FOURTH FIVE-YEAR REVIEW REPORT FOR COMMENCEMENT BAY – SOUTH TACOMA CHANNEL SUPERFUND SITE TACOMA, WASHINGTON

PREPARED BY

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Executive Summary

This document presents the fourth Five-Year Reviews (FYR) for the Commencement Bay, South Tacoma Channel (STC) Superfund site in Tacoma, Washington. Although the STC was listed on the NPL as a single site due to the proximity of three different problem areas in south Tacoma, the three areas are distinctly different with separate problems, remedies, and approaches to protectiveness. The three main project areas (Well 12A, South Tacoma Field (STF), Tacoma Landfill) were broken down into the following Operable Units (OUs) within the STC:

- OU 1 – Well 12A/groundwater
- OU 2 – Well 12A Burlington Northern Soil Removal
- OU 3 – Well 12A Soils (Vapor Extraction System)
- OU 4 - South Tacoma Field (STF)
- OU 5 - Tacoma Landfill/cap
- OU 6 - Tacoma Landfill/groundwater

The FYR groups OUs by project area, with a separate section for each project area (Well 12A, STF, Tacoma Landfill) that discusses the active OUs within that project area. Note the Burlington Northern Soil Removal and Well 12A Soils/Vapor Extraction System were designated as OUs 2 and 3 for administrative purposes, but are actually remedy components of the overall Well 12A remedy, which is designated as OU1. This FYR addresses the entire Well 12A project area including any remaining exposures in all the OUs, but OUs 2 and 3 are not mentioned further in this document. Figure ES-1 shows the location of the three project areas within the STC Superfund site.

Five-Year Review summaries, although commonly included in FYR Executive Summaries, are presented separately in this document with one summary for each project area included in its respective section.

Well 12A

The Well 12A site includes OUs 1, 2 and 3 (together referred to as the "Well 12A OU") of the STC Superfund Site. Well 12A is located in Tacoma, Washington approximately 5 miles south of Commencement Bay and directly west of Interstate 5. Well 12A encompasses the source of contamination at the property of the former Time Oil Company and the City of Tacoma's production Well 12A.

The former Time Oil property was historically used for various industrial practices including oil recycling and paint and lacquer manufacturing. Oil recycling and solvent processing began in the early 1920s and continued until 1991 with occasional interruptions due to changes in ownership and a large fire in 1976. In addition to a number of possible leaks and spills over the years, some of the filter cake generated during oil recycling was land-disposed around the Time Oil Building and additional filter cake was used as fill material in 1982 for constructing the Burlington Northern Railroad spur to the north of the Time Oil Property.

In 1981, chlorinated organic solvents were detected in groundwater at the City of Tacoma's Well 12A in part per billion (ppb) concentrations (µg/L) and above current drinking water criteria at that time. The Remedial Investigation (RI) identified the contaminants of concern (COCs) in soil and groundwater as tetrachloroethane (PCA), tetrachloroethene (PCE), trichloroethene (TCE), and trans-1,2-dichloroethene (DCE).

The remedy for the site as set forth in the 1983 Record of Decision (ROD), 1985 first ROD Amendment, and 1987 remedial design change memorandum included wellhead treatment at Well 12A using air strippers, vadose zone soil treatment by a Vapor Extraction System (VES), limited soil excavation, and a Groundwater Extraction and Treatment System (GETS) that uses carbon adsorption to treat extracted groundwater. In 2009, ROD Amendment #2 added shallow excavation to remove additional source material, In-Situ Thermal Remediation (ISTR) to treat highly impacted portions of the deep vadose zone and upper saturated zone, Enhanced Anaerobic Biodegradation (EAB) to treat the high-concentration groundwater plume, Monitored Natural Attenuation (MNA) as a contingency, groundwater monitoring, and institutional controls. In 2012 an Explanation of Significant Differences (ESD) was completed which included demolition of the old Time Oil building in order to allow for implementation of the ISTR portion of the remedy.

Construction of the remedial actions described in ROD Amendment #2 is still in progress. Shallow soil contamination to the east of the Time Oil building has been excavated and transported off-site for disposal. ISTR and EAB are still in the final stages of the design phase and are scheduled to be complete by 2015. The GETS has been shut down prior to the start of the ISTR and EAB remedial action, but may be reactivated following completion of these actions if Remedial Action Objectives (RAOs) have not been met. Municipal water from Well12A is treated via air-stripping prior to use. ICs are in place to prevent exposure to shallow soil during remedial activities and to prevent ingestion of contaminated groundwater.

Standards that have changed since the ROD, ROD Amendments, and ESD were signed may affect the protectiveness of the remedy. Changes in toxicity values for cis-1,2-DCE, trans-1,2-DCE, 1,1,2,2-PCA, PCE, and TCE have occurred in the last five years that may require future re-evaluation of selected cleanup levels (cis-and trans-1,2-DCE) to ensure protectiveness is maintained. The changes do not affect the current protectiveness since ICs are in place to prevent exposure above the new standards.

Exposure pathways described in the ROD have not changed. The vapor intrusion pathway was not evaluated during the ROD. USEPA plans to evaluate vapor intrusion after the remedial actions are complete.

The remedy at Well 12A is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

South Tacoma Field

The South Tacoma Field (STF) is OU 4 of the STC Superfund site. The STF OU is approximately 260 acres. The southern half of the OU contains industrial and commercial facilities; the northern and western portions are primarily open grass fields.

A variety of industrial and commercial operations have occupied different portions of the OU in the past 100 years including railroad vehicle manufacturing and repair, foundries, and aircraft maintenance and refueling. In addition to potential historic contaminant sources, several present day industrial facilities have contributed to the contaminant source areas. Tacoma Public Utilities (Tacoma City Light) has operated a maintenance and repair facility at the northernmost end of the OU and Pioneer Builders Supply purchased land in the southeast portion where USTs were installed.

In 1990, surface soils, and to a lesser extent, subsurface soils in the rail yard and foundry areas were contaminated with high levels of lead, arsenic, copper, and zinc. At the foundry area on the south end of the OU, a relatively small volume of nearly immiscible, heavy fuel oil was found on the surface of the water table. At the Tacoma City Light Property on the north end of the site, elevated concentrations of polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and several other organic compounds were detected in subsurface soils at and underlying some of the dry wells. At Pioneer Builders Supply, elevated concentrations of 1,2,4-trichlorobenzene, PCBs, petroleum hydrocarbons (TPH), benzene, ethylbenzene, toluene, and xylenes (BETX) were found in subsurface soil in the unsaturated zone beneath and immediately surrounding the location where three USTs had been removed. Benzene, ethylbenzene, and 1,1,2-trichloroethane (TCA) were detected at levels above maximum contaminant levels (MCLs) in groundwater at this site.

The OU was divided into three areas for remediation: STF soils, Pioneer Builders Supply, and Tacoma City Light drywells. The selected remedy for the STF soils consisted of excavation and solidification of soil contaminated at levels that exceeded hot-spot concentration thresholds; excavation, consolidation, and on-site containment (capping) of soil at levels that exceeded capping-required levels; institutional controls; and groundwater monitoring. The remedy for Pioneer Builders Supply consisted of monitored natural attenuation (MNA). The remedy for Tacoma City Light Dry Wells included excavation of soil with final treatment through either incineration or off-site.disposal in an approved landfill.

The soil remedies are complete; hot spots have been removed and treated on-site and the remaining area of soil contamination have been removed, consolidated on-site, and capped. The ICs are in place to protect direct contact of workers with contaminated soils and to prevent groundwater at Pioneer Builders Supply from being use as drinking water. Fencing has been installed around the northern and central portion of the site and at the main entrance to restrict access. Operation and maintenance procedures are in place to ensure cap and fencing integrity.

Groundwater monitoring is used to assess impacts of the soil consolidation areas on local groundwater. Concentrations of lead in two STF wells were above the cleanup level over the last three years. A significant increase was observed in December 2012, during a period of higher groundwater

levels, and may indicate that some contaminated soil in the vadose zone was exposed to continuous saturation that has not occurred in the past, resulting in some particulate or soluble material migrating into the groundwater. The groundwater monitoring program should be modified to determine if there is a continuing source of contamination to groundwater. MNA at Pioneer Builders Supply has been slower than expected; however, concentrations recently dropped below cleanup levels. Monitoring should continue to determine if MNA is effective.

Several Washington Model Toxics Cleanup Act (MTCA) standards have changed since the remedy was selected. Washington Department of Ecology modified MTCA substantially in 2007. Revisions to soil cleanup levels were primarily based on the protection of groundwater, so they do not likely impact the protectiveness of the remedy with respect to industrial worker direct contact exposure but may impact protectiveness of groundwater. Ongoing monitoring of groundwater will be conducted to confirm that groundwater concentrations continue to meet current cleanup levels. There are no changes in exposure pathways at the OU.

The remedy at the STF OU currently protects human health and the environment because ICs are in place to prevent direct contact with soil and use of groundwater at Pioneer Builders Supply as drinking water. However, in order for the remedy to be protective in the long term, the groundwater monitoring program needs to be revised to determine if there is an ongoing source to groundwater from the contaminated soils and to ensure protectiveness.

Tacoma Landfill

The City of Tacoma Refuse Utility operates a solid waste disposal facility known as the Tacoma Landfill which is located within the City of Tacoma in Pierce County, Washington. The Landfill covers 240 acres and is bounded approximately by South 31st Street on the north, Tyler Street on the east, South 48th Street on the south, and Orchard Street on the west (see Figure ES-1).

The Tacoma Landfill began operations in 1960, and has been operating as a sanitary landfill under a permit issued by the Tacoma Pierce County Health Department (TPCHD). The wastes disposed of at the Landfill include garbage, rubbish, industrial wastes, construction and demolition wastes, street refuse, litter, and bulky waste. The Landfill does not accept hazardous waste for disposal; however, the Landfill received wastes in the 1960s and 1970s that have since been designated as hazardous wastes under state and federal law. The Landfill has been filled. The last section of the Landfill to be filled is called the Central Area which covers approximately 31 acres and was developed in 1987.

Groundwater contamination, primarily volatile organic compounds (VOCs), was detected at the perimeter of the Landfill and extended in a southwesterly direction toward Leach Creek. Because of the concern about public health effects of the contamination, particularly vinyl chloride, residents whose wells were impacted or threatened were connected to the Tacoma municipal water system in the mid-1980s. Landfill gases were also found to be migrating from the Landfill to residences and businesses adjacent to the site.

The remedy selected in the Record of Decision (ROD) included management of contaminant migration using a groundwater extraction and treatment system (GETS); source control using a landfill cap, gas extraction system, and landfill closure plan; and monitoring. Institutional controls (ICs) were selected to assure that the remedial action will continue to protect human health and the environment.

The GETS has been effective at managing groundwater contaminant migration and most of the extraction wells were shut down in 2010. Five extraction wells remain in operation, two near the historical north area residual plume and three near the historical south area residual plume. Rebound monitoring data indicate that there was a slight increase in contaminant concentrations in 2011; however, concentrations have since decreased. The methodology developed for monitoring containment in the 2010 Rebound Monitoring Plan is not appropriate for OU conditions and should be revised prior to shutdown of any additional extraction wells. The reduced analyte list from the 2010 Groundwater Monitoring Plan should also be reviewed and revised as necessary to ensure all necessary ROD-established COCs are still captured in the revised monitoring plan. The landfill-gas system continues to control migration of landfill gas. Concentrations of methane above the lower explosive limit (LEL) are still detected near the Home Depot property at the north end of the landfill. New extraction wells have been installed in this area and their operation is being optimized to reduce concentrations. Final closure of the Central Area will be completed by December 31, 2013. Following this event, the Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System and the Leachate and Condensate Management Plans should be updated to reflect current site conditions. ICs are in place to assure the remedial action will continue to protect human health and the environment. Several toxicity parameters have been updated for multiple chemicals. However, performance standards still meet an acceptable level of risk at the OU. There have been no changes to the exposure pathways that would impact protectiveness at the OU.

The remedy at the Tacoma Landfill currently protects human health and the environment because the groundwater and landfill gas is being controlled through the GETS and landfill-gas management system, the Central Area final cover will be complete by December 31, 2013, and ICs are in place. However, in order for the remedy to be protective in the long term, the following actions need to be taken to ensure protectiveness:

- Continue operation optimization of gas extraction wells at the north end of the Landfill.
- Re-grade areas of the landfill cap prone to ponding and subsidence.
- Update the following management plans to ensure the monitoring program is effective and response action procedures are in place: Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System; Leachate and Condensate Management Plan; Rebound Monitoring Plan; and Groundwater Monitoring Plan.

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Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Commencement Bay, South Tacoma Channel Superfund Site		
EPA ID: WAD980726301		
Region: 10	**State:** WA	**City/County:** Tacoma/Pierce County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:**
Author name (Federal or State Project Manager): Howard Orlean (OU 1), Shawn Blocker (OU 4 and OU 5/6)
Author affiliation: EPA Remedial Project Manager
Review period: September 2008 – September 2013
Date of site inspection: March 5, 2013 (OU 1, OU-4), April 2, 2013 (OU 5/6)
Type of review: Statutory
Review number: 4
Triggering action date: September 9, 2008
Due date *(five years after triggering action date)*: September 9, 2013

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): OU 1, Well 12A	**Issue Category:** Remedy Performance			
	Issue: Selected cleanup levels for cis- and trans-1,2-DCE may no longer be protective following 2011 changes in toxicity values.			
	Recommendation: Re-evaluate the groundwater cleanup level for cis- and trans-1,2-DCE and adjust if necessary to maintain future protectiveness after achievement Tier 1 criteria outlined in the 2009 ROD Amendment.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA/State	EPA	09/2018
OU(s): OU 1, Well 12A	**Issue Category:** Remedy Performance			
	Issue: Evaluation of the vapor intrusion pathway is needed.			
	Recommendation: Evaluate vapor intrusion pathway after achievement of Tier 1 criteria.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	09/2018

Five-Year Review Summary Form (continued)

OU(s): OU 4, South Tacoma Field	**Issue Category:** Monitoring			
	Issue: Lead concentrations increased in two STF wells.			
	Recommendation: Modify the groundwater monitoring program to determine if there is an ongoing source to groundwater from the contaminated soils.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	09/2014

OU(s): OU 4, South Tacoma Field	**Issue Category:** Monitoring			
	Issue: Wells STM-1A and NMW-8A are damaged and have not been repaired.			
	Recommendation: Replace wells STM-1A and NMW-8A to ensure the groundwater monitoring programs are complete.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	09/2014
OU(s): OU 4, South Tacoma Field	**Issue Category:** Monitoring			
	Issue: The effectiveness of MNA at Pioneer Building Supply has not been evaluated as recommended in the previous FYR.			
	Recommendation: Continue groundwater monitoring at Pioneer Builders Supply and complete an evaluation of MNA. If future sampling shows an increase in concentrations, similar to the historical fluctuations, the impact of potential residual soil contamination on groundwater concentrations should be investigated. This could include additional soil and groundwater sampling and an evaluation of groundwater flow variations on contaminant concentrations.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	09/2014
OU(s): OU 5/6, Tacoma Landfill	**Issue Category:** Operations and Maintenance			
	Issue: Water ponding and cap subsidence continue to occur on areas of the landfill cap.			
	Recommendation: Regrade areas of the landfill cap that continue to have significant ponding and subsidence.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	09/2014

Five-Year Review Summary Form (continued)

OU(s): OU 5/6, Tacoma Landfill	**Issue Category:** Operations and Maintenance			
	Issue: The Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System, and the Leachate and Condensate Management Plan may not reflect current conditions following closure of the Central Area.			
	Recommendation: Update the Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System, and the Leachate and Condensate Management Plan.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	09/2014

OU(s): OU 5/6, Tacoma Landfill	**Issue Category:** Operations and Maintenance			
	Issue: Landfill gas continues to be detected near the Home Depot Property at the north end of the landfill.			
	Recommendation: Continue operation optimization of gas extraction in wells on the northern edge of the Landfill near the Home Depot property.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	09/2014

OU(s): OU 5/6, Tacoma Landfill	**Issue Category:** Monitoring			
	Issue: The Rebound Monitoring Plan statistical methodology is too restrictive, leading to numerous exceedances of the contingent action criteria, and the response action procedures described in the plan have not been followed.			
	Recommendation: Update the Rebound Monitoring Plan.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	09/2014

OU(s): OU 5/6, Tacoma Landfill	Issue Category: Monitoring			
	Issue: The 2010 Groundwater Monitoring Plan reduced the analyte list to those VOCs useful for evaluating rebound. While this may be acceptable for the rebound monitoring wells, it should not be used at locations used to determine compliance with ROD criteria, such as Leach Creek surface water sampling and GETS effluent samples.			
	Recommendation: Update the 2010 Groundwater Monitoring Plan to include the full list of ROD COCs for sampling locations used to determine compliance (e.g. Leach Creek and GETS effluent).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	09/2014

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU 1, Well 12A	**Short-term Protective**	**NA**

Protectiveness Statement:

The remedy at Well 12A OU is currently protective of human health and the environment in the short term. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. However in order for the remedy to be protective in the long term, the remedial actions for the source area should continue to be implemented.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU4, South Tacoma Field	**Short-term Protective**	**NA**

Protectiveness Statement:

The remedy at the South Tacoma Field OU is currently protective of human health and the environment in the short term because ICs are in place to prevent direct contact with soil and use of groundwater at Pioneer Builders Supply as drinking water. However, in order for the remedy to be protective in the long term, the groundwater monitoring program needs to be revised to determine if there is an ongoing source to groundwater from the contaminated soils and to ensure protectiveness.

Five-Year Review Summary Form (continued)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU 5/6	**Short-term Protective**	**NA**

Protectiveness Statement:

The remedy at the Tacoma Landfill is currently protective of human health and the environment in the short term because the groundwater and landfill gas is being controlled through the GETS and landfill gas management system, the Central Area final cover will be complete by December 31, 2013, and institutional controls are in place. However, in order for the remedy to be protective in the long term, the following actions need to be taken to ensure protectiveness: continue operation optimization of gas extraction wells at the north end of the Landfill; re-grade areas of the landfill cap prone to ponding and subsidence, update the following management plans to ensure the monitoring program is effective and response action procedures are in place: Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System; Leachate and Condensate Management Plan; Rebound Monitoring Plan; Groundwater Monitoring Plan and Institutional Controls Plan.

Sitewide Protectiveness Statement (if applicable)

For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.

Protectiveness Determination:	*Addendum Due Date (if applicable):*
Short-term Protective	*NA*

Protectiveness Statement:

The Commencement Bay, South Tacoma Channel Superfund Site is currently protective of human health and the environment in the short term. In order for the remedy to be protective in the long term, issues identified for OU 1 (Well 12A), OU 4 (South Tacoma Field) and OU 5/6 (Tacoma Landfill) need to be resolved.

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List of Abbreviations

3D	Three dimensional
ARAR	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
bgs	below ground surface
BLUS	Building and Land Use Services
BNRR	Burlington Northern Rail Road
BNSF	Burlington Northern Sante Fe
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene and xylenes
BTU	British thermal unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
cfs	cubic feet per second
CHB	Citizens for a Healthy Bay
CLARC	Cleanup Levels and Risk Calculations
COC	contaminant of concern
COD	chemical oxygen demand
CSCL	Confirmed and Suspected Contaminated Sites List
CSM	Conceptual Site Model
CTP	Central Wastewater Treatment Plant
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DOH	Department of Health
EAB	Enhanced anaerobic bioremediation
Ecology	Washington State Department of Ecology
EOP	end of plume
EPA	Environmental Protection Agency
ESD	Explanation of Significant Differences
FFS	Focused feasibility study
FS	Feasibility study
ft/day	feet per day
FYR	Five Year Review
GAC	Granular activated carbon
GCL	geosynthetic clay liner
GETS	Groundwater extraction and treatment system
gpm	gallon per minute
HDPE	high density polyethylene
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	human health risk assessment
HI	Hazard Index
HQ	Hazard quotient

IC	Institutional control
IDW	Investigation derived waste
IRM	Interim remedial measure
IRIS	Integrated Risk Information System
ISTR	In-situ thermal remediation
J&E	Johnson and Ettinger
LDR	Land Disposal Restrictions
LEL	lower explosive limit
LNAPL	Light non-aqueous phase liquid
MCL	Maximum contaminant level
mil	milliliter
MNA	Monitored natural attenuation
msl	mean sea level
MTCA	Model Toxics Control Act
MVS	Mining Visualization Software
µg/L	microgram per liter
NCP	National Contingency Plan
NPL	National Priority List
NRWQC	National Recommended Water Quality Criteria
O&M	Operation and maintenance
OU	Operable Unit
PAH	polyaromatic hydrocarbons
PCA	tetrachloroethane
PCB	polychlorinated biphenyls
PCE	Tetrachloroethene
POC	point of compliance
ppb	part per billion
ppm	part per million
PRG	preliminary remediation goal
PRP	Potentially responsible party
PSCAA	Puget Sound Clean Air Agency
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfD	reference dose
RI	Remedial Investigation
ROD	Record of Decision
RPM	remedial project manager
RSE	Remediation system evaluation
RSL	risk screening level
SDICP	Site Development and Institutional Control Plan
STC	South Tacoma Channel
STF	South Tacoma Field
SVE	Soil vapor extraction
TBC	To Be Considered
TCA	trichloroethane

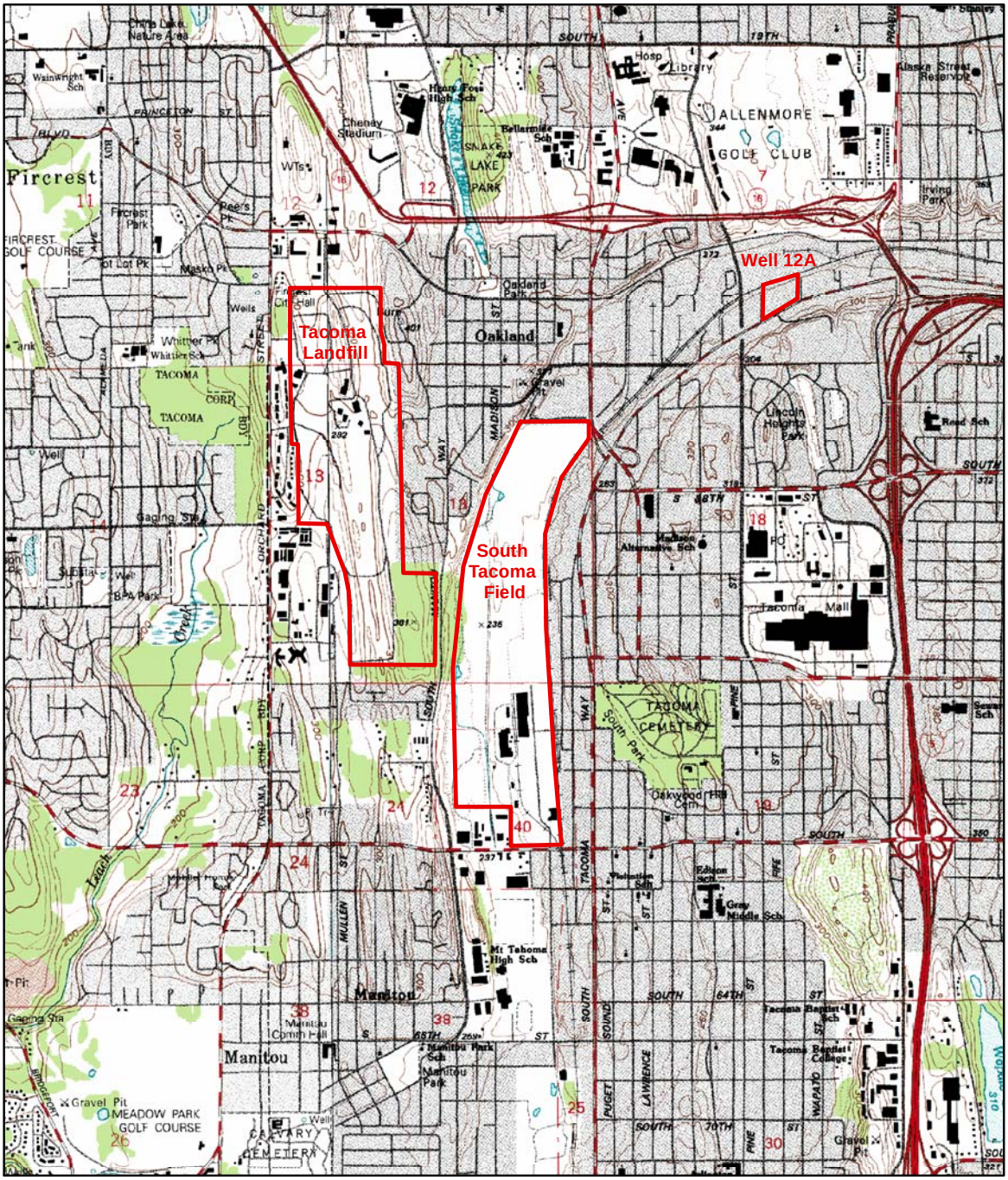
TCE	trichloroethene
TDS	total dissolved soilds
TPCHD	Tacoma Pierce County Health Department
TPH	total petroleum hydrocarbons
USACE	United States Army Corps of Engineers
UST	Underground storage tank
VES	Vapor extraction system
VOC	Volatile organic compound

Organization of This Report

The Commencement Bay, South Tacoma Channel (STC) Superfund site is located in Tacoma, Pierce County, Washington. Although the STC was listed on the National Priorities List (NPL) as a single site due to the proximity of three different problem areas in south Tacoma, the three areas are distinctly different with separate problems, remedies, and approaches to protectiveness. The three main project areas (Well 12A, South Tacoma Field (STF), Tacoma Landfill) are broken down into the following Operable Units (OUs) within the STC:

- OU 1 – Well 12A/groundwater
- OU 2 – Well 12A Burlington Northern Soil Removal
- OU 3 – Well 12A Soils (Vapor Extraction System)
- OU 4 – South Tacoma Field (STF)
- OU 5 - Tacoma Landfill/cap
- OU 6 – Tacoma Landfill/groundwater

This report contains five-year reviews (FYRs) for three separate project areas. Section 1 contains the complete FYR for Well 12A OU1 including all figures and appendices; Sections 2 and 3 each contain another separate and complete FYR for STF OU 4 and Tacoma Landfill OU 5/6, respectively. Note the Burlington Northern Soil Removal and Well 12A Soils/Vapor Extraction System were designated as OUs 2 and 3 for administrative purposes, but are actually remedy components of the overall Well 12A remedy, which is designated as OU1. This FYR addresses the entire Well 12A project area including any remaining exposures from OUs 2 and 3 as OU1, and OUs 2 and 3 are not mentioned further in this document. Figure A shows locations of the three project areas within the STC Superfund site. The following table summarizes current status and recommendations addressed in this review.



South Tacoma Channel Superfund Site
Operable Units

Source:
USGS Topographic Map, Tacoma South, WA, 1997
USGS Topographic Map, Steilacoom, WA, 1997

Figure A. Location of Project Areas in the South Tacoma Channel Superfund Site

Well 12A, Operable Unit 1

The Well 12A site has three OUs; however, OUs 2 and 3 were designated for administrative purposes. They are actually remedy components of the overall Well 12A remedy, which is designated as OU1; therefore, OUs 2 and 3 are not mentioned further in this review.

1.1. Introduction

This is the fourth FYR for the Well 12A project area (EPA ID No. WAD980726301), OU 1. The triggering action for this review is the date of the last five-year review for the Well 12A project area, completed in September 2008. The FYR is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site at levels above those that would allow for unlimited use and unrestricted exposure.

1.1.1. Purpose

The purpose of a 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 FYR reports. In addition, FYR reports identify issues found during the review, if any, and recommendations to address them.

1.1.2. Authority

The United States Environmental Protection Agency (EPA) is preparing this five-year review pursuant to Comprehensive Environmental 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 EPA 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.*

With oversight from EPA Region 10, the United States Army Corps of Engineers (USACE) Seattle District has conducted an FYR of the remedial actions implemented at the Well 12A Operable Unit (OU)

1 of the South Tacoma Channel (STC) Superfund Site located in Tacoma, Washington. The Well 12A project area also includes two other OUs (OU 2 Burlington Northern Rail Road (BNRR) Soil Removal and OU 3 Vapor Extraction System) that have completed actions summarized in this document. This section documents the results of the Well 12A project area review, which was conducted from January 2013 through September 2013. (Reviews of the other two active OUs, 4 and 5/6, are documented in Sections 2 and 3 of this document, respectively.)

1.2. Site Chronology

Table 2-1 lists major activities and milestones for the Well 12A site/OU1.

Table 2-1. Chronology of Site Events for Well 12A

Event	Date
Site Discovery	September 1981
Interim Priority NPL listing	November 1981
NPL listing	September 8, 1983
Phase I Remedial Investigation(RI)/Focused Feasibility Study (FFS) completed	January 1983
Record of Decision (ROD) Signature (Well 12A Stripping Towers Interim Remedial Measure (IRM))	March 18, 1983
Air Strippers begin operation at Well 12A	July 17, 1983
ROD Amendment (addressing source treatment)	May 3, 1985
Phase II Remedial Investigation/Feasibility Study completed	May 3, 1985
Unilateral Order (Potentially Responsible Party (PRP) 1)	June 3, 1985
Remedial Design Start – Groundwater	April 19, 1985
Remedial Design Complete – Groundwater	April 23, 1987
Remedial Design Modification (requiring soil vapor extraction system (VES)/carbon adsorption)	April 28, 1987
Remedial Design Start – Soil	March 19, 1985
Groundwater Extraction and Treatment System (GETS) begins operation	November 1988
Consent Decree for Settlement (PRP1)	November 4, 1988
Remedial Design Complete – Soil	June 5, 1991
Remedial Action Start –Soil Vapor Extraction (SVE)	July 19, 1990
SVE system begins operation	August 1993
Consent Decree for Settlement (PRP2)	January 31, 1995
Extraction Wells 2, 3, 4, and 5 added to GETS	1995
Remedial Action Complete – SVE shut down	November 1, 1997
First Five-Year Review	July 16, 1998
Light Non-aqueous Phase Liquid (LNAPL) and Soil Investigation Report	September 1999
CB/STC Construction Completion	September 29, 1999
Remediation System Evaluation (RSE)	December 10, 2001

Event	Date
Second Five-Year Review	July 2003
Capture Zone Analysis	September 2005
Third Five-Year Review	September 2008
Focused Feasibility Study (FFS) Completed	April 2009
ROD Amendment #2 (requiring additional source treatment)	October 2009
Remedial Design Investigation Conducted	October 2010
Shallow Excavation and Underground Storage Tank (UST) Removal Completed	May 2012
Explanation of Significant Differences (ESD) to the Amended ROD	June 2012
Remedial Design and In-Situ Thermal Remediation (ISTR) Pre-Design Investigation Complete	July 2012
Mass Discharge Baseline Complete	January 2013

1.3. Background

1.3.1. Physical Characteristics

The Well 12A project area of the STC Superfund site is located in Tacoma, Washington, approximately 4 miles southwest of the southern-most tip of Commencement Bay near the junction of Interstate 5 and state Highway 16 (Figure 2-1). The Well 12A project area encompasses the source of contamination at the property of the former Time Oil Company, and includes Well 12A, a municipal water supply production well owned and operated by the City of Tacoma. Well 12A is now typically pumped only during the peak water demand seasons (summer or early fall). The former Time Oil Company is located at 3011 South Fife Street, and Well 12A is located on Pine Street between 38th Avenue and South Tacoma Way.

1.3.1.1 Site Geology

The Well 12A project area is located in the Puget Sound Lowlands within the Commencement Bay drainage area. It is underlain by a sequence of glacial and interglacial deposits from the most recent glaciation. Several distinct channels were cut into these deposits by high velocity glacial meltwater, one of which is the South Tacoma Channel over which the site is situated. Where saturated, the coarse sands and gravels associated with these deposits make them conducive for high aquifer yields.

Stratigraphy in the vicinity of the site is complex and characterized by discontinuous lenses of high and low permeability sediments. The primary units of interest at the site are described below (presented from shallowest to deepest). A three dimensional (3D) representation of the units is shown on Figure 2-2. Hydraulic conductivity values are included, where appropriate, to show the relative permeability of each unit.

- Filter Cake and Artificial Fill. Fill material consists of material of variable grain size. Filtering of the tar-like sludge on the bottom of the waste oil tanks resulted in a filter cake material which was used as fill at various locations throughout the site.

- Steilacoom Gravels (Qvs). Generally characterized as gravelly sand and sandy gravel with varying silt content.
- Vashon Till (Qvt). Generally characterized as a diamict with a silty sand matrix supporting gravel and lesser amounts of cobbles and boulders.
- Vashon Advance Outwash Deposits (Qva). Generally characterized as poorly graded medium sand with varying amounts of gravel and silt. The water table is typically encountered in the Qva unit. Hydraulic conductivity in this unit has been calculated at 6-56 feet per day (ft/day).
- Sedimentary Deposits of pre-Fraser Glaciation Age, Undifferentiated (Qpf). Mixed fine and coarse grained deposits. Two non-contiguous fine-grained silt or clayey silt layers have been identified at the site; one generally above 200 feet (ft) mean sea level (msl) and one below 200 ft msl. Hydraulic conductivity within the fine-grained layer has been calculated at 0.12 ft/day.
- Coarse-Grained Deposits of pre-Fraser Glaciation Age (Qpf_c). Generally characterized as coarse grained sand and gravel with varying amounts of silt and intermittent layers of saturated silty gravel. Hydraulic conductivity is highly variable: in gravel and sand layers it ranges from 58-3,555 ft/day and in silty sand or silty gravel layers it ranges from 0.9 to 10 ft/day.
- Coarse Grained Glacial Deposits of pre-Olympia Age ($Qpog_c$). Similar in character to the overlying Qpf_c. A color change and increase in fines were observed at the transition between the Qpf_c and $Qpog_c$. Measured hydraulic conductivities measured in the transition zone ranged from 0.6-1.5 ft/day. Well 12A is believed to be screened in the coarse sand and gravels layers within this unit. Hydraulic conductivities calculated from the Well12A aquifer test ranged from 874-5,921 ft/day.
- Till of pre-Olympia Age ($Qpog_t$). Generally characterized as a very dense and dry sand and silt with fine gravel and a diamicitic texture characteristic of glacial till. This unit marks the upper portion of the primary aquitard at the site.
- Pre-Olympia deposits, undifferentiated (Qpon). Generally characterized as very dense or hard gravel, sand, silt and clay.

1.3.1.2 Hydrogeology

Groundwater in the upper aquifer is typically first encountered in the Qva unit at 30 to 35 feet below ground surface (bgs). The upper aquifer extends to approximately 100 feet bgs. Where present, the fine-grained Qpf unit may provide localized confining conditions. The principal aquitard ($Qpog_t$), is a semi-confining unit approximately 30-40 feet thick that separates the upper from the lower aquifer. The lower aquifer is estimated at approximately 40 feet thick and is underlain by the Kitsap Formation, a regional confining unit.

Groundwater flow at the site is complex due to multiple influences. The regional groundwater flow direction, without any impacts from pumping, is generally toward the east to northeast. When Well 12A is operational, the gradient shifts to the southwest. Additional discussion of groundwater flow is presented in Section 1.6.4.3.

1.3.2. Land and Resource Use

Current land use near the former Time Oil property and Well 12A is commercial and industrial. The former Time Oil property is currently under private ownership and is used by Western Moving and Storage for storage and office space.

Groundwater in the aquifer underlying the project area is currently used as a drinking water source for the City of Tacoma. Thirteen production wells located within the South Tacoma Channel are primarily used to augment inadequate supply from the Green River during periods of high demand or high turbidity. Well 12A is operated infrequently due to the expense of treatment. At a minimum, City of Tacoma wells are operated once every two years to check their operation.

The Well 12A project area is located within the South Tacoma Groundwater Protection District, which is a special zoning overlay district used to prevent the degradation of groundwater in the South Tacoma aquifer (Tacoma Municipal Code 13.09). It is managed by the Tacoma Pierce County Health Department (TPCHD). Certain facilities within this district are regulated based on their use or handling of hazardous substances. Regulated facilities are issued permits and are inspected biennially.

1.3.3. History of Contamination

The former Time Oil property was historically used for various industrial practices including oil recycling and paint and lacquer manufacturing. Oil recycling and solvent processing began in the early 1920s and continued until 1991 with occasional interruptions due to changes in ownership and a large fire in 1976. The Time Oil Company vacated the property in 1991, and the space has since been used for storage and small-scale manufacturing.

In addition to a number of possible leaks and spills over the years, some of the filter cake generated during oil recycling was land-disposed around the Time Oil Building and additional filter cake was used as fill material in 1982 for constructing the Burlington Northern Railroad spur to the north of the Time Oil Property. Subsequent investigations have identified this filter cake as a primary source of 1,1,2,2-tetrachloroethane (PCA), tetrachloroethylene (PCE), trichloroethylene (TCE), and other organic solvents discovered in the groundwater at Well 12A.

1.3.4. Initial response

Discovery and NPL Listing. In 1981, chlorinated organic solvents were detected in groundwater at Well 12A that were above drinking water criteria at that time. As a result, the City of Tacoma Water Department voluntarily removed Well 12A from production during September of that year. EPA completed a site investigation between July and September 1981 and proposed the Commencement Bay/South Tacoma Channel site for listing on the National Priority List (NPL) on September 1, 1981. The site was added to the NPL on September 8, 1983.

Phase I Remedial Investigation. EPA authorized a Remedial Investigation (RI) to determine the source, type, and extent of contamination in April 1982. Eleven groundwater wells were installed and the results of subsequent groundwater sampling and analysis revealed the following concentrations of contaminants of concern (COCs) on site:

- *trans*-1,2-dichloroethene (DCE) — 30 to 100 µg/L;
- PCA —17 to 300 µg/L;
- PCE — 1.6 to 5.4 µg/L; and
- TCE — 54 to 130 µg/L.

The RI study also determined that the major source of contamination was generally located northeast of Well 12A and that the natural, undisturbed groundwater flow direction was east and away from Well 12A. However, with the well field in production, the groundwater flow direction reversed, and the contaminant plume traveled toward the production wells.

The RI concluded that continued pumping of Well 12A could capture the contaminant plume even if other production wells were pumping. That is, pumping Well 12A could provide a hydraulic barrier to the spread of contamination and protect the rest of the well field. It was hypothesized that if Well 12A was not pumped to provide a hydraulic barrier, other operating wells could be impacted by the contaminant plume and could be lost for drinking water use.

Phase I Focused Feasibility Study/Initial Remedial Measures. In January 1983, EPA conducted a Focused Feasibility Study (FFS) to determine the most cost-effective treatment for Well 12A that would protect the drinking water supply for the City of Tacoma. The study included an Endangerment Assessment that evaluated risks to the general population if no action was taken. The FFS recommended that an extraction and treatment (i.e., pump and treat) system with air stripping be implemented on an interim basis for treatment of Well 12A groundwater to control the spread of contamination and prevent the loss of the well field. Carbon adsorption was also considered for treatment of groundwater but was more expensive and was (initially) eliminated from further evaluation for use on site.

On March 16, 1983, EPA signed a Record of Decision (ROD) for a Remedial Action calling for the design and construction of five air stripping towers at Well 12A operating in parallel to treat up to 3,500 gallons per minute (gpm) of contaminated Well 12A groundwater. The ROD required treatment to be sufficiently protective of either human consumption or of aquatic life if discharged either to Commencement Bay or to the city's sanitary sewer system. The decision criterion used to determine discharge requirements was the concentration equivalent to a $1x10^{-6}$ excess cancer risk level as measured at the tap (after treatment and dilution in the system). Construction of the treatment system was authorized on March 24, 1983, and system startup occurred on July 17, 1983. The system was operated by the City of Tacoma until early November 1983 when production from the well field for that year’s peak demand was no longer needed. Since that time, operation of the Well 12A treatment system of air stripping towers has continued on a seasonal basis (during peak demand) to reduce impact to the remaining well field and will continue until remediation is completed.

Phase II RI/FS. Because the Phase I RI identified only a general source location and not a specific site, EPA authorized a study of historical solvent use and disposal practices in the suspect area in December, 1982. Records of past investigations by TPCHD, Tacoma Water Division, and the Washington State Department of Ecology (Ecology) were reviewed and interviews were conducted with owners of numerous businesses in the area. A follow-up study focused on the historical uses and disposal of PCA in the vicinity of Well 12A. The focus on PCA was based on the fact that the RI determined this chemical to be the predominant contaminant and an uncommonly used solvent. Since few businesses nearby used PCA, these studies reduced both the number and location of potential sources of the contamination by process of elimination.

In May 1983, EPA authorized a supplemental Remedial Investigation and Feasibility Study (RI/FS) to further define the extent of groundwater contamination and to attempt to locate the source. Four monitoring wells were installed and sampled. Groundwater located near the Time Oil property contained concentrations of TCE, PCA, and *trans*-1,2-DCE in the low parts per million (ppm) range, which was substantially higher than detections in other wells, and orders of magnitude higher than at Well 12A. It was consequently determined that these monitoring wells were at or near the source of contamination.

With the apparent source area narrowed down substantially, EPA obtained air samples and near-surface soil samples along the Burlington Northern railroad spur north of the Time Oil property. Air sampling results showed very low contamination levels, but soil samples contained significant concentrations of TCE and PCA, confirming that this was the source of the contamination. The soil underlying the railroad track was composed of a fine-grained filter cake that had been generated during oil reprocessing operations at the site and disposed of on site. The filter cake consists of a tar-like sludge filtered from treated waste oil and is contaminated with high concentrations of lead (1 to 2%) as well as chlorinated organics.

Remedial alternatives were then developed to treat both the soil and the groundwater at the source and a proposed plan was issued for public comment.

1.3.5. Basis for Taking Remedial Action

As noted above (Section 1.3.4), the 1983 RI identified four COCs: trans-1,2-DCE, PCA, TCE, and PCE. The 2009 ROD Amendment #2 added two additional COCs (cis-1,2-DCE, and vinyl chloride), thereby establishing the current list of COCs in groundwater for the site as follows:

- cis-1,2-DCE
- trans-1,2-DCE
- PCA
- PCE
- TCE
- vinyl chloride

All COCs have been detected in groundwater at levels above either the Maximum Contaminant Levels (MCLs) or Washington State Model Toxics Control Act (MTCA) cleanup levels (USEPA, 2009). The Endangerment Assessment (associated with the Phase I FFS) determined that public health may be threatened either by direct contact at the source area or by consumption of contaminated drinking water if no additional remedial action was taken. On the basis of these findings, remedial action was determined to be warranted to mitigate risks to human health and the environment.

1.4. Remedial Actions

The following sections summarize the remedial actions selected in the decision documents, describe the implemented remedial actions, and summarize the operation and maintenance (O&M) activities of the

existing remedial systems. A summary of the interim and final remedial actions by decision document is presented in Table 2-2.

1.4.1. Remedy Selection

Table 2-2. Summary of ROD, ROD Amendments, and ESD for Well 12A

Date	Decision Document	Remedial Action/Components
March 16, 1983	ROD	Interim Measure: • Installation of air stripping system at Well 12A • Pumping Well 12A to provide a hydraulic barrier
May 3, 1985	ROD Amendment (first)	Address soil and groundwater contamination within source areas: • Excavation and removal of filter cake and contaminated soils in and around Time Oil Building and along the Burlington Northern Rail Road (BNRR) rail spur • Installation of GETS using air stripping for treatment • Soil flushing using treated water in areas of higher soil contamination • Capping in areas of lesser soil contamination
April 28, 1987	Remedial Design changes documented in Memorandum to Regional Administrator	Enhance soil and groundwater remedial action: • Installation of Soil Vapor Extraction (SVE) system instead of soil flushing • Use of carbon adsorption for GETS treatment instead of air stripping
October 29, 2009	ROD Amendment #2	Enhance soil and groundwater remedial action via: • Shallow excavation, in-situ thermal remediation (ISTR). and enhanced anaerobic bioremediation (EAB) of source material • IC requirement to avoid/limit exposure to contamination • Continued operation of air-stripping units at Well 12A with contingency for Monitored Natural Attenuation (MNA) • Continued plume monitoring • Continued O&M of the air strippers and groundwater monitoring at Well 12A
June 14, 2012	Explanation of Significant Differences (ESD)	Additional site characterization required modifications to the 2009 remedy: • Remove the Time Oil Building to allow access to highly contaminated soils
TBD	Future Decision Document	Following completion of remedial actions in ROD Amendment #2 and post-completion monitoring for a reasonable amount of time, this proposed decision document will select the final remedy for groundwater.

The ROD, issued March 18, 1983, provided an Interim Remedial Measure (IRM) to address groundwater contamination at Well 12A. The 1983 remedy involved the installation and operation of an air-stripping system that would treat water pumped from Well 12A using five aeration towers operating in parallel. Treated water would be discharged to Commencement Bay or to the city's drinking water system depending on measured quality and the city's need. This remedy was meant as an interim measure until the source area could be identified and the contamination mitigated (USEPA, 1983).

Following the RI and FS (discussed in 1.3.4), the ROD was amended in May 1985 to require identification of source areas and treatment for soil and groundwater contamination within those source areas. The first ROD Amendment selected several major elements, including: continuation of the

treatment at Well 12A using air stripping, excavation of contaminated soils, installation of a groundwater extraction and treatment system (GETS) using air stripping for treatment, and additional soil treatment by flushing using the extracted and treated groundwater, and capping of less-contaminated soils. The first ROD Amendment granted the EPA regional administrator authority to approve modifications to the choice and operation of certain aspects of the treatment system and soil remedy which are found to be "equivalent in effectiveness and cost or are necessary for the protection of health and the environment" (USEPA, 1985).

The IRM was amended in an April 28, 1987, memorandum to the Regional Administrator to include soil treatment by soil vapor extraction (SVE) instead of soil flushing and to include treatment of contaminated groundwater using carbon adsorption instead of air stripping in the Groundwater Extraction and Treatment System (GETS). These treatment systems were proposed to augment the air stripping system used for treatment of Well 12A groundwater that was used only during periods of peak demand. Selection of soil cleanup levels was postponed to a subsequent decision document.

In 2004-2005, EPA installed additional monitoring wells and collected soil samples and groundwater samples. Oily product was identified in some soil samples primarily collected from areas to the east of the Time Oil building. Groundwater contaminant concentrations and distribution had generally decreased compared to previous sampling events, although elevated concentrations of COCs were still found near the Time Oil property. In 2008, the third FYR concluded that the GETS was no longer effectively reducing contaminant concentrations and was not adequately controlling the migration of contamination (USEPA, 2008). Since the report concluded that the remedy was not protective, corrective actions were initiated.

In 2009, a Focused Feasibility Study (FFS) analyzing potential remedial alternatives to address ongoing contamination was completed (CDM, 2009). Shortly thereafter, a second amendment to the ROD was completed in October 2009 to address the COCs remaining in soil and groundwater. ROD Amendment #2 required continued operation of the GETS and treatment at Well 12A while adding the following remedy components:

- Excavation and off-site disposal of filter cake and contaminated soils;
- In-situ thermal remediation (ISTR) of soil and groundwater
- In-situ enhanced anaerobic bioremediation (EAB) of groundwater;
- Institutional controls (ICs) to avoid or limit exposure to site contamination and guide the use of the aquifer;
- Continued O&M of the GETS to prevent contaminant migration, with a contingency for monitored natural attenuation (MNA) to achieve further remediation once interim objectives have been achieved.
- Monitoring of the plume;
- Continued O&M of the air stripping units and groundwater monitoring for VOCs at Well 12A.

The remedy selected in Amendment #2 is considered a final remedy for soils and an interim remedy for groundwater that will be protective and assist in achieving the long-term objective of restoring the aquifer to its beneficial use as a drinking water source for the City of Tacoma.

During remedial design investigations, more residual source material was discovered beneath the Time Oil Building than was previously known. To address the additional source material, an Explanation of Significant Differences (ESD) was completed in June 2012 that modifies the remedy to include removal of the Time Oil Building to allow access to highly contaminated soils.

1.4.2. Remedial Action Objectives

In order to protect human health and the environment, ROD Amendment #2 replaced and updated the Remedial Action Objectives (RAOs) for the site. Fundamental changes were implemented to improve overall remedy effectiveness and permanence and increase the probability of achieving the ultimate goal of groundwater restoration. The RAOs were based on the updated conceptual site model (CSM) which identified four zones/areas that needed to be addressed:

- Filter cake and shallow impacted soil.
- Deep vadose zone soil and high-concentration groundwater east of the Time Oil building.
- High-concentration groundwater west and south of the Time Oil building. This area is defined by groundwater with COC concentrations greater than 300 µg/L.
- Low-concentration groundwater. This area is defined by groundwater with COC concentrations less than 300 µg/L.

Based on these definitions, RAOs for the site are:

1. Eliminate the risk to human health posed by direct contact with filter cake and contaminated soil at and near the surface still present on the east side of the Time Oil building;

2. Prevent or minimize the migration of contamination from the highly contaminated shallow soil and filter cake area into the deeper soils to prevent further degradation of groundwater;

3. Remove sufficient contaminant mass within the source area to reduce the transport of contaminants from this highly contaminated source material into down-gradient groundwater;

4. Reduce contaminant mass discharge by 90% from the source area into the low-concentration groundwater treatment zone;

5. Reduce contaminant concentrations to meet cleanup levels selected in this amendment to be protective of human health and the environment and to comply with all ARARs at specified points of compliance;

6. Eliminate risk to human health from exposure to groundwater containing COCs in excess of protective levels.

Amendment #2 further subdivided compliance with the RAOs into three tiers to allow implementation of a multi-component remedy and allow for decision-making such as when to transition from one treatment technology to another and when to transfer O&M to the State of Washington Department of Ecology (Ecology).

- 1st Tier - Address residual sources, minimize risk to receptors due to contaminated surface soils and achieve a contaminant mass discharge reduction of at least 90% from the high-concentration source area. Soil removal, ISTR, and EAB will be considered complete and the Remedy will be considered operational and functional when Tier 1 criteria have been met. O&M will be turned over to Ecology when Tier 1 criteria have been met.
- 2nd Tier – Achieve cleanup levels at interim performance monitoring points (within the current groundwater plume) to ensure groundwater concentrations are below applicable or relevant and appropriate requirements (ARAR)-specified levels at these locations.
- 3rd Tier – Determine if cleanup levels can be achieved in a reasonable timeframe throughout the contaminant plume by discontinuing GETS operation and continuing to monitor natural attenuation of any remaining contamination. If this demonstrates that cleanup levels could be achieved in a reasonable timeframe with MNA only, the MNA contingency will be implemented and GETS operation discontinued. If compliance with ARARs throughout the plume is deemed not feasible, additional remedial alternatives or a Technical Impracticability waiver may be sought for non-compliant portions of the aquifer.

1.4.3. Remedy Implementation

Collectively, the original ROD and ROD Amendments selected a multi-component remedy that was adapted as more information became available. Each component of the selected remedy is described below.

1.4.3.1 Well Head Treatment at Well 12A

The original 1983 ROD selected wellhead treatment at Well 12A using air strippers to treat pumped groundwater. This remedy was meant as an interim measure until the source area could be identified and the contamination mitigated. The air stripping system became operational in July 1983 and currently continues to operate when the well is pumped, which is typically during seasonal periods of peak demand. The system was constructed with five towers, each with its own blower and sized to treat up to 1000 µg/L of VOCs. Well 12A typically operates at about 3,500 gpm and the flow is split among the five towers. In 2009, the City of Tacoma switched to using only three towers during operation to save on costs.

1.4.3.2 Soil Excavation

Excavation and disposal of contaminated filter cake and shallow soils in and around the Time Oil Building was selected in the first ROD Amendment and again in Amendment #2. In 1986, Burlington Northern excavated approximately 1,200 cubic yards of contaminated soils along the rail spur. An additional 5,000 cubic yards of waste sludge (filter cake) from the oil recycling operations were excavated as part of the SVE system construction in 1992.

During the remedial design investigation completed in 2010, a 14,280-gallon underground storage tank (UST) was encountered on the Time Oil property; the UST and adjacent soils, including filter cake material, were subsequently removed in 2011/2012. Due to differences in the type and concentrations of contaminants in soil, the excavation area was divided into a northern and a southern area. Soil in the southern area met RCRA Land Disposal Restrictions (LDRs). Soil in the northern area contained high levels of VOCs and required chemical treatment prior to disposal. Sodium persulfate and lime were used

to reduce VOCs to levels that met RCRA LDRs. Final quantities removed included 6,775 gallons of UST liquids and 2,093 tons of contaminated soil. The final extents of the excavation are shown on Figure 2-3.

1.4.3.3 Groundwater Extraction and Treatment System

The first ROD Amendment selected a GETS consisting of extraction well(s) at the source area, treatment of the extracted water by aeration, and discharge of the treated water to Commencement Bay. Treatment was later changed to carbon adsorption in the April 28, 1987 memorandum to the Regional Administrator, before the GETS system began operation in 1988. The overall objective of the GETS has been to limit migration of dissolved contaminants in groundwater.

The GETS system as originally installed in November 1988 consisted of one well (EW-1) designed to extract water at 500 gpm, although the maximum pumping rate recorded during initial operation was only 300 gpm. Sustained pumping rates at EW-1 significantly declined due to biofouling and in 1995, four additional extraction wells (EW-2 through EW-5) were added to the system to augment extraction. Wells EW-2 through EW-5 were designed to yield 50 gpm each, although maximum sustained rates during initial operation only ranged from 7.5-24 gpm. The treatment system consists of two bag filters arranged in parallel that precede two 20,000-pound granular activated carbon (GAC) units arranged in series. Effluent is discharged via storm drains to the Thea Foss Waterway which flows into Commencement Bay. The GETS extraction well locations are shown on Figure 2-4.

1.4.3.4 Soil Vapor Extraction

The SVE system was instituted after the first ROD Amendment under authority granted by the EPA Regional Administrator. In August 1993, an SVE system was installed and began operation. The system consisted of 22 vapor extraction wells in the area where drum storage and disposal operations had previously occurred west of the Time Oil building. Vapors were treated using carbon adsorption. Operation of the SVE system was discontinued in 1997 after soil contamination was reduced to concentrations that would not impact groundwater quality along the west side of the Time Oil building (EPA, 2009). Between 1994 and May 1997, the SVE removed approximately 54,100 pounds of VOCs. Approximately 25 percent of the VOCs were chlorinated and the remainder consisted of light-end hydrocarbons. The SVE equipment is still on site, but it is in poor condition due to not being used or maintained since it was shut down in 1997.

1.4.3.5 In-Situ Thermal Remediation

ROD Amendment #2 selected ISTR to treat the highly impacted portions of the deep vadose zone and upper saturated zone near the former Time Oil building. Several phases of remedial design investigations in 2010 and 2011 have been completed and the results used to delineate the area for ISTR. Data collected during these and previous investigations were input into a 3D visualization model, Mining Visualization Software by CTech (MVS), to determine contaminant distribution in soil and groundwater.

The proposed treatment area for ISTR was based on the modeled area containing COC soil concentrations greater than 5,000 µg/kg. This area is approximately 13,150 square feet in size and extends from the ground surface to a depth of 55 feet (see Figure **2-5**). The majority of the mass is contained in two zones,

0 to 10 feet bgs and 35 to 55 feet bgs. Approximately 77% of the proposed treatment area is located beneath the Time Oil building, which will require removal of a portion of the building as described in the 2012 ESD. The most recent schedule indicates design of the ISTR remedy in 2013 with implementation in 2014.

1.4.3.6 Enhanced Anaerobic Biodegradation

ROD Amendment #2 selected EAB to treat the high-concentration groundwater plume through injection of a carbon substrate to enhance reductive dechlorination under anaerobic conditions. Treatment will be targeted along the interface of the Qpf silt unit, where high concentrations of residual contamination remain. The EAB remedy is still in the early stages of design. A bench-scale study was completed in 2012 that recommended general biodiesel waste oil or Inland Empire crude vegetable oil with bioaugmentation (i.e., addition of cultured microorganisms). A shear-thinning fluid will be used for injections to increase flow through the low permeability zones. A pilot-scale EAB test began in April 2013 to evaluate the performance of the mixing and injection strategy. The final EAB remedy will be designed to achieve the 90% mass reduction RAO. EAB design will be completed in 2013 with implementation in 2014/2015.

1.4.3.7 Monitored Natural Attenuation

ROD Amendment #2 selected MNA as a contingency to implement once interim objectives have been achieved and Tier 1 objectives have been met (i.e. 90% mass discharge reduction). Groundwater monitoring will be used to determine if the GETS operation can be discontinued and MNA can be relied on to achieve the long-term groundwater monitoring objectives of meeting cleanup levels in a reasonable timeframe.

1.4.3.8 Groundwater Monitoring

ROD Amendment #2 selected groundwater monitoring as the means to determine if RAOs have been achieved. Remedial performance monitoring will be used to evaluate the progress of ISTR and EAB toward meeting Tier 1 objectives. Interim performance monitoring points will be used to determine when Tier 2 objectives have been met (i.e. achieve cleanup levels at points of compliance). A 30-year monitoring and evaluation program will be implemented to monitor remedial performance and determine if Tier 3 objectives can be met in a reasonable timeframe (i.e. achieve cleanup levels throughout plume).

1.4.3.9 Institutional Controls

ROD Amendment #2 selected ICs to protect human health by limiting access to and future development, improvement, and use of affected properties. An IC Plan was developed in 2010 describing ICs for the site. The types of ICs selected include proprietary, such as restrictive covenants; governmental, such as zoning ordinances, well drilling regulations, or local building/development permits; and informational devices, such as EPA fact sheets. Following achievement of the Tier 1 objectives, soil and groundwater contamination may still be present at levels above those that would be protective of human health and ICs will be re-evaluated. A summary of the selected ICs and their current status is discussed in Section 1.6.7.

1.4.4. Systems Operations/Operations & Maintenance

Remedial activities with ongoing O&M are described below.

1.4.4.1 Well Head Treatment and Well 12A

The City of Tacoma owns and operates Well 12A and the five air stripping towers adjacent to the well. When in operation, treated water from Well 12A is added to the drinking water supply. Well 12A and the treatment system were used to meet peak summer demand throughout the 1980s and 1990s. Well 12A is typically now pumped only during the summer or early fall on an every-other-year frequency for testing. At the time of the site visit and the writing of this FYR, Well 12A was not being pumped to supplement drinking water supply. A mechanic from the City visits the pump house on a weekly basis to check for damage or tampering. In 2012, electrical panels that support the blowers on the air stripping towers were upgraded; the communication system was simultaneously upgraded, which allows for remote operation by the City. Vapor from the stripping towers is not treated with vapor phase carbon and is discharged to the atmosphere. In 2009, the City switched from using all five air-stripper towers for treatment to using only three to reduce the expense.

Since July 2006, the only COCs detected in influent to the treatment system have been TCE and trans-1,2-DCE. Available influent (pretreatment) data is provided in Table 1-3. Effluent data was not available; however, concentrations of COCs in the influent have remained below groundwater cleanup levels since the 2009 sampling.

Table 2-3. Well 12A Pretreatment data.

Date	TCE (µg/L)	trans-1,2-DCE (µg/L)
9/20/1999	12.0	Data unavailable
7/20/2000	8.5	
10/24/2001	2.1	
11/7/2002	2.5	
7/31/2003	7.7	
10/19/2004	10.6	
10/19/2005	3.1	
7/26/2007	7.0	0.9
9/8/2008	0.80	ND
8/6/2009	4.2	0.58
9/23/2010	1.6	ND
6/29/2011	1.49	ND
6/6/2012	0.52	ND

1.4.4.2 Groundwater Extraction and Treatment System

The GETS system has been consistently operating, except for temporary shutdown periods for maintenance. Sustained pumping rates have declined since the system was installed. Prior to well rehabilitation in 2012, combined flows from the system were approximately 83 gpm. A GETS inspection and performance evaluation was completed in August 2011. The inspection identified several deficiencies that were later fixed, including replacement of pressure gauges, transducers, and the low-level switch at well EW-1. Rehabilitation was also recommended for wells EW-1 and EW-2 due to their significant decline in specific capacity. Rehabilitation was completed in 2012 using the Hydropuls© technology, which uses bursts of compressed nitrogen along with extraction of groundwater to remove fines and biofouling accumulated on the well screen and filter pack. Rehabilitation resulted in a substantial improvement in extraction well yields and an increase in overall extraction rates by more than a factor of 2 (CDMSmith, 2012d).

Currently, only four extraction wells are in operation. The non-operating well, EW-4, is located adjacent to the treatment area for ISTR and will be decommissioned as part of the ISTR remedy. A GETS capture assessment was completed as part of the mass discharge evaluation (see Section 1.6.4.3) and it was determined that well EW-3 was capable of maintaining full capture without EW-4 in operation. The GETS has been shut down since April 2013 during the EAB pilot test and will most likely remain off during the full-scale ISTR and EAB remedial activities.

The treatment system is located south of the Time Oil property outside on a concrete pad surrounded by a chain-link fence. It consists of two bag filters arranged in parallel that precede two 20,0000-pound GAC units arranged in series. Effluent from the second GAC unit is discharged to the City of Tacoma stormwater system. Influent and effluent samples are collected bi-weekly by Tacoma Water personnel and sent to EPA's Manchester Laboratory for analysis.

Between 1988 and December 2012, the GETS treated over 860 million gallons of groundwater, removing approximately 18,625 pounds of VOCs (CDMSmith, 2012f). Influent concentrations of VOCs have

generally decreased from 2000 to 2009; however, contaminant concentrations observed in monitoring wells remain elevated.

During the period of December 27, 2012, through March 7, 2013, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride were the only chemicals that were detected in the discharge effluent from the GETS (Table 2-4). Concentrations of cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride ranged from non-detect to 0.53 µg/L, non-detect to 0.26 µg/L and non-detect to 1.8 µg/L, respectively. All three detected chemicals in the effluent were present in concentrations below their respective MCLs of 70, 100, and 2 µg/L. State water quality standards for the protection of aquatic life are unavailable for the detected compounds although federal National Toxics Rule water quality standards include a vinyl chloride concentration of 2 µg/L for the protection of human health due to the consumption of water and organisms.

Table 2-4. Recent GETS effluent data.

	12/27/2013	1/10/2013	1/24/2013	2/7/2013	2/21/2013	3/7/2013
cis-1,2-DCE	0.32	0.53	0.42 J	0.34 J	0.33 J	1.0 U
trans-1,2-DCE	1.0 U	0.26	1.0 U	1.0 U	1.0 U	1.0 U
PCA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
PCE	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
TCE	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
VC	1.3	1.7	1.7	1.8	1.8	1.0 U

All units are µg/L.

Previously, Ecology changed out the carbon when values in the effluent (from both vessels) reached 10 µg/L for vinyl chloride (Chris Maurer interview, Appendix 1-D). This limit was based on empirical observations of the system and is considered more stringent than the former operating criteria of 10.7 µg/L for the sum of PCA and PCE; this limit is also well below the former discharge criteria proposed for vinyl chloride of 100 µg/L in the O&M manual (URS and CH2MHill, 2004). Using the 10 µg/L guideline value for vinyl chloride, Ecology determined that the typical carbon change-out frequency was twice per year, which has replaced the vinyl chloride limit requirement and is now the standard.

1.4.4.3 Groundwater Monitoring

Since the remedies selected in ROD Amendment #2 are in progress, the current groundwater monitoring program is focused on evaluation of remedial technology performance. Groundwater monitoring objectives and wells to be sampled are determined for each sampling event based on the remedies currently being implemented. Three rounds of monitoring have been completed since ROD Amendment #2 was signed:

- Round 1, Fall 2011. The objective of this event was to fill data gaps in the CSM.
- Round 2, Summer 2012. The objective of this event was to fill data gaps in the CSM.

- Round 3, December 2012. The objectives of this event were to evaluate passive sampling devices and establish concentration trends in newly installed interim performance monitoring wells (IM series).

The evaluation of the passive sampling devices during the third round of groundwater monitoring concluded that the Hydrasleeve™ will provide adequate representation of subsurface conditions during future performance monitoring events. Use of this sampling technology will decrease costs associated with performance monitoring.

1.4.4.4 Summary of Costs of System Operations/O&M Effectiveness

Operating costs for Well 12A and the air stripping treatment system were unavailable from the City of Tacoma. Since 2005, Tacoma Water has reduced the number of air-stripping towers in use from five to three, resulting in significant electrical savings.

EPA contracted out the operation of the GETS from 1995 until operations were transferred to Ecology in Fall 2005. Ecology pays Tacoma Water to operate, maintain, and sample the five extraction wells. Ecology reports that the current costs are about $100,000 per year, which includes two carbon change-outs ($40,000 per change out) and $20,000 for sampling performed by Tacoma Water personnel. EPA resumed responsibility for O&M of the GETS in July 2013 for implementation of the ISTR and EAB remedial activities.

1.5. Progress Since the Last Five-Year Review

1.5.1. Protectiveness statements from last review

The protectiveness statement from the 2008 Five-Year Review was the following:

The remedy at Well 12A is not protective because of the following issues:

- *A potential threat is present from direct contact with remaining contaminated soils;*
- *Migration of the contaminated groundwater above the MCLs is not being controlled;*
- *Potential exposure to indoor air is likely. This exposure pathway requires evaluation to determine if the remedy effectively minimizes risk of this exposure pathway.*
- *An ICP that considers remedy protectiveness of pathways of concern should be developed to prevent exposure to soil and groundwater contaminated above levels of concern;*
- *An effluent discharge permit is required to establish discharge criteria and point of compliance requirements by which system O&M can be measured and potential exposure pathways from discharge can be controlled; and*
- *Drums are present on site, which contain investigative derived wastes.*

The following actions need to be taken to ensure protectiveness:

- *Institutional controls should be developed and implemented to prevent direct contact to remaining soil contamination;*

- *Additional information on the evaluation of source strength and current extent of current groundwater plume should be collected. Once this information is obtained, an evaluation of the remaining source area, impact on ability to achieve various targeted achievable RAOs for groundwater, and potential remedy modifications shall be conducted via a focused feasibility study which will screen remedial options in light of improving effectiveness of the remedy. ICs should also be put into place preventing drinking water use;*
- *Evaluation of the indoor air pathway should be conducted and, if unacceptable risks are found, they should be remedied;*
- *A discharge permit should be developed and finalized with the City of Tacoma; and*
- *Drums should be removed from the site.*

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

Recommendation 1: Use new 2008 groundwater data and pumping rates for extraction wells to establish current site conditions and capture zones.

Status: Completed. Extensive groundwater monitoring data collected as part of the remedial design work has significantly increased the understanding of current site conditions. A GETS capture zone analysis was completed in 2012 to support the use of the extraction system for mass discharge calculations. An aquifer performance test was also completed at Well 12A in 2012 to determine influence of pumping on site remedies.

Recommendation 2: Conduct modeling to evaluate if indoor air pathway is complete.

Status: Not Completed. The Time Oil building occupants will not be present during the Tier 1 remedy implementation. Only workers associated with the remedy implementation will be in the building. USEPA will evaluate the indoor air pathway after achievement of Tier 1 objectives (i.e. 90% mass discharge reduction) for future building use.

Recommendation 3: Identify potential viable RAOs and back calculate flux changes in source needed to achieve them.

Status: Completed. ROD Amendment #2 (2009) identified six RAOs for the Site. A goal of at least 90% contaminant discharge reduction was selected as the compliance level to achieve remedy complete status for soil removal, ISTR, and EAB.

Recommendation 4: Compare potential RAOs to data needs to determine if additional soil or groundwater data needed.

Status: Completed. Remedial design investigations were completed in 2010 and 2011. Numerous monitoring wells and soil borings have been completed for use in the collection of data to fill data gap obstacles to ISTR, EAB, and mass discharge flux measurements.

Recommendation 5a: Conduct focused feasibility study to evaluate benefits of additional remedial actions on ability toward achieving various RAOs. This evaluation should also include enhancements of existing remedy, to include changes in existing extraction system and options for targeted source area remediation.

Status: Completed. A Focused Feasibility Study evaluating additional remedial actions was completed in April 2009. ROD Amendment #2 selected soil excavation, ISTR, and EAB as the additional remedial actions.

Recommendation 5b: Generate decision document, as needed to document revised RAOs and or remedy modifications.

Status: Completed. ROD Amendment #2, signed in 2009, revised the RAOs and selected final and interim remedies for soil and groundwater, respectively.

Recommendation 6: Develop and implement ICs to prevent exposure to contaminated soil and groundwater.

Status: Ongoing. An IC plan was completed in 2010. ICs are in place to prevent exposure to shallow soil contamination and prevent ingestion of groundwater. However, additional environmental covenants may be needed for future protectiveness. Following the achievement of Tier 1 objectives, ICs will be re-evaluated.

Recommendation 7: Establish a new groundwater monitoring program, including pumping rates for extraction wells, and well performance monitoring (dissolved oxygen, redox, biological characteristics, etc.).

Status: Ongoing. A groundwater monitoring program has been implemented as part of the remedy selected in ROD Amendment #2. Monitoring objectives are determined by event and are based on the current active remedies. A GETS capture zone assessment was completed to determine the optimal pumping rates for the mass discharge evaluation. Interim performance monitoring wells were in July-August 2012; the location for the two new compliance wells has not yet been determined.

Recommendation 8: Establish a discharge permit, including discharge criteria and location of the point of compliance.

Status: Not Needed. The substantive portions of the ARAR for GETS discharge need to be met (e.g. discharge criteria); however, no Federal, State or local permits are required for the portion of any removal action or remedial action at a CERCLA site. If GETS operations are resumed following EAB and ISTR remedial actions, a discharge permit for treated effluent from the GETS including development of discharge criteria and a point of compliance would need to be developed.. Detected chemicals in the effluent for the period of December 27, 2012 thru March 7, 2013 included cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride. State aquatic life standards do not list these chemicals. All concentrations were below available federal MCLs and water quality standards for the protection of human health.

Recommendation 9: Remove drums from the site.

Status: Completed. The drums identified during the last FYR site inspection were inventoried and determined to be empty drums from previous drilling and well development. The drums were used to contain investigation derived water (IDW) water prior to disposal using the GETS. Some of the drums had collected rainwater and were mistakenly identified as containing IDW during the site inspection. EPA disposed of drums with solids left on the bottom along with IDW from recent investigations. Those drums in poor condition and not suitable for reuse were disposed of empty. Those drums in good condition were reused for non-hazardous waste solids.

Recommendation 10: Complete the State Superfund Contract that will turn all site responsibilities over to Ecology.

Status: Completed/Irrelevant. State Superfund Contract was signed in April 2010 however, this recommendation does not impact the protectiveness of the remedy. ROD Amendment #2 developed RAO compliance tiers that support a multi-component remedy and allow for decision making, such as when to transition from one treatment technology to another and when to transfer O&M to the State. Achievement of Tier 1, which includes a mass discharge reduction of 90% from the high concentration source area, would trigger turning the site over to the State.

1.6. Five-Year Review Process

1.6.1. Administrative Components

The USEPA Remedial Project Manager for the Well 12A project area is Howard Orlean. The five-year review team included the following personnel from the USACE Seattle District: Heather Whitney (chemist) and Sharon Gelinas (hydrogeologist). The review team established the review schedule to be completed between January 2013 and May 2013. Components of the review included:

- Document Review
- Data Review
- Site Inspection
- Local Interviews
- Five-Year Review Report Development and Review.

1.6.2. Community Involvement

A public notice announcing the five-year review for the Site was published April 25, 2013 in the Tacoma News Tribune.

1.6.3. Document review

This FYR included a review of relevant, project-related documents including RODs, ROD amendments, one ESD, monitoring reports, investigation reports, and recent monitoring data. A complete list of the documents reviewed can be found in Appendix 1-A.

1.6.4. Data Review

Two phases of Remedial Design (RD) investigations have been completed since ROD Amendment #2 was signed in 2009. The original investigation was completed in 2010 and a follow-on phase was completed in 2011. Along with the 2011 RD, a vertical profiling investigation was completed to support the evaluation of the mass discharge. A total of 46 soil borings and 6 monitoring wells were installed during the RD investigations along with collection of numerous soil and groundwater samples and hydraulic conductivity data. Figure 2-6 shows the sampling locations and groundwater monitoring wells at the site at the time of the RD investigations. Following the RD investigations, 6 interim performance monitoring wells and 8 EAB wells were installed, which included 3 test injection wells. The additional wells are shown on Figure 2-7.

The 3D visualization software MVS has been utilized throughout the project to evaluate the distribution of soil and groundwater contamination and determine treatment zones for the multi-component remedy. MVS can be used to interpolate geologic, hydrogeologic, and contaminant data. MVS uses geostatistical analyses to determine contaminant extents and to evaluate confidence and uncertainty in outputs. Where applicable, the results of the modeling are used to support the discussion below.

1.6.4.1 Soil

Soil contamination at the Well 12A project area remains in two source areas: the Time Oil source area and the Qpf fine-grained unit source area. The primary source area is associated with the Time Oil source which consists of filter cake and shallow soils impacted by residual dense non-aqueous phase liquids (DNAPL). This shallow soil contamination is generally located from 0 to 10 feet bgs. The highest concentration for the sum of the six COCs was detected at 1 foot bgs at a concentration of 462,000 µg/kg, which is indicative of filter cake material. Residual contamination is also located within the deep vadose zone beneath the former Time Oil building; the highest concentrations were located primarily between 30 and 50 feet bgs.

A fine-grained unit with high concentrations of COCs was identified to the southwest of the former Time Oil building during the RD investigations. This unit, also called the Qpf fine grained unit, is thought to act as a secondary source of contamination to groundwater. Contamination in the silt (fine-grained) unit was typically encountered at 56 to 59 feet bgs; the highest concentration for the sum of the six COCs was 43,000 µg/kg.

Elevated COC soil concentrations were also encountered at the base of the upper aquifer near South Tacoma Way during the RD investigations. For the sum of the six COCs concentrations up to 9,430 µg/kg were detected.

Figure 2-8 shows the MVS model results for soil contaminant distribution split into four zones. These zones are used to discuss mass distribution and identify remedies. Zone A represents a shallow potential secondary source southwest of the Time Oil building where elevated VOCs were encountered. It was determined that the contaminant mass in Zone A does not appear to be a secondary source and there is no remedy planned to treat contamination in this zone. Zone B represents the Qpf fine-grained unit source area and soil contamination at the base of the upper aquifer. EAB will be used treat contamination in this

zone. Zone C represents the vadose zone contamination beneath the former Time Oil Building and Zone D represents the saturated zone contamination beneath the former Time Oil Building. Excavation of shallow contaminated soil to the east of the Time Oil Building has removed some of the mass in Zone C; ISTR will target the remaining contamination in Zones C and D.

1.6.4.2 Non-Aqueous Phase Liquid

Both light non-aqueous phase liquid (LNAPL) and DNAPL (dense NAPL) have been identified at the site. LNAPL primarily exists in the smear zone near the water table where it partially fills voids in the soil. Wells TOW-6, TOW-7, EW-4, MW-1 and MW-3 have had historical detections of LNAPL (Figure 2-6). DNAPL is evidenced by high concentrations of VOCs in soils at depth. DNAPL was found in monitoring well EAB-1 installed as part of the EAB pilot study.

1.6.4.3 Groundwater

Groundwater flow in the project area is influenced by several factors including operation of the GETS and operation of the Tacoma Water production wells. Under regional, non-pumping, conditions, groundwater flow is toward the east and northeast. When the GETS is operating, flow is generally toward the extraction wells. The GETS has the strongest influence in the shallow and medium zones of the upper aquifer where the gradient reverses direction. In the base portion of the upper aquifer, the GETS has minimal influence; the flow direction remains the same, but the gradient decreases by about half. The strong downward vertical gradient typically observed in upper aquifer wells at the Site increases when the GETS is in operation. Figure 2-9 depicts the groundwater flow direction with and without the GETS in operation.

An aquifer performance test was completed in 2012 using Well 12A to evaluate the influence of pumping on site remedial actions. The test concluded that the radius of influence of Well 12A extends approximately 2,300 feet northward toward the former Time Oil building and drawdown influence is estimated to be less than 0.6 feet. When Well 12A and the GETS are both operating, the GETS maintains hydraulic control near the former Time Oil building, while groundwater south of South Tacoma Way flows toward Well 12A. The lower portion of the upper aquifer was assumed to be semi-confined to confined for the analysis. Hydraulic conductivities were calculated as 874 to 5,921 ft/day and storage coefficients ranged from 0.006 to 0.078.

Results from groundwater sampling completed during the RD investigations were used to determine the extent of the high-concentration dissolved-phase plume. Figure 2-10 shows the extent of the high-concentration plume where the sum of the six COCs is greater than 300 µg/L. This area is largely anaerobic and intrinsic anaerobic attenuation is occurring; however, not at rates that would achieve RAOs within a reasonable timeframe. All six COCs have been detected at concentrations above ROD cleanup levels during the RD investigations. PCE was the most prevalent COC detected throughout the plume; however, cis-1,2-DCE and trans-1,2-DCE also represent a significant portion of mass within the plume.

Mass discharge is being used as the performance metric for completion of remedial actions in the high-concentration source areas. As part of the remedial design, a detailed analysis of mass discharge measurement methods was completed. Two methods were evaluated: the transect method and the

pumping test method. The 2011 RD investigation included a vertical profiling investigation along two transects, one to the north and one to the south of South Tacoma Way, for use in evaluating mass discharge. Groundwater samples collected from multiple levels within the aquifer and slug testing completed in representative intervals were used to integrate concentration and flow data along the transect. The pumping test method using the GETS was also evaluated. This method relies on extracting groundwater at a constant rate and measuring the flow and mass discharges from the wells. A GETS capture zone analysis was completed to determine the optimal pumping rates and whether a representative portion of the plume would be captured. The optimal pumping rate was a combined total of 134 gpm with complete capture expected in 180 days or less. This optimum pumping rate is an improvement over the pre-rehabilitation rate of 83 gpm using all five extraction wells.

The pumping test method was selected as the preferred mass discharge measurement method. Data analysis methods were then developed to limit uncertainty and account for variability in flow rates, sampling, and analysis. Eight rounds of mass discharge measurements were collected between September 2012 and January 2013 (see Figure 2-11). The last three measurements indicated that stabilization was achieved and the average of these three measurements, 403 g/day, was agreed on as the baseline mass discharge measurement.

1.6.5. Site Inspection

A site inspection was conducted on March 6, 2013. Personnel from USACE, CDMSmith, and City of Tacoma attended. Details of the site inspection and photos are presented in Appendix 1-B. The completed inspection checklist is presented in Appendix 1-C.

The GETS system and associated extraction wells were observed to be in working condition during the site inspection. Fencing around the GETS and the associated office/storage trailer was intact.

The former Time Oil property use was confirmed to be commercial and industrial. The site was completely paved, with the exception of the former warehouse east of the former East Tank Farm. The former SVE building is used as office and storage space for current remedial design activities.

The Well 12A wellhead treatment system was not in operation during the site visit, but all components, electrical structures, and fencing appeared in good condition.

1.6.6. Interviews

Interviews were conducted with the following agencies/organizations:

- City of Tacoma (Tacoma Water branch of Tacoma Public Utilities) – Chris Johnson and Craig Downs;
- Washington State Department of Ecology – Chris Maurer, Project Manager
- Citizens for a Healthy Bay (CHB) – Leslie Ann Rose, Senior Policy Analyst

Craig Downs also provided City production well data. The full questionnaire responses are presented in Appendix 1-D.

In general, Ecology and the City of Tacoma were pleased with the progress at the Well 12A project area. The only complaint expressed by the City was the slight nuisance caused by the need to turn Well 12A and the GETS wells on and off as needed for the pumping tests. However, the contractor (CDMSmith) was reportedly doing a good job of providing information and pumping needs with enough advance notice to the City. As the cost of operating the treatment system is an increasing concern for the City, the City would like to see the cleanup completed so the treatment system can be shut down permanently.

Leslie Ann Rose of CHB was not up-to-date on current progress, stating that the last information received occurred 3-4 years ago during the ROD. She specifically requested that regular communications from EPA be established so that CHB can stay informed regarding current work on the Site.

1.6.7. Institutional Controls

An IC plan was developed in 2010 that selected ICs for the protection of human health. A title search was not completed as part of this FYR because EPA had recently completed a title search prior to the development of the IC plan in 2010. EPA has obtained access agreements from property owners where investigation work was completed and will obtain additional access agreements, as necessary, for implementation of remedial activities. In addition, six parcels, including the Time Oil property and adjacent properties, have proprietary controls in place to allow unencumbered access for purposes of remedial action activities.

A summary of the ICs and their status follows:

ICs to prevent human exposure to shallow soil contamination:

- Environmental covenants for use restrictions. Shallow soil contamination was identified at three parcels at the time the IC plan was developed. This IC has not been implemented and will be re-evaluated following the achievement of Tier 1 objectives.

- Construction permits are required to regulate excavation on affected properties. Tacoma Municipal Code 13.09.080 requires a permit before "constructing, installing, substantially modifying, or changing the use of a facility or regulated facility." All properties affected by the soil contamination are within the South Tacoma Groundwater Protection District. TPCHD is responsible for regulating pollution prevention in this District and utilizes institutional knowledge of the existing contamination at Well 12A to preclude construction permitting. This IC is currently in place.

- Land use zoning to prevent residential development and uses. Properties where soil contamination has been identified are currently located within the City of Tacoma zoning district M2 (heavy industrial). This IC is currently in place; the M2 boundary was verified as part of this FYR.

- List on a state register. The former Time Oil property is listed on the State of Washington's Confirmed and Suspected Contaminated Sites List (CSCL) and the State's Hazardous Sites List.

This IC is currently in place; the Well 12A project area was verified on the CSCL as part of this FYR. The need to list adjacent/nearby properties with remaining soil contamination should be evaluated following achievement of Tier 1 objectives.

ICs and engineering controls to prevent human exposure to contaminated groundwater by preventing ingestion of contaminated groundwater:

- Operation of air stripping towers when Well 12A is in operation will be used to reduce contaminant concentrations to levels below water quality standards. This is an engineering control operated by Tacoma Water and is currently in place.

- Development of a pumping agreement among EPA, Ecology, and Tacoma Water to coordinate pumping and implementation of the remedy so that operation of Well 12A does not disrupt certain phases of the remedy. This IC is currently in place; the agreement was signed in December 2010. Coordination meetings are conducted annually as required by the agreement.

- Well permitting process. According to communications with Sharon Bell of TPCHD, drinking water well installations are currently not allowed within the City of Tacoma because it is a municipal service area. TPCHD is very aware of the problems with the Time Oil site and not likely to consider a well installation in that vicinity for drinking water purposes. Washington State regulations (WAC-1732-160-171) also prohibit installation of any drinking water wells within or near known or potential sources of contamination.

ICs to support long-term monitoring after completion of the active remedy:

- Environmental covenants for properties where wells are located. Re-evaluation of this IC and the need for environmental covenants will be completed following the development of a long-term groundwater monitoring program. According to April 2013 parcel access agreement information available from CDMSmith, 25 parcels are currently located above or adjacent to the 300-ppm COC groundwater plume.

- A long term monitoring agreement among EPA, Ecology and Tacoma Water to identify roles, responsibilities, and communication strategy during monitoring. This IC will be completed following the development of a long-term groundwater monitoring program.

1.7. Technical Assessment

1.7.1. Question A: Is the remedy functioning as intended by the decision documents?

Yes. Construction of the remedial actions described in ROD Amendment #2 is still in progress and the remedy is expected to be protective upon completion. Shallow soil contamination to the east of the Time Oil building has been excavated and transported off-site for disposal. ISTR and EAB are still in the design phase and are scheduled to be complete by 2015. In the interim, the GETS continues to operate and remove dissolved-phase contaminants in the high-permeability zones and Well12A water is treated via air stripping prior to use for drinking water. ICs are in place to prevent exposure to shallow soil during remedial activities and to prevent ingestion of groundwater.

Remedial Action Performance

Progress had been made toward achieving the Tier 1 objective of a 90% reduction in mass discharge. Shallow soil contamination to the east of the former Time Oil building, along with a UST discovered during the RD investigation, was excavated in 2011/2012. The area for the planned ISTR treatment, beneath and adjacent to the former Time Oil building, has been defined; system design and implementation is scheduled to be complete in 2014. Pilot studies for EAB are being conducted; design and implementation of full-scale EAB is scheduled to be complete in 2015. A mass discharge measurement method has been selected and the baseline measurement, 403 g/day, has been determined.

Performance monitoring has been focused on filling data gaps in the CSM and baseline monitoring of newly installed wells. As the ISTR and EAB remedies progress, monitoring will focus on the performance of these activities. Objectives for monitoring are currently determined on a per-event basis.

System Operations/O&M

The air-stripper treatment system at Well 12A is currently working as designed. The air strippers have been in operation since 1983. Electrical and communication systems were upgraded in 2011/2012, but no other major repairs have occurred. Currently, only three of the five air stripping towers are utilized to treat groundwater, resulting in significant cost savings. All treated groundwater meets MCLs.

The GETS system has recently been repaired to keep it in working condition for use throughout the remedial actions, if necessary. Inspections identified several deficiencies, such as the need for replacement of pressure gauges, transducers, and a switch at EW-1, that were subsequently fixed. Rehabilitation of extraction wells EW-1 and EW-2 was recommended due to their decline in specific capacity. Rehabilitation was completed in 2012 using the Hydropuls© technology. Well EW-4 is no longer in operation since it will be decommissioned during the implementation of ISTR. Capture zone analyses determined that well EW-3 is capable of maintaining full capture without the use of EW-4. The optimal total pumping rates using four extraction wells determined during the mass discharge

measurements was 134 gpm, which is an improvement over the pre-rehabilitation rate of 83 gpm using all five extraction wells.

Opportunities for Optimization

An evaluation of passive samplers was completed during the last groundwater monitoring event. It was concluded that Hydrasleeve™ samplers can provide adequate representation of the subsurface condition and will be used in future performance monitoring to reduce costs.

Implementation of Institutional Controls

An IC plan was developed in 2010 that selected controls for the protection of human health. ICs to prevent human exposure to shallow soil contamination include environmental covenants and governmental controls (e.g. construction permits, zoning restrictions, and listing of the site on the State of Washington's Confirmed and Suspected Contaminated Sites List [CSCL]). ICs to prevent ingestion of contaminated groundwater include pumping agreements with Tacoma Water and TPCHD's well permitting process. ICs to support long-term monitoring will include environmental covenants or access agreements and a long-term monitoring agreement among EPA, Ecology, and Tacoma Water. Fact sheets will be used to keep citizens informed throughout implementation of the remedy.

ICs associated with governmental controls are currently in place. The project area is located within the South Tacoma Groundwater Protection District, where pollution prevention is regulated by TPCHD. TPCHD also has several other controls in place to prevent drinking water wells from being installed. Following the achievement of Tier 1 objectives, ICs will be re-evaluated and proprietary controls, such as environmental covenants, will be implemented.

Early Indicators of Potential Issues

There are no indicators of potential issues.

1.7.2. 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?

No. There have been some changes to toxicity values that may require future re-evaluation of selected cleanup levels to ensure protectiveness is maintained. The changes do not affect the current protectiveness since ICs are in place to prevent exposure above the new standards. In addition, these changes do not affect the achievement of the Tier 1 criteria, a 90% reduction in mass discharge.

Changes in standards and to-be-considered criteria (TBCs)

Table 2-5 presents the chemical-specific numerical standards selected in Amendment #2 to the ROD (USEPA, 2009). The selected groundwater cleanup levels are applicable only at the Points of Compliance, which are defined in Amendment #2 as Well 12A and compliance wells CW-1 and CW-2.

Interim performance monitoring wells were installed in July and August 2012; the locations for the two compliance wells have not yet been determined.

Table 2-5 presents all standards in the ROD, as of Amendment #2. MCLs were selected as the cleanup levels for cis- and trans-1,2-DCE. There have been no changes to the MCLs since ROD Amendment #2.

Since ROD Amendment #2, revisions to Model Toxics Control Act (MTCA) B[1] cancer and/or non-cancer values have occurred for cis-1,2-DCE, PCE, TCE, and vinyl chloride. The impact of the revisions for each of the COCs is discussed in more detail below.

Cis-1,2-DCE. The MCL (70 µg/L) was selected as the cleanup level for cis-1,2-DCE. However, since the 2009 ROD Amendment #2, the MTCA B non-cancer value has decreased from 80 to 16 µg/L. The selected cleanup level (70 µg/L) is greater (less stringent) than the current MTCA B non-cancer value (16 µg/L). The change in the MTCA B standard does not affect the current protectiveness since ICs are in place to prevent exposure above the new MTCA B non-cancer standard of 16 µg/L..

Trans-1,2-DCE. The MCL (100 ug/L) was selected as the cleanup level for trans-1,2-DCE in ROD Amendment #2. Since then, the MCL has not changed, no current MTCA B cancer standard is available, and the current MTCA B non-cancer standard of 160 ug/L is less stringent than the MCL.

PCA. ROD Amendment #2 selected the MTCA B cancer standard of 0.2 ug/L as the cleanup level for 1,1,2,2-PCA. The MTCA B cancer value has not changed since ROD Amendment #2. The MTCA B non-cancer standard (160 ug/L) remains above (less stringent). No MCL was or is currently available for PCA.

PCE. In September 2012, the MTCA B cancer value increased to 21 µg/L and a new non-cancer value (48 µg/L) was established. The selected cleanup level of 0.8 µg/L (based on MTCA B at 10^{-5} cancer risk level) is now more protective. The MCL (5 µg/L) is more stringent than the MTCA B values.

TCE. In September 2012, the TCE MTCA B cancer value increased from 0.49 to 0.54 µg/L (10^{-6} risk) while the MTCA B non-cancer value increased from 2.4 to 4 µg/L. The MCL (5 µg/L) did not change. At the time of the 2009 ROD Amendment #2, the selected GW cleanup level was the MTCA B non-cancer value, which was the lowest value among the MTCA B cancer (10^{-5} risk) and non-cancer values and the MCL. Given these revisions, if the groundwater cleanup were selected today, the MTCA B non-cancer value would still be the lowest of the three values, but the value would be 4 µg/L. Thus, the selected groundwater cleanup level of 2.4 µg/L is still protective.

Vinyl chloride. The MTCA B cancer value for vinyl chloride has undergone two revisions since the ROD Amendment #2, but the overall effect is that the value has not changed and the revisions therefore do not affect protectiveness.

The ROD and subsequent amendments does not identify specific cleanup concentration standards for site soil contamination. For groundwater, ROD Amendment #2 requires a contaminant discharge reduction of

[1] MTCA B values were obtained on 2/14/2013 via Ecology's online Cleanup Levels and Risk Calculations (CLARC) database (https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx).

at least 90% from the high-concentration source area near the Time Oil building to the dissolved-phase contaminant plume (RAO #1). Soil removal, ISTR, and EAB will be considered complete and the remedy will be considered operational and functional when this criteria has been met. This cleanup goal is specific to the project area and is not affected by changes in published numerical cleanup standards.

Table 2-5. Summary of Groundwater ARAR Changes

Contaminant of Concern	MTCA Method B (ingestion + inhalation) as provided in 2009 ROD µg/L		MCL at time of 2009 ROD (µg/L)	Ground-water Cleanup Level (µg/L)	Basis for Cleanup Level	Current Regulations (µg/L)			Change since 2009 ROD?
	Cancer	Non-cancer				MTCA B Cancer 10^{-6}	MTCA B Non Cancer	MCL	
cis -1,2-DCE	70[a]	NP	70	70	MCL	NA	**16** (revised downwards from 80 µg/L on 4/13/2011 based on updated toxicity values)	70	Yes. MTCA B non-cancer is now more stringent than selected GW cleanup level.
trans-1,2-DCE	100[a]	NP	100	100	MCL	NA	160	100	No revisions found.
1,1,2,2-PCA	0.2	NP	NA	0.2	MTCA B 10^{-6} (no MCL)	0.22	160	NA	No revisions found.
PCE	0.08	NP	5	0.8	MTCA B 10^{-5} <MCL	**21** (revised upwards 9/26/2012 based on updated toxicity values. Less stringent.)	**48** (revised upwards 9/26/2012 based on updated toxicity values. More stringent)	5	Yes. MTCA B is less stringent, but 10^{-5} risk is still less than MCL.
TCE	0.49	2.4	5	2.4	MTCA B non-carcinogenic risk; MTCA B 10^{-5} = 4.9	**0.54** (revised upward 9/26/2012. Less stringent.)	**4** (revised upward 9/26/2012. Less stringent.)	5	Yes. MTCA B cancer and non-cancer values are less stringent.
vinyl chloride	0.03	NP	2	0.3	MTCA B 10^{-5} <MCL	0.03	24	2	No.

Notes: NA – Not available. NP - not provided in 2009 ROD.

a – Cancer values for cis- and trans-1,2-DCE do not have a history of any value or revisions in the Ecology Cleanup Levels and Risk Calculations (CLARC) database history. It is unclear from where the ROD produced these values (Table 4-1 of USEPA, 2009).

Table 2-6. ARARs Analysis

ROD	Authority	ARAR / Citation	ARAR Determination	Standard Applied in ROD	Current Use / Changes
2009 ROD Amendment #2	Hazardous Waste Cleanup – Model Toxics Control Act (MTCA) of 1989, RCW 70.105D	MTCA, WAC 173-340 (as amended Nov 2007). Specific subsections: WAC 173-340-720 WAC 173-340-740 WAC 173-340-745(b) WAC 173-340-747 WAC 173-340-440(1-4,9)	Applicable	Establishes the process and methods used to evaluate risk and develop standards for soil and other environmental media.	The substantive requirements of the specified subsections are relevant and appropriate to developing cleanup standards for the selected remedy: MTCA method B levels as the cleanup levels for TCE, 1,1,2,2-PCA, PCE, and VC. Revisions have occurred for PCE, TCE, and vinyl chloride. None of the revisions adversely affect the protectiveness of the selected remedy.
2009 ROD Amendment #2	Safe Drinking Water Act of 1974, 42 USC 300 et seq.	National Primary Drinking Water Standards, Subpart G, Specific subsections: 40 CFR 141.61, 40 CFR 141.62 40 CFR 141.66	Relevant and Appropriate	Establishes maximum contaminant levels for drinking water.	The selected remedy is using the MCLs for 1,2-cis-DCE and 1,2-trans-DCE. There have been no revisions to the federal MCLs for these chemicals.
2009 ROD Amendment #2	Washington Clean Air Act (CAA) of 1967, RCW 70.94 and RCW 43.21A "State Government – Executive"	General Regulations for Air Pollution Sources, WAC 173-400 Specific subsections: WAC 173-400-040	Applicable	Requires all sources of air contaminants to meet emission standards for visible, particulate, fugitive, odors, and hazardous air emissions. Requires use of reasonably available control technology.	Applicable to remedial actions at OU1 due to the generation of fugitive dust that will occur during construction activities. General revisions occurred in March 2011, Aug 2011, Nov 2012 to bring the rule into compliance with USEPA regulations. Any revisions do not affect protectiveness.
2009 ROD Amendment #2	Washington CAA, RCW 70.94 and RCW 43.21A	Specific subsection: WAC 173-400-113	Applicable	Requires controls to minimize the release of air contaminants resulting from new or modified sources of regulated emissions. Emissions are to be minimized through application of best available control technology.	Waste generated for disposal that does not meet Environmental Restoration Disposal Facility waste acceptance criteria, will require the use of a treatment technology (e.g., to treat generated waste to meet disposal facility acceptance requirements) that may emit regulated air emissions. If such treatment is required, this requirement would be applicable. General revisions occurred in March 2011, Aug 2011, Nov 2012 to bring the rule into compliance with USEPA regulations. Any revisions do not affect protectiveness.
		Controls for New sources of Toxic Air Pollutants, WAC 173-460 Specific subsections: WAC 173-460-030 WAC 173-460-060 WAC 173-460-070	Applicable	Requires specific controls for new regulated air emissions.	Although unlikely, the selected remedy may require use of a treatment technology (e.g., to treat generated waste to meet disposal facility standards) that emits toxic air emission. If such treatment is required, this requirement would be applicable. There have been no revisions that affect protectiveness.

ROD	Authority	ARAR / Citation	ARAR Determination	Standard Applied in ROD	Current Use / Changes
2009 ROD Amendment #2	Hazardous Waste Management Act of 1985, RCW 70.105	Dangerous Waste Regulations, WAC 173-303 Specific subsections: WAC 173-303-016 WAC 173-303-017 WAC 173-303-070(3) WAC 173-303-073 WAC 173-303-077 WAC 173-303-170(3)	Applicable	Specifies how to identify dangerous waste. Establishes the management standards for solid wastes that designate as dangerous wastes.	Applicable to identifying solid and dangerous wastes generated during OU remedial actions. The management standards are applicable to the management and disposal of those wastes identified as dangerous waste. There have been no revisions that affect protectiveness.
2009 ROD Amendment #2	Hazardous Waste Management Act of 1985, RCW 70.105	Dangerous Waste Regulations, WAC 173-303 Specific subsection: WAC 173-303-140	Applicable	Identifies dangerous wastes that are restricted from land disposal, describes requirements for state-only-restricted wastes, and prohibits land disposal of restricted wastes unless treatment standards have been met. Incorporates Federal land disposal restrictions including provisions for treatability variances by reference.	Applicable to the disposal of dangerous waste that will be generated during implementation of the selected remedy. There have been no revisions that affect protectiveness.
2009 ROD Amendment #2	Solid Waste Management, Recovery, and Recycling Act of 1969, RCW 70.95	Nondangerous Non radioactive Solid Waste Management, WAC 173-304 and 173-351 Specific subsections: WAC 173-304-190 WAC 173-304-200 WAC 173-304-460	Applicable	Establishes requirements for the management of solid waste.	Applicable to the onsite management and disposal of solid waste that will be generated during implementation of the selected remedy. There have been no revisions that affect protectiveness.
2009 ROD Amendment #2	Water Well Construction, RCW 18.104	Minimum Standards for Construction and Maintenance of Water Wells, WAC 173-160 Rules and Regulations Governing the Licensing of Well Contractors and Operators, WAC 173-162	Applicable	Establishes minimum standards for design, construction, capping, scaling, and decommissioning of wells. Establishes qualifications for well contractors and operators.	Applicable to the installation of wells that will be required for groundwater extraction/injection and monitoring. Any revisions do not affect protectiveness.
2012 ESD	Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs)	Standard for demolition and renovation (40 CFR 61.145)	May be relevant and appropriate	The CAA regulates any activities (e.g. demolition or renovation) that may result in the release of airborne asbestos.	Time Oil Building has not yet been demolished. Presence of asbestos-containing materials (ACM) is unknown. There have been no revisions since the ESD.
2012 ESD	Washington Clean Air Act, 70.94 Revised Code of Washington (RCW)	Puget Sound Clean Air Agency, Asbestos Control Standards (Regulation III)	Will be considered	The Time Oil Building may contain asbestos. Asbestos Control Standards related to demolition which are administered by PSCAA will be considered.	Time Oil Building has not yet been demolished. Presence of asbestos-containing materials (ACM) is unknown.

Changes in Exposure Pathways

Table 2-7 presents the exposure pathways identified in the 1985 first ROD Amendment, the 2009 ROD Amendment #2, and the 2012 ESD. Risk estimates were provided in the 1985 first ROD Amendment.

Table 2-7. Exposure Pathways

Source	Exposure Scenario & Pathway	Risk Estimate	Reference
Contaminated soil	Inhalation	10^{-3} to 10^{-6}	1985 ROD Amendment #1
	Soil Ingestion		
	Soil Direct Contact		
Contaminated Groundwater	Groundwater Ingestion	10^{-4}	

The exposure pathways for soil and groundwater presented in the RODs have not changed. Much of the project area is paved or covered with concrete, thus limiting the occupants' exposure to surface soil. Soil and groundwater remediation is not yet complete. No new or changed human health or ecological routes or receptors have been identified.

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. The 2009 FFS included a vapor intrusion screening level analysis that concluded that further investigation for vapor intrusion may be warranted. According to the 2009 ROD Amendment #2, vapor intrusion will be evaluated after completion of the ISTR and EAB activities.

Changes in land use

Current land use has not changed since the ROD(s). The current and reasonably anticipated future land use on and around the former Time Oil property and Well 12A is commercial/industrial. The current and potential future beneficial use for groundwater is drinking water. Well 12A is currently used by the city of Tacoma for municipal water supply. It is anticipated that future use of Well 12A will increase due to increased demand for the Tacoma municipal water supply. No changes in land use or groundwater are anticipated in the future near Well 12A and the former Time Oil Site.

Changes in Toxicity and Other Contaminant Characteristics

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 but one COC at the Site. Revisions to the toxicity values for cis-1,2-DCE, PCE, and TCE indicate a higher risk from exposure to these chemicals than previously considered. Table 2-8 lists the new toxicity values.

Table 2-8. Toxicity Value Changes

Contaminant	Toxicity values in ROD[1]	Changes in Toxicity Values[2]	Date of Revision
Cis-1,2-DCE	Oral RfD: 1E-2 mg/kg-day Inhalation RfC: 1E-2 mg/kg-day	Oral RfD: 2E-3 mg/kg-day Inhalation RfC: No value	09/2010
Trans-1,2-DCE	Oral RfD: 2E-2 mg/kg-day Inhalation RfC: 2E-2 mg/kg-day	Oral RfD: No change. Inhalation RfC: 6.0E-2 mg/m^3	09/2010
1,1,2,2-PCA	Oral RfD: 6E-2 mg/kg-day Inhalation RfC: 6E-2 mg/kg-day Oral SF: 2E-1 (mg/kg-day)$^{-1}$ Inhalation SF: 2E-1 (mg/kg-day)$^{-1}$	Oral RfD: 2E-2 mg/kg-day Inhalation RfC: No value. Inhalation RfC: No value IUR: 5.8E-5 (µg /m^3)$^{-1}$	09/2010
PCE	Oral RfD: 1E-2 mg/kg-day Inhalation RfC: 1E-2 mg/kg-day Oral SF: 5.4E-1 (mg/kg-day)$^{-1}$ Inhalation SF: 2.1E-2 (mg/kg-day)$^{-1}$	Oral RfD: 6E-3 mg/kg-day Inhalation RfC: 4E-2 mg/m^3 Oral SF: 2.1E-3 (mg/kg-day)$^{-1}$ IUR: 2.6E-7(µg/m^3)$^{-1}$	02/2012
TCE	Oral RfD: 3E-4 mg/kg-day Inhalation RfC: 1E-2 mg/kg-day Oral SF: 4E-1 (mg/kg-day)$^{-1}$ Inhalation SF: 4E-1 (mg/kg-day)$^{-1}$	Oral RfD: 5E-4 mg/kg-day Inhalation RfC: 2E-3 mg/m^3 Oral SF: 4.6E-2 (mg/kg-day)$^{-1}$ IUR: 4.1E-6 (µg /m^3)$^{-1}$	09/2011
Vinyl Chloride	Oral SF: 7.2E-1 (mg/kg-day) IUR: 4.4E-6 (µg /m^3)-1 Oral RfD: 3E-3 mg/kg-day Inhalation RfC: 1E-1 mg/m^3	No changes since ROD.	08/2000 (No changes since ROD)

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 November 2012 EPA regional screening levels (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.

C – Cancer; IUR – inhalation unit risk ; NC – non-cancer; RSL – regional screening level; RfD –reference dose; RfC – referemce concentration; SF – slope factor.

Groundwater results are frequently compared to EPA Regional Screening Levels (RSLs; formerly called preliminary remediation goals [PRGs]) 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 1 x 10^{-6} (or a Hazard Quotient [HQ] of

1 for non-carcinogens) developed for standard exposure scenarios (e.g., residential and commercial/industrial). RSLs are not de facto cleanup standards for a Superfund site, but they can provide a good indication of whether actions may be needed.

Cis-1,2-DCE. 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 tapwater RSL for cis-1,2-DCE. EPA's 2010 Toxicological Review for cis-1,2-DCE also established 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. EPA's non-cancer screening value for cis-1,2 DCE is 28 µg/L, while the groundwater cleanup level (MCL) is 70 µg/L. The MTCA B non-cancer cleanup level of 16 µg/L (Table 2-5) is less (more stringent) than both the EPA non-cancer RSL and the cleanup goal. There are no current cancer or non-cancer inhalation toxicity values available for cis-1,2-DCE.

In summary, the selected groundwater cleanup level of 70 µg/L for cis-1,2-DCE may no longer be protective. As discussed previously, the change in the non-cancer EPA RSL and MTCA B non-cancer standards do not affect protectiveness as long as the implementation of the remedy prevents exposures above the new MTCA B non-cancer standard of 16 µg/L.

Trans-1,2-DCE. In September 2010, EPA completed a review of the trans-1,2-DCE toxicity literature and posted on IRIS revised non-cancer toxicity values which resulted in a lower (more stringent) tapwater RSL for trans-1,2-DCE. The current non-cancer tapwater RSL for trans-1,2-DCE is 86 µg/L which is slightly less than the MCL-based groundwater cleanup level of 100 µg/L. 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. Thus, the existing groundwater cleanup level of 100 µg/L may no longer be protective. The current MTCA B non-cancer value for trans-1,2-DCE is160 µg/L which is above the cleanup level of 100 µg/L. No MTCA B cancer value currently exists.

In summary, the selected cleanup standard for trans-1,2-DCE may no longer be protective. The change in the non-cancer RSL does not affect protectiveness as long as the implementation of the remedy prevents exposures above the new non-cancer RSL of 86 µg/L.

1,1,2,2-PCA. In September 2010, EPA completed a review of the 1,1,2,2-PCA toxicity literature and posted on IRIS non-cancer toxicity values which resulted in higher tapwater RSL. The current cancer and non-cancer tapwater RSLs for PCA are 0.066 and 280 µg/L. The selected cleanup level of 0.2 µg/L is below the non-cancer RSL and within the 0.066 to 6.6 µg/L protective excess lifetime cancer risk range and is thus still protective for both cancer and non-cancer effects.

PCE. EPA also recently reassessed PCE toxicity literature for both cancer and non-cancer effects and released the toxicological review in February 2012, posted on IRIS. The reassessment determined that the level at which there is lifetime excess cancer risk in excess of $1x10^{-6}$ was less stringent than previously assumed and the multi-pathway tapwater cancer RSL for PCE was subsequently increased

from 0.11 to 9.7 µg/L. The non-cancer RSL was also revised based on adverse neurological effects and resulted in a multi-pathway tapwater non-cancer risk RSL of 35 µg/L. The PCE groundwater cleanup level of 0.8 µg/L thus remains protective for both cancer and non-cancer effects.

TCE. 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 multi-pathway 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 groundwater cleanup level for TCE of 2.4 µg/L is within the revised protective carcinogenic risk range. However, care must be taken to not assume that the acceptable cancer risk range is protective at all concentrations for non-cancer effects. EPA's 2011 Toxicological Review for TCE also developed non-cancer 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 non-cancer effects include a subchronic outcome of fetal cardiac malformations that may occur during exposure to the pregnant mother during a nonspecific 21-day period in the first trimester of pregnancy, according to the IRIS Toxicological Review for TCE. 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 likely be without an appreciable risk of deleterious non-cancer effects, including non-cancer toxicity effects during development.

Vinyl chloride. EPA last completed a review of vinyl chloride toxicity literature in 2000; therefore no toxicity revisions have occurred since the 2009 ROD Amendment #2. The cancer and non-cancer RSL for vinyl chloride are currently 0.015 and 36 µg/L, respectively. The selected cleanup level of 0.3 µg/L is below the non-cancer RSL and within the 0.015 to 1.5 µg/L protective excess lifetime cancer risk range and is thus still protective for both cancer and non-cancer effects.

Expected Progress Toward Meeting RAOs

The remedy is progressing toward meeting the Tier 1 objective of a 90% reduction in mass discharge. Shallow soil excavation has been completed. ISTR and EAB are in the design stages and are scheduled to be complete by 2015. The baseline mass discharge measurement has been completed, which is the basis for determining achievement of Tier 1 objectives.

1.7.3. Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Ecological risks have not been evaluated for the project area. However, no significant ecological impacts due to the contamination are expected because the area around the Site is heavily developed as a commercial/industrial area and lacks suitable habitat. Furthermore, available data suggest that the contaminant plume does not currently reach local streams or rivers.

1.7.4. Technical Assessment Summary

Construction of the remedial actions described in ROD Amendment #2 is still in progress. Shallow soil contamination to the east of the Time Oil building has been excavated and transported off-site for disposal. ISTR and EAB are still in the design phase and are scheduled to be complete by 2015. Well 12A water is treated via air stripping prior to use for drinking water. ICs are in place to prevent exposure to shallow soil during remedial activities and to prevent ingestion of groundwater.

Standards that have changed since the ROD, ROD Amendments, and explanation of significant differences (ESD) were signed may affect the protectiveness of the remedy. Changes in toxicity values for cis-1,2-DCE, trans-1,2-DCE, 1,1,2,2-PCA, PCE, and TCE have occurred in the last five years that may require future re-evaluation of selected cleanup levels (cis-and trans-1,2-DCE) to ensure protectiveness is maintained. The changes do not affect the current protectiveness since ICs are in place to prevent exposure above the new standards.

Exposure pathways described in the ROD have not changed. The vapor intrusion pathway was not evaluated during development of the ROD. USEPA plans to evaluate vapor intrusion after the remedial actions are complete.

1.8. Issues

Table 1-9 summarizes the current issues for the Well 12 A project area.

Table 2-9. Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
1. Selected cleanup levels for cis- and trans-1,2-DCE may no longer be protective following 2011 changes in toxicity values.	N	Y
2. Evaluation of the vapor intrusion pathway is needed.	N	Y

1.9. Recommendations and Follow-up Actions

Table 1-10 provides recommendations to address the current issues at the Well 12A, along with proposed milestone dates to achieve the follow-up actions.

Table 2-10. Recommendations and Followup Actions

Issue	Recommendations and Followup Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1	Re-evaluate the groundwater cleanup level for cis- and trans-1,2-DCE and adjust if necessary to maintain future protectiveness after achievement of Tier 1 criteria.	Ecology/EPA	EPA	09/2018	N	Y
2	Evaluate vapor intrusion pathway after achievement of Tier 1 criteria.	EPA	EPA	09/2018	N	Y

1.10. Protectiveness Statements

The remedy at Well 12A is currently protective of human health and the environment in the short term. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. However in order for the remedy to be protective in the long term, the remedial actions for the source area should continue to be implemented.

1.11. Next Review

This is a Site that according to the CERCLA statute, as amended, requires ongoing five-year reviews as long as contaminants remain on site that do not allow for unlimited use and unrestricted exposure. The next five-year review will be due within five years of the signature date of this five-year review (September 2018)

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Well 12A Figures

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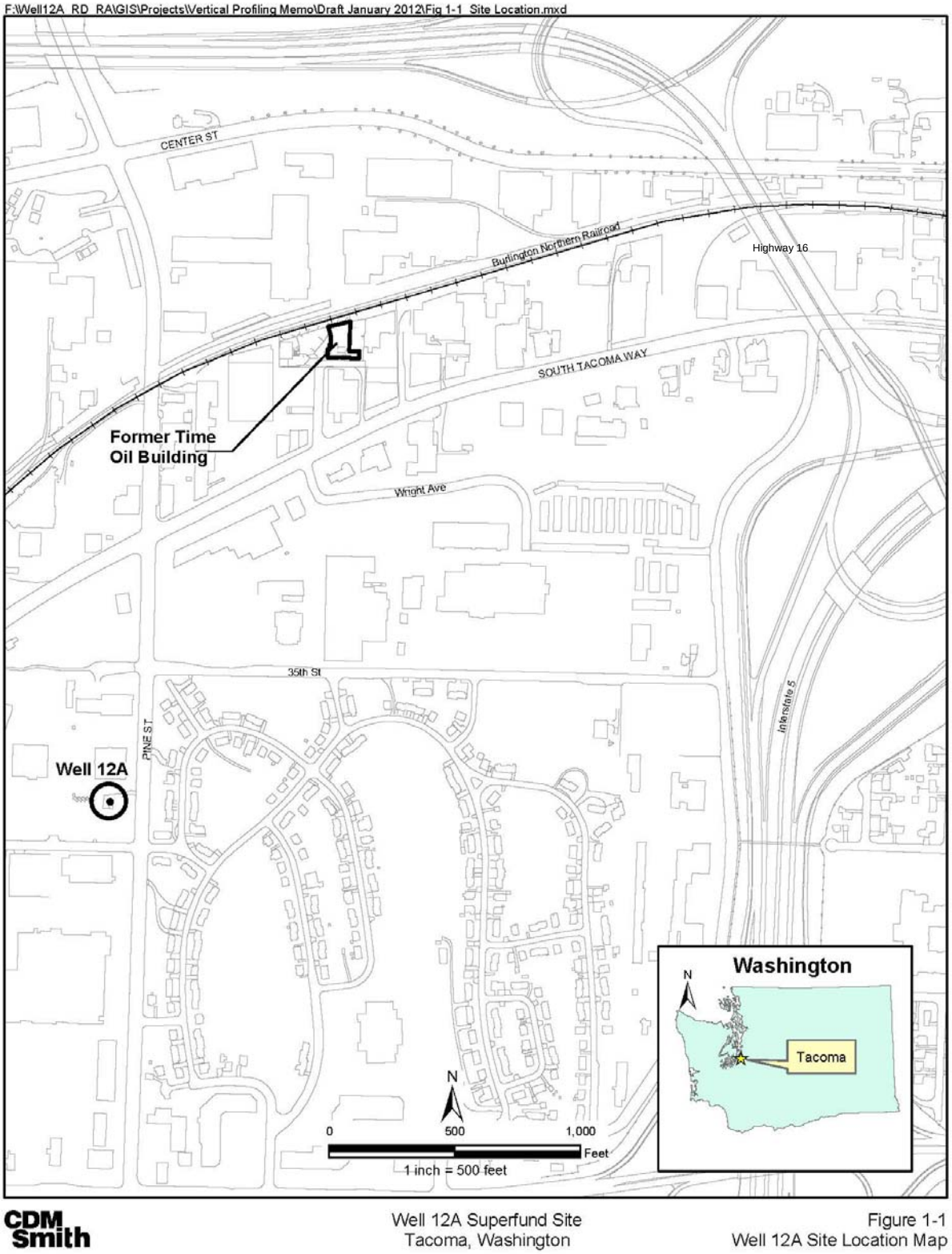


Figure 2-1. Site location map showing former Time Oil building and Well 12A.

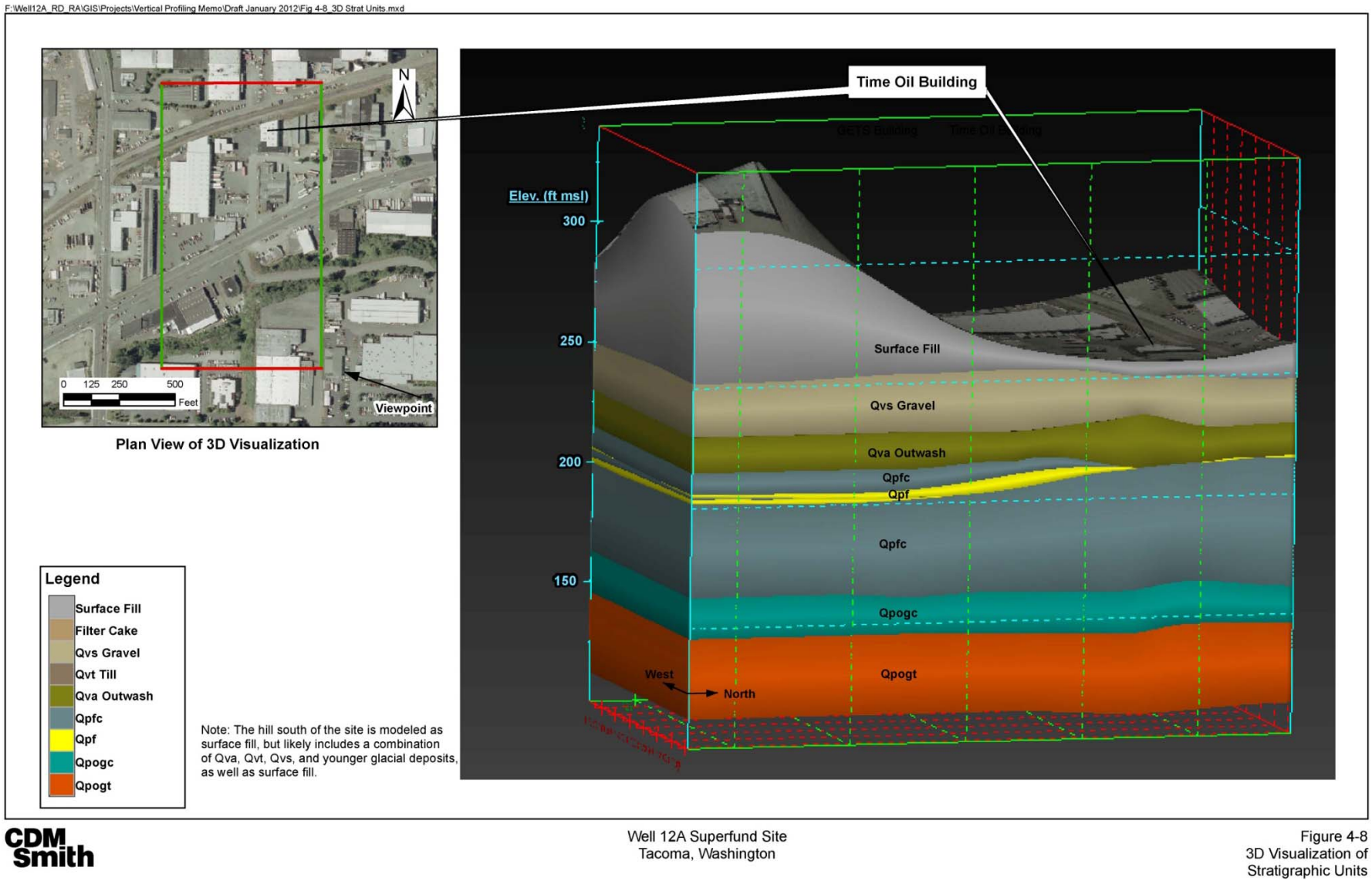


Figure 2-2. Representation of stratigraphic units.

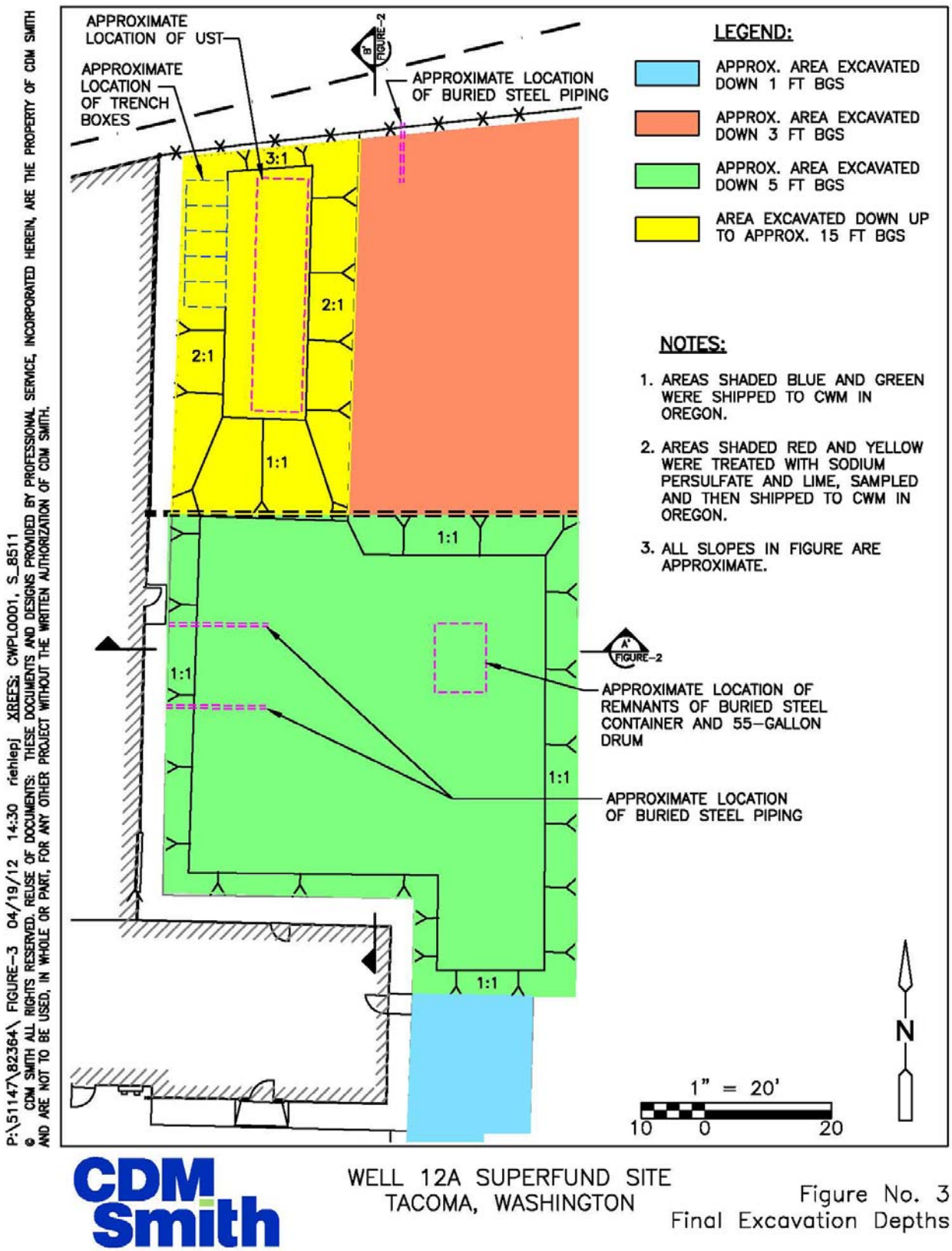


Figure 2-3. 2011/2012 final extent of excavation.

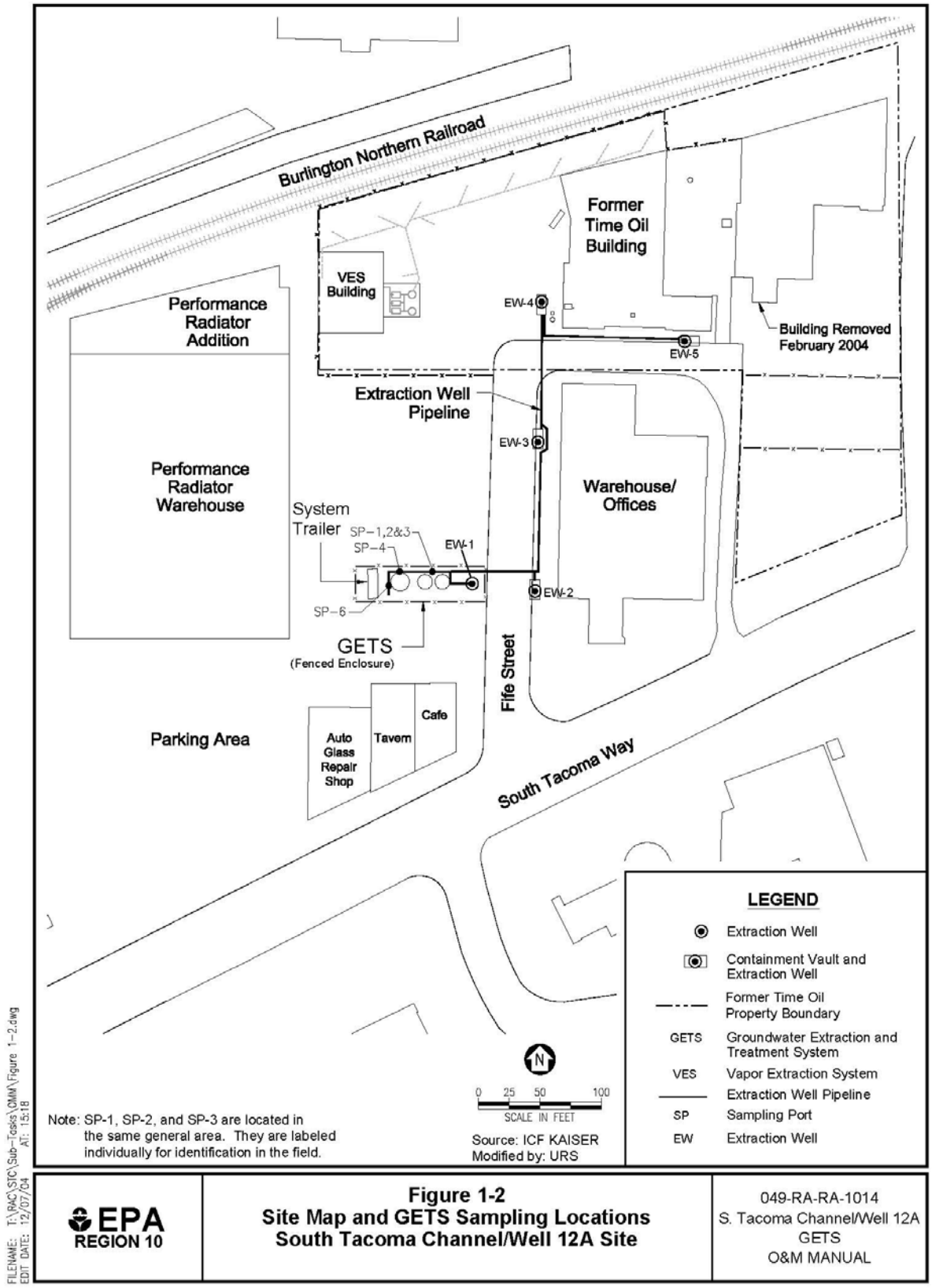


Figure 2-4. Groundwater extraction and treatment system (GETS) location map.

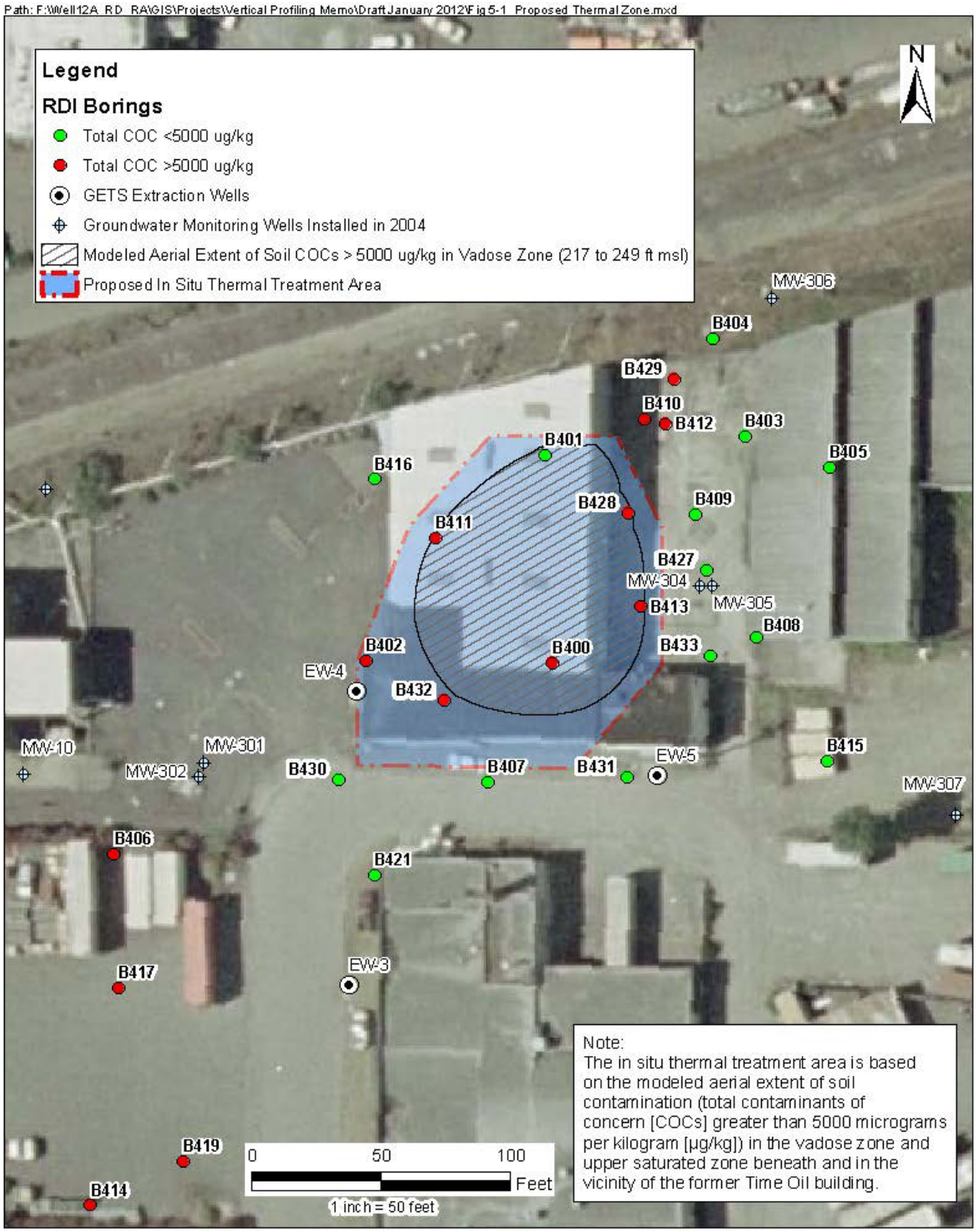
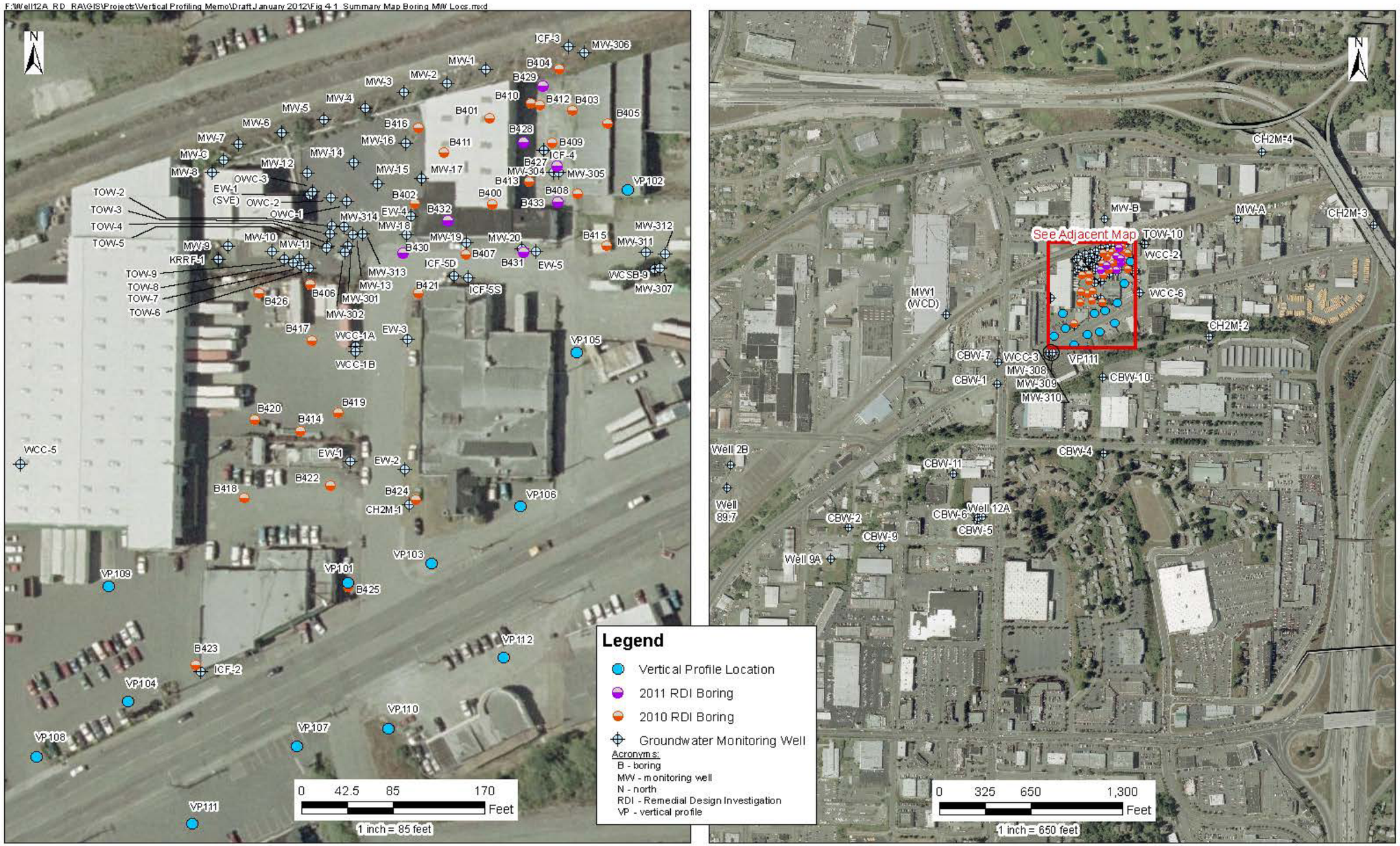


Figure 2-5**. Proposed in-situ thermal remediation (ISTR) treatment area.**



CDM Smith

Well 12A Superfund Site
Tacoma, Washington

Figure 4-1
Summary Map of All RD Investigation and
VP Borings and Groundwater Monitoring Wells

Figure 2-6. Remedial Design investigation sampling locations and groundwater monitoring wells.

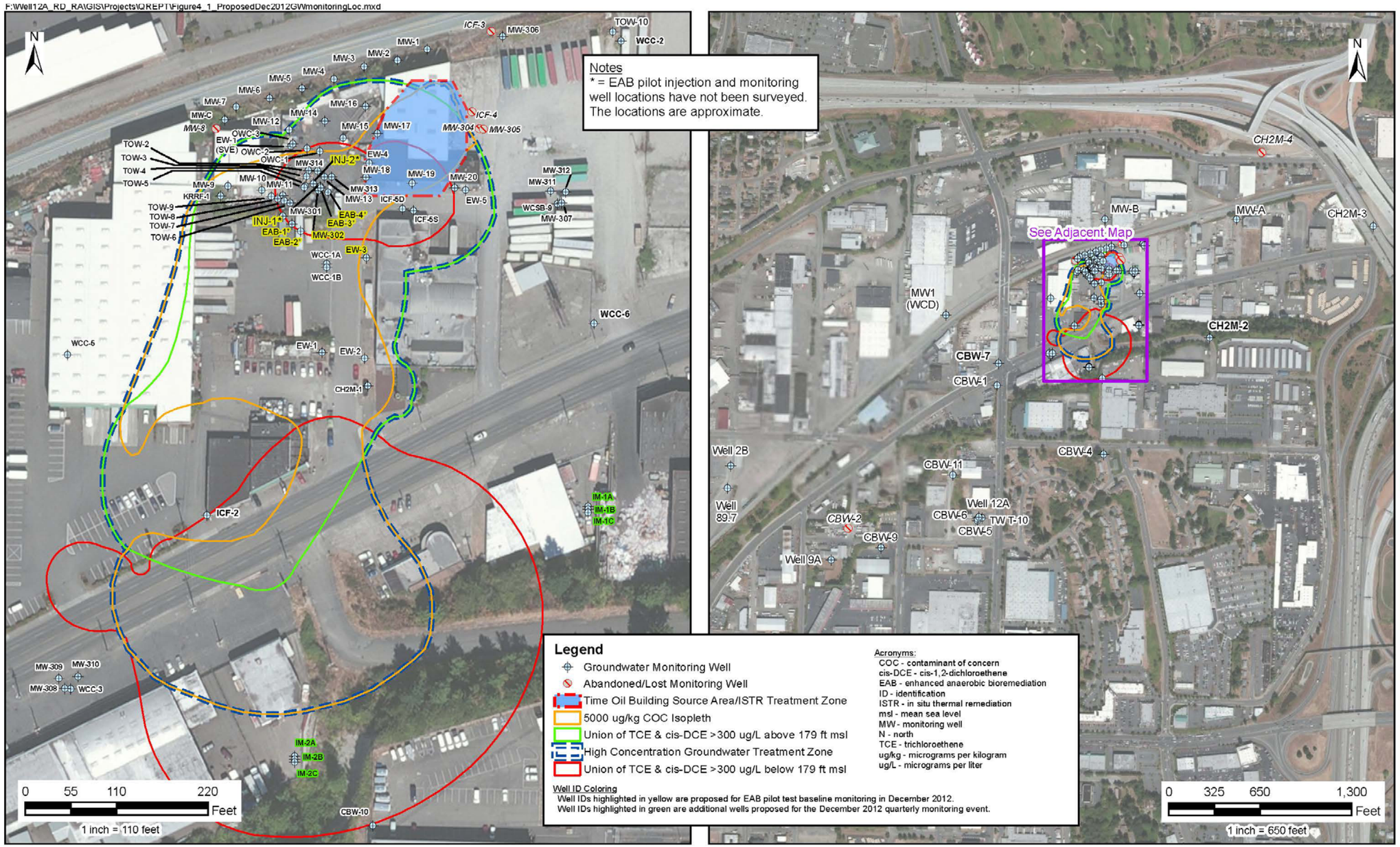


Figure 2-7. Groundwater monitoring wells including interim performance monitoring (IM) wells and enhanced anaerobic bioremediation (EAB) wells.

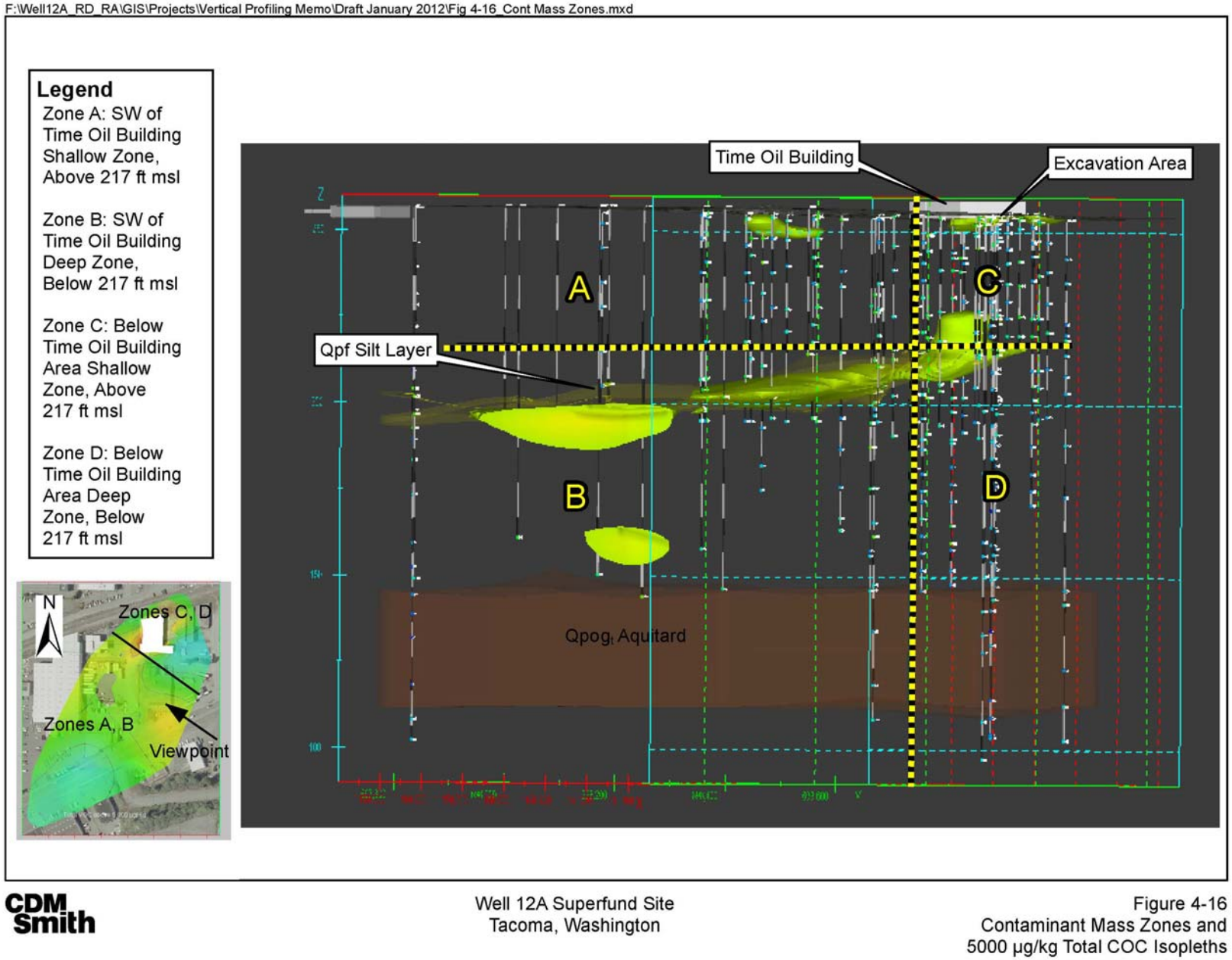


Figure 2-8. Contaminant mass zones in soil.

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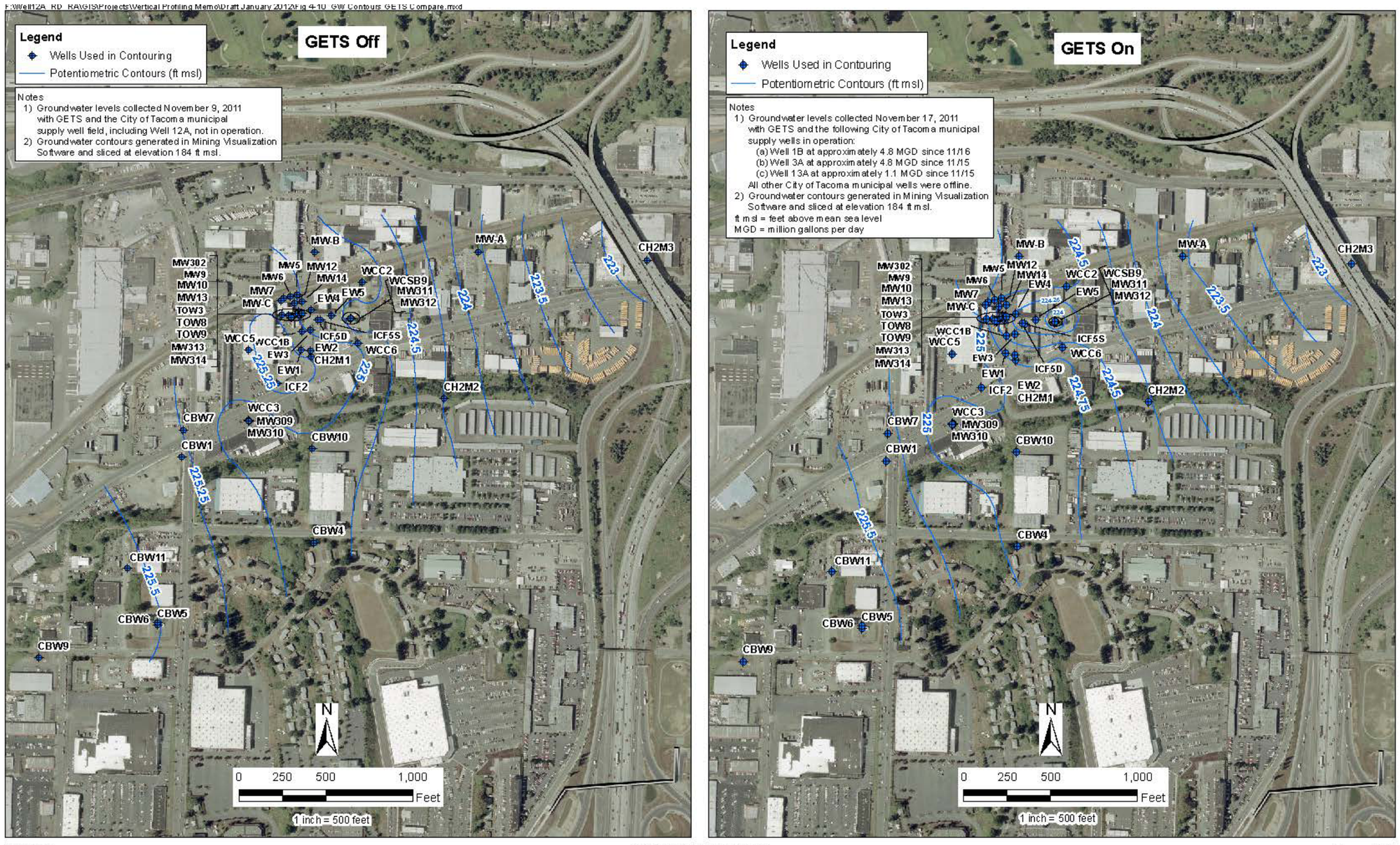

CDM Smith

Well 12A Superfund Site
Tacoma, Washington

Figure 4-10
Potentiometric Contours in Medium Zone of Upper Aquifer at Elevation 184 ft msl with GETS On and Off

Figure 2-9. Groundwater contours with groundwater extraction and treatment system (GETS) operating (on) and with GETS not operating (off).

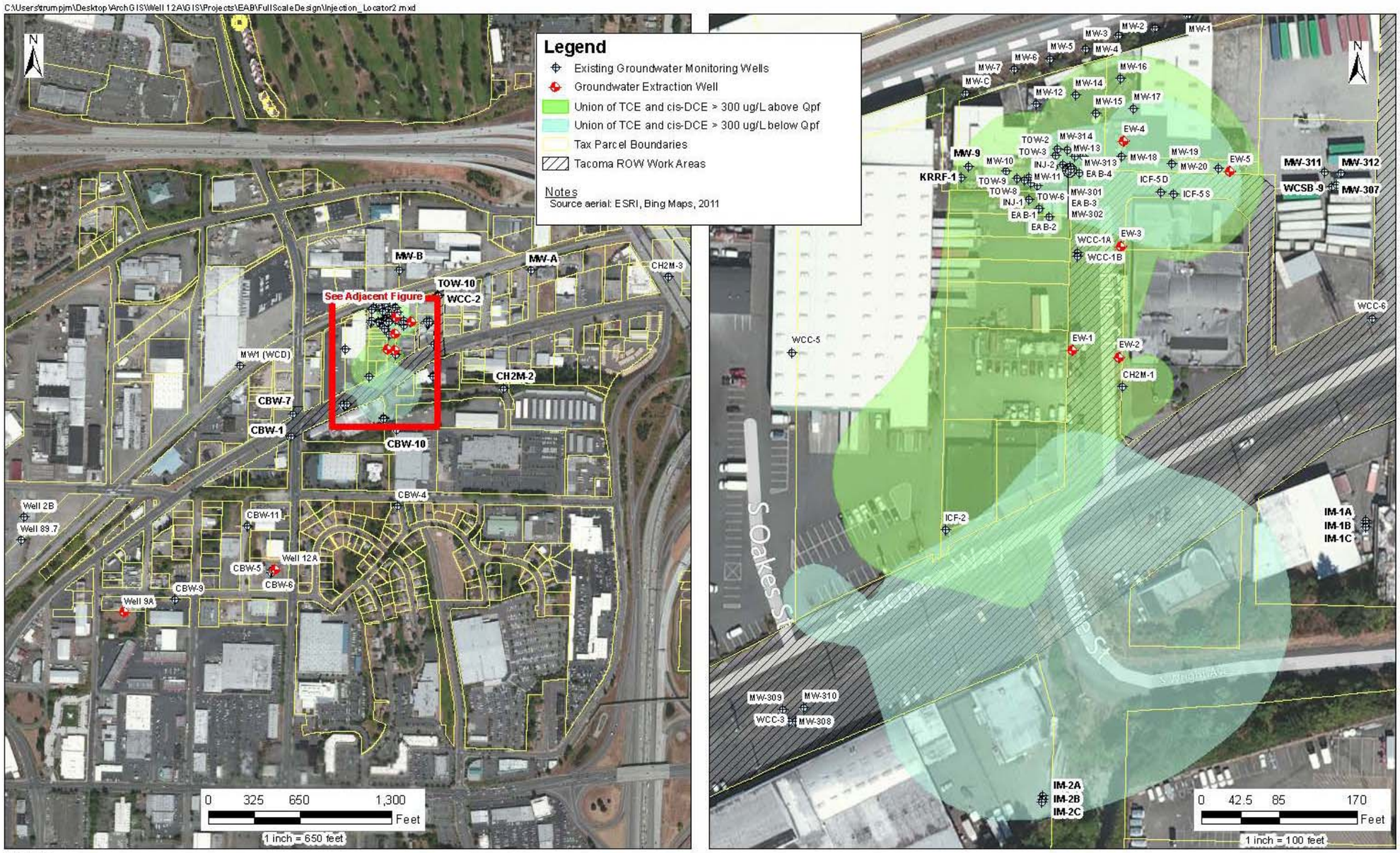

Figure 2-10. High-concentration groundwater plume extent.

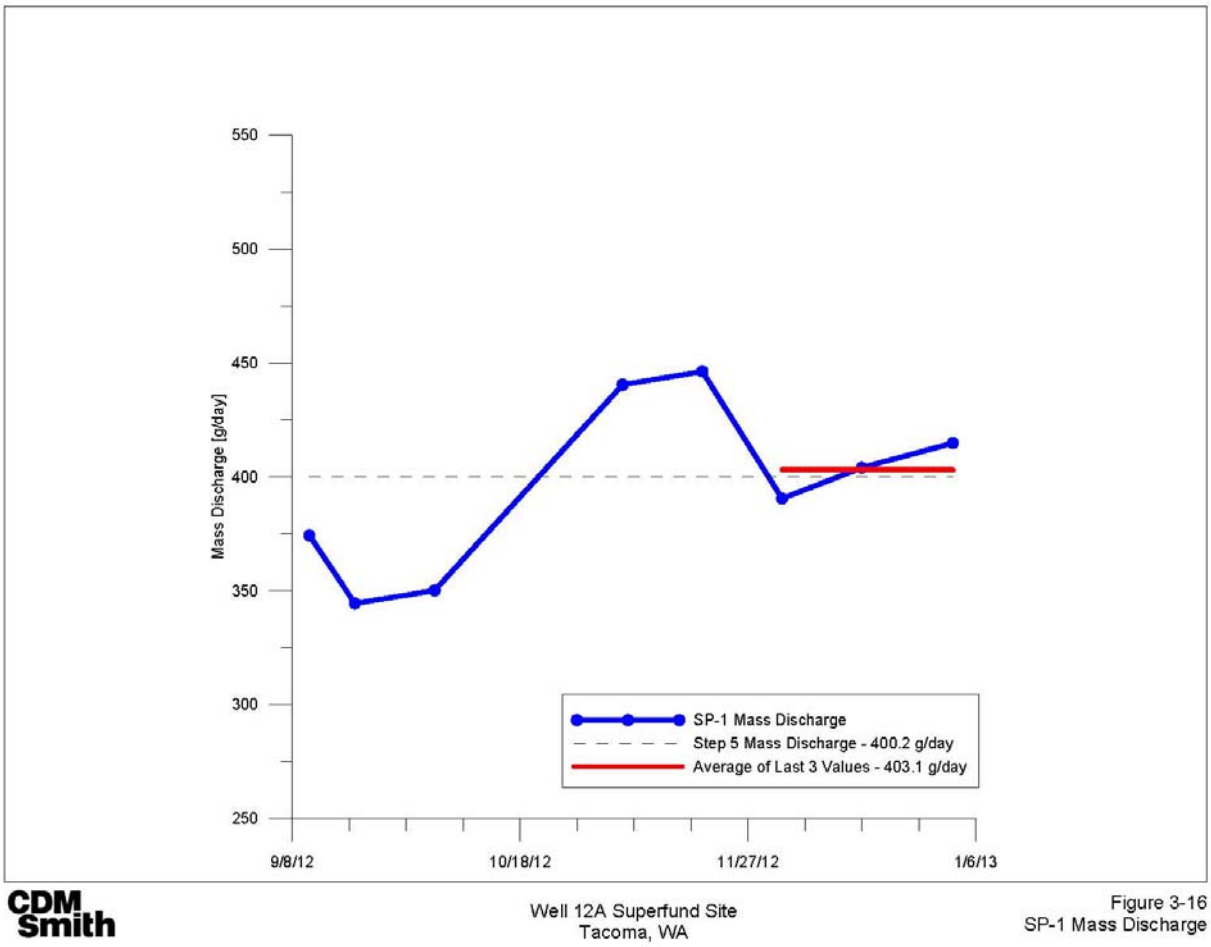

Figure 2-11. Baseline mass discharge measurements.

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Appendix 1-A: Well 12 A List of Documents Reviewed

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Well 12 A Documents Reviewed

CDM, 2009. Final Focused Feasibility Study, Well 12A Superfund Site, Tacoma, Washington. April 2, 2009.

CDM, 2010. Institutional Control Plan, Well 12A Superfund Site, Tacoma, Washington. August 6, 2010.

CDM, 2010. Draft Basis of Design Report, Well 12A Superfund Site, Tacoma, Washington. October 8, 2010.

CDM, 2011a. Memorandum re: Addendum to the Draft Basis of Design Report, South Tacoma Channel Well 12A Superfund Site, Tacoma Washington. February 1, 2011.

CDM, 2011b. Final Mass Discharge Evaluation Work Plan, Well 12A Superfund Site, Tacoma, Washington. July 19, 2011.

CDM, 2011c. Memorandum re: South Tacoma Channel Well 12A Groundwater Extraction and Treatmnet System (GETS) Inspection. August 22, 2011.

CDM, 2011d. Memorandum re: Final Selection of EAB Amendments for Bench Scale Treatability Study, Mileston 4, Well 12A Project. December 20, 2011.

CDMSmith, 2012a. Final Exacavation and Disposal Report, Well 12 Shallow Excavation Remedial Action, Tacoma, Washington. May 16, 2012.

CDMSmith, 2012b. Post Well Rehabilitation, Groundwater Extraction and Treatment System, Performance Evaluation and Capture Zone Analysis Work Plan. June 9, 2012.

CDMSmith, 2012c. Final ISTR Pre-Design and Vertical Profiling Report, South Tacoma Channel Well 12A, Superfund Site, Tacoma, Washington. July 2012.

CDMSmith, 2012d. Technical Memorandum, Final Evaluation of GETS Capture for Mass Discharge. August 14, 2012.

CDMSmith, 2012e. Memorandum, re: Addendum to the Final Technical Memorandum: Evaluation of GETS Capture for Mass Discharge Assessment. October 1, 2012.

CDMSmith, 2012f. Enhanced Anaerobic Biodegradation Bench Scale Treatability Study Final Report, Tacoma, Washington, October 30, 2012.

CDMSmith, 2012g. Final Groundwater Performance Monitoring Report, Event #2 (August 2012), South Tacoma Channel Well 12A Superfund Site, Tacoma, Washington. December 13, 2012.

CDMSmith, 2013a. Final Groundwater Performance Monitoring Report, Event #3 (December 2012) and HydraSleeve™ Evaluation, South Tacoma Channel Well 12A Superfund Site, Tacoma, Washington. March 18, 2013.

CDMSmith, 2013b. Draft Final Well 12A Mass Discharge Baseline Memorandum. March 29, 2013.

URS and CH2MHill, 2004. Operation and Maintenance Manual Groundwater Extraction and Treatment System, South Tacoma Channel/Well 12A Superfund Site. December 2004.

USEPA, 1983. EPA Superfund Record of Decision: Commencement Bay, South Tacoma Channel, EPA ID: WAD980726301, OU 01, Tacoma, Washington. March 18, 1983.

USEPA, 1985. EPA Superfund Record of Decision Amendment: Commencement Bay, South Tacoma Channel, EPA ID: WAD980726301, OU 01, Tacoma, Washington. May 3, 1985.

USEPA, 2008. Five-Year Review Report, Commencement Bay, South Tacoma Channel Superfund Sites, Tacoma, Washington. September 2008.

USEPA, 2009. Amendment #2 to the Record of Decision for the Commencement Bay – South Tacoma Channel Superfund Site, Operable Unit 1, Well 12A, Tacoma, Washington. October 2009.

USEPA, 2010. A Memorandum of Agreement between The United States Environmental Protection Agency and City of Tacoma, Department of Public Utilities, Water Division (Tacoma Water), Well 12A Operation During Superfund Remedy. December 2010.

USEPA, 2012. Explanation of Significant Differences to the Amended Record of Decision for the Commencement Bay – South Tacoma Channel Superfund Site, Operable Unit 1, Well 12A, Tacoma, Washington. June 2012.

Appendix 1-B: Well 12 A Site Inspection Trip Report

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Well 12A Site Inspection Trip Report

Attendees

USACE:

Heather Whitney, USACE Seattle District Chemist

Kristen Kerns, USACE Seattle District Physical Scientist

CDM:

Domini Giaudrone, CDMSmith Engineer

City of Tacoma Water:

Dave (no last name provided), TacomaWater representative

Purpose

Well 12A/Time Oil is one operable unit within 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 fourth Five-Year Review Report.

Report

On 5 March 2013, Heather Whitney and Kristen Kerns drove from the Seattle District office to the Well 12A/Time Oil Superfund Site located in Tacoma, Washington, arriving at approximately 1300 hrs, the arranged meeting time. The weather was cool and cloudy. The site is located in a commercial/industrial area west of Interstate 5.

The USACE team met with Mr. Giaudrone at the CDMSmith field office area near the former SVE facility. Mr. Giaudrone conducted the tour. The tour started with a walk-through inspection of the former SVE facility. CDMSmith had a plumbing sub-contractor on-site attempting to get the municipal water running to the facility so that CDMSmith would have a ready supply of clean water for the upcoming pilot-scale bioremediation testing. After turning on the water to the building, a tank labeled "waste solvent" (and previously known to be empty) was discovered to be full. CDMSmith had just finished pumping the suspect water into a drum with samples taken for inspection and potentially for analysis, although the fluid was thought to be linked to the plumbing work occurring simultaneously. The SVE components were still in their dormant condition since shut-off in the late 90s. No vandalism was apparent to components inside the facility, although parts of the external assembly were missing, presumably stolen.

The entire SVE facility is within a fenced area that includes access to the west side of the Time Oil building. Trailers and random debris were observed scattered around the inside of the fenced area. The owners of the property and Time Oil building (Western Moving Company) were not present.

Following inspection of the SVE facility, the team walked through the former Time Oil building, which contained mounds of furniture and other personal items around the inside perimeter of the main warehouse. A few boats were also parked inside the building. To the south (within the older brick portion of the building), evidence of a former apartment renovation was apparent, although the area was clearly not in current use. One room was piled full of personal belongings.

Dominic, Kristen, and Heather next walked to the adjacent GETS facility. Dominic reported that the carbon was just changed out on February 26, 2013. The extraction wells were currently in operation and no problems were observed.

Kristen and Heather next drove to the Well 12A wellhead treatment facility where they were met by two TacomaWater representatives (Dave & one other person). The team walked around the facility taking photos. Nothing unusual was noted. The well was not currently in operation.

The site visit concluded at approximately 1430 and the USACE team drove back to the district office.

Photographs:

Photo 1. View looking northwest into Time Oil property (SVE building in background).

Photo 2. North end of Fife Street looking west towards former SVE facility.

Photo 3. View looking north into Time Oil property from gated entrance.

Photo 4. Close-up of external SVE structures.

Photo 5. Former SVE piping along railroad to north of SVE building.

Photo 6. Control room of former SVE facility.

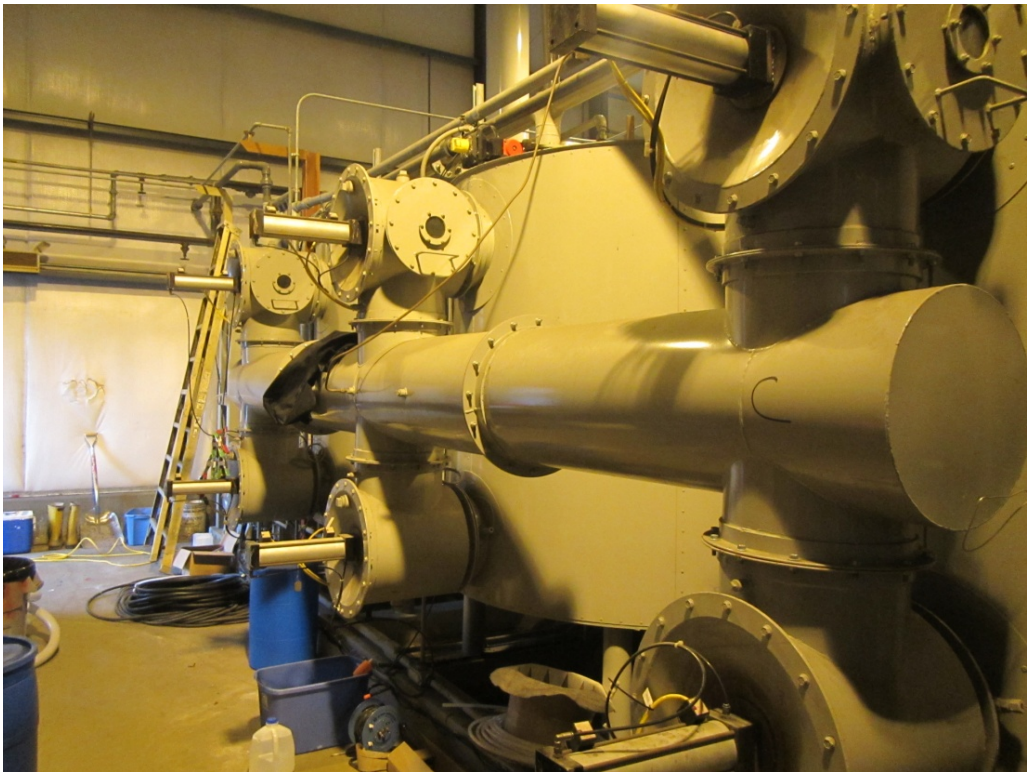

Photo 7. Inactive carbon tanks formerly used for SVE operations.

Photo 8. Dormant feed tanks for SVE operations.

Photo 8. "Waste solvent" container that filled with unknown liquid when municipal water was turned on in the building on March 6, 2013.

Photo 9. Small room in SVE facility in which dead rat was removed.

Photo 10. Staging area within former SVE facility for upcoming pilot-scale bioremediation testing (view looking south).

Photo 11. Storm water drain and oil-water separator (under concrete cap; unknown condition) next to SVE facility.

Photo 12. New Time Oil building (left) and old Time Oil building (right).

Photo 13. South side of old Time Oil building.

Photo 14. Former east tank farm area, view looking southwest towards Time Oil building.

Photo 15. Interior of new Time Oil building, view looking northeast.

Photo 16. View looking southwest within old Time Oil building.

Photo 17. Former East tank farm area as viewed from second story window of old Time Oil building.

Photo 18. Wells to be used in pilot-scale bioremediation testing immediately south of Time Oil property.

Photo 19. Extraction well 3 (EW-3) on east side of Fife Street; view looking north.

Photo 20. GETS facility as viewed from south east.

Photo 21. EW-1 (located adjacent to GETS).

Photo 22. Well 12A wellhead treatment system as viewed from southeast.

Photo 23. Well 12A wellhead treatment facility as viewed from the east.

Photo 24. Well 12A Control building and electrical.

Photo 25. Interior of Well 12A control room.

Photo 26. Blow-out pond used to purge well located direct south of air stripping towers.

Photo 27. Close-up of one the blower intake vents for the air stripping towers.

Photo 28. North side view of the air stripping towers.]

Appendix 1-C: Well 12 A Site Inspection Checklist

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Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Well 12A/Time Oil	**Date of inspection: 05 March 2013**
Location: Tacoma, WA	**EPA ID: WAD980726301**
Agency, office, or company leading the five-year review: EPA Region 10	**Weather/temperature: Cloudy, 45 F**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☐ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☒ Other: *Well-head treatment (Well 12A), Groundwater monitoring*
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

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** ___Dominic Giaudrone_____CDM Engineer_____5/5/2013
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: Washington State Department of Ecology
Contact: __Chris Maurer, Project Manager___
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____See Appendix 1-D_____
_____

Agency _Tacoma Water_____
Contact _Chris Johnson, Senior Principal Engineer and Operations supervisor_____
Problems; suggestions; ☐ Report attached _____ See Appendix 1-D _
_____

Agency _Tacoma Water_____
Name Title Date Phone no.
Contact ___Craig Downs_____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ___ See Appendix 1-D _____

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

Leslie Rose, Citizens for a Healthy Bay (See Appendix 1-D).

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_____No discharge permit for treated Well 12A effluent exists. This is an ongoing issue between City of Tacoma and Ecology._____

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_____Site is only accessed on an as needed basis by the contractor, CDMSmith for remedial design activities.

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____City of Tacoma Water manages the Well 12A wellhead treatment system. Tacoma Water and Ecology jointly manage the GETS._____

2. **O&M Cost Records**

☒ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate___$100,000 per year (from Chris Maurer interview)_____ ☐ Breakdown attached

Total annual cost by year for review period if available

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

Describe costs and reasons: None described during the site visit.

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

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
Remarks. The Time Oil property, GETS, and Well 12A wellhead treatment system are all enclosed in fencing in good condition.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks_____Time Oil property clearly labeled with site information and contact information.
_____

C. Institutional Controls (ICs)

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
ICs are planned, but have not yet been developed or implemented.

2. **Adequacy** ☐ ICs are adequate ☒ ICs are inadequate ☐ N/A
Remarks: All residents within this area use municipal water. The likelihood of a private owner installing a drinking water well is small. Vapor intrusion risk into buildings from contaminated soil and groundwater contamination exists, although since no one currently lives on the property, exposure likelihood is low. EPA plans to evaluate VI risk after active remediation is complete and institute ICs at that time if needed.

D. General

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

2. **Land use changes on site** ☐ N/A
Remarks: Land use remains commercial/industrial.

3. **Land use changes off site** ☐ N/A
Remarks: No changes observed.

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

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 ☐ N/A

Remarks__GETS was not operating during site visit._____

_____

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

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_Carbon is changed semi-annually._____

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_____
_____

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

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.).
__See Section 1.7.1_____

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.
_See Section
1.7.1._____

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.
_See Section
1.7.1_____

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. ___See Section 1.7.1_____

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Appendix 1-D: Well 12 A Interview Transcripts

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Well 12 A Interview Transcripts

Five Year Review Interview Record

Site Name:	Well 12A, South Tacoma Channel Superfund Site
EPA ID No.	WAD980726301
Interviewee:	Christopher Johnson, Tacoma Water, Supply Operations Supply
Date:	15 February 2013
Interview Method:	Phone Interview
Interviewers:	Heather Whitney, Sharon Gelinas

Q: What is your current role as it relates to the site? How long have you been aware of or associated with the site?

Senior principal engineer. Operations supervisor. Decides when to turn the production wells on/off. Well 12A is on an every other year schedule. Only use it for peak season (summer). It was just used last summer (2012) as part of pumping test at Well 12A. It is on schedule for this year. We use the wells at least as much to make sure the well is maintained and in good shape.

Testing involves just discharging. This well was installed to intercept and treat the plume. The well system would otherwise be able to pull the plume towards the main well field. 12A will kick on to protect the other wells. Treated water will go into production line.

Tacoma is building a new groundwater treatment system in the future.

Q: What is your overall impression of the work conducted at the site to date?

The consultant (CDMSmith) was pretty good to work with. They were fairly thorough and understandable of TacomaWater's needs. Things just get delayed because of the testing. I'm not part of the cleanup piece. They were good to work with. I could tell them what I was thinking and they were responsive.

Q: Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? (If so, please give purpose and results.)

Communications with CDMSmith were as needed. They [CDMSmith] would contact TacomaWater to keep TacomaWater informed. [They] Gave TacomaWater enough lead time.

Q: Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc).

We have a contract with Ecology to provide operation and maintenance for the GETS. Talk to Craig Downs. He will clarify that relationship.

Well 12A – we have an intrusion alarm on the pump house. Send mechanic out on weekly basis to check all of the well sites to check for damage, tampering, etc. At least every other testing of Well 12a. We have 24-hour water control center.

Q: Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy (e.g. the GETS) that show wear or may need additional focus during O&M?

Talk to Craig. Last year we updated the electrical panels that support the blowers at Well 12A. We feel like everything is pretty much upgraded. May be some operational changes to save on power.

Q: What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?

It's certainly not convenient to run wells and knowing which wells to run. We would like to decommission Well 12A if possible.

We have had all the blowers kick on, and we think we may be able to run some, not all to minimize using all at once to save on electrical.

Q: What is the status of the extraction wells in the GETS?

Status of wellhead treatment/air strippers?

Are there any other significant construction activities proposed?

What does the monitoring data show?

Talk to Craig.

Q: Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

Had to upgrade electrical service at Well 12A. Weather had rotted away wood wall on which electrical controls were mounted. May need painting in future. Upgraded the communication system as well so we can control remotely. Upgrades happened 2012, maybe 2011.

Q: Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

No. Tacoma Pierce County Health Dept has ordinance to prevent people from discharging water. Our concern is that this is our primary aquifer.

Q: Are private wells allowed?

I don't know what the regs are. State or County Health Dept may know the answer. We have to exercise our water right every now and then, and must report on that annually to state dept of Health.

Q: Are you aware of any ongoing community concerns regarding the site or its administration?

No.

Q: Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

No.

Q: Have any problems been encountered which required, or will require changes to this remedial design or ROD?

No, not that I am aware of. I thought if we run the wells too long through the blow-off, we risk overtopping the blow-off. It hasn't happened or happened a while ago in the past. The blow-off is a pit next to the well. After blow-off, the water will go to the production line. We usually only blow-off for 2-3 minutes, but sometimes, because of the testing we blow-off longer.

Q: Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?

No. It would just be nice to get it done and have it taken of. Talk to Craig.

Five Year Review Interview Record

Site Name: Well 12A, South Tacoma Channel Superfund Site
EPA ID No. WAD980726301
Interviewee: Craig Downs, Tacoma Water
Date: 20 February 2013
Interview Method: Phone Interview Follow-up Call
Interviewers: Heather Whitney

Notes from follow-up call with Craig Downs on 2/20/2013.

Q: Who owns the GETS?

I think EPA officially owns the GETS. Water is pumped through carbon filters. Discharge to stormwater system. EPA also built a SVE system which they ran for a few years and then shut down. In 2005, EPA went to Ecology to hand off GETS. Ecology took on O&M of GETS system in 2005. Prior to that, EPA had a contractor running the GETS. Ecology hired TacomaWater to do the actual O&M and keep the system running. TacomaWater takes the samples and submits the info to Ecology. Ecology has a vendor that does the carbon change-out.

Generally, the GETS runs continuously. CDMSmith is EPA's consultant. There's been times when CDMSmith wants GETS shut down for their remediation studies.

Well 12A is confusing because it is not near the Time Oil building. Well 12A has the air stripping towers.

History. Contamination found in 80s. Air stripping treatment system built in 80s. Way over-built. Sized to treat up to 1000 ppm. We are in the low teens, at best. There are five towers. Well puts out about 3500 gals/min. Flow is split between five towers. We don't throttle Well 12A pumping. In 2008/2009, Tacoma Water tested using fewer towers. Four towers was fine. Three was on the verge of overflowing piping system. Now we run the flow through 3 towers only. Other 2 towers are still there. This reduction in tower usage was a big cost savings. Each tower has a blower, we're now using only 60% of the blower power that we used to.

Well 12A is our most expensive well because of the treatment system. We run 12A to protect other wells (6 and 11) by creating a hydraulic barrier. In 2005, we completed another pipeline from our river supply (Green River), so now we use the production wells much less frequently since 2005. Some years we may run 12A for only a few days/year. We now run our wells once every other year to check their operation.

When you don't run Well 12A much, the contaminant levels drop to below MCLs. Must run the well to pull the contaminants toward Well 12A.

GETS wells – we physically collect the samples and samples go to EPA's Manchester lab for analysis. We get the data, but Chris Maurer (Ecology) is the coordinator. There are two carbon filters in series. Chris looks for breakthrough to determine when to change out carbon.

Extraction wells 1 and 2 recently rehabilitated. Well 1 about 80 gal/min. Well 2 about 20 gal/min. Well 3 is about 12.5 gal/min. Well 4 has been out of service now. EW-5 about 8 gal/min. Total about 120 gal/min for GETS overall. Before rehab, EW-1 was about 40 gal/min; EW-2 about 10 gal/min. Roughly doubled flow rates.

GETS discharge. We discharge to City of Tacoma stormwater system. Ecology pays a discharge fee to Tacoma.

Since 2005, demand for production wells has dropped, but we anticipate someday needing full production well capacity.

Tacoma would like to get Time Oil site cleaned up well enough to be able to run Well 12A without treatment system.

Five Year Review Interview Record

Site Name: Well 12A, South Tacoma Channel Superfund Site
EPA ID No. WAD980726301
Interviewee: Chris Maurer, Project Manager, Washington State Department of Ecology, (360)407-7223.
Date: 20 February 2013
Interview Method: Telephone
Interviewer: Heather Whitney

Q: What is your current role as it relates to the site? How long have you been aware of or associated with the site?

I am the project manager for the Site for Ecology for 25 years. Michael Kuntz is a hydrogeologist.

Q: What is your overall impression of the work conducted at the site to date?

I'm pleased with what we've done so far and what were planning to do over the next couple of years.

Q: Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? (If so, please give purpose and results.)

Yes, I participate in the current weekly telephone calls. I normally visit the site about 2x/year when they are changing the carbon. Frequency of change-out was originally determined by looking for breakthrough. Ecology took over system in 2006. Now keeps discharge under 10 ppb for vinyl chloride using 2 change-outs per year. I get bi-weekly and quarterly monitoring data from the extraction wells. Tx system is sampled every 2 weeks. In addition, every 3 months the five extraction wells are sampled (now 4). EPA decided to shutdown EW-4 because it is in a location that will interfere with the planned ITR.

Ecology has a memo with City of Tacoma whereby the City will maintain the treatment sytem and do the monitoring. Tacoma's costs are paid by Ecology. Ecology pays about $100,000 a year for GETS operation plus 2x changeouts (at 40,000 per changeout) plus 20,000 in sampling costs. Sampling results sent to Tacoma, Ecology, CDMSmith.

Discharge goes into Denali Valley sewer and then into Commencement Bay.

Q: Is there a Discharge permit?

I believe EPA had been paying the city a fee. Ecology declined to pay the fee since taking over the GETS. The matter has remained in stasis since. This does not cause problems at the day-to-day level. Problem will eventually need to be resolved by upper division management..

Q: Is there a continuous on-site O&M presence?

No. The site is self-operating, monitored electronically, and capable of remotely contacting a human if a problem is detected.

Q: If there is no continuous on-site presence, describe staff and frequency of site inspections and activities (e.g. what types of monitoring activities occur at what frequencies).

Inspections of the GETS treatment system occurs bi-weekly by the City.

Q: Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy (e.g. the GETS) that show wear or may need additional focus during O&M?

Yes. The extraction pumps and associated piping in the various extraction wells have either clogged or failed numerous times in the past. Each time the pump is pulled and a replacement installed.

EW1 and 2 were rehabilitated in 2012. I think they treated the well with chemicals to remove biofouling of slots on the well. Biofouling of slots on the well screens has been an ongoing problem.

Q: What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?

The ITR is in the planning stages, and I believe a RFP has been issued. EAB is still in planning phases. Excavation of UST is complete. GETS continues operation.

Q: Do you know about the drums on the property? A: Yes, apparently there were a series of drums stored next to the SVE building. I believe they contained soil and water from previous exploratory operations. My understanding is that CDM removed the drums off the site and disposed of them. CDMSmith on behalf of EPA arranged for the removal of the drums.

Q: What is the status of the two points of compliance, CW-1 and CW-2?

I don't think the locations of the compliance wells have been definitely selected. They were proposed as part of the remediation.

Q: Status of soil excavation?

Soil excavation as far as current remediation is complete. Former East tank farm area had a UST. UST and contaminated soil was removed. Excavation backfilled and covered with asphalt. Around the early 1980s, there were two tank farms. One (the west tank farm) where the SVE is. The other was the east tank farm to the east of the Time Oil building. The tank farms were used by Time Oil.

Q: Are there any trends in the GETS, compliance wells CW-1 and CW-2, or other wells that show contaminant levels are increasing or decreasing?

Because of all of the recent site work, the monitoring data has been erratic. Prior to the excavation, the GETS wells showed a general steady decrease for some contaminants. Others have shown little or no decrease.

Q: Have any new or emerging COCs been identified in Well 12A or nearby wells?

No. Most of the contaminants found are the ones known to be there all along. One surprise during the excavation, soil on the east tank farm was found to have naphthalene. Concentrations of naphthalene were high enough that soil could not be taken off-site for disposal.

Q: Do you think they got it all? A: Yes.

Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

Q: Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

No changes in land use. ICs have not yet been installed. Site has been fenced for many years from general public visiting. No unusual activities at the site.

The GETS Treatment system was not installed on Time Oil property. The Tx system land is leased from the local landowner who owns land adjacent to the Time Oil property. State pays cost of annual lease.

Q: Are you aware of any ongoing community concerns regarding the site or its administration?

No. Because it is an industrial area, the site draws very little attention.

Q: Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

Have any problems been encountered which required, or will require changes to this remedial design or ROD?

No, not really. The site is very complex as revealed by site investigations. The current planned treatments have been adjusted accordingly.

Q: Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?

The state is pleased that compared with the previous Five Year Review that so much more has been accomplished. The success is due to the aggressive cleanup pursuit by EPA and the State.

Look at the 1998, 2003, and 2008 FYRs and you can see significant progress.

Five Year Review Interview Record

Site Name:	Well 12A, South Tacoma Channel Superfund Site
EPA ID No.	WAD980726301
Interviewee:	Leslie Ann Rose, Citizens for a Healthy Bay (CHB)
Date:	22 February 2013
Interview Method:	Telephone
Interview Contacts:	Heather Whitney

Interview Questions

Q: What is your current role as it relates to the site? How long have you been aware of or associated with the site?

Our relationship/activities are similar to the ones we do with Commencement Bay. We [CHB] provide community oversight, input community perspective into the process from start.

Q: Do you have funding to provide community oversight to help with this project?

No. We are the only organization in Tacoma that is monitoring both superfund and MTCA cleanups. We don't get technical assistance funds, but we've just been doing it as part of our work.

We have members and supporters, but beyond that, there is no one homogenous community support CHB. At the end of the day, there are things on which we differ, but there is consensus about the endpoint. We work as collaboratively and cooperatively as possible with all stakeholders. Info is disseminated through quarterly newsletter, annual state of the bay report, always giving presentations to community groups, and other orgs. We may or may not agree with PRPs. We do not accept cash or in-kind contributions from active PRPs.

I am the senior policy analyst. I am the technical assistant to a volunteer group of 7 professionals who act as CHB's technical advisory group. They are multi-disciplinary. All are working professionals. None work for entities that would pose a conflict of interest. I work with the tech advisors. Everything that comes out of here is based on best available science. I am the "leader of the pack of volunteers."

CHB has a staff of 6. Founded in 1990. Our founding members were actually members of the citizens advisory group to EPA for Commencement Bay superfund project. At the end of that process, the members decided to continue the viewpoints in an organized fashion as CHB. We started working initially on just the Superfund. Over the years we have expanded our focus and mission. We've really expanded to cleanup, restore, protect the surrounding waters and watershed. I have one program (toxic cleanups, land use, critical areas) within CHB.

We try and avoid polarity on projects. We do not receive funding from Well 12A project to provide citizen/community input. We are concerned because I haven't had time to research the goings-on at Well 12A as much as we would like.

Q: What is your overall impression of the work conducted at the site to date?

Communication on this site has been abysmal. I can't even tell you who the project manager is. The last update that we received was more than 3 years ago right after the reopening of the site work. We've heard nothing since. This is a sore point. I assume EPA is still actively engaged. But I can't even verify that. We have real concerns about what is going on, what is being done, and why there is no communication or outreach or anything.

Well 12A is a municipal well. Right now it is offline. But sooner or later, Tacoma may need that water, and then what do we do. Contamination headed to nearby wells. But we don't know. We haven't heard anything in 4 years.

Q: Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? (If so, please give purpose and results.)

We know nothing. The last communication that I got was the proposed plan. I think it was about 3-4 years ago. Shortly thereafter, Kira Lynch was re-assigned and was no longer the project manager. I suspect Howard is the new project manager, but until your communication, there was no communication.

Q: What level of communication would work for CHB?

A: Somewhere in between weekly calls and what we have now since we don't have funding to stay involved in Well 12A and we have other projects. We would like regular updates as to what the challenges are, what the solutions are, what is being looked at, what the workplan is, basically, project status, if there are opportunities or places to include public review and input. Something, anything!

I think Howard and I can work out the details ourselves of an appropriate level of communications.

City of Tacoma and TacomaWater are independent entities that do their own things but coordinate activities. TacomaWater is a part of Tacoma Public Utilities. We (Tacoma) do things our own way. To the best of my understanding, Well 12A is being handled strictly by the TacomaWater folks. They are not required to report to one another.

Q: Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc).

[Skipped]

Q: Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy that show wear or may need additional focus during O&M? Please describe how improved efficiency has or has not occurred.

[Skipped]

Q: What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?

[Skipped]

Q: What does the monitoring data show?

[Skipped]

Q: Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

[Skipped]

Q: Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

[Skipped]

Q: Are you aware of any ongoing community concerns regarding the site or its administration?

[Skipped]

Q: Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

[Skipped]

Q: Have any problems been encountered which required, or will require changes to this remedial design or ROD?

[Skipped]

Q: Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?

While Well 12A is not needed right now, a few years of drought could flip the situation and require expanded use of the production wells.

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Appendix 1-E: Well 12 Data Summary

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Well 12 A Data Summary

Well12A Groundwater Data Summary, 2008-2012

Location	Depth Top	Depth Bottom	# Samples	Tetrachloroethylene (ug/L)		Trichloroethylene (ug/L)		cis-1,2-Dichloroethylene (ug/L)		trans-1,2-Dichloroethylene (ug/L)		Vinyl Chloride (ug/L)		1,1,2,2-Tetrachloroethane (ug/L)	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
			Cleanup Level	0.8		2.4		70		100		0.3		70	
CBW-1	44.9	54.9	1	1 U	1 U	1.8	1.8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CBW-10	149	169	3	0.22 UJ	1 U	7.2 J	21	0.23 J	1 U	0.71 J	2.4 J	0.08 UJ	1 U	0.54 J	2 U
CBW-11	144.9	158.9	1	1 U	1 U	8.5	8.5	1 U	1 U	0.83 J	0.83 J	1 U	1 U	1 U	1 U
CBW-4	167	187	1	1 U	1 U	8.9	8.9	1 U	1 U	0.82 J	0.82 J	1 U	1 U	1 U	1 U
CBW-5	178.2	188.2	1	1 U	1 U	3	3	7.2	7.2	1 U	1 U	1 U	1 U	1 U	1 U
CBW-6	138	158	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CBW-7	79	99	3	0.08 UJ	1 U	13 J	27	0.24 J	2 U	0.77 J	2.4	0.08 UJ	1 U	0.08 UJ	2 U
CBW-9	141.5	161.5	1	1 U	1 U	1.8	1.8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CH2M-1	52	72	3	36	120 J	1100	3100	210	1200	150	760	4.7	160	190 J	320
CH2M-2	160	180	3	0.08 U	1 U	15	21	1.2	1.5	0.15 J	1 U	0.08 U	1 U	0.08 U	2 U
CH2M-3	55	75	1	1 U	1 U	4.6	4.6	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CH2M-4	55	75	1	17 J	17 J	52	52	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
D-1			1	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
EAB-1	47	57	1	410 J	410 J	7900	7900	2500	2500	760 J	760 J	130 U	130 U	33000	33000
EAB-2	47	57	2	98 J	160 J	2000	4000	390	680	170	290	17 U	25 U	3800	6800
EAB-3	80	90	2	8.6 J	10 J	130	150	360	390	200	200	100	180	57	60
EAB-4	80	90	2	9.5 J	9.6 J	140	150	360	400	220	240	130	180	59	63
EW-1	60.7	80.8	10	1.2 J	2 U	50	73	24	35	14	18	0.95 J	2.7	3.2 J	3.9 J
EW-2	50.2	73.7	10	9.1 J	14	180	250	41	75	26	43	1.1 J	5.8	14	27 J
EW-3	46.8	70.3	10	4.3 J	69	230 J	1000	180 J	340	84 J	150	10 J	21	87	2500
EW-4	46.6	69.5	1	2.9	2.9	100	100	2200	2200	1400	1400	270	270	150	150
EW-5	47.6	71.1	11	2.9 J	7.5 U	51 J	75	1300 J	2200	730	1400	170 J	330	29	330
ICF-2	61	71	3	1.2 J	3.8 J	310 J	1300	310 J	1100	76	350	2.4 J	53	1.6	6.7 U
ICF-3	26.5	36.5	1	2 J	2 J	1.3	1.3	1 U	1 U	1 U	1 U	1 U	1 U	1.3	1.3
ICF-4	28.5	38.5	1	50 U	50 U	50 U	50 U	69	69	34 J	34 J	95	95	50 U	50 U
ICF-5D	44.5	54.5	3	13 U	42 J	190	220 J	1400 J	3100	170	610	91	230	73 J	81
ICF-5S	31.5	41.5	3	15 J	28 J	180	250 J	38 J	190	79 J	100	0.5 UJ	1.5	9.1 J	22
IM-1A	57.9	62.9	3	0.16 J	0.28 J	9.7	11	2.8	3.4	0.88	1.2	0.08 U	0.08 U	1.5	1.7
IM-1B	70.6	75.6	3	0.46 J	0.63 J	34	70 J	2.7	4.5 J	2	4.2 J	0.16 U	0.24 UJ	1.3	2.3 J
IM-1C	104.7	109.7	3	0.08 UJ	3.9 J	0.08 UJ	9.7	0.78 J	15	0.08 UJ	1.4	0.08 UJ	0.08 UJ	0.08 UJ	2.4
IM-2A	57.3	62.3	3	2 J	3.3 J	65	130 J	7.2	9.7 J	3.9 J	4.9 J	0.5 UJ	0.5 UJ	2 UJ	2 UJ
IM-2B	70.5	75.5	3	0.5 UJ	0.56 J	12 J	13	2 UJ	2 UJ	1.2 J	1.4 J	0.5 UJ	0.5 UJ	2 UJ	2 UJ
IM-2C	105.2	110.2	3	0.5 UJ	10 U	2200	2500 J	250	330 J	630	760 J	63 J	82 J	2 UJ	40 U
INJ-1	48	63	1	98 J	98 J	2800	2800	1300	1300	430	430	47 J	47 J	1200	1200
INJ-2	80	90	1	7.2 J	7.2 J	100	100	350	350	200	200	170	170	44	44
KRRF-1	63	73	3	1.3 J	2.1 J	73	150 J	16	36	9.7	20	0.5 R	1.7	1.6 J	3.7
MW-301	141	146	1	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-302	101	106	4	0.5 U	1 U	15	44	15	19	4.6 J	8.6	5.9 J	21	1 U	2 U
MW-304	140.5	150.5	1	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-305	101	106	1	1 U	1 U	1 U	1 U	2.1	2.1	1 U	1 U	2.6	2.6	1 U	1 U
MW-306	139	149	1	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-307	145	155	1	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-308	146	156	1	1 U	1 U	15	15	6	6	1.7	1.7	0.81 J	0.81 J	1 U	1 U
MW-309	104	109	2	0.5 U	0.8 UJ	64 J	77	2.3 J	2.8 J	5.5 J	6	0.5 U	0.8 UJ	0.8 UJ	2 U
MW-310	70	75	2	0.5 U	0.57	21	23	0.71	0.99 J	2.2	2.5 J	0.08 U	0.5 U	1.1	2 U

Well12A Groundwater Data Summary, 2008-2012

Location	Depth Top	Depth Bottom	# Samples	Tetrachloroethylene (ug/L)		Trichloroethylene (ug/L)		cis-1,2-Dichloroethylene (ug/L)		trans-1,2-Dichloroethylene (ug/L)		Vinyl Chloride (ug/L)		1,1,2,2-Tetrachloroethane (ug/L)	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
			Cleanup Level	0.8		2.4		70		100		0.3		70	
MW-311	102	107	2	0.08 UJ	0.5 U	0.08 UJ	0.5 U	0.08 UJ	2 U	0.08 UJ	0.5 U	0.08 UJ	0.5 U	0.08 UJ	2 U
MW-312	68	73	2	0.08 UJ	0.5 U	20	23 J	3.2 J	3.9 J	0.58 J	0.73 J	0.08 UJ	0.5 U	0.08 UJ	2 U
MW-313	67.5	72.5	2	2.4 J	4.2 J	100	320 J	77	140 J	64	95 J	10 J	25	39	340 J
MW-314	32.5	47.5	2	59 J	67	540	550 J	510	900 J	130	160 J	2.5 U	26 J	480	660 J
MW-89.7	50.79	60.79	1	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-A	48	68	1	1 U	1 U	3.8	3.8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-B	41	61	1	1 U	1 U	15	15	1.2	1.2	0.98 J	0.98 J	1 U	1 U	1 U	1 U
MW-C	33	53	3	3.4 J	8.8 J	71 J	260	3.8 J	89	2 J	82	0.5 R	8.6	7 J	38
SP-1			9	2.7 J	11	100 J	190	120	150	69	87	9.7	17	19 J	250
TOW-10	55	85	1	1 U	1 U	2.3	2.3	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOW-4	55	85	3	1.6 J	3.2 J	50 J	190	280	760 J	250	450 J	140	710 J	3.4 J	81
TW T-10	164.5	0	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
VP101	43	43	1	8.5	8.5	250	250	48	48	27	27	0.5 U	0.5 U	38	38
VP101	48	48	1	13	13	380	380	80	80	44	44	1 U	1 U	69	69
VP101	57	57	1	40	40	780	780	930	930	290	290	350	350	96	96
VP101	69	69	1	1.7 J	1.7 J	41	41	23	23	11	11	6.6	6.6	2 U	2 U
VP101	79	79	1	1.8 J	1.8 J	55	55	5.3	5.3	7.8	7.8	0.5 U	0.5 U	2 U	2 U
VP101	88	88	1	2.5 J	2.5 J	120	120	9.9	9.9	20	20	0.5 U	0.5 U	5.3	5.3
VP101	100	100	1	2.5 U	2.5 U	540	540	250	250	530	530	34	34	10 U	10 U
VP102	40	40	1	5.4	5.4	21	21	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP102	50	50	1	1.9 J	1.9 J	21	21	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP102	60	60	1	0.5 U	0.5 U	18	18	1.9 J	1.9 J	1 J	1 J	0.5 U	0.5 U	2 U	2 U
VP102	70	70	1	0.5 U	0.5 U	0.81 J	0.81 J	2.9 J	2.9 J	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP102	80	80	1	0.5 U	0.5 U	13	13	5.8	5.8	6.9	6.9	2 J	2 J	2 U	2 U
VP102	90	90	1	0.5 U	0.5 U	18	18	6.1	6.1	7.3	7.3	1.9 J	1.9 J	2 U	2 U
VP102	98.5	98.5	1	0.5 U	0.5 U	8.9	8.9	8.3	8.3	2.9 J	2.9 J	3 J	3 J	2 U	2 U
VP103	46	46	1	0.76 J	0.76 J	150	150	40	40	20	20	0.63 U	0.63 U	15	15
VP103	60	60	1	3.6 J	3.6 J	64	64	19	19	10	10	0.5 U	0.5 U	4.7 J	4.7 J
VP103	70	70	1	1.8 J	1.8 J	68	68	15	15	12	12	0.5 U	0.5 U	2 U	2 U
VP103	80	80	1	0.5 U	0.5 U	86	86	19	19	15	15	0.5 U	0.5 U	2 U	2 U
VP103	90	90	1	0.84 U	0.84 U	210	210	46	46	50	50	0.84 U	0.84 U	3.3 U	3.3 U
VP103	110	110	1	0.5 U	0.5 U	70	70	57	57	81	81	35	35	2 U	2 U
VP104	40	45	1	0.5 U	0.5 U	8.1	8.1	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP104	55	60	1	7.4 J	7.4 J	380	380	160	160	100	100	1.6 U	1.6 U	6.3 U	6.3 U
VP104	70	75	1	0.84 J	0.84 J	33	33	7.9	7.9	5.5	5.5	0.5 U	0.5 U	2 U	2 U
VP104	85	90	1	0.96 J	0.96 J	140	140	15	15	17	17	0.5 U	0.5 U	2.4 J	2.4 J
VP104	103	108	1	1 U	1 U	190	190	73	73	35	35	7.1 J	7.1 J	4 U	4 U
VP105	35	40	1	4.4 J	4.4 J	42	42	2.8 J	2.8 J	1.3 J	1.3 J	0.5 U	0.5 U	2 U	2 U
VP105	50	55	1	2.4 J	2.4 J	73	73	19	19	2.1 J	2.1 J	26	26	2 U	2 U
VP105	65	70	1	0.63 U	0.63 U	150	150	47	47	28	28	47	47	2.5 U	2.5 U
VP105	85	90	1	0.5 U	0.5 U	48	48	35	35	8.7	8.7	20	20	2 U	2 U
VP105	105	110	1	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP106	35	40	1	5.5	5.5	100	100	24	24	12	12	0.5 U	0.5 U	16	16
VP106	50	55	1	0.5 U	0.5 U	31	31	12	12	4.5 J	4.5 J	0.5 U	0.5 U	2 U	2 U
VP106	65	70	1	0.5 U	0.5 U	57	57	11	11	6.2	6.2	0.5 U	0.5 U	2 U	2 U

Well12A Groundwater Data Summary, 2008-2012

Location	Depth Top	Depth Bottom	# Samples	Tetrachloroethylene (ug/L)		Trichloroethylene (ug/L)		cis-1,2-Dichloroethylene (ug/L)		trans-1,2-Dichloroethylene (ug/L)		Vinyl Chloride (ug/L)		1,1,2,2-Tetrachloroethane (ug/L)	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
			Cleanup Level	0.8		2.4		70		100		0.3		70	
VP106	85	90	1	0.72 J	0.72 J	**86**	**86**	12	12	17	17	**1.2 J**	**1.2 J**	2 U	2 U
VP106	110	115	1	0.5 U	0.5 U	1.4 J	1.4 J	0.95 J	0.95 J	0.5 U	0.5 U	**28**	**28**	2 U	2 U
VP107	35	40	1	**1.2 J**	**1.2 J**	**33**	**33**	2 U	2 U	0.89 J	0.89 J	0.5 U	0.5 U	2 U	2 U
VP107	50	55	1	**16 J**	**16 J**	**360 J**	**360 J**	62 J	62 J	40 J	40 J	**10 J**	**10 J**	31 J	31 J
VP107	65	70	1	**1.6 J**	**1.6 J**	**36**	**36**	6.5	6.5	5.3	5.3	**1 J**	**1 J**	2.2 J	2.2 J
VP107	85	90	1	**4.8 J**	**4.8 J**	**480**	**480**	34	34	91	91	2.5 U	2.5 U	5.9 J	5.9 J
VP107	105	110	1	2.5 U	2.5 U	**2100**	**2100**	**400**	**400**	**1100**	**1100**	**130**	**130**	10 U	10 U
VP108	40	40	1	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP108	55	55	1	**3.7 J**	**3.7 J**	**150**	**150**	22	22	21	21	0.63 U	0.63 U	2.5 U	2.5 U
VP108	70	70	1	0.5 U	0.5 U	**25**	**25**	0.92 J	0.92 J	2.4 J	2.4 J	0.5 U	0.5 U	2 U	2 U
VP108	90	90	1	2.5 U	2.5 U	**490**	**490**	44	44	36	36	2.5 U	2.5 U	10 U	10 U
VP108	115	115	1	0.5 U	0.5 U	**3.1 J**	**3.1 J**	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP109	35	40	1	**3.6 J**	**3.6 J**	**120 J**	**120 J**	4.1 J	4.1 J	4.3 J	4.3 J	0.5 U	0.5 U	1.4 J	1.4 J
VP109	50	55	1	**18 J**	**18 J**	**880**	**880**	**290**	**290**	**190**	**190**	**63**	**63**	4.7 J	4.7 J
VP109	65	70	1	**1.3 J**	**1.3 J**	**51**	**51**	11	11	7	7	**1.2 J**	**1.2 J**	1.3 J	1.3 J
VP109	85	90	1	0.5 U	0.5 U	**24**	**24**	13	13	4.6 J	4.6 J	**0.78 J**	**0.78 J**	2 U	2 U
VP109	110	115	1	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP110	35	40	1	0.57 J	0.57 J	**14**	**14**	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP110	50	55	1	**5.6**	**5.6**	**120**	**120**	8.1	8.1	6	6	**0.9 J**	**0.9 J**	10	10
VP110	65	70	1	**1.5 J**	**1.5 J**	**33**	**33**	9.3	9.3	6.5	6.5	**1.1 J**	**1.1 J**	3.7 J	3.7 J
VP110	85	90	1	**3.8 J**	**3.8 J**	**130**	**130**	9.8	9.8	20	20	**1.9 J**	**1.9 J**	9.7	9.7
VP110	105	110	1	5 U	5 U	**1400**	**1400**	**130**	**130**	**300**	**300**	**20 J**	**20 J**	20 U	20 U
VP111	35	40	1	0.5 U	0.5 U	**20**	**20**	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP111	50	55	1	**2.9 J**	**2.9 J**	**100**	**100**	8.8	8.8	6.4	6.4	0.5 U	0.5 U	2 U	2 U
VP111	65	70	1	**2.7 J**	**2.7 J**	**59**	**59**	2.1 J	2.1 J	3.8 J	3.8 J	0.5 U	0.5 U	2.3 J	2.3 J
VP111	85	90	1	**3.1 J**	**3.1 J**	**200**	**200**	15	15	24	24	0.72 U	0.72 U	3.7 J	3.7 J
VP111	110	115	1	3.1 U	3.1 U	**910**	**910**	**250**	**250**	**220**	**220**	**44**	**44**	13 U	13 U
VP112	35	40	1	0.5 U	0.5 U	1.4 J	1.4 J	2 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
VP112	50	55	1	**2.1 J**	**2.1 J**	**270**	**270**	81	81	29	29	**69**	**69**	8.8 J	8.8 J
VP112	65	70	1	**1.1 J**	**1.1 J**	**26**	**26**	4 J	4 J	3.4 J	3.4 J	0.5 U	0.5 U	2.7 J	2.7 J
VP112	85	90	1	**4.2 J**	**4.2 J**	**280**	**280**	24	24	42	42	**3.3 J**	**3.3 J**	13	13
VP112	105	110	1	**11 J**	**11 J**	**1400**	**1400**	**130**	**130**	**250**	**250**	**23 J**	**23 J**	20 U	20 U
WCC-1A	117	132	3	0.08 UJ	1 U	**8**	**16 J**	3.5 J	6 J	2.9 J	4.6 J	**1.4 J**	**1.8 J**	0.08 UJ	2 U
WCC-1B	51	66	3	**2.2 J**	**20 J**	**92**	**1400 J**	74	**460 J**	51	**390 J**	**6.6**	**22 J**	63 J	200 J
WCC-2	38	48	1	1 U	1 U	**4.1**	**4.1**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
WCC-3	35	45	1	1 U	1 U	1.5	1.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
WCC-5	36	56	3	0.75 J	**1.4 J**	**14**	**31**	2 J	4.5	1.5 J	3.4	**0.47 J**	**1.1**	0.83	2 U
WCC-6	50	70	1	1 U	1 U	**17**	**17**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
WCSB-9	25	45	1	**4.3 J**	**4.3 J**	**33**	**33**	0.94 J	0.94 J	1 U	1 U	1 U	1 U	1 U	1 U

Notes:
Bold and highlight indicates contaminant was detected above cleanup level

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2. South Tacoma Field, Operable Unit 4

2.1. Introduction

This is the third five-year review for the South Tacoma Field, OU 4 (EPA ID No. WAD980726301) of the South Tacoma Channel (STC) Superfund site located in Tacoma, Washington. The STC Superfund site also includes Well 12A (OU 1) and Tacoma Landfill (OU 5/6). Each STC OU is treated as a separate site but for purposes of Five-Year Reviews, all three are being submitted together under one cover. The triggering action for this review is the date of the previous Five-Year Review in September 2008. The Five-Year Review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site at levels above those that would allow for unlimited use and unrestricted exposure.

2.1.1. Purpose

The purpose of five-year reviews 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 recommendations to address them.

2.1.2. Authority

The United States Environmental Protection Agency (EPA) is preparing this five-year review pursuant to Comprehensive Environmental 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 EPA 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.*

With oversight from the EPA Region 10 Remedial Project Manager, the United States Army Corps of Engineers (USACE), Seattle District conducted a five-year review of the remedial actions implemented at the South Tacoma Field (STF) OU in Tacoma, WA. This review was conducted from January 2013 through June 2013. This report documents the results of the review.

2.2. Site Chronology

Table 2-1 lists major activities and milestones related to this site.

Table 2-1. Chronology of Site Events

Event	Date
EPA issued a Record of Decision (ROD) for South Tacoma Field.	September 29, 1994
A Unilateral Administration Order (UAO) was issued for remedial design and action – soil and groundwater contamination.	January 1996
A Consent Decree for remedial design and action superseded the UAO.	January 1997
EPA conducted initial wetland monitoring.	January 1997
Tacoma City Light completed remedial design.	January 1997
Tacoma City Light initiated remedial action (RA).	August 1997
A wetland investigation was conducted.	March 1998
An RA work plan for remaining areas was completed.	April 1998
The RA for remaining areas began.	June 10, 1998
An additional wetland investigation was conducted.	April 1999
Final inspection for the RA was performed.	July 20, 1999
Construction was completed (a Preliminary Closeout Report was issued).	September 1999
An Explanation of Significant Differences (ESD) for groundwater was issued.	September 29, 1999
A Final Site Development & Institutional Controls Plan and Operations & Maintenance Plan (including groundwater monitoring) were submitted.	March 2000
An RA report for soils was approved.	September 2000
The first Five-Year Review was completed.	June 2003
A Certificate of Completion was issued for soils.	September 2003
The Final Closeout Report for STF Soils was issued.	February 24, 2005
A Partial Delisting from National Priority List (NPL), for STF Soils, was completed.	June 15, 2005
The second Five-Year Review was completed.	September 2008

2.3. Background

2.3.1. Physical Characteristics

The site is located in Tacoma, Pierce County, Washington, between South 36th Street on the north and South 56th Street to the south, and from Tyler Way on the west to Adams Street on the east (Figure 2-1).

The STF OU is approximately 260 acres. The area's elevation is lower than surrounding upland areas by as much as 150 feet on the west. The southern half of the site contains industrial and commercial facilities; the northern and western portions are primarily open grass fields. The site includes a former swamp and lake bed that has been filled and covered with grass over time. A small wetland is present in the northern portion of the site.

Storm sewer outfalls discharge water onto the north end of the site that is conveyed across the western portion in an open channel. Water is not usually present in the southern portion of the channel except in response to heavy rains. However, the channel continues along Madison Street until it feeds into a storm drain culvert 150 feet north of South 56th Street.

The site is located within the South Tacoma Groundwater Protection District, which is a special zoning overlay district managed by the Tacoma Pierce County Health Department (TPCHD). The City of Tacoma operates several drinking water wells within a half mile of the site (Wells 2B/C, 4A, 6B, and 11A) that are used to augment the City's drinking water supply during peak demand periods.

2.3.1.1 Site Geology

Due to the historical industrialization of the site and subsequent demolition of most pre-existing structures, most of the near-surface soil at the site has been disturbed. Despite the grading that has occurred over much of the site, natural processes have resulted in the formation of a thin topsoil (six inches or less in thickness) in these areas. Beneath this topsoil, fill materials have been mixed with natural soils. Fill areas are generally indistinguishable from other areas underlain by naturally deposited sediments. Fill materials generally ranged from 1 to 3 feet in thickness; however, some areas of the site contain fill materials up to 15 feet thick.

Natural soils beneath the fill materials are part of sequence of glacial and interglacial deposits from the most recent glaciations. Several distinct channels have been cut into these deposits by high velocity glacial meltwater, one of which is the South Tacoma Channel over which the site is situated. Where saturated, the coarse sands and gravels associated with these deposits make them conducive to high aquifer yields.

2.3.1.2 Hydrogeology

The upper unconfined aquifer at the STF site occurs within the Colvos Sand unit, which represents advance outwash sands and gravels that were deposited from meltwater streams along the leading edge of the glacier during its southward advance. The top of the upper aquifer was encountered at depths ranging from near ground surface (in the Former Swamp/Lakebed area, which is shown on Figure 2-2) to approximately 35 feet below ground surface in the southeastern portion of the site. The depth to the upper aquifer varies seasonally, by as much as ten feet, over much of the site. These seasonal variations in depth to the upper aquifer are dependent on climatic conditions and pumping of the City of Tacoma drinking water production wells located just east of the site. During times when the City of Tacoma is not pumping, water level data indicates the formation of a potentiometric "mound" in the upper aquifer in the southern portion of the site.

2.3.1.3 Hydrology

Although no perennial creeks, streams, or rivers flow through the STF site, a surface water (storm water) drainage channel is located below the bluff along the western portion of the site. The primary source of surface water entering this drainage channel is storm water runoff from residential and industrial areas that discharge from two storm drain outlets (i.e., northern and southern outfalls) along the northwest boundary of the site. The storm drain system is owned and operated by the City of Tacoma. Information gathered during the RI indicates that storm water in the channel does not typically flow off-site as surface water, except during major rainfall events. Instead, surface water dissipates by evaporation, transpiration, and infiltration downward through soil and sediment to recharge the upper aquifer. Surface water that leaves the STF site discharges from the trunk storm drain to the Flett Creek storm basin approximately 1.4 miles south of the site. Approximately 3 miles farther downstream, Flett Creek discharges into Chambers Creek, which leads to Chambers Bay on Puget Sound.

A perennial wetland and a possible remnant of the South Tacoma Swamp is located along the on-site drainage channel. The wetland and swamp remnant are primarily supported by storm water runoff from the surface channel. These areas contain standing water through most of the year and support perennial wetland and riparian woodland ecosystems.

2.3.2. Land and Resource Use

The site is currently zoned for commercial/industrial use with the exception of an 18 acre strip along the western border which is zoned for residential-commercial transitional use. The western side of the STF site, generally in the area of the old airport, is also used for casual recreation (e.g., biking, dog walking, and flying model airplanes) and illegal dumping of household waste. Businesses recently operating on the southern half of the STF site included Pioneer Builders Supply, General Plastics, and Industrial Properties which leases warehouse, office, and yard space to businesses. A portion of the BNSF right-of way, which comprises the eastern boundary of the STF site, was recently transferred to Sound Transit. The right-of-way extends northward through the northern boundary of the site. Residential properties are located uphill from and just off the northwest side of the site.

Since 2003, the three businesses existing at the south end of the site have expanded operations. Burlington Way was the primary public access to the site until the City completed a new access at South 50th Street, which opens the site up to traffic from South Washington Street and South Tacoma Way. Burlington Northern Sante Fe (BNSF) Railroad owns the majority of the site.

2.3.3. History of Contamination

A variety of industrial and commercial operations have occupied different portions of the site in the past hundred years. Figure 2-3 shows historic use across the site and general areas of contamination. The South Tacoma Car Shops area operated as a railroad vehicle manufacturing and repair facility from 1892 to 1974. The area was used for manufacturing, repair, and maintenance of railroad equipment including the cleaning and dismantling of rail cars. Foundry facilities operated on-site from 1890 through 1980. An iron foundry produced iron wheels until 1957. A brass foundry produced journal bearings composed primarily of lead, tin, copper, zinc and antimony until 1980. Aircraft maintenance and refueling operations were performed at the South Tacoma Airport from 1936 to 1973. A lake was located beyond

the south end of the former runway and, in the late 1940s, was used by seaplanes. A variety of filling activities occurred during the history of the site. Foundry, construction, and domestic wastes reportedly were disposed of as fill material in the former swamp/lakebed area. In the 1930s and 1940s portions of the site reportedly were used as unauthorized dumping areas for household and commercial wastes.

In addition to potential historic contaminant sources, several present day industrial facilities have contributed to the contaminant source areas. Tacoma Public Utilities (Tacoma City Light) has operated a maintenance and repair facility at the northernmost end of the STF site since 1953. The property is covered with asphalt pavement and buildings. Storm water runoff from the property currently drains to modified dry wells that have soil bottoms and inter-connecting piping leading to the City of Tacoma's storm drainage system.

Pioneer Builders Supply purchased land in the southeast portion of the site for the construction of a warehouse and office in 1988. Pioneer used two underground storage tanks (USTs) for about five years to store gasoline and diesel fuel. During removal of these tanks in 1991, petroleum contamination was discovered in surrounding soils. Reportedly, all visible soil contamination was removed during the tank removal. In addition, three other USTs were discovered in the northeast corner of the Pioneer Builders Supply property in 1990 and were subsequently removed. Soils that were visibly contaminated were removed; however, excavation did not occur below groundwater level.

2.3.4. Initial response

In 1990, the EPA signed a Consent Order with the Potentially Responsible Parties (PRPs) to conduct a Remedial Investigation and Feasibility Study (RI/FS) at the site. During the RI, contamination was identified at the former railroad maintenance area, the Tacoma Public Utilities area, the Pioneer Builders Supply property, and the Amsted property (former foundry area). The Preliminary Closeout Report (Long-Term Remedial Action), prepared and issued by EPA in September 1999, contains a detailed summary of what types of contamination were found at various concentrations and locations across the site. Surface soils, and to a lesser extent subsurface soils in the rail yard and foundry areas, were contaminated with high levels of lead, arsenic, copper and zinc. Metal concentrations in surface soil samples from the former swamp/lakebed area were found to be elevated, but to a lesser degree than in samples from the more active industrial areas.

At the foundry area on the south end of the site (Amsted property, see Figure 2-2), a relatively small volume of nearly immiscible, heavy fuel oil was found on the surface of the water table. At the Tacoma City Light Property on the north end of the site, elevated concentrations of polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and several other organics were detected in subsurface soils at and underlying some of the dry wells. At Pioneer Builders Supply, also on the south end of the site opposite Amsted, elevated concentrations of 1,2,4-trichlorobenzene, PCBs, petroleum hydrocarbons (TPH), benzene, ethylbenzene, toluene, and xylenes (BETX) were found in subsurface soil in the unsaturated zone beneath and immediately surrounding the location where the three USTs were removed. Benzene, ethylbenzene, and 1,1,2-trichloroethane (TCA) were detected above maximum contaminant levels (MCLs) in groundwater at this site.

2.3.5. Basis for Taking Remedial Action

The human health risk assessment (HHRA), as presented in the ROD, evaluated risks due to contamination in the soil, groundwater, surface water and sediment (in ditches). The routes of exposure included soil ingestion, skin contact with soil, and ingestion of groundwater. The HHRA considered the risks posed by ingestion and direct contact based on an industrial use scenario. Surface and sub-surface soils that might be carried by wind, surface water runoff, and earth moving activities were also considered. Contamination carried off-site by surface runoff could reach either Chambers Creek or Flett Creek (located to the south of STF) via the storm water drainage ditch on the west side of the site. It was also possible that Tacoma's drinking water aquifer could be threatened by the surface water runoff or by its hydrologic connection to groundwater at the site.

During the comment period for the ROD, it was discovered that an area of about 18 acres on the western portion of the site was zoned Residential-Commercial Transitional District. Based on this information, EPA determined that residential cleanup levels would apply. In conjunction with the ROD, the Agency for Toxic Substances and Disease Registry (ATSDR) issued a public health assessment for the site which reached the same conclusions as the ROD.

For surface soil ingestion under both the residential and industrial scenarios, excess cancer risks (greater than $1x10^{-4}$) and hazard quotients greater than 1 for non-cancer risks were found to be present. Risks were primarily driven by arsenic, PCBs, and PAHs. Lead was also noted as present at levels above the standard for soil at industrial properties. In addition, considering standards for both industrial and residential properties, excess cancer risk was present for the groundwater pathway.

The results of the Ecological Risk Assessment indicated that potential chemical impacts from on site contaminants to the plant species of the grassland were small. EPA also determined that levels of contaminants in the water and sediment in the wetlands/drainage channel were not unusual for urban wetlands with similar water quality problems. The wetland area was determined to serve a beneficial use as a filter for urban storm water runoff.

As described in the ROD, the STF site was broken down into three areas for remediation: STF soils, Pioneer Builders Supply, and Tacoma City Light drywells. Contaminants of concern (COCs) at these areas were identified as shown in Table 2-2.

Table 2-2. South Tacoma Field Contaminants of Concern

Area	Soil COCs	Groundwater COCs
STF Soil	Aluminum Aldrin Antimony Carcinogenic PAHs Arsenic Beryllium 3,3-Dichlorobenzidine Copper PCBs Lead Pentachlorophenol Manganese Zinc	NA

Area	Soil COCs	Groundwater COCs
Pioneer Builders Supply	Benzene Toluene Ethylbenzene Xylenes TPH	1,1,2-Trichloroethane Naphthalene Benzene Toluene Ethylbenzene Xylenes TPH
Tacoma City Light Dry Wells	Aldrin 3,3-Dichlorobenzidine Carbazole PCBs Carcinogenic PAHs Pentachlorophenol 1,4-Dichlorobenzene	NA

NA – not applicable

2.4. Remedial Actions

The ROD was issued on September 29, 1994 and utilized a combination of treatment, containment and institutional controls for the contaminated soil throughout the site and treatment of contaminated groundwater at Pioneer Builders Supply. An ESD was issued on August 29, 1999 after the UST and contaminated soils at Pioneer Building Supply were removed. The ESD changed the treatment of contaminated groundwater at Pioneer Builders Supply to MNA.

2.4.1. Remedial Action Objectives

The following Remedial Action objectives are specified in the ROD for STF:

- The objective of the subsurface soil cleanup goals is to prevent further groundwater contamination.
- The objective of the groundwater cleanup goals is to reduce total excess cancer risk from all carcinogens to no greater than 1 in 100,000 (10^{-5}) and a Hazard Index that will not exceed 1.

2.4.2. Remedy Description

The following description of the selected remedy is taken from the ROD and ESD.

STF Soils

- Excavate and solidify contaminated soil (except for PCB contaminated soil) that exceeds hot spot concentration thresholds. Treated soil shall be placed back on site under a soil or asphalt cap.
- Soil contaminated with PCBs above 50 parts per million (ppm) was found in only one location at Pioneer Builders Supply. If additional sampling at this location confirms PCB concentrations above 50 ppm, then these soils shall be excavated and either incinerated at an approved, off-site incinerator or disposed off-site at a permitted hazardous waste disposal facility.
- Excavate, consolidate on-site and contain (cap) soil which exceed capping levels (Model Toxics Control Act (MTCA) Industrial Method A). The required excavation of soil would be limited to a maximum of one foot. If, after excavating a foot of soil, an area is still contaminated above MTCA industrial soil cleanup levels, the area will be capped. The PRP may continue excavating until

contaminants in soil are below industrial cleanup levels, and thus avoid the requirement to cap in that area. Contaminated soils shall be capped with either soil or asphalt.

- Implement institutional controls (e.g., deed restrictions, access restrictions, fencing), to prohibit activities that may lead to exposure to contaminants and to protect capped areas.
- Conduct groundwater monitoring, including monitoring of the petroleum hydrocarbon contamination found at the Amsted property. This is required to ensure that groundwater levels stay below federal drinking water or MTCA based cleanup standards. Monitoring of the storm water run-on, runoff, surface water, and sediment in the wetland/drainage channel is also required. The monitoring program shall be reviewed every five years to determine whether additional actions are required or whether the monitoring program should be modified or discontinued.

Pioneer Builders Supply

- The ROD originally required implementation of air sparging and in situ vapor extraction in the vicinity of Pioneer Builders Supply to clean up contaminated subsurface soil and groundwater to achieve cleanup levels. However, after source removal contaminant concentrations in groundwater decreased and an ESD determined that groundwater monitoring for natural attenuation, rather than active treatment, was appropriate.
- Implement institutional controls in the form of restrictions on groundwater use to non-drinking water purposes in the vicinity of Pioneer Builders Supply. This restriction shall continue until groundwater cleanup levels, set at the federal drinking water standards, are achieved throughout the contaminant plume and MTCA cumulative risk requirement of risks no greater than 1 in 100,000 and a Hazard Index no greater than 1 are also achieved.
- Conduct groundwater monitoring as part of the cleanup remedy for this portion of the site. The monitoring program shall be reviewed every five years to determine whether additional actions are required or whether the monitoring program could be modified or discontinued.

Tacoma City Light Dry Wells

- Excavate contaminated soil with PCB concentrations above 50 ppm or endrin concentrations above 0.13 ppm and transport the soil off-site for incineration.
- Excavate and transport to an off-site, permitted hazardous waste disposal facility all soil with PCB, PAH and other chemical concentrations above the MTCA Method B residential clean up levels.

2.4.3. Remedy Implementation

STF Soils

The remedial action for STF soils began in June 1999. The following work was conducted in accordance with the ROD and the Consent Decree:

- Approximately 6,300 tons of soil exceeding hot-spot concentrations were excavated and treated (i.e., stabilized with a phosphate-based reagent). These soils were consolidated on-site and covered with a clean soil cap.
- 15.4 tons of soil at Pioneer Builders Supply with PCBs exceeding 50 mg/kg were excavated and disposed off-site.

- 113,607 tons of soil with contaminant concentrations between the level that would have required capping and the hot-spot level were consolidated and capped.
- An estimated 13.7 acres of the STF OU was capped.
- Buried tanks and drums and their contents were removed and disposed. Associated contaminated soils and solid wastes were also removed and disposed of at a permitted facility.
- Sub-surface soils contaminated at levels above those that would require capping were capped where excavation and consolidation were not cost-effective.
- Institutional controls (ICs) prohibiting residential development were implemented. A parcel map showing the areas where deed restrictions were recorded is shown on Figure 2-4.
- Site access controls limiting exposure to caps were installed (e.g., fencing, warning signs on consolidation areas, grid-area markers for surveying integrity of capped areas over time).
- During construction, air was monitored to assess airborne contaminant concentrations in the work area and at site boundaries.

Only three minor deviations from the ROD and approved remedial design (RD) occurred. First, the ROD called for Portland cement as a stabilizing agent; instead, a proprietary phosphate-based reagent was used to render metal contaminants stable and insoluble. Second, because the RD assumed Portland cement as the stabilizer, a retaining wall and storm water drainage were designed for the Amsted property. However, the volume of soil needing treatment was smaller than expected since cement was not used, and the retaining wall and associated storm water drainage were unnecessary. Finally, because near-term development was expected on the STF portion of the site, all excavated soil was not fully replaced because backfill from development was anticipated to fill the remaining excavated volume. (Note a minimum of six inches of topsoil was placed over all soils requiring a cap.)

Some small areas of contamination, where concentrations exceeded levels that would require capping, could not be excavated because they were beneath active rail lines. These grid-areas were documented and are shown on Figure 2-5. The Site Development and Institutional Control Plan (SDICP) contains operation and monitoring requirements for these areas to manage exposure during rail maintenance or construction or utility work.

There are three areas of consolidated soil contamination, one at the northern portion of the STF and two at the southern end (Figure 2-6). Of these three areas, only the northern area was completely fenced as part of the remedial action. One of the southern consolidation areas (Amsted) was fenced on three sides of the parcel that were easily accessible from South Proctor Street, while the third side was not fenced because steep slopes naturally limit access and trespass. Exposure is controlled by site use on the Amsted area which is parking and storage for various items (truck containers, logs). For the northern and Amsted areas, future development plans allow redesign and/or removal of the fences. The southernmost area of consolidation was not fenced as part of the remedial action. Due to its visibility from South 56th Street, which is a major thoroughfare, this area is much less attractive for use by transient people than other parts of the site which are open to less-traveled public right-of-ways where post-remedial soils are a mix of conditions suitable for industrial use/exposure as well as unrestricted use.

Pioneer Builders Supply

The ESD determined that groundwater monitoring for natural attenuation, rather than aggressive treatment, was appropriate because contaminant concentrations were decreasing and the source (USTs) had been removed. Groundwater sampling is conducted annually at Pioneer Builders Supply to monitor the effectiveness of the natural attenuation remedy. The ROD established cleanup levels for soils in 1994; however, it is not clear if these levels were achieved during the UST removals in 1990 and 1991. At the time the USTs were removed (during the RI), visibly contaminated soils were excavated but not below the groundwater level. Confirmation sample data from the UST removal actions were not assessed so this FYR cannot confirm that soil cleanup levels established afterward in the ROD were met.

Tacoma City Light Dry Wells

In 1997, Tacoma City Light remediated their dry well contamination in accordance with the ROD, choosing to perform a more aggressive cleanup than pursued for other areas of the site. Soils contaminated with 50 mg/kg or more PCBs and 0.13 mg/kg or more endrin were excavated and incinerated off-site.

Wetland Drainage Channel

As required in the ROD, EPA conducted two rounds of groundwater, surface water, and sediment sampling in the drainage channel in November 1996 and September 1997 to characterize surface water run-on and determine if the run-on has affected on-site sediment or groundwater. Select surface water and sediment sampling locations were re-sampled in August and November, 1998. Sample results confirmed that surface water and sediment concentrations were similar to those in other urban runoff channels. The later samples indicated lead was present in sediment at a concentration of 913 mg/kg, compared to the soil- capping-required level of 1,000 mg/kg. Arsenic (maximum = 7.57 micrograms per Liter [µg/L]) and carcinogenic PAHs (cPAHs; 0.13 µg/L) were also detected at levels above the MTCA Method B criteria for surface water of 0.09 µg/L and 0.03 µg/L for arsenic and individual cPAHs, respectively. EPA determined that the source of surface water and sediment contamination found in the wetland and drainage channel resulted from storm water run-on from two City of Tacoma drains and no additional action was required.

2.4.4. Systems operations/Operations & Maintenance

The 2000 Operation & Maintenance (O&M) Plan addresses the requirements presented in the ROD and the Consent Decree. The O&M Plan addresses ongoing monitoring and maintenance of remediation activities that were completed at the site in accordance with the RD and the Remedial Action Work Plan. Information collected during implementation of the O&M Plan is used to aid in the evaluation of the effectiveness of the remedy. Routine O&M activities consist of inspecting the site, assessing potential changes in site conditions that may result in exposure to contaminated soil, and correcting deficiencies.

2.4.4.1 Systems Operations/O&M Requirements

Following remedial actions, PRPs were required to perform inspections of the remedy in accordance with the O&M Plan. Monitoring activities include:

1. Inspection/Maintenance Activities:

- Inspecting for signs of unauthorized entry, vandalism or compromise of the perimeter fence at the Amsted Property and BNSF Dismantling Yard;
- Inspecting soil caps for signs of failure;
- Inspecting and identifying eroded or blocked drainage courses; and
- Inspecting monitoring wells for vandalism.

2. Groundwater Monitoring:

- Annual monitoring of STF wells to assess the impacts of the consolidated areas on groundwater; and
- Annual monitoring of Pioneer Builders Supply wells to assess the effectiveness of natural attenuation.

2.4.4.2 Systems Operations/O&M Operational Summary

The following issues have been noted in the last five O&M reports from 2008 to 2012:

- Monitoring well STM-1A was damaged prior to the site inspection in 2008. The well has not been replaced or closed.
- Monitoring well NMW-8A was reported as damaged in the 2010 site inspection. It was possible to collect a sample from well NMW-8A due to a higher than average groundwater level that year. However, future sampling will likely be inhibited due to the extent of damage.
- Fencing damage and subsequent repairs were reported in the 2008 Progress Report. The fence around the site is now in good condition and continues to be monitored for any damage.
- Trespassing and illegal dumping was noted as a continual problem from 2008 to 2012. While repairs to fencing helped to deter trespassing, signs of dumping and use by transient people still remain outside of fenced area..
- Grid-area marker 558 could not be located during the 2008 site inspection and was subsequently replaced.

2.4.4.3 Summary of Costs of System Operations/O&M Effectiveness

No operations and maintenance costs were available for the South Tacoma Field OU.

2.5. Progress Since the Last Five-Year Review

2.5.1. Protectiveness statements from last review

The protectiveness statement in the last Five-Year Review stated:

> *The remedy at South Tacoma Field is not protective because of the following issues:*
>
> - *In the short term there is an immediate threat to transients using open unused areas of the site based on the potential for direct contact with remaining contaminated soils that exceed the standard for unrestricted use on some portions of the site. The pending commercial/industrial development will significantly reduce the amount of open space currently attractive to transients;*

- *The MNA groundwater remedy at Pioneer Building Supply has not met the cleanup goal within the time specified in the ROD. It may be that residual, subsurface soil contamination is contributing to the groundwater plume; it may also be that recent paving of large areas in this vicinity is affecting natural attenuation. If residual soil contamination is present, ICs may be required to prevent contact with these soils (e.g., excavation in future construction); and*
- *Migration of the contaminated groundwater above the cleanup levels at Pioneer Building Supply may not be controlled.*

The following actions need to be taken to ensure protectiveness:

- *Work with BNSF to determine actions regarding transients living on open, unused areas of the site, including access controls along public right-of-ways;*
- *Develop and implement a revised groundwater monitoring program. Use new groundwater and soil data to assess time frame needed for MNA or modifications to the remedy. Modifications to the remedy may include ICs for residual soil contamination, if present; and*
- *Evaluate new groundwater data at Pioneer Building Supply to determine if migration of groundwater plumes is controlled.*

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

Recommendation 1: Prepare a revised Work Plan for well installation and sampling.

Status: Not Completed. A work plan for well installation and sampling has not been developed. However, well replacement and closeout of some wells is planned for 2013. Sampling continues to be performed per guidelines in the O&M Plan.

Recommendation 2: Evaluate all new and existing data to assess time frame for effectiveness of MNA, or need for additional action.

Status: Not Completed. The ESD recommended the use of MNA in 1999. In 2000 MNA was analyzed for effectiveness. No additional action, other than annual monitoring, has been taken in support of MNA.

Recommendation 3: Evaluate remaining soil contamination and verify soil cleanup levels have been achieved. This may include review of historical data and/or collection of new data.

Status: Not Completed. This action has not been completed. Groundwater concentrations have been decreasing during the last five years and recent sampling indicates that all contaminants are below current MTCA cleanup levels. This indicates that residual soil contamination may not be present at elevated concentrations as previously thought. Continued groundwater monitoring is necessary to confirm this decrease. If groundwater concentration increases occur, an evaluation of residual soil contamination should be completed.

Recommendation 4: Determine need for ICs for soil based on soil characterization data.

Status: Not Completed. No action has been taken to review changes in ICs for soil. Groundwater concentrations at Pioneer Builders Supply have decreased. If an increase is observed in the future and residual soil contamination is present, additional ICs for soil in this area may be needed.

Recommendation 5: Replace well STM-1A and complete minimum one additional year of sampling.

Status: Ongoing. BNSF has developed a work plan for replacement of well STM-1A but have yet to initiate construction.

Recommendation 6: Conduct fence repairs (fences may be removed as site is developed).

Status: Completed. Fences have been repaired around the consolidation areas and new fencing has been installed at the central portion of the site and at the primary entrance.

Recommendation 7: Verify status of capped areas in grid-areas 879, 785, and 767.

Status: Completed. Capped areas have been inspected during the annual site inspections and have been determined to be in good condition and mostly undisturbed.

Recommendation 8: Conduct an optimization of the site-wide groundwater monitoring program including a determination of wells critical for assessing the remedy.

Status: Not Completed. There has been no evaluation or changes to the monitoring program since the last FYR. However, well replacement and closeout of some wells is planned for 2013.

Recommendation 9: Work with BNSF to determine action regarding transients living on property.

Status: Completed. Repairs and installation of new fencing have significantly decreased transient use of the site. BNSF also worked with the City of Tacoma to relocate transients and meth labs away from the site.

Recommendation 10: Review need for changes in administrative ICs for EPA access and restrictive covenants.

Status: Not Completed. No action has been taken to review changes in ICs. However, site fencing has been improved and transient access appears to be minimal.

2.6. Five-Year Review Process

2.6.1. Administrative Components

BNSF Railroad was notified of the initiation of the Five-Year Review in February, 2013. The Five-Year Review team was led by Kris Flint of EPA, Remedial Project Manager (RPM), and included Kristen Kerns (Physical Scientist) and Sharon Gelinas (Hydrogeologist) of the USACE Seattle District.

From January to June 2013, the review team established the review schedule whose components included:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection;

- Local Interviews; and
- Five-Year Review Report Development and Review.

2.6.2. Community Involvement

A public notice announcing the five-year review for the Site was published April 25, 2013 in the Tacoma News Tribune.

2.6.3. Document review

This FYR included a review of relevant, site related documents including annual progress reports and applicable soil, groundwater, and surface water cleanup standards. A complete list of the documents reviewed can be found in Appendix 2-A.

2.6.4. Data Review

STF and Amsted Groundwater Monitoring

Annual groundwater monitoring is used to assess impacts of the soil consolidation areas on local groundwater. Groundwater data provided in the 2008 to 2012 annual reports were reviewed. Sampling associated with monitoring reports for 2008, 2009, and 2011 occurred in January 2009, January 2010, and January 2012 respectively. Sampling associated with the 2010 and 2012 reporting years were conducted in December 2010 and December 2012, respectively. All STF and Amsted wells were analyzed for total lead. In addition, the Amsted wells were also analyzed for TPH as oil and diesel, and PAHs. Groundwater monitoring data are presented in Appendix 2-E and well locations are shown on Figure 2-6.

At the Amsted property, TPH, PAHs, and lead are analyzed to assess impact of remaining petroleum hydrocarbon contamination. PAHs were not detected at concentrations above laboratory reporting limits during the last five years. TPH as diesel and oil and total lead were detected during the last five years, but at concentrations below the cleanup levels.

Although the ROD does not evaluate lead concentrations for drinking water, it should be noted that lead was detected at concentrations above the MTCA A cleanup level of 15 µg/L. at well STM-3A between December 2010 and December 2012 with concentrations ranging from 19.9 to 130 µg/L. Lead concentrations at well STF-4A also exceeded action levels from January 2010 to December 2012 with concentrations ranging from 15 to 260 µg/L. At well VMW-2 there was one slight exceedance (15.9 µg/L) in January 2009. Significant increases in lead concentrations at wells STF-3A and STF-4A were observed during the December 2012 sampling event. It should be noted that water-use restrictions currently at the site effectively eliminate the relevant exposure pathway for which the 15 µg /L action level was established. Field parameters were not available for review for this sampling event to determine if elevated sample turbidity impacted metals concentrations. Groundwater levels during this sampling event were at some of the highest levels recorded based on a review of available information from prior monitoring events. This indicates that some contaminated soil in the vadose zone may be exposed to continuous saturation that has not occurred in the past, potentially resulting in some particulate or soluble material migrating into the groundwater. Monitoring at the STF wells should continue to determine if concentrations remain elevated. In addition, the monitoring program should be revised to evaluate the potential impact of residual soil contamination on groundwater concentrations. Changes

should include increasing the sampling frequency to twice a year to allow for evaluation of conditions during both wet and dry seasons.

Pioneer Builders Supply Groundwater Monitoring

Annual groundwater monitoring at Pioneer Builders Supply is used to evaluate the effectiveness of MNA as a groundwater remediation method. The data provided in the 2008 to 2012 annual reports were reviewed.

Pioneer Builders Supply groundwater monitoring data are shown in Appendix 2-E and monitoring wells are shown on Figure 2-7. Well NMW-1A (within the former UST area) is the only well that contained contaminant concentrations above the cleanup level during the last five years. Concentrations of TPH as gasoline ranged from 0.22 to 3.19 mg/L, concentrations of TPH as diesel ranged from <0.076 to 0.68 mg/L, and benzene concentrations ranged from <1.0 to 5.1 µg/L. It should be noted that the cleanup level for 1,4-dichlorobenzene (1.82 µg/L) was based on Ecology's Method B cleanup level from their Cleanup Levels and Risk Calculations (CLARC) database in 2000-2001, while a review of the current CLARC database indicated that Ecology has withdrawn the listed cleanup level for this chemical. Concentrations of 1,4-dichlorobenzene exceeded the old cleanup level, ranging from 1.62 to 3.7 µg/L at well NWM-1A; however, since there is currently no cleanup level, these occurrences of 1,4-dichlorobenzene will not be considered exceedances.

To evaluate the progress of MNA, trends for contaminant concentrations at well NMW-1A that exceeded the cleanup level during the last five years were evaluated using the Mann-Kendall test for trend. Table 2-3 shows that when all data between 1999 and 2012 are considered, TPH as diesel and benzene have a statistically significant decreasing trend and TPH as gasoline is stable.

Table 2-3. Mann-Kendall Trend Test Results, Well NMW-1A

Contaminant	Confidence Factor	Concentration Trend
TPH as gas	81.0%	Stable
TPH as diesel	99.9%	Decreasing
Benzene	99.9%	Decreasing

NMW-1A also has a history of contaminant concentration fluctuations that were thought to be related to groundwater level fluctuations or groundwater flow direction variations. Figure 2-8 shows TPH as gasoline and diesel and benzene concentrations were plotted against the depth to groundwater. The data show that there is no apparent correlation; however, the groundwater flow direction could still influence contaminant concentrations if there is a residual source remaining in soil. Although contaminant concentrations found at well NMW-1A during the last sampling event had decreased to below cleanup levels, continued monitoring is necessary to determine if MNA is truly effective. If future sampling shows an increase in concentrations, similar to those seen in the historical fluctuations, the impact of potential residual soil contamination on groundwater concentrations should be investigated. This could include additional soil and groundwater sampling and an evaluation of groundwater flow variations on contaminant concentrations.

City Well Data

The City of Tacoma intermittently operates several drinking water supply wells in the South Tacoma Channel. The City of Tacoma routinely monitors water quality in their drinking water wells in accordance with the Safe Drinking Water Act. Wells are sampled at the well head either once every three years or when the well is turned on for use, whichever is more frequent. In addition, combined water from all wells is sampled once a year at the point of entry to the distribution system. The STF OU is adjacent to City drinking water supply Wells 2B/C, 4A, 6B, and 11A. Electronic data from these wells were reviewed to verify that drinking water has not been impacted by the STF. There were detections of trichlorofluoromethane, chloroform, and trichloroethylene in well 6B between 2008 and 2011. There were also detections of trichlorofluoromethane and chloroform in well 11A. In November 2010 there were detections of xylene, toluene, and ethylbenzene in well 2C. These detections are believed to be related to work that was done on a pump system. Follow-up sampling in May 2011 showed no detection of these chemicals. All concentrations for all wells were below federal MCLs. None of the contaminants in the City wells appear to be related to the STF OU. As such, there is no current risk from this exposure pathway. Results from samples collected annually at the point of entry to the distribution system have remained non-detect for volatile organics.

2.6.5. Site Inspection

Inspection at the site was conducted on March 5, 2013, by the USACE review team, BNSF Railroad, and Kennedy Jenks Consultants. Photographs taken during the site inspection are presented in Appendix 2-B. The completed site inspection checklist is presented in Appendix 2-C. The inspection consisted of checking the integrity of areas where soil has been capped and vegetation, fencing around the site, and general land use. During the site visit, several observations were noted:

- The newly installed fence was in good condition and trespassing appeared to be at a minimum.
- Areas of minor dumping were observed in the central and southern portions of the site.
- Approximately three damaged monitoring wells were noted.

2.6.6. Interviews

Nathan Graves and Dean Malte from Kennedy Jenks Consultants for BNSF Railroad, were interviewed on methods for conducting operations and maintenance activities. Bruce Sheppard from BNSF Railroad was interviewed regarding the overall status of the site. All interviewees stated that operation and maintenance at the site was going well and no major problems have been encountered. Interviewees also commented on significant improvements at the site regarding trespassing since installation of the chain link fence around the site. Because of low community interest of the site no community members were interviewed. Interview summaries are provided in Appendix 2-D.

2.6.7. Institutional Controls

Remaining soil and groundwater contamination at the site do not allow for unrestricted use/ unrestricted exposure, so ICs are required for both media. The SDICP outlines several ICs for the site. EPA is responsible for monitoring the effectiveness of the ICs, and uses checks on the development status as a tool to ensure this restriction. BNSF is responsible for the implementation, maintenance, and inspection of the ICs. The SDICP does not explicitly describe the objectives for the ICs, but it is inferred that they

include protection against direct contact with soil under industrial uses and prevention of groundwater use for drinking.

The ICs at South Tacoma Field consist of the following:

- Granting EPA access to monitor and inspect the site
- Limiting land use to industrial purposes
- Assuring maintenance of caps that contain contaminated soils
- Prohibiting groundwater use in the vicinity of Pioneer Building Supply
- Recording restrictive covenants and leases with the Pierce County Auditor
- Notifying EPA of ownership transfers or lease agreements regarding the site
- Developing safety guidelines for future potential site workers
- Developing a fact sheet to distribute to the community

BNSF and Amsted have implemented use restrictions on the property they own. Environmental restrictive covenants and access easements were filed in 1997 that include the following restrictions: land use shall be for non-residential purposes, no activities shall disturb contaminated soil or the integrity of the capped areas, groundwater from the Pioneer Builders Supply property shall not be used for drinking water, and EPA shall be notified of any conveyance of the property. The access easement allows perpetual access to the property for implementation of the remedial actions. A title search was not completed as part of this FYR to confirm that the covenants and access easement was transferred along with any property transfers.

Safety procedures have also been put in place to protect site workers and the public. Consolidated soil areas are covered with at least 1 foot of clean soil, the northern and central portions of the site have been fenced, gates are kept locked, and “Keep Out” signs are in place to warn the public. Annual inspections ensure that these safety procedures remain in place and that the cap integrity remains complete. Fencing damage noted in the inspection reports has been repaired and trespassing appears to be minimal, indicating that the safety procedures are working.

2.7. Technical Assessment

2.7.1. Question A: Is the remedy functioning as intended by the decision documents?

Yes. The remedy appears to be functioning as intended by the decision document. Hot spots have been removed and contaminated soil has been consolidated on-site. Groundwater monitoring for the STF consolidation area showed a recent increase in lead concentrations; however, the cause and impact on remedy effectiveness of this increase has not been evaluated. Groundwater contaminant concentrations at Pioneer Builders Supply have decreased; however, continued monitoring is necessary to determine if MNA is effective. Institutional controls are in place to protect future site workers and the public.

Remedial Action Performance

The selected remedy for soil hot spots was excavation and on-site treatment using solidification. For the remaining contaminated soils in which contaminant levels exceeded capping-required levels, excavation and capping was conducted. The required access controls (fences, signs, and ecology blocks) to ensure

cap integrity have been implemented in accordance with the approved design. Additional fencing has been installed around the northern and central portion of the site and at the main entrance. The fence surrounding the northern consolidation area has been repaired and access to the capped area is restricted. The fence at the Amsted consolidation area was also repaired to limit access even though that fence is not actually part of the remedy. The southernmost consolidation area is not fenced, but does have concrete ecology blocks meant to prevent vehicle access. The southernmost consolidation area appears to be mostly undisturbed.

Groundwater monitoring for the STF consolidation areas identified exceedances of MTCA A action levels for lead at wells STM-3A and STM-4A for the last three sampling events, with a significant increase in results from the last sampling event in December 2012. Groundwater levels were at some of the highest recorded and may indicate that contaminated soil in the vadose zone being exposed to continuous saturation that has not occurred in the past. The groundwater monitoring program for the STF monitoring wells should be revised to determine if soil contamination is contributing to the elevated lead concentrations in groundwater. Changes should include increasing the sampling frequency to twice a year to evaluate conditions during both wet and dry seasons and replacing the damaged STM-1A well.

Contaminant concentrations in the Amsted wells have been below site cleanup levels for all sampled analytes for seven consecutive years.

The selected remedy for the groundwater at Pioneer Builders Supply is MNA. The 1999 ESD predicted that COC concentrations would decrease to below cleanup levels within four years (by 2003). All concentrations were below current MTCA cleanup levels at well NMW-1A (within the former UST source area) for the first time in December 2012. Well NMW-1A has a history of contaminant fluctuations that could be associated with groundwater level fluctuations or groundwater flow direction variations. Continued monitoring is necessary to determine if MNA is truly effective. If future sampling at Pioneer Builders Supply shows an increase in concentrations, similar to the historical fluctuations, the impact of potential residual soil contamination on groundwater concentrations should be investigated. This could include additional soil and groundwater sampling and an evaluation of groundwater flow variations on contaminant concentrations. While sampling for well NMW-8A at Pioneer Builders has been possible due to higher than normal water levels in recent years, the damage well should be replaced.

System Operations/O&M

O&M has generally been conducted as designed, with the exception of damage to wells STM-1A and NMW-8A. This damage prevents sampling at these wells.

Opportunities for Optimization

Opportunities for optimization were not identified during this FYR.

Implementation of Institutional Controls

Institutional controls are in place to prevent direct contact with contaminated soil and prevent groundwater at Pioneer Builders Supply from being used as drinking water. Significant improvements

were made to the site with installation of new fencing around the entire northern and central portion of the site. This has restricted unauthorized access and illegal dumping at the site.

Early Indicators of Potential Issues

There are no early indicators of potential issues.

2.7.2. 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?

Yes. Generally, the standards and toxicological values used at the time of remedy selection have remained unchanged with the following exceptions.

Changes in Standards and TBCs

A review was done to identify any changes in standards that were identified as applicable or relevant and appropriate requirements (ARARs) in the ROD; newly promulgated standards including revised chemical-specific requirements (such as MCLs); revised action- and location-specific requirements; and State standards and TBCs identified in the ROD that bear on the protectiveness of the remedy. Any such changes were then evaluated to establish whether the new requirement indicates that the remedy is no longer protective. Table 2-4, and Table 2-6 provide summaries of changes. Generally, the standards and toxicological values used at the time of the remedy have remained unchanged with the following exceptions.

Soil. Washington Department of Ecology modified MTCA substantially in 2001 and 2007. MTCA Method A industrial cleanup levels were used for soil-capping-required levels. The Method A industrial cleanup levels decreased compared with those in effect at the time the ROD was issued for arsenic (from 200 to 20 mg/kg) and total PAHs (from 20 to 2 mg/kg) during the modification of MTCA in 2001 and 2007 (for PAHs) (see Table 2-4). It is important to note that the updated cleanup level of 2 mg/kg for total PAHs is based on benzo(a)pyrene. Toxic Equivalency Factors for PAHs were adopted by the Depratment of Ecology in 2007. Benzo(a)pyrene was identified as the reference chemical for establishing cleanup levels for total PAHs. Revisions to these criteria were based on the protection of groundwater, so they do not likely impact the protectiveness of the remedy with respect to direct contact exposure for industrial workers but may impact protectiveness of groundwater. Ongoing monitoring of groundwater will be conducted to confirm that groundwater concentrations remain below cleanup levels.

For informational purposes, a comparison of the revised criteria to concentrations reported in the Remedial Action Report was conducted. There are at least four uncapped grid-areas (535, 537, 789, and 900) that had concentration in soil above the revised total PAH (as benzo(a)pyrene) concentration of 2 mg/kg. Generally, arsenic concentrations in soil are below the revised criteria for this compound. However, the arsenic detection limit for many samples was 81 mg/kg, four times the revised cleanup level of 20 mg/kg.

The objective of the subsurface soil cleanup goals at Pioneer Builders Supply was to prevent further groundwater contamination. MTCA Method A industrial criteria was used for soil cleanup levels;

however, it cannot be confirmed if remaining soil concentrations meet this criteria. The Method A cleanup levels have decreased since the ROD was issued the following compounds: benzene (from 0.5 to 0.03 mg/kg), toluene (from 40 to 7 mg/kg), ethylbenzene (from 20 to 6 mg/kg), and xylenes (from 20 to 9 mg/kg). Revisions to these criteria were based primarily on the protection of groundwater. Remaining soil concentrations at the site should be reviewed in light of these new criteria to determine potential impacts to the remedy. Data on subsurface soil concentrations were collected during the RI. More recent data is not available.

Groundwater. At Pioneer Builders Supply, groundwater cleanup levels for benzene, ethylbenzene, toluene, total xylenes, and 1,2-dichloroethane were based on the federally set MCLs for drinking water. The cleanup level for naphthalene was based on MTCA Method B.

Table 2-4 compares cleanup levels identified in the ROD and revised MTCA cleanup levels (specifically, revised default concentrations under Method A and B) for all chemicals detected in groundwater. Dichlorobenzenes (1,2- and 1,4-) and 1,2,4-trichlorobenzene are contaminants that were not specifically addressed in the ROD or ESD; however, they are frequently detected at this site and have also been addressed by revisions to MTCA. Carbon tetrachloride was detected for the first time in January 2008 and again in 2010 at well NMW-11A and has been included in Table 2-4Table 2-4.

The remedy at Pioneer Builders Supply requires restrictions on groundwater use to prevent it being used for drinking water until cleanup levels are achieved and the MTCA cumulative risk requirements of no greater than 1 in 100,000 or a Hazard Index not exceeding 1 are achieved. Since concentrations for some analytes are still above cleanup levels identified in the ROD, changes to the regulations do not impact protectiveness of the remedy. However, revised criteria for drinking water will impact the time frame in which site water use restrictions can be lifted.

Changes in Exposure Pathways

The previous FYR identified exposure to those trespassing on the site, mostly transients. Since installation of the new fencing at the site this exposure pathway has largely been eliminated. There are no other changes in exposure pathways at the site.

Changes in Toxicity and Other Contaminant Characteristics

Updated toxicity values for 1,4-Dichlorobenzene and 1,2,4-Trimethylbenzene have resulted in undetermined standards. Other updates to toxicity values are reflected in revised standards and are summarized in Table 2-4.

Changes in Risk Assessment Methods

There have been no substantial changes to the standardized risk assessment methods.

Expected Progress Toward Meeting RAOs

MNA at Pioneer Builders Supply has been slower than originally anticipated, but concentrations are decreasing and have recently dropped below the cleanup levels. The increase in lead concentrations at two wells indicates that RAOs for soil have not been completely met.

Table 2-4. Changes in Chemical-Specific Standards

Contaminant	Media	ROD Cleanup Level	Standard*		Citation/Year
Arsenic	Soil – STF Hot Spot	570 mg/kg	Previous	NA	1x10^-4 risk level using MTCA exposure assumptions
			New	—	—
Lead	Soil – STF Hot Spot	18000 mg/kg	Previous	NA	Based on cost sensitivity analysis in FS
			New	—	
PAHs Total	Soil – STF Hot Spot	50 mg/kg	Previous	NA	Set at 2.5 times the MTCA Method A industrial
			New	—	
PCBs Total	Soil – STF Hot Spot	50 mg/kg	Previous	NA	TSCA requirement
			New	—	
Copper	Soil – STF Hot Spot	45000 mg/kg	Previous	NA	Based on leaching to groundwater
			New	—	
Arsenic	Soil – STF Capping	200 mg/kg	Previous	200 mg/kg	Method A industrial cleanup level
			New	20 mg/kg	Method A industrial cleanup level, 2001
Lead	Soil – STF Capping	1000 mg/kg	Previous	1,000 mg/kg	Method A industrial cleanup level
			New	—	
PAHs Total	Soil – STF Capping	20 mg/kg	Previous	20 mg/kg	Method A industrial cleanup level
			New	2 mg/kg	Method A industrial cleanup level as benzo(a)pyrene, 2007
PCBs Total	Soil – STF Capping	10 mg/kg	Previous	10 mg/kg	Method A industrial cleanup level
			New	10 mg/kg	Method A industrial cleanup level, assumes mixture is equitoxic, 2007
Benzene	Soil – Pioneer Builders	0.5mg/kg	Previous	0.5 mg/kg	Method A industrial cleanup level
			New	0.03 mg/kg	Method A industrial cleanup level, 2001
Toluene	Soil – Pioneer Builders	40 mg/kg	Previous	40 mg/kg	Method A industrial cleanup level
			New	7 mg/kg	Method A industrial cleanup level, 2001
Ethylbenzene	Soil – Pioneer Builders	20 mg/kg	Previous	20 mg/kg	Method A industrial cleanup level
			New	6 mg/kg	Method A industrial cleanup level, 2001
Xylenes	Soil – Pioneer Builders	20 mg/kg	Previous	20 mg/kg	Method A industrial cleanup level
			New	9 mg/kg	Method A industrial cleanup level, 2001
TPH	Soil – Pioneer Builders	100-200 mg/kg	Previous	100 mg/kg	Method A industrial cleanup level; enforcement by Ecology at its discretion
			New	—	

Contaminant	Media	ROD Cleanup Level	Standard*		Citation/Year
TPH-gas	Groundwater	1000µg/L	Previous	1000 µg/L	MTCA Method A
TPH-diesel	Groundwater		New	See citation	Revised 2001 MTCA calculations for Method B are 500 µg/L (non-carcinogenic) for diesel and heavy oil by NWTPH-Dx analyses. For gas range organics, revised Method B concentration is 800 µg/L (with benzene), 1000 µg/L (w/out benzene).
TPH-oil	Groundwater				
1,1,2 – Tricholorethane	Groundwater	5 µg/L	Previous	5 µg/L	MCL
			New	5 µg/L	MCL is unchanged. Calculated concentration per 2001 MTCA Revised Method B calculation is 0.768 µg/L for carcinogenic effects, and 320 µg/L for non-carcinogenic effects. Revised MTCA allows use of MCL for this contaminant.
Naphthalene	Groundwater	32 µg/L	Previous	20 µg/L	MTCA Method A, 2001
			New	160 µg/L	MTCA Method A, 2007
Benzene	Groundwater	5 µg/L	Previous	5 µg/L	MCL
			New	5 µg/L	MCL unchanged. Concentration per Revised Method A is 5µg/L, and per Revised Method B calculation is 0.8 µg/L for carcinogenic effects, 32 µg/L for non-carcinogenic effects. Revised MTCA allows use of MCL for this contaminant/
Toluene	Groundwater	1000 µg/L	Previous	1600 µg/L	MCL; MTCA Method B, non carcinogenic
			New	640 µg/L	MCL unchanged; MTCA Method B, non carcinogenic, 2001
Ethylbenzene	Groundwater	700 µg/L	Previous	700 µg/L	MCL
			New	700 µg/L	MCL unchanged. Concentration per Revised Method A is 700 µg/L, and per Revised Method B calculation is 800 µg/L for non-carcinogenic effects
Xylene (total)	Groundwater	10000 µg/L	Previous	10000 µg/L	MCL
			New	1600 µg/L	MCL unchanged; MTCA Method B, non carcinogenic, 2007
Lead	Groundwater	NE**	Previous	15 µg/L	MTCA Method A
			New	—	
Acetone	Groundwater	NE	Previous	800 µg/L	MTCA Method B, non carcinogenic
			New	7200 µg/L	MTCA Method B, non carcinogenic, 2011
2-Butanone	Groundwater	NE	Previous	4800 µg/L	MTCA Method B, non carcinogenic,
			New	—	
n-Butylbenzene	Groundwater	NE	Previous	None	None
			New	—	
Sec-Butylbenzene	Groundwater	NE	Previous	None	None

Contaminant	Media	ROD Cleanup Level	Standard*		Citation/Year
			New	—	
Tert-Butylbenzene	Groundwater	NE	Previous	None	None
			New	—	
Carbon Tetrachloride	Groundwater	NE	Previous	0.34 µg/L	MTCA Method B, carcinogenic
			New	0.63 µg/L	MTCA Method B, carcinogenic, 2011
1,2 - Dichlorobenzene	Groundwater	NE	Previous	600 µg/L	MCL
			New	—	
1,3 - Dichlorobenzene	Groundwater	NE	Previous	None	None
			New	—	
1,4 - Dichlorobenzene	Groundwater	NE	Previous	1.8 µg/L	MTCA Method B non carcinogenic
			New	Researched – no data	MTCA Method B, non carcinogenic, based on updated toxicity value, 2011
1,2 – Dichloroethane	Groundwater	NE	Previous	5 µg/L	MCL
			New	0.481 µg/L	MCL unchanged; Concentration per revised Method A is 5 µg/L, and per revised Method B is 0.481 µg/L for carcinogenic effects and 160 µg /L for non-carcinogenic effects, 2001
n-Hexane	Groundwater	NE	Previous	480 µg/L	MTCA Method B
			New	—	
Isopropylbenzene	Groundwater	NE	Previous	None	None
			New	—	
p-Isopropylbenzene	Groundwater	NE	Previous	None	None
			New	—	
n-propylbenzene	Groundwater	NE	Previous	None	None
			New	—	
1,2,3 – trichlorobenzene	Groundwater	NE	Previous	None	None
			New	—	
1,2,4 - trichlorobenzene	Groundwater	NE	Previous	70 µg/L	MCL
			New	1.5 µg/L	MCL unchanged. Calculated concen-tration per Revised MTCA Method B is 80 µg/L for non carcinogenic effects and 1.5 µg/L for carcinogenic effects, 2001
1,3,5 – Trimethylbenzene	Groundwater	NE	Previous	400 µg/L	MTCA Method B, non carcinogen
			New	80 µg/L	MTCA Method B, non carcinogen, 2011
1,2,4 – Trimethylbenzene	Groundwater	NE	Previous	400 µg/L	MTCA Method B, non carcinogen
			New	Researched – no data	MTCA Method B, non carcinogen , based on updated toxicity value, 2011
Anthracene	Groundwater	NE	Previous	4800 µg/L	MTCA Method B for non-carcinogen
			New	—	
Benzo(g,h,i)perylene	Groundwater	NE	Previous	None	None
			New	—	

*Previous Standard is at time of the ROD. If 'NA', no standard was established at the time of the ROD. New Standard is the most recent update post-ROD. If '—', no updates have been made to the standard.
**NE – Not evaluated

Table 2-5. Changes in Action-Specific Requirements

Action	Requirement		Prerequisite	Citation/Year
Soil and Groundwater	Previous	Industrial criteria used for capping levels. Some groundwater cleanup levels used MTCA levels.	Hazardous contaminants regulated under MTCA are present in groundwater and soil at the site.	Washington State Model Toxics Control Act (RCW 70.105D; WAC 173-340)
	New	Updated in 2001 and 2007 – see text for updates to standards	—	Washington State Model Toxics Control Act (RCW 70.105D; WAC 173-340), 2001 and 2007 updates
Soil	Previous	Land Disposal Restrictions provisions for placement of hazardous hot spot soils left in place. Closure requirements met by conducting a hybrid-landfill closure at site that includes cap maintenance and groundwater monitoring.	Contaminated media was contained in place and remains at the site.	Resource Conservation and Recovery Act (RCRA, 49 CFR 261) Washington State Dangerous Waste Regulations (WAC 173303)
	New	No changes that impact remedy since last Five-Year Review	—	—
Soil	Previous	Soils with PCB concentrations greater than 50 mg/kg destroyed by incineration or disposed in chemical waste landfill.	Soils are present at the site that contain PCBs.	Toxic Substances Control Act (TSCA 15 U.S.C 2601-2671; 40 CRF Part 761.60)
	New	No changes that impact remedy since last Five-Year Review	—	—
Soil	Previous	Any soil removals should be compliant with these requirements.	Soil removal is required at the site.	Transportation of Hazardous Materials (49 CFR, RCW 46.48, WAC 446-50)
	New	No changes that impact remedy since last Five-Year Review	—	—
Groundwater	Previous	Federal MCLs shall be met to prevent exposure of the public to contaminated drinking water.	Contaminated groundwater is present at the site with contaminants regulated under federal guidelines. Groundwater is adjacent to drinking water sources.	Section 1412 of the Safe Drinking Water Act (SDWA), 42 U.S.C. 300g-1, "National Drinking Water Regulations"; National Primary Drinking Water Regulations. 40 CFR Part 141
	New	Exposure toxicity for TCE is currently under revision.	—	—
Air	Previous	If groundwater treatment systems produce air emissions – not applicable to current remedy.	Original remedy specificed in the ROD required use of air sparging for treatment of groundwater.	Clean Air Act, 42 U.S.C. 7401), Washington State Clean Air Act (RCW 70.94, WAC 173-400-460) and Puget Sound Air Pollution Control Authority
	New	No changes that impact remedy since last Five-Year Review	—	—

Table 2-6. Changes in Location-Specific Requirements

Location	Requirement		Prerequisite	Citation/Year
Wetlands	Previous	Regulate actions that occur in wetlands and floodplains. Remedial actions in drainage channel are limited to ICs and were not anticipated to adversely impact drainage channel.	Portions of the site are either within or adjacent to wetlands and floodplain.	Clean Water Act (CWA) Section 402) Floodplain management (Executive Order 11988) and Protection of Wetlands (Executive Order 11900)
	New	The requirement has not been updated or superseded. This is still applicable.	—	—

2.7.3. Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. No other information has come to light that could call into question the protectiveness of the remedy.

2.7.4. Technical Assessment Summary

The soil remedies are complete; hot spots have been removed and treated on-site and the remaining areas of soil contamination have been removed, consolidated on-site, and capped. ICs are in place to protect direct contact of workers with contaminated soils and to prevent groundwater at Pioneer Builders supply from use as drinking water. Fencing has been installed around the northern and central portion of the site and at the main entrance to restrict access. Operation and maintenance procedures are in place to ensure cap and fencing integrity.

Groundwater monitoring is used to assess impacts of the soil-consolidation areas on local groundwater. Concentrations of lead in two STF wells were above the the MTCA A action level over the last three years (site specific lead concentration standards were not established in the ROD). A significant increase was observed in December 2012, during a period of higher groundwater levels, and may indicate that some contaminated soil in the vadose zone was exposed to continuous saturation that has not occurred in the past, resulting in some particulate or soluble material migrating into the groundwater. The groundwater monitoring program should be modified to determine if there is a continuing source of contamination to groundwater. MNA at Pioneer Builders Supply has been slower than expected; however, concentrations recently dropped below MTCA A action levels. Monitoring should continue to determine if MNA is effective.

Several MTCA standards have changed since the remedy was selected. Washington Department of Ecology modified MTCA substantially in 2001 and 2007. Revisions to soil cleanup levels were primarily based on the protection of groundwater, so they do not likely impact the protectiveness of the remedy with respect to industrial worker direct contact exposure but may impact protectiveness of groundwater. Ongoing monitoring of groundwater will be conducted to confirm that groundwater concentrations continue to meet current cleanup levels. There are no changes in exposure pathways at the site.

2.8. Issues

Table 2-7 summarizes the current issues for the STF OU.

Table 2-7. Issues for the South Tacoma Field OU

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
1. Lead concentrations increased in two STF wells	N	Y
2. Wells STM-1A and NMW-8A are damaged and have not been repaired.	N	Y
3. The effectiveness of MNA at Pioneer Building Supply has not been evaluated as recommended in the previous FYR.	N	Y

2.9. Recommendations and Follow-up Actions

Table 2-8 provides recommendations to address the current issues at the STF OU, along with proposed milestone dates to achieve the follow-up actions.

Table 2-8. Recommendations and Followup Actions

Issue	Recommendations and Followup Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1.	Modify the groundwater monitoring program to determine if there is an ongoing source to groundwater from the contaminated soils.	BNSF	EPA	September 2014	N	Y
2.	Replace wells STM-1A and NMW-8A to ensure the groundwater monitoring programs are complete.	BNSF	EPA	September 2014	N	Y
3.	Continue groundwater monitoring at Pioneer Builders Supply and complete an evaluation of MNA. If future sampling shows an increase in concentrations, similar to the historical fluctuations, the impact of potential residual soil contamination on groundwater concentrations should be investigated. This could include additional soil and groundwater sampling and an evaluation of groundwater flow variations on contaminant concentrations.	BNSF	EPA	September 2014	N	Y

Additional recommendations to be considered that do not affect current or future protectiveness of the remedy:

- Include field parameters in annual progress reports.

2.10. Protectiveness Statements

The remedy at the STF OU is currently protective of human health and the environment in the short term because ICs are in place to prevent direct contact with soil and use of groundwater at Pioneer Builders Supply as drinking water. However, in order for the remedy to be protective in the long term, the groundwater monitoring program needs to be revised to determine if there is an ongoing source to groundwater from the contaminated soils and to ensure protectiveness.

2.11. Next Review

The next FYR for the STF OU is required by September 2018, five years from the date of this review.

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South Tacoma Field Figures

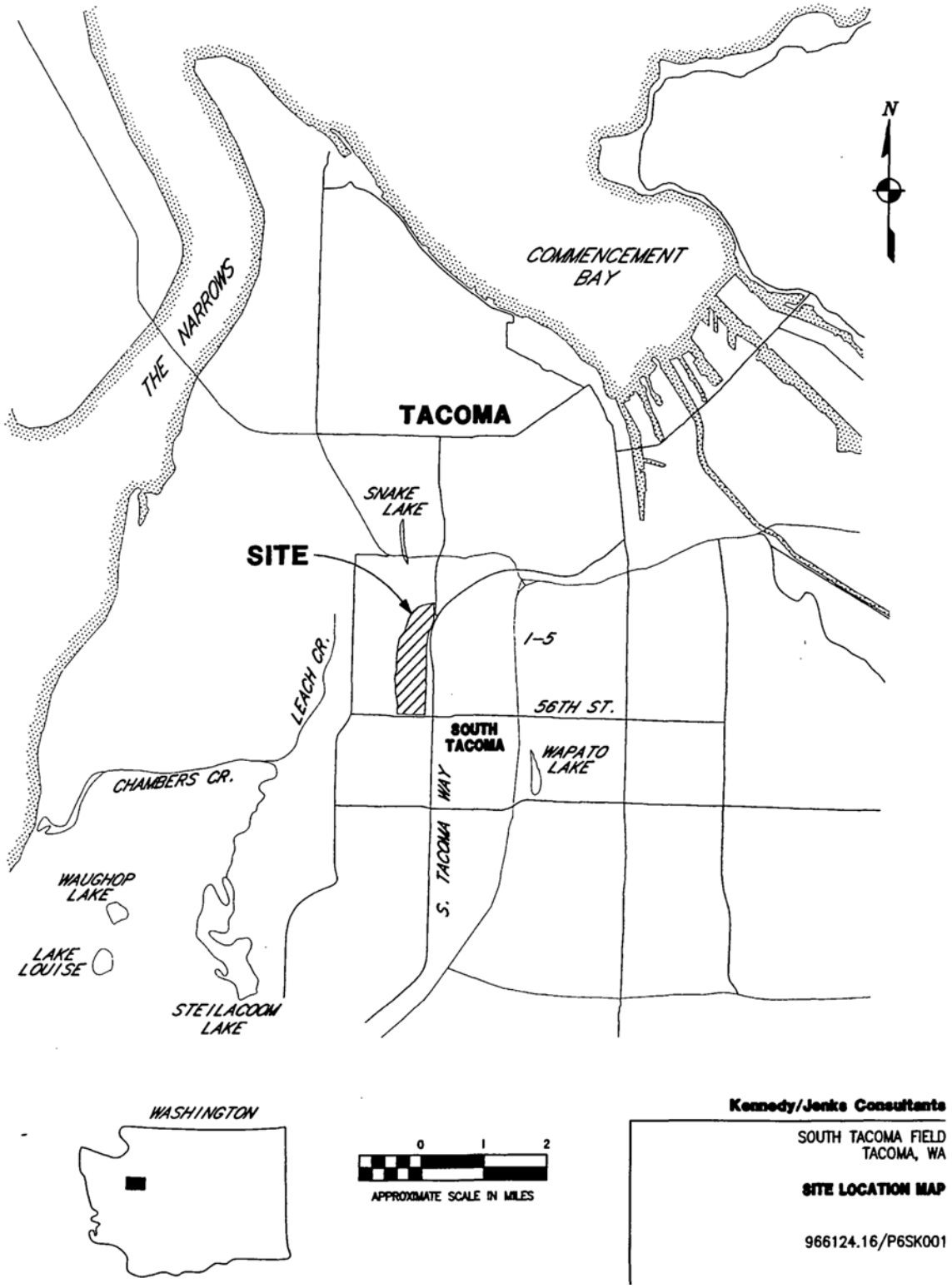


Figure 2-1. South Tacoma Field Site Vicinity Map

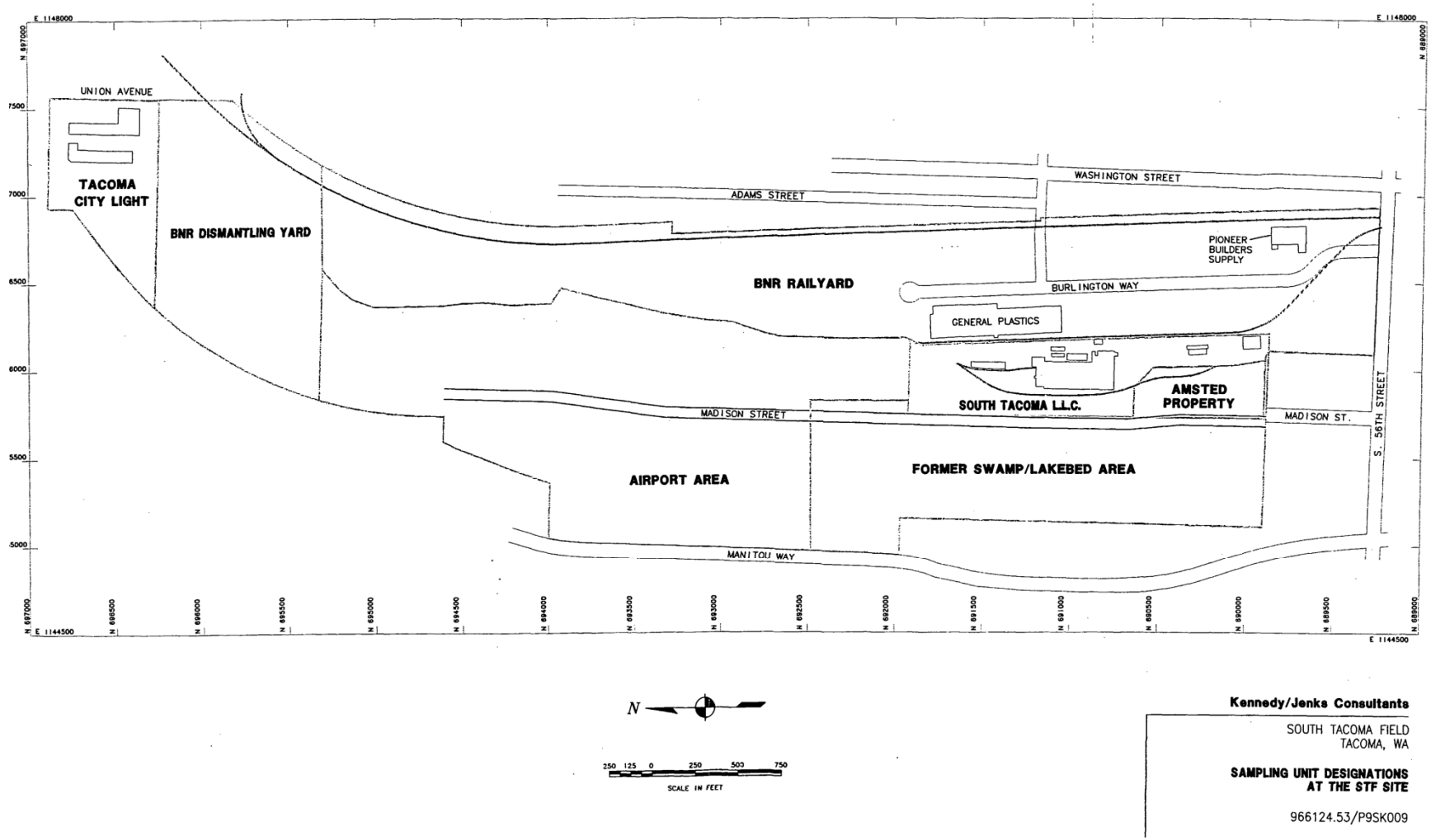


Figure 2-2. South Tacoma Field Site Sub-Area Map

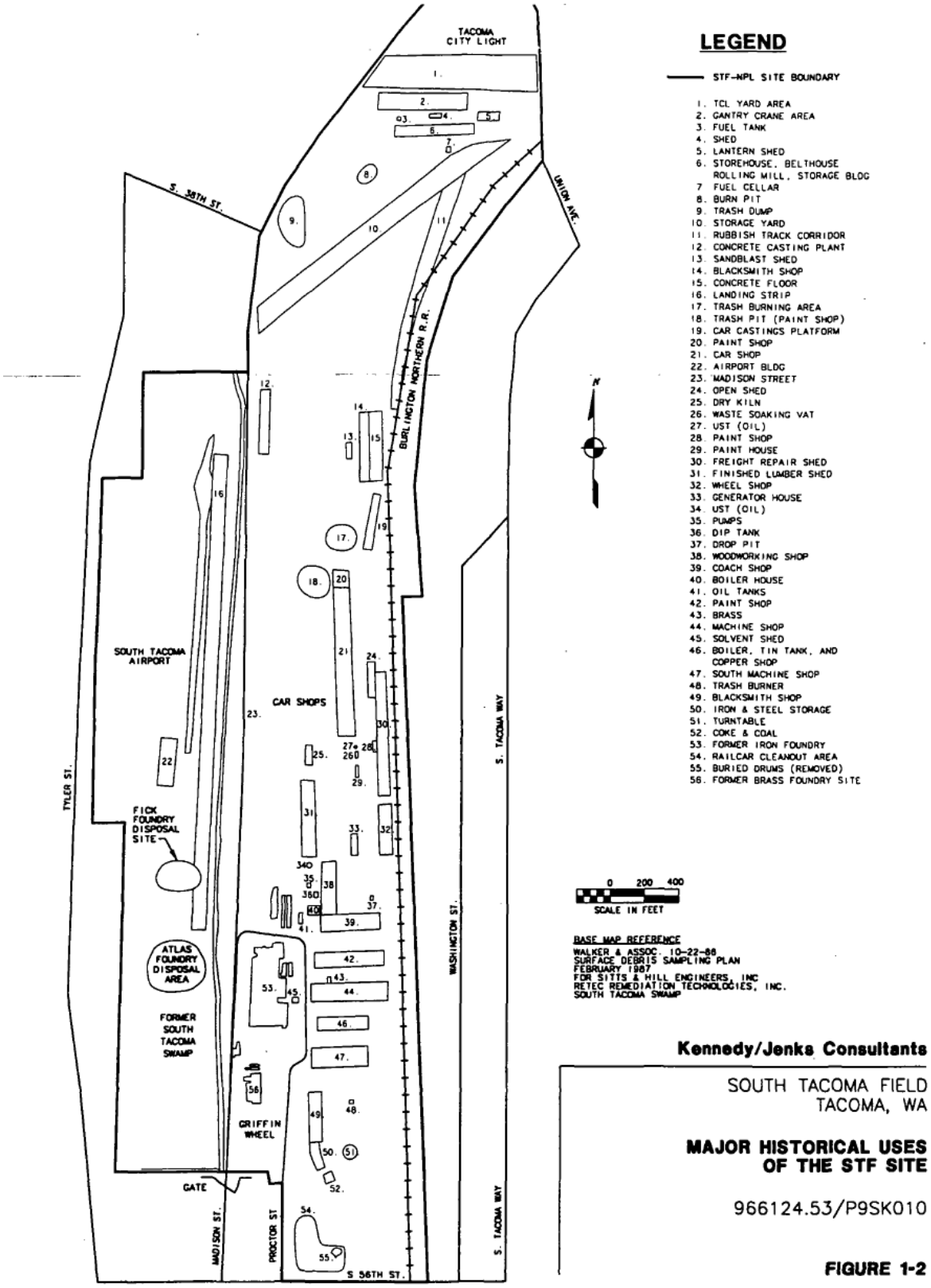
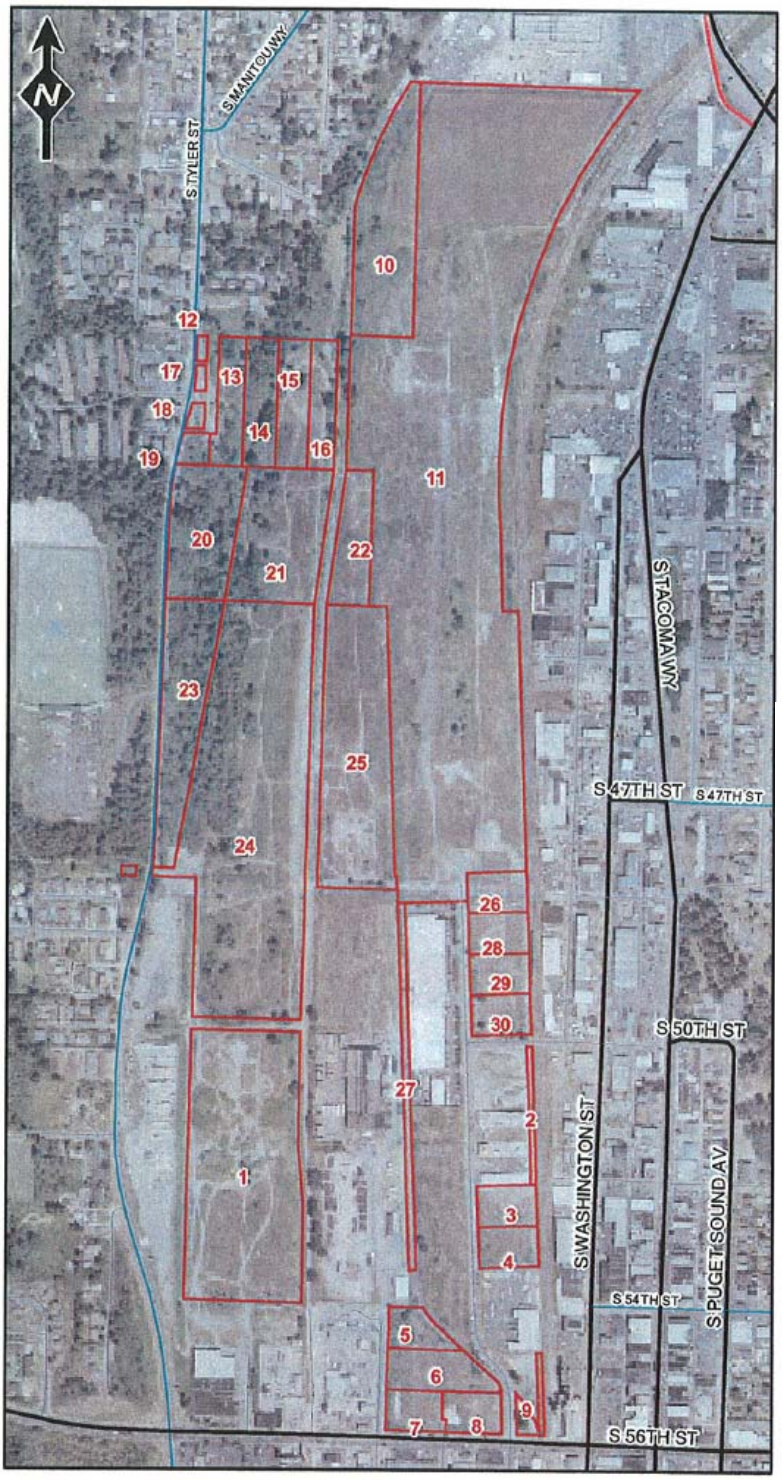


Figure 2-3. South Tacoma Field Major Historical Uses



Parcel #	Taxpayer	Acres	Map #
0220241001	BN SF RR	16.77	1
2783010062	BN RR	0.39	2
2783010050	BN SF RR	1.32	3
2783010040	BN SF RR	1.32	4
2783010231	BN LEASING CORP	1.18	5
2783010241	BN LEASING CORP	2.18	6
2783010252	BN LEASING CORP	1.29	7
2783010251	BN SF RR	1.29	8
2783010011	BN LEASING CORP	0.55	9
0220131131	BN SF RR	6.98	10
0220131130	BN SF RR	55.61	11
5735000010	BN SF RR	0.19	12
5735000110	BN SF RR	2.06	13
5735000120	BN SF RR	2.06	14
5735000130	BN SF RR	2.06	15
5735000140	BN SF RR	2.15	16
5735000030	BN SF RR	0.19	17
5735000050	BN SF RR	0.28	18
5735000070	BN SF RR	0.37	19
0220134004	BN SF RR	2.92	20
0220134800	BN SF RR	6.43	21
0220134011	BN SF RR	2.62	22
3740000140	BN SF RR	6.29	23
3740000086	BN SF RR	16.88	24
3740000181	BN SF RR	10.90	25
2783010120	BN SF RR	1.32	26
2783010260	BN SF RR	1.57	27
2783010110	BN SF RR	1.32	28
2783010100	BN SF RR	1.32	29
2783010090	BN SF RR	1.32	30

Figure 2-4. Burlington Northern Ownership Tax Parcel Map at South Tacoma Field

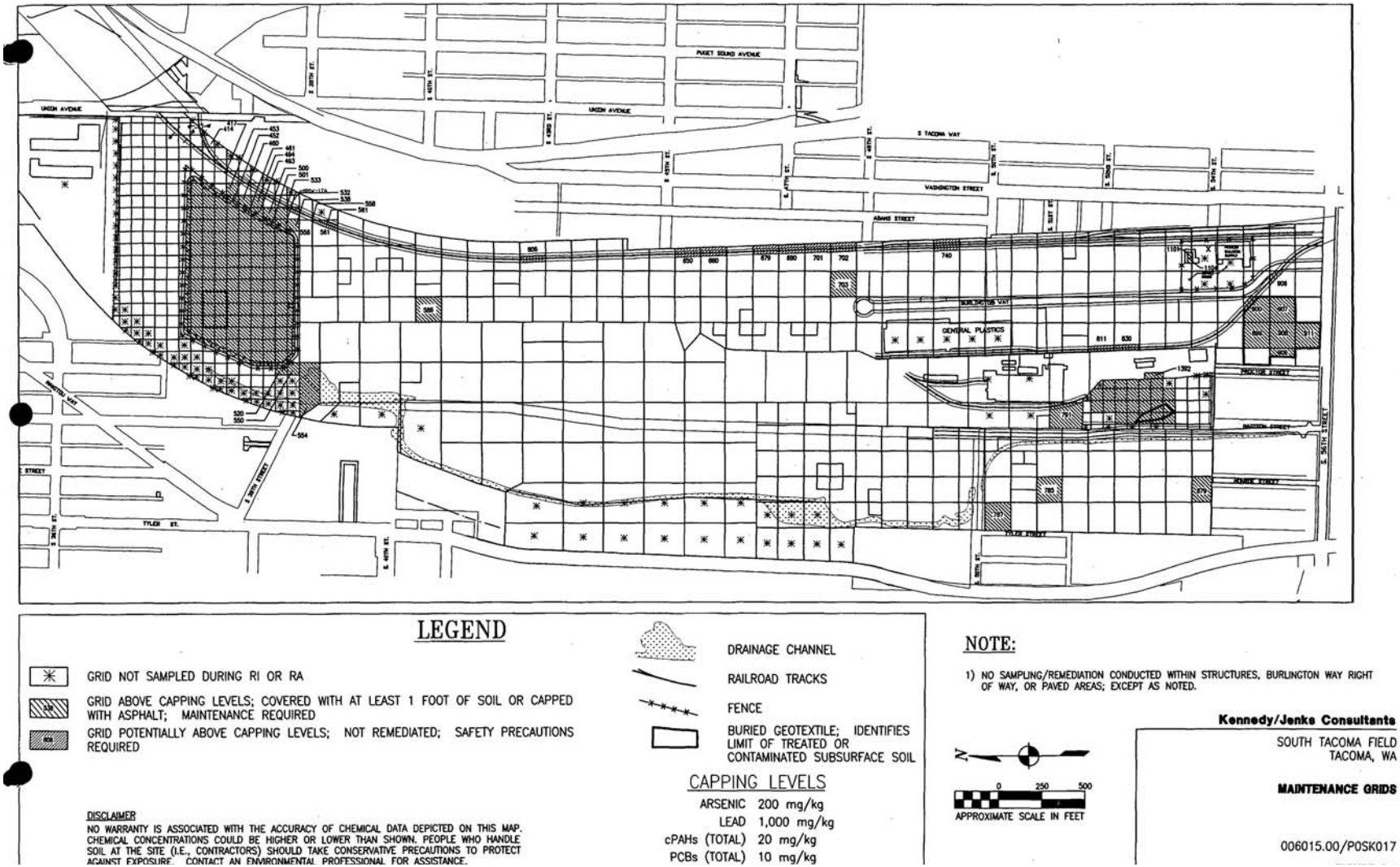


Figure 2-5. South Tacoma Field Containment Areas

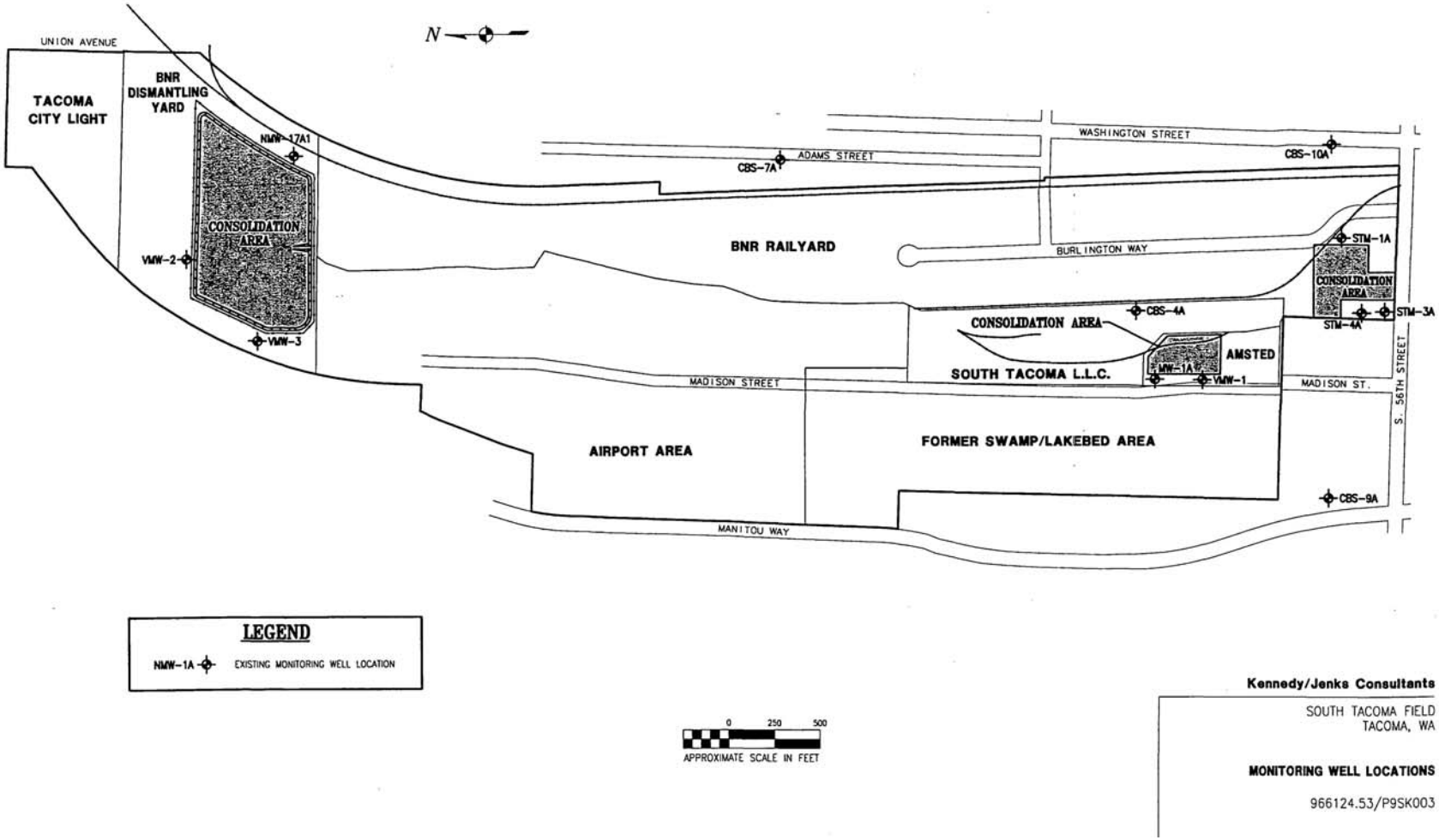


Figure 2-6. South Tacoma Field Monitoring Well Locations

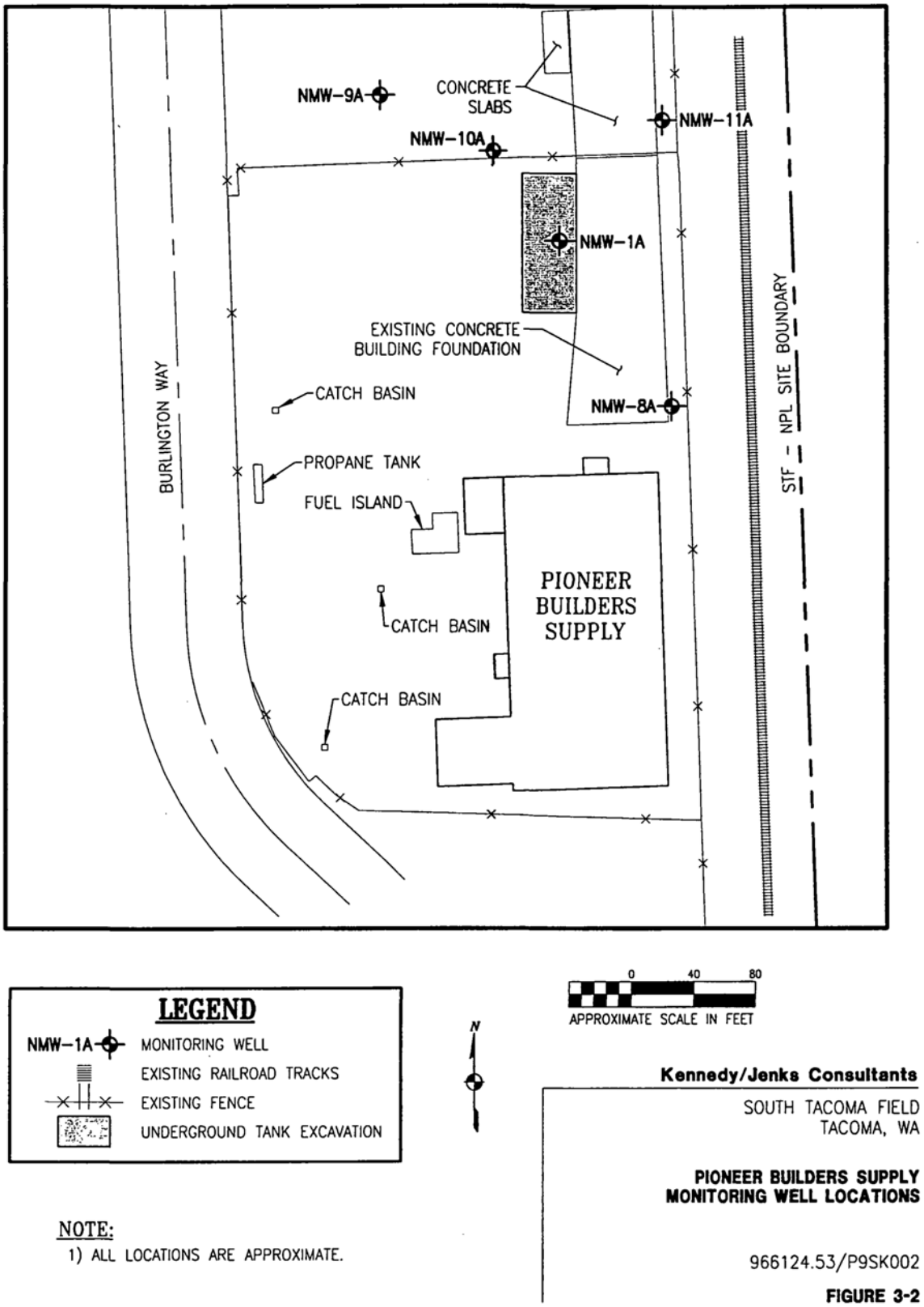


Figure 2-7. Monitoring Well Locations Pioneer Builders Supply

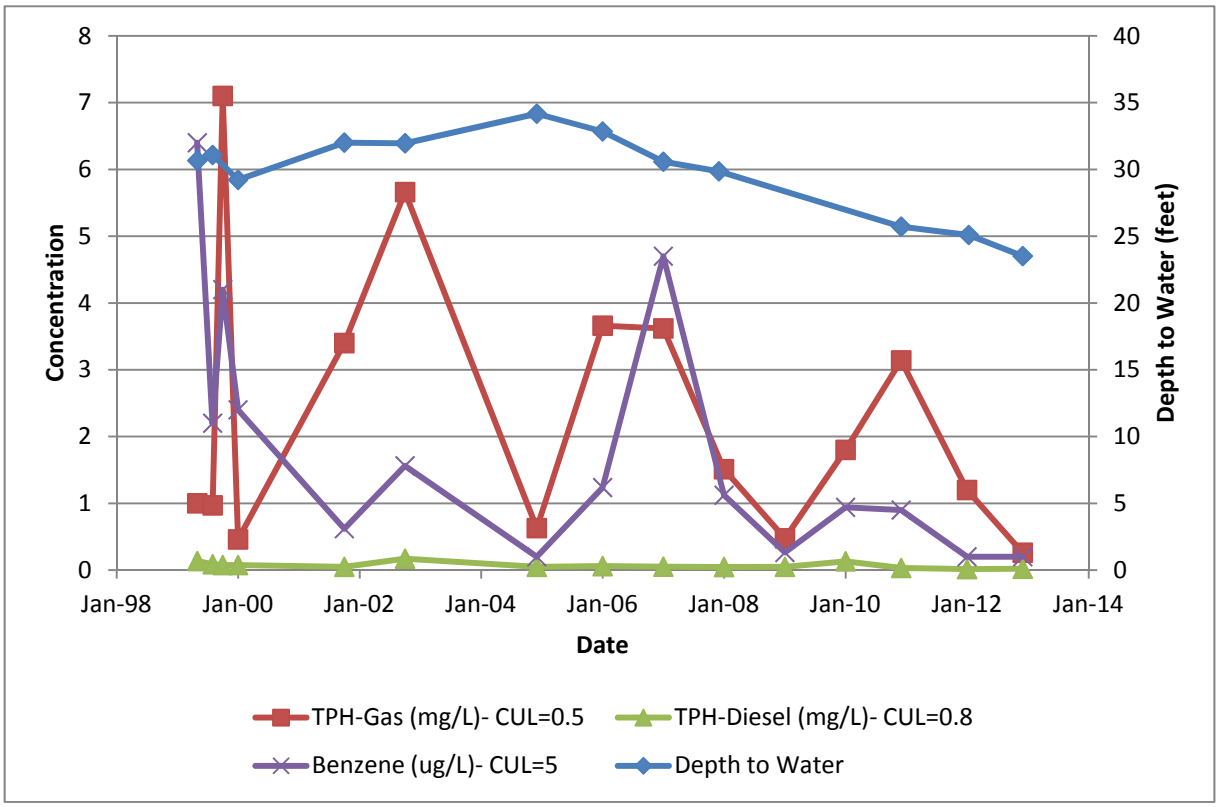


Figure 2-8. Concentrations of TPH as gas, TPH as diesel, and benzene at NMW-1A

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Appendix 2-A: South Tacoma Field List of Documents Reviewed

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List of Documents Reviewed, South Tacoma Field

Kennedy Jenks Consultants. Remedial Action Report, South Tacoma Field Site, March, 2000.

Kennedy Jenks Consultants. Site Development and Institutional Controls Plan for South Tacoma Field Site, Tacoma, Washington. March 2000.

Kennedy Jenks Consultants. Operations and Maintenance Plan for South Tacoma Field Site, Tacoma, Washington. March 2000.

Kennedy Jenks Consultants. South Tacoma Field 2008 Annual Progress Report. March 2009.

Kennedy Jenks Consultants. South Tacoma Field 2009 Annual Progress Report. April 2010.

Kennedy Jenks Consultants. South Tacoma Field 2010 Annual Progress Report. April 2011.

Kennedy Jenks Consultants. South Tacoma Field 2011 Annual Progress Report. May 2012.

Kennedy Jenks Consultants. South Tacoma Field 2012 Annual Progress Report. March 2013.

US EPA, Region 10. Record of Decision for Commencement Bay South Tacoma Channel, South Tacoma Field Operable Unit. September 1994.

US EPA, Region 10. Explanation of Significant Differences for South Tacoma Field Record of Decision, Commencement Bay, South Tacoma Channel Superfund Site. August 1999.

US EPA, Region 10. First Five-Year Review Report for South Tacoma Field, Tacoma, Washington. June 2003.

US EPA, Region 10. Second Five-Year Review Report for South Tacoma Field, Tacoma, Washington. September 2008.

US EPA, Region 10. Final Closeout Report for Soils, Commencement Bay, South Tacoma Channel Superfund Site, South Tacoma Field Operable Unit. February 2005.

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Appendix 2-B: South Tacoma Field Site Inspection Photographs

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South Tacoma Field Site Visit Photographs

Photo 1. Southern consolidation area

Photo 2. South end of site looking toward Taylor Street

Photo 3. Rail car at south end of site.

Photo 4. Northern consolidation area

Photo 5. Grid-area marker at southern portion of site

Photo 6. Fencing along east side of site

Photo 7. Gate access at Burlington Way with 'No Trespassing' sign

Photo 7. Ecology blocks at south end of site

Photo 8. Illegal dumping along Burlington Way

Photo 9. Damaged well STF-01.

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Appendix 2-C: South Tacoma Field Site Inspection Checklist

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Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: South Tacoma Field	**Date of inspection: 5 MARCH 2013**
Location: Tacoma, WA	**EPA ID: WAD980726301**
Agency, office, or company leading the five-year review: BNSF Railroad and Kennedy Jenks Consultants	**Weather/temperature: Overcast, mid 50s**

Remedy Includes: (Check all that apply)

☐ Landfill cover/containment ☒ Monitored natural attenuation

☒ Access controls ☐ Groundwater containment

☒Institutional controls ☐ Vertical barrier walls

☐ Groundwater pump and treatment

☐ Surface water collection and treatment

☒ Other: *Groundwater monitoring; soil excavation and containment*

_____

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____Bruce Sheppard_____ _Enviro Remediation Mng.__ _5 MAR 2013_

Name Title Date

Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____

Problems, suggestions; ☒ Report attached _____

_____

2. **O&M staff** ____Dean Malte_____ ____Senior Geologist_____ _5 MAR 2013_

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.
Nathan Graves, Project Manager for Kennedy Jenks Consultants, Consultant to BNSF Railroad. Interviewed on 13 March 2013 via phone.	
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_____

_____

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_____

_____

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

3.	**Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: _____ _____ _____ _____ _____ _____
	V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A
A. Fencing	
1.	**Fencing damaged** ☐ Location shown on site map ☒Gates secured ☐ N/A Remarks____New fencing recently installed ._____ _____
B. Other Access Restrictions	
1.	**Signs and other security measures** ☐ Location shown on site map ☐ N/A Remarks_____ _____

C. Institutional Controls (ICs)

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) _physical inspection at site_____

Frequency _annually_____

Responsible party/agency __Kennedy Jenks Consultants_____

Contact _____Dean Malte_____ __Senior Geologist____ _____ 253-835-6463

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

_____

_____

_____

_____

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

Remarks_____

_____

_____

D. General

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

Remarks_____

_____

2. **Land use changes on site** ☒ N/A

Remarks_____

_____

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

Remarks__Land adjacent to the site recently acquired by Sound Transit_____

_____

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			
A. Landfill Surface			
1.	**Settlement** (Low spots)	☐ Location shown on site map	☐ Settlement not evident
	Areal extent_____	Depth_____	
	Remarks_____		
	_____		
2.	**Cracks**	☐ Location shown on site map	☐ Cracking not evident
	Lengths_____ Widths_____ Depths_____		
	Remarks_____		
	_____		
3.	**Erosion**	☐ Location shown on site map	☐ Erosion not evident
	Areal extent_____	Depth_____	
	Remarks_____		
	_____		
4.	**Holes**	☐ Location shown on site map	☐ Holes not evident
	Areal extent_____	Depth_____	
	Remarks_____		
	_____		
5.	**Vegetative Cover** ☐ Grass	☐Cover properly established	☐ No signs of stress
	☐ Trees/Shrubs (indicate size and locations on a diagram)		
	Remarks_____		
	_____		
6.	**Alternative Cover (armored rock, concrete, etc.)** ☐ N/A		
	Remarks_____		
	_____		

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident

Areal extent_____ Height_____

Remarks_____

_____

8. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent_____

☐ Ponding ☐ Location shown on site map Areal extent_____

☐ Seeps ☐ Location shown on site map Areal extent_____

☐ Soft subgrade ☐Location shown on site map Areal extent_____

Remarks_____

_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability

Areal extent_____

Remarks_____

_____

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement

Areal extent_____ Depth_____

Remarks_____

_____

2. **Material Degradation** ☐ Location shown on site map ☐No evidence of degradation

Material type_____ Areal extent_____

Remarks_____

_____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion

Areal extent_____ Depth_____

Remarks_____

_____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting

Areal extent_____ Depth_____

Remarks_____

_____

5. **Obstructions** Type_____ ☐ No obstructions

☐ Location shown on site map Areal extent_____

Size_____

Remarks_____

_____

6. **Excessive Vegetative Growth** Type_____

☐ No evidence of excessive growth

☐ Vegetation in channels does not obstruct flow

☐ Location shown on site map Areal extent_____

Remarks_____

_____

D. Cover Penetrations ☐ Applicable ☒ N/A

1. **Gas Vents** ☐ Active ☐ Passive

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance

☐ N/A

Remarks_____

_____

2. **Gas Monitoring Probes**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

3. **Monitoring Wells** (within surface area of landfill)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

4. **Leachate Extraction Wells**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

5.	**Settlement Monuments**	☐ Located	☐ Routinely surveyed	☐N/A
	Remarks_____			
	_____			
E. Gas Collection and Treatment		☐ Applicable	☒N/A	
1.	**Gas Treatment Facilities**			
	☐ Flaring	☐ Thermal destruction	☐ Collection for reuse	
	☐ Good condition	☐ Needs Maintenance		
	Remarks_____			
	_____			
2.	**Gas Collection Wells, Manifolds and Piping**			
	☐ Good condition	☐ Needs Maintenance		
	Remarks_____			
	_____			
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)			
	☐ Good condition	☐ Needs Maintenance	☐ N/A	
	Remarks_____			
	_____			
F. Cover Drainage Layer		☐ Applicable	☒ N/A	
1.	**Outlet Pipes Inspected**	☐ Functioning	☐ N/A	
	Remarks_____			
	_____			
2.	**Outlet Rock Inspected**	☐ Functioning	☐ N/A	
	Remarks_____			
	_____			
G. Detention/Sedimentation Ponds		☐ Applicable	☒ N/A	

1. **Siltation** Areal extent_____ Depth_____ ☐ N/A

☐ Siltation not evident

Remarks_____

_____

2. **Erosion** Areal extent_____ Depth_____

☐ Erosion not evident

Remarks_____

_____

3. **Outlet Works** ☐ Functioning ☐ N/A

Remarks_____

_____

4. **Dam** ☐ Functioning ☐ N/A

Remarks_____

_____

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident

Horizontal displacement_____ Vertical displacement_____

Rotational displacement_____

Remarks_____

_____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident

Remarks_____

_____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident

Areal extent_____ Depth_____

Remarks_____

_____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A

☐ Vegetation does not impede flow

Areal extent_____ Type_____

Remarks_____

_____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident

Areal extent_____ Depth_____

Remarks_____

_____

4. **Discharge Structure** ☐ Functioning ☐ N/A

Remarks_____

_____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident

Areal extent_____ Depth_____

Remarks_____

_____

2. **Performance Monitoring** Type of monitoring_____

☐ Performance not monitored

Frequency_____ ☐ Evidence of breaching

Head differential_____

Remarks_____

_____

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

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 ☐ 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_____

_____

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_____

_____

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

3. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

4. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

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____Some wells are damaged and need to be decommissioned or replaced. _____

_____

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.). The remedy is generally functioning as intended. There is the possibility for remaining soil contamination at Pioneer Builders supply that may be contributing groundwater contamination and requires characterization.
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. O&M effort has been optimized base on the need to only do annual sampling. Historical problem with trespassing and illegal dumping has been remediated with the installation of new fences and gates.

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. ___None_____ _____ _____ _____ _____ _____ _____ _____ _____
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. _____None_____ _____ _____ _____ _____ _____ _____ _____ _____

Appendix 2-D: South Tacoma Field Interview Transcripts

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South Tacoma Field Interview Transcripts

Five Year Review Interview Record
Site Name: South Tacoma Field, South Tacoma Channel Superfund Site
EPA ID No. WAD980726301
Interviewee: **Bruce Sheppard**
Date: 5 March 2013
Interview Method: In person at Site Visit
Interview Contacts: Kristen Kerns USACE Seattle, Kristen.kerns@usace.army.mil

Interview Questions (responses are paraphrased)

1. What is your current role as it relates to the site? How long have you been aware of or associated with the site?

   Bruce Sheppard oversees environmental restoration and remediation for BNSF. He is the primary representative for the PRP for this site.

2. What is your overall impression of the work conducted at the site to date?

   Work at site is going well. No major issues recently.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? (If so, please give purpose and results.)

   BNSF has contracted with Kennedy Jenks Consultants to conduct site inspection and monitoring. Results of inspection/monitoring are reported to BNSF annually.

4. Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc).

   No

   Follow on Question: If there is no continuous on-site presence, describe staff and frequency of site inspections and activities (e.g. what types of monitoring activities occur at what frequencies).

   Kennedy Jenks Consultants performs annual inspection/monitoring. Tacoma water has catch basins and infrastructure on site that they might periodically check. City of Tacoma likely patrols adjacent to the site due to previous trespassing issues.

5. Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy (e.g. the GETS) that show wear or may need additional focus during O&M?

   O&M sampling efforts are going well. No specific comment regarding possible optimization.

6. What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?

   Complete

   - Are there any other significant construction activities proposed?

     NA

7. What does the monitoring data show?
   - Are there any trends in the data that show contaminant levels are increasing or decreasing?

     Data shows possible natural attenuation occurring at Pioneer Builder Site.

   - Have any new or emerging COCs been identified?

     No

8. Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

   There have been difficulties with trespassing at the site, including illegal dumping. Cleanup of dumping resulted in significant costs for regular removal of trash. Installation of fencing around the site in 2011 greatly improved issues related to trespassing.

9. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

   No

10. Are you aware of any ongoing community concerns regarding the site or its administration?

    No community concerns. Community is interested in seeing the site developed.

11. Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

    Trespassing, illegal dumping, transient use, and meth labs. All incidents have been remediated with installation of fencing. City of Tacoma helped clear out meth labs.

12. Have any problems been encountered which required, or will require changes to this remedial design or ROD?

    No

13. Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?

    No

Five Year Review Interview Record

Site Name:	South Tacoma Field, South Tacoma Channel Superfund Site
EPA ID No.	WAD980726301
Interviewee:	**Dean Malte**
Date:	5 March 2013
Interview Method:	In person at Site Visit
Interview Contacts:	Kristen Kerns USACE Seattle, Kristen.kerns@usace.army.mil

Interview Questions (responses from interviewee are paraphrased)

1. What is your current role as it relates to the site? How long have you been aware of or associated with the site?

   Kennedy Jenks Consultants is a contractor to BNSF designated for inspection and monitoring of the South Tacoma Field Site. Dean's role is the primary site inspector and conducting monitoring annually at the site.

2. What is your overall impression of the work conducted at the site to date?

   Work has been routine and generally running smoothly. Installation of gates has improved access and inhibited trespassing.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? (If so, please give purpose and results.)

   Dean has been responsible for conducting annual site inspections and monitoring at the site. Purpose is to comply with O&M requirements. With the exception of some damaged well heads, monitoring has been routine and results of monitoring have not produced any significantly unexpected results.

4. Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc).

   No continuous on site presence.

   Follow on Question: If there is no continuous on-site presence, describe staff and frequency of site inspections and activities (e.g. what types of monitoring activities occur at what frequencies).

   Dean is the primary site inspector and is on site once per year in the December/January time frame.

5. Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy (e.g. the GETS) that show wear or may need additional focus during O&M?

   Deferred specifics regarding optimization to Nathan Graves, colleague at Kennedy Jenks Consultants.

6. What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?

   Construction is complete.

   - Are there any other significant construction activities proposed?

     No construction activities proposed in the near future.

7. What does the monitoring data show?
   - Are there any trends in the data that show contaminant levels are increasing or decreasing?

     No surprising trends in the data. Some traces of lead at STF and Amsted wells.

   - Have any new or emerging COCs been identified?

     No new contaminants have emerged.

8. Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

   Damage to monitoring well inhibited traditional sampling but still able to collect using modified method because of shallow water level. Prior difficulties with transients and unknown site access conditions prior to installation of fencing in 2011.

9. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

   None.

10. Are you aware of any ongoing community concerns regarding the site or its administration?

    Community is not very vocal regarding the site.

11. Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

    Significant trespassing issues prior to installing fence around site. Transient use and illegal dumping was a major concern. Meth labs were also present on the western portion of the site but have cleaned up by the City of Tacoma and have not been an issue recently.

12. Have any problems been encountered which required, or will require changes to this remedial design or ROD?

    None.

13. Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?

    None

Five Year Review Interview Record

Site Name:	South Tacoma Field, South Tacoma Channel Superfund Site
EPA ID No.	WAD980726301
Interviewee:	Nathan Graves
Date:	13 March 2013
Interview Method:	Phone
Interview Contacts:	Kristen Kerns USACE Seattle, Kristen.kerns@usace.army.mil

Interview Questions (responses from interviewee are paraphrased)

1. What is your current role as it relates to the site? How long have you been aware of or associated with the site?

   Nathan is the project manager from Kennedy Jenks Consultants, a contractor to BNSF. Nathan has been involved with the project since 1987. He wrote the RI and FS report. Prior to the RI/FS Nathan worked with other parties, primarily related to Amstead, regarding contamination at the site.

2. What is your overall impression of the work conducted at the site to date?

   The FS went relatively well and faster than expected. Issues that were encountered along the way were typically resolved quickly. A UST containing petroleum products was discovered during remedial design and transferred over to Department of Ecology. A No Further Action notice is expected sometime shortly for the site.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? (If so, please give purpose and results.)

   Inspection and monitoring is performed once per year. There are sometimes other infrequent visits to the site (related to UST, well replacement, etc).

4. Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc).

   No

   Follow on Question: If there is no continuous on-site presence, describe staff and frequency of site inspections and activities (e.g. what types of monitoring activities occur at what frequencies).

   Kennedy Jenks Consultants staff are on site once per year to perform site inspection and groundwater sampling.

5. Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy (e.g. the GETS) that show wear or may need additional focus during O&M?

Yes, the O&M effort has been optimized based on the need to only do annual sampling. Historical problem with trespassing and illegal dumping has been remediated with the installation of new fences and gates.

6. What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?

   Construction of the remedy is complete. There are plans to close out wells and replace a damaged well at the site in 2013.

   - Are there any other significant construction activities proposed?

     No

7. What does the monitoring data show?

   Groundwater levels have increased over the last several years. This has resulted in increased saturation of the vadose zone. This is most notable at the north consolidation area and the southern portion of the site. This does not appear to have an impact at the Amsted site. Lead has also increase over time at the STF wells. Pioneer Builders concentrations have fluctuated over time. Most recent sampling shows all concentrations are below cleanup levels at Amsted.

   - Are there any trends in the data that show contaminant levels are increasing or decreasing?

     See response above

   - Have any new or emerging COCs been identified?

     No

8. Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

   No significant difficulties. Some additional maintenance needed to install gates and fencing. Some maintenance activities required prior to the previous five year review to fill areas of standing water in maintenance grids.

9. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

   None

10. Are you aware of any ongoing community concerns regarding the site or its administration?

    None

11. Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?

    Vandalism and trespassing. Much of this was remediated with installation of new gates and fencing.

12. Have any problems been encountered which required, or will require changes to this remedial design or ROD?

    No

13. Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?

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Appendix 2-E: South Tacoma Field Data Summary

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South Tacoma Field Data Summary

South Tacoma Field Groundwater Monitoring Data

Well	Date	PAHs (µg/L)	Total Lead (µg/L)	TPH as Diesel (mg/L)	TPH as Oil (mg/L)
Cleanup Level		**NA**	**15**	**0.5**	**0.5**
Amsted Wells					
MW-1A	Jan-09	ND	<1	<0.240	<0.481
MW-1A	Jan-10	ND	<2.0	<0.12	<0.24
MW-1A	Dec-10	ND	0.45	<0.078	<0.39
MW-1A	Jan-12	ND	0.35	<0.075	<0.38
MW-1A	Dec-12	ND	<1.0	0.33	<0.250
CBS-4A	Jan-09	ND	<1.0	<0.238	<0.476
CBS-4A	Jan-10	ND	<2.0	<0.12	<0.24
CBS-4A	Dec-10	ND	<0.10	<0.076	<0.38
CBS-4A	Jan-12	ND	<0.10	<0.76	<0.38
CBS-4A	Dec-12	ND	<1.0	0.34	<0.250
VMW-1	Jan-09	ND	<1.0	<0.238	<0.476
VMW-1	Jan-10	ND	<2.0	<0.12	<0.24
VMW-1	Dec-10	ND	2.7	<0.079	<0.40
VMW-1	Jan-12	ND	0.44	<0.77	<0.38
VMW-1	Dec-12	ND	3.2	0.32	<0.250
STF Wells					
STM-1A	Jan-09	NA	NA	NA	NA
STM-1A	Jan-10	NA	NA	NA	NA
STM-1A	Dec-10	NA	NA	NA	NA
STM-1A	Jan-12	NA	NA	NA	NA
STM-1A	Dec-12	NA	NA	NA	NA
STM-3A	Jan-09	NA	<1.0	NA	NA
STM-3A	Jan-10	NA	8.9	NA	NA
STM-3A	Dec-10	NA	***19.9***	NA	NA
STM-3A	Jan-12	NA	***16.3***	NA	NA
STM-3A	Dec-12	NA	***130***	NA	NA
STM-4A/MW-100	Jan-09	NA	13.2/2.71	NA	NA
STM-4A/MW-100	Jan-10	NA	***15.0/19.0***	NA	NA
STM-4A/MW-100	Dec-10	NA	***50.4/45.6***	NA	NA
STM-4A/MW-100	Jan-12	NA	***74.5/70.8***	NA	NA
STM-4A/MW-100	Dec-12	NA	***260/290***	NA	NA
CBS-7A	Jan-09	NA	2.03	NA	NA
CBS-7A	Jan-10	NA	9.8	NA	NA
CBS-7A	Dec-10	NA	0.92	NA	NA
CBS-7A	Jan-12	NA	0.69	NA	NA
CBS-7A	Dec-12	NA	<1.0	NA	NA
CBS-10A	Jan-09	NA	<1.0	NA	NA
CBS-10A	Jan-10	NA	<2.0	NA	NA
CBS-10A	Dec-10	NA	0.76	NA	NA
CBS-10A	Jan-12	NA	0.61	NA	NA
CBS-10A	Dec-12	NA	<1.0	NA	NA
VMW-2	Jan-09	NA	***15.9***	NA	NA
VMW-2	Jan-10	NA	<2.0	NA	NA
VMW-2	Dec-10	NA	3.2	NA	NA
VMW-2	Jan-12	NA	6.3	NA	NA
VMW-2	Dec-12	NA	<1.0	NA	NA
VMW-3	Jan-09	NA	<1.0	NA	NA
VMW-3	Jan-10	NA	<2.0	NA	NA
VMW-3	Dec-10	NA	1.4	NA	NA
VMW-3	Jan-12	NA	14.4	NA	NA
VMW-3	Dec-12	NA	<1.0	NA	NA
NMW-17A1	Jan-09	NA	<1.0	NA	NA
NMW-17A1	Jan-10	NA	<2.0	NA	NA
NMW-17A1	Dec-10	NA	<0.10	NA	NA
NMW-17A1	Jan-12	NA	<0.10	NA	NA
NMW-17A1	Dec-12	NA	<1.0	NA	NA

Notes:
Bold and highlight indicates concentration exceeds cleanup level
< - analyte not detected at the indicated laboratory reporting limit

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Pioneer Builders Supply Groundwater Monitoring Data for TPH

Well	Date	TPH as gasoline (mg/L)	TPH as diesel (mg/L)	TPH as oil (mg/L)
Cleanup Level		**0.8**	**0.5**	**0.5**
NMW-1A/NMW-102	Jan-09	0.475/0.469	<0.243/<0.245	<0.485/<0.490
NMW-1A/NMW-102	Jan-10	***1.8/1.8***	***0.66/0.68***	<0.24/<0.24
NMW-1A/NMW-102	Dec-10	***3.14/3.19***	0.16/0.16	<0.38/<0.38
NMW-1A/NMW-102	Jan-12	***1.20/1.25***	<0.077/<0.076	<0.38/<0.38
NMW-1A/NMW-102	Dec-12	0.26/0.22	<0.10/<0.10	<0.25/<0.25
NMW-8A	Jan-09	<0.500	<0.250	<0.500
NMW-8A	Jan-10	<0.050	<0.12	<0.24
NMW-8A	Dec-10	<0.50	<0.77	<0.38
NMW-8A	Jan-12	<0.50	<0.77	<0.38
NMW-8A	Dec-12	<0.10	<0.13	<0.33
NMW-9A	Jan-09	<0.500	<0.250	<0.500
NMW-9A	Jan-10	<0.050	<0.12	<0.24
NMW-9A	Dec-10	<0.050	<0.082	<0.41
NMW-9A	Jan-12	<0.50	<0.75	<0.38
NMW-9A	Dec-12	<0.10	<0.10	<0.25
NMW-10A	Jan-09	<0.500	<0.243	<0.485
NMW-10A	Jan-10	0.63	0.029	<0.24
NMW-10A	Dec-10	0.407	<0.078	<0.39
NMW-10A	Jan-12	<0.50	<0.77	<0.38
NMW-10A	Dec-12	0.58	<0.10	<0.25
NMW-11A	Jan-09	<0.500	<0.250	<0.500
NMW-11A	Jan-10	<0.050	<0.12	<0.25
NMW-11A	Dec-10	<0.050	<0.082	<0.41
NMW-11A	Jan-12	<0.50	<0.75	<0.38
NMW-11A	Dec-12	<0.10	<0.10	<0.25

Notes:
Bold and highlighted indicates concentration above the cleanup level
< - analyte not detected at the indicated laboratory reporting limit

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Pioneer Builders Supply Groundwater VOCs

Well	Date	Benzene	Toluene	Ethyl-benzene	Total Xylenes	n-Butyl-benzene	sec-Butyl-benzene	tert-Butyl-benzene	p-Isopropyl-toluene	1,2-Dichloro-benzene	1,3 -Dichloro-benzene	1,4-Dichloro-benzene	1,3,5-Trimethyl-benzene	1,2,4-Trimethyl-benzene	Isopropyl-benzene	n-Propyl-benzene	1,2,4-Trichloro-benzene	1,2,3-Trichloro-benzene	Naphthalene	1,2-Dichloro-ethane	Chloroform	Chloro-benzene	Carbon tetrachloride
ROD/MTCA Cleanup Level		**5**	**640[a]**	**700**	**1600[a]**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**80[a]**	**NA**	**NA**	**NA**	**80[a]**	**NA**	**160[a]**	**0.481[a]**	**NA**	**NA**	**0.63[a]**
NMW-1A/NMW-102	Jan-09	1.32/1.32	2.41/2.43	9.96/9.94	6.96/6.94	<1.00/<1.00	2.06/20.7	<1.00/<1.00	<1.00/<1.00	<1.00/<1.00	<1.00/<1.00	1.62/1.67	<1.00/<1.00	7.32/7.35	5.30/5.33	2.80/2.77	<5.00/<5.00	<5.00/<5.00	<5.00/<5.00	<1.00/<1.00	NA	<1.00/<1.00	<1.00/<1.00
NMW-1A/NMW-102	Jan-10	4.7/***5.1***	19/20	28/30	66/69	<0.10/<0.10	5.0/5.5	0.67/0.73	<0.20/<0.20	0.62/0.62	4.7/5.2	10.0/11.0	6.1/6.5	120/110	32/33	6.7/7.0	12.0/13.0	3.5/3.8	29/33	<0.10/<0.10	<0.10/<0.10	<0.10/<0.10	<0.10/<0.10
NMW-1A/NMW-102	Dec-10	4.5/4.1	24.2/21.2	157/137	161/141	4.7/4.1	6.1/5.3	<1.0/<1.0	5.3/4.7	1.3/1.3	12.7/11.6	37.5/34.2	14.2/13.1	137/123	32.2/28.1	30.3/26.4	3.8/3.6	<1.0/<1.0	39.5/41.9	<1.0/<1.0	1.6/1.4	<1.0/<1.0	<1.0/<1.0
NMW-1A/NMW-102	Jan-12	<1.0/<1.0	3.0/2.8	36.5/35.6	21.9/20.8	2.0/2.0	3.5/3.6	<1.0/<1.0	1.2/1.2	<1.0/<1.0	3.3/3.2	12.9/12.4	4.8/4.6	22.4/22.7	8.3/8.2	9.1/9.4	3.7/3.7	<1.0/<1.0	8.6/8.5	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0
NMW-1A/NMW-102	Dec-12	<1.0/<1.0	<5.0/<5.0	10/8.9	13/11	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	1.3/1.4	3.7/3.8	<1.0/<1.0	6.6/5.8	1.5/1.4	1.1/<1.0	<1.0/<1.0	<1.0/<1.0	<5.0/<5.0	<1.0/<1.0	<5.0/<5.0	<1.0/<1.0	<1.0/<1.0
NMW-8A	Jan-09	<1.0	<1.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	<5.0	<5.0	<1.0	NA	<1.0	<1.0
NMW-8A	Jan-10	<0.10	<0.10	<0.10	<0.30	<0.10	<0.10	<0.10	<0.20	<0.20	<0.20	<0.20	<0.10	<0.10	<0.10	<0.10	<0.20	<0.40	<0.40	<0.10	<0.10	<0.10	<0.10
NMW-8A	Dec-10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NMW-8A	Jan-12	<1.0	<1.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NMW-8A	Dec-12	<1.0	<5.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	<1.0	<5.0	<1.0	<1.0
NMW-9A	Jan-09	<1.0	<1.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	<5.0	<5.0	<1.0	NA	<1.0	<1.0
NMW-9A	Jan-10	<0.10	<0.10	<0.10	<0.30	<0.10	<0.10	<0.10	<0.20	<0.20	<0.20	<0.20	<0.10	<0.10	<0.10	<0.10	<0.20	<0.40	<0.40	<0.10	<0.10	<0.10	<0.10
NMW-9A	Dec-10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NMW-9A	Jan-12	<1.0	<1.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NMW-9A	Dec-12	<1.0	<5.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	<1.0	<5.0	<1.0	<1.0
NMW-10A	Jan-09	<1.0	<1.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	<5.0	<5.0	<1.0	NA	<1.0	<1.0
NMW-10A	Jan-10	1.7	8	44	20.2	<0.10	3.9	0.57	0.72	<0.20	<0.20	<0.20	<0.10	30	11	5.8	<0.20	<0.40	11	<0.10	<0.10	<0.10	<0.10
NMW-10A	Dec-10	1.4	1.6	14.5	3.4	<1.0	3.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	12.1	8.3	3.8	<1.0	<1.0	4.4	<1.0	<1.0	<1.0	<1.0
NMW-10A	Jan-12	<1.0	<1.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NMW-10A	Dec-12	<1.0	<5.0	2.4	<3.0	<1.0	3.9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.9	11	1.4	<1.0	<1.0	<5.0	<1.0	<5.0	<1.0	<1.0
NMW-11A	Jan-09	<1.0	<1.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	<5.0	<5.0	<1.0	NA	<1.0	<1.0
NMW-11A	Jan-10	<0.10	<0.10	<0.10	<0.30	<0.10	<0.10	<0.10	<0.20	<0.20	<0.20	<0.20	<0.10	<0.10	<0.10	<0.10	<0.20	<0.40	<0.40	<0.10	0.19	<0.10	0.34
NMW-11A	Dec-10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NMW-11A	Jan-12	<1.0	<1.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NMW-11A	Dec-12	<1.0	<5.0	<1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	<1.0	<5.0	<1.0	<1.0

Notes:
All concentrations in µg/L
Bold and highlighted indicates concentration exceeded the cleanup level
[a] Cleanup level based on the most recent MTCA guidance

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3. Tacoma Landfill, Operable Unit 5/6

3.1. Introduction

This is the fourth Five-Year Review (FYR) for the Tacoma Landfill Operable Unit (OU) 5/6 (EPA ID No. WAD980726301) of the South Tacoma Channel (STC) Superfund Site located in Tacoma, Washington. The STC Superfund site also includes Well 12A (OU 1) and South Tacoma Field (OU 4). Each STC OU is treated as a separate site but for purposes of Five-Year Reviews, all three are being submitted together under one cover. The triggering action for this review is the date of the last FYR, dated September 2008. The FYR is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site at levels above those that would allow for unlimited use and unrestricted exposure.

3.1.1. Purpose

The purpose of the FYR 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 FYR reports. In addition, FYR reports identify issues found during the review, if any, and identify recommendations to address them.

3.1.2. Authority

The United States Environmental Protection Agency (EPA) is preparing this five-year review pursuant to Comprehensive Environmental 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 EPA 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.*

With oversight from the EPA Region 10 Remedial Project Manager, the United States Army Corps of Engineers (USACE), Seattle District conducted a Five-Year Review of the remedial actions implemented

at the Tacoma Landfill (OU 5/6) of the STC Superfund Site located in Tacoma, WA. This review was conducted from January 2013 through September 2013. This report documents the results of the review.

3.2. Site Chronology

Table 3-1 lists major activities and milestones for the Tacoma Landfill site, OU5/6.

Table 3-1. Chronology of Site Events, Tacoma Landfill, OU5/6

Event	Date
Tacoma Landfill begins operation	1960
Investigation detects hazardous substances in groundwater and soils near site	1983
Landfill placed on the National Priorities List	1983
Landfill gases cause small explosion at a neighboring business	1986
City of Tacoma begins Remedial Investigation and Feasibility Study (RI/FS) pursuant to Consent Order with the State	1986
RI/FS completed	1988
EPA issues Record of Decision (ROD)	1988
Consent Decree finalized among Tacoma, Washington State Department of Ecology (Ecology) and EPA	1991
Landfill cap and gas management system construction completed	1993
Groundwater extraction and treatment system construction completed	1995
First Five-Year Review completed	1997
First 5-year Extension on Closure requested September1997, issued May 1998	1997/1998
Treatment of groundwater at on-site facility discontinued	1998
Extracted groundwater discharge diverted from sanitary sewer to storm sewer	2002
Second Five-Year Review completed	2003
Second 5-year Extension on Closure requested August 2004, issued February 2005	2004/2005
Third Five-Year Review completed	2008
Third 5-year Extension on Closure requested February 2009, issued December, 2009	2009
Replacement/Decommissioning of Landfill Gas Probes	2009
Landfill Gas Monitoring Plan Revisions	December 2009
GETS Shutdown (except W-1, W-2, W-4, W-15, and W-16)	March 2010
New Landfill Flare Operational	August 2010
Groundwater Monitoring Plan Revisions	November 2010
Replacement of Landfill Gas Extraction Wells PW-60 and PW-62	2011
Central Area Closure	2012/2013

3.3. Background

3.3.1. Physical Characteristics

The City of Tacoma Refuse Utility operates a solid waste disposal facility known as the Tacoma Landfill (Landfill) located within the City of Tacoma in Pierce County, Washington. Specifically, the Landfill is situated in Sections 12 and 13 of Township 20 North, Range 2 East, near the western border of Tacoma. The Landfill covers 240 acres and is bounded approximately by South 31st Street on the north, Tyler Street on the east, South 48th Street on the south, and Orchard Street on the west. Surface water located near the landfill includes Leach Creek to the west and Flett Creek to the south (Figure 3-1).

The site is located within the South Tacoma Groundwater Protection District, which is a special zoning overlay district managed by the Tacoma Pierce County Health Department (TPCHD). The City of Tacoma operates several drinking water wells within a half mile east of the site in the South Tacoma Channel that are used to augment the City's drinking water supply during peak demand periods. Groundwater in the South Tacoma Channel provides the primary contingency to maintain the municipal drinking water supply in the event that the main source (Green River) is not available.

3.3.1.1 Site Geology

The Tacoma Landfill site is located in the northern portion of the Chambers/Clover Creek Drainage Basin. This area is part of the Puget Sound Lowlands. The South Tacoma Channel, a glacial outwash channel capable of producing high groundwater yields, is located to the east of the site.

The geology of the site consists of a series of glacial materials, mostly sand and gravel laid down over older alluvial silts and sands. The stratigraphic units (layers) were described in the Remedial Investigation and refined in the End of Plume Residual Characterization Report (Landau 2006). Figure 3-2 shows a representative geologic cross-section. From youngest to oldest (top down) the units are:

- Vashon recessional deposits (Qvr). Consists of unconsolidated (stiff to very stiff; medium to dense to dense) silt, sand, and gravel.
- Vashon till (Qvt). Consists of very dense silt, sand, and gravel.
- Vashon advance outwash (Qva). Consists of consolidated (dense to very dense) gravelly sand and sand. Has a fining downward sequence where the grain size is coarsest at the top and becomes finer toward the bottom. Includes Colvos Sand.
- Pre-Olympia older gravel (Qog). Consists of dense to very dense gravel deposits.
- Pre-Olympia lacustrine deposits (Qol). Consists of fine-grained silt deposits.

3.3.1.2 Hydrogeology

The Qva and Qog deposits represent a single aquifer unit at the Site. The upper portion of the aquifer in the Qva has also been referred to as the Colvos Sand aquifer. The older lacustrine unit, Qol, serves as the regional aquitard in the landfill area.

Recharge to the aquifer beneath the landfill occurs from the Fircrest Upland, north of the landfill, and the South Tacoma Channel, east of the landfill. The dominant groundwater flow direction is to the south and west and towards Leach Creek located approximately 1/2 mile west of the Landfill. Leach Creek flows into Chambers Creek which enters Puget Sound approximately five miles southwest of the Landfill. A north-south groundwater divide (dividing east from west) is located between the City of Tacoma production wells in the South Tacoma Channel and the Tacoma landfill. During periods of heavy water use by City of Tacoma wells (i.e., heavy groundwater pumping at those wells), the groundwater flow divide shifts westward toward the landfill.

The depth to groundwater beneath the landfill is about 70 feet. Units above the water table include the Vashon Till (Qvt) and portions of the Advance Outwash (Qva). In areas where the till lies below the refuse, the relatively low hydraulic conductivity of the till slows the downward migration of water. Where the till is absent, water moves through the unsaturated zone into the aquifer.

3.3.2. Land and Resource Use

The Tacoma Landfill began operations in 1960, and has been operating as a sanitary landfill under a permit issued by the TPCHD. The wastes disposed at the Landfill include garbage, rubbish, industrial wastes, construction and demolition wastes, street refuse, litter, and bulky waste. The Landfill does not accept hazardous waste for disposal; however, the Landfill received wastes in the 1960s and 1970s that have since been designated as hazardous wastes under state and federal law. The site has been filled. The last section of the site to be filled is called the Central Area which covers approximately 31 acres, which was developed in 1987. The Central Area was covered with a double flexible membrane bottom liner and leachate collection system. The Central area did not accept waste from December 2002 through 2010. The Central area is now filled and is scheduled for final closure in December 2013. In addition to waste disposal, the site is the operations center for all solid waste management activities in the City of Tacoma. Solid wastes transported to the site are segregated, processed, and removed from the site.

The Landfill is surrounded primarily by residential and commercial development with some open land and industrial development. Groundwater beneath the site is hydraulically connected to the drinking water aquifer used by both the City of Tacoma and the City of Fircrest. Groundwater level measurements indicate that the City of Tacoma wells located to the east within half a mile of the site in the South Tacoma Channel (Wells 2B/C, 4A, 6A/B and 11A) potentially influence the groundwater flow direction at the Landfill. The City of Fircrest wells, located northwest of the site, are generally cross-gradient from the Landfill. Private residential wells are also present in the area. However, residences whose wells have been impacted have been connected to municipal water. Drilling of new wells in the area affected by contamination from the site is currently prohibited by the Cities of Tacoma, Fircrest, and University Place.

3.3.3. History of Contamination

In 1983, EPA conducted an investigation and detected hazardous compounds in samples of groundwater and soil near the Landfill. This led EPA to including the Landfill on the National Priorities List (NPL) of hazardous sites as part of the South Tacoma Channel site. Through a cooperative agreement with EPA, the Washington State Department of Ecology (Ecology) began an investigation into contamination at the site in 1984. In 1986, the City of Tacoma assumed responsibility for conducting the remedial investigation/feasibility study (RI/FS) under a response Order on Consent issued by Ecology.

3.3.4. Initial response

Groundwater contamination, primarily volatile organic compounds (VOCs), was detected during the RI at the perimeter of the Landfill and extended in a southwesterly direction toward Leach Creek.Because of the concern about public health effects of the contamination, particularly vinyl chloride, residents whose wells were impacted or threatened were hooked up to the Tacoma municipal water system in the mid-1980s. Landfill gases were found to be migrating from the Landfill to residences and businesses adjacent to the site. The landfill gases contained methane, which can cause explosions at certain concentrations, and VOCs, which can cause negative health effects at elevated concentrations. Because of a concern over the migration of landfill gases, the first stage of a landfill gas management system was constructed in 1986.

3.3.5. Basis for Taking Remedial Action

Monitoring at the site revealed that hazardous substances had been released from the Landfill into the soils, groundwater, and air at the site. The hazardous substances released to groundwater include a variety of VOCs and semi-volatile organic compounds (SVOCs) and heavy metals, many of which were at concentrations above State and Federal drinking water standards. Vinyl chloride was the most pervasive compound found in groundwater and represented the greatest risk to human health. Landfill gases were found to contain a wide variety of VOCs as well as methane. VOCs represent a risk to human health if the gases seep into neighboring homes and businesses. The methane in the gases represents the greatest risk to human health as it can cause explosions when it accumulates to certain concentrations. Accumulation of landfill gas in a utility vault at a company located adjacent to the Landfill resulted in a small explosion in May 1986.

The following contaminants of concern (COCs) were identified in the Endangerment Assessment from the Remedial Investigation (RI):

- Vinyl Chloride
- Benzene
- 1,2-Dichloroethane (DCA)
- Methylene Chloride
- 1,1-DCA
- Chloroethane
- Toluene

EPA and Ecology later added three additional COCs in the Record of Decision (ROD):

- Xylenes
- 1,1,1-Trichloroethane
- Ethylbenzene

3.4. Remedial Actions

3.4.1. Regulatory Actions

On March 31, 1988, EPA issued the ROD which selected the final remedial action for the site based on the RI/FS. On November 13, 1989, a Consent Decree among EPA, Ecology, and the City of Tacoma was lodged in federal court. The Decree addressed implementation of the remedial actions specified in the ROD. This Consent Decree was not accepted by the Court and was subsequently modified. The modified Decree was entered by the Court on May 17, 1991.

3.4.2. Remedial Action Objectives

The ROD required treatment (extraction and treatment) to reduce contaminant levels in the groundwater to or below cleanup standards with treatment performance levels for COCs based on federal Maximum Contaminant Levels (MCLs) and discharge to surface water. The goal of the extraction is defined as preventing any further degradation of existing water quality beyond the boundaries of the existing plume. The ROD specifies treatment standards based on the point of discharge, but allowed for discharge to Leach Creek, Flett Creek, or the sanitary sewer. Extraction and treatment was required to continue until water quality at the edge of the filled area are at or below MCLs or previously established and approved health-based standards. In addition, consideration of potential impacts to public and private water supplies and to adjacent Leach Creek were required in any future decision about when to shut off the system. The remedial action objectives outlined in the ROD are as follows:

- Prevent further migration of the plume via the groundwater extraction and treatment system.
- Reduce the production of leachate by placing constraints on site operations and by properly grading and capping the landfill.
- Eliminate off-site gas migration through the gas extraction system.
- Further protect public health and the environment via monitoring of groundwater, surface water, gas probes, air emissions, and by providing alternate water supplies where necessary.

A methodology to determine treatment performance standards for indicator compounds was developed in the ROD. If MCLs were not available, the lower of either ambient water quality criteria (AWQC) for protection of human health for water and fish consumption or chronic fresh water criteria for the protection of fish was used. For compounds that did not have either an MCL or AWQC, a value was derived based on an EPA Region 10 risk assessment. The ROD also states that if discharge is to either Leach Creek or Flett Creek, the effluent must meet or exceed MCLs or chronic fresh water criteria, whichever is lower, and meet water quality standards for waters of Washington State (WAC 173-201).

3.4.3. Remedy Description

The selected remedy included management of contaminant migration using a groundwater extraction and treatment system; source control using a landfill cap, gas extraction system, and landfill closure plan; and monitoring. Institutional controls (ICs) were selected to assure that the remedial action will continue to protect human health and the environment. The remedy, as described in the ROD, is presented below.

3.4.3.1 Management of Migration

Migration control will be achieved through a groundwater extraction and treatment system (GETS) and a system or method to confirm performance. Minimum flows as required by WAC 173-512 shall be maintained in Leach and Flett Creeks. The treatment process shall be permanent and shall effectively reduce the toxicity, mobility, and volume of contaminants. It shall also employ all known, available, and reasonable methods to treat the contaminated groundwater, and to prevent the spread of contamination. Discharge of treated groundwater may be either to Leach Creek, Flett Creek, or the sanitary sewer. If the discharge is to either Leach Creek or Flett Creek, the effluent must meet or exceed MCLs developed pursuant to the Safe Drinking Water Act or meet the chronic fresh water criteria as set forth in EPA's Quality Criteria for Water, 1986 (EPA 440/5-86-001), whichever is more stringent. The extraction and treatment system can be shut off when water quality outside the compliance boundary (defined by WAC 173-304 as the edge of the filled area) consistently meets or exceeds drinking water standards or approved health based criteria.

3.4.3.2 Source Control

Source control measures consist of constructing a cap on the landfill to minimize infiltration and maximize run-off. Unlined areas of the landfill will be capped as soon as possible. Increased run-off due to the construction of the cap will be routed off the landfill to reduce infiltration. The run-off collected from the landfill will be directed to the appropriate storm or sanitary sewers consistent with local storm water drainage ordinances or pre-treatment regulation. Filling unused areas will require a liner consistent with WAC 173-304. A schedule for closure of the landfill under WAC 173-304 is considered part of the remedial action at this site. The schedule will address various waste reduction measures and develop contingency plans if these do not produce the expected results.

The production of methane gas at the landfill is being addressed through the installation of a gas extraction system and is being monitored using a series of gas probes installed around the landfill. The gas collected by the extraction system is burned at the flare which meets air quality requirements. The quantity and quality of condensate from the gas collection lines and flare will be determined during the remedial action and treated, if necessary. Additional gas probes will be installed in the surrounding neighborhoods to verify that the extraction system is preventing off-site gas migration.

3.4.3.3 Monitoring

Groundwater monitoring wells shall be installed in locations appropriate for obtaining the following information:

- *Determine if the groundwater extraction system is preventing the spread of the contaminant plume.*
- *Determine the extent of the plume migration to the east of the site.*
- *Identify any potential impacts to Leach Creek and the Fircrest well system.*
- *Ensure there is no dense-phase plume migrating away from the site in the deepest zones of the aquifer.*

Leach Creek will be monitored for both water quality and quantity. Other surface waters receiving either effluent from the GETS or the surface drainage system will be monitored for water quality. At a minimum, the private wells in the path of the plume will continue to be monitored on a quarterly basis. Fircrest wells will be sampled monthly. Any well, public or private, which becomes contaminated due to the landfill, will be replaced and water will be supplied from existing City of Tacoma water supply systems.

3.4.3.4 Institutional Controls

ICs will be implemented to assure that the remedial action will continue to protect human health and the environment. Tacoma, in cooperation with the town of Fircrest and Pierce County, will pursue the establishment of an ordinance or other suitable methodology to restrict drilling of water supply wells.

3.4.4. Remedy Implementation

Each component of the remedy is described below.

3.4.4.1 Groundwater Extraction and Treatment System (GETS)

The GETS system was constructed in 1992 and 1993 and consisted of 19 point of compliance (POC) extraction wells (W1 through W19), 9 edge-of plume (EOP) extraction wells (W30 through W38), pipelines to transport the extracted groundwater to a treatment facility, and a groundwater treatment system (see Figure 3-3). The POC wells are located on the down-gradient edge of the Landfill and their purpose is to capture contaminated groundwater before it flows outside of the Landfill boundary. The EOP wells are located along Leach Creek and their purpose is to clean up contaminated groundwater at the edge of the plume and prevent contamination from impacting Leach Creek and groundwater beyond the creek. Once extracted from the EOP and POC wells, groundwater was originally transported via pipelines to a treatment facility. The treatment facility is equipped with two air-strippers to remove VOCs; an acid-wash system to periodically remove scale buildup from the internal packing material in the towers; and a control building where overall operations, control, and monitoring of the groundwater extraction/treatment facilities are managed. The treated groundwater was then discharged to the sanitary sewer system for further treatment and disposal.

Based on groundwater monitoring and several years of experience in operating the groundwater extraction and treatment system, improvements were made to the system between 1995 and 1997. These included rehabilitation of EOP wells, installation of four new EOP extraction wells (W40 through W43) near the southern extent, and installation of three new POC wells (W20 through W22) at the north end of the landfill near Fircrest municipal well field.

Under an amendment to the Consent Decree, the City was required to maintain 1.7 cubic feet per second (cfs) of flow in Leach Creek since groundwater was being extracted from wells east of the creek (EOP extraction wells) and discharged to the sanitary sewer. Leach Creek flow was supplemented, as needed, using a well the City installed at the Leach Creek Holding Basin pump station. Groundwater was extracted from this well at approximately 2.5 cfs. Flow in the creek is monitored at the USGS gauging station located at 40th Street.

Configuration of the pipeline to the treatment facility allowed groundwater extracted from highly contaminated areas to mix with groundwater from less contaminated areas, which effectively dilutes contaminant concentrations prior to treatment. By 1998, the combined water from all groundwater extraction wells met performance standards specified in the ROD for discharge into the sanitary sewer for six consecutive quarters and the treatment system was mothballed. The extracted groundwater was then discharged directly into the sanitary sewer for treatment and disposal. By August 2002, the combined water from all the groundwater extraction wells met performance standards specified by the ROD and by Ecology for discharge to surface water for four consecutive quarters. In response, the City requested to temporarily change the discharge of extracted groundwater from the sanitary sewer to Leach Creek and to evaluate the feasibility of a permanent discharge location. EPA and Ecology approved that request and the City periodically discharged all or a portion of extracted groundwater to Leach Creek. By 2003, a permanent discharge channel and holding basin was constructed and all of the extracted groundwater was discharged to Leach Creek. The City subsequently ceased augmentation of flow in the creek and flow monitoring. The augmentation well remains available to supplement flows in the creek, if needed.

3.4.4.2 Landfill Cover

A landfill cover was installed over areas containing buried waste in two stages from 1990 to 1992 with the exception of the cell in the Central Area. Figure 3-4 shows the sequence of fill operations at the landfill. The cover was installed on approximately 125 acres of the 240 acre site. The purpose of the cover is to minimize rainwater and surface water infiltration into the landfill thereby reducing the production of leachate which is the source of groundwater contamination. The cover consists of two 60 milliliter (mil) high density polyethylene (HDPE) liners separated by a leak detection and water collection layer. A 4-acre area that that became part of an expanded operations area was capped using a geomembrane layer and then covered by buildings or low-permeability asphalt pavement.

The City constructed the Central Area in the center of the landfill to receive municipal solid waste. The Central Area is the only portion of the site with a bottom liner and was designed to meet the state requirements for solid waste disposal given in WAC 173-304 (Minimum Functional Standards for Solid Waste Handling). The Central Area was designed and constructed in two phases. The first phase, encompassing approximately 18 acres, was constructed in 1987. The second phase, which consisted of extending the sidewall liners and leachate collection system, was constructed in 1990, bringing the total lined area within the Central Area to approximately 31 acres. The bottom liner is composed of two HDPE liners separated by a leak detection and leachate collection system. The side slopes in the Central Area consist of a single HDPE liner which separates the Central Area from the old landfill.

The leachate generated within and under the east sidewall liner of the Central Area is discharged to the 24-inch sanitary sewer through a manhole located in the Resource Recovery Area, typically referred to as the leachate collection manhole. The 24-inch sanitary sewer discharges from the east side of the landfill into the Tyler Street sanitary sewer.

Waste was not put into the Central Area between December 2002 and 2010. Final closure of the Central Area began in 2010. Currently it is filled to grade and final closure will be completed in December 2013. In accordance with requirements in the Consent Decree, the final cover must be similar to the one installed over the rest of the Landfill. Due to advancements in materials for landfill caps, the City requested a modification to use an alternate cap that is equivalent or better than the existing cover system and meets the criteria in WAC 173-351-500 for alternative covers. The final cover at the Central Area will contain a geosynthetic clay liner (GCL), a 60-mil HDPE geomembrane, and a geocomposite drainage layer.

Storm water from the northern and western portions of the landfill site drain to the Leach Creek Holding Basin, from which it is then discharged into Leach Creek. Runoff draining to Leach Creek leaves the landfill property through five separate discharge points, and is then conveyed to the basin via the City storm sewer system. The southern portion of the landfill site drains to Flett Creek via the City storm sewer system. Runoff draining to Flett Creek leaves the landfill property through two separate discharge points. The first point is via the east detention pond and the second point is the City storm sewer system at the south end of the landfill.

3.4.4.3 Landfill Gas Management

A landfill gas management system was installed in several phases starting in 1986. Additions to the system have been and will continue to be made if monitoring results indicate that the existing system is not controlling landfill gas migration to within the limits set forth in the Minimum Functional Standards. The system currently has over 300 gas extraction well stations each consisting of one to four wells completed to various depths, piping for transferring the collected gas to a flare station, and the flare station where the gas is destroyed. It has been expanded into the Central Area as other areas are filled to final grade. See Figure 3-5 for the gas extraction well locations. The effectiveness of the landfill gas management system is evaluated through regular monitoring of gas probes situated around the perimeter of the landfill and off-site. Off-site probes are located up to 1,000 feet from the edge of the landfill. Each probe consists of one to five monitoring ports completed to various depths. See Figure 3-6 for the gas monitoring probe locations.

The initial system, installed in 1986, was constructed under emergency conditions and included 128 gas extraction wells within the landfill wastes and in native soil along the site perimeter and 66 gas probe locations around the perimeter of the site. During the first year of operation, the initial system proved to be effective in controlling or reducing gas migration throughout the landfill, particularly in the upper regions of the surrounding soil. However, perimeter and off-site monitoring test results indicated that this system was not effectively controlling the deep migration of landfill gas. In 1988, the City began work on the design and installation of the second phase of the landfill gas control system. This phase was specifically designed to eliminate the deep gas migration problem and to increase off-site monitoring

capabilities. It included the installation of 82 deep landfill gas extraction well stations, 11 off-site landfill gas monitoring probe stations, and additional collection header piping.

Since 1988, additional gas extraction wells and gas monitoring probes have been installed under several different projects. These include 41 new probes installed as required in the Consent Decree, additional extraction wells installed prior to each stage of landfill capping, and replacement of damaged extraction wells and probes. In 2006, the City installed three new gas extraction wells near the Home Depot property in response to methane detections in gas probes located in the parking lot. Most recently, gas extraction wells were installed as part of the final closure of the Central Area. With the addition of these new gas wells, the entire capped area is covered by the gas extraction system, with well spacing based on a conservative radius of influence (125 feet).

The gas extracted from the wells is discharged into gas header pipes for transport to the flare system. As the warm moist gas moves through the cooler header pipes, condensate is formed. Condensate collection pipes are installed below the ground to collect the moisture from the gas header pipes through condensate drip legs. The collected gas condensate is transported through the condensate collection pipes to the vacuum valve stations by gravity. At the vacuum valve stations, pumps are utilized to pump the gas condensate to the discharge locations. All the gas condensate discharges into the sanitary sewer. In 1993, the condensate discharge pipes were re-rerouted to the leachate collection manhole to provide a single discharge for all the leachate and condensate waste streams. A condensate collection system was also installed with each phase of landfill closure. This eliminated the condensate drain traps previously in use in which the condensate was drained back into the landfill.

The flare station was originally installed in 1986 as part of the initial construction phase and included two 1,000 cubic feet/minute (cfm) Sur-Lite flares. In 1992, two additional 1,670-cfm Perennial gas flares were installed to increase the flow capacity of the system. The City signed a contract in 1995 to lease the landfill gas field to a private company for the purpose of constructing an electrical generation facility at the Landfill. This facility became operational in 1998, but was shut down in 2003 due to low energy sales, the end of gas credits, and low gas production. Currently, all gas is collected and sent to the flare station for destruction. In 2009, construction started on a new, lower-capacity blower and flare system to effectively process the collected gas, which is declining in both overall gas volumes and British thermal units (BTU). The new blower and flare became operational in 2010.

3.4.4.4 Landfill Closure

The schedule identified in the ROD required landfill closure by December 31, 1999, and included provisions for three five –year extensions. The Consent Decree stipulates that the Tacoma Landfill will be closed in stages. During each stage, final grading and cap installation will take place in the specified areas. The three stages and their effective dates, as defined by the Consent Decree, are:

- Stage 1, 1990-1991 construction season - Northeast and southern sections of the landfill and the Public Receiving Facility. (Completed in April 1991)
- Stage 2, 1991-1992 construction season -Western section of the landfill and the section east of the Central Area. (Completed in June 1992)

- Stage 3, closure of the Central Area required by December 31, 1999. Extensions of this deadline up to a combined 15 years in increments of no longer than 5 years were allowed, making the final closure deadline December 31, 2014 (the landfill is currently scheduled for closure in December 2013).

The Consent Decree required that the following conditions be met in order for a closure extension to be granted:

- That the continued operation of the landfill shall not result in a release or substantial threat of hazardous substances, pollutants or contaminants to the environment;
- That the performance standards for the extraction-treatment system have been achieved;
- That since the effective date of the Consent Decree, the Settling Defendant has instituted and is operating an aggressive solid waste recycling and hazardous materials collected project; and
- That other feasible solid waste management alternatives to disposal at the landfill do not exist.

The City met all of the requirements for closure extensions. Operation of the GETS and gas management system controlled the potential for releases and performance levels for GETS operation were met. Since 1988, the City has been implementing programs to collect and process recyclable materials and hazardous waste. These include: collection programs such as curbside recycling, collection of yard waste, produce waste recycling, and waste oil recycling; Landfill Waste Diversion Facilities such as the recycling center and household hazardous waste collection facility; and On-Site Diversion and Source Control Efforts for recyclable and hazardous materials. The City also participates in waste reduction and environmental stewardship programs and promotes their programs through community education and outreach. The Central Area was allowed to stay opened during the extension periods for use as an emergency disposal facility.

The third and final five-year extension request was originally submitted on February 27, 2009, and amended on June 8, 2009. EPA conditionally granted approval of the extension in a letter dated December 21, 2009. Conditions included: complete final closure by December 31, 2014, bring the southern half of the Central Area to grade by 2010 and the northern half by 2012, continue to submit Central Area flow and leachate data, update the groundwater management plan, and update the IC plan. The City requested several modifications to the conditions, which were subsequently approved by EPA in a letter dated July 28, 2010. Modifications to the request included allowance for continuous fill to replace partial closure in two separately staged phases of construction. Date modifications were also made to require the Central Area to be entirely at final grade elevation with a temporary cover by December 2012, with construction completion by December 31, 2013.

3.4.4.5 Monitoring

Monitoring of groundwater and surface water is used to evaluate the performance of the GETS. Wells at the site are shown on Figure 3-3 and include: monitoring wells (TL-series), performance monitoring wells (P-series), groundwater extraction wells (W-series), existing residential wells (EW-series), and Fircrest water supply wells (FW-series). Surface water sampling is conducted along Leach Creek at three stations (LC-series). The Consent Decree requires quarterly monitoring and then biannual monitoring for the subsequent 30 years following issuance of the certificate of completion. The Consent Decree states that

the extraction/treatment system can be shut down when the groundwater at the point of compliance and within the existing plume has reached the drinking water standards or health based criteria for four consecutive quarterly samples.

The City of Tacoma is required to provide an alternate water supply to all residents whose wells became or become contaminated by the Landfill. The City has connected most of the affected residents to the Tacoma municipal water system. According to the criteria established for this site, a well is considered contaminated when the concentration of a chemical exceeds 20% of its drinking water standard or health-based level. Some private wells are still in use in the vicinity of the Landfill; however, their use is typically restricted to outdoor purposes only, such as lawn or garden watering.

The city of Fircrest has water supply wells located to the northwest of the Landfill. In 1995, Tacoma asked the neighboring City of Fircrest to limit the amount of water being pumped from its municipal well closest to the Landfill, Fircrest Well # 5 (FW-05), because of the potential threat of pulling in landfill contaminants at higher pumping levels. In 1996, Tacoma drilled a new well to replace Fircrest Well #5. The old well has been temporarily closed.

3.4.4.6 Institutional Control Plan

The ROD generally identifies that ICs should be developed. The Consent Decree specified that ICs should be developed to prevent installation of drinking water wells within the vicinity of the Landfill.

Section V, Paragraph 21 of the Consent Decree requires that the City implement the following types of ICs at the Tacoma Landfill:

> *1. Place a notice on any deed, title, or other instrument of conveyance relating to the Tacoma Landfill indicating that the site is subject to a Consent Decree (i.e., Restrictive Covenant). The notice must include a reference to and a description of the Consent Decree, as well as a statement that the landfill has been used to manage hazardous substances, some of which remain under the cap. The notice must also include a statement that land use is restricted and that any actions that disturb the cap or the containment system, including the monitoring system, will not be allowed unless the Environmental Protection Agency and the Department of Ecology find that such disturbance does not increase the potential hazard to human health and the environment, or is necessary to reduce a threat to human health and the environment. An assurance will be provided in the notice that the restrictions and obligations set forth in the Consent Decree will be binding upon persons who acquire any interest in the Tacoma Landfill property.*
>
> *2. In accordance with Sections 4 and 5 of the Restrictive Covenant, the City will provide advance notice to the Environmental Protection Agency and Department of Ecology whenever the City sells or leases any portion of the Tacoma Landfill to a third party. The notice must also indicate whether any of the City's obligations will be performed by the third party acquiring the real property.*

3. Place restrictions on the use of groundwater at the property, including a prohibition against pumping groundwater in affected aquifers unless it's done to monitor groundwater contamination and/or the effectiveness of the remedial action at the landfill.

4. Use best efforts to implement ICs on properties outside the City's jurisdiction including the recording of notices, plot plans, and other similar documents, and providing notice of the ICs to other affected local zoning authorities or other affected governmental entities.

Another underlying function of the IC Plan is to outline the approach for evaluating future development concepts for various portions of the landfill to ensure that remedial actions and monitoring systems that are in place remain protective and are not compromised by future uses. This includes not only a plan for obtaining public input, as determined appropriate on a case-by-case basis, evaluation of consistency with remedial systems in place, engineering to resolve any modifications to either the remedy (i.e., burying portions of the gas system), or the design of the development (i.e., boots around cap penetrations), and agency review and approval.

The City originally developed an IC Plan dated July 17, 1992, which outlined procedures to prohibit drilling of water supply wells within and adjacent to the Landfill and to prohibit any activity that will negatively impact the remedies constructed at the Landfill. The Plan was conditionally approved by EPA and Ecology on August 17, 1992. An updated IC and Land Use Plan was submitted by the City in November 2010. The plan was conditionally approved by EPA and and finalized on July 30, 2012. Details of the plan are presented in Section 6.7.

3.4.5. Systems Operations/Operations & Maintenance

A compilation of the operation and maintenance (O&M) procedures for the Landfill are provided in the 2004 Operations and Closure Plan, which was revised in 2009. This plan was required as part of the Consent Decree and was developed to comply with the requirements of the Minimum Functional Standards for Solid Waste Handling (WAC 173-304) and the Criteria for Municipal Solid Waste Landfills (WAC 173-351). It is periodically updated as the remedial action or landfill operations change and includes summaries of the maintenance and management, environmental monitoring, and recycling programs, and it presents the site closure and post-closure plan.

3.4.5.1 Groundwater Extraction and Treatment System

O&M for the GETS is conducted according to the 1993 Groundwater Extraction/Treatment System Operation and Maintenance Plan. Groundwater extraction wells in operation are monitored weekly for pumping rates and water elevations. Extraction rates have gradually decreased over time, primarily due to iron bacteria precipitation in the wells and well laterals. The City periodically treats the wells using the carbon dioxide freezing method to remove the natural soil bacteria on the well screens, which then allows the wells to increase their extraction rates. Extraction well W-1 was replaced in 2009 due to ongoing maintenance problems.

Individual extraction rates at operational wells during the last five years ranged from about 2 to 75 gallons per minute (gpm). Plume capture is verified by evaluating extraction rates at the southern end of the

landfill near the residual VOC plume (POC extraction wells W-1 through W-9). The hydraulic gradient is evaluated for each quarterly event and is used in the calculation method to determine the required production rates to maintain capture. In 2008 and 2009, the gradient ranged from 0.0009 to 0.0018 ft/ft and the required flow ranged from 101 to 192 gpm. Comparison of the required to actual extraction rates verifies that capture has been obtained at the southern end of the landfill. A full capture zone analysis, based on the EPA recommendation for the POC extraction wells has also been completed as part of the Third Five-Year Closure Extension Request. The horizontal capture zone curve for each well was calculated and plotted on the site map. Figure 3-7 shows the capture zone curves for the fourth quarter of 2008, which indicates that when all POC extraction wells are operational, full horizontal capture of contamination from the landfill is obtained.

In December 2009 the City requested approval to shut down the GETS because groundwater concentrations in most of the POC and EOP extraction wells had met the Consent Decree performance levels for four consecutive quarterly sample rounds. Specifically, monitoring results demonstrated that 19 of the 21 POC extraction wells met VOC performance standards, 15 of the 21 POC extraction wells met the arsenic performance standards, 32 of the 33 off-site monitoring wells met VOC performance standards, 12 of the 13 EOP extraction wells met VOC performance standards, and all EOP extraction wells and off-site monitoring wells met the arsenic performance standards. EPA approved the request for shutdown on an interim basis in February 2010, pending the results of rebound monitoring (discussed below). Fourteen of the 19 operational POC wells and 8 of the 9 operational EOP wells were shut down in March 2010. POC extraction wells remaining in operation are W-1, W-2, W-4, W-15, and W-16. EOP extraction well W-36 remained in operation due to low levels of vinyl chloride detected at nearby residential well EW-12. Well W-36 was shutdown in 2011 after EW-12 was decommissioned and the residence hooked up to the Fircrest water supply.

The City has decommissioned some of the EOP extraction wells (W-34, W-35, and W-42) due to property development in the area. In 2012, EPA granted the City request that that EOP extraction wells W-30, W-40, and W-41 be decommissioned. POC extraction wells that are shut down will be maintained in the event that these wells need to be used in the future.

3.4.5.2 Landfill Cover

O&M for the landfill cover is conducted according to the 1992 Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System. The capped areas are inspected for evidence of erosion, settlement, ponding of water, improper or inadequate vegetation, burrowing animals, cracking, odor, or any other adverse activities/conditions. Results of the monitoring are reported annually.

O&M for the asphalt cap is conducted according to the 1992 Asphalt Cap Inspection and Maintenance Plan. The asphalt cap is inspected for cracks, deterioration, subsidence, uneven or excessive wear, bleeding, or expansion of joints on the retaining wall. The permeability of the asphalt cover is regularly checked with lysimeters installed in the cover. Results of the monitoring are reported annually.

Leachate and Condensate Monitoring

Leachate and Condensate are managed in accordance with the 1992 Leachate and Condensate Management Plan. The objective of the plan was to characterize, classify, and determine the volumes of leachate and condensate discharges from the site; determine collection, disposal, and treatment requirements for each of the waste streams comprising leachate and condensate discharging to the sanitary sewer; determine sewer discharge permitting requirements; and develop the sampling and monitoring requirements. Sampling during the pre-design studies determined that the leachate and condensate could be discharged to the City's Central Wastewater Treatment Plant (CTP) without treatment.

Leachate discharged to the sanitary sewer consists of leachate from the Central Area collection system and toe drain that connect to the leachate collection manhole and leachate from the leak detection system that connects to the leak detection manhole. Surface runoff at the Central Area is collected and also routed to the leachate collection manhole. The central Area leachate collection, detection, surface runoff, and toe drain pipes are visually inspected each month by field crews. There were no significant equipment or collection issues in the last five years.

Condensate is generated from the landfill gas extraction system. As the warm, moist extracted gas moves through the cooler header pipes, condensate is formed and collected. The condensate is then routed to the leachate collection manhole for discharge to the sanitary sewer. The condensate collection system operated as expected during the last five years. Routine operation problems, such as plugged air release valves, broken pipe fittings, electrical malfunctions, and pump failures were identified and corrected as they occurred. The system remained operational during most repairs. System down time was minimal and had little effect on condensate collection.

Leachate and condensate monitoring are completed according to the following schedule:

- Quarterly sampling of the combined effluent is analyzed for VOCs, semi-VOCs, metals, and conventional analytes (ammonia, biological oxygen demand [BOD], chemical oxygen demand [COD], free cyanide, total cyanide, oil and grease, and total suspended solids [TSS]). Analyses for pesticides and PCBs is not required.
- Quarterly sampling of the toe-drain influent is analyzed for ammonia, BOD, COD, chloride, total dissolved solids (TDS), hardness, pH, conductivity.
- Annual sampling of the combined effluent and toe drain, precipitation runoff, and condensate influents is analyzed for flow rate, VOCs, semi-VOCs, metals, and conventional analytes. Analyses for pesticides and PCBs are not required. Condensate is to be monitored only for VOCs.

In EPA and Ecology's approval of the second five-year extension, the City was required to monitor daily volumes collected from the Central Area leachate collection system, leak detection system, and toe-drain collection system. In the event that the leachate flows from the Central Area differ significantly from what EPA and Ecology have determined is reasonable, EPA and Ecology may impose further requirements in order to reduce leachate generation at the Central Area. Monitoring results were to be reported monthly. In 2005, the City re-installed meters in the leachate collection, leachate detection, and

surface water discharge pipes. A Hydrologic Evaluation of Landfill Performance (HELP) model was also developed to estimate the amount of generation. Data collected generally agreed with the HELP model results indicating that there is no significant loss of water in the Central Area. Monitoring has been completed as required; however, there were numerous issues with the meter and data logger installed in the leachate collection manhole due to the harsh physical environment. The City frequently made repairs and replaced parts, but monitoring equipment was not able to continuously collect leachate generation data. The EPA and Ecology required continued monitoring of the Central Area leachate generation as part of the third five-year extension approval. Following the final closure of the Central Area in 2013, the Leachate and Condensate Management Plan should be updated to reflect the current conditions and future monitoring requirements.

On April 15, 1994, the City received a letter from Ecology's Water Quality Program which oversees the City's pretreatment program. Upon their review of the leachate and condensate flow and pollutant data, they determined that the Tacoma Landfill leachate and condensate effluent did not require permitting as a Significant Industrial User (SIU) under the City's pretreatment program. The de-designation was based upon low flow rate and analysis done to date on samples of combined effluent discharge to the sanitary sewer. The letter indicated the City could de-designate the effluent; however, the restrictions of the pretreatment program could not be taken as an exclusion or waiver of program requirements.

Cap Maintenance/Construction

Cap maintenance activities completed in the last five years include the West 1 Area Cap Repair, East Cap Extension project, and repairs due to a water line break. The West 1 Area Cap Repair and East Cap Extension project conducted in 2007-2008 replaced an area of cap due to settlement, and extended the landfill cap on the east side of the landfill due to refuse that was found outside the limits.. In 2007, a water line break on the western side of the landfill washed out a section of the landfill cap. This section of cap was repaired in 2008.

Additional construction activities include filling the Central Area to grade and installation of the cover. A GCL and HDPE cap was installed over the Central Area in several phases. The southern 15 acres were capped in 2011, an additional 7 acres were capped in 2013, and the final 8 acres were capped in 2013.

3.4.5.3 Landfill Gas Management

Monitoring of the gas extraction wells, monitoring probes, and flare is conducted according to the 1999 Landfill Gas Management Plan, as updated in 2009.

Gas Extraction Wells

There are more than 300 gas extraction wells in operation around the perimeter and within the interior of the landfill. Inspection of the gas collection header system is conducted on a regular basis and the overall system is inspected daily. At a minimum, each well is monitored and adjusted twice per year to account for seasonal fluctuations. Testing at each well includes:

- Percent methane by volume

- Percent oxygen by volume
- Percent carbon dioxide by volume
- Pressure in inches water column (positive or negative)
- Gas temperature in degrees Fahrenheit
- Flow velocity in feet per minute and in standard cubic feet per minute

The system was designed to meet State of Washington Criteria for Municipal Solid Waste Landfills which require that methane concentrations must not exceed the lower explosive limit (LEL), 5% methane by volume, at the property boundary of a landfill and must not exceed 100 parts per million (ppm) in off-site structures. A landfill gas management system is dynamic and affected by changes in the barometric pressure, pressure changes created by the development of landfill gas within the landfill, and the vacuum applied by the gas collection system. Because of the dynamic nature of the system, some fluctuations of both the pressure and methane readings at the probe stations are normal. It is from these fluctuations that the need for an adjustment to the gas system is identified. Changes in pressure alone do not trigger adjustments to the system, because they are generally temporary in nature and result from changes in the barometric pressure.

In recent years, leachate ponding has been identified at some extraction wells at the south end of the landfill. If ponded leachate covers the entire perforated interval of the extraction well, then the well will not be able to extract gas. The City historically pumped out gas extraction wells necessary to maintain capture on an as-needed basis. This pumping program was ended in 2008 since the City believed that the leachate collecting in the lower extraction well completions was not impacting their ability to control gas migration (City of Tacoma, 2008d).

An evaluation of the perimeter extraction wells was completed in 2008 to determine which wells were broken or damaged. Figure 3-5 presents the results of the 2008 inspection. Several wells were noted to be damaged; however, the City determined that the spatial coverage with functional wells is sufficient in these areas and these wells will not be replaced. In the northeast portion of the landfill, near Home Depot, several wells were suspected of having issues (PW-60, PW-61, and PW-62). Three extraction wells installed in 2006 (HD-A, HD-B, and HD-C) replaced much of the coverage for these wells, but in order in ensure complete capture of landfill gas, the City replaced wells PW-60 and PW-62. These wells were initially installed in 2010; however, due to installation mistakes the wells were decommissioned and re-installed in 2011.

Gas Monitoring Probes

The gas monitoring system includes 139 gas monitoring probe stations around the perimeter, off-site, and near the north-end gas system. The function of the perimeter landfill-gas monitoring-probe stations is to evaluate the effectiveness of the landfill-gas control system in controlling landfill-gas migration. The effectiveness of the system is indicated by the presence of a vacuum and absence or reduction of gas concentration in the soils surrounding the probes. Perimeter landfill-gas probe stations are tested once per week. If gas concentrations exceed the LEL for methane, the monitoring frequency for that probe is increased to daily until the readings drop below the LEL at which time weekly monitoring is resumed.

The function of the off-site probes is to ensure that landfill gas has not migrated off-site into the surrounding community. Off-site probes are monitored monthly. If significant gas concentrations (20% of LEL or greater than 1% by volume) are detected in the probe, the probe is monitored daily for 30 days. VOCs are not currently analyzed as part of the program.

Over the last several years, some probes have been damaged either by construction or by vandals, experienced problems evacuating, or experienced water problems. Due to these issues, the City completed an evaluation in 2008 of all probes to determine where problems were historically observed. Figure 3-6 shows the results of the evaluation. The City subsequently, in 2010, replaced two perimeter probes, PS-17 and PS-18 replaced with one probe, PS-34, to maintain the perimeter gas monitoring system. Since landfill-gas migration has decreased significantly over the years, the City requested that off-site probe monitoring locations be reduced to 29 and that the discontinued probes be decommissioned. EPA approved the request in August 2009 and the off-site probes were decommissioned between November 2011 and January 2012.

Off-Site Monitoring

As described in the 1999 Landfill Gas Management Plan, off-site businesses were to be monitored monthly, utility vaults in the area were to be monitored daily, and home monitoring was to be completed as needed. Due to the decrease in migration of landfill gas and lack of gas detections, these monitoring programs were discontinued in 2009. If gas probe data indicate a release from the landfill, these programs will be reinstated.

Flare Station

The flare station is operated under a permit issued by Puget Sound Clean Air Agency (PSCAA) and is monitored five days per week. Equipment is also inspected to ensure proper operation. The flare is required to be sampled every three years for air emissions.

Due to the decline in combustible gas volumes a new, smaller flare was constructed and became operational in 2010. This new system includes a new John Zinc flare, new blowers, and blower pad. The two older Sur-Lite flare were removed and eventually one of the Perennial flares will be removed. The remaining Perennial flare will be used as backup. Emissions testing at the new flare was completed in December 2010 and demonstrated compliance with PSCAA requirements.

3.4.5.4 Monitoring

Groundwater monitoring is conducted according to the 1996 Groundwater Monitoring Plan, which was updated in 2010. There are 98 groundwater monitoring wells at the site. Groundwater elevation and analytical data are collected at 76 wells, and groundwater elevation data only are collected at 22 wells. The well type, current purpose, and sampling frequency are shown on Figure 3-8. Background monitoring wells are sampled semi-annually or annually, all others are sampled quarterly. In 2008, the City and TPCHD completed a door to door survey of the residents with residential wells to verify their status. Most of residents were later notified that sampling would be discontinued in November 2009 due to a lack of

detected landfill constituents in their wells. A couple of exceptions were at EW-12 due to detections of vinyl chloride at low concentrations and at EW-13 due to detections of arsenic at concentrations above the MCL. Residential well EW-12 was decommissioned in 2010 after the residence was hooked up to Fircrest City Water and well EW-13 is the only residential well currently being sampled. A summary of the final residential well status as summarized from the 2008 survey is presented in Table 3-2 below.

Table 3-2. Residential Well Status

Well No.	Well Functional	Water Used for Drinking	City of Tacoma Sample History	2008 Survey Comments
EW-00	Yes	Yes	Aug 1991 – Nov 2009	In use
EW-01	—	No	Aug 1986 – Nov 1991	Unknown status
EW-02	No	No	Not sampled	No evidence that this well exists
EW-03	Decommissioned	No	Aug 1996 – Sept 1990	House demolished, no sign of well.
EW-04	No	No	Not Sampled, well dry	No one home, status not verified
EW-05	No	No	Aug 1986 – Aug 1995	Believed to be on City water
EW-06	No	No	Not sampled	No one home, status not verified
EW-07	Yes	Yes	Aug 1986 – Jun 1987	In use
EW-08	Yes	No	Mar 1985 – Oct 1988	Connected to City water, well used for irrigation.
EW-09	Decommissioned	No	Mar 1985 – Nov 2009	Not used, located on a low area of the lot susceptible to surface water runoff. Decommissioned 2010.
EW-10	Yes	Yes	Aug 1984 – Nov 2009	In use
EW-11	—	No	Mar 1985 – Oct 1988	Unknown status
EW-12	Decommissioned	No	Aug 1986 – May 2010	Well covered with bricks, in use at time of survey
EW-13	Yes	Yes	Aug 1986 – Present	Not observed
EW-14	No	No	Aug 1986 – Aug 2000	Not functional, well house overgrown
EW-15	Decommissioned	No	Aug 1986 – May 1992	Decommissioned
EW-16	Yes	Yes	Aug 1986 – Nov 2009	In use
EW-17	Decommissioned	No	Mar 1985 – Oct 1988	Decommissioned
EW-18	—	No	Mar 1985 – Aug 2003	Unknown status, but City water meter observed.
EW-19	Yes	Yes	Nov 1994 – Nov 2009	In use
EW-20	No	No	Nov 1994 – Nov 2006	Not functional
EW-21	Yes	Yes	Nov 1994 – Nov 2009	In use
EW-22	Yes	Yes	Nov 1994 – Dec 1995	Well used for drinking water, hookup from City of Fircrest used for irrigation.
EW-23	Decommissioned	No	Jun 1985	Decommissioned, connected to City water
EW-24	Yes	Yes	Feb 1994 – Nov 2009	In use
EW-25	Yes	No	Nov 1994 – Nov 2009	Connected to City water in 1989, unknown if used for irrigation
EW-26	Decommissioned	No	May 1988 – May 1990	New duplex on property, decommissioned Jun 1997
EW-27	Decommissioned	No	Nov 1994 – May 1988	Subdivision constructed over historical well location
EW-28	Yes	Yes	Nov 1994 – Nov 2009	In use
EW-29	—	No	Aug 1992	Unknown status
EW-30	Yes	No	Nov 1994 – May 2000	Used for irrigation

Well No.	Well Functional	Water Used for Drinking	City of Tacoma Sample History	2008 Survey Comments
EW-30R	Yes	Yes	Aug 2000 – Nov 2009	Installed in 2000 since other well not producing (EW-30)
EW-31	Decommissioned	No	May 1995 – May 1999	Subdivision constructed over historical well location
EW-32	Decommissioned	No	Mar 1996 – Nov 2003	Subdivision constructed over historical well location

Surface water sampling is detailed in the 1990 Surface Water Sampling and Analysis Plan for the Tacoma Landfill Remedial Design/Remedial Action. Surface water sampling at Leach Creek is conducted semi-annually to evaluate potential impacts to the creek. The Fircrest water supply well FW-05 was sampled monthly by the City of Tacoma until November 2009. At that time, the City met with Fircrest Public Works and decided that the City will sample FW-05 one every three years until 2019 and Fircrest Public Works will sample the well annually. The City continues to sample monitoring wells up-gradient of the Fircrest well field on a quarterly basis (TL-01, TL-02, and W-22).

Following the reduction in GETS pumping in 2010, a Rebound Monitoring Plan (Landau 2010) was developed to provide procedures for evaluating containment and actions to be taken if there is indication of loss of containment. For the purposes of the plan, containment was defined quantitatively in terms of groundwater quality measured at designated monitoring wells. Demonstration of containment was evaluated using statistical procedures to assure that there is not a significant increase in concentrations.

Sixty-four monitoring wells were evaluated using the following procedures developed in the Rebound Monitoring Plan. Results of the rebound analysis are reported annually.

1) Develop contingent action criteria using historical data based on methods described in EPA's Statistical Analysis of Groundwater Monitoring Data at Resource Conservation and Recovery Act (RCRA) Facilities Unified Guidance (EPA 530-R-09-007).

2) Compare post-shutdown sampling results to contingent action criteria.

3) If a contingent criterion was exceeded, re-sample to confirm the initial sampling results.

4) If an exceedance is confirmed, complete one of the three levels of response:

- Level 1 – Increase extraction rates of one of the remaining operational extraction wells or turn on an existing extraction well.
- Level 2 – Install additional extraction wells.
- Level 3 – Add active or passive remediation actions that do not include groundwater extraction and treatment.

As part of the update to the Groundwater Monitoring Plan in 2010, the analyte list was reduced to those VOCs that are useful for evaluating rebound. Ethylbenzene, methylene chloride, toluene, and total xylenes were removed from the analyte list. Landfill-indicators parameters COD, nitrate+nitrite, ammonia, sulfide, and sulfate were also removed from the analyte list. These were historically used to

evaluate redox conditions in the aquifer and long-term changes in groundwater quality. The current analyte list is presented in Figure 3-9.

3.4.5.5 Summary of Costs of System Operations/O&M Effectiveness

No operations and maintenance costs were available for the Tacoma Landfill OU.

3.5. Progress Since the Last Five-Year Review

3.5.1. Protectiveness statements from last review

The protectiveness statement in the last Five-Year Review (2008) stated:

> *A protectiveness determination of the remedy at the Tacoma Landfill cannot be made at this time until further information is obtained. An evaluation of impacts from the remaining groundwater plumes to Leach Creek and migration west of the creek is required. Surface water and GETS effluent discharge data need to be evaluated against more current surface water criteria and reporting limits should be lowered as applicable. Concentrations of COCs in two residential wells not connected to municipal water supply exceed the performance criteria. Pending a site visit to determine status of these wells, additional actions may be required at these homes. Finally, additional evaluations on the effects of elevated arsenic concentrations on human health and the groundwater to indoor air pathway are required. It is expected that these actions will take one year to complete, at which time a protectiveness determination can be made (between August and December 2009). Details of project completion dates are presented in Table 3-3.*

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

Recommendation 1: Continue to monitor gas probes at Home Depot for another year to evaluate effectiveness of extraction wells in reducing gas concentrations.

Status: Completed. Monitoring continues at the gas probes adjacent to Home Depot. Gas extraction wells PW-60 and PW-62, located near the Home Depot were replaced in 2011 to ensure full capture of landfill gas in this area.

Recommendation 2: Determine which landfill gas probes are critical for monitoring and replace/repair broken gas probes, as required.

Status: Completed. An evaluation of the gas monitoring probes and perimeter gas extraction wells was completed in 2008 and recommendations were provided in a memorandum (City of Tacoma, 2009f). Two damaged probes were replaced and 23 off-site probes were decommissioned due to no measurable gas concentrations in the last 10 years.

Recommendation 3: EPA/Ecology to determine if SPS-13 is critical for monitoring and provide recommendation for abandonment to the City.

Status: Completed. Gas probe SPS-13 had low detections of gas over the last 10 years, but was not critical for monitoring gas migration from the landfill. Adequate gas monitoring stations are located at the perimeter of the landfill to detect gas migration from the landfill. EPA/Ecology approved the request to decommission SPS-13. After further inspection, it was determined that the SPS-13 monitoring location has two separate vaults. One contained landfill gas monitoring probes and one contained a landfill-gas monitoring probe and groundwater monitoring well. The one containing only landfill-gas monitoring probes was decommissioned; the other remains operational due to the presence of the groundwater monitoring well.

Recommendation 4: Develop sampling approach for additional surface water and groundwater data for the vinyl chloride and 1,2- DCA plumes near point of discharge (Leach Creek) and west of the Creek (see above text for recommended requirements). Conduct sampling, as required.

Status: Completed. The City hired a consultant, Floyd|Snider, to evaluate the sampling approach near Leach Creek. Floyd|Snider evaluated what standards were appropriate to monitor (e.g. pH, dissolved oxygen, etc.) and the hydrogeology of the Leach Creek basin. They determined that the current sampling program is sufficient to monitor potential comtaminant migration of the residual vinyl chloride and 1,2-DCA plumes in the Leach Creek area.

Recommendation 5: Reduce reporting limits for surface water and effluent samples to below the new surface water quality criteria.

Status: Completed. In the process of working with EPA and Ecology on technical issues raised in the Third Five-Year Review, the City's laboratory attempted to decrease their reporting limit and their method detection limit to at or below 0.02 microgram per liter (µg/L). A careful review of their performance over the past year indicated that the laboratory was able to consistently quantify vinyl chloride in clean water to 0.2 µg/L. However, as they reached for lower detection limits of 0.02 to 0.03 µg/L, a chronic background level of vinyl chloride was detected in field samples, blanks, and lab control samples. It is not completely clear whether the background levels of 0.02 to 0.03 µg/L represent low levels of contamination throughout the process or signal-to-noise issues at the low levels. Since selective ion monitoring is needed to obtain these low detection limits, it is difficult to tease these two limiting factors apart. Based on this, the City recommended to EPA and Ecology that the laboratory uses a reporting level of 0.2 µg/L for aqueous samples from the Tacoma Landfill. EPA and Ecology agreed verbally to this request. This information was documented in a February 2009 technical memorandum (Floyd|Snider, 2009a).

Recommendation 6: Evaluate GETS effluent at point of discharge and surface water samples against newer surface water criteria, including WAC 173-201 and human health criteria, to determine if modifications to discharge and/or sampling are required. Modifications to the decision document may be required.

Status: Completed. After reviewing the water-use regulations for waters affected by discharges from the Tacoma Landfill, the City presented the Leach Creek closure information to EPA and Ecology and requested that the standard for vinyl chloride remain at 2.0 µg/L—in compliance with the MCL (a default

groundwater standard under Superfund) and the non-drinking water National Recommended Water Quality Criteria (NRWQC). The EPA and Ecology verbally concurred with the recommendation but asked for the appropriate documentation for their files. A February 2009 technical memorandum was developed to summarize the issue (Floyd|Snider, 2009a). Because the proposed 0.025 µg/L water quality standard for vinyl chloride was determined to not be appropriate for Leach Creek, the GETS standard remains at 2.0 µg/L. No changes to the system were required and no changes to the sampling and analysis program at the Tacoma Landfill were needed.

Recommendation 7: Verify status of residential wells – to be conducted by the City in coordination with Tacoma Pierce County Health Department.

Status: Completed. The City of Tacoma and TPCHD completed a door to door survey to verify the status of residential wells in 2008 to determine which wells were or were no longer in use. With the EPA and Ecology concurrence, the City notified residences with private wells where data indicate that there have been no landfill impacts that their well will no longer be sampled after November 2009.

Recommendation 8: Address exceedances of vinyl chloride and arsenic at well EW-12 and arsenic at well EW-10 pending determinations of well-use status. If in use, determine need to connect residences to municipal drinking water.

Status: Completed. Vinyl chloride concentrations were detected at low concentrations in well EW-12; all have been below the MCL. Well EW-12 is located across Leach Creek near the residual vinyl chloride plume. EOP extraction well W-36 is located nearby, although it is screened at a lower depth than EW-12. EPA and Ecology strongly recommended that the residence be put on the public water supply to remove any potential exposure pathways. In 2010, the City connected the residence to Fircrest Water and decommissioned the well.

The 2009 arsenic evaluation (Floyd|Snider, 2009c) determined that the residential wells with arsenic concentrations above 10 µg/L were located outside the groundwater plume boundary and that these wells were not impacted by historical contaminant releases from the landfill. In addition, it was determined that the new 10 µg/L arsenic MCL is not applicable to private drinking water wells and is not applicable as a cleanup level in areas where it is less than background. Sampling at well EW-10 was discontinued in November 2009.

Recommendation 9: Determine if arsenic is site-related or if reducing conditions from the Landfill are causing mobilization. Evaluate effects of elevated arsenic on the human health pathway.

Status: Completed. An evaluation of arsenic was completed in 2009 (Floyd|Snider, 2009c). Long-term groundwater monitoring results show arsenic concentrations were and remain less than 10 µg/L in most down-gradient monitoring wells. The generally low arsenic concentrations in the down-gradient wells reflect natural conditions and suggest that landfill leachate has not significantly impacted groundwater geochemistry in this area. This indicates the redox conditions which caused arsenic dissolution from aquifer soils, prior to cap installation, were mainly limited to the Landfill Boundary Area. Arsenic halos with limited areal extent around landfills are well documented. Slightly elevated groundwater arsenic

concentrations in monitoring wells to the southwest of the landfill and near Leach Creek resulted from organic-rich wetland soils and/or well completions in oxygen-poor deeper aquifers. Groundwater in these areas was not impacted by migration of landfill leachate.

Recommendation 10: Complete a groundwater model to evaluate the effects of increased pumping of City wells.

Status: Completed. At the time of the last FYR, the City of Tacoma was expecting to increase their use of production wells with full use of the City's water rights within about 25 years. Since then, a second water supply line from the Green River was activated and additional capacity was added to Howard Hanson Dam leading to a decrease in well production. Well production rates are anticipated to remain below average for the next several years. Additional predictive groundwater model simulations were completed to evaluate the impact of increased pumping, if required. The models indicate that the groundwater divide would likely shift beneath the southeast boundary of the Tacoma Landfill under the City's current production rates with the EOP and POC wells removed and that progressively higher production rates would shift the divide further westward towards Leach Creek (City of Tacoma, 2008c). This would cause any remaining groundwater contamination from the landfill to flow toward the east, rather than toward the west as it currently flows.

Recommendation 11: Evaluate the potential for a completed groundwater to indoor air pathway.

Status: Completed. To determine if a potential risk exists for vapor intrusion to impact indoor air quality, the Johnson and Ettinger (J&E) Model was used as a screening tool to determine if vinyl chloride and 1,2- DCA were present in high enough concentrations to cause a potential vapor intrusion risk. Results indicate that the residual off-site concentrations do not pose a risk to residents in the area. This analysis and results were documented in a technical memorandum by Floyd|Snider in 2009 (Floyd|Snider, 2009b). Depending on the accuracy of the City's survey of the types of building foundations and location relative to the residual contaminant plumes, the EPA and Ecology concurred that there was very little risk of vapor intrusion.

Recommendation 12: EPA/Ecology to provide recommendations for modifications to extraction well operation and well sampling.

Status: Completed. EPA/Ecology approved the City's request to shut down most of the GETS extraction wells on February 11, 2010. The approval was contingent on the following conditions: development of a statistical approach to determine if rebound has occurred; compilation of a full inventory and status update of groundwater monitoring wells and extraction wells; and development of data quality objectives for each contaminant, development of contingent action criteria, modifications to the sampling program, and submittal of quarterly monitoring data. The City shut down all of the extraction wells in March 2010, except W-1, W-2, W-4, W-14, and W-15 which remain in operation. The City also submitted a Rebound Monitoring Plan in 2010 (Landau 2010) that described the statistical methods for evaluation rebound.

Recommendation 13: EPA/Ecology to approve the Final Closure Plan. Request due from the City no later than on January 31, 2009 (based on 2/24/05 authorization of the second Closure Extension).

Status: Completed. The Third Five-Year Closure Extension was submitted to EPA and Ecology on February 27, 2009. An amendment to the report was submitted on June 8, 2009. EPA conditionally approved the extension on December 21, 2009 (modifications approved on July 28, 2010) with the following provisions: bring the southern half of the Central Area to partial closure by 2011 and the northern portion by 2012; continue Central Area flow metering for leachate and precipitation; comply with all terms of the annual Solid Waste Permit; update the Groundwater Management Plan; update the Landfill's IC Plan and Land Use Plan; and close the Central Area no later than December 31, 2013.

3.6. Five-Year Review Process

3.6.1. Administrative Components

The City of Tacoma was notified of the initiation of the Five-Year Review in January 2013. The Five-Year Review team was led by Kris Flint of EPA, Remedial Project Manager, and included Kristen Kerns (Physical Scientist) and Sharon Gelinas (Hydrogeologist) of the USACE Seattle District.

From January to June 2013, the review team established the review schedule whose components included:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection;
- Local Interviews; and
- Five-Year Review Report Development and Review.

3.6.2. Community Involvement

Activities to involve the community in the FYR included a notice to run in the Tacoma News Tribune local newspaper on April 25, 2013 that a FYR was to be conducted. No comments have been received by the community on this review.

A Fact Sheet was prepared describing the City's Third Five Year Closure Extension Request. EPA made the request available for public comment from October 26 through November 25, 2009. No comments were received.

3.6.3. Document review

This FYR included a review of relevant, site related documents including groundwater monitoring data, gas extraction data, annual inspection reports, and applicable cleanup standards as listed in the 1988 ROD and Consent Decree. A complete list of the documents reviewed can be found in Appendix A.

3.6.4. Data Review

3.6.4.1 GETS Effluent Monitoring

The City collects quarterly effluent samples from the GETS at several locations prior to discharge to Leach Creek to verify that discharge criteria are being met. Historically, samples were collected from the catch basin, which was the last sampling point before effluent leaves the site; however, construction of a storm water pond in the northwest corner of the site required this location to be moved. The GETS outfall is also sampled which is the last sampling point before entry into Leach Creek. Since effluent is discharged to Leach Creek, the ROD states that the effluent must meet the MCL or chronic fresh water criteria, whichever is more stringent. Concentrations of VOCs (tetrachloroethene [PCE], trichloroethene [TCE], total 1,2-dichloroethene [DCE], and vinyl chloride) in the GETS effluent increased slightly after the majority of the extraction wells were shut down in 2010 because there was less dilution; however, all concentrations have been below ROD-specified criteria.

3.6.4.2 Landfill Gas Monitoring

A Home Depot store was constructed adjacent to and north of the landfill in 2000. At that time several soil gas probes were replaced. One of the newly constructed gas monitoring wells located in the Home Depot parking lot had detections of methane gas in excess of the LEL. The Home Depot store was reportedly constructed on old fill material not related to the Tacoma Landfill. Investigations by the City and TPCHD confirmed elevated levels of methane gas on the Home Depot property; however, the early investigations did not determine whether the methane was coming from the Landfill or the fill material that underlies the site. One sampling event conducted by the City inside the Home Depot building indicated that methane gas was either not detected or detected at levels well below standards. Even though the origin of the methane at Home Depot was not established, the City of Tacoma agreed to take actions to reduce the potential for landfill gas to migrate to the Home Depot property.

Concentrations of methane in excess of the LEL continue to be detected at gas monitoring probes HD and HD-A, located on the Home Depot property to the north of the Landfill. Probe HD has the most consistent detections of methane in the red (shallow level) and yellow (mid level) completions at concentrations ranging from 0 up to 25 percent methane by volume. In 2011, gas extraction wells PW-60 and PW-62 were replaced to ensure capture is maintained in the north end of the landfill. Since these wells were replaced, methane detections have gone down. During the second half of 2012, concentrations of methane at HD-A were mostly zero and concentrations at HD had gone down, although there were still exceedances of the LEL for more than 5 consecutive days. Optimization of gas extraction in this area should continue until concentrations remain below the LEL.

Sporadic detections of methane above the LEL have been detected at perimeter monitoring probes. These types of detections are typically a result of normal system fluctuations. With the exception of probe SPS-17A, there were no methane detections in exceedance of the LEL in off-site probes. SPS-17A had methane readings in excess of the LEL for more than five consecutive days during the first half of 2008; concentrations have remained below the LEL since that time.

Several probes continue to have problems with evacuation during sampling. This can be caused by flooding in the area of the probe station or by individual probes being constructed through saturated soil zones. Probes that continually had evacuation problems or were damaged were evaluated by the City in 2008. Two of the damaged probes were identified to be in critical monitoring areas and were replaced. The remainder had no action proposed and continue to have evacuation problems. It is recommended that the City continue to periodically evaluate gas probe conditions in critical areas, such as near the Orchard Terrace apartments that were constructed adjacent to the landfill.

3.6.4.3 Landfill Cover Monitoring

The annual inspections of physical cap integrity from 2008 to 2012 found the asphalt cap and landfill cap to be in generally good condition. The asphalt cap meets the minimum permeability requirements, as determined through annual pan-lysimeter observations. Several cracks and abrasions were noted on the cap, all superficial in nature, and were either repaired or monitored depending on the severity. Subsidence has been observed in several areas and repaired as needed. The retaining wall around the transfer station was checked on a daily basis and measurements were taken at each joint on a monthly basis to monitor for movement. No significant changes in expansion joints were observed from previous years.

The landfill cap previously had several areas of sparse protective vegetation. Those areas were slowly reseeded by adjacent vegetation. Affected areas are hydroseeded if erosion is observed. The perennial noxious weed Scotch Broom was present on the landfill and subsequently removed and sprayed to control future growth. Subsidence of the landfill cap was observed in several areas, but does not exceed the allowable strain limit of one percent. Ponding on the landfill cap was observed during the winter after periods of heavy rain, particularly at the southern and northeastern areas. In the 2010, 2011, and 2012 annual reports, ponding was also observed in other areas of the landfill cap. Ponded water is either pumped off the cap or evaporated within a few days. Since ponding and subsidence on the landfill cap continues to be an ongoing issue, it is recommended that areas with significant water ponding be regraded and the 1992 Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System be updated to include procedures or criteria for cap repairs to control this problem.

Leachate and precipitation runoff data collected indicated that the Central Area linear and leachate collection and detection systems performed in accordance with design expections. Annual analytical monitoring data for leachate and condensate was also reviewed. Monitoring results showed that concentrations exceeded the ROD performance levels for 1,2-DCA, arsenic, and methylene chloride for the condensate and combined effluent. Since all condensate is processed by the City's wastewater treatment system before being discharged, these exceedances do not impact the protectiveness of the remedy at the site.

3.6.4.4 Groundwater Monitoring

Concentrations of COCs in groundwater have been decreasing over time. Groundwater monitoring data over the last five years were reviewed and compared to the ROD-specified groundwater criteria. Exceedances of the ROD criteria over the last five years were limited to the following constituents at the

following wells: PCE at TL-11A and W-03; TCE and 1,2-DCA at TL-04 and TL-26A; TCE at TL-11A and W-03; and vinyl chloride at W-15, W-16, and W-36. In 2012 only TL-11A had any exceedances of the performance levels required by the ROD: PCE at 8.4 µg/L in November 2012 and TCE at 12 µg/L in November 2012. Well TL-11A is located near the southwestern corner of the landfill where extraction wells W-1, W-2, and W-4 remain in operation.

Historically, two lobes of the groundwater plume existed at the site: the north area vinyl chloride plume and the south area 1,2-DCA plume. The north area plume was defined by wells W-15, TL-10A, TL-7A, and W-36. Concentrations of vinyl chloride at these wells are currently below the ROD performance standard of 2 µg/L. The south area plume was defined by wells W-1 through W-5, TL-11A, TL-26A, TL-9A, and PW-3/4. Concentrations of 1,2-DCA at these wells are currently below the ROD performance standard of 5 µg/L. Extraction wells W-1, W-2, and W-4 in the south area and W-15 and W-16 in the north area remain in operation to ensure that contamination associated with these historical plumes is controlled.

3.6.4.5 Rebound Monitoring

The rebound monitoring plan was designed to evaluate containment following shutdown of the majority of the extraction wells at the Tacoma Landfill. The plan contains contingent action criteria for each extraction/monitoring well for the nine primary contaminants: 1,1,1-trichloroethane (TCA); 1,1-DCA; 1,2-DCA; total 1,2-DCE; benzene; chloroethane; PCE; TCE; and vinyl chloride. This is a reduced COC list to focus on those VOCs that are useful for evaluating rebound. The contingent action criteria were based on historical data collected prior to the shutdown. Three methods were developed based on the number of detections within the historical dataset:

- If historical data are 100% non-detections, the contingent action criterion will be set at the historical detection limit. If an analyte was not detected in the 2 years prior to the development of criteria, the historical data set was considered to be 100% non-detect.
- If the historical data are more than 50% non-detections, the contingent action criterion will be calculated using a non-parametric prediction limit, which is typically set at the maximum value of the historical data set for a confidence level of 90 to 99%. Prior to calculation of the maximum value, the dataset was tested for outliers, which were then removed.
- If the historical data are less than or equal to 50% non-detections, the contingent action criterion will be calculated using a Shewhart-CUSUM control chart.

An exceedance of a contingent action criteria may indicate a lack of containment and requires implementation of procedures outlined in the Rebound Monitoring Plan. These procedures include include resampling for verification and contingent actions. In Appendix 3-E, Table E-1 presents the contingent action criteria exceedances for samples collected between Q2 2010 and Q4 2012, after the majority of the GETS wells were shut down. The data show that there have been numerous exceedances of the rebound criteria since the GETS was shutdown, indicating that there has been a shift in concentration levels. However, many of these exceedances are considered “minor,” such as a slight exceedance of a criteria that was developed based on the reporting limit. According to the rebound monitoring plan, an exceedance of the contingent action criterion required re-sampling and then a

response if the exceedance was verified. There was no indication of re-sampling or response actions in any of the documents reviewed.

In order to determine the significance of these contingent action criteria exceedances, a brief data exploration was completed. Those wells that had an exceedance were analyzed for trend using the Mann-Kendall test for trend. The results of the analysis are presented in Appendix 3-E, Table E-2. The data show that wells PW-01, W-11, and W-16 had a "probably increasing" trend; however, concentrations were well below the ROD performance level of 5 µg/L, ranging from 0.5 to 2 µg/L. A review of the time versus data plots for those wells with exceedances of the contingent action criteria show an increase in concentrations of PCE, TCE, 1,1-DCA, and vinyl chloride in August and November 2011, but concentrations have since decreased (see graphs in Appendix E). This brief data exploration indicates that there has not been a significant loss of containment at the site.

The evaluation of groundwater data using the methodology presented in the Rebound Monitoring Plan does not appear to provide the information necessary for regulators and project personnel to make decisions on containment. Numerous exceedances of the contingent action criteria could mask issues that arise following the shutdown of most of the GETS wells. It is recommended that the Rebound Monitoring Plan be revised to include a statistical methodology appropriate to determine containment at the site. The approved revised plan should be in place prior to shutdown of any additional GETS wells.

3.6.4.6 Surface Water Monitoring

Surface water samples from Leach Creek are collected semi-annually. Samples are collected just below the holding basin at the head of Leach Creek (LC-01), at the southern end of the historical groundwater plume near 48th St (LC-02), the furthest downstream location at 56 th St (LC-03), and near the residual, northern vinyl chloride plume, down-gradient of well TL-07A (LC-04). Figure 3-3. Tacoma Landfill extraction and monitoring wells.Figure 3-3. Tacoma Landfill extraction and monitoring wells. shows the locations of LC-01 and LC-02; LC-03 and LC-04 are not depicted.

Most VOC concentrations in surface water samples were non-detect or below ROD criteria during the last five years. Methylene chloride was the only VOC detected at levels above ROD-specified criteria. Exceedance of ROD criteria for methylene chloride occurred in February of 2011 at locations LC-02, LC-03, and LC-04 with concentrations of 5.7, 5.5, and 5.1 µg/L, respectively. Methylene chloride is a common lab contaminant and may not be indicative of contaminant migration from the landfill. LC-01 had a detection of 4 µg/L in February 2011, which was below the ROD criteria of 5.0 µg/L. Toluene was detected at all four sampling locations in February 2011 at low concentrations, ranging from 1 to 1.3 µg/L, where historically it had been non-detect. Since toluene is no longer analyzed, per the 2010 Groundwater Monitoring Plan update, these detections cannot be verified. Revisions to the analyte list in the 2010 Groundwater Monitoring Plan were proposed to support the efficient review of rebound monitoring data. Since Leach Creek is a discharge point for groundwater, compliance monitoring should include all COCs listed in the ROD.

3.6.5. Site Inspection

The following text describes the trip report for the site visit conducted on April 2, 2013. The site inspection checklist and photos associated with the site visit can be found in Appendices B and C, respectively.

Sharon Gelinas (USACE), Kris Flint (EPA PRM), and Calvin Taylor (City of Tacoma) attended the site visit. Calvin Taylor provided transportation and tour of the site. The tour began at the northern cap area at the location of the former greenhouse pre-load project. This area provided an excellent view of the new recycling center, with individual bays and a hazardous waste recycling area, and maintenance center. Mr. Taylor stated that grade elevation was raised during construction of the maintenance center and several small areas of the cap were repaired. The northern settlement basin and mothballed groundwater treatment plant were also observed.

The tour proceeded to the newly capped Central Area. One section still needs to have vegetation placed, which will be completed this year. All vegetation planted last year appeared in good condition as well as the gas probes and gas extraction wells. Mr. Taylor stated that the City will be monitoring settlement of this area using survey points. Mr. Taylor also noted that all the brass valves on the gas wells were stolen and were replaced with plastic to avoid future vandalism.

The southern cap area was then toured. Settlement is evident in this area as observed by the piping extensions and elevated roadway. Mr. Taylor noted that there are areas where ponding occurs, which the City pumps out to the sanitary sewer on an as-needed basis. The remaining extraction wells in operation (EW-1, EW-2, and EW-4) in the southern area were observed and appeared to be in good condition.

Several other areas were observed toward the end of the tour: the new gas extraction wells at the northern edge of the site near the Home Depot property, the transfer station, the flare (recently updgraded), and the location of the manholes where leachate is monitored and pumped out to the sanitary sewer.

The tour then proceeded off-site. The gauging station on Leach Creek was observed as well as some of the monitoring wells and extraction wells (currently shut down) located off-site. Off-site area land use remains residential, with areas of higher-density residences.

3.6.6. Interviews

Dave Bosch with Tacoma Pierce County Health Department and Chris Maurer with Department of Ecology were interviewed as part of this five year review process. Both of the interviewees generally believed that operations and monitoring at the site was going well and that no significant issues have been encountered in the past five years. A more detailed summary of questions and responses from each of the interviewees is provided in Appendix 3-D.

3.6.7. Institutional Controls

An implementation plan for ICs for Tacoma Landfill was completed in November 2010. The plan fulfills the requirement under the ROD and Consent Decree to establish and implement ICs to ensure that the integrity of the remedial actions undertaken at the landfill are maintained in order to provide short- and long-term protection of human health and the environment. A revised plan was submitted on July 30, 2013, which EPA subsequently approved. The City has also developed a long-range plan for site use after

closure of the Central Area cell as documented in the 1998 Land Use Plan. The long-range plan includes continued use of a portion of the site for solid waste transfer activities and recreational use of the rest of the site when no longer needed for remediation activities.

A summary of each IC and its status is provided in Table 3-3 below.

Table 3-3. Institutional Controls Summary and Status

Institutional Control	Purpose	Action Summary	Party Responsible for Action	Enforcing Party	Timing	Status
1	Place a notice on any deed, title, or other instrument of conveyance relating to the Tacoma Landfill indicating that the site is subject to a Consent Decree. The notice must include a reference to and a description of the Consent Decree, as well as a statement that the Landfill has been used to manage hazardous substances, some of which remain under the cap. The notice must also include a statement that land use is restricted and that any actions that disturb the cap or the containment system, including the monitoring system, will not be allowed unless the Environmental Protection Agency and the Department of Ecology find that such disturbance does not increase the potential hazard to human health and the environment, or is necessary to reduce a threat to human health and the environment. An assurance will be provided in the notice that the restrictions and obligations set forth in the Consent Decree will be binding upon persons who acquire any interest in the Tacoma Landfill property.	Record a Restrictive Covenant with the Pierce County Auditor's office on the title for the Tacoma Landfill site to ensure that remedial actions are not damaged by Site activities and to notify future owners of the Consent Decree restrictions for use of the property. Include the above provisions in any notice of conveyance relating to the Tacoma Landfill property as well as language requiring compliance with applicable institutional controls.	City of Tacoma Solid Waste Division staff in coordination with the City's Real Property Services Section of the Facilities Management Division, and the Legal Department.	EPA and Ecology	Restrictive Covenant complete -filed November 11, 2001. Notice provisions will be provided whenever any portion of the Site is transferred via sale or lease to another party.	Complete and ongoing
2	In accordance with Sections 4 and 5 of the Restrictive Covenant for the Site, the City will provide advance notice to the Environmental Protection Agency and Department of Ecology whenever the City sells or leases any portion of the Tacoma Landfill to a third party. The notice must also indicate whether any of the City's obligations will be performed by the third party acquiring the real property.	Provide sixty (60)days advance notice to EPA and Ecology whenever the City sells or leases any portion of the Tacoma Landfill to a third party.	City of Tacoma Solid Waste Division staff in coordination with the City's Legal Department.	EPA and Ecology	In accordance with the Restrictive Covenant the City will provide sixty (60) day notice to EPA and Ecology prior to selling or leasing any interest in the Property.	Complete and ongoing
3	Place restrictions on the use of groundwater at the property, including a prohibition against pumping groundwater in affected aquifers unless it's done to monitor groundwater contamination and/or the effectiveness of the remedial action at the landfill.	a. Public Water System Coordination Act gives exclusive franchise to Tacoma Water and the Fircrest Water Utility in the vicinity of the site. Unless either purveyor denies services, no new public water systems can be installed. A new public water system would need to be approved by the Department of Health (DOH) or TPCHD.	No action required. Regulations in place.	DOH or TPCHD	Not applicable. Regulations already in place.	Complete
		b. Since the area near the site is within the Urban Growth Area, no new or replacement private wells could be installed without the public drinking water provider (Tacoma Water or the Fircrest Water Utility) denying service and TPCHD approving the well location.	No action required. Regulations in place.	TPCHD	Not applicable. Regulations already in place.	Complete
		c. Ordinances in place in the cities of Tacoma, Fircrest, and University Place restrict well installations near the Site.	No action required. Ordinances in place.	City of Tacoma	Not applicable. Ordinances already in place.	Complete
		d. A one-time notification to well drilling companies and utility locating services will be provided as part of an overall public notice related to the final Institutional Controls Plan.	City of Tacoma Solid Waste Division.	EPA and Ecology	One-time notification to occur within 3 months following approval of this Plan.	Not complete; notification expected in 2013
4	Use best efforts to implement institutional controls on site properties outside the City's jurisdiction including the recording of notices, plot plans, and other similar documents and providing notice of the institutional controls to other affected local zoning authorities or other affected governmental entities.	a. Provide a copy of the IC Plan to the City's Building and Land Use Services (BLUS) Division along with training to permit staff. A layer will be added to the City's govME website showing the location of the restrictions. This website is used by both the City permit staff and by the public.	City of Tacoma Solid Waste Division in coordination with the City's BLUS Division.	City of Tacoma BLUS Division	6 months following approval of this plan.	Not Complete; delivery of final IC plan expected in 2013
		b. Provide copies of the City's IC Plan and maps showing the location of the restrictions to the cities of Fircrest and University Place.	City of Tacoma Solid Waste Division.	Cities of Fircrest and University Place	3 months following approval of this plan.	Complete

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3.7. Technical Assessment

3.7.1. Question A: Is the remedy functioning as intended by the decision documents?

Yes. The GETS has effectively managed contaminant migration and most of the extraction wells have met the ROD performance levels and have been shut down. Only five extraction wells remain in operation in areas of the historical north and south residual plumes. The landfill gas extraction system is controlling migration of landfill gas. Elevated methane concentrations are still present near the north end of the landfill and the Home Depot property; however, new gas extraction wells have been installed in this area and operation is being optimized to reduce concentrations. Final closure of the Central Area will be completed by December 31, 2013, and will complete source control measures at the site. ICs are in place to assure that the remedial action will continue to protect human health and the environment.

Remedial Action Performance

The majority of the GETS extraction wells were shut down in March 2010. Extraction wells W-1, W-2 and W-4 near the historical south plume and W-15 and W-16 near the historical north plume remain in operation. Monitoring of all residential wells, except EW-13, was discontinued in 2009/2010 since data indicated that there were no impacts from the landfill. Rebound monitoring data indicate that there was a slight increase in concentrations in 2011, but concentrations have since decreased. In 2012, PCE and TCE at TL-11A were the only constituents that exceeded the ROD performance levels.

The landfill-gas system continues to control migration of landfill gas. Sporadic detections of methane concentrations above the LEL were observed at the perimeter monitoring probes; however, this is typical of normal system fluctuations. Concentrations of methane in excess of the LEL remain near the Home Depot property at the north end of the Landfill.

The final closure extension for the Central Area was approved by the EPA and Ecology in 2009. The Central Area has been filled to grade and the final cover will be complete by December 31, 2013.

System Operations/O&M

Extraction wells in operation are regularly monitored for pumping rates and water elevations. Extraction rates continue to gradually decline over time due to iron bacteria precipitation in the wells. The City periodically rehabilitates the wells using the carbon dioxide freezing method. Extraction well W-1 was replaced in 2009 due to ongoing maintenance problems. GETS effluent, which is discharged to the Leach Creek holding basin, continues to meet discharge criteria.

An evaluation of evacuation problems or damage at landfill gas extraction wells and monitoring probes was completed in 2008. Two extraction wells, PW-60 and PW-62, which were not fully operational were replaced in 2011 to ensure capture of landfill gas in the northern area near the Home Depot property. Methane concentrations have been reduced since their replacement; however, there are still periods of elevated methane concentrations. The evaluation of perimeter and off-site monitoring probes resulted in

the replacement of two perimeter monitoring probes and decommissioning of 23 off-site probes due to no measurable gas concentrations in the last 10 years.

Monitoring of the landfill cap and the asphalt cap is regularly completed. Subsidence of the landfill cap has occurred, but has not exceeded the allowable strain limit. Water frequently ponds on the cap after heavy winter rains and is either pumped off the by cap or allowed to evaporate. Leachate and precipitation flow data at the Central Area continue to be monitored and reported monthly to ensure that the there is no significant loss of water from the Central Area; however, there have been numerous issues with the meter and data logger installed in the leachate collection manhole due to the harsh physical environment.

Opportunities for Optimization

Methane concentrations above the LEL continue to be detected near the Home Depot property at the northern end of the landfill. Operation optimization of the gas extraction wells in this area should continue in order to reduce/control gas migration.

Final closure of the Central Area will be complete in 2013. Following this event, the Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System and the Leachate and Condensate Management Plans should be updated to reflect the current site conditions. Items to consider in the revision include procedures or criteria for repair of ponding problems and evaluation of the leachate and precipitation runoff monitoring requirements.

Following the reduction in GETS extraction, a Rebound Monitoring Plan was developed to provide procedures for evaluating containment and actions to be taken if there is indication of loss of containment. An evaluation of these procedures, using groundwater data collected following the shutdown, indicate the that the statistical methodology developed may be too restrictive and may mask potential containment problems. In addition, the contingent response action procedures described in the plan have not been followed. It should be noted, that although response action procedures were not followed, the exceedences identified were minor and do not indicate significant occurrence of rebound. The Rebound Monitoring Plan should be revised to include a statistical methodology appropriate for site conditions. This plan should be approved and in place prior to shutdown of any additional GETS wells.

The 2010 Groundwater Monitoring Plan reduced the analyte list for all sampling locations to those that would be useful for evaluating rebound. While this may be appropriate for most of the groundwater monitoring location, it may not be applicable to compliance monitoring locations, such as Leach Creek surface water samples and GETS effluent samples, where the full list of ROD-established COCs should be analyzed. The analyte lists for all samples should be reviewed and revised as necessary.

Implementation of Institutional Controls

A revised IC plan was approved by EPA in July 2013. ICs currently in place include: a restrictive covenant filed on November 11, 2001, to ensure that the remedial actions are not damaged by site activities and to notify future owners of the Consent Decree restrictions; restrictions on use of the groundwater at the site through the Public Water System Coordination Act that gives exclusive franchise

to Tacoma Water and Fircrest Water; city ordinances; and use of best efforts to provide notice of IC plan and restrictions to properties outside the City's jurisdiction.

Early Indicators of Potential Issues

There are no indicators of potential issues.

3.7.2. 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?

Yes. Despite updates to several toxicity parameters for multiple chemicals, the performance levels still meet an acceptable level of risk at the site.

Changes in Standards and TBCs

A review was done to identify any changes in standards that were identified as applicable or relevant and appropriate requirements (ARARs) in the ROD; newly promulgated standards including revised chemical-specific requirements (such as MCLs); revised action- and location-specific requirements; and State standards and to-be-considered criteria (TBCs) identified in the ROD that bear on the protectiveness of the remedy. Any such changes were then evaluated to establish whether the new requirement indicates that the remedy is no longer protective. A summary table is presented in Table 3-4. Generally, the standards and toxicological values used at the time of remedy selection have remained unchanged except that the MCL for arsenic and several reference dose (RfD) values for groundwater and surface water constituents have changed.

When the 1988 ROD was issued the arsenic MCL was 50 µg/L; in 2002, it was reduced to 10 µg/L. Residences with drinking water wells that were impacted by contamination from the Landfill have been connected to the municipal water. For the homes where residents reportedly drink municipal water, the change in standard has no impact on protectiveness.

The MCL for TCE was 5 µg/L when the ROD was issued in 1988 and remains unchanged. Since that time, the toxicity factor used to estimate the excess cancer risk associated with exposure to TCE has been revised. In September 2011, EPA completed a review of the TCE toxicity literature and posted on Integrated Risk Information System (IRIS) both cancer and non-cancer toxicity values which resulted in lower risk screening levels (RSLs; previously called preliminary remediation goals [PRGs]) for TCE. The screening level for chronic exposure for cancer excess risk level of $1x10^{-6}$ is 0.44 µg/L. EPA uses an excess cancer risk range between 10^{-4} and 10^{-6} for assessing potential exposures, which means a TCE concentration between 0.44 and 44 µg/L. The current MCL for TCE is 5 µg/L, is within the revised protective carcinogenic risk range. EPA's 2011 Toxicological Review for TCE 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. EPA's 2011 toxicity evaluation of TCE's non-cancer effects also included a subchronic outcome of fetal cardiac malformations that may occur during exposure to the pregnant mother during a nonspecific 21-

day period in the first trimester of pregnancy, according to the IRIS Toxicological Review for TCE. 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 likely be without an appreciable risk of deleterious non-cancer effects, including non-cancer toxicity effects during development. The non-cancer screening level for TCE is 2.6 µg/L. As mentioned earlier in this section, Institutional controls are in place to prohibit the use of groundwater at this site. Additionally, a deed restriction exists to prohibit the construction of a building on this site without approval from EPA; which will ensure protectiveness for potential vapor intrusions issues in the future.

State requirements promulgated in WAC 173-201 and chronic surface water quality criteria were used in the ROD, in part, to evaluate discharge to Leach Creek, which is used for spawning of coho and chum salmon, and may also include rainbow and cutthroat trout. Since the ROD, changes in both criteria have occurred. Chronic values are no longer promulgated for several compounds, as noted in Table 3-4. The revised WAC code has been updated to incorporate the EPA NRWQC. As presented in Table 3-4, the values for consumption of water and fish are lower than surface water discharge criteria presented in the Consent Decree for 1,2-DCA, vinyl chloride, and methylene chloride. Concentrations of VOCs in surface water from Leach Creek have been detected below the cleanup level since 2003, with the exception of methylene chloride. Reporting limits for 1,2-DCA and vinyl chloride are above the surface water quality criteria so impacts from these changes cannot be evaluated.

Changes in Exposure Pathways

The ROD for the Tacoma Landfill site described current and future land uses accurately and identified likely exposure pathways. The potential risk due to the intrusion of VOCs into indoor air was identified in the previous five-year review as a potentially significant pathway that had not be previously identified. In the August 28, 2009 memo by Floyd|Snider, it was determined that vapor intrusion is an incomplete pathway and does not present a significant risk to human health. Use of the J&E Model to screen groundwater concentrations for vinyl chloride and 1,2-DCA under worst-case conditions found that residual concentrations off-site of the Tacoma Landfill do not pose a risk to residents in the area.

Changes in Toxicity and Other Contaminant Characteristics

In addition to several changes to MCL values for arsenic and TCE, several RfD values have also been updated since the previous 5 year review. The oral RfD for 1,2-DCA was updated under MTCA in 2005 from ‘no data’ to 0.02mg/kg/day. The oral RfD for toluene was updated in 2008 from 0.2 to 0.8 mg/kg/day. The oral reference dose was updated in 2010 for 1,1,1-tricholoroethane from 9.0 to 2.0 mg/kg/day. Xylenes were also updated in 2005 from 2.0 to 0.2 mg/kg/day. Despite these changes, the performance levels at the site still fall within an acceptable level of risk.

Changes in Risk Assessment Methods

There have been no substantial changes to the standardized risk assessment methods.

Expected Progress Toward Meeting RAOs

At this time it appears the remedy at Tacoma Landfill is progressing as expected. Despite revisions that have resulted in decreased MCL values, the site continues to see generally decreasing concentrations of constituents over time that either meet or fall below the ROD-specified performance levels.

Table 3-4. Changes in Chemical-Specific Standards

Contaminant**	Media	Cleanup Level (µg/L)	Standard*** (µg/L)		Citation/Year (µg/L)
Benezene	Groundwater	5.0	Previous	5.0	MCL, 1988
			New	5.0	MCL, 2012
Chloroethane	Groundwater	20.0	Previous	No data	Researched – no data
			New	No data	Researched – no data
1,1-Dichloroethane	Groundwater	20.0	Previous	800	MTCA Groundwater Method B, non-carcinogen, standard formula value
			New	1600	2008 MTCA Groundwater Method B, non-carcinogen, standard formula value
1,2-Dichloroethane	Groundwater	5.0	Previous	5.0	MCL, 1988
			New	5.0	MCL, 2012
Ethyl Benzene	Groundwater	320.0	Previous	700.0	MCL, 1988
			New	700.0	MCL, 2012
Methylene Chloride	Groundwater	5.0	Previous	5.0	MCL, 1988
			New	5.0	MCL, 2012
Toluene	Groundwater	175.0	Previous	1,000.0	MCL, 1988
			New	1,000.0	MCL, 2012
1,1,1-Trichloroethane	Groundwater	200.0	Previous	200.0	MCL, 1988
			New	200.0	MCL, 2012
Xylenes	Groundwater	10.0	Previous	10,000.0	MCL, 1988
			New	10,000.0	MCL, 2012
1,2-Dichloroethene*	Groundwater	70.0	Previous	72	MTCA Method B, non-carcinogen, standard formula value
			New	72	MTCA Method B, non-carcinogen, standard formula value
Trichloroethene*	Groundwater	5.0	Previous	5.0	MCL, 1988
			New	5.0	MCL, 2012
Arsenic*	Groundwater	50.0	Previous	50	MCL, 1988
			New	10	MCL, 2012
Benezene	Surface water (fresh)	5.0	Previous	5.0	MCL, 1988
			New	5.0	MCL, 2012
Chloroethane	Surface water (fresh)	20.0	Previous	No data	Researched – no data
			New	No data	Researched – no data

Contaminant**	Media	Cleanup Level (µg/L)	Standard*** (µg/L)		Citation/Year (µg/L)
1,1-Dichloroethane	Surface water (fresh)	20.0	Previous	800	MTCA Groundwater Method B, non-carcinogen, standard formula value
			New	1600	2008 MTCA Groundwater Method B, non-carcinogen, standard formula value
1,2-Dichloroethane	Surface water (fresh)	5.0	Previous	5.0	MCL, 1988
			New	5.0	MCL, 2012
Ethyl Benzene	Surface water (fresh)	320.0	Previous	700.0	MCL, 1988
			New	700.0	MCL, 2012
Methylene Chloride	Surface water (fresh)	5.0	Previous	5.0	MCL, 1988
			New	5.0	MCL, 2012
Toluene	Surface water (fresh)	175.0	Previous	1,000.0	MCL, 1988
			New	1,000.0	MCL, 2012
1,1,1-Trichloroethane	Surface water (fresh)	200.0	Previous	200.0	MCL, 1988
			New	200.0	MCL, 2012
Vinyl Chloride	Surface water (fresh)	2.0	Previous	2.0	MCL, 1988
			New	2.0	MCL, 2012
Xylenes	Surface water (fresh)	10.0	Previous	10,000.0	MCL, 1988
			New	10,000.0	MCL, 2012

*Additional COCs were added as performance levels for groundwater during the Remedial Design study in 1991.
**In addition to performance standards dictated by the ROD, additional Washington State standards for active landfill operations must be met. These standards are set forth in WAC 173-200, Water Quality Standards for Groundwaters of the State of Washington; WAC 173-290, Drinking Water Regulations; WAC 173-304-490, Leachate Parameters; and, WAC 173-351-200, Gas Production.
***Previous Standard is at time of the ROD. If 'NA', no standard was established at the time of the ROD. New Standard is the most recent update post-ROD. If '—', no updates have been made to the standard.

Table 3-5. Changes in Action-Specific Requirements

Action	Requirement		Prerequisite	Citation/Year
Landfill	Previous	Groundwater corrective action required until concentrations of hazardous constituents at the point of compliance achieve either MCLs or alternate concentrations limits. All hazardous wastes at a site should be removed, treated on site, or capped in such a way as to minimize the migration of contaminants from the site.	Contaminated media contributing to groundwater contamination is present at the site.	Resource Conservation and Recovery Act (RCRA, 49 CFR 261) Washington State Dangerous Waste Regulations and Washington State Minimal Functional Standards for Solid waste Handling
	New	No changes that impact remedy since last Five-Year Review.	—	—
Drinking Water	Previous	Federal MCLs shall be met to prevent exposure to the public to contaminated drinking water. Affected water supplies will be connected to City Water.	Contaminants regulated under federal guidelines. Groundwater is adjacent to drinking water sources.	Section 1412 of the Safe Drinking Water Act (SDWA), 42 U.S.C. 300g-1, "National Drinking Water Regulations"; National Primary Drinking Water Regulations. 40 CFR Part 141
	New	Exposure toxicity for TCE was revised in 2011. However, the MCL remains unchanged and is considered protective of both carcinogenic and non-carcinogenic effects.	—	—
Air	Previous	Regulates air emissions to protect human health and the environment associated with air stripper (if used) and any flares used at the site.	Original remedy specified in the ROD required use of air stripper for treatment of groundwater.	Clean Air Act, 42 U.S.C. 7401
	New	Air stripper not used on site. Flares under permit. No change that impacts remedy since last Five-Year Review.	—	—
Surface Water	Previous	Treatment and release of effluent. Landfill cap will reduce leachate generation.	The landfill produces leachate and effluent due to daily operations and treatment technologies.	Clean Water Act (CWA) Section 402 NPDES Requirements
	New	ROD specifies no permit required for on site remedial activities.	—	—

*Although not specified in the ROD, The City also maintains a Solid Waste Permit for the Landfill, managed by TPCHD under the authority of RCW 70.95 and in accordance with WAC 173-351 and 173-350. Recent revisions to WAC 173-351 require monitoring of total metals in groundwater. The previous version of the rule required the monitoring of dissolved metals in groundwater. Tacoma Landfill has tentative plans to incorporate this new requirement into their Closure Monitoring Plan.

3.7.3. Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

3.7.4. Technical Assessment Summary

The GETS has been effective at managing contaminant migration and most of the extraction wells were shut down in 2010. Five extraction wells remain in operation, two near the historical north area residual plume and three near the historical south area residual plume. Rebound monitoring data indicate that there was a slight increase in contaminant concentrations in 2011; however, concentrations have since decreased. The methodology developed for monitoring containment in the 2010 Rebound Monitoring Plan is not appropriate for site conditions and should be revised prior to shutdown of any additional extraction wells. The reduced analyte list from the 2010 groundwater monitoring plan should also be reviewed and revised as necessary to ensure that compliance monitoring locations, e.g. Leach Creek surface water samples and GETS effluent samples, are analyzed for the full list of ROD COCs. The landfill-gas system continues to control migration of landfill gas. Concentrations of methane above the LEL are still detected near the Home Depot property at the north end of the landfill. New extraction wells have been installed in this area and their operation is being optimized to reduce concentrations. Final closure of the Central Area will be completed by December 31, 2013. Following this event, the Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System and the Leachate and Condensate Management Plans should be updated to reflect the current site conditions. ICs are in place to assure that the remedial action will continue to protect human health and the environment. Several toxicity parameters have been updated for multiple chemicals. However, performance levels still meet an acceptable level of risk at the site. There have been no changes to the exposure pathways that would impact protectiveness at the site.

3.8. Issues

Table 3-6 summaries the current issues for the Tacoma Landfill site.

Table 3-6. Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
1. Water ponding and cap subsidence continue to occur on areas of the landfill cap.	No	Yes
2. The Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System and Leachate and Condensate Management Plan may not reflect current conditions following closure of the Central Area.	No	Yes
3. Landfill gas continues to be detected near the Home Depot Property at the north end of the landfill.	No	Yes
4. The Rebound Monitoring Plan statistical methodology is too restrictive, leading to numerous exceedances of the contingent action criteria, and the response action procedures described in the plan have not been followed.	No	Yes
5. The 2010 Groundwater Monitoring Plan reduced the analyte list to those VOCs useful for evaluating rebound. While this may be acceptable for the rebound monitoring wells, it should not be used at locations used to determine compliance with ROD criteria, such as Leach Creek surface water sampling and GETS effluent samples.	No	Yes

3.9. Recommendations and Follow-up Actions

Table 3-7 provides recommendations to address the current issues at the Tacoma Landfill site, along with proposed milestone dates to achieve the follow-up actions.

Table 3-7. Recommendations and Followup Actions

Issue	Recommendations and Followup Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1.	Regrade areas of the landfill cap that continue to have significant ponding and subsidence.	City of Tacoma	EPA, Ecology, TPCHD	September 2014	No	Yes
2.	Update the Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System and the Leachate and Condensate Management Plan.	City of Tacoma	EPA, Ecology, TPCHD	September 2014	No	Yes
3.	Continue operation optimization of gas extraction in wells on the northern edge of the Landfill near the Home Depot property.	City of Tacoma	EPA, Ecology, TPCHD	September 2014	No	Yes
4.	Update the Rebound Monitoring Plan.	City of Tacoma	EPA, Ecology, TPCHD	September 2014	No	Yes
5.	Update the 2010 Groundwater Monitoring Plan to include the full list of ROD COCs for sampling locations used to determine compliance (e.g. Leach Creek and GETS effluent).	City of Tacoma	EPA, Ecology, TPCHD	September 2014	No	Yes

Included below are additional recommendations to be considered that do not affect current or future protectiveness of the remedy:

- Continue to evaluate gas-monitoring probes that have a history of evacuation problems during sampling and replace as necessary to ensure a complete gas monitoring program is in place.

3.10. Protectiveness Statements

The remedy at the Tacoma Landfill is currently protective of human health and the environment in the short term because the groundwater and landfill gas is being controlled through the GETS and landfill-gas management system, the Central Area final cover will be complete by December 31, 2013, and ICs are in

place. However, in order for the remedy to be protective in the long term, the following actions need to be taken to ensure protectiveness:

- Continue operation optimization of gas extraction wells at the north end of the Landfill.
- Re-grade areas of the landfill cap prone to ponding and subsidence.
- Update the following management plans to ensure the monitoring program is effective and response action procedures are in place: Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System; Leachate and Condensate Management Plan; Rebound Monitoring Plan; Groundwater Monitoring Plan; and Institutional Controls Plan.

3.11. Next Review

The next Five-Year Review for the Tacoma Landfill OU is required by September 2018, five years from the date of this review.

Tacoma Landfill Figures

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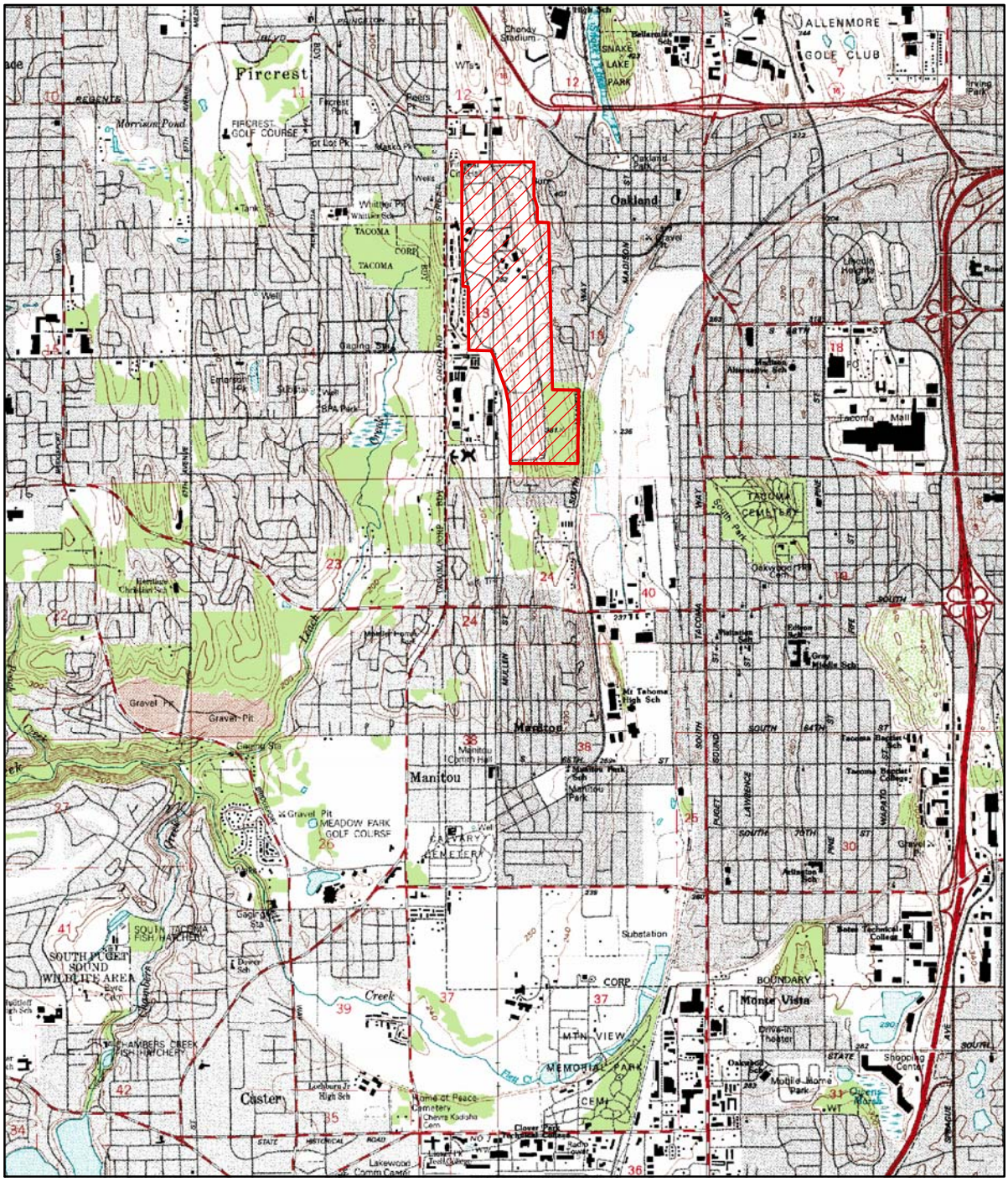

Tacoma Landfill
Site Vicinity Map

0 250 500 1,000 Feet

Source:
USGS Topographic Map, Tacoma South, WA, 1997
USGS Topographic Map, Steilacoom, WA, 1997

Figure 3-1. Tacoma Landfill site vicinity map.

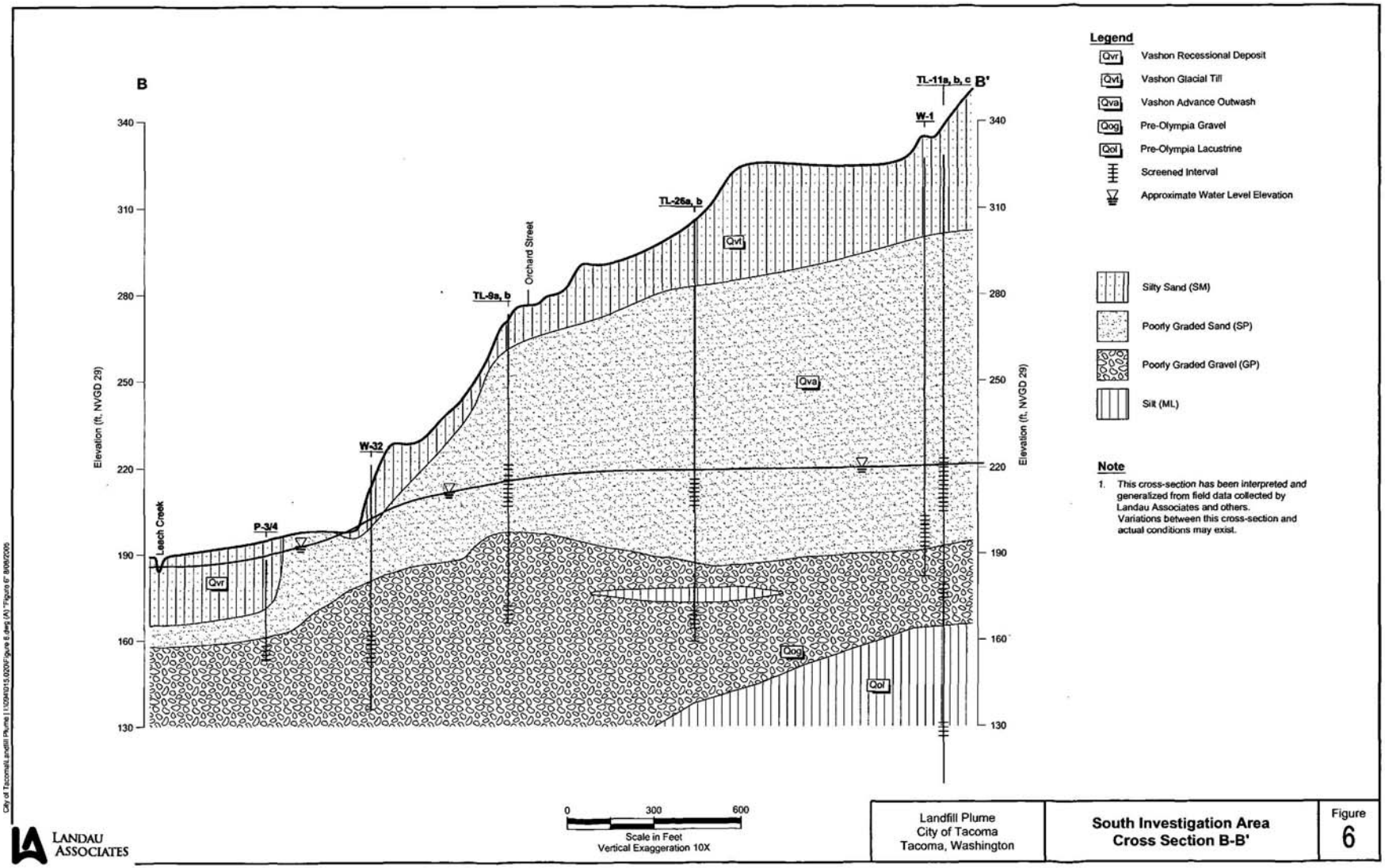

Figure 3-2. Representative geologic cross-section.

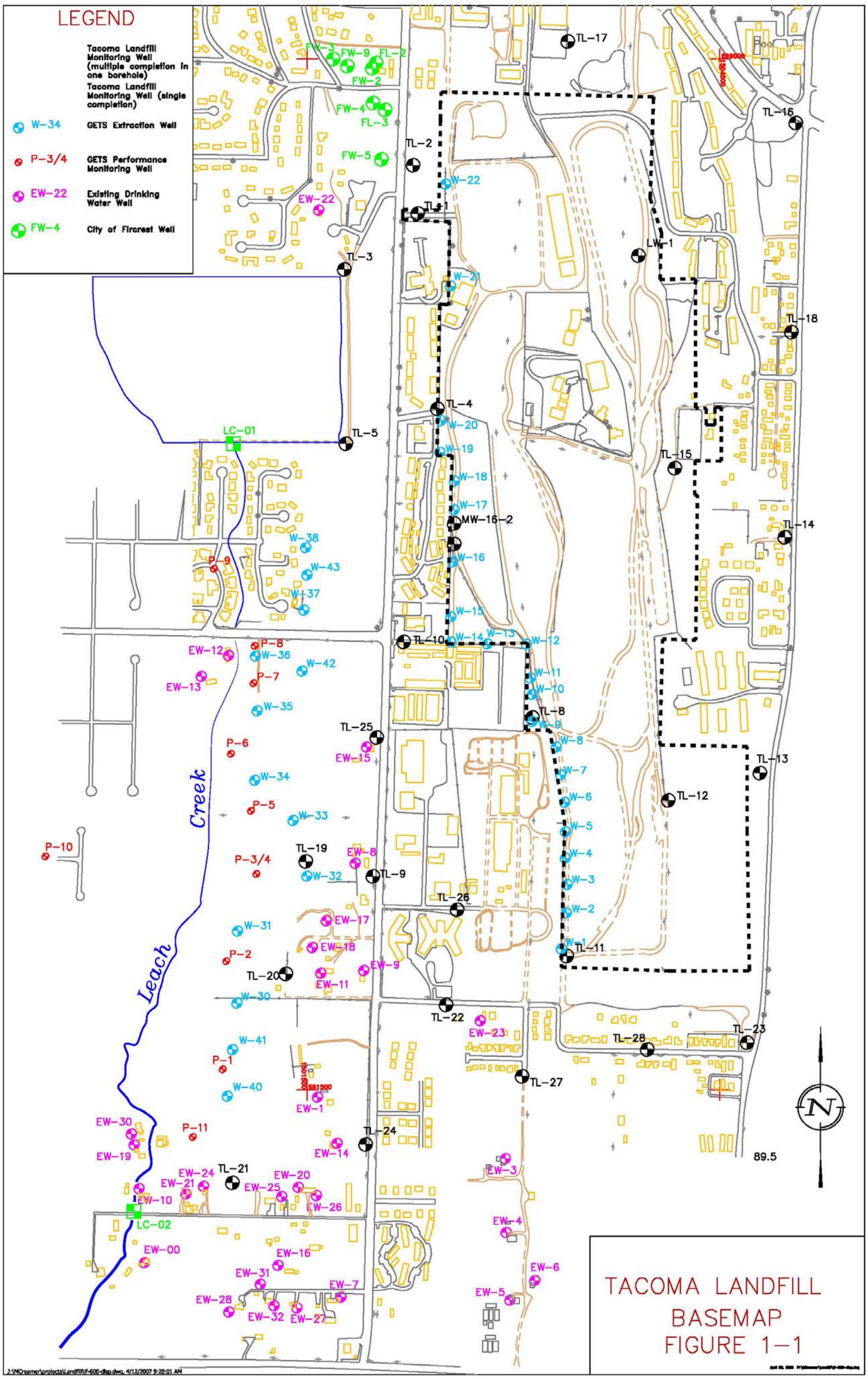

Figure 3-3. Tacoma Landfill extraction and monitoring wells.

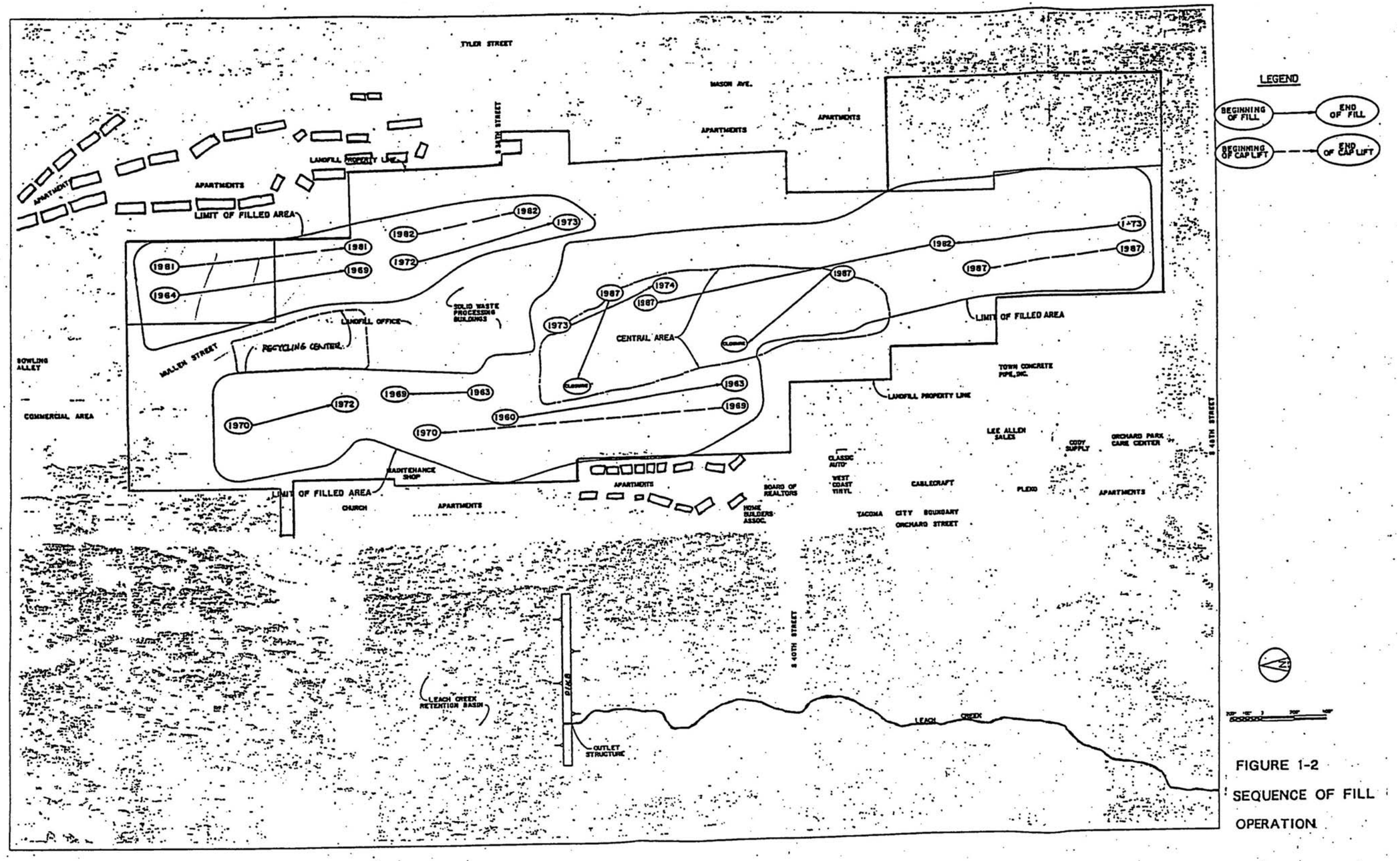

Figure 3-4. Tacoma Landfill sequence of fill operations.

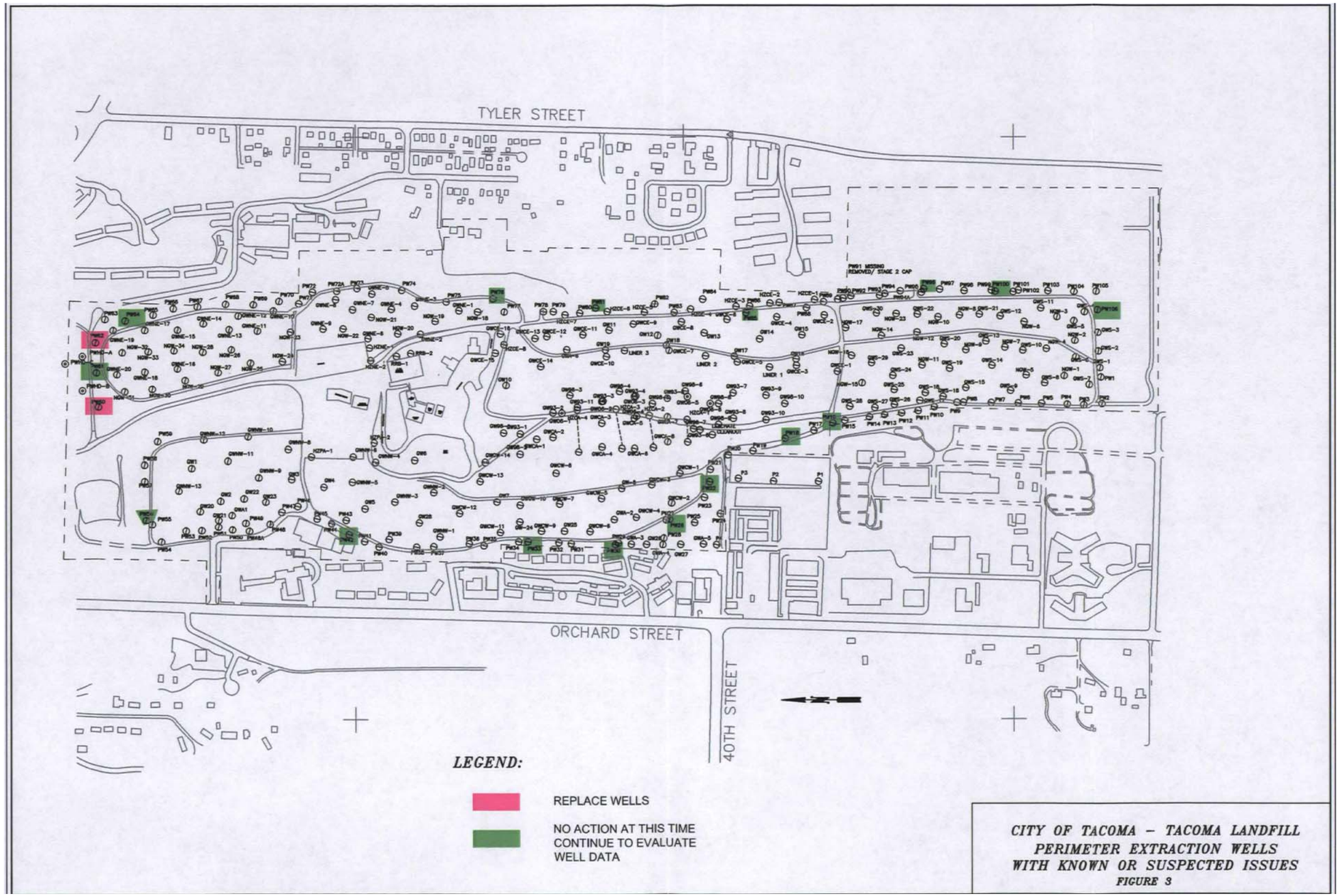

Figure 3-5. Tacoma Landfill gas extraction wells.

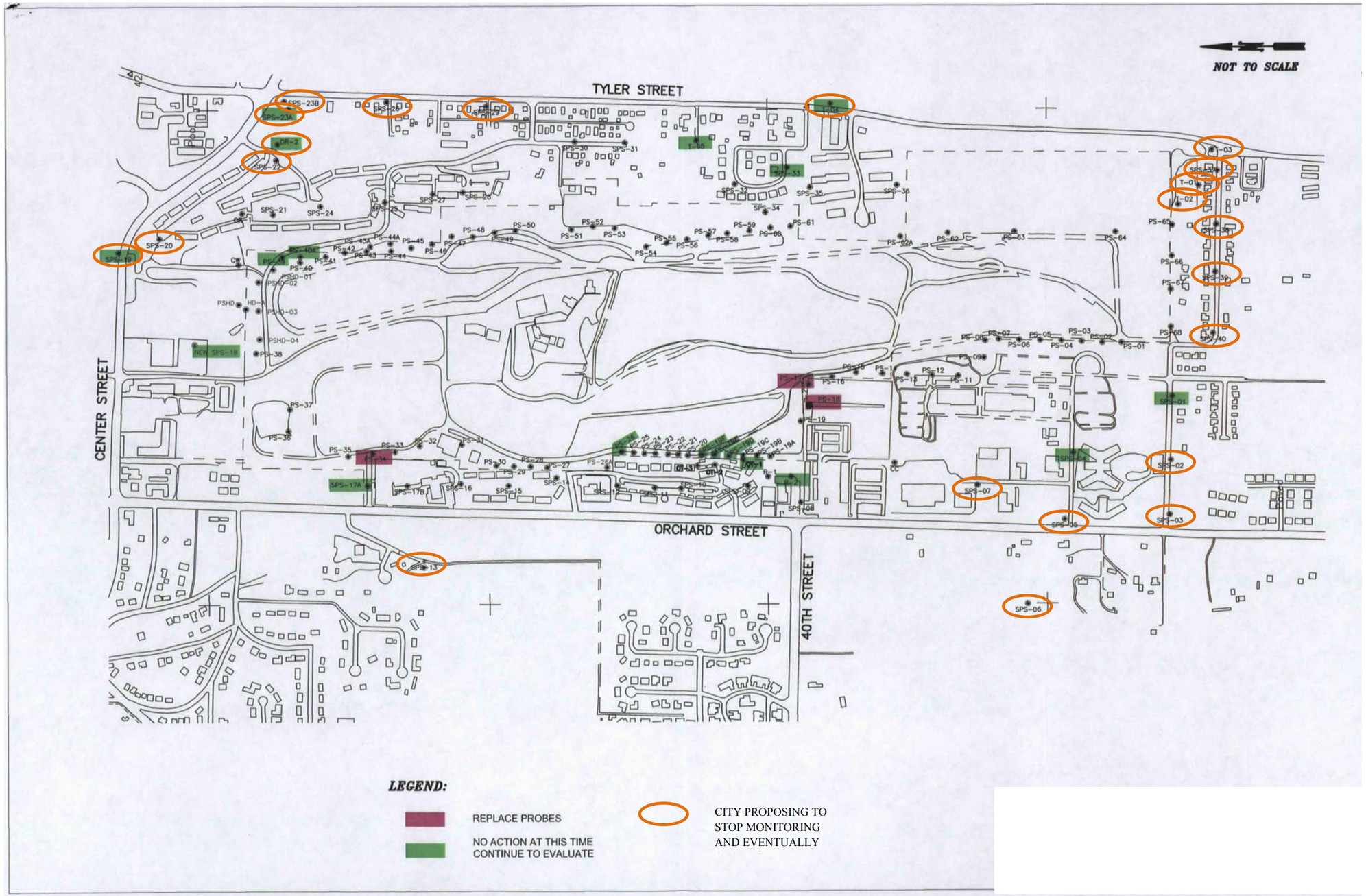

Figure 3-6. Tacoma Landfill gas monitoring probes.

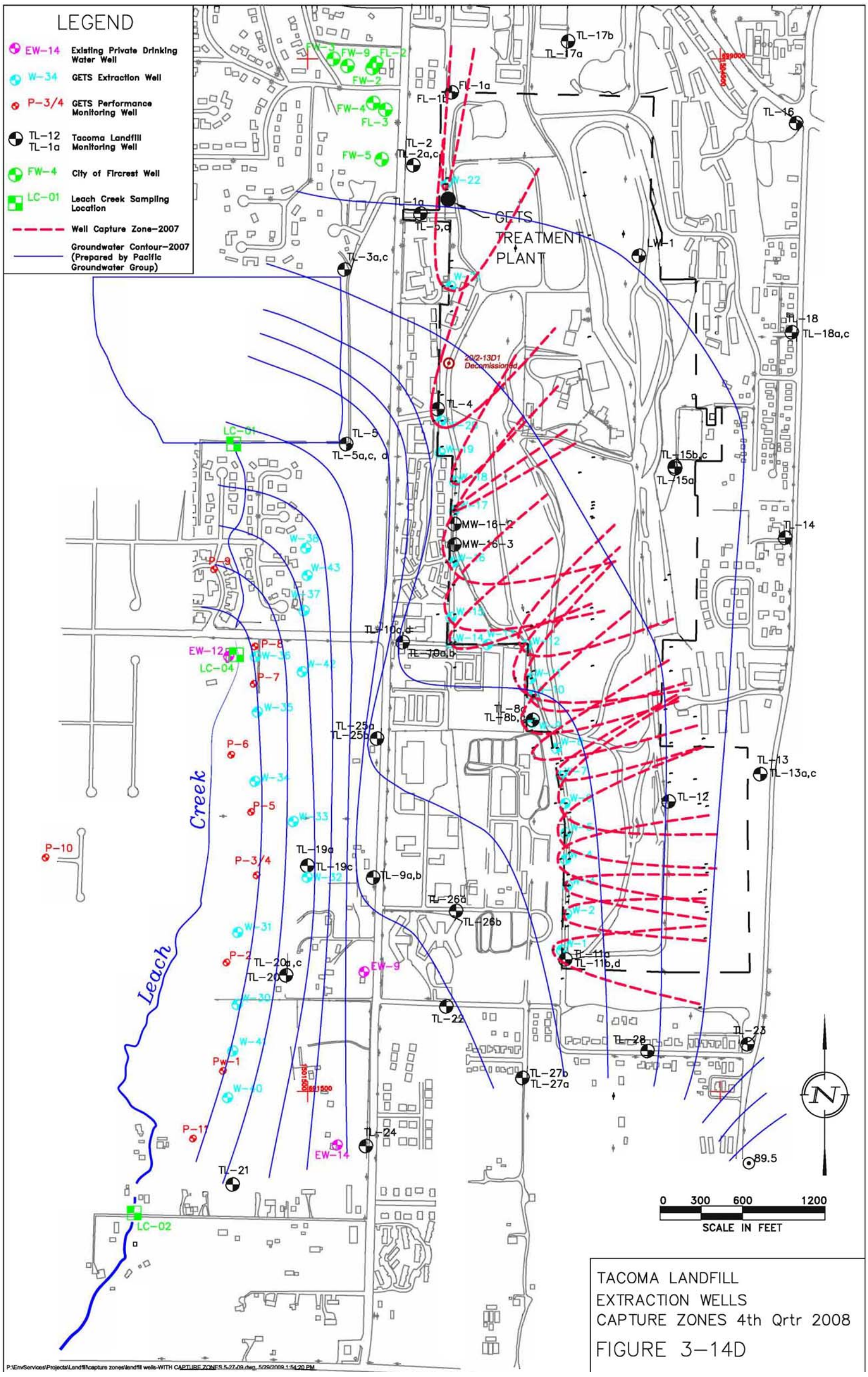

Figure 3-7. Tacoma Landfill capture zones 4th quarter 2008.

Table 1 Groundwater Extraction and Monitoring Wells
November 2010

Location	Well	Well Type	On-Site or Off-Site	Screened Interval (ft bgs)	Historical Purpose	Current Purpose	Groundwater Monitoring Frequency	Years Groundwater Analytical Samples Collected	Description/Comments
Point of Compliance (POC) - Landfill Boundary	W-01	Extraction	On-Site	148–153	Groundwater Extraction and Monitoring	Groundwater Extraction and Rebound Monitoring	Quarterly	1996–	Continue operation. Collect groundwater analytical data to support shutdown.
	W-02	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Extraction and Rebound Monitoring	Quarterly	2005–	Continue operation. Collect groundwater analytical data to support shutdown.
	W-03	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down May 2009 to monitor for rebound. Likely screen failure. Well failure had occurred twice before. No groundwater performance standard exceedances for five years prior to shutdown.
	W-04	Extraction	On-Site	148-163	Groundwater Extraction and Monitoring	Groundwater Extraction and Rebound Monitoring	Quarterly	2005-	Continue operation. Collect groundwater analytical data to support shutdown.
	W-05	Extraction	On-Site	145–153	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1996–	Shut down to monitor for rebound March 2010.
	W-06	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down to monitor for rebound March 2010.
	W-07	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down to monitor for rebound March 2010.
	W-08	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down to monitor for rebound March 2010.
	W-09	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down to monitor for rebound March 2010.
	W-10	Extraction	On-Site	138–146	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1996–	Shut down to monitor for rebound March 2010.
	W-11	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down to monitor for rebound March 2010.
	W-12	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down to monitor for rebound March 2010.
	W-13	Extraction	On-Site	-	Groundwater Extraction and Monitoring	N/A	N/A	1995	Shutdown February 2002; redundant well w/ poor production. One groundwater quality analysis in 1995.
	W-14	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shutdown in February 2010 to monitor for rebound. Likely screen failure discovered during rehab on 2/26/10. No groundwater performance standard exceedances five years prior to shutdown.
	W-15	Extraction	On-Site	78.5–86.5	Groundwater Extraction and Monitoring	Groundwater Extraction and Rebound Monitoring	Quarterly	1996–	Continue operation. Only slightly exceeds VC GWPS, downward trend in VC evident for past 5
	W-16	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Extraction and Rebound Monitoring	Quarterly	2005-	Continue operation. One vinyl chloride exceedance reported since sampling began.
	W-17	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down to monitor for rebound March 2010.
	W-18	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	Shut down to monitor for rebound March 2010.
	W-19	Extraction	On-Site	-	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	2005-	W-19 shutdown in November 2005 to monitor for rebound. Also excessive sand in well noted during last rehab in 2005.
	W-20	Extraction	On-Site	130–145	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1997–	Shut down to monitor for rebound March 2010.
	W-21	Extraction	On-Site	125–140	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1997–	Shut down to monitor for rebound March 2010.
	W-22	Extraction	On-Site	135–150	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1997–	Shut down to monitor for rebound March 2010.
Tacoma Landfill Monitoring Wells	89.5 P1	Monitoring	Off-Site	-	Groundwater Monitoring - Background	Groundwater Monitoring - Elevation Only	Quarterly	1996–	Concluded analytical sampling November 2009. Not impacted by groundwater plume.
	89.5 P2	Monitoring	Off-Site	-	Groundwater Monitoring - Background	Groundwater Monitoring - Elevation Only	Quarterly	1996–	Concluded analytical sampling November 2009. Not impacted by groundwater plume.
	EW-13	Private Well	Off-Site	-	Groundwater Monitoring	Groundwater Monitoring	Quarterly	1985–2009	Continue analytical monitoring well. Groundwater elevation not monitored at this well.
	FL-1A	Monitoring	On-Site	-	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1996	One VOC sample analysis; no impacts to groundwater. This is an upgradient well.
	FL-1B	Monitoring	On-Site	-	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1996	One VOC sample analysis; no impacts to groundwater. This is an upgradient well.
	LW-01	Monitoring	On-Site		Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1989-1995	Sampling concluded 1995. Well located in a closed cell. Long-term decreasing VOC
	MW-11-1	Monitoring	On-Site	128-136	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	N/A	Water elevations collected 1994 to present. No analytical sampling conducted at this well.
	MW-11-2	Monitoring	On-Site	130-135	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	N/A	Water elevations collected 1994 to present. No analytical sampling conducted at this well.
	MW-16-2	Monitoring	On-Site	118-123	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1995	Sampled once for water quality analysis.
	MW-16-3	Monitoring	On-Site	95-105	Groundwater Monitoring	N/A	N/A	N/A	Monitored water elevations only from 1994-2005; likely stopped due to poor well condition.
	TL-01A	Monitoring	On-Site	97–111	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1986–	Resume quarterly monitoring January 2010.
	TL-01B	Monitoring	On-Site	133–138	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1986–	Resume quarterly monitoring January 2010.
	TL-01C	Monitoring	On-Site	163–173	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1986–	Resume quarterly monitoring January 2010.
	TL-02A	Monitoring	Off-Site	72-92	Groundwater Monitoring	N/A	NA	1989-1996	No groundwater performance exceedances. No longer monitored.
	TL-02C	Monitoring	Off-Site	140–145	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1989–	Resume quarterly monitoring January 2010.
	TL-03A	Monitoring	Off-Site	40-50	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1989-1995	Resume sampling if drinking water detection limit exceedance occurs in TL-02C.
	TL-03C	Monitoring	Off-Site	105-110	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1989-1996	Resume sampling if drinking water detection limit exceedance occurs in TL-02C.
	TL-04	Monitoring	Off-Site	91–105	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1986–	
	TL-05A	Monitoring	Off-Site	14–19	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1989–	
	TL-05C	Monitoring	Off-Site	34–38	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1989–	
	TL-05D	Monitoring	Off-Site	73-78	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1990–1996	No groundwater performance standard exceedances.
	TL-07A	Monitoring	Off-Site	22–29	Groundwater Monitoring	Groundwater Monitoring	Quarterly	1989–	
	TL-08A	Monitoring	On-Site	101-115	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1986-1995	No groundwater performance standard exceedances.
	TL-08B	Monitoring	On-Site	140-145	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1986-1995	No groundwater performance standard exceedances.
	TL-08C	Monitoring	On-Site	170175	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1986-1995	No groundwater performance standard exceedances.
	TL-09A	Monitoring	Off-Site	52-67	Groundwater Monitoring	Groundwater Monitoring	Annually	1986–	
	TL-09B	Monitoring	Off-Site	100–105	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1986–	Sampled annually for analysis since 1996.
	TL-10A	Monitoring	Off-Site	46–61	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1987–	
	TL-10B	Monitoring	Off-Site	76–81	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1987–	
	TL-10C	Monitoring	Off-Site	98–103	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1989–	

Tables 1 and 2 - Monitoring Wells Status & Schedule.xlsx

Table 1
Page 1 of 2

Figure 3-8. Tacoma Landfill monitoring well status table.

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Table 1 Groundwater Extraction and Monitoring Wells
November 2010

Location	Well	Well Type	On-Site or Off-Site	Screened Interval (ft bgs)	Historical Purpose	Current Purpose	Groundwater Monitoring Frequency	Years Groundwater Analytical Samples Collected	Description/Comments
	TL-10D	Monitoring	Off-Site	121-126	Groundwater Monitoring	N/A	N/A	N/A	No groundwater performance standard exceedances. No longer monitored.
	TL-11A	Monitoring	On-Site	105–124	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1986–	Trichloroethene and tetrachloroethene exceed GWPS.
	TL-11B	Monitoring	On-Site	149–154	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1987–	
	TL-11D	Monitoring	On-Site	198-203	Groundwater Monitoring	N/A	N/A	N/A	No groundwater performance standard exceedances. No longer monitored.
	TL-12	Monitoring	Off-Site	140-155	Groundwater Monitoring	On-site - Groundwater Monitoring	Annually	1987–	
	TL-13A	Monitoring	Off-Site	88-103	Background Monitoring	Groundwater Monitoring - Background	Semiannually	1989–	Requested annual sample frequency starting January 2011
	TL-13C	Monitoring	Off-Site	147-152	Groundwater Monitoring - Background	Groundwater Monitoring - Background	Semiannually	1989–	Requested annual sample frequency starting January 2011
	TL-14A	Monitoring	Off-Site	81-96	Groundwater Monitoring - Background	Groundwater Monitoring - Background	Annually	1989–	
	TL-15A	Monitoring	On-Site	69-83	Groundwater Monitoring - Background	Groundwater Monitoring - Elevation Only	Quarterly	1986-1995	Background well not impacted by groundwater plume.
	TL-15B	Monitoring	On-Site	113-123	Groundwater Monitoring - Background	Groundwater Monitoring - Elevation Only	Quarterly	1986-1995	Background well not impacted by groundwater plume.
	TL-15C	Monitoring	On-Site	152-157	Groundwater Monitoring - Background	Groundwater Monitoring - Elevation Only	Quarterly	1986-1995	Background well not impacted by groundwater plume.
	TL-16R	Monitoring	Off-Site	108-112	Groundwater Monitoring - Background	Groundwater Monitoring - Background	Quarterly	1995–	Requested annual sample frequency starting January 2011
	TL-17AR	Monitoring	Off-Site	75-90	Groundwater Monitoring - Background	Groundwater Monitoring - Background	Quarterly	2000–	Requested annual sample frequency starting January 2011
	TL-17BR	Monitoring	Off-Site	114-119	Groundwater Monitoring - Background	Groundwater Monitoring - Background	Quarterly	2000–	Requested annual sample frequency starting January 2011
	TL-18A	Monitoring	Off-Site	81-96	Groundwater Monitoring - Background	Groundwater Monitoring - Background	Annually	1989–	
	TL-18C	Monitoring	Off-Site	140-145	Groundwater Monitoring - Background	Groundwater Monitoring - Background	Annually	1989–	
	TL-19A	Monitoring	Off-Site	11-25	Groundwater Monitoring	Groundwater Monitoring	Annually	1989–	
	TL-19C	Monitoring	Off-Site	59–64	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1989–	
	TL-20A	Monitoring	Off-Site	18-33	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1989–1996	No groundwater performance standard exceedances.
	TL-20C	Monitoring	Off-Site	73–77	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1989–	
	TL-21A	Monitoring	Off-Site	38–48	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1989–2010	
	TL-22A	Monitoring	Off-Site	85–100	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1989–	
	TL-23A	Monitoring	Off-Site	61-76	Groundwater Monitoring - Background	Groundwater Monitoring - Elevation Only	Quarterly	1989–2010	Well was not impacted by the groundwater plume.
	TL-24A	Monitoring	Off-Site	82-97	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1989-1995	Well was not impacted by the groundwater plume.
	TL-25A	Monitoring	Off-Site	59–69	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1995–	
	TL-25B	Monitoring	Off-Site	94–99	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1995–	
	TL-26A	Monitoring	Off-Site	90–100	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1995–	Long-term decreasing trend for 1,2-dichloroethane.
	TL-26B	Monitoring	Off-Site	136–141	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1995–	
	TL-27A	Monitoring	Off-Site	91–101	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1995–	
	TL-27B	Monitoring	Off-Site	130–135	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1995–	
	TL-28A	Monitoring	Off-Site	67-77	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1995–2009	No groundwater performance standard exceedances. Well not impacted by groundwater
End of Plume (EOP)	W-30	Extraction	Off-Site	39–49	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1996–	Shut down August 2008 to monitor for rebound.
	W-31	Extraction	Off-Site	35–50	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1996–	Shut down to monitor for rebound March 2010.
	W-32	Extraction	Off-Site	58–68	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1996–	Shut down to monitor for rebound March 2010.
	W-33	Extraction	Off-Site	60–70	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1996–	Shut down to monitor for rebound March 2010.
	W-34	Extraction	Off-Site	32-49	Groundwater Extraction and Monitoring	Well Decommissioned	N/A	1996	Well decommissioned during October 2010.
	W-35	Extraction	Off-Site	40-50	Groundwater Extraction and Monitoring	Well Decommissioned	N/A	1996	Well decommissioned during October 2010.
	W-36	Extraction	Off-Site	42–52	Groundwater Extraction and Monitoring	Groundwater Extraction and Rebound Monitoring	Quarterly	1996–	Continue operation until EW-12 is abandoned.
	W-37	Extraction	Off-Site	48–56	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1996–	Shut down to monitor for rebound March 2010.
	W-38	Extraction	Off-Site	48–56	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1996–	Shut down to monitor for rebound March 2010.
	W-40	Extraction	Off-Site	50–65	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1997–	Shut down August 2008 to monitor for rebound.
	W-41	Extraction	Off-Site	50–70	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1997–	Shut down to monitor for rebound March 2010.
	W-42	Extraction	Off-Site	50–60	Groundwater Extraction and Monitoring	Well Decommissioned	N/A	1997–2009	Well decommissioned during October 2010.
	W-43	Extraction	Off-Site	38–53	Groundwater Extraction and Monitoring	Groundwater Rebound Monitoring	Quarterly	1997–	Shut down to monitor for rebound March 2010.
Performance Monitoring (PW) (for EOP Wells)	PW-01	Performance Monitoring	Off-Site	47–57	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1993–	Resume quarterly monitoring January 2010
	PW-02	Performance Monitoring	Off-Site	28–38	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1993–	Resume quarterly monitoring January 2010
	PW-3/4	Performance Monitoring	Off-Site	25–35	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1993–	Resume quarterly monitoring January 2010
	PW-05	Performance Monitoring	Off-Site	46–50	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1993–	On-going edge of plume groundwater monitoring.
	PW-06	Performance Monitoring	Off-Site	41–51	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1993–	On-going edge of plume groundwater monitoring.
	PW-07	Performance Monitoring	Off-Site	44–54	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1993–	On-going edge of plume groundwater monitoring.
	PW-08	Performance Monitoring	Off-Site	43–48	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1993–	On-going edge of plume groundwater monitoring.
	PW-09	Performance Monitoring	Off-Site	30–35	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1993–	On-going edge of plume groundwater monitoring.
	PW-10	Performance Monitoring	Off-Site	62-72	Groundwater Monitoring	Groundwater Monitoring - Elevation Only	Quarterly	1994-1995	Well located west of Leach Creek not impacted by the groundwater plume.
	PW-11	Performance Monitoring	Off-Site	36–41	Groundwater Monitoring	Groundwater Rebound Monitoring	Quarterly	1997–	Resumed quarterly monitoring January 2010

Groundwater samples collected for analysis from these monitoring wells.

No well was designated with the name W-39.

Tables 1 and 2 - Monitoring Wells Status & Schedule.xlsx

Table 1
Page 2 of 2

Figure 8 cont. Tacoma Landfill monitoring well status table.

Table 4 Groundwater Monitoring Analytical Schedule

Chemical	Chemical of Concern	Indicator Parameter	EPA Analytical Method	Quantitation Limit	Source/Comments	Quarterly	Semi-annual	Annual
Volatile Organic Compound								
1,1,1-Trichloroethane	X		8260A	0.5 µg/L	VOC listed in ROD	X		
1,1-Dichloroethane	X		8260A	0.5 µg/L	VOC listed in ROD	X		
1,2-Dichloroethane	X		8260A	0.5 µg/L	VOC listed in ROD	X		
1,2-Dichloroethene, Total	X		8260A	0.5 µg/L	VOC not listed in ROD added during RDPS	X		
Benzene	X		8260A	0.5 µg/L	VOC listed in ROD	X		
Chloroethane	X		8260A	0.5 µg/L	VOC listed in ROD	X		
Tetrachloroethene	X		8260A	0.5 µg/L	VOC not listed in ROD added during RDPS	X		
Trichloroethene	X		8260A	0.5 µg/L	VOC not listed in ROD added during RDPS	X		
Vinyl Chloride	X		8260A	0.5 µg/L	VOC listed in ROD	X		
Metals								
Arsenic (total)		X	6020A	5 µg/L	Removed from COC list.			X
Manganese (total)		X	6020A	5 µg/L	Discharge to Leach Creek Holding Basin; must be <1,900ug/L		X	
Iron (total)		X	6020A	25 µg/L	Discharge to Leach Creek Holding Basin; must be <1,500ug/L		X	
Other Landfill Parameters								
Specific Conductance		X	2510A	10 umhos/cm	Field Parameter	X		
pH		X	EPA 150.1	N/A	Field Parameter	X		
Temperature (°F)		X	2550	N/A	Field Parameter	X		
Water Level		X	-	N/A	Field Parameter	X		
Turbidity, field or lab nephelometric		X	EPA 180.1	10 NTU	Field Parameter	X		
TDS		X	2540C	10.0 mg/L	Landfill parameter; used as a surrogate measure for increases in cations and anions due to landfill leachate.			X
Chloride		X	4500Cl E	1 mg/L	Landfill parameter; used to track "leachate" impacts			X

Annual samples collected during first quarter.
Semi-annual samples collected during first and third quarters.

Figure 3-9. Tacoma Landfill groundwater monitoring analytic schedule.

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Appendix 3-A: Tacoma Landfill Documents Reviewed

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Tacoma Landfill Documents Reviewed

AmTest Air Quality, 2011. Parametrix, Inc. @ City of Tacoma Landfill, Tacoma, Washington, Gas Combustor Testing, December 16, 2010.

City of Tacoma, 2008a. Tacoma Landfill, Biannual Gas System Evaluation Report. January 1 – June 30, 2008.

City of Tacoma, 2008b. Annual Summary of Inspections for the Tacoma Landfill Cap, Condensate Collection System, and Central Area Leachate Collection System. May 2008.

City of Tacoma, 2008c. Technical Memorandum, Subject: Tacoma Landfill Third 5-Year Review – Modeled Effects on the Groundwater Divide Location Due to Potential Tacoma Water Wells Production Increase. September 30, 2008.

City Of Tacoma, 2008d. Technical Memorandum, Subject: Tacoma Landfill – South End Perched Leachate. October 20, 2008.

City of Tacoma, 2008e. Tacoma Landfill, Biannual Gas System Evaluation Report. July 1 – December 31, 2008.

City of Tacoma, 2009a. Tacoma Landfill, Biannual Gas System Evaluation Report. January 1 – June 30, 2009.

City of Tacoma, 2009b. Tacoma Landfill Operations and Closure Plan. Revised February 2009.

City of Tacoma, 2009c. Tacoma Landfill Third Five-Year Closure Extension Request. February 27, 2009.

City of Tacoma, 2009d. Tacoma Landfill Consent Decree 2008 Annual Report. March 2009.

City of Tacoma, 2009e. Annual Summary of Inspections for the Tacoma Landfill Cap, Condensate Collection System, and Central Area Leachate Collection System. March 2009.

City of Tacoma, 2009f. Letter to EPA, re: Tacoma Landfill – Gas Extraction Well and Probe Proposal. March 17, 2009.

City of Tacoma, 2009g. Letter to EPA, re: Tacoma Landfill – Off-Site Gas Probe Data. May 8, 2009.

City of Tacaom, 2009h. Tacoma Landfill, Third Five-Year Closure Extension Request, Amendment #1. June 8, 2009.

City of Tacoma, 2009i. Tacoma Landfill, Biannual Gas System Evaluation Report. July 1 – December 31, 2009.

City of Tacoma, 2009j. Tacoma Landfill, Extraction Wells Shutdown Request. December 3, 2009.

City of Tacoma, 2009k. Tacoma Landfill, Landfill Gas Management Plan. December 29, 2009.

City of Tacoma, 2010a. Tacoma Landfill, Biannual Gas System Evaluation Report. January 1 – June 30, 2010.

City of Tacoma, 2010b. Letter to EPA, re: Request for Modifications to the Closure Extension III Conditional Approval. March 30, 2010.

City of Tacoma, 2010c. Annual Summary of Inspections for the Tacoma Landfill Cap, Condensate Collection System, and Central Area Leachate Collection System. May 2010.

City of Tacoma, 2010d. Tacoma Landfill Consent Decree 2009 Annual Report. June 2010.

City of Tacoma, 2010e. Tacoma Landfill, Biannual Gas System Evaluation Report. July 1 – December 31, 2010.

City of Tacoma, 2010f. Tacoma Landfill, Addendum, Extraction Wells Shutdown Request. October 2010.

City of Tacoma, 2010g. Letter to EPA re: Tacoma Landfill – Stage 3 Closure – Central Area. November 3, 2010.

City of Tacoma, 2010h. Tacoma Landfill, Groundwater Monitoring Plan. November 2010.

City of Tacoma, 2010i. Tacoma Landfill Institutional Controls Plan. November 2010.

City of Tacoma, 2011j. Tacoma Landfill, Biannual Gas System Evaluation Report. January 1 – June 30, 2011.

City of Tacoma, 2011k. Annual Summary of Inspections for the Tacoma Landfill Cap, Condensate Collection System, and Central Area Leachate Collection System. March 2011.

City of Tacoma, 2011l. Tacoma Landfill Consent Decree 2010 Annual Report. March 2011.

City of Tacoma, 2011m. Tacoma Landfill, Biannual Gas System Evaluation Report. July 1 – December 31, 2011.

City of Tacoma, 2012a. Tacoma Landfill, Biannual Gas System Evaluation Report. January 1 – June 30, 2012.

City of Tacoma, 2012b. Tacoma Landfill Consent Decree 2011 Annual Report. March 2012.

City of Tacoma, 2012c. Tacoma Landfill, Biannual Gas System Evaluation Report. July 1 – December 31, 2012.

City of Tacoma, 2012d. Tacoma Landfill Institutional Controls Plan, Errata sheets. July 2012.

City of Tacoma, 2012e. Tacoma Landfill, Request to Decommission Extraction Wells W-30, W-40, and W-41. November 2012.

City of Tacoma, 2013a. Tacoma Landfill Consent Decree 2012 Annual Report. March 2013.

City of Tacoma, 2013b. Annual Summary of Inspections for the Tacoma Landfill Cap, Condensate Collection System, and Central Area Leachate Collection System. March 2013.

EPA, 2009a. Letter to City of Tacoma, re: Proposal for Gas Extraction Wells and Probes at Tacoma Landfill Operable Unit of the South Tacoma Channel Superfund Site, Tacoma, Washington. August 20, 2009.

EPA, 2009b. Letter to City of Tacoma, re: Third Five-Year Closure Extension Request. December 21, 2009.

EPA, 2010a. Letter to City of Tacoma, re: Conditional Approval of Shutdown Request & Rebound Monitoring Proposal for Extraction Wells at the Tacoma Landfill Operable Unit, South Tacoma Channel Superfund Site. February 11, 2010.

EPA, 2010b. Letter to City of Tacoma, re: Modifications to the Closure Extension III Conditional Approval. July 28, 2010.

EPA, 2010c. Letter to City of Tacoma, re: Amendment to Institutional Control Plan. November 1, 2010.

EPA, 2011. Letter to City of Tacoma, re: November 2010 Draft Landuse and Institutional Control Plan. April 29, 2011.

Floyd|Snider, 2009a. Memorandum, re: Vinyl Chloride Issues from the Third 5-Year Review. February 24, 2009.

Floyd|Snider, 2009b. Memorandum, re: Vapor Intrusion Evaluation for the Tacoma Landfill Off-site Plume Area. August 28, 2009.

Floyd|Snider, 2009c. Memorandum, re: Arsenic and Human Health Exposure Issues from the Third 5-Year Review. October 12, 2009.

Landau Associates, 2006. End of Plume Residual Plume Characterization Report, Tacoma Landifll – North Area & South Area, Tacoma, Washington. February 1, 2006.

Landau Associates, 2010. Tacoma Landfill Groundwater Rebound Monitoring Plan, Tacoma, Washington. September 15, 2010.

State of Washington Department of Ecology (Ecology), 2010. Letter to City of Tacoma, re: Tacoma Landfill Nested Gas Extraction Well Decommissioning and Construction Requirements. December 20, 2010.

Appendix 3-B: Tacoma Landfill Site Inspection Checklist

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Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Tacoma Landfill	**Date of inspection: 4/2/2013**
Location: Tacoma, WA	**EPA ID: WAD980726301**
Agency, office, or company leading the five-year review: EPA	**Weather/temperature: Cloudy, ~50 F**

Remedy Includes: (Check all that apply)

☒ Landfill cover/containment ☐ Monitored natural attenuation

☒ Access controls ☐ Groundwater containment

☒Institutional controls ☐ Vertical barrier walls

☒ Groundwater pump and treatment

☒ Surface water collection and treatment

☒ Other: *Groundwater monitoring*

_____

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

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_____

_____

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_____

_____

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: _____ _____ _____ _____ _____ _____
V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A	
A. Fencing	
1.	**Fencing damaged** ☐ Location shown on site map ☐Gates secured ☐ N/A Remarks_Fencing on west side, near former pipe facility, damaged._____ _____
B. Other Access Restrictions	
1.	**Signs and other security measures** ☐ Location shown on site map ☐ N/A Remarks__Active transfer station, numerous signs on site._____ _____

C. Institutional Controls (ICs)

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

_____

_____

_____

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

Remarks_____

_____

_____

D. General

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

Remarks____Cal Taylor stated brass valves on gas wells stolen. The City replaced with plastic to avoid future problems._____

2. **Land use changes on site** ☐ N/A

Remarks___Central Area closed. Site continues to be used as a transfer station._____

_____

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

Remarks___none_____

_____

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			
A. Landfill Surface			
1.	**Settlement** (Low spots)	☐ Location shown on site map	☐ Settlement not evident
	Areal extent_____	Depth_____	
	Remarks__Documented in Annual reports_____		
2.	**Cracks**	☐ Location shown on site map	☒ Cracking not evident
	Lengths_____ Widths_____ Depths_____		
	Remarks_____		
3.	**Erosion**	☐ Location shown on site map	☒ Erosion not evident
	Areal extent_____	Depth_____	
	Remarks_____		
4.	**Holes**	☐ Location shown on site map	☒ Holes not evident
	Areal extent_____	Depth_____	
	Remarks_____		
5.	**Vegetative Cover** ☒ Grass	☒Cover properly established	☐ No signs of stress
	☐ Trees/Shrubs (indicate size and locations on a diagram)		
	Remarks__Vegetation on central area cap will be completed this year_____		
6.	**Alternative Cover (armored rock, concrete, etc.)** ☒ N/A		
	Remarks_____		

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident

Areal extent_____ Height_____

Remarks_____

_____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent_____

☐ Ponding ☐ Location shown on site map Areal extent_____

☐ Seeps ☐ Location shown on site map Areal extent_____

☐ Soft subgrade ☐Location shown on site map Areal extent_____

Remarks___Wet areas during winter documented in annual report. None observed during site visit.

_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability

Areal extent_____

Remarks_____

_____

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement

Areal extent_____ Depth_____

Remarks_____

_____

2. **Material Degradation** ☐ Location shown on site map ☐No evidence of degradation

Material type_____ Areal extent_____

Remarks_____

_____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion

Areal extent_____ Depth_____

Remarks_____

_____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting

Areal extent_____ Depth_____

Remarks_____

_____

5. **Obstructions** Type_____ ☐ No obstructions

☐ Location shown on site map Areal extent_____

Size_____

Remarks_____

_____

6. **Excessive Vegetative Growth** Type_____

☐ No evidence of excessive growth

☐ Vegetation in channels does not obstruct flow

☐ Location shown on site map Areal extent_____

Remarks_____

_____

D. Cover Penetrations ☒ Applicable ☐ N/A

1. **Gas Vents** ☒ Active ☐ Passive

☐ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance

☐ N/A

Remarks_____

_____

2. **Gas Monitoring Probes**

☐ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

3. **Monitoring Wells** (within surface area of landfill)

☐ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

4. **Leachate Extraction Wells**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks___Gas probes that collect leachate are pumped out_____

_____

5. **Settlement Monuments** ☐ Located ☒ Routinely surveyed ☐N/A

Remarks_____

_____

E. Gas Collection and Treatment ☐ Applicable ☐N/A

1. **Gas Treatment Facilities**

☒ Flaring ☐ Thermal destruction ☐ Collection for reuse

☐ Good condition ☐ Needs Maintenance

Remarks_New, smaller flare installed_____

_____

2. **Gas Collection Wells, Manifolds and Piping**

☒ Good condition ☐ Needs Maintenance

Remarks_____

_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)

☒ Good condition ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

F. Cover Drainage Layer ☒ Applicable ☐ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A

Remarks__not inspected_____

_____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A

Remarks__not inspected_____

_____

G. Detention/Sedimentation Ponds ☒ Applicable ☐ N/A

1. **Siltation** Areal extent_____ Depth_____ ☐ N/A

☒ Siltation not evident

Remarks_____

_____

2. **Erosion** Areal extent_____ Depth_____

☒ Erosion not evident

Remarks_____

_____

3. **Outlet Works** ☐ Functioning ☒ N/A

Remarks_____

_____

4. **Dam** ☐ Functioning ☒ N/A

Remarks_____

_____

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident

Horizontal displacement_____ Vertical displacement_____

Rotational displacement_____

Remarks_____

_____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident

Remarks_____

_____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident

Areal extent_____ Depth_____

Remarks_____

_____

2.	**Vegetative Growth** ☐ Location shown on site map ☐ N/A ☐ Vegetation does not impede flow Areal extent_____ Type_____ Remarks_____ _____
3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent_____ Depth_____ Remarks_____ _____
4.	**Discharge Structure** ☐ Functioning ☐ N/A Remarks_____ _____
	VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A
1.	**Settlement** ☐ Location shown on site map ☐ Settlement not evident Areal extent_____ Depth_____ Remarks_____ _____
2.	**Performance Monitoring** Type of monitoring_____ ☐ Performance not monitored Frequency_____ ☐ Evidence of breaching Head differential_____ Remarks_____ _____
	IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A
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 ☐ 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___not inspected_____

_____

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__not inspected_____

_____

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_____

_____

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_____

_____

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

5. Monitoring Data
☒ Is routinely submitted on time ☐ Is of acceptable quality

6. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

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.). ___The purpose of the remedy is to prevent migration of the groundwater plume and protect human health and the environment. The Central Area cap is complete; the only remaining item is vegetation on one portion. Landfill gas continues to be extracted and burned at the flare. Most of the GETS wells have been shutdown; only 5 remain in operation in areas of residual plumes. The property will continue to be used as a transfer station and recycling center by the City of Tacoma._____
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. __The site appears to well maintained. Gas and groundwater are regularly monitored. The cap has settlement and some ponding, typical of a landfill. The City pumps out ponded water on an as needed basis._____

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. ____There are no indicators of remedy problems._____
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. ____No optimization opportunities noted during the site visit._____

Appendix 3-C: Tacoma Landfill Site Inspection Photographs

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Tacoma Landfill Site Inspection Photographs

Photo 1. Recycling center.

Photo 2. Mothballed groundwater treatment system.

Photo 3. Remaining portion of Central Area needing vegetation.

Photo 4. Completed cap with vegetation at Central Area.

Photo 5. Southern cap area.

Photo 6. Monitoring wells TL-11A, B and C.

Photo 7. Extraction well W-1.

Photo 8. Elevated piping for gas extraction system at southern cap area.

Photo 9. New gas extraction well, HD-1, near Home Depot.

Photo 10. Location of manholes for leachate monitoring and collection system.

Photo 11. Landfill flare.

Photo 12. Leach Creek gauging station.

Appendix 3-D: Tacoma Landfill Interview Transcripts

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Tacoma Landfill Interview Transcripts

Five Year Review Interview Record
Site Name: Tacoma Landfill, South Tacoma Channel Superfund Site
EPA ID No. WAD980726301
Interviewee: Dave Bosch, Tacoma Pierce County Health Department
Date: 22 April 2013
Interview Method: phone
Interview Contacts: Sharon Gelinas, USACE; Kristen Kerns, USACE

Interview Questions (responses are paraphrased)

1. What is your current role as it relates to the site? How long have you been aware of or associated with the site?
   Dave's title is Environmental Health Specialist II. He is in charge of overseeing regulation of solid waste at the Tacoma landfill site.

2. What is your overall impression of the work conducted at the site to date?
   Overall impression is that the remedy has been very effective. Capping and maintenance of the cap has been effective at decreasing trends of COCs and allowed for the discontinuation of monitoring extraction wells off site. Gas production at the site has decreased over time due to the cap and the age of the landfill.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? (If so, please give purpose and results.)
   There is routine inspection of the solid waste handling and of the closed areas. Since 2009 the health department has performed over 200 inspections. Also conduct inspections that focus on construction activities, such as cap repairs.

4. Is there a continuous on-site O&M presence? If so, who are they? (contractors, etc).
   Yes, the City maintains a constant on site presence.

   Follow on Question: If there is no continuous on-site presence, describe staff and frequency of site inspections and activities (e.g. what types of monitoring activities occur at what frequencies).
   City is responsible for continuous on site presence.

5. Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy (e.g. the GETS) that show wear or may need additional focus during O&M?
   The city has done a good job at assigning staff specifically to the remedial action activities to ensure monitoring is performed and systems are maintained. Improvements could be made regarding ponding on areas of the cap, specifically the sw corner and east of the central area on the closed portion. This requires a balance between evaluating the impact to the areas where ponding is occurring and the cost of the repairs. However, most of the ponding is not considered a critical issue at this time. Ponding indicates that the water is not leaching through the cap, however, it does indicate the cap is not functioning as intended. It is recommended that the O&M plan for leachate developed in 1992 be updated to address more modern activities associated with the landfill. Also need to update information regarding the asphalt cap and its replacement with HDPE liner in high traffic areas.

6. What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?
   - Are there any other significant construction activities proposed?
     There are no significant problems associated with the central area closure. The closure has been split into three phases. Phase I in 2011 closed 15 acres in the southern portion of the site. Phase II in 2012 closed an additional 7 acres and hydroseeded the phase I closure area. Phase III will occur this summer and close the remaining 8 acres at the site. There are cap repairs scheduled in the summer of 2013 for the parking lot west of the administrative building. There will also be infrastructure installed for compressed natural gas.

7. What does the monitoring data show?
   - Are there any trends in the data that show contaminant levels are increasing or decreasing?
     Trends show a decrease in contaminant levels overall. The Home Depot area is also showing decrease concentrations over time.

   - Have any new or emerging COCs been identified?
     No

8. Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.
   No

9. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.
   There have been issues associated with flooding in the Fircrest neighborhood that the city is addressing. This issue is not believed to be related to the landfill site. The city also coordinated with a local highschool for a school project related to methyl mercury.

10. Are you aware of any ongoing community concerns regarding the site or its administration?
    No

11. Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?
    A drunk driver crashed into the entrance gate, which subsequently required repairs. The fence was cut through and bras valves from the gas extraction system were stolen. These were later replaced. There are occasional emergency responses associated with public waste handling, which is not related to the remedy.

12. Have any problems been encountered which required, or will require changes to this remedial design or ROD?
    No

13. Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?
    No

Five Year Review Interview Record
Site Name: Tacoma Landfill, South Tacoma Channel Superfund Site
EPA ID No. WAD980726301
Interviewee: Chris Mauer, Department of Ecology
Date: 16 April 2013
Interview Method: phone
Interview Contacts: Sharon Gelinas, USACE; Kristen Kerns, USACE

Interview Questions (responses are paraphrased)

1. What is your current role as it relates to the site? How long have you been aware of or associated with the site?
   Chris is a project manager with Ecology for the Tacoma Landfill Site. He has been involved with the project for 25 years.

2. What is your overall impression of the work conducted at the site to date?
   The work at the site has been well done.

3. Have there been routine communications or activities (for example site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
   The project team used to meet monthly. Meetings were moved to quarterly and are now on an as needed basis. Chris has no other recent communications or activities.

4. Would you say that O&M and/or sampling efforts have been optimized? Are there portions of the remedy (for example the GETS) that show wear or may need additional focus during O&M?
   Efforts have been optimized. There are no portions of the remedy that need additional focus during O&M.

5. Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.
   There have been two occasions where rart of the site washed out. One incident was due to a ruptured pipe that washed out the soil from beneath the cap. The other washout incident was similar in nature. In both instances the City responded promptly to repair the damage.

6. What does the monitoring data show?
   - Are there any trends in the data that show contaminant levels are increasing or decreasing?
     The offsite plume has shrunk over the past decade and is almost completely contained within the landfill boundary. This is part of the reason why off site monitoring wells have been shut down.

   - Have any new or emerging COCs been identified?
     No. The site was initially well characterized.

7. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

Not at this time. A land use control plan is in effect and was revised approximately three years ago. Institutional controls, including fencing and prohibition against drilling wells for water, are in effect.

8. Are you aware of any ongoing community concerns regarding the site or its administration?
   Not in the past five years. Historically there were problems with odor but a control plan has been put in place and has proven effective.

9. Are you aware of any events, incidents, or activities that have occurred at the site, such as excavation, vandalism, trespassing, or emergency response from local authorities?
   A well was destroyed by vandalism approximately ten years ago. Recently copper gas headers were stolen.

10. Have any problems been encountered which required, or will require changes to this remedial design or ROD?
    No

11. Do you have any comments, suggestions, or recommendations regarding the site's management, operation, or any other aspects of the site?
    No

Appendix 3-E: Tacoma Landfill Data Summary

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Tacoma Landfill Data Summary

Table E-1
Wells with Exceedence of the Contingent Action Criteria

Well No.	Date	Constituent	Result (ug/L)	CAC Basis	CAC
PW-01	5/12/2010	1,1-Dichloroethane	0.6	RL	0.5
PW-01	8/6/2010	1,1-Dichloroethane	0.6	RL	0.5
PW-01	11/10/2010	1,1-Dichloroethane	0.6	RL	0.5
PW-01	2/7/2011	1,1-Dichloroethane	0.7	RL	0.5
PW-01	5/13/2011	1,1-Dichloroethane	0.8	RL	0.5
PW-01	8/4/2011	1,1-Dichloroethane	0.8 J	RL	0.5
PW-01	11/4/2011	1,1-Dichloroethane	0.7 J	RL	0.5
PW-01	2/15/2012	1,1-Dichloroethane	0.8	RL	0.5
PW-01	5/4/2012	1,1-Dichloroethane	0.8	RL	0.5
PW-01	8/10/2012	1,1-Dichloroethane	0.8	RL	0.5
PW-01	11/1/2012	1,1-Dichloroethane	0.6	RL	0.5
PW-11	11/8/2011	Tetrachloroethene	0.9 J	RL	0.5
TL-05C	11/1/2011	1,2-Dichloroethane	0.7 J	RL	0.5
TL-07A	11/1/2011	1,2-Dichloroethane	0.7 J	RL	0.5
TL-11A	11/9/2011	Benzene	0.9 J	RL	0.5
TL-11B	11/9/2011	1,1-Dichloroethane	1.1	RL	0.5
TL-11B	11/9/2011	Tetrachloroethene	0.9 J	RL	0.5
TL-11B	11/9/2011	Trichloroethene	1.8	Control Chart	1.7
W-02	11/9/2011	1,1-Dichloroethane	2	Control Chart	1.8
W-02	9/16/2011	Benzene	1.9	RL	0.5
W-02	11/9/2011	Vinyl Chloride	1	Pred. Limit	0.8
W-03	8/11/2011	Trichloroethene	7.4	Control Chart	6.2
W-04	11/9/2011	1,1-Dichloroethane	2.6	Control Chart	2.3
W-04	5/18/2011	Tetrachloroethene	1	Pred. Limit	0.9
W-04	8/10/2011	Tetrachloroethene	1	Pred. Limit	0.9
W-04	11/9/2011	Tetrachloroethene	1.7	Pred. Limit	0.9
W-06	11/9/2011	1,1-Dichloroethane	3.3	Control Chart	2.7
W-06	11/9/2011	Tetrachloroethene	0.9 J	RL	0.5
W-06	11/9/2011	Trichloroethene	0.9 J	Pred. Limit	0.8
W-06	5/18/2010	Vinyl Chloride	0.6	Pred. Limit	0.5
W-06	8/10/2011	Vinyl Chloride	0.6	Pred. Limit	0.5
W-06	11/9/2011	Vinyl Chloride	1	Pred. Limit	0.5
W-07	5/18/2011	1,1-Dichloroethane	2.8	Control Chart	2.7
W-07	8/10/2011	1,1-Dichloroethane	2.9	Control Chart	2.7
W-07	11/9/2011	1,1-Dichloroethane	4.5	Control Chart	2.7
W-07	11/9/2011	Benzene	1.1	RL	0.5
W-07	8/10/2011	Chloroethane	0.6 J	RL	0.5
W-07	8/10/2011	Vinyl Chloride	1	Pred. Limit	0.7
W-07	11/9/2011	Vinyl Chloride	1.3	Pred. Limit	0.7
W-08	11/9/2011	1,1-Dichloroethane	1.8	Control Chart	0.9
W-08	11/9/2011	Benzene	1.1	RL	0.5
W-08	5/18/2010	Tetrachloroethene	1	RL	0.5
W-08	11/9/2011	Tetrachloroethene	0.9 J	RL	0.5
W-08	5/18/2010	Trichloroethene	2.6	RL	0.5
W-08	8/16/2010	Trichloroethene	1.7	RL	0.5
W-08	11/15/2010	Trichloroethene	0.9	RL	0.5
W-08	2/18/2011	Trichloroethene	1.1	RL	0.5
W-08	5/18/2011	Trichloroethene	0.7	RL	0.5
W-08	11/9/2011	Trichloroethene	1.1	RL	0.5
W-08	5/18/2010	Vinyl Chloride	0.6	RL	0.5
W-08	11/9/2011	Vinyl Chloride	0.8	RL	0.5

Table E-1
Wells with Exceedence of the Contingent Action Criteria

Well No.	Date	Constituent	Result (ug/L)	CAC Basis	CAC
W-09	5/18/2010	1,1-Dichloroethane	0.9	RL	0.5
W-09	8/16/2010	1,1-Dichloroethane	0.8	RL	0.5
W-09	11/15/2010	1,1-Dichloroethane	0.8	RL	0.5
W-09	2/18/2011	1,1-Dichloroethane	1.3	RL	0.5
W-09	5/18/2011	1,1-Dichloroethane	0.9	RL	0.5
W-09	8/10/2011	1,1-Dichloroethane	1	RL	0.5
W-09	11/9/2011	1,1-Dichloroethane	2.4	RL	0.5
W-09	2/21/2012	1,1-Dichloroethane	0.9	RL	0.5
W-09	5/18/2010	Tetrachloroethene	1.3	RL	0.5
W-09	8/16/2010	Tetrachloroethene	1.3	RL	0.5
W-09	11/15/2010	Tetrachloroethene	1	RL	0.5
W-09	2/18/2011	Tetrachloroethene	1.8	RL	0.5
W-09	5/18/2011	Tetrachloroethene	0.9	RL	0.5
W-09	8/10/2011	Tetrachloroethene	1.1	RL	0.5
W-09	11/9/2011	Tetrachloroethene	1.6	RL	0.5
W-09	5/18/2010	Trichloroethene	3.2	Pred. Limit	0.6
W-09	8/16/2010	Trichloroethene	3.3	Pred. Limit	0.6
W-09	11/15/2010	Trichloroethene	2.7	Pred. Limit	0.6
W-09	2/18/2011	Trichloroethene	2.3	Pred. Limit	0.6
W-09	5/18/2011	Trichloroethene	2.6	Pred. Limit	0.6
W-09	8/10/2011	Trichloroethene	2.9	Pred. Limit	0.6
W-09	11/9/2011	Trichloroethene	2.6	Pred. Limit	0.6
W-09	2/21/2012	Trichloroethene	1.4	Pred. Limit	0.6
W-09	5/8/2012	Trichloroethene	1.3	Pred. Limit	0.6
W-09	8/20/2012	Trichloroethene	1.2	Pred. Limit	0.6
W-09	11/6/2012	Trichloroethene	1.1	Pred. Limit	0.6
W-09	5/18/2010	Vinyl Chloride	0.6	RL	0.5
W-09	2/18/2011	Vinyl Chloride	0.7	RL	0.5
W-09	11/9/2011	Vinyl Chloride	1.2	RL	0.5
W-10	5/18/2010	1,1-Dichloroethane	0.9	Pred. Limit	0.7
W-10	8/16/2010	1,1-Dichloroethane	0.8	Pred. Limit	0.7
W-10	11/15/2010	1,1-Dichloroethane	0.9	Pred. Limit	0.7
W-10	2/18/2011	1,1-Dichloroethane	1.2	Pred. Limit	0.7
W-10	5/18/2011	1,1-Dichloroethane	0.9	Pred. Limit	0.7
W-10	8/10/2011	1,1-Dichloroethane	1.1	Pred. Limit	0.7
W-10	11/9/2011	1,1-Dichloroethane	2.4	Pred. Limit	0.7
W-10	2/21/2012	1,1-Dichloroethane	0.9	Pred. Limit	0.7
W-10	5/8/2012	1,1-Dichloroethane	0.8	Pred. Limit	0.7
W-10	8/20/2012	1,1-Dichloroethane	0.9	Pred. Limit	0.7
W-10	5/18/2010	Tetrachloroethene	1.1	RL	0.5
W-10	8/16/2010	Tetrachloroethene	1.1	RL	0.5
W-10	11/15/2010	Tetrachloroethene	1	RL	0.5
W-10	2/18/2011	Tetrachloroethene	1.5	RL	0.5
W-10	5/18/2011	Tetrachloroethene	0.9	RL	0.5
W-10	8/10/2011	Tetrachloroethene	1.2	RL	0.5
W-10	11/9/2011	Tetrachloroethene	1.6	RL	0.5
W-10	2/21/2012	Tetrachloroethene	0.6	RL	0.5
W-10	11/6/2012	Tetrachloroethene	0.6	RL	0.5
W-10	5/18/2010	Trichloroethene	3	Pred. Limit	0.7
W-10	8/16/2010	Trichloroethene	3.1	Pred. Limit	0.7
W-10	11/15/2010	Trichloroethene	2.6	Pred. Limit	0.7

Table E-1
Wells with Exceedence of the Contingent Action Criteria

Well No.	Date	Constituent	Result (ug/L)	CAC Basis	CAC
W-10	2/18/2011	Trichloroethene	2.1	Pred. Limit	0.7
W-10	5/18/2011	Trichloroethene	2.3	Pred. Limit	0.7
W-10	8/10/2011	Trichloroethene	3.1	Pred. Limit	0.7
W-10	11/9/2011	Trichloroethene	2.8	Pred. Limit	0.7
W-10	2/21/2012	Trichloroethene	1.6	Pred. Limit	0.7
W-10	5/8/2012	Trichloroethene	1.4	Pred. Limit	0.7
W-10	8/20/2012	Trichloroethene	1.8	Pred. Limit	0.7
W-10	11/6/2012	Trichloroethene	1.6	Pred. Limit	0.7
W-10	5/18/2010	Vinyl Chloride	0.4	Pred. Limit	0.3
W-10	2/18/2011	Vinyl Chloride	0.9	Pred. Limit	0.3
W-10	8/10/2011	Vinyl Chloride	0.6	Pred. Limit	0.3
W-10	11/9/2011	Vinyl Chloride	1.1	Pred. Limit	0.3
W-11	5/19/2010	1,1-Dichloroethane	0.7	RL	0.5
W-11	8/16/2010	1,1-Dichloroethane	0.7	RL	0.5
W-11	11/16/2010	1,1-Dichloroethane	0.7	RL	0.5
W-11	2/22/2011	1,1-Dichloroethane	0.8	RL	0.5
W-11	5/19/2011	1,1-Dichloroethane	0.7	RL	0.5
W-11	8/10/2011	1,1-Dichloroethane	0.9 J	RL	0.5
W-11	11/9/2011	1,1-Dichloroethane	2	RL	0.5
W-11	2/21/2012	1,1-Dichloroethane	0.8	RL	0.5
W-11	5/8/2012	1,1-Dichloroethane	0.9	RL	0.5
W-11	8/20/2012	1,1-Dichloroethane	0.8	RL	0.5
W-11	11/6/2012	1,1-Dichloroethane	0.8	RL	0.5
W-11	5/19/2010	Tetrachloroethene	0.8	RL	0.5
W-11	8/16/2010	Tetrachloroethene	1	RL	0.5
W-11	11/16/2010	Tetrachloroethene	0.7	RL	0.5
W-11	2/22/2011	Tetrachloroethene	0.6	RL	0.5
W-11	5/19/2011	Tetrachloroethene	0.7	RL	0.5
W-11	8/10/2011	Tetrachloroethene	1	RL	0.5
W-11	11/9/2011	Tetrachloroethene	1.4	RL	0.5
W-11	5/8/2012	Tetrachloroethene	0.6	RL	0.5
W-11	8/20/2012	Tetrachloroethene	0.6	RL	0.5
W-11	5/19/2010	Trichloroethene	2.3	RL	0.5
W-11	8/16/2010	Trichloroethene	2.5	RL	0.5
W-11	11/16/2010	Trichloroethene	1.7	RL	0.5
W-11	2/22/2011	Trichloroethene	1.5	RL	0.5
W-11	5/19/2011	Trichloroethene	1.9	RL	0.5
W-11	8/10/2011	Trichloroethene	2.7	RL	0.5
W-11	11/9/2011	Trichloroethene	2.6	RL	0.5
W-11	2/21/2012	Trichloroethene	1.4	RL	0.5
W-11	5/8/2012	Trichloroethene	1.4	RL	0.5
W-11	8/20/2012	Trichloroethene	1.5	RL	0.5
W-11	11/6/2012	Trichloroethene	1.5	RL	0.5
W-11	8/10/2011	Vinyl Chloride	0.7	RL	0.5
W-11	11/9/2011	Vinyl Chloride	0.9	RL	0.5
W-14	8/12/2010	1,1-Dichloroethane	0.7	Pred. Limit	0.6
W-14	8/12/2010	Tetrachloroethene	1.9	Pred. Limit	0.5
W-14	11/10/2011	Tetrachloroethene	1	Pred. Limit	0.5
W-14	8/12/2010	Trichloroethene	1.3	Pred. Limit	0.5
W-14	11/10/2011	Trichloroethene	0.8 J	Pred. Limit	0.5
W-15	11/10/2011	1,1-Dichloroethane	2.2	Control Chart	1.5

Table E-1
Wells with Exceedence of the Contingent Action Criteria

Well No.	Date	Constituent	Result (ug/L)	CAC Basis	CAC
W-15	11/10/2011	Benzene	0.9 J	RL	0.5
W-15	11/10/2011	Tetrachloroethene	2.3	Control Chart	1.9
W-15	11/10/2011	Trichloroethene	1.9	Control Chart	1.7
W-16	11/10/2011	1,1-Dichloroethane	1.9	Control Chart	1.8
W-16	5/19/2010	Tetrachloroethene	0.9	RL	0.5
W-16	8/17/2010	Tetrachloroethene	1	RL	0.5
W-16	11/10/2011	Tetrachloroethene	1.1	RL	0.5
W-16	5/19/2010	Trichloroethene	2.1	RL	0.5
W-16	8/17/2010	Trichloroethene	2.2	RL	0.5
W-16	11/16/2010	Trichloroethene	0.8	RL	0.5
W-16	8/11/2011	Trichloroethene	0.7 J	RL	0.5
W-16	11/10/2011	Trichloroethene	1.3	RL	0.5
W-17	11/10/2011	Tetrachloroethene	0.8 J	RL	0.5
W-17	11/10/2011	Trichloroethene	0.8 J	RL	0.5
W-18	5/19/2010	1,1-Dichloroethane	0.7	RL	0.5
W-18	8/17/2010	1,1-Dichloroethane	0.8	RL	0.5
W-18	11/16/2010	1,1-Dichloroethane	0.9	RL	0.5
W-18	2/22/2011	1,1-Dichloroethane	1	RL	0.5
W-18	5/19/2011	1,1-Dichloroethane	0.9	RL	0.5
W-18	8/11/2011	1,1-Dichloroethane	0.9 J	RL	0.5
W-18	11/10/2011	1,1-Dichloroethane	2.2	RL	0.5
W-18	2/22/2012	1,1-Dichloroethane	0.9	RL	0.5
W-18	8/21/2012	1,1-Dichloroethane	0.8	RL	0.5
W-18	8/17/2010	Tetrachloroethene	0.8	RL	0.5
W-18	11/16/2010	Tetrachloroethene	0.8	RL	0.5
W-18	2/22/2011	Tetrachloroethene	0.9	RL	0.5
W-18	5/19/2011	Tetrachloroethene	0.8	RL	0.5
W-18	8/11/2011	Tetrachloroethene	0.9 J	RL	0.5
W-18	11/10/2011	Tetrachloroethene	1.5	RL	0.5
W-18	5/19/2010	Trichloroethene	1	RL	0.5
W-18	8/17/2010	Trichloroethene	2	RL	0.5
W-18	11/16/2010	Trichloroethene	2	RL	0.5
W-18	2/22/2011	Trichloroethene	1.5	RL	0.5
W-18	5/19/2011	Trichloroethene	2.1	RL	0.5
W-18	8/11/2011	Trichloroethene	1.9	RL	0.5
W-18	11/10/2011	Trichloroethene	2.4	RL	0.5
W-18	2/22/2012	Trichloroethene	1.3	RL	0.5
W-18	5/14/2012	Trichloroethene	0.8	RL	0.5
W-18	8/21/2012	Trichloroethene	1.1	RL	0.5
W-18	2/22/2011	Vinyl Chloride	0.9	Pred. Limit	0.6
W-18	11/10/2011	Vinyl Chloride	1.3	Pred. Limit	0.6
W-19	11/10/2011	1,1-Dichloroethane	1.1	RL	0.5
W-20	2/22/2011	1,1-Dichloroethane	0.7	RL	0.5
W-20	5/19/2011	1,1-Dichloroethane	0.7	RL	0.5
W-20	11/10/2011	1,1-Dichloroethane	1	RL	0.5
W-20	2/22/2011	Tetrachloroethene	0.8	RL	0.5
W-20	5/19/2011	Tetrachloroethene	0.8	RL	0.5
W-20	11/10/2011	Tetrachloroethene	0.9 J	RL	0.5
W-20	8/17/2010	Trichloroethene	0.6	RL	0.5
W-20	11/16/2010	Trichloroethene	1	RL	0.5
W-20	2/22/2011	Trichloroethene	1.1	RL	0.5

Table E-1
Wells with Exceedence of the Contingent Action Criteria

Well No.	Date	Constituent	Result (ug/L)	CAC Basis	CAC
W-20	5/19/2011	Trichloroethene	1.3	RL	0.5
W-20	11/10/2011	Trichloroethene	1	RL	0.5
W-21	5/19/2010	1,1-Dichloroethane	0.8	RL	0.5
W-21	2/22/2011	1,1-Dichloroethane	0.6	RL	0.5
W-21	8/11/2011	1,1-Dichloroethane	0.9 J	RL	0.5
W-21	11/10/2011	1,1-Dichloroethane	1.4	RL	0.5
W-21	5/19/2010	Tetrachloroethene	0.8	RL	0.5
W-21	8/11/2011	Tetrachloroethene	0.8 J	RL	0.5
W-21	11/10/2011	Tetrachloroethene	0.9 J	RL	0.5
W-21	5/19/2010	Trichloroethene	2.1	RL	0.5
W-21	8/17/2010	Trichloroethene	0.9	RL	0.5
W-21	2/22/2011	Trichloroethene	0.8	RL	0.5
W-21	5/19/2011	Trichloroethene	0.7	RL	0.5
W-21	8/11/2011	Trichloroethene	1.7	RL	0.5
W-21	11/10/2011	Trichloroethene	1.2	RL	0.5
W-22	5/19/2010	1,1-Dichloroethane	0.8	RL	0.5
W-22	8/17/2010	1,1-Dichloroethane	0.8	RL	0.5
W-22	11/16/2010	1,1-Dichloroethane	0.9	RL	0.5
W-22	2/22/2011	1,1-Dichloroethane	1.1	RL	0.5
W-22	5/19/2011	1,1-Dichloroethane	0.7	RL	0.5
W-22	8/11/2011	1,1-Dichloroethane	1.1	RL	0.5
W-22	11/10/2011	1,1-Dichloroethane	2.4	RL	0.5
W-22	2/22/2012	1,1-Dichloroethane	0.9	RL	0.5
W-22	5/9/2012	1,1-Dichloroethane	0.9	RL	0.5
W-22	8/21/2012	1,1-Dichloroethane	0.7	RL	0.5
W-22	11/6/2012	1,1-Dichloroethane	0.6	RL	0.5
W-22	8/17/2010	Tetrachloroethene	0.6	RL	0.5
W-22	11/16/2010	Tetrachloroethene	0.6	RL	0.5
W-22	2/22/2011	Tetrachloroethene	0.6	RL	0.5
W-22	5/19/2011	Tetrachloroethene	0.8	RL	0.5
W-22	11/10/2011	Tetrachloroethene	1.4	RL	0.5
W-22	2/22/2011	Vinyl Chloride	0.8	Pred. Limit	0.4
W-31	11/5/2012	Trichloroethene	0.9	RL	0.5
W-36	11/17/2010	1,1-Dichloroethane	1	RL	0.5
W-36	8/14/2012	1,1-Dichloroethane	0.8	RL	0.5
W-36	11/5/2012	1,1-Dichloroethane	0.6	RL	0.5
W-36	5/17/2010	Chloroethane	2.2	RL	0.5
W-36	11/17/2010	Tetrachloroethene	0.6	RL	0.5
W-36	8/14/2012	Tetrachloroethene	0.7	RL	0.5
W-36	11/17/2010	Trichloroethene	1.7	RL	0.5
W-36	8/14/2012	Trichloroethene	1.8	RL	0.5
W-36	11/5/2012	Trichloroethene	1.5	RL	0.5
W-41	8/14/2012	Trichloroethene	1	RL	0.5
W-43	2/17/2011	Vinyl Chloride	0.5	Pred. Limit	0.3

Notes:
CAC - Contingent action criteria
Control Chart - CAC calculated using Shewart-CUSUM control chart
RL - CAC set at historical reporting limit
Pred. Limit - CAC calculated using non-parametric prediction limit

Table E-2
Mann-Kendall Test for Trend Results

Well No.	Constituent	Mann-Kendall Results	
		Confidence Factor	Trend Result
PW-01	1,1-Dichloroethane	92.9%	Prob Increasing
TL-11B	1,1-Dichloroethane	99.0%	Decreasing
W-02	1,1-Dichloroethane	84.0%	Stable
W-04	1,1-Dichloroethane	72.9%	No Trend
W-06	1,1-Dichloroethane	59.0%	No Trend
W-07	1,1-Dichloroethane	56.0%	No Trend
W-08	1,1-Dichloroethane	96.4%	Decreasing
W-09	1,1-Dichloroethane	87.5%	Stable
W-10	1,1-Dichloroethane	70.3%	Stable
W-11	1,1-Dichloroethane	94.9%	Prob Increasing
W-14	1,1-Dichloroethane	98.0%	Decreasing
W-15	1,1-Dichloroethane	85.9%	Stable
W-16	1,1-Dichloroethane	92.9%	Prob Increasing
W-18	1,1-Dichloroethane	70.3%	Stable
W-19	1,1-Dichloroethane	90.5%	Prob Decreasing
W-21	1,1-Dichloroethane	92.9%	Prob Decreasing
W-22	1,1-Dichloroethane	67.6%	Stable
W-36	1,1-Dichloroethane	45.1%	Stable
TL-05C	1,2-Dichloroethane	67.6%	Stable
TL-07A	1,2-Dichloroethane	67.6%	Stable
TL-11A	Benzene	85.9%	Stable
W-02	Benzene	89.1%	No Trend
W-07	Benzene	94.0%	Prob Decreasing
W-08	Benzene	94.0%	Prob Decreasing
W-15	Benzene	91.8%	Prob Decreasing
W-07	Chloroethane	95.7%	Decreasing
W-36	Chloroethane	99.5%	Decreasing
PW-11	Tetrachloroethene	90.5%	Prob Decreasing
TL-11B	Tetrachloroethene	90.5%	Prob Decreasing
W-04	Tetrachloroethene	77.7%	No Trend
W-06	Tetrachloroethene	90.5%	Prob Decreasing
W-08	Tetrachloroethene	97.0%	Decreasing
W-09	Tetrachloroethene	99.2%	Decreasing
W-10	Tetrachloroethene	94.9%	Prob Decreasing
W-11	Tetrachloroethene	92.9%	Prob Decreasing
W-14	Tetrachloroethene	95.7%	Decreasing
W-15	Tetrachloroethene	77.7%	Stable
W-16	Tetrachloroethene	98.4%	Decreasing
W-17	Tetrachloroethene	90.5%	Prob Decreasing
W-18	Tetrachloroethene	85.9%	Stable
W-20	Tetrachloroethene	84.0%	Stable
W-21	Tetrachloroethene	91.8%	Prob Decreasing
W-22	Tetrachloroethene	87.5%	Stable
W-36	Tetrachloroethene	77.7%	Stable
TL-11B	Trichloroethene	85.9%	Stable
W-03	Trichloroethene	64.8%	Stable
W-06	Trichloroethene	95.7%	Decreasing
W-08	Trichloroethene	100.0%	Decreasing
W-09	Trichloroethene	>99.9%	Decreasing
W-10	Trichloroethene	98.7%	Decreasing

Table E-2
Mann-Kendall Test for Trend Results

Well No.	Constituent	Mann-Kendall Results	
		Confidence Factor	Trend Result
W-11	Trichloroethene	89.1%	Stable
W-14	Trichloroethene	97.5%	Decreasing
W-15	Trichloroethene	91.8%	Prob Decreasing
W-16	Trichloroethene	99.7%	Decreasing
W-18	Trichloroethene	90.5%	Prob Decreasing
W-20	Trichloroethene	94.9%	Prob Decreasing
W-21	Trichloroethene	99.4%	Decreasing
W-31	Trichloroethene	77.7%	Stable
W-36	Trichloroethene	53.0%	No Trend
W-41	Trichloroethene	63.6%	Stable
W-02	Vinyl Chloride	83.2%	Stable
W-06	Vinyl Chloride	89.1%	Stable
W-07	Vinyl Chloride	87.5%	Stable
W-08	Vinyl Chloride	94.9%	Prob Decreasing
W-09	Vinyl Chloride	96.4%	Decreasing
W-10	Vinyl Chloride	92.9%	Prob Decreasing
W-11	Vinyl Chloride	87.5%	Stable
W-18	Vinyl Chloride	70.3%	Stable
W-22	Vinyl Chloride	67.6%	Stable
W-43	Vinyl Chloride	91.8%	Prob Decreasing

Notes:
Well showed increasing trends

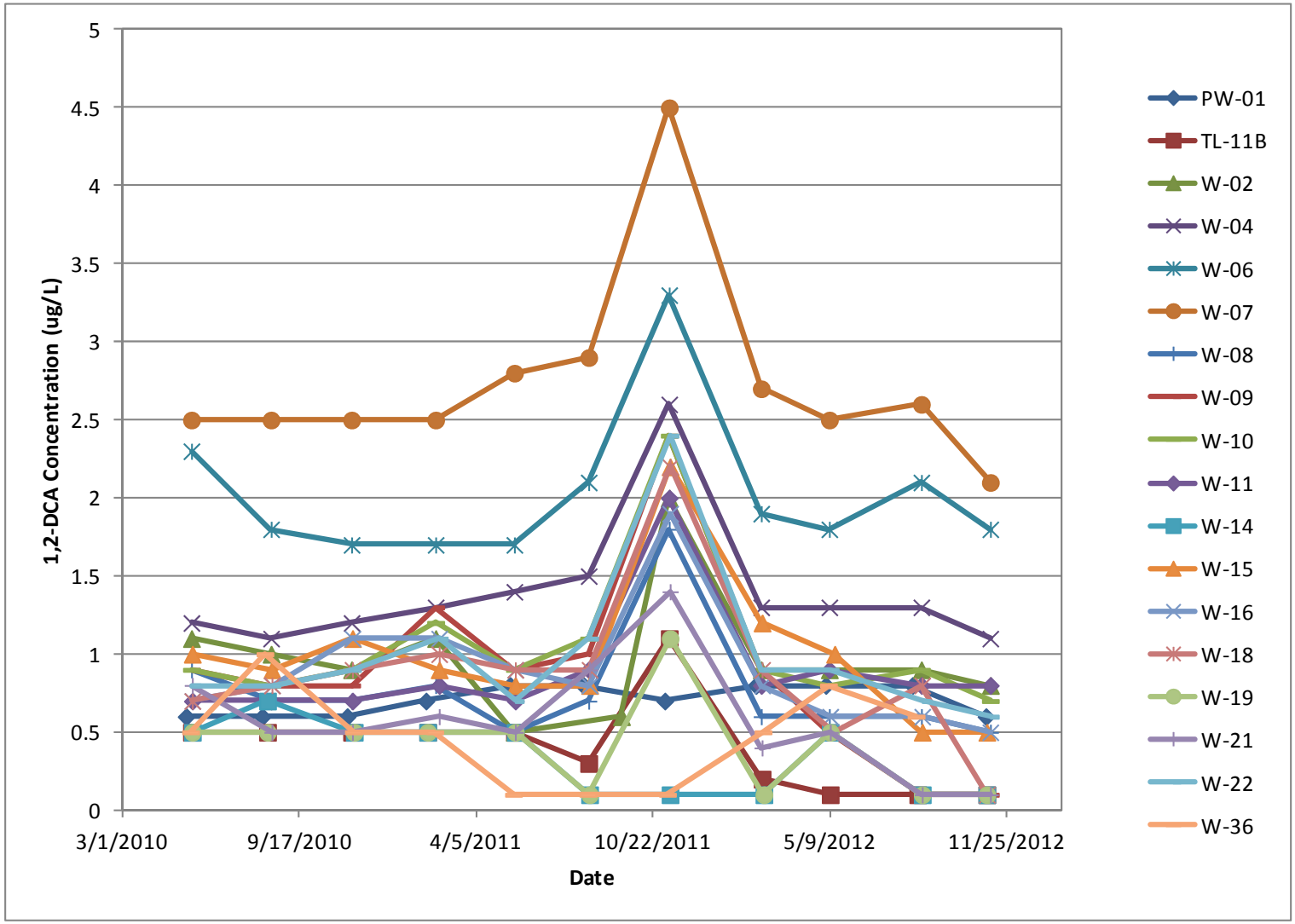

Figure E-1. 1,2-dichloroethane (DCA) concentrations at wells that exceeded the contingent action criteria.

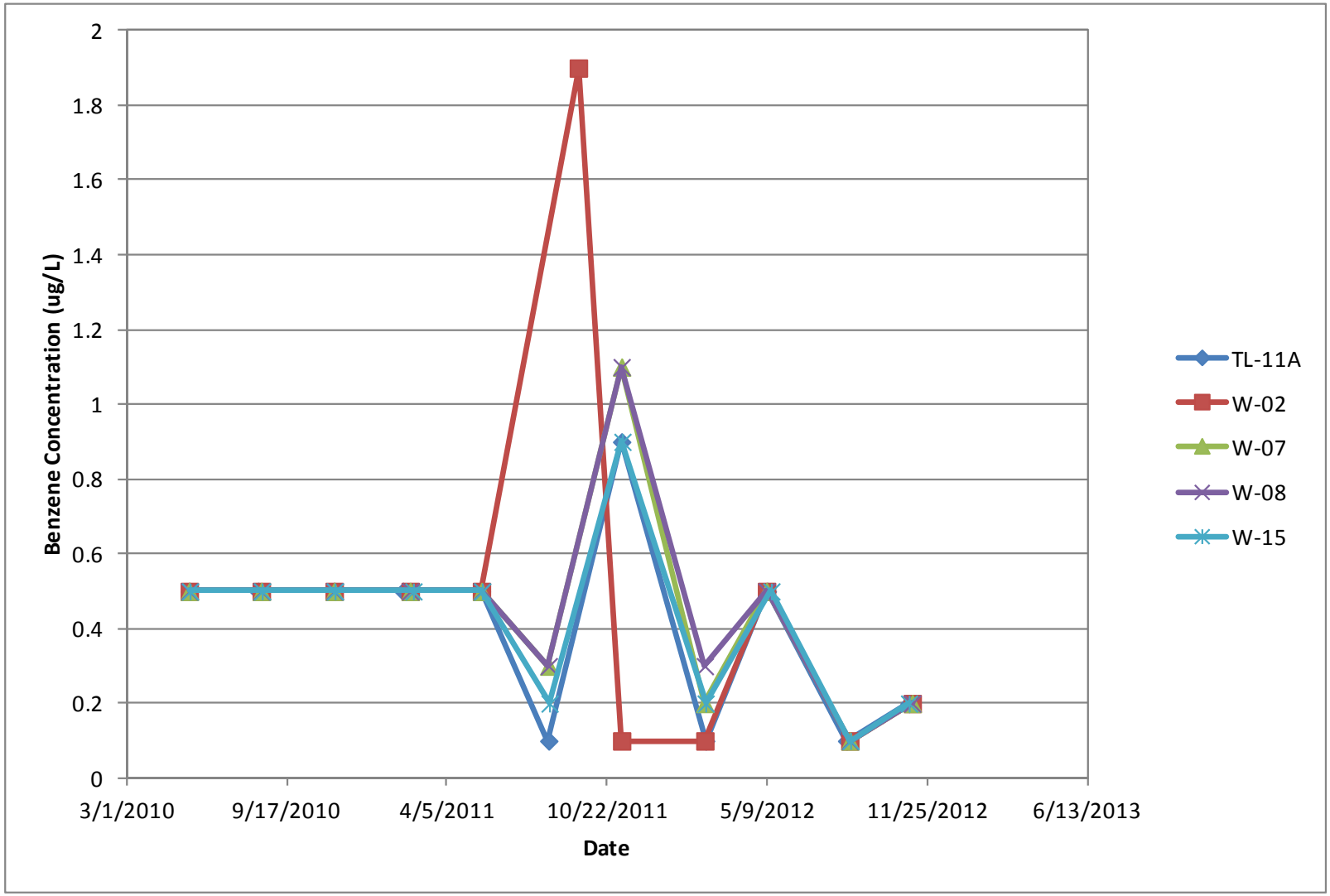

Figure E-2. Benzene concentrations at wells that exceeded the contingent action criteria.

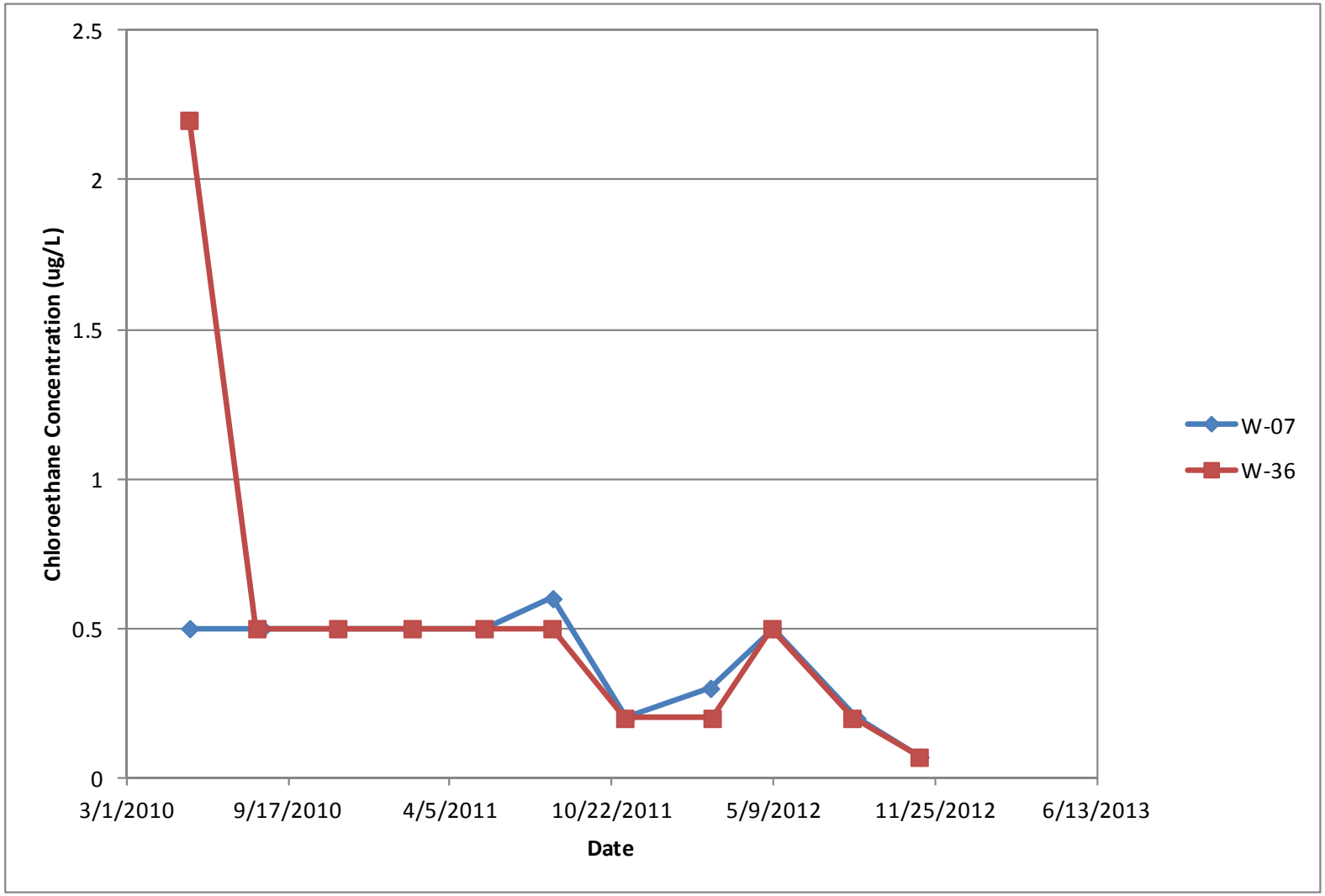

Figure E-3. Chloroethane concentrations at wells that exceeded the contingent action criteria.

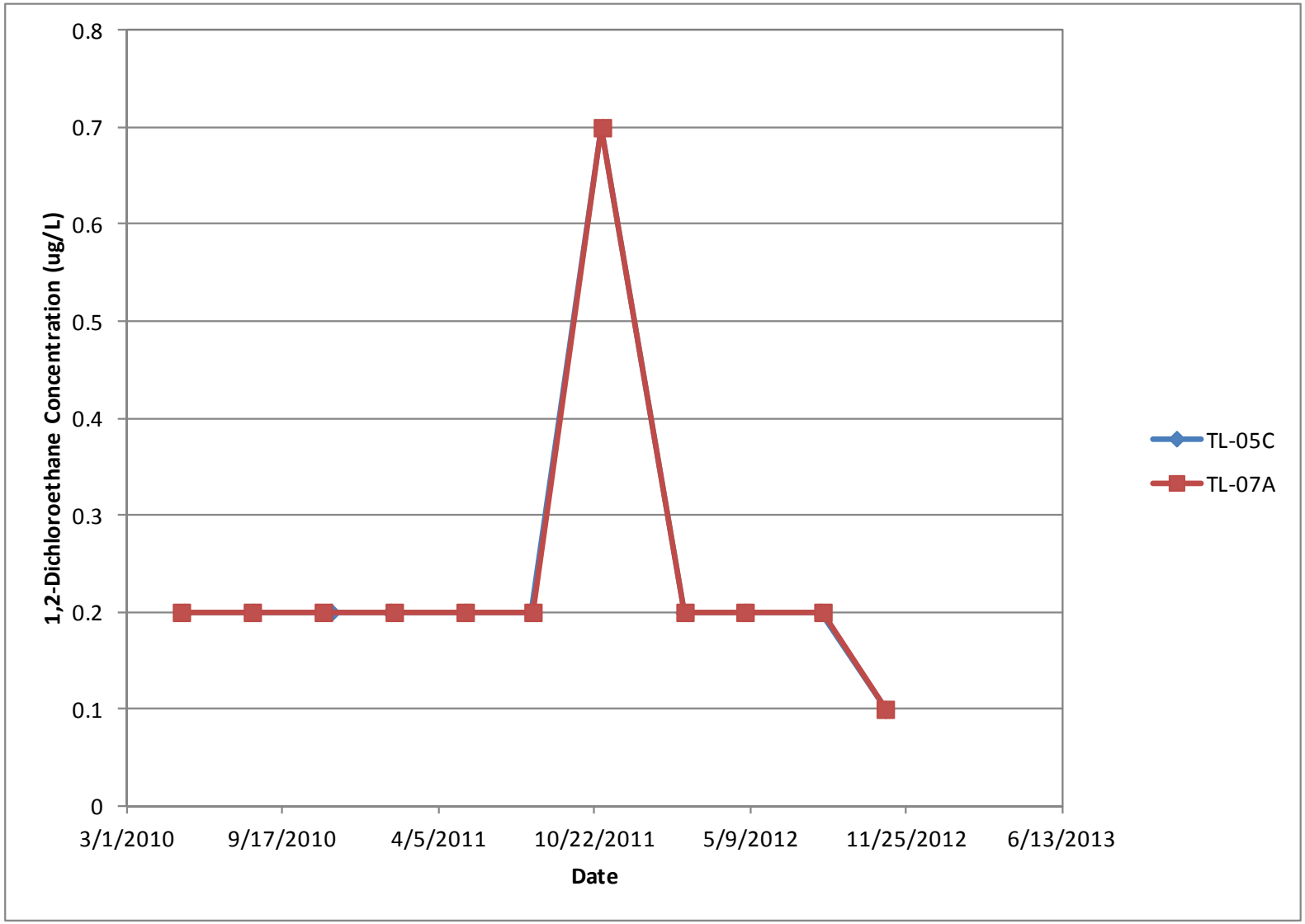

Figure E-4. 1,2-dichloroethane concentrations at wells that exceeded the contingent action criteria.

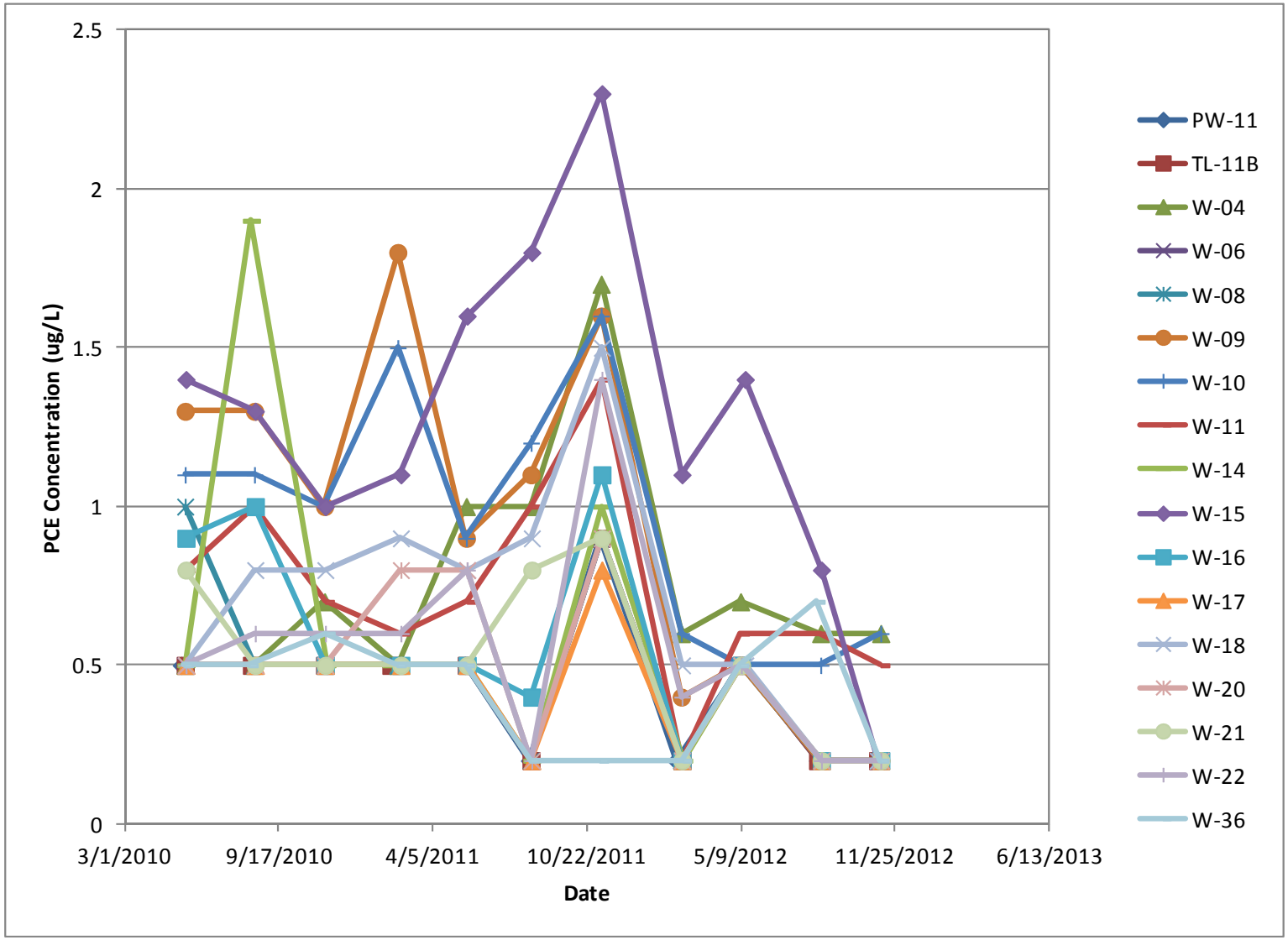

Figure E-5. Tetrachloroethene (PCE) concentrations at wells that exceeded the contingent action criteria.

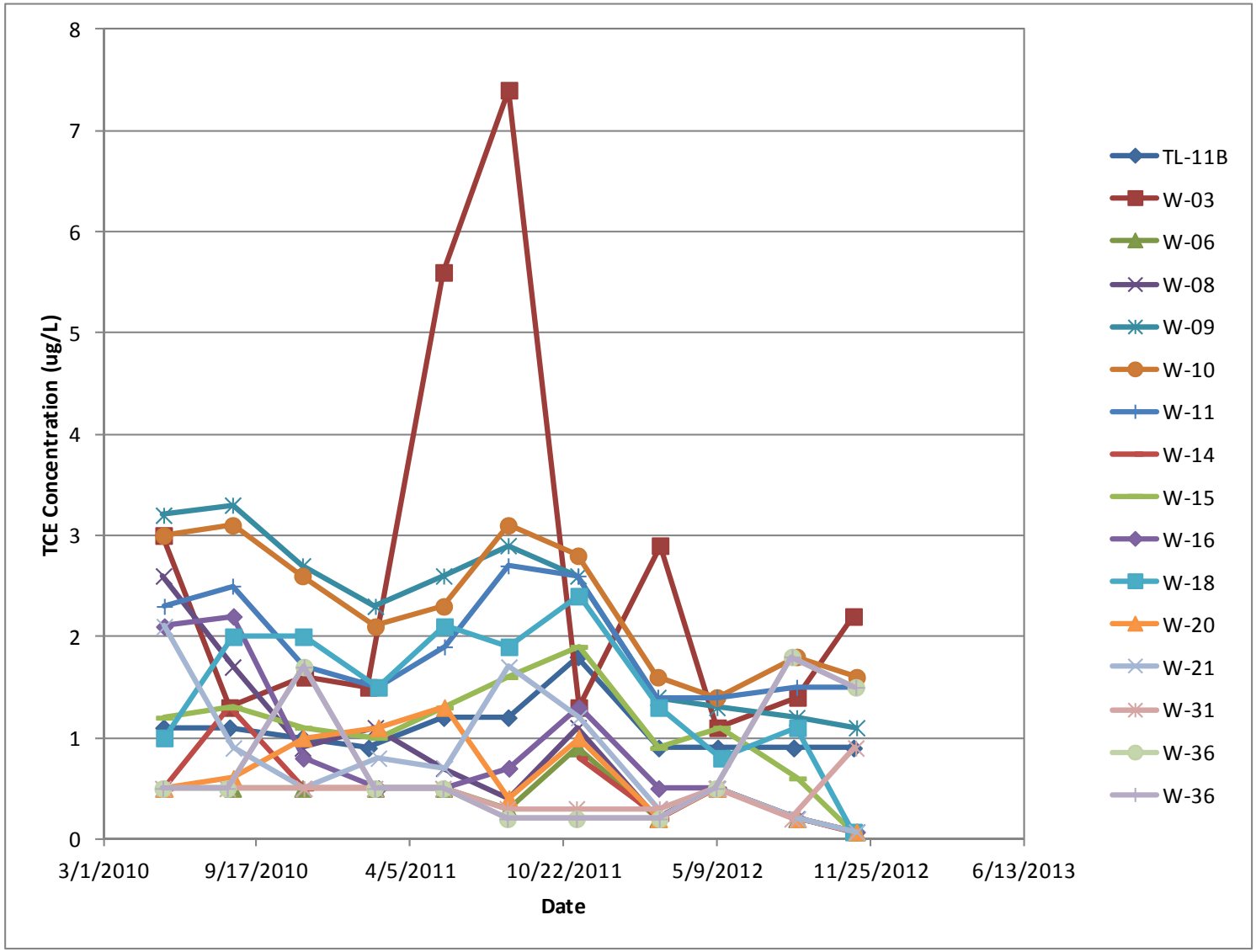

Figure E-6. Trichloroethene (TCE) concentrations at wells that exceeded the contingent action criteria.

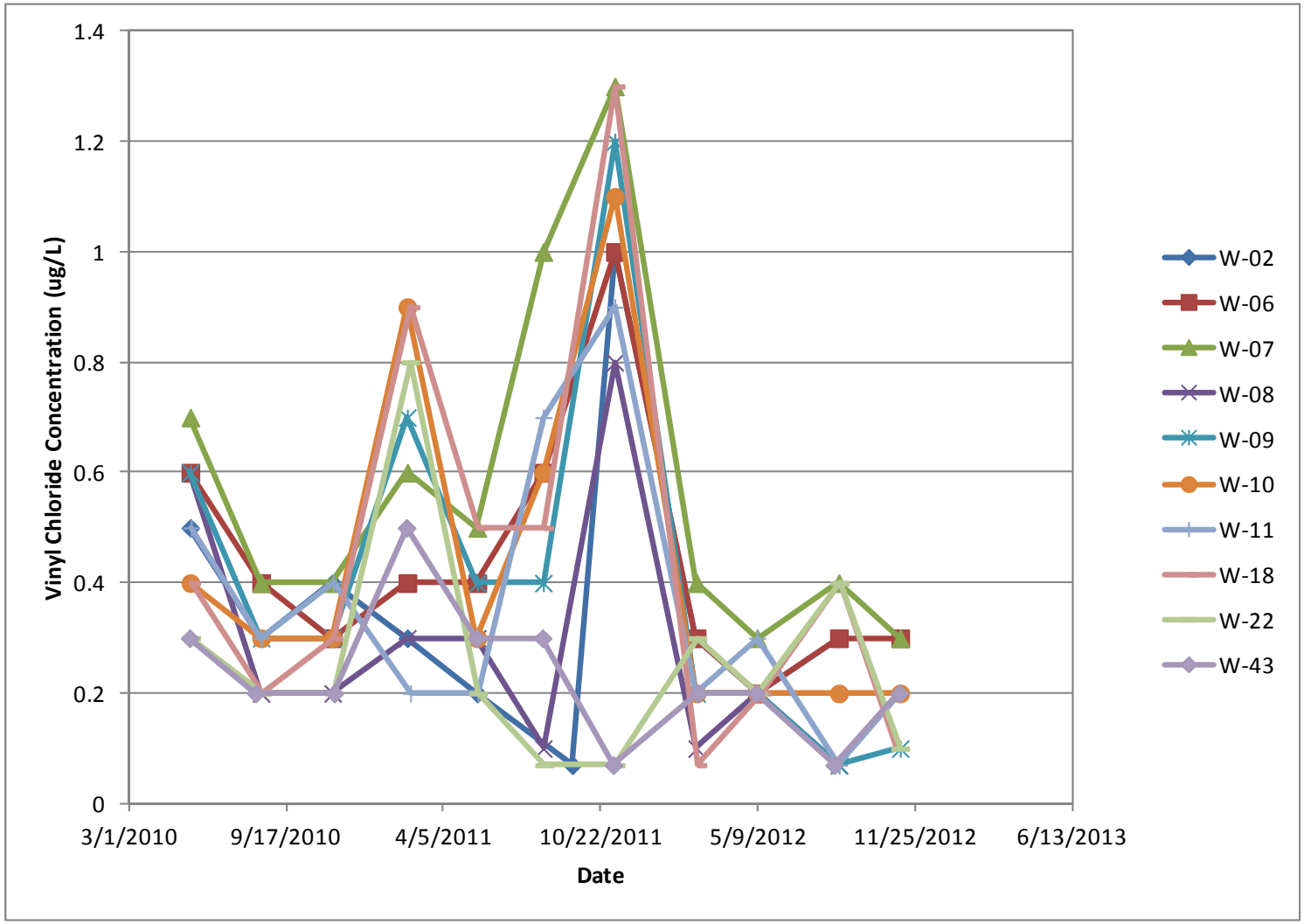

Figure E-7. Vinyl Chloride concentrations at wells that exceeded the contingent action criteria.