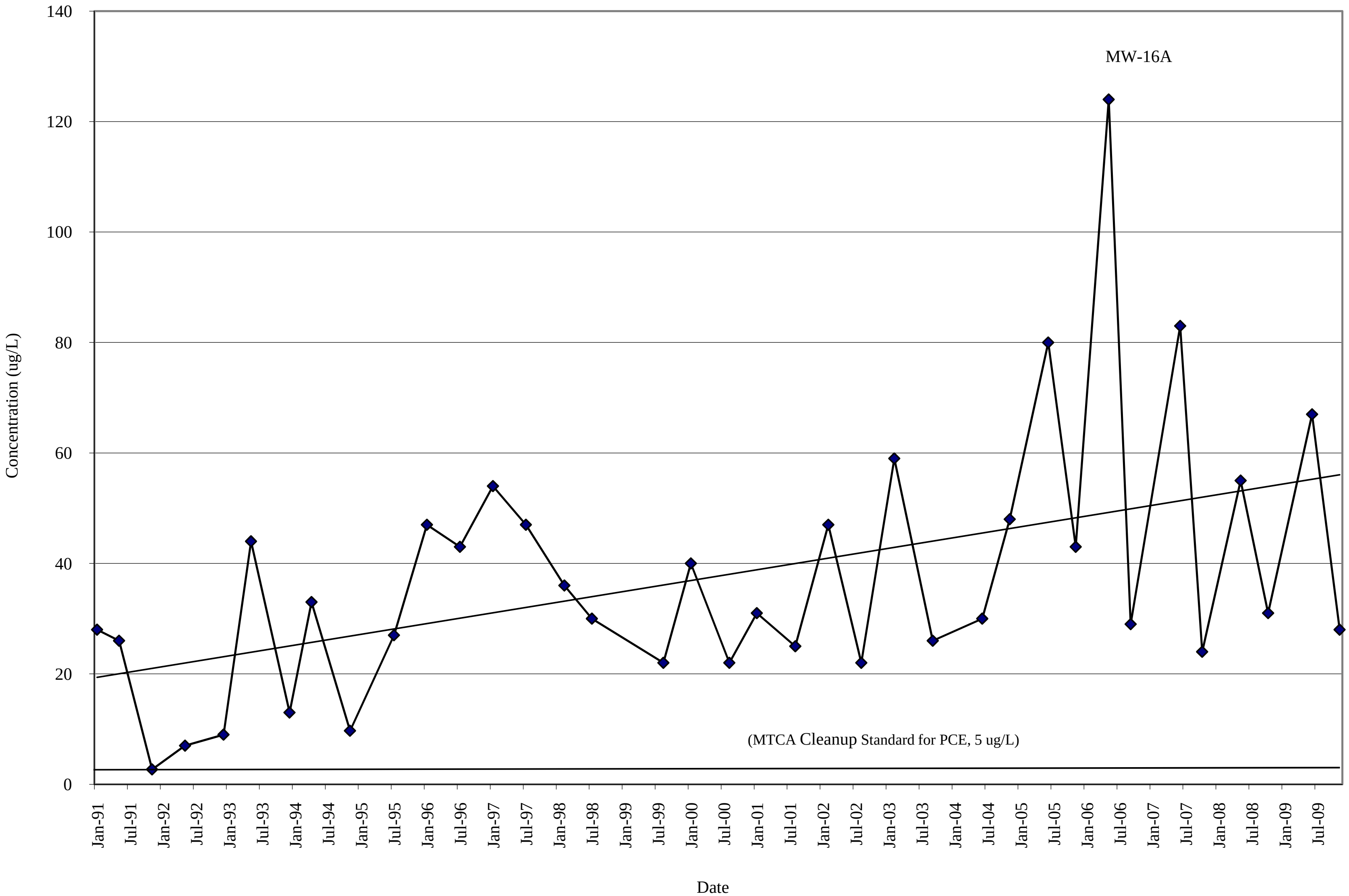

Figure A-2. PCE Concentrations for Well MW-16A, January 1991 to November 2009.

Appendix B. Glossary, Acronyms, and Abbreviations

Glossary

Aquifer: An underground geological formation, or group of formations, containing water.

Aquitard: Geologic formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients. May function as a confining bed.

Depth-to-water: A measure of depth to the water (i.e., water level) in a well.

Groundwater: Water in the subsurface that saturates the rocks and sediment in which it occurs. The upper surface of groundwater saturation is commonly termed the water table.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Purge water: Water removed from the sampling zone in a well prior to sample collection.

Specific conductance: A measure of water's ability to conduct an electrical current. Specific conductance is related to the concentration and charge of dissolved ions in water.

Volatile organics: Organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the earth's atmosphere.

Acronyms and Abbreviations

Cis-1,2-DCE	Cis-1,2-dichloroethene
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	Environmental Protection Agency
MTCA	Model Toxic Control Act
PCE	Tetrachloroethene
PVC	Polyvinyl chloride
RPD	Relative Percent Difference
TCE	Trichloroethene
VOA	Volatile Organics Analysis
WAC	Washington Administrative Code

Units of Measurement

°C	degrees centigrade
µg/L	micrograms per liter (parts per billion)
umhos/cm	micromhos per centimeter

DEPARTMENT OF ECOLOGY
State of Washington

Lakewood Plaza Cleaners
Groundwater Monitoring Results

June and October 2010

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Lakewood Plaza Cleaners, Groundwater Monitoring Results

June and October 2010

by
Pamela B. Marti

Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

Waterbody Number: WA-12-1115

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Abstract

This progress report is one in a series describing results of long-term groundwater monitoring at the former Lakewood Plaza Cleaners site south of Tacoma. The Washington State Department of Ecology (Ecology) began collecting groundwater data at the site in the early 1990s as part of its official responsibilities for operation and maintenance of the remedial actions. The goal was to evaluate the effectiveness of municipal wells H1 and H2 to contain and remove the contaminated groundwater.

This report discusses volatile organic results of samples collected from project monitoring wells and Lakewood Water District municipal wells in June and October 2010.

Tetrachloroethene (PCE) concentrations continue to not meet (exceed) the MTCA cleanup level of 5 ug/L in monitoring wells MW-20B (130 and 520 ug/L) and MW-16A (85 and 61 ug/L). Since Ecology began sampling, PCE concentrations have varied, but overall trends indicate that concentrations in well MW-20B are decreasing while concentrations in well MW-16A are increasing. The average annual PCE concentration in well MW-20B in 1991 was 657 ug/L, decreasing to 325 ug/L in 2010. The average annual PCE concentration in well MW-16A in 1991 was 19 ug/L, increasing to 73 ug/L in 2010.

Samples collected from municipal wells H1 and H2 prior to treatment continue to have PCE concentrations near the MTCA cleanup level.

PCE was also detected in well LPMW-2 (4.4 and 5 ug/L). This well is located near the former septic system of Lakewood Plaza Cleaners which was identified as a source of the contamination.

The use of municipal wells H1 and H2 to treat contaminated groundwater associated with the Lakewood Plaza Cleaners site continues since the cleanup goals have not been achieved. Early groundwater monitoring results projected that compliance with cleanup goals would be achieved throughout the contaminated plume by the mid-1990s. Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals.

Introduction

In 1981, the U.S. Environmental Protection Agency (EPA) confirmed that the Lakewood Water District production wells H1 and H2 were contaminated with tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE). Lakewood is south of Tacoma in Pierce County. The source of the contamination was identified as the former Lakewood Plaza Cleaners (EPA, 1983). Contamination had resulted from the dumping of PCE into on-site septic tanks and the disposal of sludge on the ground surface. The Lakewood Plaza Cleaners site was added to the National Priorities List (NPL) in 1982.

Remedial activities at the site began in 1983. They included the operation of wells H1 and H2 to pump and treat contaminated groundwater, the removal of contaminated soils and sludge from the source area, and treatment of a small portion of the contaminated septic field soils with vapor extraction. Soil remediation was completed in 1993. The soils unit of the site was removed from the NPL in 1996 (EPA, 1996a). Treatment of the contaminated groundwater with wells H1 and H2 continued. Early groundwater monitoring results projected that compliance with cleanup goals of 5 ug/L for PCE and TCE, and 70 ug/L for cis-1,2-DCE would be achieved throughout the contaminated plume by the mid-1990s.

Although the Washington State Department of Ecology's (Ecology) official responsibilities for operation and maintenance of the remedial actions did not begin until 1994, Ecology began semi-annual groundwater compliance monitoring at the site in 1991. The objective of the sampling was to collect groundwater quality data to evaluate the effectiveness of Lakewood water supply wells H1 and H2 to contain, remove, and treat the groundwater contaminated by Plaza Cleaners.

In accordance with EPA policy and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA § 121(42 U.S.C. Section 9621) and the National Contingency Plan (NCP) five-year reviews of the project are also required as long as cleanup goals have not been achieved. Four 5-year reviews have been completed: in 1992, 1997, 2002, and 2007. During the 5-year reviews the monitoring program is evaluated. Groundwater monitoring has been modified over the years to focus primarily on wells in the immediate vicinity of the former Plaza Cleaners. Currently there are 14 monitoring wells and the two production wells (H1 and H2) being monitored.

Remediation and monitoring of the groundwater is ongoing under a long-term response action as cleanup goals have not yet been achieved (EPA, 2007). Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals. EPA has recommended that if cleanup goals throughout the contaminant plume are not achieved in a reasonable time-frame, then the pump and treat system should be evaluated to determine if it is adequate to meet the cleanup goals. If it is not, then EPA and Ecology need to determine what additional actions are needed for this site to meet the cleanup goals (EPA, 2007).

Methods

Groundwater Monitoring

In June 2010, Ecology collected groundwater samples from monitoring wells MW-16A, MW-20A, MW-20B, MW-27, MW-32, MW-33, MW-41, and LPMW-2 and municipal well H2 (Figure 1).

In October 2010, Ecology collected groundwater samples from wells MW-16A, MW-20A, MW-20B, and LPMW-2.

Wells MW-16A, MW-20A, MW-27, MW-32, MW-33, MW-41 and municipal wells H1 and H2 are screened in the Advance Outwash deposits, the primary water-supply aquifer for the area.

Well MW-20B is screened in the Vashon Till, typically a very low permeable layer which forms an aquitard of unsaturated and saturated sediment separating the Steilacoom Gravel above and the Advance Outwash below. Well MW-20B is the only well screened in the Vashon Till where contamination had been detected.

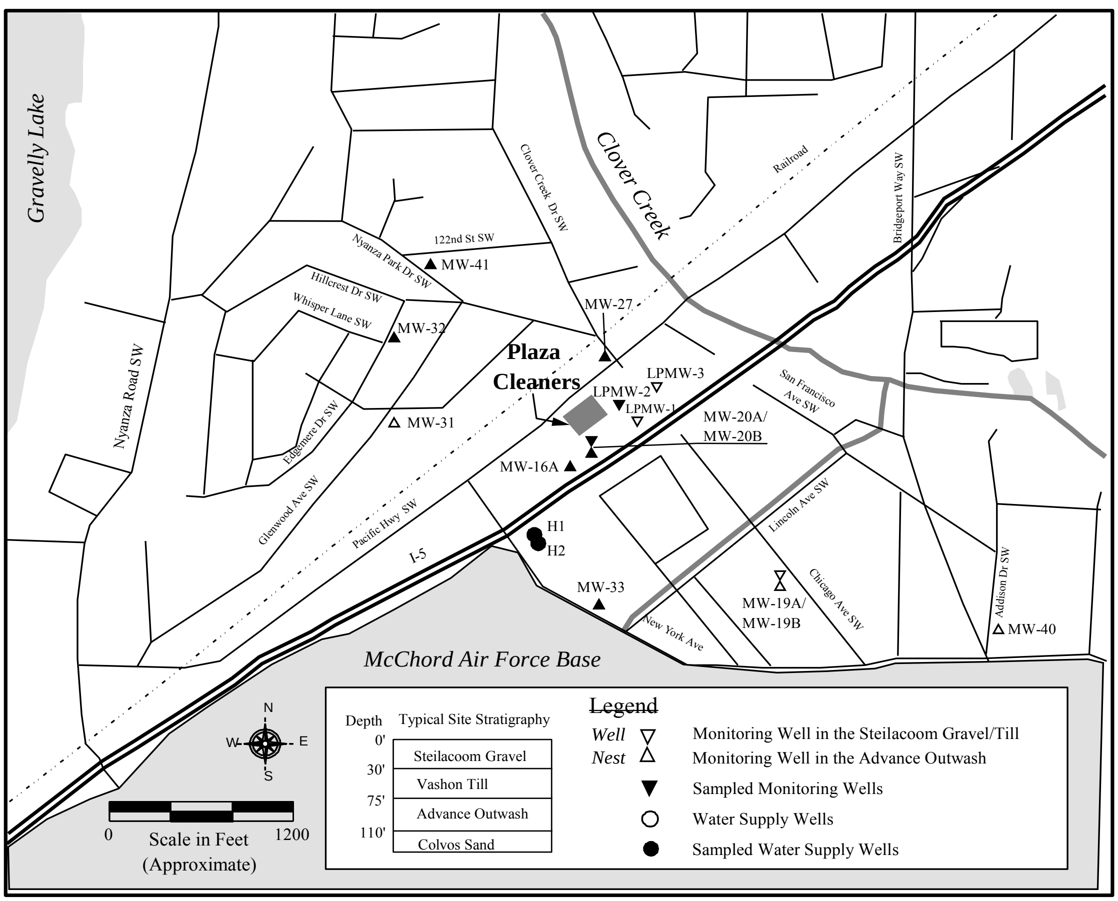

Figure 1. Lakewood Plaza Cleaners Sampling Locations.

Well LPMW-2, along with wells LPMW-1 and LPMW-3, are screened in the Steilacoom Gravel, which generally contains areas of perched water above the Vashon Till and regional water table. These observation wells were installed in 2004 by the adjoining property owner. Due to the wells' location next to the former Plaza Cleaners, Ecology added them to the monitoring program in 2006 to provide additional information on the groundwater contamination. Wells LPMW-1 and LPMW-3 were removed from the monitoring program in 2008 because PCE had not been detected and access to the wells had become more restricted.

Ecology continues to sample well LPMW-2 because PCE is detected in samples from this well. This well is located near the former septic system of Plaza Cleaners which was identified as a source of the contamination.

Ecology measured static water levels in all wells prior to well purging and sampling. Measurements were collected according to procedures in standard operating procedure (SOP) EAP052 (Marti, 2009).

Monitoring wells MW-16A, MW-20A, MW-32, MW-33, and MW-41 were purged and sampled using dedicated bladder pumps.

Wells MW-20B, MW-27, and LPMW-2 were purged and sampled with a stainless-steel submersible pump with dedicated tubing using low-flow sampling techniques. The submersible pump was decontaminated between wells by circulating laboratory-grade detergent/water through the pump followed by a clean water rinse, with each cycle lasting five minutes.

The monitoring wells were purged until pH, temperature, and specific conductance readings stabilized or three well volumes of water had been removed. Purge water from the monitoring wells was collected and stored in 55-gallon drums. The purge water waste was transported and disposed of in accordance with Washington State regulations (Chapter 173-340-400 WAC). At the completion of purging, samples were collected from the monitoring wells directly from the dedicated pump discharge tubing into laboratory-supplied containers. Municipal well H2, which pumps continuously, was sampled from the tap nearest the well.

Volatile organics samples were collected free of headspace in three 40-mL glass vials with Teflon-lined septa lids and preserved with 1:1 hydrochloric acid. After labeling, all samples were stored in an ice-filled cooler. Samples were transported to Ecology's Operations Center in Lacey. Samples were kept in the walk-in cooler until taken by the courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Laboratory protocol (Ecology, 2008).

Analysis

Table 1 lists analytes, analytical methods, and reporting limits for both field and laboratory parameters. Manchester Laboratory analyzed all groundwater samples for volatile organics.

Table 1. Field and Laboratory Methods.

Field Measurements	Instrument Type	Method	Accuracy
Water Level	Solinst Water Level Meter	SOP EAP 052	±0.03 feet
pH	YSI ProPlus with Quatro Cable	EPA 150.1 (EPA, 2001a)	±0.2 std. units
Specific Conductance	YSI ProPlus with Quatro Cable	EPA 120.1 (EPA, 2001b)	±10 umhos/cm
Temperature	YSI ProPlus with Quatro Cable	EPA Method 150.1	±0.2 ºC
Laboratory Analytes	Method	Reference	Reporting Limit
Volatile Organics	EPA SW-846 Method 8260B	EPA 1996b	1-5 ug/L

EAP = Environmental Assessment Program, Ecology.

Results

Data Quality Assessment

Quality control samples collected in the field consisted of blind field duplicates obtained from well MW-16A. 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 also by the natural variability of the concentrations in the media (e.g., groundwater) being sampled.

The numeric comparison of duplicate results is expressed as the relative percent difference (RPD). The RPD is calculated as: the difference between sample results, divided by the mean, and expressed as a percent.

Table 2 shows the results of the duplicate samples and their RPD. The RPD for the June and October data ranged from 0% to 8%. The quality of the data for this progress report is acceptable.

Table 2. Relative Percent Difference (RPD) of Duplicate Sample Results (ug/L), June and October 2010.

Well Sample ID	Tetrachloroethylene (PCE)		Trichloroethylene (TCE)		Cis-1,2-Dichloroethylene (cis-DCE)	
	6/10	10/10	6/10	10/10	6/10	10/10
MW-16A	85	61	1.3	0.86 J	1.6	1.2
MW-16B	81	66	1.2	0.81 J	1.6	1.2
RPD[1] (%)	5%	8%	8%	--	0%	0%

MW-16B is the duplicate sample identification.

[1] : RPD target ±30%.

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

In October an equipment rinsate blank was collected from the submersible pump to determine if field cleaning procedures were sufficient to prevent cross-contamination of samples from the sample equipment. A rinsate blank was collected by pumping deionized water through the submersible pump after the pump had been cleaned. The target analytes, PCE, TCE, and cis-1,2-DCE, were not detected in the rinsate blank.

A review of the data quality control and quality assurance from laboratory case narratives indicates that overall the 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 major problems were reported that compromised the usefulness or validity of the sample results; therefore, all results are usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

Field Results

Depth-to-water measurements and purge volume, as well as pH, specific conductance, and temperature readings, at the time of sampling are listed in Table 3.

Table 3. Summary of Field Parameter Results, June and October, 2010.

Well	Total Depth (feet)[1]	Depth to Water (feet)[1]	pH (standard units)	Specific Conductance (umhos/cm)	Temperature (°C)	Purge Volume (gallons)
June						
MW-16A	109	32.04	7.1	213	13.1	62
MW-20A	97.3	26.90	7.9	202	12.7	21
MW-20B	50.4	25.86	6.7	328	14.8	10
MW-27	93	26.62	6.9	185	13.7	18
MW-32	88.3	57.93	7.1	191	12.1	18
MW-33	99.3	++	7.2	204	11.6	30
MW-41	96.8	26.69	7.2	196	12.2	21
LPMW-2	29	21.60	6.7	152	14.3	3
H2	110	++	6.7	216	--	--
October						
MW-16A	109	36.52	--	221	12.6	62
MW-20A	97.3	31.69	--	212	12.3	24
MW-20B	50.4	31.79	--	348	14.5	11
LPMW-2	29	25.27	--	194	14.0	2

[1] Measured from top of PVC casing.
++ Dedicated pump obstructed water-level measurement.
-- Not Measured.

Most of the sampled wells are screened in the Advance Outwash deposits (MW-16A, MW-20A, MW-27, MW-32, MW-33, MW-41, and H1/H2). Depth to water in the Advance Outwash ranged from 26.62 - 57.93 ft. in June and 31.69 - 36.52 ft. in October. A pump test conducted in 1981, when municipal wells H1/H2 were shut down, determined that the natural groundwater flow direction in the Advance Outwash is west-northwest toward Gravelly Lake. When in use, these wells create a large cone of depression which influences groundwater flow directions. Previous studies showed that drawdowns occur in shallow monitoring wells drilled in the Steilacoom gravel when H1 and H2 are pumping (EPA, 1985). This indicates possible hydraulic interconnection between the Steilacoom gravel and the Advance Outwash.

Well MW-20B is screened in the Vashon Till. Depth to water was 25.86 ft. in June and 31.79 ft. in October. The Vashon Till forms an aquitard when composed of silt and clay-rich gravels. The Vashon Till also contains thin layers of sandy gravel, one of which appears to be large in lateral extent, covering the area including Plaza Cleaners. This lens is saturated and appears to be hydraulically interconnected with the Steilacoom gravel (EPA, 1985). Well LPMW-2 is screened in the Steilacoom Gravel. Depth to water was 21.60 in June and 25.27 ft. in October. Field parameters (pH, specific conductance, and temperature) were within expected ranges. pH was not measured in October due to a probe malfunction. The specific conductance in well MW-20B (328 - 348 umhos/cm) was greater than the other wells. Well MW-20B is screened in the fine-grained till unit. Specific conductance readings are typically higher for water from fine-grained units. In October dissolved oxygen (DO) was measured at the end of purging using a field photometer. DO measurements in the advanced outwash ranged from 3.2 – 4.3 mg/L and was 3.5 mg/L in the Vashon Till.

Analytical Results

June and October 2010 analytical results for volatile organics of interest are summarized in Table 4 and presented in Figure 2.

All field measurements and analytical results data are available in electronic format from Ecology's EIM data management system: www.ecy.wa.gov/eim/index.htm. Search study ID LAKEWOOD.

Table 4. Results (ug/L) of Volatile Organics of Interest, June and October, 2010.

Well	Tetrachloroethene (PCE)	Trichloroethene (TCE)	Cis-1,2-Dichloroethene (cis-1,2-DCE)
June 2010			
MW-16A	**85**	**1.3**	**1.6**
MW-20A	1 U	1 U	1 U
MW-20B	**130**	**3.7**	**6.3**
MW-27	1 U	1 U	1 U
MW-33	1 U	1 U	1 U
MW-32	**1.8**	1 U	1 U
MW-41	1 U	1 U	1 U
LPMW-2	**4.4**	1 U	1 U
H2	**4.3**	1 U	1 U
October 2010			
MW-16A	**61**	**0.86 J**	**1.2**
MW-20A	2 U	1 U	1 U
MW-20B	**520**	**5.8**	**10**
LPMW-2	**5**	1 U	1 U

Bold: Analyte detected.
U: Analyte was not detected at or above the reported value.
J: Analyte was positively identified. The associated numerical result is an estimate.

Chlorinated solvents continue to be detected in monitoring wells MW-20B, MW-16A, and LPMW-2 as well as in municipal wells H1 and H2.

PCE also continues to be detected in well MW-32 near the reporting limit of 1 ug/L. Although this well is sampled once every 5 years, PCE concentrations have remained consistent since Ecology began monitoring in 1991.

Monitoring wells MW-20B and MW-16A, and municipal wells H1 and H2, continue to have PCE concentrations that exceed the MTCA cleanup level of 5 ug/L.

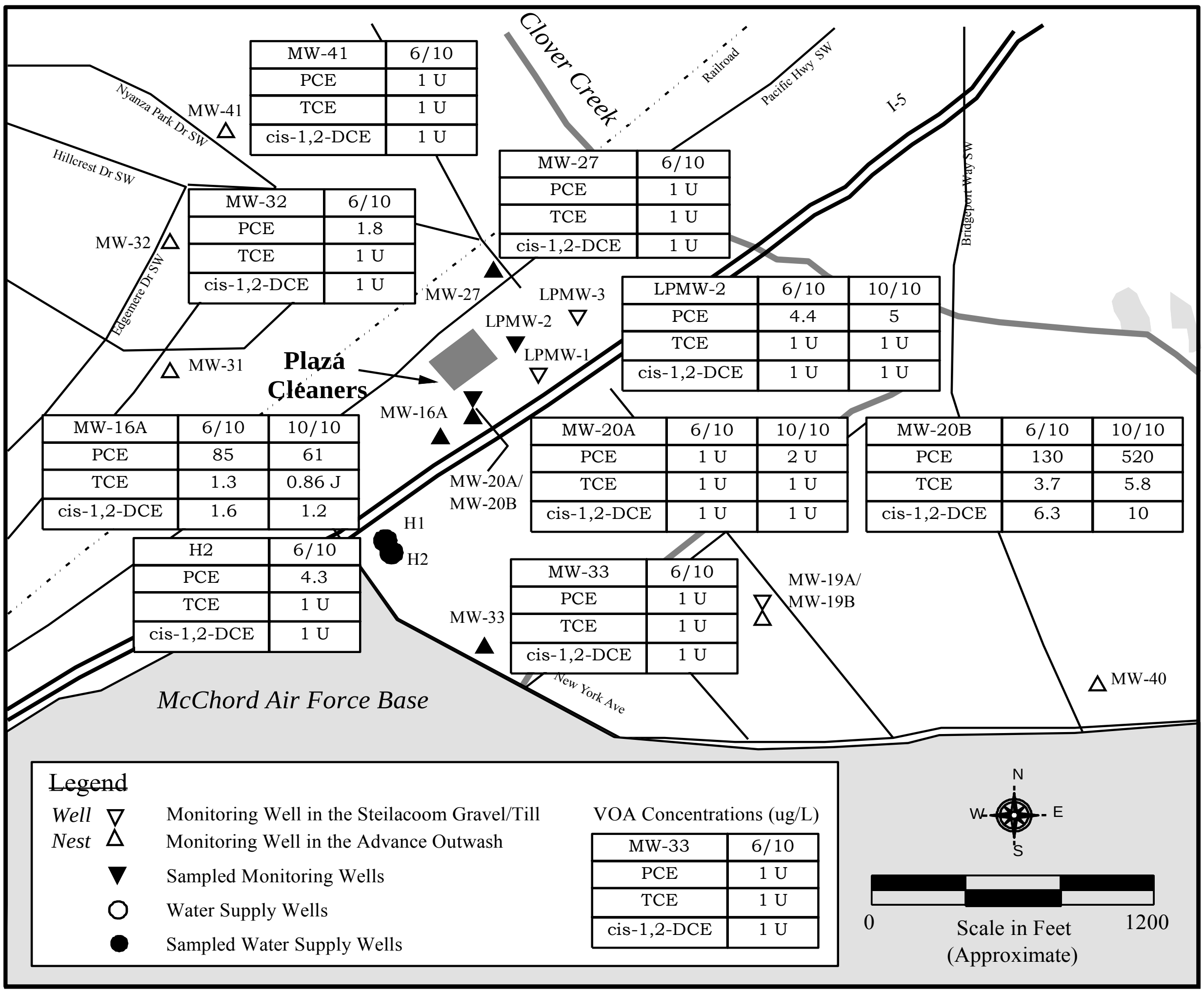

Figure 2. Lakewood Plaza Cleaners PCE, TCE, and Cis-1,2-DCE Concentrations (ug/L), June and October 2010.

Discussion

In 1991, Ecology assumed responsibility for long-term groundwater monitoring of the former Lakewood Plaza Cleaners site with the goal of collecting data to evaluate the effectiveness of municipal wells H1 and H2 to contain and remove the contaminated groundwater.

Table 5 shows average PCE and TCE concentrations for the wells that have consistently had concentrations that exceeded the MTCA cleanup level of 5 ug/L during Ecology's sample period of 1991 to 2010. All PCE, TCE, and cis-1,2-DCE concentrations from January 1991 through October 2010 are presented in Appendix A. PCE concentrations for wells MW-20B and MW-16A for the same time period are also presented as graphs in Appendix A.

Table 5. Average Annual PCE and TCE Concentrations (ug/L) for Wells that Exceed the MTCA Method A Cleanup Level for Groundwater of 5 ug/L.

Year	MW-20B		MW-16A	H1/H2	LPMW-2
	PCE	TCE	PCE	PCE	PCE
1991	657	12	19	---	---
1992	640	14	8	---	---
1993	443	12	28	---	---
1994	279	8.6	21	---	---
1995	340[a]	8.4[a]	27[a]	9[a]	---
1996	370	7	45	4	---
1997	297	4	50	13	---
1998	515	8	33	10	---
1999	715	7	22[a]	3	---
2000	416	6	31	9	---
2001	489	7	28	9	---
2002	309	8.5	34	9	---
2003	234	5.4	42	6.4	---
2004	293	6.6	39	5.3	---
2005	484	6.5	62	10.2	---
2006	367	4.9	77	6.1	9.9[a]
2007	348	6	54	4.5	4.8[a]
2008	201	5	43	7.4	2.5[a]
2009	205	4.4	48	6.8[a]	7.6
2010	325	4.8	73	4.3[a]	4.7

--: Not tested.
a: Single annual result.

Figures 3 and 4 show the average annual PCE concentrations for MW-20B and MW-16A from 1985 through 2010. PCE concentrations in both wells have varied substantially.

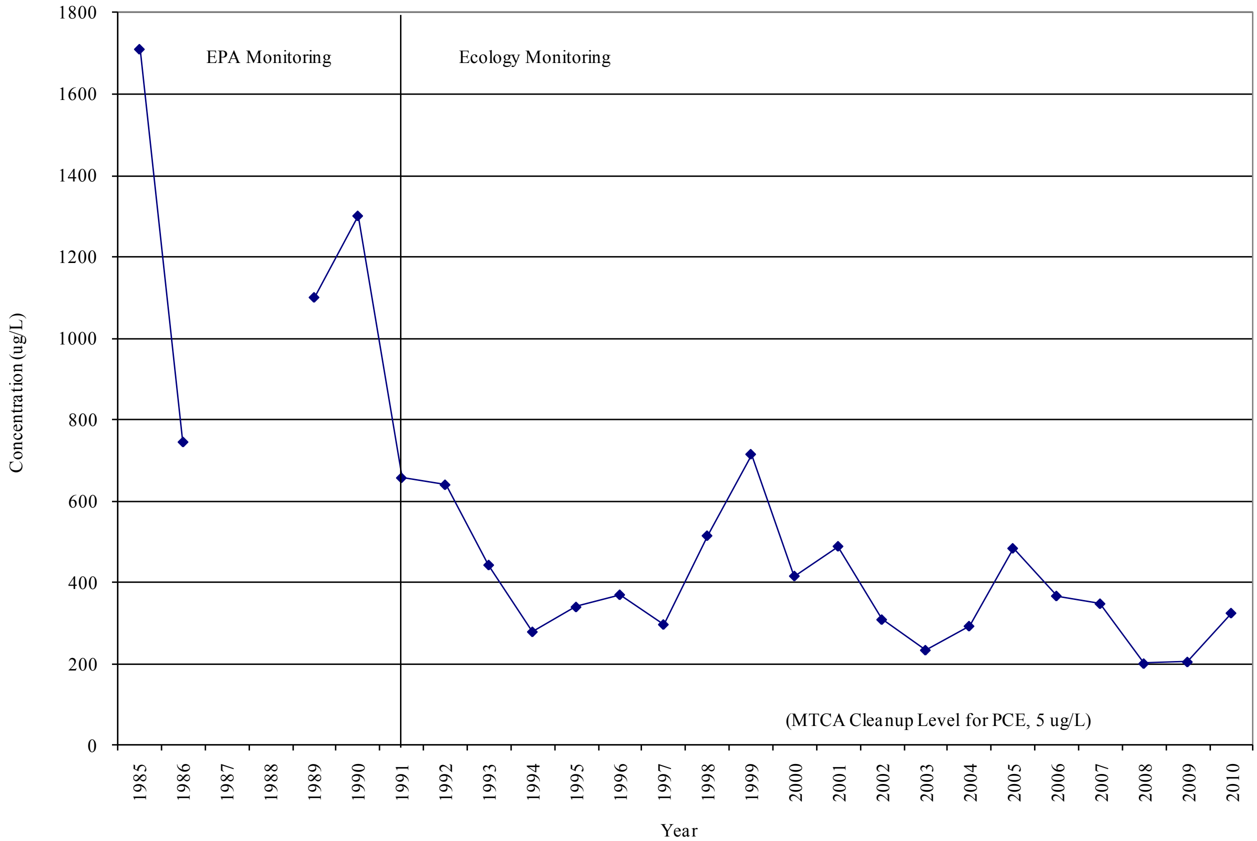

Figure 3. Average Annual PCE Concentrations for Well MW-20B, 1985 through 2010.

PCE concentrations decreased in well MW-20B during the 1980s with the implementation of remedial activities. In 1991, Ecology began semi-annual, long-term groundwater monitoring at the site. Although PCE concentrations have varied, primarily due to seasonal fluctuations, the overall trend indicates that concentrations in well MW-20B are decreasing (Figure A1). The average annual PCE concentration in 1991 was 657 ug/L, and in 2010 it was 325 ug/L.

PCE concentrations also initially decreased in well MW-16A. As with well MW-20B, concentrations have varied over the monitoring period. However, the overall trend indicates that PCE concentrations in well MW-16A are increasing (Figure A2). The average annual PCE concentration in 1991 was 19 ug/L, and in 2010 it was 73 ug/L.

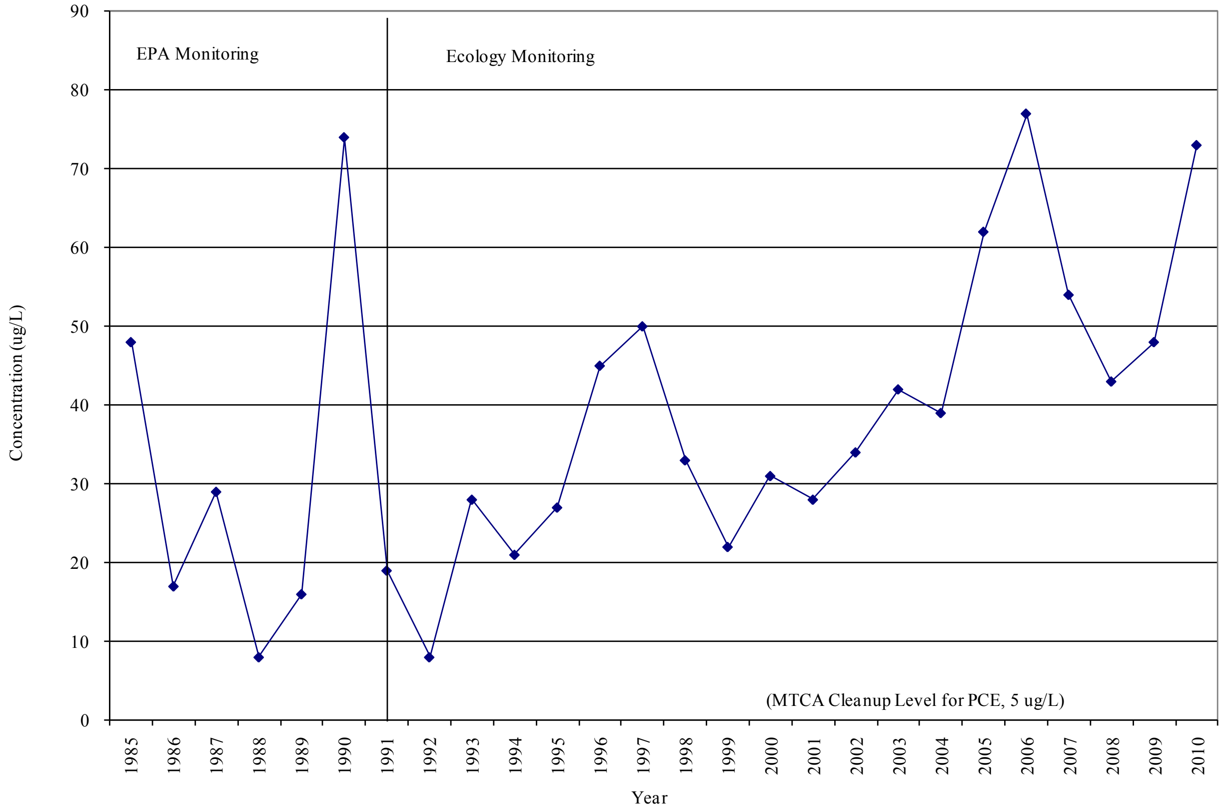

Figure 4. Average Annual PCE Concentrations for Well MW-16A, 1985 through 2010.

As shown in Figures 3 and 4, PCE concentrations continue to exceed the MTCA cleanup level of 5 ug/L in monitoring wells MW-20B and MW-16A. In addition, contaminant concentrations in well MW-16A appear to be gradually increasing over time.

Samples collected from municipal wells H1 and H2 prior to treatment continue to have PCE concentrations near the MTCA cleanup level (Table 5).

PCE also continues to be detected near the MTCA cleanup level of 5 ug/L in well LPMW-2. This well is located near the former septic system of Plaza Cleaners which was identified as a source of the contamination.

Compliance with the groundwater cleanup goals have not been met for this project. Site specific cleanup levels were established in 1992 in an Explanation of Significant Difference at 5 ug/L for PCE and TCE, and 70 ug/L for cis-1,2-DCE (EPA, 1992). Compliance with these cleanup goals is required throughout the contaminated groundwater plume in order to consider the site remediated. Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals.

Conclusions

Ecology conducted groundwater monitoring in June 2010 at 8 monitoring wells and 1 municipal well, and in October 2010 at 4 monitoring wells, to evaluate volatile organics in groundwater at the former Lakewood Plaza Cleaners site.

- Monitoring wells MW-20B and MW-16A continue to have PCE concentrations that do not meet the MTCA cleanup level of 5 ug/L.
- Samples collected from municipal wells H1 and H2 prior to treatment continue to have PCE concentrations near the MTCA cleanup level.
- PCE concentrations in well LPMW-2 continue to be detected near the cleanup level of 5 ug/L.

Concentrations of PCE have decreased from their 1980s levels, but still do not meet the project cleanup goals of 5 ug/L. Since Ecology began sampling in 1991, PCE concentrations have varied, but overall trends indicate that concentrations in well MW-20B are decreasing while concentrations in well MW-16A are increasing. The average annual PCE concentration in well MW-20B in 1991 was 657 ug/L, decreasing to 325 ug/L in 2010. The average annual PCE concentration in well MW-16A in 1991 was 19 ug/L, increasing to 73 ug/L in 2010.

The use of municipal wells H1 and H2 to contain, remove, and treat contaminated groundwater associated with the Lakewood Plaza Cleaners site continues since the cleanup goals have not yet been achieved. Project data indicates that it will take much longer than the projected timeframe to meet the cleanup goals. EPA has recommended that if cleanup goals throughout the contaminant plume are not achieved in a reasonable timeframe, then the pump and treat system should be evaluated to determine if it is adequate to meet the cleanup goals. If it is not, then EPA and Ecology need to determine what additional actions are needed for this site to meet the cleanup goals. (EPA, 2007).

References

References Cited

Ecology, 2008. Manchester Environmental Laboratory - Lab Users Manual. 9th edition. Washington State Department of Ecology, Manchester, WA.

EPA, 1983. Report of the Groundwater Investigation – Lakewood, Washington, October 1981 to February 1983. U.S. Environmental Protection Agency.

EPA, 1985. Final Draft Remedial Investigation Report – Ponders Corner, Washington. U.S. Environmental Protection Agency. EPA 112-0L22.

EPA, 1992. EPA Superfund Explanation of Significant Differences: Lakewood EPA ID: WAD050075662 OU 01 Lakewood, WA 9/15/1992. EPA/ESD/R10-92/500.

EPA, 1996a. Fact Sheet: Notice of Intent to Delete - September 27, 1996 Federal Register. EPA announcement in the Federal Register the partial deletion of the Lakewood site "Soil Unit" from the NPL.

EPA, 1996b. Test Methods for Evaluating Solid Waste, SW-846. Office of Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

EPA, 2001a. Method 150.1, Determination of pH. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.

EPA, 2001b. Method 120.1, Determination of Conductivity. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.

EPA, 2007. Five-Year Review Report. Fourth Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, Pierce County, WA – September 2007. U.S. Environmental Protection Agency.

Marti, Pamela, 2009. Standard Operating Procedure for Manual Well-Depth and Depth-to-Water Measurements. Washington State Department of Ecology, Olympia, WA. SOP Number EAP052, Version 1.0. www.ecy.wa.gov/programs/eap/quality.html.

Previous Studies at the Lakewood Plaza Cleaners Site and Other References

CH2M HILL, 1990a. Sampling and Analysis Plan Remedial Action - Lakewood.

CH2M HILL, 1990b. Technical Memorandum from Lisa Dally Wilson to Ann Williamson RE: Groundwater Sampling at Lakewood (April 1990). Project No. SEA69018RA.FQ.

Ecology, 2002. Five-Year Review Report. Third Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, WA – October 2002. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

EPA, 1992. Lakewood/Ponders Corner Superfund Site - Five Year Review Report. U.S. Environmental Protection Agency.

EPA, 1997. Lakewood/Ponders Corner Superfund Site - Five Year Review Report. U.S. Environmental Protection Agency.

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round I - January 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e34. www.ecy.wa.gov/biblio/91e34.html

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round II - June 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e35. www.ecy.wa.gov/biblio/91e35.html

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round III - November 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e43. www.ecy.wa.gov/biblio/92e43.html

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round IV - June 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e44. www.ecy.wa.gov/biblio/92e44.html

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round V - December 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e38. www.ecy.wa.gov/biblio/93e38.html

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round VI - June 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e39. www.ecy.wa.gov/biblio/93e39.html

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VII - December 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 94-131. www.ecy.wa.gov/biblio/94131.html

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VIII - April 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 94-198. www.ecy.wa.gov/biblio/94198.html

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring Round IX - November 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 95-340. www.ecy.wa.gov/biblio/95340.html

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring - July 11, 12 & 14, 1995. Washington State Department of Ecology, Olympia, WA. Publication No. 95-359. www.ecy.wa.gov/biblio/95359.html

Marti, P., 1996. Lakewood/Plaza Cleaners Monitoring - January 17-18, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 96-317. www.ecy.wa.gov/biblio/96317.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 31, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 97-312. www.ecy.wa.gov/biblio/97312.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - January 9, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-324a. www.ecy.wa.gov/biblio/97324a.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 23-24, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-339. www.ecy.wa.gov/biblio/97339.html

Marti, P., 1998. Lakewood/Plaza Cleaners Monitoring - February 2, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 98-325. www.ecy.wa.gov/biblio/98325.html

Marti, P., 1999. Lakewood/Plaza Cleaners Monitoring - July 15, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 99-312. www.ecy.wa.gov/biblio/99312.html

Marti, P., 1999. Lakewood/Plaza Cleaners Long-term Monitoring, January and August, 1999. Washington State Department of Ecology, Olympia, WA. Publication No. 99-344. www.ecy.wa.gov/biblio/99344.html

Marti, P., 2000. Lakewood/Plaza Cleaners, January and August 2000 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 00-03-046. www.ecy.wa.gov/biblio/0003046.html

Marti, P., 2001. Lakewood/Plaza Cleaners, January and August 2001 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 01-03-032. www.ecy.wa.gov/biblio/0103032.html

Marti, P., 2002. Lakewood Plaza Cleaners, February and August 2002 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-007. www.ecy.wa.gov/biblio/0303007.html

Marti, P., 2003. Lakewood Plaza Cleaners, February and October 2003 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-050. www.ecy.wa.gov/biblio/0303050.html

Marti, P., 2004. Lakewood Plaza Cleaners, June and November 2004 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-054. www.ecy.wa.gov/biblio/0403054.html

Marti, P., 2005. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html

Marti, P., 2006. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html

Marti, P., 2007. Lakewood Plaza Cleaners, May and September 2006 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 07-03-013. www.ecy.wa.gov/biblio/0703013.html

Marti, P., 2008. Lakewood Plaza Cleaners, June and October 2007 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 08-03-010. www.ecy.wa.gov/biblio/0803010.html

Marti, P., 2009. Lakewood Plaza Cleaners Groundwater Monitoring Results, May and October 2008. Washington State Department of Ecology, Olympia, WA. Publication No. 09-03-012. www.ecy.wa.gov/biblio/0903012.html

Marti, P., 2010. Lakewood Plaza Cleaners Groundwater Monitoring Results, June and November 2009. Washington State Department of Ecology, Olympia, WA. Publication No. 10-03-010. www.ecy.wa.gov/biblio/1003010.html

Appendices

Appendix A. Summary of Results

Table A-1. Summary of Sample Results (ug/L), January 1991 to October 2010.

Well	January 1991			May 1991			November 1991			May 1992			December 1992		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**28**	**1 J**	**2.4 J**	**26**	**0.6 J**	**2**	**2.7 J**	1 U	**0.6 J**	**7**	1 U	**1**	**9 J**	**0.3 J**	**0.8 J**
MW-20A	1 U	1 U	1 U	**0.4 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.5 J**	1 U	1 U	**0.8 J**	1 UJ	1 UJ
MW-20B	**1100 D**	**18**	**33**	**752**	**16**	**30**	**120**	**2.6 J**	**6.7**	**940**	**13**	**32**	**340 J**	**14 J**	**20 J**
MW-21	**2.1 J**	1 U	**1 J**	**2**	1 U	**0.7 J**	**2.2 J**	1 U	**1.0 J**	**2**	1 U	**0.6 J**	**2**	**0.2 J**	**0.3 J**
MW-27	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 UJ	1 UJ	1 UJ
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-31	**1 J**	1 U	**1.9 J**	**0.6 J**	1 U	**2**	**0.9 J**	1 U	**2.2 J**	**0.8 J**	1 U	**1**	**0.5 J**	1 UJ	**0.9 J**
MW-32	**1 J**	1 U	**1.1 J**	**1**	1 U	**2**	**0.6 J**	1 U	**0.6 J**	**0.7 J**	1 U	**1**	**0.7 J**	1 UJ	**0.5 J**
MW-41	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 UJ	1 UJ	1 UJ
MW-19A	--	--	--	--	--	--	1 U	**0.5 J**	1 U	--	--	--	1 UJ	1 UJ	1 UJ
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-40	1 U	1 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--	1 UJ	1 UJ	1 UJ
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well	May 1993			December 1993			April 1994			November 1994			July 1995		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**44**	10 U	**2 J**	**13**	**0.3 J**	**0.7 J**	**33**	**0.6**	**1.4**	**9.7**	**0.3 J**	**0.5 J**	**27**	**0.5 J**	**0.8 J**
MW-20A	10 U	10 U	10 U	**0.3 J**	1 U	1 U	**0.4**	0.2 U	0.2 U	**0.3 J**	1 U	1 U	**0.4 J**	1 U	1 U
MW-20B	**700 D**	**12**	**21**	**187**	50 U	**8.2 J**	**472**	**8.6 J**	**12.6**	**86**	50 U	**3 J**	**340 D**	**8.4**	**17**
MW-21	**1 J**	10 U	10 U	**1.6**	1 U	**0.4 J**	**1.5**	**0.2 J**	**0.3**	**1.8**	**0.2 J**	**0.3 J**	--	--	--
MW-27	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-31	10 U	10 U	10 U	**0.8 J**	1 U	**1.2 J**	**0.7**	0.2 U	**1.0**	**0.8 J**	1 U	**1**	**0.6 J**	1 U	**0.5 J**
MW-32	10 U	10 U	10 U	**0.7 J**	1 U	**0.6 J**	**0.7**	0.2 U	**0.6**	**0.6 J**	1 U	**0.5 J**	**0.7 J**	1 U	**0.5 J**
MW-41	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-19A	--	--	--	1 U	**0.4**	1 U	0.2 U	**0.5**	0.2 U	--	--	--	1 U	**0.4 J**	1 U
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	--	--	--	1 U	1 U	1 U
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	**9**	**0.3 J**	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2010.

Well Number	January 1996			July 1996			January 1997			July 1997			February 1998		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**47 E**	**0.8 J**	**1.5**	**43**	**0.7 J**	**1.9**	**54**	**1.1**	**3.1**	**47**	**0.7 J**	**2.5**	**36**	**0.7 J**	**2 J**
MW-20A	**0.2 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.3 J**	1 U	2 U	**0.4 J**	1 U	1 U
MW-20B	**353**	**7.2**	**15**	**387**	**7.6**	**15**	**373**	100 U	**6.4 J**	**222**	**4**	**6.4**	**456**	**7 J**	**12**
MW-21	--	--	--	Well Decommissioned											
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
MW-28A	1 U	1 U	1 U	Well Decommissioned											
MW-31	**0.6 J**	1 U	**0.7 J**	--	--	--	--	--	--	**0.9 J**	1 U	**0.9 J**	--	--	--
MW-32	**0.8 J**	1 U	**0.6 J**	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	--	--	--	1 U	**0.3 J**	2 U	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--	1 U	1 U	2 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	**8.4**	**0.2 J**	**0.2 J**	**0.1 J**	1 U	1 U	**18**	**0.4 J**	**0.4 J**	**8.8**	**0.3 J**	**0.6 J**	**11**	**0.4 J**	**0.3 J**

Well Number	July 1998			January 1999			August 1999			January 2000			August 2000		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**30**	1 U	**1.5 J**	--	--	--	**22**	**0.4 J**	**1.1**	**40**	**0.7 J**	**1.9**	**22**	**0.3 J**	**0.7**
MW-20A	**0.6 J**	1 U	1 U	1 U	2 U	1 U	**0.8 J**	2 U	1 U	**0.2 J**	2 U	1 U	**0.1 J**	2 U	1 U
MW-20B	**575 D**	**10**	**23**	**708**	**5.2**	**12**	**722**	**8.4 J**	**16 J**	**184**	**6**	**13**	**648**	200 U	100 U
MW-27	**0.05 J**	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U
MW-31	--	--	--	--	--	--	**0.9 J**	2 U	**0.4 J**	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	**0.8 J**	2 U	1 U
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
MW-19A	--	--	--	--	--	--	1 U	**0.4 J**	1 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	1 U	2 U	1 U	--	--	--	1 U	2 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
H1/H2	**10**	1 U	**0.1 J**	**1.5**	1 U	1 U	**5.2**	**0.2 J**	1 U	**10**	1 U	1 U	**8.7**	**0.03 J**	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2010.

Well	January 2001			August 2001			February 2002			August 2002			February 2003		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	31	0.4 J	1	25	0.3 J	0.7 J	47	0.8 J	2.3	22	0.3 J	0.8 J	59 J	0.2 J	2.4
MW-20A	0.2 J	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U
MW-20B	493	6.6 J	12	486	8.2	18	248	200 U	100 U	371	8.5	16	230	100 U	100 U
MW-27	1 U	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	0.4 J	2 U	0.3 J	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	1 U	0.3 J	1 U	--	--	--	--	--	--	--	--	--
MW-33	--	--	--	1 U	2 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	11	0.2 J	1 U	6.8	0.2 J	1 U	12	0.2 J	0.2 J	6.1	1 U	1 U	1.3	1 U	1 U

Well	September 2003			June 2004			November 2004			June 2005			November 2005		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	26	0.3 J	0.5 J	30	0.4 J	0.8 J	48	1 U	1.4	80	1.3	2.8	43	0.7 J	1.0 J
MW-20A	0.1 J	1 U	1 U	0.2 J	1 U	1 U	0.3 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-20B	239	5.4 J	12	344	6.5 J	15	241	6.7	13	413	6.6	12	555	6.4	11
MW-27	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
MW-31	0.5 J	1 U	0.1 NJ	--	--	--	--	--	--	0.5 J	1 U	1 U	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	1.4	1 U	1 U	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-19A	1 U	0.4 NJ	1 U	--	--	--	--	--	--	1 U	0.6 J	1 U	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
H1/H2	6.4	0.2 NJ	1 U	7.9	0.2 J	0.1 J	2.6	1 U	1 U	14	0.3 J	1 U	6.4	1 U	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2010.

Well Number	May 2006			September 2006			June 2007			October 2007			May 2008		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**124**	**1.8**	**4.6**	**29**	**0.3 J**	**0.48 J**	**83**	**1.2**	**2.5**	**24**	1 U	**0.64 J**	**55**	**1.2**	**2.8**
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**216**	**4.2**	**6.6**	**518**	**5.6**	**11**	**204**	**4.4**	**7.8**	**491**	**7.5**	**15**	**143**	**5.5**	**12**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	--	--	--	**1.6 J**	2 U	2 U	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	2 U	**1.2 J**	2 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	2 U	2 U	2 U	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LPMW-2	**9.9**	1 U	1 U	--	--	--	**4.8**	1 U	1 U	--	--	--	**2.5**	1 U	1 U
LPMW-3	1 U	1 U	1 U	--	--	--	2 U	1 U	1 U	--	--	--	--	--	--
H1/H2	**7.3**	**0.2 J**	1 U	**4.8**	1 U	1 U	**5.2**	2 U	2 U	**3.8**	1 U	1 U	**9.6**	1 U	1 U

Well Number	October 2008			June 2009			November 2009			June 2010			October 2010		
	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.45 J**	**0.6 J**	**67**	**0.94 J**	**2.2**	**28**	**0.52 J**	**0.83 J**	**85**	**1.3**	**1.6**	**61**	**0.86 J**	**1.2**
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	**0.64 J**	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U
MW-20B	**258**	**4.5**	**9**	**160**	**4.1**	**7.4**	**250**	**4.7**	**9.6**	**130**	**3.7**	**6.3**	**520**	**5.8**	**10**
MW-27	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-31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	**1.8**	1 U	1 U	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-19A	--	--	--	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LPMW-2	--	--	--	**4.1**	1 U	1 U	**11**	1 U	1 U	**4.4**	1 U	1 U	**5**	1 U	1 U
H1/H2	**5.1**	1 U	1 U	**6.8**	1 U	1 U	--	--	--	**4.3**	1 U	1 U	--	--	--

U = The analyte was not detected at or above the reported result.
J = The analyte was positively identified. The associated numerical result is an estimate.
UJ = The analyte was not detected at or above the reported estimated result.
D = Analysis performed at secondary dilution.
E = The concentration of the associated value exceeds the known calibration range.
-- = Not tested
Bold = The analyte was positively identified.

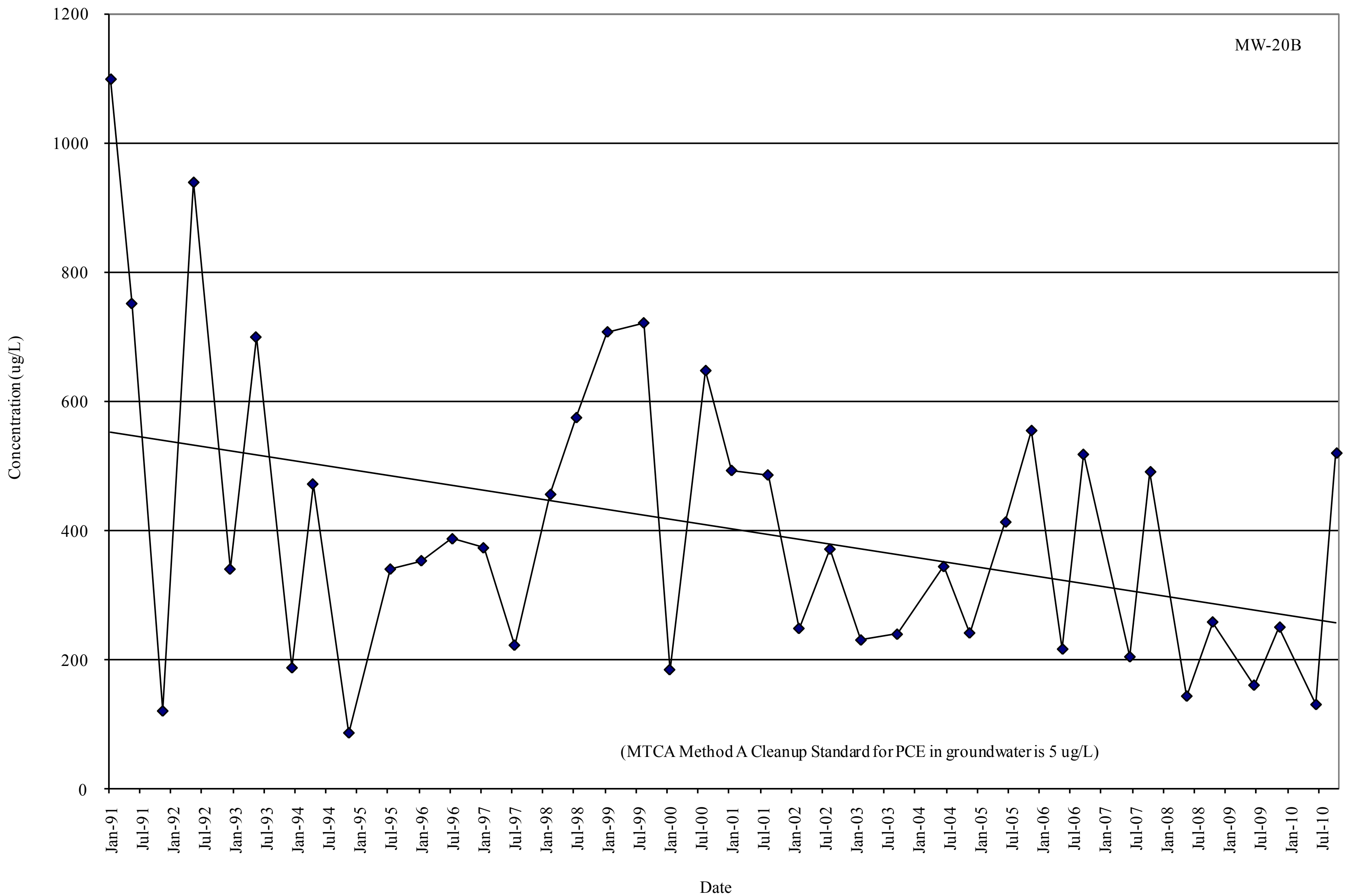

Figure A-1. PCE Concentrations for Well MW-20B, January 1991 to October 2010.

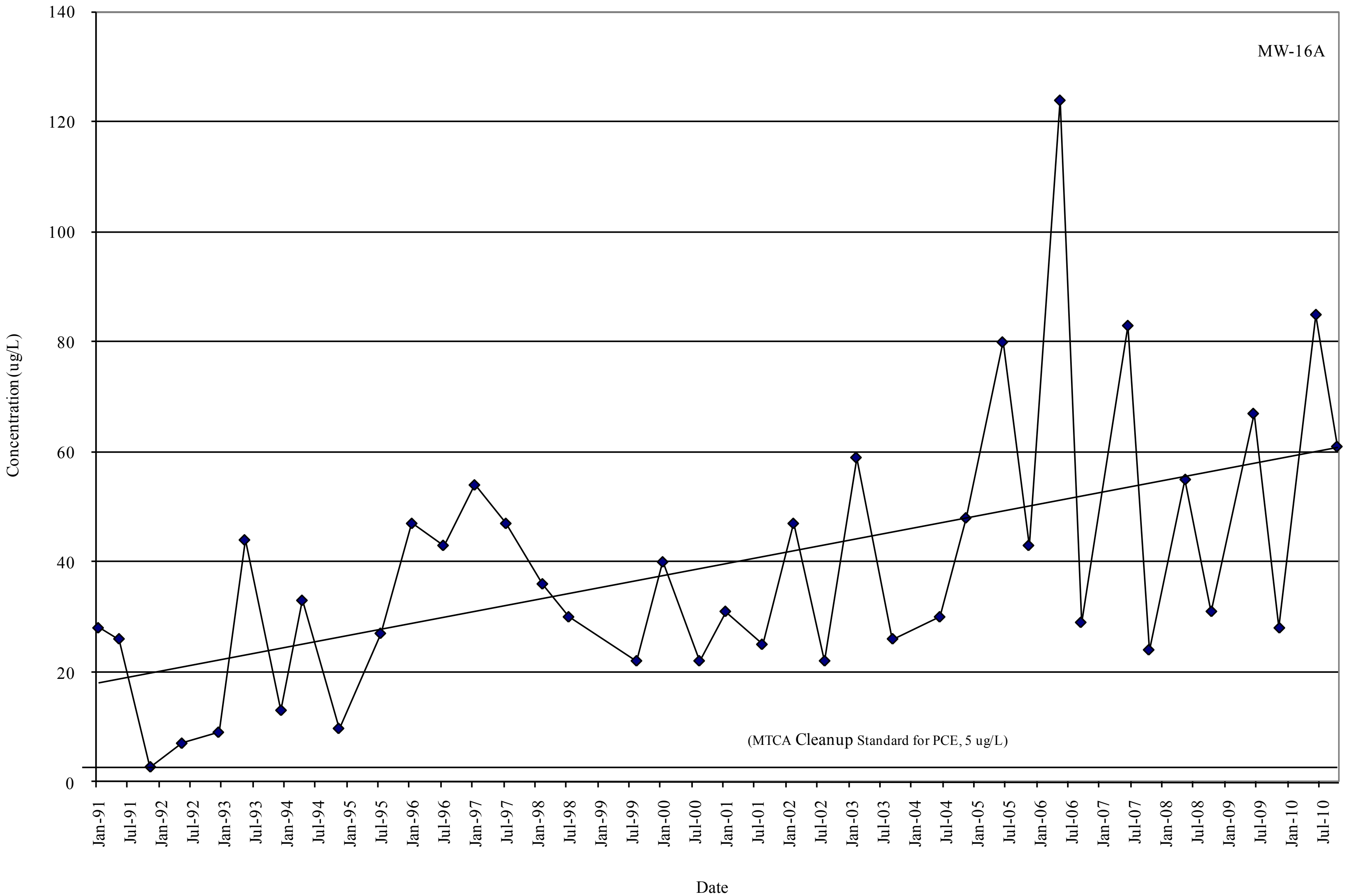

Figure A-2. PCE Concentrations for Well MW-16A, January 1991 to October 2010.

Appendix B. Glossary, Acronyms, and Abbreviations

Glossary

Aquifer: An underground geological formation, or group of formations, containing water.

Aquitard: Geologic formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients. May function as a confining bed.

Depth-to-water: A measure of depth to the water (i.e., water level) in a well.

Groundwater: Water in the subsurface that saturates the rocks and sediment in which it occurs. The upper surface of groundwater saturation is commonly termed the water table.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Purge water: Water removed from the sampling zone in a well prior to sample collection.

Specific conductance: A measure of water's ability to conduct an electrical current. Specific conductance is related to the concentration and charge of dissolved ions in water.

Volatile organics: Organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the earth's atmosphere.

Acronyms and Abbreviations

Cis-1,2-DCE	Cis-1,2-dichloroethene
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	Environmental Protection Agency
MTCA	Model Toxic Control Act
PCE	Tetrachloroethene
PVC	Polyvinyl chloride
RPD	Relative Percent Difference
TCE	Trichloroethene
VOA	Volatile Organics Analysis
WAC	Washington Administrative Code

Units of Measurement

°C	degrees centigrade
ug/L	micrograms per liter (parts per billion)
umhos/cm	micromhos per centimeter

DEPARTMENT OF ECOLOGY
State of Washington

Lakewood Plaza Cleaners Groundwater Monitoring Results

June and October 2011

January 2012

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Lakewood Plaza Cleaners, Groundwater Monitoring Results

June and October 2011

by
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Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

Waterbody Number: WA-12-1115

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Abstract

This progress report is one in a series describing results of long-term groundwater monitoring at the former Lakewood Plaza Cleaners site south of Tacoma. The Washington State Department of Ecology (Ecology) began collecting groundwater data at the site in the early 1990s as part of its official responsibilities for operation and maintenance of the remedial actions. The goal was to evaluate the effectiveness of municipal wells H1 and H2 to contain and remove the contaminated groundwater.

This report discusses volatile organic results of samples collected from project monitoring wells and a Lakewood Water District municipal well in June and October 2011.

Tetrachloroethene (PCE) concentrations continue to not meet (exceed) the MTCA cleanup level of 5 ug/L in monitoring wells MW-20B (200 and 720 ug/L) and MW-16A (100 and 57 ug/L). Since Ecology began sampling, PCE concentrations have varied, but overall trends indicate that concentrations in well MW-20B are decreasing while concentrations in well MW-16A are increasing. The average annual PCE concentration in well MW-20B in 1991 was 657 ug/L, decreasing to 460 ug/L in 2011. The average annual PCE concentration in well MW-16A in 1991 was 19 ug/L, increasing to 79 ug/L in 2011.

Samples collected from municipal well H1 prior to treatment continue to have PCE concentrations near the MTCA cleanup level.

PCE was also detected in well LPMW-2 in June (3.2 ug/L). This well is near the former septic system of Lakewood Plaza Cleaners which was identified as a source of the contamination.

The use of municipal wells H1 and H2 to treat contaminated groundwater associated with the Lakewood Plaza Cleaners site continues since the cleanup goals have not been achieved. Early groundwater monitoring results projected that compliance with cleanup goals would be achieved throughout the contaminated plume by the mid-1990s. Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals.

Introduction

In 1981, the U.S. Environmental Protection Agency (EPA) confirmed that the Lakewood Water District production wells H1 and H2 were contaminated with tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE). Lakewood is south of Tacoma in Pierce County. The source of the contamination was identified as the former Lakewood Plaza Cleaners (EPA, 1983). Contamination had resulted from the dumping of PCE into on-site septic tanks and the disposal of sludge on the ground surface. The Lakewood Plaza Cleaners site was added to the National Priorities List (NPL) in 1982.

Remedial activities at the site began in 1983. They included the operation of wells H1 and H2 to pump and treat contaminated groundwater, the removal of contaminated soils and sludge from the source area, and treatment of a small portion of the contaminated septic field soils with vapor extraction. Soil remediation was completed in 1993. The soils unit of the site was removed from the NPL in 1996 (EPA, 1996a). Treatment of the contaminated groundwater with wells H1 and H2 continued. Early groundwater monitoring results projected that compliance with cleanup goals of 5 ug/L for PCE and TCE, and 70 ug/L for cis-1,2-DCE would be achieved throughout the contaminated plume by the mid-1990s.

Although the Washington State Department of Ecology's (Ecology) official responsibilities for operation and maintenance of the remedial actions did not begin until 1994, Ecology began semi-annual groundwater compliance monitoring at the site in 1991. The objective of the sampling was to collect groundwater quality data to evaluate the effectiveness of Lakewood water supply wells H1 and H2 to contain, remove, and treat the groundwater contaminated by Plaza Cleaners.

In accordance with EPA policy and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA § 121(42 U.S.C. Section 9621) and the National Contingency Plan (NCP), five-year reviews of the project are also required as long as cleanup goals have not been achieved. Four 5-year reviews have been completed: in 1992, 1997, 2002, and 2007. During the 5-year reviews the monitoring program is evaluated. Groundwater monitoring has been modified over the years to focus primarily on wells in the immediate vicinity of the former Plaza Cleaners. Currently there are 14 monitoring wells and the two production wells (H1 and H2) being monitored.

Remediation and monitoring of the groundwater is ongoing under a long-term response action as cleanup goals have not yet been achieved (EPA, 2007). Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals. EPA has recommended that if cleanup goals throughout the contaminant plume are not achieved in a reasonable time-frame, then the pump and treat system should be evaluated to determine if it is adequate to meet the cleanup goals. If it is not, then EPA and Ecology need to determine what additional actions are needed for this site to meet the cleanup goals (EPA, 2007).

Methods

Groundwater Monitoring

Ecology collected groundwater samples in June and October 2011 from two shallow and eight deep wells (Figure 1). The two shallow wells are screened in the Steilacoom Gravel (LPMW-2) and the Vashon Till (MW-20B) and are located near the source area. The Steilacoom Gravel generally contains areas of perched water above the Vashon Till and the regional water table. The Vashon Till is typically a very low permeable layer which forms an aquitard of unsaturated and saturated sediment separating the Steilacoom Gravel above and the Advance Outwash below. Well MW-20B is the only well screened in the Vashon Till where contamination had been detected. This well continues to have the highest PCE concentrations. The majority of the monitoring wells and municipal wells H1 and H2 are screened in the Advance Outwash deposits, the primary water-supply aquifer for the area.

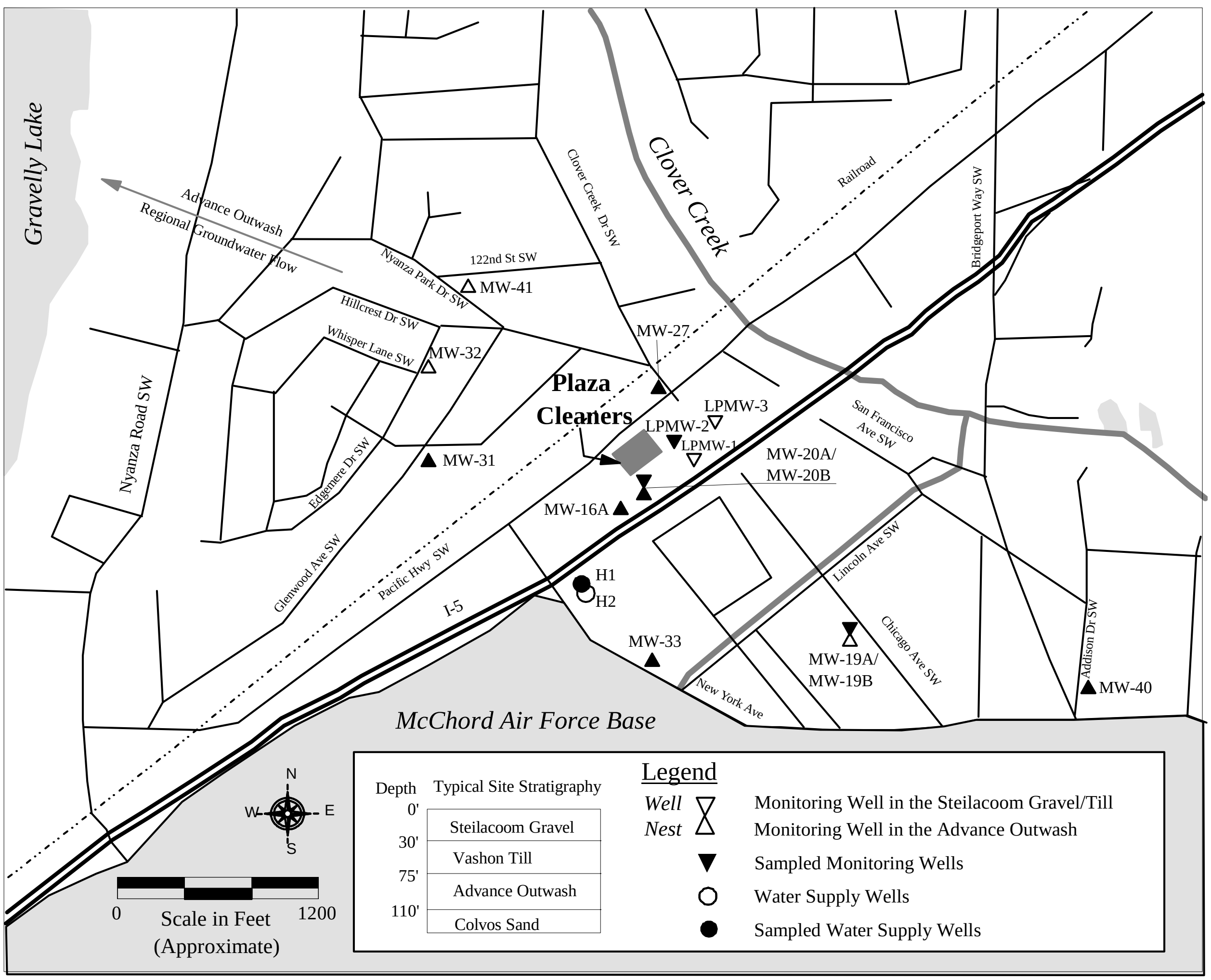

Figure 1. Lakewood Plaza Cleaners Sampling Locations.

During 2011 the following wells were sampled: LPMW-2, MW-20B, MW-16A, MW-19A, MW-20A, MW-27, MW-31, MW-33, MW-40, and municipal well H1. Samples were submitted for analysis of volatile organic compounds (VOCs) to monitor PCE concentrations.

Ecology measured static water levels in all wells prior to well purging and sampling. Measurements were collected according to procedures in standard operating procedure (SOP) EAP052 (Marti, 2009).

Monitoring wells MW-16A, MW-19A, MW-20A, and MW-40 were purged and sampled using dedicated bladder pumps.

Wells MW-20B, MW-27, MW-31, MW-33, and LPMW-2 were purged and sampled with a stainless-steel submersible pump with dedicated tubing using low-flow sampling techniques. The submersible pump was decontaminated between wells by circulating laboratory-grade detergent/water through the pump followed by a clean water rinse, with each cycle lasting five minutes.

The monitoring wells were purged until pH, specific conductance, dissolved oxygen, and temperature readings stabilized. Purge water was collected and stored in 55-gallon drums. The purge water waste was transported and disposed of in accordance with Washington State regulations (Chapter 173-340-400 WAC).

At the completion of purging, samples were collected from the monitoring wells directly from the dedicated pump discharge tubing into laboratory-supplied containers. Municipal well H1 was sampled from the tap nearest the well.

Volatile organics samples were collected free of headspace in three 40-mL glass vials with Teflon-lined septa lids and preserved with 1:1 hydrochloric acid. After labeling, all samples were stored in an ice-filled cooler. Samples were transported to Ecology’s Operations Center in Lacey. Samples were kept in the walk-in cooler until taken by the courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Laboratory protocol (Ecology, 2008).

Analysis

Table 1 lists analytes, analytical methods, and reporting limits for both field and laboratory parameters. Manchester Laboratory analyzed all groundwater samples for volatile organics.

Table 1. Field and Laboratory Methods.

Field Measurements	Instrument Type	Method	Accuracy
Water Level	Solinst Water Level Meter	SOP EAP 052	±0.03 feet
pH	YSI ProPlus with Quatro Cable	EPA 150.1 (EPA, 2001a)	±0.2 standard units
Specific Conductance	YSI ProPlus with Quatro Cable	EPA 120.1 (EPA, 2001b)	±10 umhos/cm
Dissolved Oxygen	YSI ProPlus with Quatro Cable	EPA 360.1 (EPA, 2002)	±0.2 mg/L
Temperature	YSI ProPlus with Quatro Cable	EPA Method 150.1	±0.2 ºC
Laboratory Analytes	**Method**	**Reference**	**Reporting Limit**
Volatile Organics	EPA SW-846 Method 8260B	EPA 1996b	1-5 ug/L

EAP: Environmental Assessment Program, Ecology.

Results

Data Quality Assessment

Quality control samples collected in the field consisted of blind field duplicates obtained from well MW-16A. 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 also by the natural variability of the concentrations in the media (e.g., groundwater) being sampled.

The numeric comparison of duplicate results is expressed as the relative percent difference (RPD). The RPD is calculated as: the difference between sample results, divided by the mean, and expressed as a percent.

Table 2 shows the results of the duplicate samples and their RPD. The RPD for the June and October data ranged from 0% to 10%. The quality of the data for this progress report is good.

Table 2. Relative Percent Difference (RPD) of Duplicate Sample Results (ug/L), June and October 2011.

Well Sample ID	Tetrachloroethylene (PCE)		Trichloroethylene (TCE)		Cis-1,2-Dichloroethylene (cis-DCE)	
	6/11	10/11	6/11	10/11	6/11	10/11
MW-16A	100	57	1.4	0.75 J	1.6	1.0
MW-16B	100	58	1.4	0.79 J	1.6	1.1
RPD[1] (%)	0%	2%	0%	--	0%	10%

MW-16B is the duplicate sample identification.

[1] RPD target ±30%.

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

A review of the data quality control and quality assurance from laboratory case narratives indicates that overall the 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 major problems were reported that compromised the usefulness or validity of the sample results; therefore, all results are usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

Field Results

Depth-to-water measurements, as well as pH, specific conductance, dissolved oxygen, and temperature readings, at the time of sampling are listed in Table 3.

Table 3. Summary of Field Parameter Results, June and October, 2011.

Well	Total Depth (feet)[1]	Depth to Water (feet)[1]	pH (standard units)	Specific Conductance (umhos/cm)	Dissolved Oxygen (mg/L)	Temperature (°C)
June 2011						
MW-16A	109	32.93	7.1	217	6.0	12.4
MW-20A	97.3	26.18	7.8	213	4.7	12.3
MW-20B	50.4	23.39	6.6	296	5.3	13.7
MW-27	93	25.58	6.8	181	4.7	13.7
LPMW-2	29	20.07	6.6	140	9.9	13.3
H1	110	++	6.6	198	--	12.3
October 2011						
MW-16A	109	37.76	7.2	222	--	12.1
MW-19A	97.5	38.41	6.8	199	--	11.2
MW-20A	97.3	32.57	7.8	213	--	12.1
MW-20B	50.4	33.18	6.5	300	2.9	14.2
MW-27	93	31.58	6.7	183	5.2	14.3
MW-31	91.2	38.05	6.7	185	6.6	13.2
MW-33	98.4	34.83	6.9	211	6.4	12.5
MW-40	75.1	35.98	7.2	415	--	11.2
H1	110	++	6.8	188	--	10.8

[1] Measured from top of PVC casing.
++ Dedicated pump obstructed water-level measurement.
-- Not Measured.

Most of the sampled wells are screened in the Advance Outwash deposits (MW-16A, MW-19A, MW-20A, MW-27, MW-31, MW-33, MW-40, and H1). Depth to water in the Advance Outwash ranged from 25.58 - 32.93 ft. in June and 31.58 - 38.41 ft. in October. An aquifer stress test conducted in 1981, when municipal wells H1/H2 were shut down, determined that the natural groundwater flow direction in the Advance Outwash is west-northwest toward Gravelly Lake. When in use, these wells create a large cone of depression which influences groundwater flow directions. Previous studies showed that drawdown occurs in shallow monitoring wells drilled in the Steilacoom gravel when H1 and H2 are pumping (EPA, 1985). This indicates possible hydraulic interconnection between the Steilacoom gravel and the Advance Outwash.

Well MW-20B is screened in the Vashon Till. Depth to water was 23.39 ft. in June and 33.18 ft. in October. The Vashon Till forms an aquitard when composed of silt and clay-rich gravels. The Vashon Till also contains thin layers of sandy gravel, one of which appears to be large in lateral extent, covering the area including Plaza Cleaners. This lens is saturated and appears to be hydraulically interconnected with the Steilacoom gravel (EPA, 1985). Well LPMW-2 is screened in the Steilacoom Gravel. Depth to water was 20.07 in June and 26.63 ft. in October.

In October well LPMW-2 did not have sufficient amount water to collect a sample with the submersible pump.

Field parameters (pH, specific conductance, dissolved oxygen, and temperature) were within expected ranges. During the monitoring period pH of the groundwater ranged from 6.5 to 7.8. Specific conductance measurements ranged from 140 to 296 umhos/cm in June and 183 to 415 umhos/cm in October. Generally, the specific conductance in well MW-20B, which is screened in the till unit, is greater than the other wells. Specific conductance readings are typically higher for water from fine-grained units such as the till. Dissolved oxygen measurements in the advanced outwash ranged from 4.7 to 6.6 mg/L, 2.9 to 5.3 mg/L in the Vashon Till, and in June was 9.9 mg/L in the Steilacoom Gravel. Groundwater temperatures over the monitoring period ranged from 10.8º to 14.3 ºC. Temperature measurements are subject to change due to ambient air conditions and therefore are not considered to be representative of in-situ groundwater conditions.

Analytical Results

June and October 2011 analytical results for volatile organics of interest are summarized in Table 4 and presented in Figure 2.

All field measurements and analytical results data are available in electronic format from Ecology's EIM data management system: www.ecy.wa.gov/eim/index.htm. Search study ID LAKEWOOD.

Table 4. Results (ug/L) of Volatile Organics of Interest, June and October, 2011.

Well	Tetrachloroethene (PCE)	Trichloroethene (TCE)	Cis-1,2-Dichloroethene (cis-1,2-DCE)
MTCA Cleanup Level	5 ug/L	5 ug/L	70 ug/L
June 2011			
MW-16A	**100**	**1.4**	**1.6**
MW-20A	1 U	1 U	1 U
MW-20B	**200**	**3.5**	**5.6**
MW-27	1 U	1 U	1 U
LPMW-2	**3.2**	1 U	1 U
H1	**5.9**	1 U	1 U
October 2011			
MW-16A	**57**	**0.75 J**	**1.0**
MW-19A	1 U	**0.42 J**	1 U
MW-20A	1 U	1 U	1 U
MW-20B	**720**	**4.8**	**7.9**
MW-27	1 U	1 U	1 U
MW-31	**0.65 J**	1 U	1 U
MW-33	1 U	1 U	1 U
MW-40	1 U	1 U	1 U
H1	**1.4**	1 U	1 U

Bold: Analyte detected.
U: Analyte was not detected at or above the reported value.
J: Analyte was positively identified. The associated numerical result is an estimate.

Chlorinated solvents continue to be detected in monitoring wells MW-20B, MW-16A, and LPMW-2 as well as in municipal well H1.

PCE also continues to be detected in well MW-31 near the reporting limit of 1 ug/L. Although this well is sampled once every other year, PCE concentrations have remained consistent since Ecology began monitoring in 1991.

Monitoring wells MW-20B and MW-16A, and municipal well H1, continue to have PCE concentrations that exceed the MTCA cleanup level of 5 ug/L.

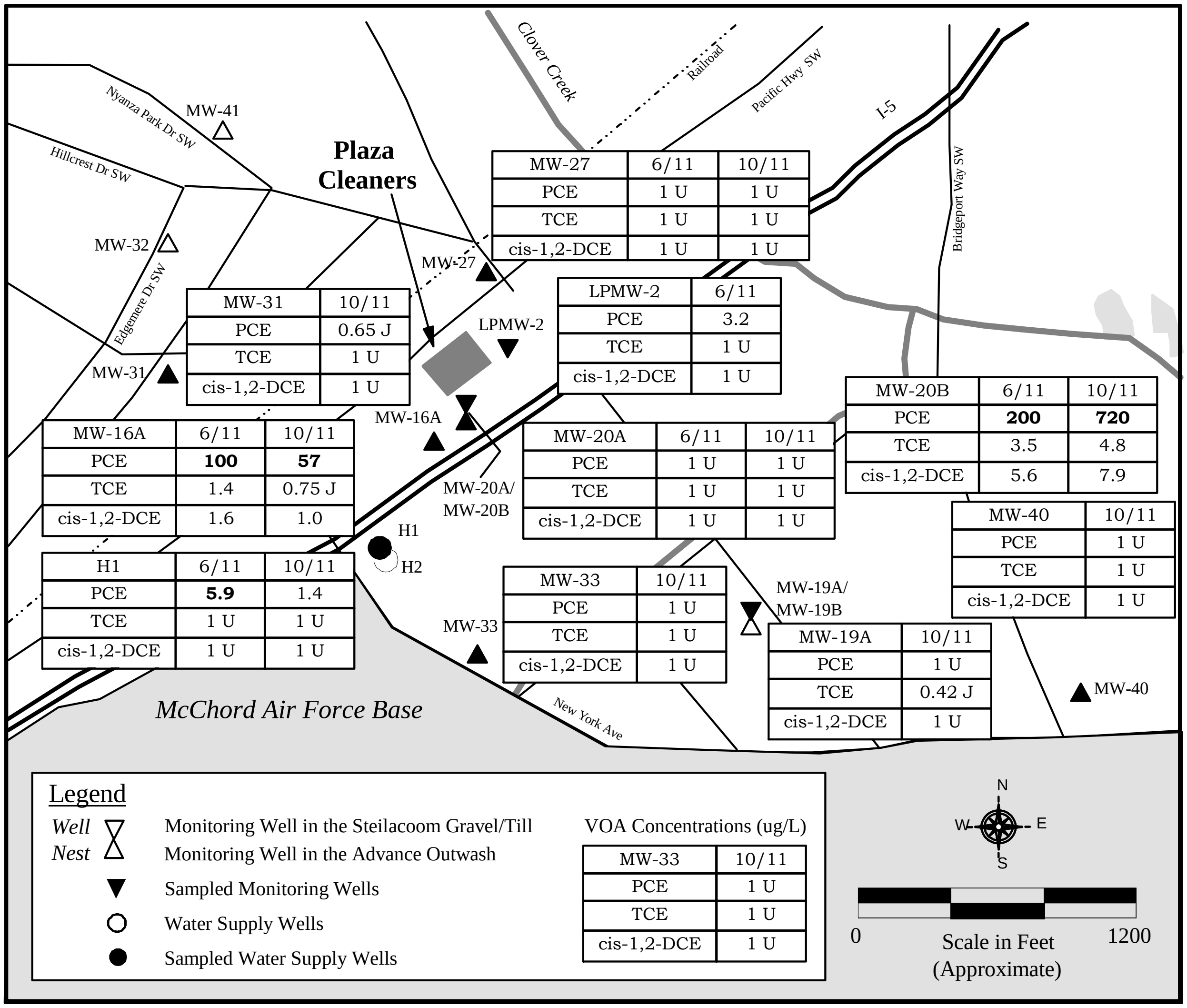

Figure 2. Lakewood Plaza Cleaners PCE, TCE, and Cis-1,2-DCE Concentrations (ug/L), June and October 2011.

Discussion

In 1991, Ecology assumed responsibility for long-term groundwater monitoring of the former Lakewood Plaza Cleaners site with the goal of collecting data to evaluate the effectiveness of municipal wells H1 and H2 to contain and remove the contaminated groundwater.

Table 5 shows average PCE and TCE concentrations for the wells that have consistently had concentrations that exceeded the MTCA cleanup level of 5 ug/L during Ecology's sample period of 1991 to 2011. All PCE, TCE, and cis-1,2-DCE concentrations from January 1991 through October 2011 are presented in Appendix A. PCE concentrations for wells MW-20B and MW-16A for the same time period are also presented as graphs in Appendix A.

Table 5. Average Annual PCE and TCE Concentrations (ug/L) for Wells that Exceed the MTCA Method A Cleanup Level for Groundwater of 5 ug/L.

Year	MW-20B		MW-16A	H1/H2	LPMW-2
	PCE	TCE	PCE	PCE	PCE
1991	657	12	19	---	---
1992	640	14	8	---	---
1993	443	12	28	---	---
1994	279	8.6	21	---	---
1995	340[a]	8.4[a]	27[a]	9[a]	---
1996	370	7	45	4	---
1997	297	4	50	13	---
1998	515	8	33	10	---
1999	715	7	22[a]	3	---
2000	416	6	31	9	---
2001	489	7	28	9	---
2002	309	8.5	34	9	---
2003	234	5.4	42	6.4	---
2004	293	6.6	39	5.3	---
2005	484	6.5	62	10.2	---
2006	367	4.9	77	6.1	9.9[a]
2007	348	6	54	4.5	4.8[a]
2008	201	5	43	7.4	2.5[a]
2009	205	4.4	48	6.8 [a]	7.6
2010	325	4.8	73	4.3 [a]	4.7
2011	460	4.2	79	3.7	3.2 [a]

-- Not tested.
a: Single annual result.

Figures 3 and 4 show the average annual PCE concentrations for MW-20B and MW-16A from 1985 through 2011. PCE concentrations in both wells have varied substantially.

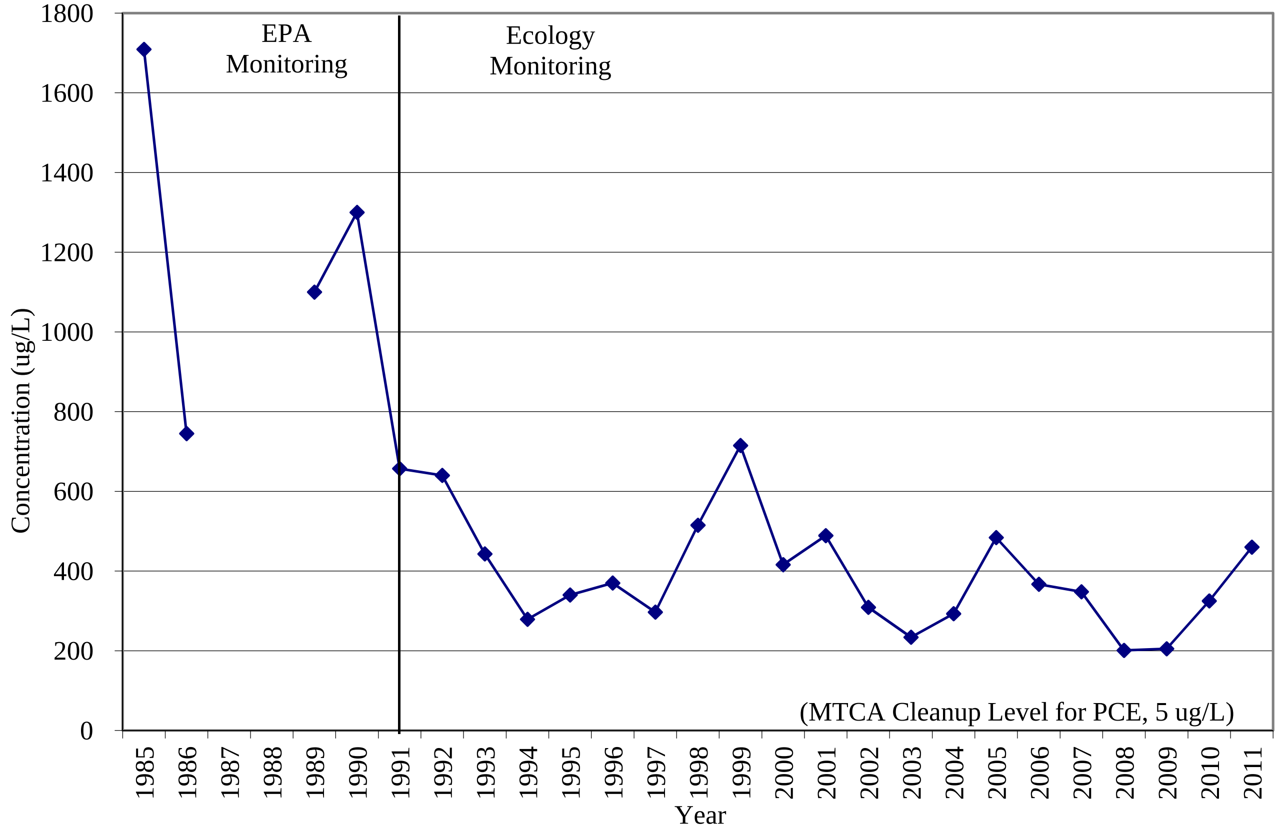

Figure 3. Average Annual PCE Concentrations for Well MW-20B, 1985 through 2011.

PCE concentrations decreased in well MW-20B during the 1980s with the implementation of remedial activities. In 1991, Ecology began semi-annual, long-term groundwater monitoring at the site. Although PCE concentrations have varied, primarily due to seasonal fluctuations, the overall trend indicates that concentrations in well MW-20B are decreasing (Figure A1). The average annual PCE concentration in 1991 was 657 ug/L, and in 2011 it was 460 ug/L.

PCE concentrations also initially decreased in well MW-16A. As with well MW-20B, concentrations have varied over the monitoring period. However, the overall trend indicates that PCE concentrations in well MW-16A are increasing (Figure A2). The average annual PCE concentration in 1991 was 19 ug/L, and in 2011 it was 79 ug/L.

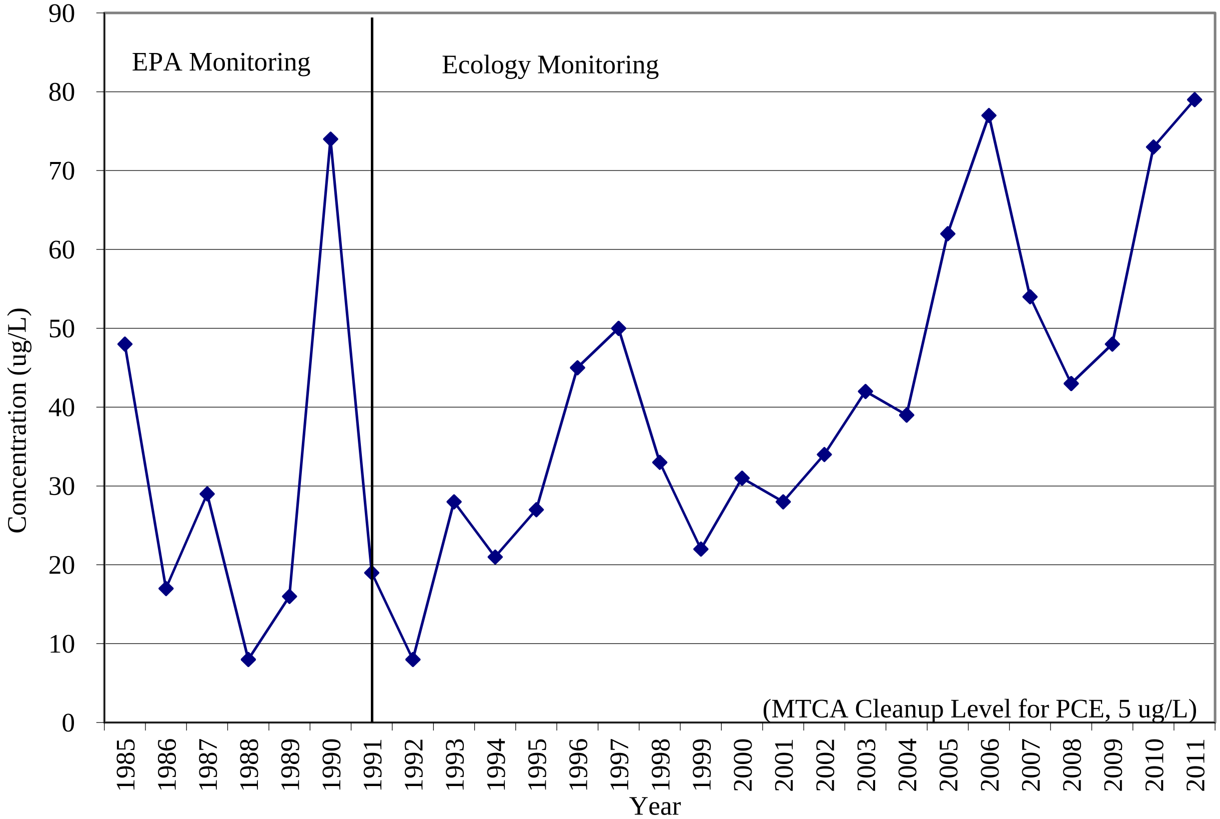

Figure 4. Average Annual PCE Concentrations for Well MW-16A, 1985 through 2011.

As shown in Figures 3 and 4, PCE concentrations continue to exceed the MTCA cleanup level of 5 ug/L in monitoring wells MW-20B and MW-16A. In addition, contaminant concentrations in well MW-16A appear to be gradually increasing over time.

Samples collected from municipal wells H1 and H2 prior to treatment continue to have PCE concentrations near the MTCA cleanup level (Table 5).

PCE also continues to be detected near the MTCA cleanup level of 5 ug/L in well LPMW-2. This well is located near the former septic system of Plaza Cleaners which was identified as a source of the contamination.

Compliance with the groundwater cleanup goals have not been met for this project. Site specific cleanup levels were established in 1992 in an Explanation of Significant Difference at 5 ug/L for PCE and TCE, and 70 ug/L for cis-1,2-DCE (EPA, 1992). Compliance with these cleanup goals is required throughout the contaminated groundwater plume in order to consider the site remediated. Project data indicate that it will take much longer than the projected timeframe to meet the cleanup goals.

Conclusions

Ecology conducted groundwater monitoring in June 2011 at 5 monitoring wells and 1 municipal well, and in October 2011 at 8 monitoring wells and 1 municipal well, to evaluate volatile organics in groundwater at the former Lakewood Plaza Cleaners site.

- Monitoring wells MW-20B and MW-16A continue to have PCE concentrations that do not meet the MTCA cleanup level of 5 ug/L.
- Samples collected from municipal wells H1 and H2 prior to treatment continue to have PCE concentrations near the MTCA cleanup level.
- PCE concentrations in well LPMW-2 continue to be detected near the cleanup level of 5 ug/L.

Concentrations of PCE have decreased from their 1980s levels, but still do not meet the project cleanup goals of 5 ug/L. Since Ecology began sampling in 1991, PCE concentrations have varied, but overall trends indicate that concentrations in well MW-20B are decreasing while concentrations in well MW-16A are increasing. The average annual PCE concentration in well MW-20B in 1991 was 657 ug/L, decreasing to 460 ug/L in 2011. The average annual PCE concentration in well MW-16A in 1991 was 19 ug/L, increasing to 79 ug/L in 2011.

The use of municipal wells H1 and H2 to contain, remove, and treat contaminated groundwater associated with the Lakewood Plaza Cleaners site continues since the cleanup goals have not yet been achieved. Project data indicates that it will take much longer than the projected timeframe to meet the cleanup goals. EPA has recommended that if cleanup goals throughout the contaminant plume are not achieved in a reasonable timeframe, then the pump and treat system should be evaluated to determine if it is adequate to meet the cleanup goals. If it is not, then EPA and Ecology need to determine what additional actions are needed for this site to meet the cleanup goals (EPA, 2007).

References

References Cited

Ecology, 2008. Manchester Environmental Laboratory - Lab Users Manual. 9th edition. Washington State Department of Ecology, Manchester, WA.

EPA, 1983. Report of the Groundwater Investigation – Lakewood, Washington, October 1981 to February 1983. U.S. Environmental Protection Agency.

EPA, 1985. Final Draft Remedial Investigation Report – Ponders Corner, Washington. U.S. Environmental Protection Agency. EPA 112-0L22.

EPA, 1992. EPA Superfund Explanation of Significant Differences: Lakewood EPA ID: WAD050075662 OU 01 Lakewood, WA 9/15/1992. EPA/ESD/R10-92/500.

EPA, 1996a. Fact Sheet: Notice of Intent to Delete - September 27, 1996 Federal Register. EPA announcement in the Federal Register the partial deletion of the Lakewood site "Soil Unit" from the NPL.

EPA, 1996b. Test Methods for Evaluating Solid Waste, SW-846. Office of Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

EPA, 2001a. Method 150.1, Determination of pH. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.

EPA, 2001b. Method 120.1, Determination of Conductivity. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.

EPA, 2007. Five-Year Review Report. Fourth Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, Pierce County, WA – September 2007. U.S. Environmental Protection Agency.

Marti, P., 2009. Standard Operating Procedure for Manual Well-Depth and Depth-to-Water Measurements. Washington State Department of Ecology, Olympia, WA. SOP Number EAP052, Version 1.0. www.ecy.wa.gov/programs/eap/quality.html.

Previous Studies at the Lakewood Plaza Cleaners Site and Other References

CH2M HILL, 1990a. Sampling and Analysis Plan Remedial Action - Lakewood.

CH2M HILL, 1990b. Technical Memorandum from Lisa Dally Wilson to Ann Williamson RE: Groundwater Sampling at Lakewood (April 1990). Project No. SEA69018RA.FQ.

Ecology, 2002. Five-Year Review Report. Third Five-Year Review Report for Lakewood/ Ponders Corner Superfund Site, Tacoma, WA – October 2002. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

EPA, 1992. Lakewood/Ponders Corner Superfund Site - Five Year Review Report. U.S. Environmental Protection Agency.

EPA, 1997. Lakewood/Ponders Corner Superfund Site - Five Year Review Report. U.S. Environmental Protection Agency.

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round I - January 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e34. www.ecy.wa.gov/biblio/91e34.html

Marti, P., 1991. Lakewood/Plaza Cleaners Monitoring Round II - June 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 91-e35. www.ecy.wa.gov/biblio/91e35.html

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round III - November 1991. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e43. www.ecy.wa.gov/biblio/92e43.html

Marti, P., 1992. Lakewood/Plaza Cleaners Monitoring Round IV - June 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 92-e44. www.ecy.wa.gov/biblio/92e44.html

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round V - December 1992. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e38. www.ecy.wa.gov/biblio/93e38.html

Marti, P., 1993. Lakewood/Plaza Cleaners Monitoring Round VI - June 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 93-e39. www.ecy.wa.gov/biblio/93e39.html

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VII - December 1993. Washington State Department of Ecology, Olympia, WA. Publication No. 94-131. www.ecy.wa.gov/biblio/94131.html

Marti, P., 1994. Lakewood/Plaza Cleaners Monitoring Round VIII - April 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 94-198. www.ecy.wa.gov/biblio/94198.html

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring Round IX - November 1994. Washington State Department of Ecology, Olympia, WA. Publication No. 95-340. www.ecy.wa.gov/biblio/95340.html

Marti, P., 1995. Lakewood/Plaza Cleaners Monitoring - July 11, 12 & 14, 1995. Washington State Department of Ecology, Olympia, WA. Publication No. 95-359. www.ecy.wa.gov/biblio/95359.html

Marti, P., 1996. Lakewood/Plaza Cleaners Monitoring - January 17-18, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 96-317. www.ecy.wa.gov/biblio/96317.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 31, 1996. Washington State Department of Ecology, Olympia, WA. Publication No. 97-312. www.ecy.wa.gov/biblio/97312.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - January 9, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-324a. www.ecy.wa.gov/biblio/97324a.html

Marti, P., 1997. Lakewood/Plaza Cleaners Monitoring - July 23-24, 1997. Washington State Department of Ecology, Olympia, WA. Publication No. 97-339. www.ecy.wa.gov/biblio/97339.html

Marti, P., 1998. Lakewood/Plaza Cleaners Monitoring - February 2, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 98-325. www.ecy.wa.gov/biblio/98325.html

Marti, P., 1999. Lakewood/Plaza Cleaners Monitoring - July 15, 1998. Washington State Department of Ecology, Olympia, WA. Publication No. 99-312. www.ecy.wa.gov/biblio/99312.html

Marti, P., 1999. Lakewood/Plaza Cleaners Long-term Monitoring, January and August, 1999. Washington State Department of Ecology, Olympia, WA. Publication No. 99-344. www.ecy.wa.gov/biblio/99344.html

Marti, P., 2000. Lakewood/Plaza Cleaners, January and August 2000 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 00-03-046. www.ecy.wa.gov/biblio/0003046.html

Marti, P., 2001. Lakewood/Plaza Cleaners, January and August 2001 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 01-03-032. www.ecy.wa.gov/biblio/0103032.html

Marti, P., 2002. Lakewood Plaza Cleaners, February and August 2002 Groundwater Monitoring Sampling Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-007. www.ecy.wa.gov/biblio/0303007.html

Marti, P., 2003. Lakewood Plaza Cleaners, February and October 2003 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-050. www.ecy.wa.gov/biblio/0303050.html

Marti, P., 2004. Lakewood Plaza Cleaners, June and November 2004 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-054. www.ecy.wa.gov/biblio/0403054.html

Marti, P., 2005. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html

Marti, P., 2006. Lakewood Plaza Cleaners, June and November 2005 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-010. www.ecy.wa.gov/biblio/0603010.html

Marti, P., 2007. Lakewood Plaza Cleaners, May and September 2006 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 07-03-013. www.ecy.wa.gov/biblio/0703013.html

Marti, P., 2008. Lakewood Plaza Cleaners, June and October 2007 Groundwater Monitoring Results. Washington State Department of Ecology, Olympia, WA. Publication No. 08-03-010. www.ecy.wa.gov/biblio/0803010.html

Marti, P., 2009. Lakewood Plaza Cleaners Groundwater Monitoring Results, May and October 2008. Washington State Department of Ecology, Olympia, WA. Publication No. 09-03-012. www.ecy.wa.gov/biblio/0903012.html

Marti, P., 2010. Lakewood Plaza Cleaners Groundwater Monitoring Results, June and November 2009. Washington State Department of Ecology, Olympia, WA. Publication No. 10-03-010. www.ecy.wa.gov/biblio/1003010.html

Marti, P., 2011. Lakewood Plaza Cleaners Groundwater Monitoring Results, June and October 2010. Washington State Department of Ecology, Olympia, WA. Publication No. 11-03-011. www.ecy.wa.gov/biblio/1103011.html

Appendices

Appendix A. Summary of Results

Table A-1. Summary of Sample Results (ug/L), January 1991 to October 2011.

Well	January 1991			May 1991			November 1991			May 1992			December 1992		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	28	1 J	2.4 J	26	0.6 J	2	2.7 J	1 U	0.6 J	7	1 U	1	9 J	0.3 J	0.8 J
MW-20A	1 U	1 U	1 U	0.4 J	1 U	1 U	0.4 J	1 U	1 U	0.5 J	1 U	1 U	0.8 J	1 UJ	1 UJ
MW-20B	1100 D	18	33	752	16	30	120	2.6 J	6.7	940	13	32	340 J	14 J	20 J
MW-21	2.1 J	1 U	1 J	2	1 U	0.7 J	2.2 J	1 U	1.0 J	2	1 U	0.6 J	2	0.2 J	0.3 J
MW-27	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 UJ	1 UJ	1 UJ
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-31	1 J	1 U	1.9 J	0.6 J	1 U	2	0.9 J	1 U	2.2 J	0.8 J	1 U	1	0.5 J	1 UJ	0.9 J
MW-32	1 J	1 U	1.1 J	1	1 U	2	0.6 J	1 U	0.6 J	0.7 J	1 U	1	0.7 J	1 UJ	0.5 J
MW-41	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 UJ	1 UJ	1 UJ
MW-19A	--	--	--	--	--	--	1 U	0.5 J	1 U	--	--	--	1 UJ	1 UJ	1 UJ
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-40	1 U	1 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--	1 UJ	1 UJ	1 UJ
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well	May 1993			December 1993			April 1994			November 1994			July 1995		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	44	10 U	2 J	13	0.3 J	0.7 J	33	0.6	1.4	9.7	0.3 J	0.5 J	27	0.5 J	0.8 J
MW-20A	10 U	10 U	10 U	0.3 J	1 U	1 U	0.4	0.2 U	0.2 U	0.3 J	1 U	1 U	0.4 J	1 U	1 U
MW-20B	700 D	12	21	187	50 U	8.2 J	472	8.6 J	12.6	86	50 U	3 J	340 D	8.4	17
MW-21	1 J	10 U	10 U	1.6	1 U	0.4 J	1.5	0.2 J	0.3	1.8	0.2 J	0.3 J	--	--	--
MW-27	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-31	10 U	10 U	10 U	0.8 J	1 U	1.2 J	0.7	0.2 U	1.0	0.8 J	1 U	1	0.6 J	1 U	0.5 J
MW-32	10 U	10 U	10 U	0.7 J	1 U	0.6 J	0.7	0.2 U	0.6	0.6 J	1 U	0.5 J	0.7 J	1 U	0.5 J
MW-41	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-19A	--	--	--	1 U	0.4	1 U	0.2 U	0.5	0.2 U	--	--	--	1 U	0.4 J	1 U
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	--	--	--	1 U	1 U	1 U
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	9	0.3 J	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2011.

Well	January 1996			July 1996			January 1997			July 1997			February 1998		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	47 E	0.8 J	1.5	43	0.7 J	1.9	54	1.1	3.1	47	0.7 J	2.5	36	0.7 J	2 J
MW-20A	0.2 J	1 U	1 U	0.4 J	1 U	1 U	0.4 J	1 U	1 U	0.3 J	1 U	2 U	0.4 J	1 U	1 U
MW-20B	353	7.2	15	387	7.6	15	373	100 U	6.4 J	222	4	6.4	456	7 J	12
MW-21	--	--	--	Well Decommissioned											
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
MW-28A	1 U	1 U	1 U	Well Decommissioned											
MW-31	0.6 J	1 U	0.7 J	--	--	--	--	--	--	0.9 J	1 U	0.9 J	--	--	--
MW-32	0.8 J	1 U	0.6 J	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	--	--	--	1 U	0.3 J	2 U	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--	1 U	1 U	2 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	8.4	0.2 J	0.2 J	0.1 J	1 U	1 U	18	0.4 J	0.4 J	8.8	0.3 J	0.6 J	11	0.4 J	0.3 J

Well	July 1998			January 1999			August 1999			January 2000			August 2000		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	30	1 U	1.5 J	--	--	--	22	0.4 J	1.1	40	0.7 J	1.9	22	0.3 J	0.7
MW-20A	0.6 J	1 U	1 U	1 U	2 U	1 U	0.8 J	2 U	1 U	0.2 J	2 U	1 U	0.1 J	2 U	1 U
MW-20B	575 D	10	23	708	5.2	12	722	8.4 J	16 J	184	6	13	648	200 U	100 U
MW-27	0.05 J	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U
MW-31	--	--	--	--	--	--	0.9 J	2 U	0.4 J	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	0.8 J	2 U	1 U
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
MW-19A	--	--	--	--	--	--	1 U	0.4 J	1 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	1 U	2 U	1 U	--	--	--	1 U	2 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
H1/H2	10	1 U	0.1 J	1.5	1 U	1 U	5.2	0.2 J	1 U	10	1 U	1 U	8.7	0.03 J	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2011.

Well	January 2001			August 2001			February 2002			August 2002			February 2003		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.4 J**	**1**	**25**	**0.3 J**	**0.7 J**	**47**	**0.8 J**	**2.3**	**22**	**0.3 J**	**0.8 J**	**59 J**	**0.2 J**	**2.4**
MW-20A	**0.2 J**	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U
MW-20B	**493**	**6.6 J**	**12**	**486**	**8.2**	**18**	**248**	200 U	100 U	**371**	**8.5**	**16**	**230**	100 U	100 U
MW-27	1 U	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	**0.4 J**	2 U	**0.3 J**	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	1 U	**0.3 J**	1 U	--	--	--	--	--	--	--	--	--
MW-33	--	--	--	1 U	2 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	**11**	**0.2 J**	1 U	**6.8**	**0.2 J**	1 U	**12**	**0.2 J**	**0.2 J**	**6.1**	1 U	1 U	**1.3**	1 U	1 U

Well	September 2003			June 2004			November 2004			June 2005			November 2005		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**26**	**0.3 J**	**0.5 J**	**30**	**0.4 J**	**0.8 J**	**48**	1 U	**1.4**	**80**	**1.3**	**2.8**	**43**	**0.7 J**	**1.0 J**
MW-20A	**0.1 J**	1 U	1 U	**0.2 J**	1 U	1 U	**0.3 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**239**	**5.4 J**	**12**	**344**	**6.5 J**	**15**	**241**	**6.7**	**13**	**413**	**6.6**	**12**	**555**	**6.4**	**11**
MW-27	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
MW-31	**0.5 J**	1 U	**0.1 NJ**	--	--	--	--	--	--	**0.5 J**	1 U	1 U	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	**1.4**	1 U	1 U	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-19A	1 U	**0.4 NJ**	1 U	--	--	--	--	--	--	1 U	**0.6 J**	1 U	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
H1/H2	**6.4**	**0.2 NJ**	1 U	**7.9**	**0.2 J**	**0.1 J**	**2.6**	1 U	1 U	**14**	**0.3 J**	1 U	**6.4**	1 U	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2011.

Well	May 2006			September 2006			June 2007			October 2007			May 2008		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**124**	**1.8**	**4.6**	**29**	**0.3 J**	**0.48 J**	**83**	**1.2**	**2.5**	**24**	1 U	**0.64 J**	**55**	**1.2**	**2.8**
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**216**	**4.2**	**6.6**	**518**	**5.6**	**11**	**204**	**4.4**	**7.8**	**491**	**7.5**	**15**	**143**	**5.5**	**12**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	--	--	--	**1.6 J**	2 U	2 U	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	2 U	**1.2 J**	2 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	2 U	2 U	2 U	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LPMW-2	**9.9**	1 U	1 U	--	--	--	**4.8**	1 U	1 U	--	--	--	**2.5**	1 U	1 U
LPMW-3	1 U	1 U	1 U	--	--	--	2 U	1 U	1 U	--	--	--	--	--	--
H1/H2	**7.3**	**0.2 J**	1 U	**4.8**	1 U	1 U	**5.2**	2 U	2 U	**3.8**	1 U	1 U	**9.6**	1 U	1 U

Well	October 2008			June 2009			November 2009			June 2010			October 2010		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.45 J**	**0.6 J**	**67**	**0.94 J**	**2.2**	**28**	**0.52 J**	**0.83 J**	**85**	**1.3**	**1.6**	**61**	**0.86 J**	**1.2**
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	**0.64 J**	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U
MW-20B	**258**	**4.5**	**9**	**160**	**4.1**	**7.4**	**250**	**4.7**	**9.6**	**130**	**3.7**	**6.3**	**520**	**5.8**	**10**
MW-27	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-31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	**1.8**	1 U	1 U	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-19A	--	--	--	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LPMW-2	--	--	--	**4.1**	1 U	1 U	**11**	1 U	1 U	**4.4**	1 U	1 U	**5**	1 U	1 U
H1/H2	**5.1**	1 U	1 U	**6.8**	1 U	1 U	--	--	--	**4.3**	1 U	1 U	--	--	--

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2011.

Well	June 2011			October 2011					
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE			
MW-16A	**100**	**1.4**	**1.6**	**57**	**0.75 J**	**1**			
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U			
MW-20B	**200**	**3.5**	**5.6**	**720**	**4.8**	**7.9**			
MW-27	1 U	1 U	1 U	1 U	1 U	1 U			
MW-31	--	--	--	**0.65 J**	1 U	1 U			
MW-32	--	--	--	--	--	--			
MW-41	--	--	--	--	--	--			
MW-19A	--	--	--	1 U	**0.42 J**	1 U			
MW-33	--	--	--	1 U	1 U	1 U			
MW-40	--	--	--	1 U	1 U	1 U			
LPMW-2	**3.2**	1 U	1 U	--	--	--			
H1/H2	**5.9**	1 U	1 U	**1.4**	1 U	1 U			

U: The analyte was not detected at or above the reported result.
J: The analyte was positively identified. The associated numerical result is an estimate.
UJ: The analyte was not detected at or above the reported estimated result.
D: Analysis performed at secondary dilution.
E: The concentration of the associated value exceeds the known calibration range.
-- Not tested
Bold: The analyte was positively identified.

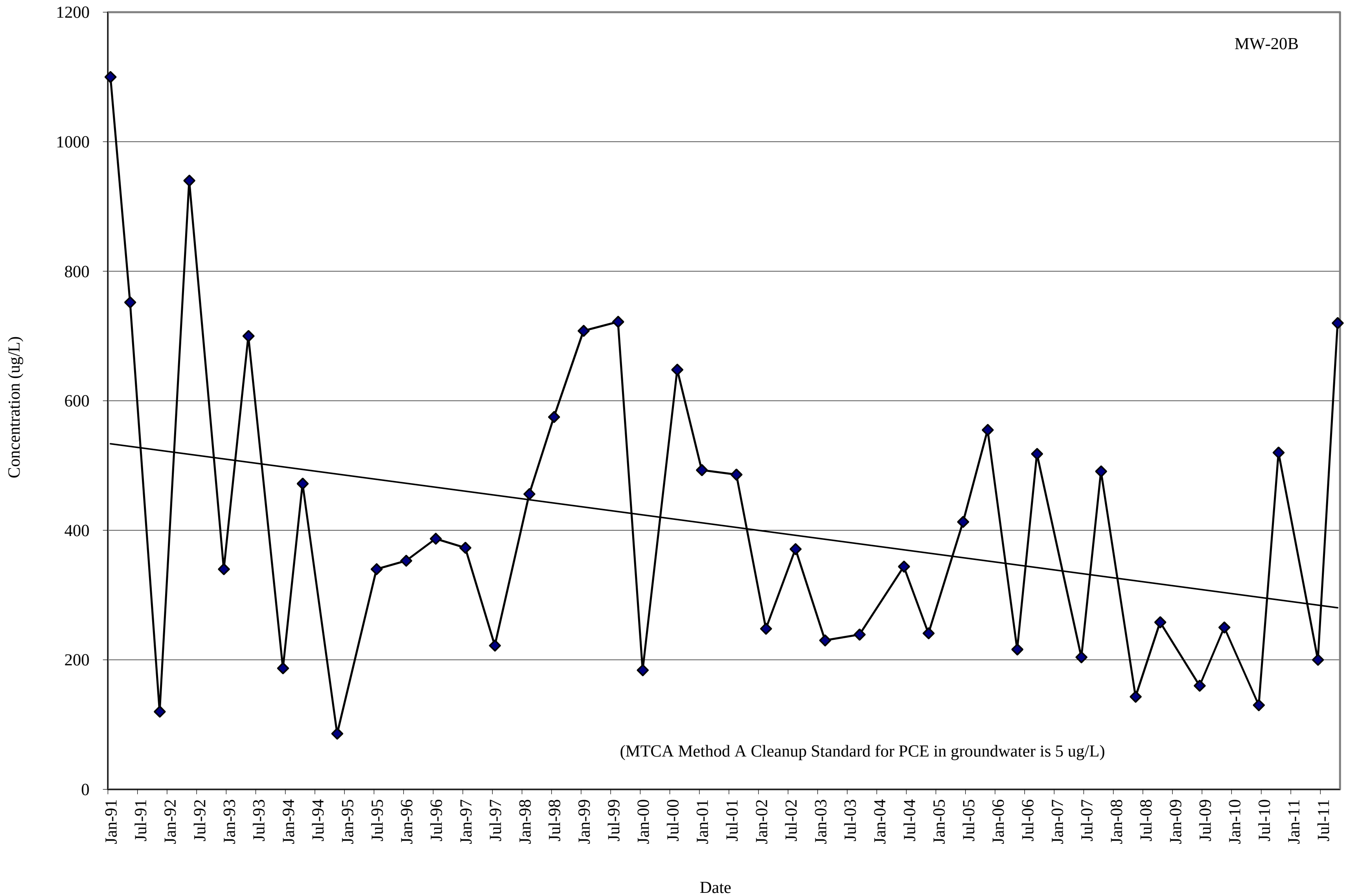

Figure A-1. PCE Concentrations for Well MW-20B, January 1991 to October 2011.

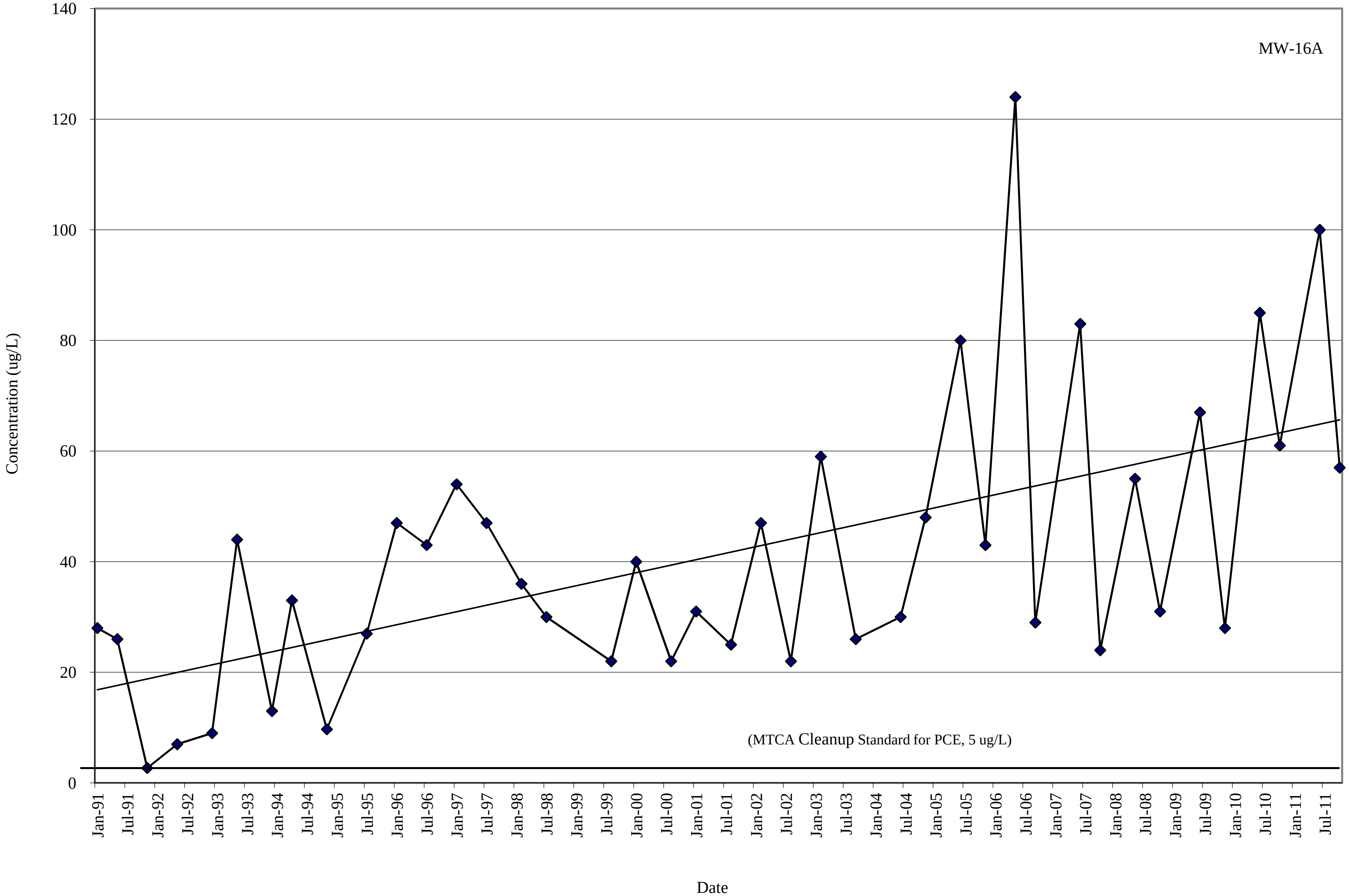

Figure A-2. PCE Concentrations for Well MW-16A, January 1991 to October 2011.

Appendix B. Glossary, Acronyms, and Abbreviations

Glossary

Aquifer: An underground geological formation, or group of formations, containing water.

Aquitard: Geologic formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients. May function as a confining bed.

Depth-to-water: A measure of depth to the water (i.e., water level) in a well.

Groundwater: Water in the subsurface that saturates the rocks and sediment in which it occurs. The upper surface of groundwater saturation is commonly termed *water table*.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Purge water: Water removed from the sampling zone in a well prior to sample collection.

Specific conductance: A measure of water's ability to conduct an electrical current. Specific conductance is related to the concentration and charge of dissolved ions in water.

Volatile organics: Organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the earth's atmosphere.

Acronyms and Abbreviations

Cis-1,2-DCE	Cis-1,2-dichloroethene
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	Environmental Protection Agency
MTCA	Model Toxic Control Act
PCE	Tetrachloroethene
PVC	Polyvinyl chloride
RPD	Relative Percent Difference
TCE	Trichloroethene
VOA	Volatile Organics Analysis
WAC	Washington Administrative Code

Units of Measurement

°C	degrees centigrade
ug/L	micrograms per liter (parts per billion)
umhos/cm	micromhos per centimeter