Final

Third Five-Year Review Report for Fairchild AFB, Washington

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Third Five-Year Review for Fairchild Air Force Base Washington

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United States Air Force
Fairchild Air Force Base, WA

Approved by:

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Acronyms

AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AFI	Air Force Instruction
ARAR	applicable or relevant and appropriate requirement
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CES/CEIE	Civil Engineer Squadron, Environmental Element
CFR	Code of Federal Regulations
COC	contaminant of concern
CRL	Craig Road Landfill
CSM	conceptual site model
CTC	carbon tetrachloride
CUL	cleanup level
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
Ecology	Washington State Department of Ecology
EC	engineering control
EISB	enhanced in-situ bioremediation
EPA	U.S. Environmental Protection Agency
EQM	Environmental Quality Management, Inc.
ERD	enhanced reductive dechlorination
ESD	Explanation of Significant Differences
ESTCP	Environment Security Technology Certification Program
EVO	emulsified vegetable oil
FFA	Federal Facility Agreement
FFS	focused feasibility study
FPR	free-product recovery
GAC	granular activated carbon
GETS	groundwater extraction and treatment system
HI	Hazard Index
HQ	Hazard Quotient
IC	institutional control
IRIS	EPA's Integrated Risk Information System
IROD	Interim Record of Decision
IRP	Installation Restoration Program
ISCO	in-situ chemical oxidation
LNAPL	light non-aqueous phase liquid
LTM	long-term monitoring
LUC	land use controls
MCL	maximum contaminant level
MTCA	Model Toxics Control Act
NCP	National Contingency Plan
NDA	Northeast Disposal Area
NFA	no further action
NPL	National Priorities List
O&M	operations and maintenance

OU	operable unit
OWS	oil-water separator
PAH	polycyclic aromatic hydrocarbon
PCE	perchloroethene (aka tetrachloroethene)
PCB	polychlorinated biphenyl
PVC	polyvinyl chloride
RA	remedial action
RACR	remedial action completion report
RAB	Restoration Advisory Board
RAO	remedial action objective
RA-O	remedial action operations
RD	remedial design
RI	remedial investigation
ROD	Record of Decision
RPO	remedial process optimization
SAIC	Science Applications International Corporation
SDA	Southwest Disposal Area
SDWA	Safe Drinking Water Act
SVE	soil vapor extraction
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TPH-D	total petroleum hydrocarbons, diesel-range organics
TPH-G	total petroleum hydrocarbons, gasoline-range organics
UCL	upper confidence limit
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USC	United States Code
UST	underground storage tank
UU/UE	unlimited use/unlimited exposure
VI	vapor intrusion
VOC	volatile organic compound
WAC	Washington Administrative Code
WDOH	Washington Department of Health
WWTP	wastewater treatment plant

Executive Summary

The United States Air Force (USAF) conducted this Third Five-Year Review of remedial actions implemented for Installation Restoration Program (IRP) sites at Fairchild Air Force Base, Washington. The USAF conducted this Third Five-Year Review pursuant to:

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code (USC) 9621(c)
- National Contingency Plan (NCP)—40 Code of Federal Regulations (CFR) 300.430(f)(4)(ii)
- Executive Order 12580 (January 23, 1987)
- Federal Facility Agreement (FFA) for Fairchild AFB (USAF, March 1990)

This report was prepared consistent with the United States Environmental Protection Agency's *Comprehensive Five-Year Review Guidance* and supplemental guidance documents. The triggering action for this review was acceptance of the *Second Five-Year Review* on 12 August 2008.

The purpose of the Third Five-Year Review is to ensure that selected remedies, as directed by three Records of Decision (RODs) for Fairchild AFB, remain protective of human health and the environment and are functioning as designed. The scope of this review includes three operable units (OUs) at Fairchild Air Force Base:

- OU-1, Craig Road Landfill (an Off-Base Priority One Site)
- OU-2, On-Base Priority One Sites
- OU-3, Priority Two Sites

These OUs consist of 28 IRP sites. Among these, there were 2 sites in OU-2 and 13 sites in OU-3 for which no further action (NFA) determinations were made when the RODs for these OUs were signed. The remaining 13 sites are the primary subjects of this report:

<u>OU-1</u>: Site SW-8 (LF002) – Craig Road Landfill

<u>OU-2</u>: Site SW-1 (LF001) – Old Base Landfill
Site PS-2 (SS018) – Refueling Pit Area
Site PS-8 (SS026) – Underground Fuel Line Area
Site FT-1 (FT004) – Former Fire Training Area
Site WW-1 (WP003) – Industrial Wastewater Lagoons

<u>OU-3</u>: Site IS-3 (OT016) – Reciprocating Engine Test Cell, Bldg 2150
Site IS-4 (OT017) – Jet Engine Test Cell, Bldg 3000
Site PS-1 (ST006) – Bulk Fuel Storage Area
Site PS-5 (SS009) – Heating Oil Tank Area, Wherry Housing
Site PS-7 (ST010) – Fuel Oil Storage Tanks
Site PS-10 (SD031) – Fuel Truck Maintenance, Bldg 1060
Site FT-2 (FT032) – Old Fire Training Area

Overall, implemented remedies for these sites were found to be functioning as designed and were operated and maintained in an appropriate manner. Issues identified for these sites and recommendations to address those issues are contained in the *Five-Year Review Summary Form*.

The remedies as implemented for OU-1, OU-2, and OU-3 are currently protective of human health and the environment and are expected to be protective of human health and the environment upon attainment of remedial action objectives. In the interim, LUCs exist that prevent exposure to contaminated media.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Fairchild Air Force Base		
EPA IDs: Craig Road Landfill: WAR000000992, On-base: WA9571924647		
Region: 10	**State:** WA	**City/County:** Fairchild AFB, Spokane

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** No

REVIEW STATUS
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** US Air Force
Author name (Federal or State Project Manager): Marc Connally, Fairchild AFB RPM
Author affiliation: N/A
Review period: November 2012 – July 2013
Date of site inspection: 4 December 2012
Type of review: Statutory
Review number: 3
Triggering action date: 12 August 2008
Due date *(five years after triggering action date)*: 12 August 2013

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None

Issues and Recommendations Identified in the Five-Year Review:

OU-1	Issue Category: Remedy Performance			
	Issue: To reduce the time until remedial action objectives are met at CRL, source treatment (via ISCO and SVE) was pilot tested during the review period. To maximize ISCO effectiveness, groundwater extraction has been temporarily reduced to avoid withdrawing treatment substrate from the aquifer, potentially impacting the hydraulic control element of the remedy.			
	Recommendation: Evaluate reductions to GETS operations following ISCO with regard to hydraulic control. Present evaluation results in a post-ROD treatability study report and annual RA-O reports.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA	September 2013

OU-1	Issue Category: Monitoring			
	Issue: TCE concentrations in an off-site monitoring well (MW-118) located downgradient of CRL are decreasing but remain above the MCL.			
	Recommendation: Evaluate TCE concentrations at MW-118 and off-site LUCs in a ROD amendment.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA	August 2016

OU-1	Issue Category: Remedy Performance			
	Issue: Recent optimization and treatment activities (i.e., SVE and ISCO) are not included in the CRL ROD. If selected for long-term addition to the remedy to reduce the time to RAOs, a draft Proposed Plan and ROD amendment will be prepared to adopt one or both of these source treatment activities.			
	Recommendation: Prepare a draft Proposed Plan and ROD amendment to select one or more remedial optimization (source reduction) techniques as potential remedy components at CRL.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	USAF	EPA	August 2016

OU-1	Issue Category: Monitoring
	Issue: Secondary impacts from ISCO operations may include potential increases in dissolved chromium concentrations, which exceed the MCL.
	Recommendation: Evaluate chromium background concentrations and potential increases in dissolved chromium that may result from ISCO

	operations.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA	November 2014

OU-1	**Issue Category: Institutional Controls**			
	Issue: Current off-base LUCs to prevent the use of contaminated groundwater will need to be supplemented. However no off-base exposures are occurring.			
	Recommendation: Evaluate LUC enhancements in ROD amendment.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA	August 2016

Issues and Recommendations Identified in the Five-Year Review:

OU-2	**Issue Category: Monitoring**			
	Issue: Site WW-1 (WP003). Vinyl chloride and arsenic exceed their respective MCLs in shallow alluvial groundwater on-site and off-site, and while regularly monitored at this site, these constituents are not identified in the ROD as site COCs.			
	Recommendation: Site WW-1 (WP003). Prepare an ESD to include vinyl chloride and arsenic as COCs for groundwater. Conduct a base-wide background study for arsenic, including an evaluation of potential arsenic mobilization under reducing conditions.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA	March 2015

OU-2	**Issue Category: Monitoring**			
	Issue: Site WW-1 (WP003). TCE concentrations in off-base well MW-120 continue to exceed the MCL.			
	Recommendation: Site WW-1 (WP003). Evaluate TCE concentration trends at MW-120 and nearby wells to determine whether natural attenuation should be added as a remedy component.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA	August 2018

OU-2	**Issue Category: Institutional Controls**

	Issue: Site WW-1 (WP003). Current off-base LUCs to prevent the use of contaminated groundwater may need to be supplemented. However, no off-base exposures are occurring.			
	Recommendation: Site WW-1 (WP003). Revise residential monitoring program and enhance off-base LUCs with an ESD.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA	March 2015

Issues and Recommendations Identified in the Five-Year Review:

OU-3	**Issue Category: Changed Site Conditions**			
	Issue: Site PS-10 (SD031). Residual TCE contaminated soil may remain in areas not previously addressed during soil removal activities completed in 1996.			
	Recommendation: Site PS-10 (SD031). Conduct additional soil investigations to evaluate whether site soils remain an ongoing source of TCE contamination in groundwater associated with Site SS-39.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA/State	September 2013

Protectiveness Statement(s)

Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU-1	Protective	Click here to enter date.

Protectiveness Statement:
The remedies as implemented for OU-1 are protective of human health and the environment in the short-term because potential exposure to contaminated groundwater continues to be prevented by base LUCs and off-site monitoring of water supply wells provides no evidence of exposure to contaminated groundwater. For the remedy to remain protective in the long-term, off-site LUCs should be enhanced to prevent potential exposure to contaminated groundwater.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU-2	Protective	Click here to enter date.

Protectiveness Statement:
The remedies implemented at OU-2 are protective in the short term. However, some areas

of the OU require additional actions to remain protective in the long-term. The remedies as implemented for Site SW-1, Site PS-2, Site PS-8 and Site FT-1 are protective of human health and the environment. These remedies are functioning as intended and all human and ecological risks are under control and are anticipated to be under control in the future.

The remedy as implemented for Site WW-1 is protective of human health and the environment in the short term because potential exposure to contaminated groundwater continues to be prevented by on-base LUCs and off-base monitoring of water supply wells provides no evidence of exposure to impacted groundwater. For the remedy to remain protective in the long-term, off-base LUCs should be enhanced to prevent potential exposure to contaminated groundwater.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU-3	Protective	Click here to enter date.

Protectiveness Statement:

The remedies as implemented for OU-3 are currently protective of human health and the environment and will be protective of human health and the environment upon attainment of remedial action objectives. In the interim, LUCs exist that prevent exposure to contaminated media.

1. Introduction

The United States Air Force (USAF) has conducted a review of remedial actions implemented for Installation Restoration Program (IRP) sites at Fairchild Air Force Base (AFB), Washington (Figures 1-1 and 1-2). The USAF conducted this Third Five-Year Review pursuant to:

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code (USC) 9621(c)
- National Contingency Plan (NCP)—40 Code of Federal Regulations (CFR) 300.430(f)(4)(ii)
- Executive Order 12580 (January 23, 1987)
- Federal Facility Agreement (FFA) for Fairchild AFB (March 1990)

This report was prepared consistent with the U.S. Environmental Protection Agency's (EPA's) *Comprehensive Five-Year Review Guidance* (EPA, June 2001) and supplemental guidance documents, including *Recommended Evaluation of Institutional Controls: Supplement to the "Comprehensive Five-Year Review Guidance"* (EPA, September 2011). The USAF is the lead agency for restoration projects at Fairchild AFB, and EPA is the lead regulatory agency. The Washington State Department of Ecology (Ecology) is a support regulatory agency in accordance with the FFA.

1.1 Purpose and Scope of Third Five-Year Review

The purpose of the Third Five-Year Review is to ensure that selected remedies, as directed by Records of Decision (RODs) for Fairchild AFB, remain protective of human health and the environment and are functioning as designed.

The scope of this review includes three operable units (OUs) addressed by the following RODs:

- OU-1, Craig Road Landfill: *Record of Decision, Craig Road Landfill (CRL), Fairchild Air Force Base, Final* (USAF, February 1993) – prepared for USAF by Science Applications International Corporation (SAIC)
- OU-2, On-Base Priority One Sites: *Final Record of Decision, On-Base Priority One Operable Units, Fairchild Air Force Base* (USAF, June 1993) – prepared for USAF by Halliburton NUS
- OU-3, Priority Two Sites: *Record of Decision for Priority 2 Sites at Fairchild Air Force Base, Washington, Final* (USAF, September 1995) – prepared for USAF by ICF Technology

Operable Units for Fairchild AFB were established based upon priorities for environmental investigation and cleanup, documented in an FFA signed by Fairchild AFB, EPA, and Ecology (March 1990). Sites that posed the greatest potential risk to human health or the environment were listed as Priority One sites. Priority Two sites were those that posed lesser potential risk, and the Priority Three sites were those that posed the lowest potential risk. OUs initially established for these priority groupings and recent OU revisions include:

- OU-1, Craig Road Landfill (off-base Priority One Site)
- OU-2, On-Base Priority One sites
- OU-3, Priority Two Sites (on-base)
- OU-4, Priority Three Sites (on-base)
- OU-5, Site SS-39 (Priority Three Site, previously part of OU-4)
- OU-6, Site SS-39 (reserved for final ROD)
- OU-7, Site SD-37 (Priority Three Site, previously part of OU-4)

These OUs include the 39 IRP sites listed in Table 1-1 at the locations shown in Figure 1-3. OU-1, OU-2, and OU-3 include 28 sites. Site SS-39 (the "orphan" TCE plumes) and Site SD-37 (base-wide oil-water separators) were previously part of OU-4. In August 2011, an Interim Record of Decision (IROD) was signed that established Site SS-39 as OU-5 (USAF, August 2011); OU-6 is reserved for the final Site SS-39 ROD. Most recently, Site SD-37 was established as OU-7. No ROD has been signed for OU-4 or OU-7; as such, these eight Priority Three sites and two Areas of Concern (AOCs) are not included in this Five-Year Review. The IROD for OU-5 (Site SS-39) was signed in August 2011, but as construction of this remedy has been neither initiated nor completed, a policy five-year review requirement has not been triggered; therefore Site SS-39 is not included in this five-year review. OU-5 is included in Table 1-1 not because RA has been initiated, but because the selected interim remedy requires future action and ICs to be in place during remediation of contaminated groundwater.

Among the 28 sites in OU-1, OU-2, and OU-3, there were 15 sites for which no further action (NFA) determinations were made when the OU-2 and OU-3 RODs were signed, as shown in Table 1-1. The NFA determinations for these sites were based on concentrations for contaminants of potential concern (COPCs) that were either non-detect or below applicable cleanup levels (CULs), and no restrictions were placed on future land use. As such, these 15 sites do not require assessment under Defense Environmental Restoration Program (DERP) five-year review guidance. The remaining 13 sites shown in Table 1-1 for which remedial action (RA) and/or institutional controls (ICs) were required are the primary subjects of this five-year review.

IRP sites at Fairchild AFB historically have been referenced in three ways—by their site name, base code, or USAF code, each of which are cross-referenced in Table 1-1. In this report, sites are addressed by their site name and/or base code with cross-references provided to USAF codes.

Fairchild AFB conducted this Third Five-Year Review of the implemented remedial actions based primarily on available data collected through September 2012. The triggering action for this review was completion and Base Commander acceptance of the *Second Five-Year Review* on 12 August 2008 (USAF, June 2008).

1.2 Report Organization and Terminology

This report was organized consistent with Exhibit 3-3 of EPA's *Comprehensive Five-Year Review Guidance* (EPA, June 2001). Within Sections 3 through 7, subsections are provided for each of the three OUs addressed in this report with additional subsections provided (as necessary) for individual sites at Fairchild AFB. For each site, general background information is provided in Section 3. Selected remedies identified in the applicable ROD for

a site and remedial actions completed to address those selected remedies are summarized in Section 4 (Remedial Actions). More detailed discussions and analysis of data collected during the period covered by this Third Five-Year (concerning remedial system operations, land use controls (LUCs), and groundwater monitoring) are provided in Section 6.3.2 (Document and Data Review). Progress relative to issues and recommendations identified in the last five-year review is contained in Section 5, the five-year review process is presented in Section 6, and the technical assessment is contained in Section 7. Issues identified during the current five-year review and recommendations to address those issues are contained in Sections 8 and 9, respectively.

Terminology concerning LUCs consists of both ICs and engineering controls (ECs). ICs are administrative or legal measures to restrict land use at contaminated sites, such as deed restrictions and property zoning. ECs are physical mechanisms to prevent exposure to contaminated media, such as landfill caps and fencing. Within the three RODs for OU-1, OU-2, and OU-3, the term *institutional controls* is used generally and synonymously with the above LUC definition. For consistency with the RODs, the term *institutional controls* is used in the remedy selection and remedy implementation portions of Section 4.

2. Chronology of Major Events

2.1 Overview

Fairchild AFB generated considerable quantities of hazardous waste throughout its seven-decade history as an aircraft maintenance and refueling station. Most of the waste generated for recycling or disposal was fuel oil, machine oil, or solvents. Releases of these materials to the environment occurred from landfilling, discharge to the base wastewater drainage system, fire training exercises, and accidental spills and leaks.

As part of a four-phase IRP, the base initiated investigations of potential hazardous waste releases in September 1984. The IRP was designed so that each military branch could conduct its own inspections and take appropriate actions in compliance with the NCP under CERCLA. Fairchild's IRP report, completed in 1985, recommended further investigation of contaminated areas.

In March 1989, Fairchild AFB was listed on EPA's National Priorities List (NPL). In 1990, Fairchild AFB, EPA, and Ecology signed an FFA that established schedules and priority rankings for environmental investigation and cleanup as described in Section 1.3. Table 1-1 lists the IRP sites according to the ROD in which they have been or will be addressed, their OU, their status at the time their respective RODs were signed, and their status as of September 2012.

The Fairchild AFB Restoration Advisory Board (RAB) was established in 1994 to provide an information exchange between the community and the base. Board members review documents and comment on plans related to environmental studies and cleanup activities, including the draft of this Third Five-Year Review. RAB meetings are held at least annually, and the general public is invited to attend and participate. The RAB is comprised of approximately 15 board members from the community and is led by the installation and community co-chairs. As described in Section 6.5 below, RAB community co-chair (Mr. Craig Schwyn) was interviewed for this five-year review.

2.2 Records of Decision

As shown in Table 1-1, 28 of the 39 IRP sites at Fairchild AFB have been addressed through three RODs for OU-1, OU-2, and OU-3, respectively, as summarized below. Among these 28 sites, the 13 sites shown in Table 1-1 for which RA and/or ICs were required are the primary subjects of this five-year review.

2.2.1 OU-1 ROD – Craig Road Landfill, Site SW-8 (LF002)

OU-1 is the Craig Road Landfill (CRL), which was the first IRP site at Fairchild AFB where RA was implemented. Due to its size and off-base location, this Priority One site was considered separate from the other Priority One sites and addressed in its own ROD (USAF, February 1993). Remedial action construction was completed in 1995, which included installation of landfill caps and a groundwater extraction and treatment system (GETS).

2.2.2 OU-2 ROD – Priority One Sites

OU-2 includes On-Base Priority One Sites SW-1, PS-2, PS-8, FT-1, WW-1, IS-1, and PS-6. Initial characterization of these sites began in 1986. Site investigations completed from 1986 to 1990 were used to direct remedial investigation (RI) activities conducted in 1991 and 1992. The OU-2 ROD (USAF, June 1993) was signed in July 1993, which determined that RA was required at Sites SW-1, PS-2, PS-8, FT-1, and WW-1. Remedial construction activities for these sites were completed by 1998. The ROD also determined that NFA was required at Sites IS-1 and PS-6. These NFA determinations were based on unlimited use of the sites without restrictions on future land use.

2.2.3 OU-3 ROD – Priority Two Sites

The OU-3 ROD addresses 20 Priority Two sites. Initial characterization of these sites was conducted from 1986 to 1989; limited field investigations were initiated in 1991 and completed in 1992. Field investigation results were used to direct RI activities conducted in 1993 and 1994. The OU-3 ROD (USAF, September 1995) was signed in December 1995, which determined that RA and/or ICs were required at Sites IS-3, IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2. For the 13 remaining IRP sites, the ROD designated them for NFA based on unlimited use of the sites without restrictions on future land use.

2.2.4 OU-5 Interim ROD – Site SS-39

The OU-5 Interim ROD was signed in August 2011 to address Site SS-39 (the "orphan" TCE plumes). OU-5, Site SS-39, represents the combination of sites with detected chlorinated hydrocarbons dissolved in the groundwater found along the flight line. Site SS-39's groundwater contamination was initially identified in 1985 as a result of three separate investigations at PS-10, IS-1 and PS-3. Field investigations and sampling were conducted at sites PS-10, IS-1, and PS-3 beginning in 1991 and continuing through 1995, at which time the "orphan" trichloroethylene (TCE) plumes were consolidated into Site SS-39. Soil contamination at these three sites has been addressed under the OU-2 and OU-3 RODs. The selected remedy for OU-5 (discussed in Section 3.6) has not been constructed, although the conceptual site model (CSM) has been updated and pilot studies have been conducted in support of the remedial design. The Final ROD for SS-39 will be used to establish this site as OU-6.

2.3 Five-Year Reviews

The First Five-Year Review Report for Priority One and Two Sites was completed in November 2000 (USAF, November 2000). The Second Five-Year Review Report (USAF, June 2008) was signed by the USAF on 12 August 2008, and EPA provided a letter of concurrence on 25 September 2008. See Section 5 for discussion of progress since the last five-year review.

3. Background

Background information in this section is provided for Fairchild AFB in general and for each site where RA was required in the RODs. Pertinent site features are shown in Figures 3-1 through 3-13, and site photographs are provided in Appendix A.

3.1 Installation Overview

Fairchild AFB encompasses approximately 4,300 acres located approximately 12 miles west of Spokane, Washington (Figures 1-1 and 1-2). Established in 1942, the base has had numerous missions ranging from a repair depot for damaged aircraft returning from World War II, a Strategic Air Command bomber wing during the Cold War, to its current primary mission as the largest air refueling wing in the USAF.

3.2 Physical Characteristics of the Base Vicinity

The following provides a brief overview of the generalized geology and groundwater occurrence in the vicinity of Fairchild AFB. More detailed descriptions and evaluations of geology and groundwater occurrence, with respect to nature and extent of contamination, are presented in early RI reports, annual remedial action operations (RA-O) reports (see Section 6 for a list of documents reviewed), or in the *Basewide Conceptual Site Model for Fairchild AFB* (AECOM, November 2012).

3.2.1 General Geology

The geology in the vicinity of the base consists of three primary strata. The near-surface geology is characterized by alluvial sediments (primarily sand and gravel with some silt deposits) that generally vary from 0 to 50 feet thick. The alluvial sediments generally were deposited by receding floodwaters associated with glacial Lake Missoula. Beneath the alluvium is a thick sequence of layered basalt bedrock associated with the regional Columbia River Basalt Group. The basalt bedrock represents a series of individual flows that vary from a few feet to hundreds of feet thick. Interbedded layers of sand, silt, and clay occur between individual basalt flows; these interbeds can range from several feet to over 40 feet thick beneath the base. Massive granitic bedrock underlies basalt at depth.

The uppermost basalt at the Fairchild AFB is referred to as Basalt A. It is separated from a deeper basalt sequence (Basalt B) by a layer of low-permeability clay (Interbed A). Within the immediate vicinity of the base, Basalt A varies in thickness of about 50 to 160 feet. RI activities conducted at the base have provided a detailed characterization of geologic and hydrogeologic conditions within the alluvial sediments, Basalt A, and, to a lesser extent, the upper portions of Basalt B.

The top of the Basalt A unit is fractured and highly weathered in places, whereas the center portion of Basalt A is more massive with infrequent fractures and lower permeability. Interbed A generally consists of a laterally extensive, silty claystone that is approximately 5 to 30 feet thick. Basalt B generally is porous and vesicular at the top and progressively denser and less vesicular with depth.

3.2.2 Groundwater Occurrence

The uppermost groundwater at the base typically is encountered from 3 to 30 feet below ground surface in alluvium and/or the fractured and weathered upper portion of Basalt A under unconfined conditions. Groundwater flow within alluvium and Basalt A generally is southwest to northeast across the base, except for the very western margins of the base where a groundwater flow divide is present and some groundwater flows westerly. In some locations, a high degree of hydraulic connection exists between alluvium and shallow basalt water-bearing zones. In other areas, the shallow alluvium and basalt bedrock water-bearing zones are separated by a low-permeability silt/clay layer. Groundwater flow within Basalt A predominantly occurs within the upper and lower portions of the formation where the number of interconnected fractures is highest. Vertical groundwater movement through Basalt A is limited due to the tightness of fractures within the center of the basalt flows.

3.2.3 Land Use and Demographics

As shown in Figure 1-2, Fairchild AFB lies within unincorporated Spokane County. The majority of land surrounding the base is zoned for rural traditional development, with some mining (sand and gravel), light industrial, and commercial zoning east of the base. The predominant land use in the base vicinity is agriculture, which includes cattle grazing and non-irrigated cultivation of wheat and hay. The City of Airway Heights and an eastern extension of the City of Spokane lie one mile northeast and east of the base, where the land is zoned for mining (sand and gravel), light industrial, and commercial development. Residential zoning is present farther to the northeast and east within the City of Airway Heights.

Approximately 10,000 military personnel and civilians reside or are employed at Fairchild AFB. Family housing and dormitory units house approximately 3,700 residents. Within the base boundary, land is both developed and undeveloped. The base water supply is groundwater that is piped from near the Spokane River (nine miles to the east) and distributed throughout all on-base locations. One on-base water supply well (Well #2) provides supplemental water during the summer when demand increases for irrigation. Well #2 is located near the southern end of the base, along the eastern base boundary near Hallet Road (Figure 1-1). It is 400 feet deep, with perforated casing at depths of 205 to 215 feet and 380 to 400 feet. The City of Airway Heights has a population of over 6,000 residents. The city uses groundwater as its water-supply source, which is pumped from alluvial and basalt aquifers.

3.3 OU-1 Background – Craig Road Landfill, Site SW-8 (LF002)

3.3.1 Craig Road Landfill Site Description

The CRL is located approximately one-half mile east of Fairchild AFB (Figure 1-1) and occupies approximately 39 acres of a 100-acre parcel owned by the USAF (Figures 3-1a-c). CRL was operated as an unlined, general-purpose landfill with three waste disposal areas. The northeast disposal area (NDA), located in the northeast corner of the site, is the oldest waste disposal cell and is about 6 acres in size (Figure 3-1d). The NDA was actively used as the main solid-waste disposal area for the base from the late 1950s until the early 1960s. A standard trench-and-fill disposal method was used in the NDA. The area was given a natural soil cover and graded following disposal activities. Depths of fill in the NDA exceed

30 feet below natural ground surface. A second disposal area, the southwest disposal area (SDA), is located in the southwest corner of the property and is approximately 13 acres in size (Figure 3-1e, Photo 1). The SDA was active from the late 1960s until the late 1970s. Disposal practices in the SDA consisted of fill and-cover in the topographical low areas, possibly with some excavation. The SDA also was given a soil cover and then overlaid in some areas with concrete blocks and asphalt from base runway-replacement activities. Disposal depths in this area are estimated to exceed 25 feet. General waste types reportedly disposed in this area included municipal and industrial wastes and construction and demolition debris; suspected disposal items are thought to include such items as solvents, dry-cleaning filters, paints, thinners, and coal ash. A third disposal area is located in the southeast corner of the property (south of the NDA) and is approximately 20 acres in size (Figure 3-1a). This area was active in the late 1950s and received surface disposal of construction debris from runway work performed during base conversion.

While the landfill was active, the base's wastewater treatment plant (WWTP) also was operational in the north-central portion of the 100-acre property. Treated wastewater was discharged into a percolation/evaporation pond and into a series of buried percolation trenches located on the east side of the property (Figure 3-1a). Effluent from the WWTP was intermittently discharged into landfill areas to aid in waste compaction. In 1994, wastewater from the base was routed to the City of Spokane's WWTP, eliminating the discharge of treated effluent into the infiltration pond and trenches on the landfill property. The base WWTP was demolished, and its former site has been occupied by an Army Reserve asphalt plant since 1998.

Figure 3-1c shows land use and zoning surrounding CRL. The City of Airway Heights lies east and northeast of CRL (across Craig Road) where the land is zoned for mining (sand and gravel) and commercial development. The nearest residential property lies immediately northeast of CRL, a manufactured housing area (Vietzke Village) within a commercial zone. Additional residential areas lie approximately one-half mile to the northeast (across Highway 2) and approximately three-quarters of a mile to the east-northeast. The City of Spokane lies southeast of CRL where the land is zoned light industrial. CRL itself and areas to the north, west, and south lie within unincorporated Spokane County. The land is zoned light industrial to the north, light industrial and rural traditional to the west, and light industrial to the south.

Figure 3-1c also shows water supply wells located within one mile downgradient of CRL. PS-1 and PS-4 are adjacent public supply wells operated by the City of Airway Heights, which are approximately 4,600 feet east of CRL. BC FSS4 is located approximately 2,700 feet east of CRL. This well was recently installed by the City of Airway Heights as a capture/reclamation well for treated wastewater that is discharged to infiltration basins at the city's wastewater treatment plant; the City of Airway Heights may seek Ecology approval to use BC FSS4 as a water supply well in the future (USAF, 2013). The Ecology Well Log website (http://apps.ecy.wa.gov/welllog) has well log records for additional water supply wells in this area. Seven of these wells are shown as owned by Ron Vietzke (at Vietzke Village), which were abandoned in 1993 (Ecology, June 2013). Two wells are shown as owned by SCAFCO (a culvert manufacturer east of the SDA). One of these was abandoned in 1996; the status of the second well is unknown, and its approximate location is shown on Figure 3-1c (Ecology, June 2013). One well is shown as owned by Ross Jensen and is reported to be approximately one-half mile east-southeast of the SDA. The status of

the Jensen well is unknown, and its approximate location (as described on the well log) is shown on Figure 3-1c (Ecology, June 2013).

The primary contaminant of concern (COC) at the site is trichloroethene (TCE) in groundwater. As early as 1989, groundwater samples collected from nearby off-site wells (at Vietzke Village) had TCE concentrations above the 5 µg/L maximum contaminant level (MCL). Consequently, the base provided water from its own system to the impacted water supply system from August 1989 through October 1998. In October 1998, Vietzke Village was disconnected from USAF supplied water and was connected to the City of Airway Heights municipal water supply system. As noted above, the water supply wells at Vietzke Village were abandoned in 1993. In 1991, the base initiated an interim remedial action at CRL that included the design and construction of a GETS to remove TCE contamination from the upper aquifer (Basalt A) and to minimize migration of contaminants off-site. Nine extraction wells initially were installed in the NDA and SDA as part of this work along with air stripping units to treat contaminated groundwater. Limited GETS operations began in October 1992. Full-scale GETS operations using 12 extraction wells was initiated in 1995. Further GETS operational information is described in Sections 4.1.2.2 and 6.3.1.1.

3.3.2 CRL Geology and Hydrogeology

Approximately 15 to 70 feet of alluvial sediments overlay basalt bedrock at CRL. These alluvial sediments generally are composed of sand and gravel with minor amounts of silty-sand. Off-site alluvial deposits support commercial sand and gravel operations. Geophysical and drilling activities completed during the *RI* (SAIC, April 1992) identified deep, incised channels cut into the basalt bedrock east of CRL that have been filled with as much as 250 feet of highly-permeable, unconsolidated alluvium. Beneath the alluvial deposits lie two major basalt flow groups separated by a sedimentary interbed (Interbed A) consisting of lacustrine clay deposits. These two major basalt flow groups have been termed Basalt A (upper flow) and Basalt B (lower flow). At CRL, Basalt A ranges in thickness from about 50 to 120 feet; the surface of Basalt A generally slopes gently downward to the northeast. Interbed A is approximately 10 to 15 feet thick and occurs at a depth of approximately 150 feet. Basalt B is at least 70 feet thick below the site.

Groundwater near CRL occurs within both alluvial and basalt bedrock aquifers. The alluvial and Basalt A aquifers generally form a single, unconfined to semi-confined hydrogeologic unit, termed the alluvial/Basalt A aquifer. The alluvium and upper basalt bedrock are hydraulically connected by fractures, weathered and altered zones, and vesicular zones in the basalt. Interbed A serves as a confining unit at the base of Basalt A. Interbed A separates the underlying confined Basalt B aquifer from the upper aquifer. Groundwater flow in both aquifers generally is to the east (Figure 3-1f). For groundwater under the influence of the groundwater extraction system at CRL, groundwater generally flows radially-inward, toward the extraction wells (Figure 3-1g). Monitoring wells near CRL monitor water quality within the alluvial/Basalt A and Basalt B aquifers. Static groundwater (outside the influence of the CRL extraction system) generally occurs at depths ranging from 40 to 100 feet. More detailed descriptions of site geology and hydrogeology at CRL are provided in the *RI Report* (SAIC, April 1992).

3.4 OU-2 Background – Priority One Sites

As shown in Table 1-1, OU-2 includes five sites (SW-1, PS-2, PS-8, FT-1, and WW-1) for which the ROD required RA and two sites (IS-1 and PS-6) for which NFA determinations were made. Background information for the NFA sites was provided in the *On-Base Priority One Sites ROD* (USAF, June 1993). Background information for each site where RA was required is provided below. More detailed descriptions of site geology and hydrogeology are provided in the *On-Base Priority One Sites RI Report* (Halliburton NUS, February 1993).

3.4.1 Site SW-1 (LF001) Background – Old Base Landfill

Site SW-1 is located on the western boundary of the base adjacent to the west end of Parallel Taxiway B (Figure 1-3). Site SW-1 was the main disposal area for the base from 1949 to 1958 and is approximately 16 acres in size (Figure 3-2a, Photo 2). Wastes disposed at Site SW-1 may have included industrial wastes, plating sludge, lubrication oils, cutting oils and shavings, cleaning solvents, paint wastes, and municipal solid wastes. Site SW-1 last received wastes in 1958. The landfill contains approximately 10 to 20 feet of mounded landfill material and is capped with a 1 to 3 foot non-engineered soil cover. It is currently a topographic high in an area of relatively flat natural topography.

Initial field investigations were completed at Site SW-1 from 1986 through 1990. Results from these investigations were used to direct RI activities conducted in 1991 and 1992. The ROD identified TCE in groundwater as the Site SW-1 COC.

3.4.1.1 SW-1 Geology and Hydrogeology

A thin layer of soils (10 feet or less) overlies basalt bedrock across the site. The shallow subsurface consists of alluvial deposits of silty sands with some clay and gravel. The alluvium grades downward into more gravel-rich sediments terminating at the fractured and weathered bedrock surface. Much of this material was removed during construction of the landfill when waste fill was placed within a few feet of the underlying basalt. The top of the basalt is weathered and forms a bedrock high beneath the landfill footprint. At Site SW-1, Basalt A is estimated to be about 150 to 160 feet thick. Interbed A is approximately 10 feet thick and occurs at a depth of approximately 170 feet. Basalt B underlies the interbed and is at least 70 feet thick beneath the site.

The shallowest water-bearing interval at Site SW-1 is within Basalt A at depths of 10 to 15 feet. No alluvial aquifer is present at this site, as groundwater does not rise within alluvium at any time of the year. Historical data indicate a local mounding of groundwater in the northern and western portions of the landfill and possibly west of the landfill. A radial groundwater flow pattern away from the landfill has historically been mapped in three directions (north, east, and south), but groundwater quality impacts only have been identified east of the landfill. This strongly suggests that the predominant groundwater flow direction at the site is easterly, as seen across most the base (Figure 3-2b). In 2012, during development of a base-wide conceptual site model, groundwater level measurements confirmed an easterly groundwater flow direction within Basalt A near Site SW-1 (AECOM, November 2012). Well clusters have indicated a downward vertical gradient at the site.

3.4.2 Site PS-2 (SS018) Background – Refueling Pit Area

Site PS-2 is located on the flightline along Taxiway No. 1, between Buildings 1033 and 1029 (Figure 1-3 and Figure 3-3a, Photo 3). A storage tank at refueling/defueling Pit 18 was known to have leaked up to 120 gallons of JP-4 fuel in 1984. Additionally, a large fuel spill occurred in 1985 when approximately 5,000 gallons of fuel were spilled on the taxiway in front of Building 1037, located about 600 feet southwest of the site. Approximately 4,000 gallons of this spill were recovered in a four-day cleanup effort, leaving approximately 1,000 gallons that may have entered the stormwater system and/or soil. Evidence of groundwater contamination at the PS-2 site was later found during drilling activities.

Field investigations completed before 1992 at Site PS-2 identified diesel-range total petroleum hydrocarbons (TPH-D) and benzene as COCs in shallow groundwater. Benzene was detected in several wells at concentrations exceeding its federal MCL of 5 µg/L, reportedly up to 2,600 µg/L. TPH-D was reportedly detected in three monitoring wells at concentrations exceeding the Washington State Model Toxics Control Act (MTCA) Method A CUL at the time of 1,000 µg/L. Free-floating petroleum product was observed in two site wells, MW-228 and MW-228A.

3.4.2.1 PS-2 Geology and Hydrogeology

A layer of alluvial soils (15 to 24 feet thick) overlies basalt bedrock at Site PS-2. The alluvial deposits consist of silty sand and sandy gravel with silty clay lenses. The silty clay lenses are laterally discontinuous near the bedrock surface and occur as inter-fingered lenses. The alluvium grades downward into more gravel-rich sediments terminating at the fractured and weathered bedrock surface.

The shallowest water-bearing interval at the site is within alluvium and uppermost Basalt A bedrock at depths of 7 to 12 feet. Historic water levels indicate there is also a deeper water-bearing zone within shallow basalt at PS-2, but with limited apparent hydraulic continuity between it and overlying alluvium. The predominant groundwater flow direction for the site is consistent with the overall east-northeasterly flow direction observed in this part of the base (Figure 3-3b).

3.4.3 Site PS-8 (SS026) Background – Underground Fuel Line Area

Site PS-8 is located on the flightline along Taxiway J, near Buildings 1015, 1017, and 1019 (Figure 1-3 and Figure 3-4a, Photo 4). Petroleum odors were noted in July 1982 during runway soil compaction testing nearby. These petroleum vapors were attributed to leaking underground jet fuel distribution lines in the vicinity. Site PS-8 is used for aircraft parking, maintenance, fueling, and defueling.

Field investigations completed through 1992 indicated that fuel-line leaks had impacted groundwater at Site PS-8. TPH and benzene, toluene, ethylbenzene, and xylenes (BTEX) constituents were detected in monitoring wells located immediately downgradient of the suspected release area. The contaminants were suspected to be limited to the upper alluvial aquifer and had already begun to show declining concentration trends. Benzene in groundwater was identified by the ROD as the site COC.

3.4.3.1 PS-8 Geology and Hydrogeology

Approximately 10 to 43 feet of alluvial deposits, consisting of silty sands and gravels and deeper silty clay, overlay basalt bedrock at the site. The uppermost clay layer is present at depths between 5 and 20 feet and extends downward to the top of the fractured and weathered bedrock surface at 38 to 45 feet. The uppermost weathered basalt is massive and moderately fractured; the top of this surface undulates across the site.

The shallowest water-bearing interval at Site PS-8 is within shallow alluvial materials and uppermost weathered basalt, typically at depths of 6 to 10 feet. Historical data indicate that the predominant groundwater flow direction for the site is consistent with the overall east-northeasterly flow direction observed in this portion of the base (Figure 3-4b).

3.4.4 Site FT-1 (FT004) Background – Former Fire Training Area

Site FT-1 is a former fire training area located in the eastern area of the base, south of the east end of the main runway (Figure 1-3 and Figure 3-5a, Photo 5). As described in the OU-2 ROD (USAF, June 1993) and the 1997 annual monitoring report (EA Engineering, December 1998), from the early 1960s to 1991, the FT-1 area was used for fire training exercises two to three times per month, around a mock aircraft in an unlined, bermed area. During these fire training exercises, the bottom of the bermed area was filled with a few inches of water, and JP-4 jet fuel held in a nearby underground storage tank (UST) was pumped onto the surface of the water. The fuel was then ignited and extinguished using water or film-forming foam (beginning in the 1970s). Approximately 300 gallons of jet fuel and 125 gallons of extinguishing foam were used during each exercise. After each exercise, the water, remaining fuel, and foam were drained into an oil/water separator (OWS). The OWS discharged into a low area east of the training site, which contributed to elevated concentrations of petroleum hydrocarbons in local soil and groundwater.

Fuel stains and dead vegetation were observed in the effluent drainage area during RI activities (Halliburton NUS, February 1993); TPH and benzene were identified as primary contaminants in soil, and benzene was identified as the primary contaminant in shallow alluvial groundwater.

3.4.4.1 FT-1 Geology and Hydrogeology

Approximately 10 to 30 feet of alluvial deposits, consisting of silt, sand, and gravel, overlay basalt bedrock (Basalt A) at the site. The alluvium grades downward into more gravel-rich sediments terminating at the fractured and weathered bedrock surface.

The shallowest water-bearing interval at Site FT-1 is within alluvium and uppermost Basalt A at depths of 4 to 11 feet. Based on water elevation data from alluvial and shallow Basalt A wells, hydraulic continuity likely exists between these water-bearing units at this site. The predominant groundwater flow direction at the site is easterly (Figure 3-5b), consistent with Site WW-1, located just to the north of FT-1. Groundwater underlying the site is not used as drinking water. There are 14 residential wells east of Site FT-1, with the nearest of these approximately 1,600 feet east-northeast of the site. The residential well monitoring program is discussed in Section 4.2.4.2.

3.4.5 Site WW-1 (WP003) Background – Industrial Wastewater Lagoons

Site WW-1 is located south of the eastern end of the runway between the perimeter road (Rambo Road) and the north-south portion of Taxiway No. 10 (Figures 3-6a and 3-6b). The site consists of two interconnected industrial lagoons (Photo 6) that were designed to accept industrial wastewater and stormwater that had been treated by OWSs and grit chambers located along the flightline and eastern portions of the base. However, the OWSs and grit chambers were not serviced regularly and routinely discharged untreated water directly into the lagoons. The lagoons drain into "No Name Ditch," which flows perennially off-base to the southeast. Water from No Name Ditch eventually infiltrates into the ground over a large, flat area about two miles east of the site.

Waste types known to have been discharged into the lagoons in the past included JP-4 fuel, oils, industrial solvents, acids, and cleaning compounds. Until 1989, the lagoons were periodically dredged, and the dredged material was spread over the lagoon banks. The OWSs have since been removed or upgraded. In addition, the stormwater lines on the base have been separated from the industrial wastewater lines, preventing any industrial cross-water flows from entering the lagoons.

Field investigation activities conducted at the WW-1 site through 1992 indicated that TCE was the primary groundwater contaminant, which had migrated at least 600 feet off-base (eastward) within the shallow alluvial aquifer. No substantial vertical migration of TCE into the lower basalt aquifer system was observed. Further source area investigation and removal actions completed in 2000 (CH2M HILL, December 2001) indicated that the likely source of TCE in shallow groundwater at the site was from leaking drums formerly buried east of the skimming lagoon, just east of MW-102 (Figure 3-6a). These source removal actions are described in Section 4.2.10.2.

3.4.5.1 WW-1 Geology and Hydrogeology

Approximately 20 to 46 feet of alluvium overlay basalt bedrock at WW-1. Shallow sub-surface alluvial deposits are comprised of clay, sand, and gravel overlying a 5 to 25 foot thick layer of silty clay. The silty clay unit extends downward to the fractured and weathered bedrock surface (Basalt A). The upper 35 feet or so of Basalt A bedrock is weathered and fractured; the base of Basalt A is estimated to be at a depth of approximately 200 feet below ground.

The shallowest water-bearing interval at WW-1 is within alluvium at depths of 3 to 10 feet. Groundwater also is present in the weathered and fractured Basalt A unit, separated from the shallow alluvial aquifer by a silty clay sequence. The groundwater flow direction is easterly on-base at Site WW-1 and east-southeasterly off-base (Figure 3-6c). The lagoons appear to have a localized recharge effect on shallow groundwater. Groundwater underlying the on-base portion of the site is not used as drinking water. There are 14 residential wells east of Site WW-1, with the nearest of these approximately 1,300 feet east of the site (Figure 3-6b). The residential well monitoring program is discussed in Section 4.2.5.2.

3.4.6 Background for Sites Designated for No Further Action in ROD

The OU-2 ROD identified NFA determinations for Sites IS-1 and PS-6, which were based on unlimited use of the sites without limitations or restrictions on future land use. No new

information has emerged that would call into question the protectiveness of the remedy for these two sites. Thus, IS-1 and PS-6 are not further addressed in this Five-Year Review. Background information for these sites is provided in the OU-2 ROD.

3.5 OU-3 Background – Priority Two Sites

As shown in Table 1-1, OU-3 includes 7 sites (IS-3, IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2) for which the ROD required RA and/or ICs; NFA determinations were identified for the remaining 13 sites. Background information for the NFA sites was provided in the OU-3 ROD. Background information for each site where RA was required is provided below. More detailed descriptions of site geology and hydrogeology are provided in the *Priority Two Sites RI Report* (ICF Technology, February 1995).

3.5.1 Site IS-3 (OT016) Background – Building 2150, Reciprocating Engine Test Cell

Site IS-3 is associated with Building 2150, located in the central portion of the base (Figures 1-3 and 3-7, Photo 7). The building was constructed in 1942. It was designed as a radial-engine test facility and was used until approximately 1956 to test gasoline-driven reciprocating aircraft engines. It later was used during base-wide polychlorinated biphenyl (PCB) removal as a temporary storage facility for transformers that contained PCBs. The transformers were stored in steel pans to contain any spills or fluid leaks. PCB materials stored in the building were removed in 1991. Building 2150 was demolished in 1996.

Limited field investigations completed by 1992 focused on assessing a sump located in the basement of Building 2150 as a possible contaminant source and release point. These activities identified detectable concentrations of fuel-related volatile organic compounds (VOCs), metals, and PCBs in sump sediment samples, but no evidence was found that any release had occurred outside the building.

Alluvium at Site IS-3 has been described as silt and sandy silt grading downward to sand and basalt gravel that overlies weathered basalt. Shallow groundwater has been reported at depths of 5 to 15 feet within unconsolidated sediments (ICF Technology, September 1992).

3.5.2 Site IS-4 (OT017) Background – Jet Engine Test Cell, Building 3000

Site IS-4 is a former jet engine testing facility located south of the east end of the instrument runway in the eastern portion of the base (Figure 1-3 and Figure 3-8, Photo 8). This site currently is inactive and all structures have been demolished. Site IS-4 formerly consisted of engine test cells, a stormwater ditch, and a large rubble pile that served as a blast shield during testing activities (Figure 3-8). From 1953 to 1989, this site was used for jet engine testing activities. Testing activities that occurred prior to 1979 resulted in releases of JP-4 jet fuel to the test stand surface. Fuel released to the stand surface was routinely washed into a centrally located dry well, which was connected to an OWS that discharged into a stormwater ditch. The USAF reportedly used spill prevention procedures for activities conducted after 1979.

Field investigations at Site IS-4 (ICF Technology, September 1992 and February 1995) confirmed TPH contamination in shallow soils. These investigations also included sampling of deeper groundwater beneath Site IS-4 where below-MCL carbon tetrachloride (CTC) concentrations ranged from non-detect to 4.5 µg/L and below-MCL TCE concentrations

ranged from non-detect to 1 µg/L in several rounds of sampling (ICF Technology, February 1995).

3.5.2.1 IS-4 Geology and Hydrogeology

Thirty-five feet of alluvium overlay basalt bedrock at the site. The alluvial deposits primarily consist of a massive silty clay unit with interbedded sand and gravel lenses, 5 to 15 feet thick, underlain by silty sand. The alluvium grades downward into more gravel-rich sediments terminating at the fractured and weathered Bedrock A surface. During construction of the test cells in the 1950s, native soils were removed and replaced with fill material over portions of the site.

The shallowest water-bearing interval at IS-4 is within alluvium at depths of 2 to 3 feet. The predominant groundwater flow direction is to the east-northeast. Groundwater underlying the site currently is not used as a drinking water source.

3.5.3 Site PS-1 (ST006) Background – Bulk Fuel Storage Area

Site PS-1 is located at the base's main bulk fuel storage facility (Figures 1-3 and 3-9a, Photo 9). The site is comprised of four above-ground storage tanks that were constructed between 1952 and 1960 to store approximately 3 million gallons of JP-4 fuel. Originally, fuel was received by rail. Today, most fuel moves to and from the storage tanks via underground pipelines.

Three fuel releases have been documented at Site PS-1. The first was in 1990, at the fuel transfer pipeline east of Storage Tank 2406. Approximately 4,500 gallons of fuel were released, and 3,000 gallons were recovered. A second release was determined to have occurred as base personnel unearthed soil contaminated with approximately 2,000 gallons of fuel near the transfer pipeline and Building 2404 (date unknown). A third release (date unknown) was determined to have occurred as discovered during road construction activities in 1993, near the road bed north of Storage Tank 2410. In addition to these releases, sludge removed from storage-tank bottoms historically was placed in bermed areas surrounding the tanks. Field investigations at Site PS-1 (ICF Technology, September 1992 and February 1995) confirmed TPH contamination in soil gas, shallow soils, and groundwater.

Unrelated to IRP activities, Fairchild AFB decommissioned Storage Tank 2406 in 2008. The tank has been removed, but all secondary containment for the former tank location and facility remains in place.

3.5.3.1 PS-1 Geology and Hydrogeology

Approximately 3 to 6 feet of fine-grained alluvial sands and silts are underlain by 5 to 15 feet of stiff clay at Site PS-1. The clay terminates at the fractured and weathered Basalt A bedrock surface with localized silt intervals. The clay layer generally slopes to the northeast and has a depression near the center of the tank farm. The clay layer extends to the northwest end of the site near MW-194. The original site location was native wetlands, which were backfilled prior to tank farm construction.

The shallowest water-bearing interval at Site PS-1 is within alluvium and uppermost Basalt A bedrock at depths of 2 to 10 feet. Perched groundwater is present periodically above the clay, which most likely restricts the lateral and vertical movement of groundwater

and potential contaminant transport off-site. The predominant groundwater flow direction is generally to the northeast (Figure 3-9b) but has shown seasonal variations to the north as well. Groundwater underlying the site is not used as a drinking water source.

3.5.4 Site PS-5 (SS009) Background – Heating Oil Tank Area, Wherry Housing

Site PS-5 is located in the west-central portion of the base, along the eastern edge of the Wherry Housing Area, an on-base family housing development (Figures 1-3 and 3-10, Photo 10). This site contained a former 20,000-gallon aboveground steel storage tank that stored No. 2 heating oil for on-base residences. Soil and groundwater contamination is suspected to have been caused by uncontrolled oil spills directly to the surface soil and into a dry well located at the former fuel loading platform. The base removed the tank in 1985.

Field investigation activities confirmed fuel oil contamination in soil and groundwater. In 1992, the base excavated and treated approximately 850 cubic yards (1,150 tons) of petroleum-contaminated soil. However, during the excavation, an approximate 2-foot layer of medium- to coarse-grained sand, located at the water table, was observed to have considerable fuel-oil contamination. In addition, an approximate 1/8-inch-thick layer of light non-aqueous phase liquid (LNAPL) fuel oil was observed at the water table, downgradient of the excavation. The predominant groundwater flow direction at Site PS-5 is to the east.

Field investigations completed during the RI (ICF Technology, February 1995) confirmed that limited TPH contamination remained in site soil and groundwater, but concentrations exceeded state CULs at that time for TPH-D: 200 mg/kg in soil and 1,000 µg/L in groundwater[1].

Alluvium at Site PS-5 has been described as sandy silt and silty sand grading downward to coarse sand. Weathered basalt bedrock was reported at depths of 13 to 18 feet, and some clay was reported above and within the basalt. Groundwater was reported at depths of 8 to 20 feet within unconsolidated sediments and the upper weathered basalt. A deeper water bearing zone was reported at 48 to 50 feet within basalt bedrock. Groundwater levels in completed wells showed a higher hydraulic head in the deeper groundwater, indicating limited potential for downward migration of contaminants from shallow to deeper groundwater (ICF Technology, September 1992).

3.5.5 Site PS-7 (ST010) Background – Fuel Oil Storage Tanks

Site PS-7 site is located at the Air Force survival school in the south-central portion of the base (Figures 1-3 and 3-11, Photo 11). The site formerly contained two 12,000-gallon USTs that provided No. 6 oil to fuel two boilers at the Deep Creek Steam Plant (Building 1350) and one 500 gallon UST containing No. 2 fuel oil for preheating the boilers. Prior to 1982, waste solvents from maintenance activities were added to the No. 6 oil and burned. Contamination is believed to have resulted from overfills and spills, and possibly from tanks or pipes that developed leaks. Throughout the history of the steam plant, base personnel have observed fuel and groundwater infiltrating through cracks in the Building 1350 foundation.

[1] Since the RODs for OU-2 and OU-3 were signed in 1993 and 1995, respectively, the MTCA Method A CULs for TPH-D have changed; for groundwater the MTCA Method A CUL for TPH-D was lowered from 1,000 to 500 µg/L. For soil, the CUL was raised from 200 to 2,000 mg/kg (see Section 7.4.2).

In 1992, three USTs were removed and 400 cubic yards of petroleum-contaminated soil were excavated and treated off-site. However, contaminated soil and groundwater were believed to remain on-site, beneath Building 1350. Field investigations in 1992 and 1995 (ICF Technology, September 1992 and February 1995) confirmed that TPH-D contaminated soil and groundwater remained on-site at concentrations above state CULs at the time (200 mg/kg in soil and 1,000 µg/L in groundwater). With the change in site conditions in January 2013 (upon demolition of Building 1350), actions to address this remaining contaminated soil will be covered in the next five-year review.

Alluvium at Site PS-7 has been described as silt, sand, and gravel to depths of 10 to 25 feet where fractured basalt was encountered. Groundwater was reported at depths of 14 to 25 feet during drilling and at depths of 6 to 7 feet in completed monitoring wells (ICF Technology, September 1992). The predominant direction of groundwater flow at Site PS-7 is to the southeast.

3.5.6 Site PS-10 (SD031) Background – Fuel Truck Maintenance, Building 1060

Site PS-10 is located on the west side of the base, south of the former fuel truck maintenance shop (Building 1060) that was demolished in 2012 and north of Parallel Taxiway 1 (Figure 1-3 and 3-12). Building 1060 was constructed in 1959 as a liquid nitrogen/oxygen production facility. Floor drains inside the building captured liquid wastes and discharged them to an OWS located south of the building. Overflow from the OWS discharged to an unlined drainage swale located south of Building 1060 (Photo 12). The materials that flowed into the floor drains most likely were lubricating oils and cleaners.

In 1973, the building was converted to a corrosion control paint shop. During the shop's approximate nine years of operation, personnel are estimated to have discharged more than 6,000 gallons of a degreasing solution. This TCE-containing solution is water-soluble and likely passed through the OWS and into the unlined drainage ditch. Since 1981, this building has served as a fuel truck maintenance facility. In 1987, the discharge line to the ditch was disconnected and rerouted to an underground collection tank. TCE contamination was subsequently identified in soil and groundwater, and petroleum contamination was indentified in soil.

3.5.6.1 PS-10 Geology and Hydrogeology

At Site PS-10, alluvial sand and gravel occur to depths of 7 to 15 feet, underlain by weathered basalt and competent basalt. The thickness of weathered basalt varies considerably in this vicinity from just a few feet near Building 1060 to over 30 feet north and east of Building 1060. Groundwater occurrence also varies. In some areas, groundwater is encountered at a depth of about 15 feet under unconfined conditions, generally within the upper weathered basalt. In other areas, groundwater is encountered at a depth of about 30 feet under semi-confined conditions within weathered basalt. The predominant groundwater flow direction at Site PS-10 is to the north-northeast.

Contaminated groundwater at Site PS-10 was consolidated with other "orphan" TCE plumes to be addressed under the Interim ROD for OU-5 (Site SS-39). A detailed description of the geology and hydrogeology in the vicinity of Site PS-10 can be found in the Site SS-39 *Conceptual Site Model Update* (CH2M HILL, February 2013).

3.5.7 Site FT-2 (FT032) Background – Old Fire Training Area

Site FT-2 is an old fire training area used in the 1950s and 1960s, within an area of about 0.3 acre (Photo 13). The site is located on the east side of the base, south of Taxiway No. 10 (Figures 1-3 and 3-13). Potential contamination was initially identified while characterizing Priority Two Site SW-7, an inactive rubble pile of asphalt from runway construction that is located immediately south of FT-2. Field investigations at Site FT-2 (ICF Technology, September 1992 and February 1995) identified stained and discolored soil, petroleum odors, and areas of suppressed vegetation.

3.5.7.1 FT-2 Geology and Hydrogeology

About 6 to 15 feet of alluvium overlay basalt bedrock at the site. Alluvial deposits primarily consist of silty sands and gravels with lenses of clayey silts and organic material. The alluvium grades downward into more gravel-rich sediments terminating at the fractured and weathered Basalt A bedrock surface.

The shallowest water-bearing interval at FT-2 is within shallow alluvium and the uppermost Basalt A bedrock at depths of 2 to 8 feet. The predominant groundwater flow direction for the site is east-southeasterly. Groundwater underlying the site currently is not used as a drinking water source.

3.5.8 Background for Sites Designated for No Further Action in ROD

The OU-3 ROD identified NFA determinations for 13 Priority Two sites (Table 1-1). These NFA determinations were based on unlimited use of the sites without limitations or restrictions on future land use. No new information has emerged that would call into question the protectiveness of the remedy for these sites; they are thus not further addressed in this Five-Year Review. Background information for these sites is provided in the *Priority Two Sites ROD*.

4. Remedial Actions

The remedy selected in the applicable ROD is summarized for each site included in this section, followed by descriptions of the implemented remedies. A summary of site COCs, completed RAs, and current status are provided in Table 4-1.

4.1 OU-1 Remedial Actions – CRL (LF002)

4.1.1 CRL Remedy Selection

The CRL ROD (USAF, February 1993) identified the remedial action objectives (RAOs) to protect human health, public welfare, and the environment from contamination associated with the site. The site COC is TCE in groundwater, soil, and landfill debris. RAOs included the following:

- Prevent consumption by area residents of groundwater exceeding federal MCLs.
- Restore contaminated groundwater in the upper aquifer to safe drinking levels.
- Minimize migration of contaminants from fill material to groundwater.
- Prevent human exposure to contaminants within subsurface soil and debris.
- Prevent further migration of contaminated groundwater across the site boundary and to the lower aquifer.

To satisfy the RAOs, components of the selected remedy for CRL included the following:

- Cap the NDA and SDA portions of the landfill.
- Extract contaminated groundwater from the upper aquifer at the landfill boundary with treatment by air stripping and granular activated carbon (treated groundwater would be discharged at an off-site location, downgradient from the landfill).
- Install an active soil vapor extraction (SVE) system in both capped areas.
- Monitor off-site water supply wells within the off-site portion of the plume and provide point-of-use treatment and/or an alternative water supply, if needed.
- Monitor groundwater in the upper and lower aquifers.
- Implement ICs.

4.1.2 CRL Remedy Implementation

4.1.2.1 Landfill Caps

Engineered landfill caps, consisting of a composite soil, geotextile, and 30-mil polyvinyl chloride (PVC) liner, were installed over the NDA and SDA in 1994 and 1995, respectively. These caps are barriers to prevent direct contact with contaminated soil and to prevent precipitation from percolating through contaminated soil/refuse and conveyance of these contaminants to groundwater. Caps are inspected quarterly and maintained according to the site's current operations and maintenance (O&M) plan (CH2M HILL, July 2005).

The caps remain functional and intact, requiring little annual maintenance except for occasional repairs resulting from shallow, animal burrows.

As detailed in the Site Inspection Report (Appendix A), the following elements were verified intact: No signs of settlement, cracks, erosion or holes that would compromise the remedy were observed. The vegetative cover was well-maintained and intact to blend with natural vegetation in surrounding areas. No bulges were observed, and wet areas/water damages (including ponding, seeps, soft subgrade) were absent. No slope instability was observed.

4.1.2.2 Groundwater Extraction and Treatment

The GETS was designed to remove TCE from on-site groundwater and to provide hydraulic containment of the on-site portion of the plume, thus preventing further off-site migration of contaminated groundwater. The portion of the TCE plume located downgradient of the property boundary was allowed to naturally attenuate.

Groundwater extraction and treatment began in October 1992 as an interim action. In 1994 and 1995, the extraction system was expanded from 9 to 12 extraction wells (6 wells each in the SDA and NDA), and an air stripping unit was added to the treatment system. Groundwater from the extraction wells is pumped to the treatment plant where TCE is volatized through air stripping, and the resulting offgas is treated (adsorbed) by granular activated carbon (GAC). The treated water is discharged to the aquifer via two infiltration trenches located on-site, just west of Craig Road, and downgradient of the SDA and NDA. The treatment plant began 24-hour operation on 19 September 1995. From September 1995 through September 2012, approximately 1.22 billion gallons of TCE-contaminated groundwater were extracted and treated at CRL. Details of GETS operation at CRL are provided in Section 6.3.1.1.

4.1.2.3 Soil Vapor Extraction

SVE was identified as a component of the selected remedy for CRL in both the NDA and SDA but was not implemented until 2010. In September 1993, a post-ROD treatability study determined that SVE would not be effective at CRL since the significant source of groundwater contamination was believed to be present as a dense non-aqueous phase liquid (DNAPL). As such, an Explanation of Significant Differences (ESD) was prepared and concluded that the additional costs of an SVE system would not provide any significant decrease in overall risk from contaminants at the site (USAF, April 1996).

The potential effectiveness of SVE at CRL was reconsidered by the USAF and CH2M HILL in 2008. Evaluation of sampling results and GETS operational data indicated that substantial VOC contamination remained within the dewatered zone during active groundwater extraction, and it was recognized that SVE could enhance removal of these contaminants. With concurrence of Ecology, the USAF initiated investigations to reduce source materials at CRL (CH2M HILL, May 2009). From 2010 through 2012, 22 remediation wells in the SDA and 14 in the NDA were constructed as multipurpose wells that could be used for SVE, in-situ chemical oxidation (ISCO), or additional monitoring wells. Details of SVE (and ISCO) operations at CRL are provided in Section 6.3.1.1.

4.1.2.4 Groundwater Monitoring

A long-term monitoring (LTM) program for CRL groundwater was implemented in 1995 for on-site and off-site monitoring wells completed in the upper (alluvium and Basalt A) aquifer

and the lower (Basalt B) aquifer. Evaluation of LTM data is documented in annual RA-O reports; recommended changes in wells to be sampled, or modifications to sampling frequencies have been incorporated into subsequent LTM with concurrence of Ecology or EPA. In 2012, the CRL LTM program consisted of the following:

Basalt A/Alluvial Wells

- Quarterly sampling of 4 extraction wells and 2 on-site monitoring wells
- Semi-annual sampling of 8 extraction wells, 3 on-site monitoring wells, and 2 off-site monitoring wells
- Annual sampling of 6 off-site monitoring wells
- Semi-annual water level monitoring of 10 off-site monitoring wells
- Periodic sampling of 14 NDA remediation wells and 21 SDA remediation wells to assess ISCO effectiveness.

Basalt B Wells

- Semi-annual sampling of 1 off-site well and annual sampling of 1 off-site well
- Semi-annual water level monitoring of 1 off-site monitoring well

Historical groundwater sampling results for CRL are summarized in Section 6.3.1.1.

4.1.2.5 Institutional Controls

Fairchild AFB has implemented ICs per the ROD and the Fairchild AFB LUC Plan (USAF, May 2007) to prevent potential exposure to contaminated soil, wastes, or groundwater at CRL. Specific objectives for on-site ICs at CRL include:

- Prevent disturbance to the landfill caps, except as necessary for authorized activities.
- Prevent drilling of new wells except for monitoring wells authorized by regulators.
- Protect existing monitoring wells.
- Prevent use of contaminated groundwater for drinking water purposes.
- Prevent unauthorized soil excavations at the site.
- Notify EPA and Ecology prior to any development or redevelopment of the landfill site to ensure that the integrity of the engineered cap will not be jeopardized.
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land.

TCE-contaminated groundwater from CRL is found downgradient of Air Force controlled property. Regulatory jurisdictions limit and/or restrict use of groundwater in these areas are in place under governance of the City of Airway Heights, the Spokane County Health District, and the State of Washington (WAC 173-160-171). Collectively, these jurisdictions effectively restrict current and future use of any contaminated groundwater associated with CRL. Information on the status of groundwater contamination within the CRL vicinity is routinely presented at Fairchild AFB RAB meetings, which are open to the general public. Groundwater from the City of Airway Heights water supply wells (PS-1 and PS-4) is sampled quarterly as part of the base's residential well monitoring program; combined sampling results from these adjacent wells are provided to the City for information and review purposes. Note that PS-1 and PS-4 are the only water supply wells in the downgradient vicinity of CRL (Figure 3-1); these wells are completed within an alluvial channel and screened at depths of 162 to 201 feet.

Specific objectives for off-site ICs include:

- Prevent drilling of new wells except for monitoring wells authorized by regulators
- Protect existing monitoring wells
- Prevent use of contaminated groundwater for drinking water purposes

Specific well installation regulations include state law, which does not allow construction of water supply wells with 1,000 feet of a landfill. Areas downgradient of CRL also are within the City of Airway Heights drinking water supply service area. Thus, distribution (and consumption) of contaminated water is not permissible. Additional details concerning ICs at Fairchild AFB are provided in Sections 6.3.5.

4.2 OU-2 Remedial Actions – Priority One Sites

As discussed in Section 2.2.2, OU-2 includes five sites (SW-1, PS-2, PS-8, FT-1, and WW-1) where RA was required in the ROD. RA conducted at each site is discussed below.

4.2.1 Site SW-1 (LF001)

4.2.1.1 SW-1 (LF001) Remedy Selection

The COC for Site SW-1 is TCE in groundwater. The ROD established the following RAOs for Site SW-1:

- Prevent residential exposure to potential contaminants within subsurface soil and debris.
- Minimize movement of contaminants from debris to groundwater.
- Prevent consumption of groundwater with contamination exceeding MCLs.
- Restore contaminated groundwater to drinking water quality.
- Prevent further migration of contaminated groundwater.

To satisfy RAOs, the ROD identified the following components for the selected remedy at Site SW-1:

- Maintain ICs that restrict access and prevent on-base usage of TCE-contaminated groundwater associated with the site until CULs are met.
- Monitor groundwater at the site to identify a trend in contaminant concentrations, estimate a time frame for restoration by natural actions, evaluate the acceptability of the estimated time frame, and implement a compliance monitoring program to estimate attainment of CULs.
- Monitor off-site water supply wells in the site vicinity and provide point-of-use treatment and alternative water supply, if necessary.

4.2.1.2 Site SW-1 (LF001) Remedy Implementation

Fairchild AFB has implemented ICs per the ROD and the base's LUC Plan (USAF, May 2007) to restrict site access and prevent exposure to or consumption of contaminated groundwater at Site SW-1. It has not been necessary to provide point-of-use treatment or an alternative water supply for any off-site residences located near the site.

An LTM program for the site was initiated in 1994 and consisted of quarterly monitoring of ten shallow (alluvial/Basalt A aquifer) wells. In 1998, with the concurrence of Ecology and

EPA, the number of LTM wells sampled was reduced from ten to three, as detected concentrations of TCE in the other seven LTM wells were routinely below its 5 µg/L MCL.

Given that Site SW-1 last received wastes in 1958 and that no groundwater samples collected at the site have exceeded the TCE MCL of 5 µg/L since 2005, Ecology concluded (following their review of the *2008 Annual RA-O Report* [CH2M HILL, July 2009]), that routine monitoring at the site was no longer necessary and only should be conducted to support this Third Five-Year Review (Ecology, 4 June 2009). Ecology also verbally concurred with the recommendation that Response Complete has been attained for the site. EPA also concurred with this recommendation (EPA, October 2012). To seek Response Complete under joint DOD/EPA guidance (2005), a Remedial Action Completion Report (RACR) will be prepared in the future.

Groundwater monitoring at Site SW-1 for this Five-Year Review was performed in June 2012. These and historical groundwater sampling results for Site SW-1 are summarized in Section 6.3.2.2.

4.2.2 Site PS-2 (SS018)

4.2.2.1 Site PS-2 (SS018) Remedy Selection

The COCs for Site PS-2 identified by the ROD are benzene and TPH-D in shallow groundwater. The ROD concluded that RA was required at Site PS-2 with a RAO to restore groundwater to drinking water quality within a reasonable time frame. The ROD outlined the following elements for the selected remedy at Site PS-2:

- Maintain ICs that restrict access to PS-2 and prevent on-base usage of TPH-contaminated groundwater associated with the site until CULs are met.
- Monitor groundwater at the site to identify trends in contaminant concentrations, estimate a time frame for restoration by natural actions, evaluate the acceptability of the estimated time frame, and implement a compliance monitoring program to estimate attainment of CULs.
- Remove free-floating petroleum product (specifically at MW-228 and MW-228A) through passive collection and treatment.

4.2.2.2 Site PS-2 (SS018) Remedy Implementation

Fairchild AFB has implemented ICs as described above and in accordance with the Fairchild AFB LUC plan (USAF, May 2007) to restrict site access and prevent exposure to or consumption of contaminated groundwater from Site PS-2.

A groundwater LTM program was initiated in 1994 that consisted of quarterly monitoring of seven alluvial/Basalt A aquifer monitoring wells and passive free-product recovery (FPR) from two wells. In 1998, with the concurrence of Ecology and EPA, the sampling frequency was reduced to annual for five wells. In response to an issue identified in the *Second Five-Year Review*, three new groundwater monitoring wells (MW-370, -371, and -372) were installed in alluvial sediments downgradient of Site PS-2 (Figure 3-3a) in April 2011 to evaluate if benzene had migrated downgradient from the site. Historical FPR and groundwater sampling results for Site PS-2 are summarized below in Sections 6.3.2.1 and 6.3.2.2, respectively.

4.2.3 Site PS-8 (SS026)

4.2.3.1 Site PS-8 (SS026) Remedy Selection

The COC for Site PS-8 is benzene in groundwater. The RAO established in the ROD is to restore groundwater to drinking water quality within a reasonable time frame. The ROD outlined the following elements for the selected remedy:

- Maintain institutional controls that restrict access to the site and prevent on-base usage of benzene-contaminated groundwater associated with the site until CULs are met.
- Monitor groundwater at the site to identify a trend in contaminant concentrations, estimate a time frame for restoration by natural actions, evaluate the acceptability of the estimated time frame, and implement a compliance monitoring program to estimate attainment of CULs.

4.2.3.2 Site PS-8 (SS026) Remedy Implementation

Fairchild AFB has implemented ICs as described above and in accordance with the Fairchild AFB LUC plan (USAF, May 2007) to restrict site access and prevent exposure to or consumption of contaminated groundwater from Site PS-8.

A groundwater LTM program was initiated in 1994 and consisted of quarterly monitoring of nine alluvial monitoring wells. In 1996, with the concurrence of Ecology and EPA, the number of monitoring wells was reduced to four (MW-67, -68, -183, and -184) and the sampling frequency was reduced to semi-annual. Benzene concentrations have not exceeded its MCL of 5 µg/L since 2006.

Following review of the *2008 Annual RA-O Report* [CH2M HILL, July 2009]), Ecology concluded that routine monitoring at the site was no longer necessary because there are no immediate threats to human health and the environment and because site access is restricted due to its location on an active taxiway (Ecology, 4 June 2009). Routine groundwater monitoring thus was discontinued in 2009. Ecology recommended that groundwater monitoring only be conducted to support this Third Five-Year Review.

Sampling results indicate that Site PS-8 has reached a Response Complete status. EPA concurred with this recommendation (EPA, October 2012), pending their review of groundwater sampling results for this Five-Year Review. To seek Response Complete under joint DOD/EPA guidance (2005), a RACR will be prepared in the future.

Groundwater monitoring at Site PS-8 for this Five-Year Review was performed in March 2012. These and historical groundwater sampling results for Site PS-8 are summarized in Section 6.3.2.2.

4.2.4 Site FT-1 (FT004)

4.2.4.1 Site FT-1 (FT004) Remedy Selection

The COC for Site FT-1 is benzene in soil and groundwater. TPH-D was not established as a COC in the ROD but is a known contaminant in soil and groundwater at concentrations above current MTCA Method A CULs for unrestricted land use. RAOs established in the ROD for Site FT-1 are to remediate soils to levels that are protective of groundwater and to restore groundwater to drinking water quality. The ROD outlined the following elements for the selected remedy at Site FT-1:

- Maintain ICs that restrict access to the site and prevent on-base usage of benzene-contaminated groundwater (associated with the site) until CULs are achieved.
- Implement an in-situ bioventing treatment system for benzene-contaminated soil.
- Implement a pilot-scale in-situ air-sparging system to evaluate the effectiveness of this technology for remediating benzene-contaminated groundwater, to be followed by implementation of a full-scale system if the pilot-scale system is successful.
- Monitor off-site water supply wells in the vicinity of the site and provide point-of-use treatment or alternate water supply, if necessary.

4.2.4.2 Site FT-1 (FT004) Remedy Implementation

FT-1 Institutional Controls

Fairchild AFB has implemented ICs as described above and in accordance with the Fairchild AFB LUC plan (USAF, May 2007) that restrict site access and prevent exposure to or consumption of contaminated groundwater from Site FT-1. It has not been necessary to provide point-of-use treatment or an alternative water supply for any off-site residences located near the site.

FT-1 Bioventing Systems and Soil Monitoring Program

An in-situ bioventing treatment system was constructed in 1997 and was fully operational until late December 2006. Through a remedial process optimization (RPO) evaluation (CH2M HILL, October 2006b), it was determined that the system had achieved its purpose of remediating vadose zone soils and preventing movement of mobile TPH fractions into groundwater. Ecology concurred with the RPO evaluation (USAF, 6 December 2006) and the system was shutdown in December 2006.

Soil monitoring was initiated in 1997 as a part of bioventing systems operation to monitor soil remediation progress. Annual sampling events generally consisted of collecting 25 soil samples from 25 soil borings, at depths ranging from 2 to 4 feet, 4 to 6 feet, or 6 to 8 feet. Between 2001 and 2005, 110 soil samples were analyzed for BTEX. Benzene was detected at concentrations exceeding the current MTCA Method A CUL of 0.03 mg/kg (for unrestricted land use) at concentrations of 0.57 to 4.8 mg/kg in 3 of 110 samples (3 percent) from borings primarily located in the former burn pit area or north and west of this area. To reduce the natural remediation timeframe for contaminated soils in this vicinity, a decommissioned OWS, associated piping, and surrounding impacted soils were removed in 2000 and disposed off-site. In lieu of annual monitoring for 2005 and with concurrence of Ecology, an additional 1,630 tons of impacted soil, located primarily in the former burn pit area and north and west of the burn pit, were excavated and disposed off-site in February 2005 (Figure 3-5a). Analytical results from samples collected from the sidewalls of the 2005 excavation indicated that some gasoline-range total petroleum hydrocarbons (TPH-G), TPH-D, ethylbenzene, and xylene remained at concentrations that exceeded state CULs for unrestricted land use (CH2M HILL, April 2006).

In June 2008, additional contaminated soil was excavated adjacent to the 2005 excavation areas, again with concurrence of Ecology. Approximately 1,500 tons (1,000 cubic yards) of soil were excavated from two suspected “hot spot” areas located north of the former burn pit area (Figure 3-5a) and disposed off-site at Waste Management’s Graham Road Landfill. Twelve confirmation samples were collected from excavation sidewalls and analyzed for TPH-G, TPH-D, and BTEX. As the removal effort was designed to reach current (industrial

active base) land use-based goals, the removal did not target TPH at the lower levels that would permit unrestricted future land use. Current MTCA Method A CULs for unrestricted land use were exceeded in the 2008 soil samples as follows:

- In five samples for TPH-G at concentrations of 130 to 12,000 mg/kg (CUL = 100 mg/kg or 30 mg/kg where benzene is present)
- In three samples for TPH-D at concentrations of 2,300 to 5,200 for TPH-D (CUL = 2,000 mg/kg)
- In two samples for total xylenes at concentrations from 32 to 54 mg/kg (CUL = 9 mg/kg) (Environmental Quality Management, Inc. [EQM], August 2008).

FT-1 Air-Sparge System

The west air-sparge curtain was installed at Site FT-1 in 1997 for full-time operation based on pilot-scale results. It consisted of 19 air-sparge points situated in two offset and adjacent rows at the locations shown in Figure 3-5a. Its purpose was to treat the on-base portion of a benzene plume in shallow groundwater. In 1999, a team representing the Environment Security Technology Certification Program (ESTCP) evaluated the performance of the air-sparge system and concluded that the system was not effective because air flow was observed at less than one-half of the 19 sparge points. The ESTPC's recommendations to improve performance were deemed to not be cost effective. As such, the air-sparge system continued to operate (as is) through 2003. In 2004 through 2006, the system was operated periodically to maintain the equipment. The air-sparge and bioventing systems were shut down indefinitely with concurrence of Ecology on 6 December 2006 (USAF, 6 December 2006), following their review of a *RPO Report* (CH2M HILL, October 2006b).

FT-1 Groundwater Monitoring

The COC for Site FT-1 groundwater is benzene, which previously exceeded its 5 µg/L MCL in five site wells. Other constituents of potential concern monitored in Site FT-1 groundwater have included vinyl chloride, cis 1,2-dichloroethene (DCE), TPH-G, and TPH-D. A groundwater LTM program for Site FT-1 was initiated in 1996 and consisted of quarterly monitoring of up to 27 site wells, including 12 air-sparge curtain monitoring wells and 15 alluvial/Basalt A monitoring wells.

Due to attenuation of VOCs in shallow groundwater and soil, the groundwater LTM program was significantly reduced in 2008 to annual sampling of five wells for TPH-G and TPH-D, and further reduced in 2011 to TPH-D only, with Ecology's concurrence. To support this Five-Year Review, ten site wells were sampled in March 2012 for TPH-D and VOCs. These and historical groundwater sampling results for Site FT-1 are summarized in Section 6.3.2.2.

Fourteen residential wells, located east of Sites FT-1 and WW-1 (Figure 3-6b), have been regularly monitored since 1988 as part of the base's residential well monitoring program. No COCs associated with Site FT-1 have been detected in these wells for at least the past 14 years. Provisions for providing point-of-use treatment or an alternate water supply have been in place, but have not been required to date.

4.2.5 Site WW-1 (WP003)

4.2.5.1 Site WW-1 (WP003) Remedy Selection

The COC set forth in the OU-2 ROD for Site WW-1 was TCE in groundwater. The ROD concluded that RA was required to restrict the site from future residential or agricultural uses and to restore groundwater to drinking water quality. The ROD outlined the following elements for the selected remedy at the site:

- Maintain ICs that restrict access to the site and prevent on-base usage of TCE-contaminated groundwater until CULs are achieved (i.e., the federal MCL for TCE of 5 µg/L).
- Conduct additional source investigation activities to identify the source of groundwater TCE contamination.
- Implement a GETS using air stripping and/or carbon adsorption.
- Monitor off-base water supply wells in the vicinity of the site and provide point-of-use treatment or alternate water supply, if necessary.

4.2.5.2 Site WW-1 (WP003) Remedy Implementation

WW-1 Institutional Controls

Fairchild AFB has implemented ICs per the ROD and the base's LUC plan to restrict site access and prevent exposure to or consumption of on-base contaminated groundwater at Site WW-1. It has not been necessary to provide point-of-use treatment or an alternative water supply for any off-site residences located near the site.

WW-1 Additional Source Area Investigations

Before 2000, no formal additional source investigation activities had been conducted at Site WW-1. LTM results evaluated in preparation of the *First Five-Year Review* (USAF, November 2000) suggested that the source of observed TCE contamination in groundwater likely was contaminated soil that seasonally became saturated. In June 2000, Fairchild AFB performed depth-specific soil and groundwater sampling in the immediate vicinity of on-base MW-102. Results of this investigation further indicated that the likely source of the TCE contamination was located west of MW-102, in soils at depths of 6 to 10 feet. The base initiated source removal activities in October 2000. During soil removal, a cluster of 35 buried drums were discovered at a depth of 10 to 14 feet in the suspected vicinity (Figure 3-6a). An estimated 750 gallons of liquid waste, including sulfuric acid, heavy oils, and used hydraulic oils containing solvents such as TCE, were recovered from the drums and later treated off-site (CH2M HILL, December 2001). Approximately 225 cubic yards of TCE- and TPH-contaminated soils were removed and landfarmed adjacent to the site. TCE was remediated from the landfarmed soil over the next six months. However, TPH concentrations were persistent and remained above the MTCA Method A CUL (for unrestricted land use), so the 225 cubic yards of soil were thermally treated at an off-site location in 2001 (CH2M HILL, December 2001). The former excavation was backfilled with clean fill material once it was determined that the landfarmed soil could not be used as backfill. Prior to backfill, seven soils samples were collected from the excavation perimeter and analyzed for VOCs and TPH-D. TCE was detected in four soil samples at concentrations ranging from 0.007 to 0.024 mg/kg, below the current MTCA Method A CUL for unrestricted land use of 0.03 mg/kg; no TPH-D or other VOCs were detected in any of these samples (CH2M HILL, December 2001).

WW-1 Groundwater Extraction and Treatment System

A RD field investigation was conducted within an off-base portion of the TCE plume in 1993-1994 to provide data to design a network of groundwater extraction wells and select operating criteria for the associated GETS. Objectives of the system were to establish hydraulic control of the TCE plume, prevent further off-site migration, and treat contaminated groundwater to levels below the TCE MCL. One off-base extraction well (EW-1) and two on-base extraction wells (EW-2 and EW-3) were installed in 1994 and 1995 as initial components of the groundwater extraction network. Because extraction-well yields varied considerably on-base, five well points were installed on-base that could later be incorporated into the extraction system.

The WW-1 treatment system was designed to treat up to 90 gpm, using air stripping with offgas GAC treatment. The treatment system became operational in February 1996, using EW-1 and EW-3. The other on-base extraction well, EW-2, was later decommissioned because of low well yield and limited contaminant removal. In December 1997, the system was modified by adding three on-base well points as additional extraction locations. The well points and nearby EW-3 operated using an above-ground vacuum/eductor system; a submersible pump was installed in EW-1. Clean effluent water from the treatment system was re-introduced into the aquifer through infiltration ditches located north of the extraction zone.

Full-time groundwater extraction and treatment operations continued until December 2004. The GETS was placed in standby mode with concurrence of Ecology at that time in accordance with recommendations presented in a technical memorandum (CH2M HILL, November 2004). Specific conditions identified for idling or restart of the GETS were followed through 2010 and included the following:

- The GETS could be idled when sampling data indicate that no above-MCL TCE contaminated groundwater is present at MW-102 or WP-01, coupled with water-level trends in on-site wells that indicate water levels generally are declining. To better track contaminant trends, the frequency of groundwater monitoring at MW-102 and WP-01 was increased to twice per quarter.
- The GETS would be restarted when sampling results indicate that above-MCL TCE-contaminated groundwater is present at MW-102 or WP-01 or when water levels show a dramatic rise (1.5 feet) within a 6 to 7-week period, increasing the potential for contaminant flushing. The system will remain in operation until the conditions described above for idling have been met.

From 2005 through June 2006, the GETS was required to be operational for only seven months based on the triggering conditions described above. Since July 2006, conditions have not been met that would trigger restart of the GETS, except for a TCE concentration of 13 µg/L in MW-102 during first quarter 2011. After subsequent confirmation sampling in April 2011, TCE concentrations returned to below 5 µg/L. Thus, the system was not required to be operated and has remained idle since July 2006.

Following review of the *2010 Annual RA-O Report* (CH2M HILL, September 2011), Ecology concurred with the recommendation that the provisional requirement to operate the groundwater extraction system can be eliminated (Ecology, 29 June 2011).

WW-1 Groundwater Monitoring Program

A groundwater LTM program was initiated in 1995 using both on-base and off-base monitoring wells, and by 1999, had expanded to include 24 wells. The TCE plume was estimated to be up to 200 feet wide, and TCE concentrations were estimated to exceed the MCL at least 1,500 feet off-base within the shallow alluvial aquifer. Prior to the source removal activities conducted in October 2000 (CH2M HILL, December 2001), on-base TCE concentrations exceeded the MCL at up to four wells, with a maximum TCE concentration of 830 µg/L reported at MW-102 in 1997. At off-base wells, TCE concentrations ranged from non-detect up to 69 µg/L at MW-120 in 1996, which is located approximately 700 feet downgradient of the base boundary.

Even before source removal, TCE concentrations began to show declining trends in most locations. Once source removal activities were completed in 2000, TCE concentrations began declining quickly. TCE concentrations have been below its MCL at all on-base wells since June 2001, except at MW-102, where TCE concentrations periodically exceeded the MCL at up to 13 µg/L through March 2011. TCE concentrations have been below its MCL at all off-base wells since 2003, except MW-120, where concentrations were up to 24 µg/L through September 2012. A more complete discussion of historical groundwater sampling results for Site WW-1 are summarized in Section 6.3.2.2.

Fourteen residential wells, located east of Sites WW-1 and FT-1 (Figure 3-6b), have been regularly monitored since 1988 as part of the base's residential well monitoring program. No COCs associated with Site WW-1 have been detected in these wells exceeding any applicable CULs for at least the past 14 years. Provisions for providing point-of-use treatment or an alternate water supply have been in place, but have not been required to date.

4.3 OU-3 Remedial Actions – Priority Two Sites

As discussed in Section 2.2.3, OU-3 includes seven sites (IS-3, IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2) for which RA and/or ICS were required by its *ROD* (USAF, September 1995). Remedial actions conducted at each of these sites are discussed below.

4.3.1 Site IS-3 (OT016)

4.3.1.1 Site IS-3 (OT016) Remedy Selection

Although the *RI* (ICF Technology, February 1995) identified that a release of wastes containing PCBs had taken place within the building and accumulated in a building sump, no evidence was found that any release had occurred outside the building.

The selected remedy identified in the ROD for IS-3 was ICs. This decision was based on results of a human health risk assessment, which determined that conditions at the site posed no unacceptable risks to human health or the environment. When Building 2150 was demolished, underlying soil was to be assessed for PCBs to assure compliance with state and federal regulations: this remedy was implemented in 1997, as noted in Section 4.3.2.

4.3.1.2 Site IS-3 (OT016) Remedy Implementation

Building 2150 was demolished in 1996, and the sump was found to be intact. In 1997, five soil samples were collected beneath the former building area around the former sump and evaluated for the presence of PCBs. No PCBs were detected above the laboratory reporting

limit of 0.1 mg/kg (Lambert Group, May 1997); the current MTCA Method A CUL for unrestricted land use is 1 mg/kg. EPA and Ecology concurred that soil samples collected from beneath the former building area and condition of the sump indicated there was not a release of PCBs from the sump at the site, and that all remedial actions as specified in the ROD have been completed (EPA, 27 May 1997; Ecology, 2 June 1997). Fairchild AFB continues to enforce ICs per the ROD and the Fairchild AFB LUC Plan (USAF, May 2007), which require a Work Clearance Permit for intrusive activities at the site. Since the 1997 soil results were below the current MTCA Method A CUL for unrestricted land use, a future multi-site RACR may be prepared to establish that ICs for Site IS -3 are no longer required.

4.3.2 Site IS-4 (OT017)

4.3.2.1 Site IS-4 (OT017) Remedy Selection

The COC for Site IS-4 is TPH-D in soil. The RAO established in the ROD is to remediate soil to achieve state CULs. The ROD outlined the following elements for the selected remedy at Site IS-4:

- Maintain ICs that restrict site access and require a Work Clearance Permit for intrusive activities until CULs are achieved.
- Allow natural attenuation to reduce the concentration of diesel-range petroleum contamination in soil and monitor degradation until levels decrease below the state CUL of 200 mg/kg. *Note: the current MTCA Method A CUL for TPH-D in soil (unrestricted land use) is 2,000 mg/kg. See Section 7.4.2.*

4.3.2.2 Site IS-4 (OT017) Remedy Implementation

IS-4 Institutional Controls

Fairchild AFB has implemented ICs per the ROD and the Fairchild AFB LUC Plan as previously described to restrict site access and limit intrusive activities at Site IS-4.

IS-4 Soil Monitoring Program

Long-term soil monitoring was initiated in 1996. From 1996 through 1998, soil samples were collected semi-annually, annually in 1999 and 2000, and again semi-annually from 2001 through 2004. In 2000, the soil sampling program included three-point composite samples collected from five representative grids at depths of 0 to 2 feet. In 2001, the soil LTM program was expanded from 5 to 15 sample locations, with borings advanced to 8 feet. Concentrations of TPH-D exceeded CULs for approximately 15 to 45 percent of soil samples collected during each sampling event between 2000 and 2004, except in October 2003, when no samples exceeded CULs.

A soil excavation and landfarming program was initiated in late 2002 to reduce soil contamination. Approximately 150 cubic yards of contaminated soil were excavated from a known hotspot located near a former drywell. This soil was landfarmed, and through managed efforts to enhance natural attenuation of the TPH-contaminated soil, the soil achieved CULs by September 2004 and was returned to the original excavation.

An additional 1,200 cubic yards of contaminated soil were excavated from other hotspots at the site in 2004 and landfarmed on-site beginning in September 2004. These efforts were conducted to remove the most impacted site soils and treat them through landfarming, not to remove all contaminated soil. Soils removed during this effort primarily were located beneath the concrete pad of the former engine test cell building.

Sixteen composite soil samples were collected from landfarmed soils in March 2006. All sample results were either non-detect or below the ROD CUL (200 mg/kg). As such, all landfarmed soils were returned to the excavation in June 2006. No further soil monitoring has been conducted since landfarming activities were completed in 2006.

IS-4 Groundwater Monitoring

The ROD does not require groundwater monitoring at this site. However, in 2001 a groundwater LTM program was established for the site to provide hydrogeologic and analytical data to support eventual site closure. Three monitoring wells installed in 2001 were sampled semi-annually through 2006 and annually in 2007, 2008 and 2010. With the concurrence of Ecology, groundwater samples were not collected during 2009. TPH-D was not detected in any site well since 2001.

IS-4 Remedial Process Optimization Evaluation and NFA Determination

CH2M HILL performed a RPO evaluation (CH2M HILL, January 2009) for Site IS-4 in 2008 to evaluate whether a Response Complete determination (or site closure) was justified based on RAs implemented and monitoring results. Recommendations presented in the RPO report identified sufficient technical justification for a NFA determination and site closure. Ecology reviewed the RPO and recommended that a supplementary round of groundwater samples be collected during 2010 to support a NFA determination (Ecology, 10 June 2010). This supplementary sampling event was completed in July 2010 (CH2M HILL, August 2010). Based upon analytical results, Ecology concluded there appears to be no more impact to local groundwater resources from residual soil contamination (if any) and concurred that a NFA determination for Site IS-4 was warranted (Ecology, 1 October 2010a). Three existing site monitoring wells were decommissioned in December 2010. To seek Response Complete under joint DOD/EPA guidance (2005), a RACR will be prepared in the future.

4.3.3 Site PS-1 (ST006)

4.3.3.1 Site PS-1 (ST006) Remedy Selection

COCs established for Site PS-1 are TPH-D in soil and groundwater and benzene in groundwater. RAOs established in the ROD are to remediate soil to state CULs that are protective of groundwater and to remediate groundwater to below the MCL for benzene and below the MTCA Method A CUL for TPH-D. The ROD outlined the following elements for the selected remedy at Site PS-1:

- Maintain ICs that restrict site access and require a Work Clearance Permit for intrusive activities until CULs are achieved.
- Implement an in-situ bioventing treatment system for TPH-D contaminated soil until concentrations decrease below the state CUL of 200 mg/kg.
- Monitor groundwater across the site and downgradient to assess natural degradation and migration of TPH-D and benzene until concentrations are below the state CUL of 1,000 µg/L for TPH-D and the MCL of 5 µg/L for benzene. *Note: the current MTCA Method A CULs for TPH-D are 2,000 mg/kg for soil (unrestricted land use) and 500 µg/L for groundwater. See Section 7.4.2.*

4.3.3.2 Site PS-1 (ST006) Remedy Implementation

PS-1 Institutional Controls

Fairchild AFB has implemented ICs per the ROD and the base's LUC Plan as previously described to restrict site access and limit intrusive activities at Site PS-1.

PS-1 Bioventing System and Soil Monitoring Program

An in-situ bioventing treatment system was constructed in 1998 and was fully operational through December 2006 when Ecology determined it was no longer necessary to operate the system (USAF, 6 December 2006). The bioventing system consisted of four blowers serving 14 vent wells. Each blower was designed to inject air into the subsurface through vent wells to maintain oxygen levels sufficient to support biodegradation of TPH compounds. Details concerning operation of the Site PS-1 bioventing system and the soil monitoring program are summarized in Section 6.3.3.1.

PS-1 Groundwater Monitoring

A groundwater LTM program for PS-1 was initiated in 1996 and consisted of semi-annual monitoring of six wells for benzene and TPH-D. In 2002, TCE was detected in two wells, notably MW-195 where concentrations exceeded its MCL of 5 µg/L. In 2008, the LTM program was reduced with Ecology concurrence such that MW-195 is sampled twice per year for VOC analysis only, and three wells are sampled annually for TPH-D analysis only Ecology, June 4, 2009). To support this Five-Year Review, groundwater samples were collected in March 2012 from six site wells for TPH-D analyses and from two site wells for VOC analyses, one of which was sampled again for VOCs in June 2012. These and historical groundwater sampling results for Site PS-1 are summarized in Section 6.3.3.2.

4.3.4 Site PS-5 (SS009)

4.3.4.1 Site PS-5 (SS009) Remedy Selection

The COC identified in the ROD for Site PS-5 was TPH-D in both soil and groundwater. RAOs at Site PS-5 are to remediate groundwater and soil to state CULs that are protective of groundwater. To satisfy RAOs identified in the ROD, the selected remedy included the following elements:

- Maintain ICs to restrict site access and require a Work Clearance Permit for intrusive activities until state CULs are achieved through passive natural degradation.
- Monitor site groundwater and downgradient to assess natural degradation and migration of TPH-D.

4.3.4.2 Site PS-5 (SS009) Remedy Implementation

RA-O activities for Site PS-5 was initiated in 1996. ICs were implemented and continue to be maintained to restrict site access and require a Work Clearance Permit for any intrusive activities until CULs are achieved. Groundwater monitoring began in 1996, which included sampling of four monitoring wells. Sampling results for 1996 and 1997 revealed that TPH-D concentrations had been reduced below ROD CULs (and below the current MTCA Method A CUL of 500 µg/L). In 1998, Ecology agreed that groundwater monitoring at Site PS-5 could be discontinued (EA Engineering, December 1998); Site PS-5 monitoring wells were decommissioned in 1999 (EA Engineering, April 2001).

4.3.5 Site PS-7 (ST010)

4.3.5.1 Site PS-7 (ST010) Remedy Selection

The COC for Site PS-7 is TPH-D in soil and groundwater. RAOs are to remediate groundwater and soil to state CULs. To satisfy RAOs identified in the ROD, the selected remedy included the following:

- For soil, maintain ICs to restrict site access and require a Work Clearance permit for intrusive activities until state CULs are achieved. Remaining soil contamination to be addressed when Building 1350 is demolished.
- Monitor both site and downgradient groundwater to assess natural degradation and migration of TPH-D until the state CUL of 1,000 µg/L identified in the ROD is achieved. *Note: the current MTCA Method A CULs for TPH-D are 2,000 mg/kg for soil (unrestricted land use) and 500 µg/L for groundwater.* The updated soil TPH CUL is ten times less conservative than the RAO specified in the ROD, and therefore, protectiveness is not in question due to this change. See Section 7.4.2.

4.3.5.2 Site PS-7 (ST010) Remedy Implementation

ICs have been implemented and maintained to restrict site access and require a Work Clearance Permit for any intrusive activities until CULs are achieved. Building 1350 was demolished in January 2013, which was past the September 2012 cutoff date for the Third Five-Year Review. Post-demolition soil excavation and sampling results will appear in future RAO reports and the impacts of this change in site conditions (e.g., Building 1350 demolition) will be revisited in the next five-year review.

Groundwater LTM at PS-7 was initiated in 1996, which included sampling of three monitoring wells. Results from four rounds of sampling in 1996 and 1997 revealed that TPH-D concentrations were well below the state CUL (and below the current MTCA Method A CUL of 500 µg/L). In 1998, Ecology agreed that groundwater monitoring at Site PS-7 could be discontinued (EA Engineering, December 1998); Site PS-7 monitoring wells were decommissioned in 1999 (EA Engineering, April 2001).

4.3.6 Site PS-10 (SD031)

4.3.6.1 Site PS-10 (SD031) Remedy Selection

RAOs at Site PS-10 were to remediate soil to state CULs that are protective of groundwater and prevent exposure to contaminated soil. The site COCs are TCE and TPH-D in soil. TCE contamination observed in groundwater at PS-10 was deferred to Priority Three Site SS-39, which was subsequently established as OU-5. To satisfy RAOs identified by the ROD, the selected remedy included the following elements:

- Maintain ICs to restrict site access and require a Work Clearance Permit for intrusive activities until CULs for soil are achieved.
- Excavate and treat 67 cubic yards of TCE-contaminated soil. Contaminated soils were to be treated using high-temperature incineration prior to disposal. The excavation was to be backfilled with clean soil and graded.
- Monitor natural degradation of TPH-D in soil until the contamination level decreases below the state CUL of 200 mg/kg. *Note: the current MTCA Method A CUL for TPH-D in soil (unrestricted land use) is 2,000 mg/kg.* The updated TPH CUL is ten times less

conservative than the RAO specified in the ROD, and therefore, protectiveness is not in question due to this change. See Section 7.4.2.

4.3.6.2 Site PS-10 (SD031) Remedy Implementation

Fairchild AFB has implemented ICs per the ROD and the base's LUC Plan as previously described to prevent exposure to contaminated soil and groundwater at Site PS-10.

In 1996, approximately 140 cubic yards of TCE-contaminated soil were excavated from the drainage ditch near the OWS discharge and transported off-site for incineration and disposal (R&R International, 1998). The excavation area was approximately 1,100 square feet with a depth of 3.5 feet deep, where basalt bedrock was reported. The CUL identified for this work was 91 mg/kg, which was cited in the ROD as the MTCA Method B CUL for residential use, based on direct contact with soil. Following excavation, 18 confirmation soil samples were collected. TCE was non-detect in 14 samples and ranged from 0.16 to 0.85 mg/kg in four samples. *Note: for TCE in soil, the current MTCA Method A CUL (for unrestricted land use) is 0.03 mg/kg. See Section 7.4.1.*

Additional soil samples were collected in 1996 and 1997, in which TPH-D concentrations remained above the 200 mg/kg ROD CUL. Soil samples were again collected in March 1998 and analyzed for extractable petroleum hydrocarbons, volatile petroleum hydrocarbons, and polycyclic aromatic hydrocarbon (PAHs) to provide data to apply Ecology's Interim TPH Policy for calculation of a site-specific cleanup level. March 1998 sampling event results and application of the subsequent Interim TPH Policy calculations indicated that both the hazard quotient and risk to groundwater were acceptable. Following review by Ecology, Site PS-10 was considered to have met the Interim TPH CULs, and further soil monitoring was discontinued (EA Engineering, October 1999). *Note: the Interim TPH Policy was nullified with the adoption of revised MTCA CULs in 2007.*

In October 2012, after the September 2012 data review cutoff for this five-year review, the remaining OWS was removed and Building 1060 was demolished. Additional investigation of potentially TCE-contaminated soil in the Building 1060 vicinity (which will help evaluate whether TCE remains in soil at concentrations above the current MTCA Method A CUL) is planned in 2013. This work is tied to future groundwater investigations and remedial actions for Site SS-39 (OU-5) to which TCE-contaminated groundwater has been deferred.

4.3.7 Site FT-2 (FT032)

4.3.7.1 Site FT-2 (FT032) Remedy Selection

The COC for Site FT-2 is TPH-D in soil and groundwater. RAOs established in the ROD are to remediate soil and groundwater to achieve state CULs. The ROD outlined the following elements for the selected remedy:

- Maintain ICs that restrict site access and require a Work Clearance Permit for intrusive activities until state CULs are achieved.
- Monitor site soil and groundwater and downgradient groundwater to assess natural degradation and migration of diesel-range petroleum contamination until state CULs for soil (200 mg/kg) and groundwater (1,000 µg/L) are achieved. *Note: the current MTCA Method A CULs for TPH-D are 2,000 mg/kg for soil (unrestricted land use) and 500 µg/L for groundwater.* The updated TPH CUL is ten times less conservative than the RAO

specified in the ROD, and therefore, protectiveness is not in question due to this change. See Section 7.4.2.

4.3.7.2 Site FT-2 (FT032) Remedy Implementation

FT-2 Institutional Controls

Fairchild AFB has implemented ICs per the ROD and the base's LUC Plan as previously described to restrict site access and limit intrusive activities at Site FT-2.

FT-2 Soil Monitoring and Landfarming

Soil LTM was initiated in 1996. From 1996 through 1998, soil samples were collected semi-annually, annually in 1999 and 2000, and again semi-annually from 2001 through 2004. In 2000, the soil sampling program included three-point composite samples collected from five representative grids at depths of 0 to 2 feet. In 2001, the soil RA-O program was expanded from 5 to 15 sampling locations, with borings advanced to 8 feet. From 2000 through 2004, concentrations of TPH-D exceeded unrestricted land use state CULs for approximately 20 to 60 percent of all soil samples collected during each sampling event. The highest TPH-D concentration detected during this period was 4,000 mg/kg in April 2003.

A soil excavation and landfarming program was initiated in late 2002 to reduce soil contamination. Approximately 220 cubic yards of contaminated soil were excavated from a known hotspot. The soil was landfarmed, and through managed efforts to enhance natural attenuation of the TPH contaminated soil, the soil achieved CULs by September 2004 and was returned to the original excavation. An additional 320 cubic yards of contaminated soil were excavated from other hotspots at the site and again landfarmed on-site in September 2004. Nine composite soil samples were collected from landfarmed soils in March 2006. Although two samples had TPH-D concentrations above the ROD CUL of 200 mg/kg, all TPH-D concentrations were well below the current MTCA Method A CUL of 2,000 mg/kg for unrestricted land use. As such, all landfarmed soils were returned to the excavation in June 2006. These efforts were conducted to remove only the most impacted site soils and treat them through landfarming, not to remove all contaminated soil. No soil monitoring has been conducted since 2006.

FT-2 Groundwater Monitoring

Groundwater monitoring at Site FT-2 was initiated in 1996 at one well. Following two years of successive non-detects for TPH-D, groundwater monitoring was discontinued in 1997. In October 2001, three shallow groundwater monitoring wells were installed at FT-2 to reestablish site groundwater monitoring ahead of potential site closure. These wells were sampled semi-annually through 2006, then annually in 2007, 2008, and 2010. All TPH-D concentrations in these samples were below the ROD CUL of 1,000 µg/L. Although some TPH-D concentrations in one well (MW-285) exceeded the current MTCA Method A CUL for TPH-D of 500 µg/L, Ecology determined that NFA was appropriate for Site FT-2 (Ecology, 1 October 2010b). Details of this NFA determination are provided below.

FT-2 Remedial Process Optimization Evaluation and NFA Determination

CH2M HILL prepared an *RPO Report* (CH2M HILL, January 2009) for Site FT-2 in 2008 to evaluate whether a Response Complete determination (or site closure) was justified based on RAs implemented and monitoring results. Recommendations presented in this *RPO Report* identified sufficient technical justification for an NFA determination and site closure. Ecology reviewed the *RPO Report* and recommended that a supplementary round of

groundwater samples be collected during 2010 to support a NFA determination. Supplementary sampling was completed in July 2010 (CH2M HILL, January 2011). Based upon analytical results, Ecology concurred that a NFA determination for Site FT-2 was warranted (Ecology, 1 October 2010b). In their NFA determination, Ecology noted:

Per WAC 173-340-720(9)(d), the 95% UCL on the true mean value on TPH-Dx and oil was conducted to evaluate compliance along with other past site cleanup actions conducted at the site below:

1. *Compliance Statistical evaluation for MW-285:*
   - ✓ *95% UCL on the true mean value on TPH-Dx and oil is found to be 0.37 mg/L based on the assumption of log-normal distribution.*
   - ✓ *No single sample has been greater than two times the GW cleanup level of 0.5 mg/L.*
   - ✓ *Less than 10% of the sample concentrations exceed the groundwater cleanup level of 0.5 mg/L.*
2. *Compliance monitoring period of 10 yrs appears to be sufficient at the site based on the trend of ground water monitoring results.*
3. *Significant amount of contaminant source materials have been already removed from the site.*
4. *Ecology's understanding on the IC use at FT-2 site is: Through institutional and land-use controls at Fairchild AFB, groundwater extraction for domestic uses at the FT-2 site is not permitted, except for limited, supplementary groundwater extraction by the base from one well, which is located approximately 1.5 miles south of the site, and produces water from deeper basalt aquifers. As such, shallow groundwater on base, and at the site FT·2 in particular, <u>are not</u> a source of domestic/residential use.*

Ecology concluded there appears to be <u>no more</u> impact to local groundwater resources from any residual soil (if any) at the FT-2 site. As such, Ecology <u>concurs</u> with USAF's recommendation that a NFA determination for FT-2 site is warranted.

Based on Ecology's NFA determination, and given the above ICs, Site FT-2 monitoring wells were decommissioned in December 2010.

EPA concurred with Ecology that a Response Complete determination is appropriate for this site. To seek Response Complete under joint DOD/EPA guidance (2005), a RACR will be prepared in the future, which should include a final inspection and describe the activities required to monitor long-term protectiveness and any LUCs that may be required (EPA, October 2012). A future multi-site RACR may be desirable under the joint DOD/EPA (2005) guidance, including detailed evaluation to establish whether additional measures are recommended to achieve UU/UE.

5. Progress Since Last Five-Year Review

Progress since the last five-year review is evaluated below relative to issues and recommendations contained in *Second Five-Year Review* (USAF, June 2008)[2] and reported in EPA's Five-Year Review Tracking System. The specific issue and recommendation citations shown below in *italics* were copied from EPA's Five-Year Review Tracking System, provided to CH2M HILL (the USAF five-year review contractor) via email (EPA, 20 November 2012).

5.1 OU-1 Progress Since Last Review – CRL (LF002)

For OU-1 (CRL), two issues were identified in the *Second Five-Year Review, Table 3-1.* Each of these issues, recommendations to address them, and actions taken since the *Second Five-Year Review* are discussed in Section 5.1.1. Additional recommendations that were identified during the *Second Five-Year Review* are discussed in Section 5.1.2.

5.1.1 Issues Identified During Technical Assessment

Issue 1

TCE concentrations in an off-site monitoring well (MW-118) located downgradient of the CRL have increased in recent years to levels approaching 400 µg/L (Table 3-1, USAF, June 2008).

- **Recommendation:** *TCE concentrations in MW-118 will continue to be evaluated through semi-annual LTM.*
- **Action:** TCE concentrations at off-site monitoring well MW-118 began to increase in September 2003, reaching 430 µg/L in September 2008. Since that time, semi-annual monitoring at MW-118 has shown a general decrease in TCE concentrations to 170 µg/L (September 2012). See Table 6-1b and Figure 6-1c for historical TCE concentrations at MW-118 and Figure 6-1e for 2012 TCE concentrations at CRL.
- **Status:** Remains an issue for the Third Five-Year Review and is discussed further in the Technical Assessment (See Section 7.1 and Table 8-1). TCE contamination observed in MW-118 is potentially a result of third-party actions and not attributable to CRL, based on: 1) monitoring wells upgradient of MW-118 but outside the influence of the GETS having significantly lower TCE concentrations, and 2) these same upgradient wells showing dissimilar TCE concentration trends. Additionally, there are no users of groundwater in the vicinity of MW-118. The nearest water supply wells (the City of Airway Heights wells PS-1 and PS-4) are located approximately 2,700 feet cross/downgradient of MW-118 (Figure 3-1b). TCE concentrations in this well pair have never exceeded 1 µg/L (CH2M HILL, June 2008 through November 2012). In monitoring wells just upgradient of PS-1 and PS-4 (MW-127 and MW-139), TCE has never been detected at MW-127 and has not exceeded 1 µg/L at MW-139 since 1996. Based on these observations, the remedy is believed to remain protective in the short term, as no

[2] For the *Second Five-Year Review*, the initial cut-off date established for results presentation was September 2004 (in advance of a projected 2005 completion date), but the report was not signed until August 2008. As such, progress since the last five-year review is reported here prior to 2008 for most sites.

exposures are occurring, and in the long term, as concentrations have continued to decline.

Issue 2
No definitive timeframe has been established at this time to determine when CULs will be achieved for the upper aquifer (Table 3-1, USAF, June 2008).

- **Recommendation:** *Evaluate existing data using statistical means to identify potential timeframes for achieving CULs.*
- **Action:** To improve upon the ROD estimates of 10-75 years to attain RAOs, the last five years included post-ROD treatability studies in suspected source areas. Despite these efforts to treat source materials, a definitive timeframe has not yet been established to determine when CULs will be achieved for the upper aquifer. However, substantial progress has been made to enhance TCE removal and reduce TCE concentrations for on-site portions of the upper aquifer through continued implementation of periodic GETS idling, implementation of SVE beginning in 2010 and through 2012, and ISCO operations in 2011 and 2012. The full impacts of these post-ROD treatability study/optimization actions will be evaluated in the forthcoming post-ROD treatability study report to provide an updated estimate of when CULs will be achieved and when statistically significant trends can be re-established.
- **Status:** This is not directly related to protectiveness and is not presented as an issue in this Third Five-Year Review.

5.1.2 Additional Recommendations for OU-1

In the *Second Five-Year Review*, the following additional recommendations were identified for OU-1 in Table 3-2. Each recommendation and subsequent actions are discussed below.

Recommendation: *Reduce RA-O groundwater monitoring (Table 3-2, USAF, June 2008).*

- **Specific Recommendation:** *Evaluate and receive regulatory approval to reduce groundwater monitoring by eliminating some wells or reducing sampling frequency.*
- **Action:** Following review of the *2008 Annual RA-O Report* (CH2M HILL, July 2009), Ecology concurred with recommendations to reduce monitoring frequencies at several wells and remove other wells from the LTM program (Ecology, 4 June 2009). Additional LTM reductions were made following Ecology concurrence with recommendations in subsequent annual RA-O reports through 2011; specific LTM reductions are documented in those reports.
- **Status:** Complete. Further reductions or additional groundwater monitoring could be incorporated into future RA-O.

Recommendation: *Extraction well pumps and motors may not be sized appropriately (Table 3-2, USAF, June 2008).*

- **Specific Recommendation:** *As extraction well pumps and motors fail, replace them with "right-sized" units to match current conditions.*
- **Action:** As extraction well pumps require replacement, they continue to be "right-sized" to increase operational efficiency. Specific pump replacement and repair activities are documented in quarterly RA-O reports. During the five-year review period, pumps

were replaced in the following extraction wells: EW-14 in July 2009 and again in May 2010, EW-3 in September 2011, and EW-11 in August 2012.

- **Status:** Ongoing.

Recommendation: *Reduce overall operational costs and increase contaminant removal rates (Table 3-2, USAF, June 2008).*

- **Specific Recommendation:** *Evaluate the potential to employ batch treatment* (GETS idling) *to maintain hydraulic containment while increasing potential TCE removal.*
- **Action:** Batch treatment operations were fully incorporated into system operations beginning in 2007. Over a 12-month period, the GETS typically is idled for about four months. During this time, groundwater levels are allowed to recover beneath the landfill cells (which results in the transfer of TCE mass from the vadose zone [within fractured basalt bedrock] to groundwater). When the system is restarted, the GETS re-establishes hydraulic containment within 30 to 45 days (based on evaluation of groundwater elevation data as reported in annual RA-O reports) and increases contaminant removal rates. Modeling efforts completed during a RPO evaluation (CH2M HILL, October 2006a) concluded that the GETS could remain off for up to six months without jeopardizing overall hydraulic containment.

  Thus, operational costs and utility usage (natural gas and electricity) have been reduced by about one-third with GETS idling since 2007. Prior to implementing batch treatment, typical TCE removal rates were approaching asymptotic levels of between 3 to 5 pounds per quarter. Since batch treatment pilot testing was implemented in mid-2006, an average of 20.2 pounds per quarter of TCE have been removed (with a maximum of 49 pounds per quarter), at least a four-fold increase in contaminant removal rates (CH2M HILL, July 2013).
- **Status:** A review of ongoing O&M costs will be completed in the post-ROD treatability study report in support of an OU-1 ROD amendment.

5.2 OU-2 Progress Since Last Review – Priority One Sites

For OU-2 (On-Base Priority One Sites), five issues were identified in the *Second Five-Year Review*. Each of these issues, recommendations to address them, and actions taken since the *Second Five-Year Review* are discussed in Section 5.2.1. Additional recommendations that were identified during the *Second Five-Year Review* are discussed in Section 5.2.2.

5.2.1 Issues Identified During Technical Assessment

Issue 1 – Site FT-1 (FT004)

Operation of the air sparging system is not necessary because benzene-contaminated groundwater has been remediated (Table 4.4-1, USAF, June 2008).

- **Recommendation:** *Discontinue operation of air-sparge system.*
- **Action:** In December 2006, the air-sparge system was shutdown indefinitely with concurrence of Ecology (USAF, 6 December, 2006).
- **Status:** Complete. The FT-1 air-sparge system remains shutdown given that all benzene concentrations have been less than its MCL of 5 µg/L since 2000 and that benzene has

not been detected in site groundwater since 2007 (see Section 6.3.2.2 for additional details).

Issue 2 – Site FT-1 (FT004)
Benzene-contaminated soil has been largely remediated through bioventing and dig-and-hauls. Future operation of this system may not be necessary (Table 4.4-1, USAF, June 2008).

- **Recommendation:** *Place bioventing system in standby mode.*
- **Action:** In December 2006, the bioventing system was shutdown indefinitely with concurrence of Ecology (USAF, 6 December, 2006).
- **Status:** Complete. The FT-1 bioventing system remains shutdown and is inoperable due to soil excavation and removal activities completed in 2008 (see below). Twelve confirmation samples were collected from excavation sidewalls. Benzene was not detected in nine samples; detections in the three remaining samples ranged up to 8.3 µg/kg, well below the current MTCA Method A CUL of 30 µg/kg.

Issue 3 – Site WW-1 (WP003)
Source removal activities and natural attenuation processes have largely remediated TCE-contaminated groundwater. Future operation of the extraction and treatment system may not be necessary (Table 4.5-1, USAF 2008).

- **Recommendation:** *Continue to proceed with monitoring mechanisms in place to determine system operations.*
- **Action:** The WW-1 GETS last operated for seven months through June 2006 when triggering conditions described in Section 4.2.10.3 were met. Since that time, conditions have not been met that would trigger restart of the GETS, except for a single TCE detect of 13 µg/L in MW-102 during first quarter 2011. After confirmation sampling in April 2011, TCE concentrations returned to below 5 µg/L. Thus, the system was not required to be operated and remained idle. Following review of the *2010 Annual RA-O Report* (CH2M HILL, September 2011), Ecology concurred with the USAF's recommendation that the provisional requirement to operate the groundwater extraction system can be eliminated (Ecology, 29 June 2011).
- **Status:** Complete (for the stated triggering conditions). However, see Section 8.2 for related issues identified at Site WW-1. The remedy remains protective as TCE RAOs have been met in wells effectively treated by the WW-1 GETS. The one well with TCE concentrations currently above the MCL, MW-120, lies approximately 700 feet downgradient of the base boundary, outside the potential influence of the WW-1 GETS (Figure 3-6a). However, this issue does not relate to protectiveness, as (1) no exposures to shallow alluvial groundwater are occurring, (2) downgradient sentinel monitoring wells are not impacted over MCLs, and (3) TCE has not been detected in residential wells downgradient of Site WW-1. See Table 6-10, Figure 6-11a, and Figure 6-11c.

Issue 4 – Site PS-2 (SS018)
It is unknown if contaminants have migrated beyond the most downgradient site well (Table 4.2-1, USAF, June 2008).

- **Recommendation:** *Pursue installation of additional downgradient monitoring wells, subsequent to mission operations command staff approval.*

- **Action:** Three new downgradient monitoring wells (MW-370, MW-371, and MW-372) were installed in April 2011 as shown on Figure 3-3a. Groundwater samples were collected from these new wells in 2011 and 2012 and analyzed for VOCs and TPH-D. Benzene was non-detect in five of six samples collected in 2011 and 2012; the lone detect was 0.14 µg/L in MW-371 for April 2011. Benzene concentrations for all Site PS-2 wells have been below its MCL for four consecutive years (Table 6-4 and Figure 6-5). These results indicate that benzene has not migrated downgradient of the site.

  TPH-D concentrations for 2011 and 2012 exceeded the (lower) current Method A CUL of 500 µg/L at MW-370 (both years) and at MW-371 (2011) at concentrations up to 2,000 µg/L (Table 6-5 and Figure 6-6). The underlying basis for Ecology's December 2007 change to the MTCA Method A CUL is discussed further in Section 7.4.2.

- **Status:** Complete for benzene in groundwater. TPH-D concentrations in groundwater remain and downgradient extent should continue to be evaluated, with detailed assessment of MTCA Method A CUL development assumptions and compliance options (similar to those applied in Section 4.3.14.3 for Site FT-2) as the site progresses toward Response Complete with preparation of a future multi-site RACR under the joint DOD/EPA (2005) guidance. This issue does not relate to protectiveness of the remedy, however, since no exposures are occurring.

Issue 5 – Sites SW-1, PS-2, and PS-8

The timeframe to achieve CULs in the upper aquifer has not been definitively established.

- **Recommendation:** *Further evaluate existing data to identify a potential timeframe for achieving CULs in site wells.*

- **Action for Site SW-1:** Historical concentration data for TCE in groundwater have been evaluated through 2012, and all TCE concentrations have been below its MCL since 2005 (Table 6-2 and Figure 6-3). Thus the primary RAO for Site SW-1 has been met.

- **Action for Site PS-2:** Historical concentration data for benzene and TPH-D in groundwater and free-product recovery data have been evaluated through 2012. All benzene concentrations have been below its MCL since March 2009 (Table 6-4 and Figure 6-5) and no free-product has been observed since 2009 (Table 6-3 and Figure 6-4). However, TPH-D concentrations remain above the CUL in two site wells (Table 6-5 and Figure 6-6), and as described in Section 6.3.2.2, a 95% UCL evaluation was inconclusive. Thus, the RAO for benzene at Site PS-2 is being met, although not for TPH-D. Thus LTM for TPH-D should continue.

- **Action for Site PS-8:** Historical concentration results for benzene in groundwater have been evaluated through 2012, and all benzene concentrations have been below its MCL since 2006 (Table 6-6 and Figure 6-7). Thus, the primary RAO for Site PS-8 has been met.

- **Status:** Groundwater has achieved RAOs for TCE at Site SW-1 and benzene at Sites PS-2 and PS-8. However, TPH-D concentrations in groundwater at Site PS-2 should continue to be evaluated. This is not considered an issue since it is not directly related to protectiveness now or in the future. As the site progresses closer to Response Complete, compliance with Ecology's December 2007 updated MTCA Method A CUL for TPH will be explored in more detail to be documented in a future RACR under the joint DOD/EPA (2005) guidance.

5.2.2 Additional Recommendations for OU-2

In the *Second Five-Year Review,* the following additional recommendations were identified for OU-2. Each recommendation and subsequent actions are discussed below.

Site FT-1 (FT004)
Recommendation: *Consider dig-and-haul for remaining soil contamination near bioventing lines in west bioventing system (Table 4.4-2, USAF, June 2008).*

- **Specific Recommendation:** *Identify potential costs to excavate and dispose of remaining contaminated soils near west bioventing lines.*
- **Action:** Following recommendations identified in the *2007 Annual RA-O Report* (CH2M HILL, July 2008), the USAF determined that available funding was sufficient to perform an additional dig-and-haul at Site FT-1 in an area of known contamination. In June 2008, approximately 1,500 tons of TPH-contaminated soil were excavated from the west bioventing system area (Figure 3-5a) and disposed offsite at Waste Management's Graham Road Landfill. Twelve confirmation samples were collected from excavation sidewalls and analyzed for TPH-G, TPH-D, and BTEX. The current MTCA Method A CULs for unrestricted land use were exceeded in five samples for TPH-G, in three samples for TPH-D, and in two samples for total xylenes. Above CUL concentrations ranged from 130 to 12,000 mg/kg for TPH-G (CUL = 100 mg/kg or 30 mg/kg where benzene is present), from 2,300 to 5,200 for TPH-D (CUL = 2,000 mg/kg), and from 32 to 54 mg/kg for total xylenes (CUL = 9 mg/kg). Further details are provided in the *Post-Project Report, Excavation of Contaminated Soil at FT-1* (EQM, August 2008).
- **Status:** Complete. Residual TPH contamination in Site FT-1 soils is expected to attenuate over time. No further soil removal is planned at this time.

Site FT-1 (FT004)
Recommendation: *Revise RA-O soil monitoring (Table 4.4-2, USAF, June 2008).*

- **Specific Recommendation:** *Consider biennial soil sampling with a focus on locations near east bioventing system*
- **Action.** At this time, additional routine soil monitoring has been deferred for TPH-contaminated soils, as petroleum contamination will attenuate naturally.
- **Status:** No soil sampling has occurred at Site FT-1 since 2008. As Site FT-1 joins other sites in a Response Complete status, the DOD/EPA (2005) joint guidance will be applied to preparation of a multi-site RACR with contemporary soil sampling for TPH to demonstrate that natural attenuation is occurring and compliance with CULs.

Site WW-1 (WP003)
Observation: *Soybean oil may have reached its effective lifespan for enhancing reductive dechlorination (Table 4.5-2, USAF, June 2008).*

- **Recommendation:** *Evaluate site conditions and determine if additional substrate addition would be beneficial.*
- **Action:** LTM results for Site WW-1 wells are routinely evaluated following each sampling event and during annual reviews. Since 2007, TCE concentrations in all on-base wells have been below the MCL, with the exception of one result (13 µg/L) at

MW-102 in March 2011 (note, a confirmation sample collected from MW-102 in April 2011 had a TCE concentration of 0.43 µg/L). Thus, further evaluation of the effectiveness of injected substrates is not necessary, as the enhancement has effectively reached RAOs in the water-bearing zone effectively treated.

During this same period, TCE concentrations in off-base well MW-120 have risen above the MCL. However, this well is not located within the flow path of where substrate injections were completed in 2000 and 2005. This particular issue is further discussed in Sections 8 and 9.

- **Status:** Complete. Based on LTM results, no additional substrate injections are planned for on-base locations at Site WW-1 at this time.

Site WW-1 (WP003)

Observation: *Vinyl chloride and arsenic exceed some CULs and/or MCLs (Table 4.5-2, USAF, June 2008).*[3]

- **Recommendation:** *Continue to monitor these constituents to assess restoration of site groundwater.*
- **Action:** Fairchild AFB annually reviews performance of remedial actions at Site WW-1, and Ecology has approved USAF progress and recommendations for monitoring and optimization during their review of annual RA-O reports. Routine LTM for Site WW-1 wells includes analysis for vinyl chloride at all sampled wells and annual analysis for arsenic (typically in March) at up to nine wells (CH2M HILL, July 2013, Table 7-2).

  Concentrations of vinyl chloride and arsenic continue to exceed applicable CULs at some wells. In 2012, vinyl chloride concentrations exceeded its MCL of 2 µg/L at one on-base well (MW-102 at concentrations of 3 to 29 µg/L) and one off-base well (OW-2 at concentrations of 2.4 to 12 µg/L); the current vinyl chloride MTCA Method A CUL of 0.2 µg/L was exceeded at one additional off-base well (MW-243 at 0.68 µg/L). Arsenic concentrations exceeded its MCL of 10 µg/L at two on-base and four off-base wells in 2012 at concentrations ranging from 12 to 130 µg/L. The greatest arsenic concentrations (both historically and recently) have been observed at MW-102. In two residential drinking water wells located downgradient of Site WW-1 (Figure 3-6a), arsenic concentrations (recently assessed in September 2012) were below the MCL at 0.04 and 3.6 µg/L, respectively (CH2M HILL, November 2012b). Additional details concerning the occurrence of vinyl chloride and arsenic in Site WW-1 groundwater are contained in Section 6.3.2.2, Tables 6-11 and 6-12, and Figures 6-12a through 6-13b.

  There is considerable evidence for ongoing natural attenuation processes, as indicated by the presence of TCE degradation compounds such as cis- and trans-1,2-DCE and vinyl chloride in on-base and off-base wells (CH2M HILL, July 2013). Vinyl chloride is a reductive dechlorination product of TCE, but unlike TCE, vinyl chloride requires aerobic conditions for natural attenuation to occur. For wells in on-base, near off-base, and mid off-base locations, groundwater is generally anaerobic, favorable for attenuation of TCE but not vinyl chloride. Farther downgradient, groundwater becomes aerobic and vinyl chloride is not detected in monitoring or residential wells – these results are further

[3] While this issue is quoted from the last five-year review, no WW-1 decision document set CULs for vinyl chloride or arsenic, as these were not established as site COCs in the ROD. An ESD adding these COCs and setting CULs is forthcoming.

detailed in Section 6.3.2.2 below and in *Quarterly Residential Groundwater Sampling Reports* (CH2M HILL, June 2008 through November 2012). The USAF recommends continued periodic monitoring of vinyl chloride and other TCE degradation products.

Groundwater in the vicinity of Fairchild AFB contains arsenic that is naturally present in saturated alluvium and, to a lesser extent, basalt. The historic base-wide maximum detection of arsenic of 4,840 µg/L at MW-102 in 2001 was previously cause for further evaluation to determine whether historic operations, pre-2000 releases, or interim remedial actions at WW-1 in the last 12 years were having a secondary effect of mobilizing (solubilizing) arsenic above natural, background conditions, and contributing an anthropogenic (man-made) concentration of arsenic. This concern arises because in soil and groundwater systems, arsenic exhibits unique environmental behavior. Arsenic solubility is governed by redox conditions, biological activity, adsorption reactions, and pH. Accordingly, dissolved groundwater concentrations may be controlled by environmental conditions rather than contaminant mass present. Naturally-occurring arsenic is thus present in shallow groundwater, and may occur at Fairchild AFB above its MCL of 10 µg/L within the range of ambient arsenic concentrations found in Washington State (Ecology, May 2010). The occurrence of above-MCL arsenic concentrations in some site wells may be attributable to mobilization of naturally occurring arsenic from site soils. However, concentrations of arsenic previously observed at MW-102 suggest arsenic may have been historically present in possible former source materials removed in 2000 (CH2M HILL, December 2001). The distribution of naturally-occurring arsenic in groundwater throughout Fairchild AFB must be understood to establish whether site-specific RAOs need to be established for arsenic at Site WW-1.

- **Status:** As shown in Table 8-2, above-MCL concentrations of arsenic and vinyl chloride in groundwater are acknowledged as an issue for Site WW-1. Short-term protectiveness is not impacted, as these two analytes have and will continue to be regularly monitored at Site WW-1 and no exposures are occurring. Long-term protectiveness will be addressed with enhanced off-base LUCs.

Site PS-2 (SS018)

Recommendation: *Refine the frequency of free product recovery (Table 4.2-2, USAF, June 2008).*

- **Specific Recommendation:** *Vary the frequency of free product recovery efforts to better match site conditions.*
- **Action:** No free product has been observed or recovered at Site PS-2 since 2008 (Table 6-3 and Figure 6-4). Given these results, the frequency of free-product monitoring was reduced to semi-annually in 2011 and annually in 2012. Ecology and EPA concurred with these changes with the understanding that free-product monitoring would occur in the spring when water levels are generally highest (and the potential for free-product recovery is greatest) (Ecology, 5 October 2010; EPA, 19 October 2012).
- **Status:** Complete.

Sites SW-1, PS-2, PS-8, FT-1, and WW-1
Recommendation: *Reduce RA-O groundwater monitoring.*

- **Specific Recommendation:** *Evaluate and receive regulatory approval to reduce groundwater monitoring because CULs have been achieved.*
- **Action:** Following review of the *2008 Annual RA-O Report* (CH2M HILL, July 2009), Ecology concurred with recommendations to reduce monitoring frequencies at several wells and remove other wells from the LTM program (Ecology, 4 June 2009). These recommendations included suspending annual LTM for SW-1 and PS-8 sites, with sampling conducted only to support this five-year review. Additional optimization and reduction in LTM were made following Ecology concurrence (through 2010) and following EPA concurrence (for 2011) with recommendations presented in subsequent annual RA-O reports; specific LTM reductions are documented in each of those reports.
- **Status:** Ongoing, as each site prepares for future multi-site RACR submittal under the joint DOD/EPA (2005) guidance. This recommendation is ongoing, primarily related to optimization and "O&M" processes.

Sites SW-1, PS-2, PS-8, FT-1, and WW-1
Recommendation: *Develop an overall site management strategy.*

- **Specific Recommendation:** *In consideration of contaminant levels and LUCs in place, potentially revise RA-O program to a level acceptable to the base and regulators.*
- **Action:** The RA-O programs for these sites have been optimized as discussed above. LTM results through 2012 indicated that RAOs for Sites SW-1 and PS-8 have been achieved, which may lead to site closure or further reductions to their RA-O programs. Some RAOs for PS-2 and FT-1 also have been achieved. However, recent observations of residual TPH contamination in groundwater and a 95% UCL evaluation described in Section 6.3.2.2 indicate that monitoring of Site PS-2 and FT-1 groundwater for TPH-D should continue.
- **Status:** These sites are progressing towards a multi-site RACR determination under the joint DOD/EPA (2005) guidance. Detailed assessment of Ecology methods to comply with the lower (December 2007) MTCA Method A CULs for TPH in groundwater (discussed in Section 7.4.2) are needed.

5.3 OU-3 Progress Since Last Review – Priority Two Sites

For OU-3 (Priority Two Sites), three issues were identified in the *Second Five-Year Review*. Each of these issues, recommendations to address them, and actions taken since the *Second Five-Year Review* are discussed in Section 5.3.1. Additional recommendations that were identified during the *Second Five-Year Review* are discussed in Section 5.3.2.

5.3.1 Issues Identified in Technical Assessment

Issue 1 – Sites IS-4 and FT-2
Data may be inconclusive regarding natural attenuation and overall reduction of TPH

- **Recommendation:** *Develop an overall site management strategy and revise LTM program to a level acceptable to the regulators and Air Force*

- **Action:** An RPO evaluation was completed in January 2009 that identified site conditions and results of implemented remedial actions. The recommended path forward was to pursue a Response Complete determination.
- **Status:** Complete. Following its review of the RPO report, Ecology concluded that one more round of groundwater sampling should be conducted, which was completed in July 2010. Based on sampling results and further evaluation of data and site conditions, Ecology issued an NFA determination (Ecology, 1 October 2010a,b).

Issue 2 – Sites IS-4 and FT-2
Overall site annual O&M costs are high

- **Recommendation:** *Reduce soil and groundwater LTM program.*
- **Action:** Semi-annual soil LTM was discontinued in 2004; groundwater LTM reduced from semi-annual to annual in 2007 and 2008, then discontinued until single event in 2010.
- **Status:** Complete. Both sites received an NFA determination from Ecology in 2010.

Issue 3 – Site PS-1 (ST006)
The bioventing system has remediated TPH-contaminated soil within the influence of the system as designed. Future operation of this system may not be necessary.

- **Recommendation:** *Place bioventing system in standby mode.*
- **Action:** The PS-1 bioventing system was shutdown indefinitely in December 2006 based on recommendations from an RPO evaluation (CH2M HILL, October 2006b) and concurrence from Ecology. The RPO evaluation concluded that benzene and lighter-fraction TPH contamination within the influence of the bioventing systems had remediated these soils to levels that were protective of groundwater (benzene in groundwater last exceeded its MCL in 1999). Details are provided in Section 6.3.1.1.
- **Status:** Complete. The PS-1 bioventing system remains shut down.

5.3.2 Additional Recommendations for OU-3

In the *Second Five-Year Review*, the following additional recommendations were identified for OU-3. Each recommendation and subsequent actions are discussed below.

Sites IS-4, PS-1, and FT-2
Recommendation: *Reduce RA-O groundwater monitoring.*

- **Specific Recommendation:** *Evaluate and receive regulatory approval to reduce groundwater monitoring.*
- **Action:** Following review of the *2008 Annual RA-O Report* (CH2M HILL, July 2009), Ecology concurred with recommendations to reduce groundwater LTM at Sites IS-4, PS-1, and FT-2 (Ecology, 4 June 2009). In 2010, following review of a *RPO Report* (CH2M HILL, January 2009), Ecology concurred with NFA determinations for Sites IS-4 and FT-2 (Ecology, 1 October 2010a,b); the monitoring wells at these sites were decommissioned in December 2010.
- **Status:** Benzene concentrations in Site PS-1 have achieved RAOs (Table 6-13 and Figure 6-14). TPH-D concentrations have been below the ROD CUL of 1,000 µg/L since

September 2003, but the current MTCA Method A CUL of 500 µg/L was exceeded in March 2012 at one well (Table 6-15 and Figure 6-16). As described in Section 6.3.3.2, a 95% UCL evaluation for TPH-D in groundwater was performed on the two PS-1 wells where the ROD CUL of 1,000 µg/L (or the current MTCA Method A CUL of 500 µg/L) previously was exceeded. The calculated 95% UCL values for these wells were 484 and 460 µg/L. This evaluation parallels a similar analysis done by Ecology for FT-2 under WAC 173-340-720(9)(d) as described in Section 4.3.14.3. Based on this analysis, the response for TPH-D at this site is complete, which will be documented in a future multi-site RACR under the joint DOD/EPA (2005) guidance.

Sites IS-4 and FT-2
Landfarming activities.

- **Recommendation:** *Evaluate the cost-effectiveness of the current program versus off-site disposal if landfarm soils do not achieve cleanup levels.*
- **Action:** Previously landfarmed soils achieved CULs in 2006 and were thus returned to the site. Based on this work, a RPO evaluation, and subsequent sampling conducted at each site, NFA determinations were issued for Sites IS-4 and FT-2 by Ecology in 2010 (Ecology, 1 October 2010a,b).
- **Status:** Complete.

Sites IS-4, PS-1, and FT-2
Recommendation: *Revise RA-O soil monitoring*

- **Specific Recommendation:** *Reduce soil monitoring frequency.*
- **Action:** At Sites IS-4 and FT-2, soil LTM was last completed in 2006; NFA determinations by Ecology for these sites followed in 2010. At Site PS-1, soil LTM was last completed in 2005. Ecology concurred with the recommendation to eliminate all soil monitoring activities at Site PS-1 as long as groundwater LTM continues (Ecology, 4 June 2009). Soil LTM and/or further investigations at Site PS-1 may be necessary if access to the Vet Road area (where residual soil contamination has been identified) or beneath the entire tank farm can be achieved when the tank farm facility is no longer operational. However, the USAF has not identified any time frame for when further evaluation could be completed.
- **Status:** Complete.

Sites IS-4, PS-1, and FT-2
Recommendation: *Develop an overall site management strategy.*

- **Specific Recommendation:** *In consideration of remaining TPH levels in site soils, LUCs in place and physical site soil conditions, revise the RA-O program to a level acceptable to the base and regulators.*
- **Action:** The USAF received NFA determinations from Ecology for Sites IS-4 and FT-2 in 2010 (Ecology, 1 October 2010a,b). Overall RA-O for Site PS-1 has also been reduced. Routine groundwater LTM continues but has been optimized. Bioventing operations were also suspended in 2006. Further soil investigations may be necessary at Site PS-1, but potentially TPH-contaminated soils in the Vet Road area and/or beneath the entire tank farm facility cannot be assessed until the tank farm facility is no longer in use.

- **Status:** Residual TPH contamination in groundwater at Site PS-1 has been evaluated as described above in this section for Issue 1. The results of this evaluation indicate that a response complete determination is appropriate for this site, which will be documented in a future multi-site RACR under the joint DOD/EPA (2005) guidance.

6. Five-Year Review Process

6.1 Administrative Components

This Third Five-Year Review was conducted by CH2M HILL under contract with the Air Force Civil Engineer Center (AFCEC). Fairchild AFB staff (Marc Connally and Danielle Adams) from the 92nd Civil Engineer Squadron, Environmental Element (CES/CEIE) have coordinated review activities with EPA and CH2M HILL. A kickoff teleconference initiating this review was conducted by Marc Connally on 2 April 2012, which included representatives of Fairchild AFB, EPA, and CH2M HILL. Scheduling and report outlines have been discussed during a number of meetings held between these parties in October and November 2012.

It is anticipated that this Third Five-Year Review will be finalized no later than 12 August 2013, five years following acceptance of the *Second Five-Year Review*.

6.2 Community Notification and Involvement

The public was given notice that Fairchild AFB was conducting this Third Five-Year Review at the Fairchild AFB RAB meeting on 29 October 2012, and a legal notice was published in the Spokesman Review on 20 June 2013. No comments were received following these notices. An additional public notice will be published in the Spokesman Review following completion of this Third Five-Year Review.

During the next RAB meeting (anticipated for October 2013), results of the Third Five-Year Review also will be presented and discussed. Once signed, copies of the Third Five-Year Review will be made available to the public through placement of the report in the administrative record/information repository at the Spokane Falls Community College Library.

6.3 Document and Data Review

The following documents and types of documents were reviewed in preparation of this Third Five-Year Review:

- Fairchild AFB's *First Five-Year Review* (USAF, November 2000)
- Fairchild AFB's *Second Five-Year Review* (USAF, June 2008)
- Three RODs for OUs 1, 2, and 3, respectively
- RI/FS reports, RD, and RA, and limited field investigation reports
- Air Mobility Command Administrative Record for Fairchild AFB, http://amcadminrec.com/fairchild.html[4]
- Various correspondence with Ecology and EPA (as shown in Section 12)
- The base's LUC plan (USAF, May 2007)
- Annual and Quarterly RA-O reports

[4] The official Administrative Record for Fairchild AFB is maintained in the information repository at the Spokane Falls Community College Library.

Section 12 provides a complete list of references for over 60 documents reviewed or cited for this Third Five-Year Review.

6.3.1 OU-1 Document and Data Review – CRL (LF002)

6.3.1.1 CRL Remedial Systems Analysis

Remedial system operations have continued at CRL since the last Five-Year Review was completed and include on-going GETS operation. To further enhance TCE removal at the site, RA-O operations were optimized beginning in 2010 to include SVE and ISCO source area pilot treatment operations in areas beneath the landfill caps where significant source materials have been encountered. Given that the original ROD indicated that the time to reach RAOs would range from 10 to 75 years based on the source remediation technologies applied, optimization of source treatment will continue to be a key consideration in reaching objectives for CRL. Post-ROD treatability studies will be the mechanism by which future remedy components are assessed, with a ROD amendment when needed.

GETS Operations

As recommended in the OU-1 ROD, full-time GETS operations at CRL began in September 1995, although some interim pumping and treatment was initiated in October 1992. The extraction system currently consists of 12 extraction wells (6 each in the SDA and NDA). Groundwater from the extraction wells is pumped to the treatment plant where TCE is volatized through air stripping, and the resulting offgas is treated (adsorbed) by GAC. The treated water is discharged to the aquifer via two infiltration trenches located west of Craig Road, downgradient of the SDA and NDA.

From September 1995 through September 2012, approximately 1.22 billion gallons of TCE-contaminated groundwater were extracted and treated at CRL. The GETS initially extracted approximately 11 million gallons of groundwater per month. Due to dewatering of the saturated zone beneath the NDA and SDA, reduced recharge as a result of capping, and recent batch treatment operations that incorporate planned idling periods, extraction rates have been reduced to average about 5 million gallons per month. Water levels in on-site wells were lowered by as much as 40 to 100 feet due to full-time GETS operations. As discussed below, batch treatment procedures were implemented in September 2006 to enhance overall TCE removal rates.

Approximately 1,342 pounds of TCE are estimated to have been removed by the GETS from September 1995 through December 2012. About 86 percent of this mass was removed from the SDA, with two SDA extraction wells (EW-10 and EW-14) accounting for approximately 77 percent of the site-wide total. The TCE removal rate declined from over 100 pounds per quarter in late 1995, to about 15 pounds per quarter in 1999, and to less than 7 pounds per quarter in 2004. These reductions primarily were the result of reduced extraction rates (discussed above) and declining TCE concentrations in groundwater.

To improve TCE removal rates, the GETS has been periodically idled since September 2006. During idling, groundwater levels are allowed to rise beneath the NDA and SDA to enhance contaminant mass transfer, as rising groundwater contacts potential DNAPLs within previously dewatered sediments and fractured basalt bedrock. TCE removal rates (following an idling period) increased to as high as 49 pounds/quarter in 2007, and ranged from 16 to 32 pounds per quarter through second quarter 2011. Supplemental post-ROD

treatability study efforts including ISCO operations completed in 2011 and 2012 in the SDA and NDA (discussed below) have substantially reduced overall TCE concentrations. These reduced TCE concentrations, coupled with limited pumping since ISCO was implemented, have reduced TCE mass removal by the GETS.

As set forth in the OU-1 ROD, a primary objective of the GETS is to maintain hydraulic control of the on-site TCE plume and to prevent further migration of groundwater across the site boundary and to a lower aquifer. Available water level data clearly indicate that when the GETS is operational, hydraulic capture is maintained. Groundwater modeling results completed to support the implementation of batch treatment operations (CH2M HILL, October 2006a) indicated that the GETS could continue to maintain hydraulic capture of the on-site portion of the TCE plume for idling periods up to six months in length. In light of this, most periodic idlings since 2006 have lasted less than 3 months, with one as long as 4.5 months. Routine water level data collected from 2006 through 2011 have continued to support these modeling results (Figures 3-1f and 3-1g).

In addition to the idling of the GETS, since ISCO operations were initiated in July 2011, operation of nearby extraction wells (particularly in the SDA) were reduced. To maximize ISCO effectiveness, sodium permanganate needs to remain in the aquifer as long as possible. To avoid withdrawing permanganate prematurely, extraction wells are taken off-line when permanganate (as indicated by pink and/or purple hues) is observed in discharge water. Specifically, during the 2011-2012 ISCO post-ROD treatability studies with ISCO, operation of EW-9, EW-10, and EW-14 in the SDA has been limited from late 2011 through 2012. Although idling was specifically modeled in 2006, the additional potential impacts to maintaining hydraulic control after initiating ISCO treatability study operations needs further evaluation to determine whether this source control remedy element also will effectively contain the plume, given present conditions.

Soil Vapor Extraction

In 2010, post-ROD SVE pilot testing was conducted in the SDA and it is estimated that 81 pounds of TCE were removed over 154 days of operation. Given these results, a full-scale SVE system began operation in the SDA in February 2011. Through December 2012, the SDA SVE system is estimated to have removed an additional 81 pounds of TCE, 34 pounds of cis-1,2-DCE, and 69 pounds of vinyl chloride. The SVE system will continue to operate in the SDA until TCE removal rates diminish to the point that running the system is no longer effective.

Based on investigation results for the SDA, post-ROD SVE pilot testing was initiated and completed in the NDA during mid-2012 in areas where RI soil gas data and post-ROD treatability testing indicated areas of elevated TCE in soil gas. Six remediation wells (four completed in fractured basalt and two in native alluvium beneath waste) were installed in the NDA during 2012. During pilot testing activities, it is estimated that about 15 pounds of TCE were removed from beneath the NDA. Full-time SVE operations that began in the NDA in July 2012 are estimated to have removed an additional 4 pounds of TCE through December 2012. The NDA's SVE system will continue to operate until TCE removal rates diminish to the point that running the system is no longer effective. During the 2012 SVE post-ROD treatability studies in the NDA, EW-6 has been offline since late-April 2012 to supply power to the SVE system. The impact of EW-6 and/or other NDA extraction wells being offline will be further evaluated in a post-ROD treatability study, along with

efficiencies of the SVE, to establish whether these source reduction technologies in the SDA and NDA should be considered in a ROD amendment, in order to reduce the time to reach RAOs at OU-1.

In-Situ Chemical Oxidation

As discussed in Section 4.1.2.3, SDA and NDA remediation wells were installed in the past five years to support SVE, ISCO, and groundwater monitoring. Groundwater sampling results from these wells prior to ISCO injections showed TCE concentrations that ranged as high as 16,200 µg/L (in the SDA) and as high as 5,260 µg/L in the NDA. Given these results, supplemental post-ROD ISCO source area pilot treatments were implemented in 2011 and 2012 to reduce TCE concentrations in CRL groundwater.

ISCO was performed in the NDA and SDA by injecting a dilute sodium permanganate solution into the groundwater remediation wells shown in Figure 3-1d and Figure 3-1e. Sodium permanganate ($NaMnO_4$) oxidizes TCE (C_2HCl_3) as follows:

$$2NaMnO_4 + C_2HCl_3 \rightarrow 2CO_2 + 2MnO_2 + 3Cl^- + H^+ + 2Na^+$$

Prior to injection, a 40 percent sodium permanganate solution was diluted with groundwater obtained from downgradient extraction wells. The 40 percent solution was injected at volumetric dosing rates of 1 to 2 percent, which yielded sodium permanganate concentrations of 5,500 to 11,000 mg/L.

In the SDA, 30,000 pounds of 40 percent sodium permanganate were injected along with approximately 170,000 gallons of dilution water into nine remediation wells in July and August 2011. In July 2012, another 18,000 pounds of 40 percent sodium permanganate were injected along with approximately 161,000 gallons of dilution water into eight SDA remediation wells.

In the NDA, 12,000 pounds of 40 percent sodium permanganate were injected along with approximately 92,000 gallons of dilution water into eight remediation wells in October 2012.

ISCO effectiveness in these areas is assessed by collecting performance monitoring groundwater samples from injection wells and other nearby wells before and after injections; results are discussed in the groundwater monitoring section below for the SDA. Post-ISCO performance monitoring in the NDA was not conducted until 2013 (after the September 2012 closing date for data review during this five-year review period), and as such, will be presented in future quarterly RA-O reports and post-ROD treatability study, with detailed assessment in the next five-year review.

6.3.1.2 CRL Groundwater Monitoring Data Analysis

A LTM program for CRL groundwater was implemented in 1995 for on-site and off-site monitoring wells completed in the upper (alluvium and Basalt A) aquifer and the lower (Basalt B) aquifer. In 2012, this monitoring program consisted of periodic sampling of 12 on-site extraction wells, 5 on-site monitoring wells, 35 on-site remediation wells, and 10 off-site monitoring wells (CH2M HILL, December 2012).

TCE concentrations in site extraction wells have declined significantly since GETS operations began in 1995 (Table 6-1a, Figure 6-1a, and Figure 6-1b). When periodic GETS idling began in 2006, TCE concentrations increased substantially in three SDA extraction

wells (EW-9, -10, and -14) located near suspected source materials. TCE concentrations at these same wells decreased substantially following ISCO operations in the SDA in August 2011 and July 2012. TCE concentrations decreased from 76, 390, and 390 µg/L at EW-9, -10, and -14, respectively in June 2011 to non-detect in all of these wells in March 2012 and then rebounded to 94, 85, and 29 µg/L by September 2012 (CH2M HILL, July 2013).

Within the more-recently installed remediation wells in the SDA source area, TCE concentrations have exceeded the MCL at 16 of 19 wells, with elevated concentrations of 184 to 16,200 µg/L for 11 of these wells. Following ISCO in the SDA in 2011, TCE concentrations decreased substantially at nine remediation wells, although concentrations remain above the MCL in the majority of these wells.

Among the 16 CRL monitoring wells that continue to be regularly monitored (6 on-site and 10 off-site wells), TCE concentrations generally have declined and have been below its MCL of 5 µg/L since 2006 (or earlier) in 10 of these wells (Table 6-1b and Figures 6-1c, 6-1d, and 6-1e). The remaining six wells are discussed below.

On-Site Monitoring Wells above RAOs at CRL
At four on-site monitoring wells, TCE concentrations remain or have been above the MCL in recent years (Table 6-1b and Figures 6-1d and 6-1e).

- At MW-63 (a Basalt A well in the northeast corner of the site) TCE concentrations have dropped from 66 µg/L since 2008 (Table 6-1b and Figure 6-1d) and fluctuated between 27 and 44 µg/L in 2012 (Figure 6-1e).
- At MW-75, a Basalt A well located on the eastern site boundary between the NDA and SDA, TCE concentrations generally have been below its MCL but have periodically fluctuated up to 9.5 µg/L since 2007. Although the fourth quarter 2012 data is after the September 2012 cutoff date for the Third Five-Year Review, a 10 µg/L TCE measurement was reported in this well in December 2012 (Figure 6-1e).
- At MW-77, located east of the SDA, TCE concentrations generally have declined since 2000, been below the MCL since 2011, and was 4 to 4.3 µg/L in 2012.
- At MW-96, located north of the SDA, TCE concentrations remain above the MCL but declined from 57 to 14 µg/L from 2000 through 2012.

Off-Site Monitoring Wells above RAOs at CRL
Among the 10 off-site monitoring wells that continue to be regularly sampled, TCE concentrations have been below the MCL since 2004 at eight of these wells; at MW-118 and MW-141, TCE concentrations remain above the MCL (Table 6-1b and Figures 6-1c, 6-1d, and 6-1e).

- At MW-118, located approximately 2,000 feet east of CRL, TCE concentrations have fluctuated from 78 to 430 µg/L since 2000, with a concentration of 170 µg/L in 2012 (Table 6-1b and Figure 6-1c). This well is completed in the weathered upper (Basalt A) aquifer. At MW-141, located approximately 2,600 feet northeast of CRL, TCE concentrations declined from 30 to 16 µg/L from 2000 through 2012 (Table 6-1b, Figure 6-1d, and Figure 6-1e).

For monitoring wells completed in the lower Basalt B aquifer (such as MW-139, sampled twice in 2012; see Figure 6-1e), TCE has not been detected or at concentrations less than 1 µg/L since 1996 (Table 6-1b).

Other contaminants which have exceeded MCLs at CRL are cis-1,2-DCE, vinyl chloride, and chromium. Concentrations of cis-1,2 DCE initially exceeded its MCL of 70 µg/L in some extraction wells, but no exceedences have occurred since 1997; no exceedences have ever occurred at a CRL monitoring well. Vinyl chloride concentrations in CRL monitoring and extraction wells have never exceeded its MCL of 2 µg/L or the MTCA Method A CUL of 0.2 µg/L since 1996, with one exception: in September 2011, vinyl chloride was detected at an estimated concentration of 0.28 µg/L at EW-10.

Samples for chromium analysis were collected from CRL monitoring wells from 1989 through 1991 during the RI and recently (2011 and 2012) from CRL remediation wells and selected extraction wells to determine if groundwater chemistry changes induced by ISCO have potentially solubilized chromium (Table 6-1c). With the exception of one sample collected from MW-20 in April 1991, no chromium concentrations at CRL monitoring wells have exceeded the MCL of 100 µg/L or the MTCA Method A CUL of 50 µg/L[5]. In 2011 and 2012, chromium concentrations exceeded the MTCA Method A CUL in two extraction wells and seven SDA remediation wells at above-CUL concentrations ranging from 56 to 410 µg/L. The extent of chromium concentrations in CRL groundwater in 2012 is shown in Figure 6-2.

Off-site water supply wells have been monitored by the base since 1988 as part of its residential well monitoring program. These results are communicated to wells owners (including the City of Airway Heights) as part of administering off-base LUCs (see Section 6.3.5). As described in Section 3.3.1, TCE concentrations were found to exceed the MCL in some water supply wells downgradient of CRL in 1989, and Fairchild AFB subsequently provided water from its own system to the impacted water supply system. Other water supply wells in the CRL vicinity were monitored quarterly for several years; all VOC concentrations were considerably below their respective MCLs. As a result, the number of wells sampled has been reduced over time to now include only two adjacent water supply wells that currently are sampled quarterly: the City of Airway Heights production wells PS-1 and PS-4 (from which flows are combined into a single manifold). At PS-1/4 (Figure 3-1c), TCE occasionally has been detected, but at concentrations less than 1 µg/L (CH2M HILL, June 2008 through November 2012).

6.3.1.3 CRL Land Use Control Analysis

An analysis of LUCs at CRL is presented in Section 6.3.5.

6.3.2 OU-2 Document and Data Review – On-Base Priority One Sites

6.3.2.1 OU-2 Remedial Systems Analysis

Since the last Five-Year Review, remedial system operations have been minimal for OU-2 sites and limited to Sites PS-2, FT-1, and WW-1.

[5] The MTCA Method A cleanup level of 50 µg/L is based on concentration derived for hexavalent chromium. This is a total value for chromium III and chromium VI. If just chromium III is present, a cleanup level of 100 µg/L may be used (Ecology, November 2007).

Site PS-2 (SS018) – Refueling Pit Area

Passive free-product recovery (FPR) was initiated as part of a treatability study conducted in 1994, with over 80 gallons of free product recovered at PS-2 during the study. Routine FPR became a part of the RA-O program in 1996 and has continued at two wells where free product had been observed (MW-228 and MW-228A). FPR volumes (which include some petroleum/water emulsions) were approximately 10 gallons from 1996 through 1999, approximately 34 gallons from 2000 through 2006, and less than 0.7 gallon in 2007 and 2008. No free product was observed or recovered from 2009 through 2012 (Table 6-3 and Figure 6-4). Given these results, the frequency of FPR efforts at the site was reduced to semi-annual in 2011 and annually in 2012, as reflected in the updated LTM workplan (CH2M Hill, December 2012). Ecology and EPA concurred with these changes with the understanding that observation and FPR efforts would occur in the spring when water levels generally are highest (Ecology, 5 October 2010; EPA, 19 October 2012).

Site FT-1 (FT004) – Former Fire Training Area

An in-situ bioventing treatment system was constructed in 1997 and was fully operational until late December 2006. At that time, the system was shutdown with concurrence of Ecology as it was determined that the system had achieved its purpose of remediating vadose zone soils and preventing movement of mobile TPH fractions into groundwater.

An air-sparge curtain was installed at Site FT-1 in 1997 to treat the on-base portion of a benzene plume in shallow groundwater. In 1999, it was determined that the system was not effective because air flow was observed at less than one-half of the sparge points. The air-sparge system continued to operate through 2003. In 2004 through 2006, the system was operated periodically to maintain the equipment. In December 2006, the air-sparge system was shut down indefinitely with concurrence of Ecology (USAF, 6 December 2006).

Site WW-1 (WP003) – Industrial Wastewater Lagoons

The WW-1 site GETS became operational in February 1996, using one off-base extraction well (EW-1) and one on-base extraction well (EW-3). In December 1997, three on-base well points (WP-1 through WP-3) were added as extraction locations, as shown in Figure 3-6a. Full-time operations continued until December 2004, when the system was placed in standby mode with concurrence of Fairchild AFB and Ecology (USAF, June 2008). From 2005 through June 2006, the GETS was required to be operational for only seven months, based on triggering mechanisms described in Section 4.2.10.3, and since July 2006, conditions have not been met that would trigger restart of the GETS. Following review of the *2010 Annual RA-O Report* (CH2M HILL, September 2011), Ecology concurred with the USAF's recommendation that the provisional (trigger-based) requirement to operate the groundwater extraction system can be eliminated (Ecology, 29 June 2011).

Enhanced Reductive Dechlorination

In early 2001, CH2M HILL evaluated mixing various carbon sources with aquifer materials at Site WW-1 to enhance reductive dechlorination of remaining TCE in groundwater in the former drum disposal area near MW-102. With concurrence of Ecology, an excavator was used to mix approximately 520 gallons of food-grade soybean oil with saturated aquifer materials in an 84-foot long trench located perpendicular to groundwater flow just downgradient of MW-102. The soybean oil application was completed in June 2001.

Based on an evaluation of available data through mid-2005, CH2M HILL concluded that the benefits of soybean-oil application completed in June 2001 were waning. Consequently, CH2M HILL identified a conceptual optimization effort that included installation of "injection wells" in the former source area with subsequent injection of a soluble substrate to stimulate ERD. Five remediation wells were installed on-base at WW-1 in December 2005, and approximately 80 to 140 gallons of dilute solutions of liquid cheese whey were injected into each remediation well at that time. TCE concentrations in groundwater near the former source area and in off-base wells within the flow path of these injections have been below its MCL since 2007 (except for one event at MW-102 in 2011) (Table 6-10). As such, further injections in this area to enhance dechlorination and actively reduce TCE concentrations are not necessary.

6.3.2.2 OU-2 Groundwater Monitoring Data Analysis

Site SW-1 (LF001) – Old Base Landfill

An LTM program for the site was initiated in 1994 and consisted of quarterly monitoring of ten shallow (alluvial/Basalt A aquifer) wells. By 1998, , the number of LTM wells sampled had been reduced from ten to three (with the concurrence of EPA and Ecology [EA, 1996; EA, 2001]) based on recurring non-detects for TCE and/or below its MCL. .

Given that Site SW-1 last received wastes in 1958 and that no groundwater samples collected at the site have exceeded the TCE MCL of 5 µg/L since 2005 (Table 6-2 and Figure 6-3), Ecology concluded (following their review of the *2008 Annual RA-O Report* [CH2M HILL, July 2009]), that routine monitoring at the site was no longer necessary and only should be conducted to support this Third Five-Year Review (Ecology, 4 June 2009). Ecology verbally concurred with the recommendation that Response Complete has been attained for the site. EPA also concurred with this recommendation (EPA, October 2012). To seek Response Complete under joint DOD/EPA guidance (2005), a RACR will be prepared in the future.

Groundwater monitoring at Site SW-1 for this Five-Year Review was performed in June 2012. Samples were collected from the only remaining site wells (MW-128, -131, -132, -167, -168, and -309) and analyzed for VOCs. As reported in the *Second Quarter 2012 RA-O Report* (CH2M HILL, November 2012c), concentrations of TCE (the site COC) were non-detect in three site wells and ranged from 0.6 to 2.8 µg/L in the other three wells (Table 6-2 and Figure 6-3).

Site PS-2 (SS018) – Refueling Pit Area

A groundwater LTM program was initiated in 1994 and consisted of quarterly monitoring of seven alluvial/Basalt A aquifer monitoring wells. In 1998, with the concurrence of Ecology and EPA, the sampling frequency was reduced to annual for five wells. In response to an issue identified in the *Second Five-Year Review*, three new groundwater monitoring wells (MW-370, -371, and -372) were installed downgradient of Site PS-2 (Figure 3-3a) in April 2011 to evaluate if benzene had migrated downgradient from the site. As reported in the *Annual 2011 RA-O Report* (CH2M HILL, November 2012a) and the *First Quarter 2012 RA-O report* (CH2M HILL, June 2012), benzene concentrations in the new wells were non detect, except for one detect of 0.14 µg/L in 2011, and benzene concentrations have been below its MCL of 5 µg/L in all site wells since 2009 (Table 6-4 and Figure 6-5). TPH-D concentrations also generally have declined at the site but remain above the ROD cleanup level of 1,000 µg/L (and the current MTCA Method A cleanup level of 500 µg/L) in two

wells through March 2012: MW-109 and MW-370, at concentrations of 1,500 and 2,000 µg/L, respectively (Table 6-5 and Figure 6-6).

Upper Confidence Limit Evaluation for TPH-D at Site PS-2

A 95%UCL evaluation for TPH-D concentrations in Site PS-2 groundwater was performed on wells where the ROD CUL of 1,000 µg/L (or the current MTCA Method A CUL of 500 µg/L) has been exceeded and where at least six samples have been collected. As shown in Table 6-5 and Figure 6-6, these criteria apply to two site wells: MW-109 and MW-110.

The 95% UCL was calculated for each of these data sets using the most current version of EPA's statistics program ProUCL (v4.1). For MW-109, samples were collected roughly annually or semi-annually from 1994 through 2002 and then annually from 2006 through 2012. Using the most recent seven samples for MW-109 (from 2006 through 2012), the 95% UCL was 1,517 µg/L. For MW-110, samples were collected roughly annually or semi-annually from 1995 through 1999 and then once in 2002. Using all available data for MW-110, the 95% UCL was 546 µg/L. This analysis is presented in Appendix A-4 of the 2012 Annual RA-O report (CH2M HILL, July 2013).

This evaluation parallels a similar analysis done by Ecology for FT-2 under WAC 173-340-720(9)(d) as outlined in Section 4.3.14.3. The TPH-D evaluation results for Site PS-2 are inconclusive given the lack of recent sampling results at MW-110 and limited data at more recently installed wells (MW-370 and MW-371), where the ROD or MTCA Method A CUL recently was exceeded but only two samples have been collected (insufficient data to perform the evaluation) (Table 6-5). Additional and/or more recent sample data are needed to calculate conclusive 95% UCLs for Site PS-2.

Site PS-8 (SS026) – Underground Fuel Line Area

A groundwater LTM program was initiated in 1994 and consisted of quarterly monitoring of nine alluvial monitoring wells. In 1996, with the concurrence of Ecology and EPA, the number of monitoring wells was reduced to four (MW-67, -68, -183, and -184) and the sampling frequency was reduced to semi-annual.

Following review of the *2008 Annual RA-O Report* [CH2M HILL, July 2009]), Ecology concluded that routine monitoring at the site was no longer necessary because there are no immediate threats to human health and the environment and because site access is restricted due to its location on an active taxiway (Ecology, 4 June 2009). Routine groundwater monitoring thus was discontinued in 2009 with a recommendation from Ecology that groundwater monitoring only be conducted to support this Third Five-Year Review.

Groundwater monitoring at Site PS-8 to support this Third Five-Year Review was performed in March 2012. Samples were collected from five site wells (MW-31, -67, -68, -183, and -184) and analyzed for BTEX. As reported in the *First Quarter 2012 RA-O Report* (CH2M HILL, June 2012) and shown in Table 6-6, benzene was not detected in three site wells and concentrations were 0.4 and 1.6 µg/L in MW-67 and MW-184, respectively. Benzene concentrations have not exceeded its MCL (5 µg/L) in any site well since 2006 (Table 6-6 and Figure 6-7).

Site FT-1 (FT004) – Former Fire Training Area

The COC for Site FT-1 groundwater is benzene. A groundwater LTM program for Site FT-1 was initiated in 1996 and consisted of quarterly monitoring of up to 27 site wells, including

12 air-sparge curtain monitoring wells and 15 alluvial/Basalt A monitoring wells. Benzene concentrations have been below the MCL in all site wells since 1999 and less than 1 µg/L since 2002 (Table 6-7 and Figure 6-8). Vinyl chloride previously exceeded its MCL of 2 µg/L in five site wells, but all concentrations have been below the MCL since 1999 and less than 0.5 µg/L since 2001 (Table 6-8 and Figure 6-9). Concentrations of cis-1,2-DCE previously had been reported as elevated in some site wells, with concentrations as high as 23 µg/L. However, all cis 1,2-DCE concentrations have been less than 1 µg/L since 1999, and the MCL of 70 µg/L has never been exceeded.

Other constituents monitored in Site FT-1 groundwater have included TPH-G and TPH-D. From 2007 through 2010, TPH-G concentrations ranged from non-detect to 150 µg/L, well below the MTCA Method A CUL of 800 µg/L (for TPH-G where benzene is also present). From 2007 through 2012, TPH-D concentrations have exceeded the current MTCA Method A CUL of 500 µg/L in at least one and up to three wells per sampling event (Table 6-9 and Figure 6-10a). In 2012, TPH-D concentrations exceeded the Method A CUL at three site wells (MW-3, MW-226, and MW-247) with concentrations ranging from 590 to 980 µg/L.

Fourteen residential wells, located east of Sites FT-1 and WW-1 have been regularly monitored since 1988 as part of the base's residential well monitoring program. No COCs associated with Site FT-1 have been detected in these wells for at least the past 14 years.

Upper Confidence Limit Evaluation for TPH-D at Site FT-1

A 95%UCL evaluation for TPH-D concentrations in Site FT-1 groundwater was performed on wells where the current MTCA Method A CUL of 500 µg/L has been exceeded and where at least six samples have been collected. As shown in Table 6-9, these criteria apply to four site wells: MW-3, MW-227, MW-247, and MW-248. Note that unlike Site PS-2 for which a similar analysis was performed above, TPH-D was not established as a Site COC, so no ROD CUL exists.

The 95% UCL was calculated for each of these data sets using the most current version of EPA's statistics program ProUCL (v4.1). For all of these wells, samples were collected annually from 2007 through 2012. Using all available data, the 95% UCLs were 2,481 µg/L for MW-3, 539 µg/L for MW-227, 1,434 µg/L for MW-247, and 1,174 µg/L for MW-248. This evaluation is presented in Appendix A-4 of the 2012 Annual RA-O report (CH2M HILL, July 2013).

This evaluation parallels a similar analysis done by Ecology for FT-2 under WAC 173-340-720(9)(d) as outlined in Section 4.3.14.3. Given that only six sample results were available for evaluation at Site FT-1 and that a minimum of eight sample results are recommended for statistical robustness, evaluation of TPH-D in Site FT-1 groundwater should continue.

Site WW-1 (WP003) – Industrial Wastewater Lagoons

Groundwater LTM was initiated in 1995 using both on- and off-base monitoring wells, and by 1999, had expanded to include 24 wells. Before source removal activities were conducted in 2000, overall TCE concentrations began to show declining trends in most off-base locations. Once source removal activities were completed in 2000, TCE concentrations began declining quickly. Since 2003 TCE concentrations have been below the MCL in all off-base wells except MW-120 (Table 6-10, Figure 6-11a, and Figure 6-11c). TCE concentrations in MW-120 were above the MCL from 1991 through 2001, below it from 2001 through 2006,

and back above the MCL since 2007. The most recent (September 2012) TCE concentration at MW-120 was 14 µg/L.

For on-base wells, TCE concentrations also have been below the MCL since 2003, except at MW-102, where the MCL periodically has been exceeded, with higher concentrations generally correlated to higher groundwater elevations (Table 6-10, Figure 6-11b, and Figure 6-11c). The last TCE exceedance at MW-102 of 13 µg/L occurred in March 2011, but in the last seven monitoring events through September 2012, all concentrations at MW-102 have been below the MCL.

Even before the soybean oil addition in June 2001, considerable evidence existed that natural attenuation processes were ongoing, including a reduction of TCE mass, the presence of TCE degradation products (*cis*-DCE, *trans*-DCE, and vinyl chloride), and a favorable groundwater geochemical environment (low DO and low or negative ORP) for reductive dechlorination to occur. Vinyl chloride concentrations historically have exceeded the 2 µg/L MCL in several wells, both on-base and off-base (Table 6-11 and Figures 6-12a-c). In 2012, as shown in Table 6-11 and Figure 6-12d, vinyl chloride concentrations exceeded the MCL at one on-base well (MW-102 at concentrations of 3 to 29 µg/L) and one off-base well (OW-2 at concentrations of 2.4 to 12 µg/L); the current vinyl chloride MTCA Method A CUL of 0.2 µg/L was exceeded at one additional off-base well (MW-243 at 0.68 µg/L). In contrast to TCE and its other breakdown products, vinyl chloride requires aerobic conditions for natural attenuation to occur. For wells in on-base, near off-base, and mid off-base locations, groundwater generally is anaerobic, favorable for reductive dechlorination of TCE and DCE, but not for natural attenuation of vinyl chloride. Farther downgradient, groundwater becomes aerobic, and vinyl chloride is not detected (Figure 6-12d).

Historical arsenic concentrations for Site WW-1 wells are presented in Table 6-12 and Figure 6-13a, and the extent of arsenic in site groundwater in 2012 is shown in Figure 6-13b. The greatest arsenic concentrations (both historically and recently) have been observed at MW-102, where the base-wide maximum arsenic concentration of 4,840 µg/L initially was found in March 2001 following source removal activities conducted nearby in 2000 (see Section 4.2.10.2). Since that time, arsenic concentrations at MW-102 have been less than 250 µg/L and have fluctuated between 47 and 190 µg/L over the last five years. Arsenic concentrations also have fluctuated above the MCL of 10 µg/L at MW-12, MW-147, and MW-241, with greater fluctuations generally observed beginning in 2003. As shown in Table 6-12 and Figure 6-13b, arsenic concentrations in 2012 exceeded the MCL at two on-base and four off-base wells at concentrations ranging from 12 µg/L (at MW-147) to 130 µg/L (at MW-102).

Residential water supply wells located east and southeast of the WW-1 site have been regularly monitored since 1988. Before 2004, at least 15 wells were sampled quarterly with most wells non-detect for site contaminants. Occasional detects of TCE were reported for a few of these wells, but at concentrations considerably below its 5 µg/L MCL. Based on several years of non-detects for TCE in most wells, this monitoring program was significantly reduced in 2004 to include quarterly sampling of four wells, semi-annual sampling of one well, and annual sampling of ten other wells (Figure 3-6b). For residential wells located downgradient (east) of Site WW-1, TCE only has been detected in three residential wells since 2004, with no TCE detections above 0.5 µg/L, and no detections of vinyl chloride. EPA recently requested arsenic analysis be performed for two residential

wells (RW-12 and RW-13) located immediately downgradient of Site WW-1 (EPA, October 2012) (Figure 3-6a). Samples were collected for arsenic analysis from these wells in September 2012. For RW-12 (a basalt well drawing water from a depth of approximately 80 feet), the arsenic concentration was 0.04 µg/L, and for RW-13 (a shallow, hand-dug well drawing water from the alluvium at a depth of 12-20 feet), the arsenic concentration was 3.6 µg/L (CH2M HILL, November 2012b). Both of these concentrations are below the MCL of 10 µg/L.

Following its review of the *Annual 2011 RA-O Report* (Revision 1) (CH2M HILL, August 2012), EPA requested the following for Site WW-1 (EPA, October 2012):

- *EPA requests that the USAF prepare a brief ESD to add vinyl chloride and arsenic to the list of COCs for Fairchild AFB site WW-l and identify the associated CULs/performance standards based on MCLs, risk-based concentrations and/or ARARs. This may require an evaluation of arsenic concentrations in background. In conjunction with this, make it clear this change means that the contingent remedies selected in the OU-2 ROD for site WW-l could be required if COC concentrations in excess of MCLs and other relevant or appropriate risk-based performance standards persist or increase and/or the plume expands.* The USAF and EPA have discussed the path forward toward the ESD to address this issue (EPA, 25 February, 2013).
- *Update the groundwater monitoring plan as necessary to ensure it includes robust sampling and analysis of groundwater in sentry and off-base wells in order to demonstrate that the existing remedy (coupled with further aerobic degradation of vinyl chloride) results in decreasing concentrations with distance from the source. Increasing trends or indications that contaminated groundwater is moving further downgradient may require enhanced remediation for vinyl chloride.* As requested, the monitoring plan was updated (CH2M HILL, December 2012), and LTM for off-base monitoring is continuing. As shown in this plan, groundwater samples are collected quarterly from two on-site and one off-site well (MW-102, WP-01, and MW-120), semi-annually from six off-site wells, and annually from three on-site and four off-site wells.
- *Continue regular monitoring of water supply wells and add arsenic to monitoring of two water supply wells adjacent to the site boundary.* Arsenic analyses were added for two residential wells (RW-12 and RW-13) routinely sampled during the 3rd quarter (September) monitoring event (CH2M HILL, December 2012).
- *Enhance and document the off-base ICs being relied upon to prevent exposure to contaminated groundwater (see Section 6.3.2.3).* No language in the OU-2 ROD is specific to LUCs/ICs off-base, although there is a commitment to provide point-of-use treatment and/or alternative water supply, as necessary, in the event that concentrations in off-base water supply wells exceed MCLs. Possible governmental controls that could help meet the objective of preventing use of contaminated groundwater for drinking include:

  Regulatory jurisdictions that may limit or restrict use of groundwater in these areas may be in place under the governance of the City of Airway Heights, Spokane County Health District, or the State of Washington (WAC 173-160-171, well siting locations as identified in the *Minimum Standards for the Construction and Maintenance of Wells).* Collectively, these jurisdictions appear to effectually restrict current and future use of any contaminated groundwater associated with the base.

Strengthening of these ICs for areas outside the base boundary will be documented in a forthcoming ESD.

6.3.2.3 OU-2 Land Use Control Analysis

An analysis of LUCs for OU-2 is presented in Section 6.3.5.

6.3.3 OU-3 Document and Data Review – Priority Two Sites

6.3.3.1 OU-3 Remedial System Operations Analysis

Since the September 2004 data review cutoff date applied to the *Second Five-Year Review*, remedial system operations at OU-3 sites have been limited to bioventing at Site PS-1.

Site PS-1 (ST006) Bioventing System Operations

An in-situ bioventing treatment system was constructed in 1998 and was fully operational through December 2006. The bioventing system consisted of four blowers serving 14 vent wells. Each blower was designed to inject air into the subsurface through vent wells to maintain oxygen levels sufficient to support biodegradation of TPH compounds.

Baseline soil sampling was completed in 1997 during installation of the bioventing system. Approximately 25 percent of the samples collected exceeded the ROD CUL of 200 mg/kg, with concentrations of TPH-D ranging from 280 mg/kg to 3,200 mg/kg. From 2001 through 2005, 115 soil samples were analyzed for TPH-D (reported as diesel and as Jet A) during LTM activities. In total, 24 percent (28 of 115) of these samples exceeded the ROD CUL for TPH of 200 mg/kg; the bulk of the samples were located in an area of a former rail yard adjacent to Vet Road, outside the influence of the B-3 and B-4 bioventing lines. Comparing the 2001 through 2005 results to the revised MTCA Method A CUL of 2,000 mg/kg, less than 6 percent of the samples (7 of 115) exceeded the current CUL, all of which were located in the same area.

The PS-1 bioventing system was shutdown indefinitely in December 2006 based on recommendations from a RPO evaluation (CH2M HILL, October 2006b) and concurrence from Ecology (USAF, 6 December 2006). The RPO evaluation determined that remaining site soil contamination was not within the influences of the bioventing system and that benzene and TPH-D in groundwater had achieved ROD CULs. Subsurface soil sampling has not been conducted at the site since 2005. Based on the remediation of shallow groundwater to date, Ecology concurred with the recommendation to eliminate all soil monitoring activities as long as groundwater monitoring continues. Soil monitoring may be resumed in the future if access to the Vet Road or beneath the entire tank farm can be achieved, when the tank farm facility is no longer in use.

6.3.3.2 OU-3 Groundwater Monitoring Data Analysis

Among the seven OU-3 sites for which RA was required, groundwater monitoring since the last Five-Year Review has been conducted only at Sites IS-4, PS-1, and FT-2. As noted in Table 1-1, ICs and/or previous RA also were needed for soils at OU-3 sites IS-5, PS-3, and PS-10: soils data review for these sites was discussed in Section 3.5.1, 3.5.4, 3.5.6 and 4.3.2, 4.3.8, and 4.3.12, respectively.

Site IS-4 (OT017) – Jet Engine Test Cell, Building 3000

In 2001, a groundwater LTM program was established with the installation of three monitoring wells. These wells were sampled semi-annually through 2006, then annually in

2007, 2008, and 2010. TPH-D was not detected in any site well since 2001. Following an NFA determination by Ecology (Ecology, 1 October 2010a), site monitoring wells were decommissioned in December 2010.

Site PS-1 (ST006) – Bulk Fuel Storage Area

Groundwater LTM for PS-1 was initiated in 1996 and consisted of semi-annual monitoring of six wells for benzene and TPH-D. In 2002, TCE was detected at two wells, notably at MW-195 where the TCE concentration exceeded its 5 µg/L MCL at 24.6 µg/L. In 2008, the LTM program was reduced with Ecology concurrence such that MW-195 is sampled twice per year for VOC analysis only (which includes benzene and TCE), and three wells are sampled annually for TPH-D analysis only. To support this Five-Year Review, groundwater samples were collected in March 2012 from six site wells for TPH-D analysis and from two site wells for VOC analysis, with one well sampled again for VOCs in June 2012.

Benzene concentrations previously exceeded its 5 µg/L MCL at two site wells (MW-196 and MW-208). All benzene concentrations at Site PS-1 have been below the MCL since 2000, and benzene has not been detected since June 2006 (Table 6-13 and Figure 6-14).

TCE is not a formal site COC, but TCE was detected above its MCL at MW-195 in the majority of samples collected from 2002 through 2007 at concentrations up to 24.6 µg/L. TCE concentrations have been less than the MCL in all samples collected at MW-195 since September 2007 (Table 6-14 and Figure 6-15). TCE concentrations will continue to be monitored at MW-195 twice per year. An additional well, MW-308, was installed at Site PS-1 in 2004. This well was added to the LTM program as a replacement for MW-195, which was erroneously believed to be damaged during installation and repair of a water supply line. However, MW-195 has never officially been removed from the LTM program (primarily due to previous exceedences of the TCE MCL at this well). Thus, both MW-195 and MW-308 are part of the LTM program for PS-1. Continued LTM trends will help determine whether TCE detections warrant revisiting the ROD with an ESD to add TCE as a COC: since concentrations are below MCLs at this time, a change to the remedy is not warranted at this time, and would only be needed if TCE trends were to increase in the future.

TPH-D concentrations previously exceeded the ROD CUL of 1,000 µg/L in two site wells (MW-196 and MW-208). Since 2004, all TPH-D concentrations at Site PS-1 wells have been below the ROD CUL. However, TPH-D concentrations increased in five site wells monitored in 2012, and the current MTCA Method A CUL of 500 µg/L was exceeded at one well, MW-208, where the concentration was 620 µg/L. In the other site wells, TPH-D concentrations ranged from 110 to 310 µg/L (Table 6-15 and Figure 6-16). Since PS-1 remains on an active military installation and no beneficial use of the groundwater is anticipated, and LUCs are in place to prohibit installation of drinking water wells on base, the exceedance of the current MTCA Method A CUL (set to protect residential exposures) in a single well does not impact protectiveness at PS-1, particularly given the results of the last three events prior to the 2012 result being below the current MTCA Method A 500 µg/L CUL. Further evaluation of compliance with the TPH-D MTCA CUL is presented below.

Upper Confidence Limit Evaluation for TPH-D at Site PS-1

A 95% UCL evaluation for TPH-D concentrations in groundwater was performed on the two Site PS-1 wells where the ROD CUL of 1,000 µg/L (or the current MTCA Method A CUL of 500 µg/L) previously was exceeded: MW-196 and MW-208. The data shown in Table 6-15 were evaluated for the past 10 years (2003-2012). Using this approach, thirteen

sample results for each of these wells were included in the data sets. The 95% UCL was calculated for each of these data sets using the most current version of EPA's statistics program ProUCL (v4.1). For non-detect results, a value of 30 µg/L was used. The calculated 95% UCL values for TPH-D were 484 µg/L for MW-196 and 460 µg/L for MW-208. In addition to the 95% UCL being less than both the ROD CUL and the current Method A CUL, less than 10% of the results exceeded 500 µg/L and none of the results exceeded two times the ROD CUL. The only result that exceeded 1,000 µg/L (two times the Method A CUL) is from April 2003 (1,400 µg/L at MW-195); this is the oldest data point evaluated and arguably not representative of current conditions at the site, based on the age of the sample and the overall apparent trend of decreasing TPH-D concentrations at that well. This evaluation parallels a similar analysis done by Ecology for FT-2 under WAC 173-340-720(9)(d) as outlined in Section 4.3.14.3. Based on this analysis, the response for TPH-D at this site is complete and will be documented in a future multi-site RACR under the joint DOD/EPA (2005) guidance. Thus, the remedy remains protective at PS-1.

Site FT-2 (FT032) – Old Fire Training Area

In 2001, groundwater LTM was established at Site FT-2 with installation of three monitoring wells that were sampled semi-annually through 2006, then annually in 2007, 2008, and 2010. TPH-D results since 2001 were all below the ROD CUL of 1,000 µg/L. Although some TPH-D concentrations in one well (MW-285) exceeded the current MTCA Method A CUL for TPH-D of 500 µg/L, Ecology determined that NFA was appropriate for Site FT-2 (Ecology, 1 October 2010b). Details of the NFA determination for Site FT-2 are provided in Section 4.3.14.3. Based on Ecology's NFA determination, Site FT-2 monitoring wells were decommissioned in December 2010.

6.3.3.3 OU-3 Institutional Control Analysis

An analysis of LUCs for OU-3 is presented in Section 6.3.5.

6.3.4 Vapor Intrusion

During this five-year review process, currently available site data associated with remedial actions were reviewed to assess a) the potential for vapor intrusion (VI) from volatile COCs and b) activities taken that may address or impact VI exposure pathways. At the time of the ROD signature for OU-1, OU-2 and OU-3, the VI exposure pathway was not well understood and not identified as an issue. During this review, the data were reviewed in the context of VI to support an assessment of site protectiveness for CRL (OU-1) and Site WW-1 in OU-2, the only two sites covered by this review period where TCE in groundwater has exceeded its MCL.

6.3.4.1 OU-1 Vapor Intrusion Evaluation – Craig Road Landfill

Groundwater monitoring data collected from MW-118 (an off-base monitoring well where the highest TCE concentrations in groundwater recently have been observed) were used to evaluate potential VI pathways in this area. TCE has been detected in other off-base monitoring wells, including MW-82, MW-83 and MW-117 (see Table 6-1b). However, because concentrations were lower in all other off-base wells compared with MW-118, the TCE data from MW-118 was considered to represent a reasonable maximum exposure associated with future land use.

MW-118 is screened at a depth of 98 to 118 feet within Basalt A; groundwater at this location occurs at a depth of approximately 65 feet. There are no shallow alluvial monitoring wells in this vicinity. A site-specific evaluation of potential indoor air concentrations from TCE detected in groundwater at MW-118 was performed using EPA's Johnson and Ettinger model (EPA, 2004). The modeled indoor air concentrations then were used to calculate increased lifetime cancer risks and non-cancer Hazard Quotients (HQs) using EPA's Vapor Intrusion Screening Level (VISL) Calculator (EPA, 2012). Risks were calculated for hypothetical future residential and commercial/industrial land uses.

The following site-specific assumptions were used in the Johnson and Ettinger model to calculate indoor air concentrations from TCE in groundwater at MW-118:

- Exposure point concentration in groundwater is assumed to be 170 µg/L. This represents the most recently detected concentration of TCE in groundwater, from September 2012. As shown in Table 6-1b, TCE concentrations in MW-118 have declined since 2008. Therefore, the most recent groundwater concentration is considered to be a conservative representation of health risks associated with future land uses.
- The depth to groundwater is assumed to be 65 feet. As discussed above, there are no shallow alluvial wells in the vicinity of MW-118. TCE concentrations have been detected within Basalt A from a depth of 98 to 118 feet. TCE concentrations in overlying alluvial groundwater (if present) are not known. The assumption was made that the TCE concentrations detected at the top of the water table, which is the media of concern for potential vapor intrusion from groundwater, are the same as the concentrations detected at depth in the basalt formation.
- Partitioning of TCE from groundwater into overlying soil vapor was modeled with the temperature-corrected Henry's Law constant using a groundwater temperature of 12 degrees C. This represents a typical groundwater temperature as measured in previous monitoring events.
- The overlying vadose zone was assumed to be alluvial sand from the water table to the ground surface, using the default assumptions for total and water-filled porosity built into the EPA's Johnson and Ettinger model. The assumptions for a sand provide the most conservative estimate of the diffusion of TCE through soil available within the Johnson and Ettinger model.
- All other assumptions in the Johnson and Ettinger model were held at the default values supplied by EPA.

The indoor air concentration modeled from a 170 µg/L TCE concentration in groundwater using these assumptions is 7.69 µg/m^3. This was the indoor air concentration used to estimate human health risks under hypothetical future residential and commercial/industrial land use scenarios, with the VISL calculator.

The results from that analysis indicate an increased lifetime cancer risk of 1.8E-05 and a non-cancer HQ of 3.7 (Table 6-16) with a hypothetical future residential land use. While the increased lifetime cancer risk falls within the acceptable target risk range of 1E-06 to 1E-04, the HQ exceeds the acceptable limit of 1, indicating a potential for VI, should a residence be

constructed within 100 feet of MW-118 in the future. The results from the analysis indicate an increased lifetime cancer risk of 2.6E-06 and a non-cancer HQ of 0.9 (Table 6-16) with a hypothetical future commercial/industrial land use. The risks associated with the commercial/industrial land use fall at the lower end of the 1E-06 to 1E-04 target cancer risk range, and are less than a non-cancer HQ limit of 1. Commercial/industrial use is the most likely future land use at this site. Therefore, no unacceptable risks from VI are present off-base of the Craig Road Landfill in the vicinity of MW-118 based on the most likely future land use. A key uncertainty in this assessment is that groundwater monitoring data from overlying alluvium are not available. If concentrations in shallower groundwater (if present) were below screening levels, or not detected, the resulting "clean water lens" would preclude the occurrence of VI from the concentrations detected in MW-118 groundwater. The approach to this assessment therefore most likely overstates the potential occurrence and significance of VI offsite near the Craig Road Landfill site.

6.3.4.2 OU-2 Vapor Intrusion Evaluation – Site WW-1

Groundwater monitoring data collected from MW-120 and OW-2 (off-base monitoring wells where the greatest concentrations of TCE and vinyl chloride, respectively, recently have been observed) were used to evaluate potential VI pathways at Site WW-1. Groundwater at these wells typically occurs at a depth of approximately 9 feet. MW-120 is screened in the alluvium at a depth of 16 to 27 feet. OW-2 is screened in the alluvium at a depth of 7 to 17 feet. There are no current receptors located within 100 feet of either well.

A site-specific evaluation of potential indoor air concentrations from TCE and vinyl chloride detected in groundwater was performed using EPA's Johnson and Ettinger model (EPA, 2004). The modeled indoor air concentrations then were used to calculate increased lifetime cancer risks and non-cancer HQs using EPA's VISL Calculator (EPA, 2012). Risks were calculated for hypothetical future residential and commercial/industrial land uses.

The following site-specific assumptions were used in the Johnson and Ettinger model to calculate indoor air concentrations from TCE and vinyl chloride in groundwater:

- Exposure point concentration for TCE in groundwater is assumed to be 14 µg/L. This represents the most recently detected concentration of TCE in groundwater at MW-120 in September 2012. As shown in Table 6-10, this TCE concentration represents the median concentration observed in MW-120 since 2008. Therefore, the most recent groundwater concentration is considered to be a reasonable representation of health risks associated with future land uses.
- Exposure point for vinyl chloride in groundwater is assumed to be 12 µg/L. This represents the most recently detected concentration of vinyl chloride in groundwater at OW-2 in September 2012. As shown in Table 6-11, vinyl chloride concentrations in OW-2 have been variable since 2008. However, the most recent groundwater concentration is representative of peak concentrations observed in previous groundwater sampling events.
- The depth to groundwater is assumed to be 9 feet.
- Partitioning of TCE and vinyl chloride from groundwater into overlying soil vapor was modeled with the temperature-corrected Henry's Law constant using a

groundwater temperature of 10 degrees C. This represents a typical groundwater temperature as measured in previous monitoring events.

- The overlying vadose zone was assumed to be alluvial sand from the water table to the ground surface, using the default assumptions for total and water-filled porosity built into the EPA's Johnson and Ettinger model. The assumptions for a sand provide the most conservative estimate of the diffusion of TCE and vinyl chloride through soil available within the Johnson and Ettinger model.
- All other assumptions in the Johnson and Ettinger model were held at the default values supplied by EPA.

The indoor air concentration modeled from a 14 µg/L TCE concentration in groundwater using these assumptions is 1.8 µg/m^3. This was the indoor air concentration used to estimate human health risks under hypothetical future residential and commercial/industrial land use scenarios, with the VISL calculator.

The results from this analysis indicate that TCE in groundwater is associated with an increased lifetime cancer risk of 4.1E-06 and a non-cancer HQ of 0.8 (Table 6-17) with a hypothetical future residential land use. The results from the analysis indicate an increased lifetime cancer risk of 5.9E-07 and a non-cancer HQ of 0.2 (Table 6-17) with a hypothetical future commercial/industrial land use.

The indoor air concentration modeled from a 12 µg/L vinyl chloride concentration in groundwater using these assumptions is 6.8 µg/m3. This was the indoor air concentration used to estimate human health risks under hypothetical future residential and commercial/industrial land use scenarios with the VISL calculator.

The results from this analysis indicate that vinyl chloride in groundwater is associated with an increased lifetime cancer risk of 4.2E-05 and a non-cancer HQ of 0.1 (Table 6-17) with a hypothetical future residential land use. The results from the analysis indicate an increased lifetime cancer risk of 2.5E-06 and a non-cancer HQ of 0.02 (Table 6-17) with a hypothetical future commercial/industrial land use.

The combined risk from TCE and vinyl chloride in groundwater was calculated using the assumption that a future water supply to a hypothetical receptor could be drawn from groundwater in the area represented by both MW-120 and OW-2. The combined cancer risk from both chemicals under the hypothetical future residential land use scenario was 4.6E-05. The combined cancer risk under the hypothetical future commercial/industrial land use scenario was 3.1E-06. The combined non-cancer Hazard Index (HI) is less than 1 for both land use scenarios.

The increased lifetime cancer risk falls either within or below the acceptable target risk range of 1E-06 to 1E-04, and the HQ is less than the acceptable limit of 1, indicating no unacceptable human health risks from potential for VI for either future residential or commercial/industrial land uses in this vicinity.

6.3.5 LUC Analysis for OU-1, OU-2, and OU-3

LUCs have been implemented at Fairchild AFB and CRL to limit access and restrict use of real property where contaminated media are present. LUCs consist of ICs – administrative

or legal measures to restrict land use, and engineering controls – physical measures that prevent exposure to contaminated media. LUCs include controlled entry gates and security fencing that prevents access by the general public to Fairchild AFB and additional fences surrounding industrial areas of the base.

The Fairchild AFB LUC Plan (USAF, May 2007) and the Base General Plan (USAF, 2010) are used to manage and control current and future land uses at contaminated sites, which include current land users, current site uses, and site-specific use restrictions.

The USAF has administrative processes and procedures that require approval for all projects involving construction or digging/subsurface soil disturbance, currently set forth in Air Force Instruction (AFI) 32-1001, Operations Management, and AFI 32-1021, Planning and Programming of Facility Construction Projects (also known as the base permit process, Fairchild Form 103). These instructions require coordination and approval by base environmental personnel for all proposed construction, excavation, and other subsurface soil-disturbing activities at the base, especially those located in or near contaminated sites.

In accordance with the LUC Plan, Fairchild AFB conducts site inspections at least annually of all sites where an NFA determination has not yet been made. Fairchild AFB will take prompt action to restore, repair, or correct any LUC deficiencies that occur. All fencing, locked gates, signage, and other security measures remain intact, as verified during the site inspection on 4 December 2012 and detailed in the Site Inspection Report (Appendix A).

Fairchild AFB will notify EPA and Ecology immediately upon discovery of any activity that is inconsistent with the site-specific LUC objectives for a site, or of any change in land use or land use designation for a site. Fairchild AFB will determine a plan of action to rectify the situation, except in the case where the facility believes the activity creates an emergency situation. The facility will respond to the emergency immediately upon notification to EPA and Ecology and need not wait for EPA or Ecology input to determine a plan of action. The facility will also identify what went wrong with the LUC process, evaluate how to correct the process to avoid future problems and implement these changes.

Fairchild AFB will notify EPA and Ecology at least six months prior to any transfer, sale, or lease of any property subject to LUCs required by an EPA decision document so that EPA and Ecology can be involved in discussions to ensure that appropriate provisions are included in the conveyance documents to maintain effective LUCs. If it is not possible for the facility to notify EPA and Ecology at least six months prior to any transfer, sale, or lease, then Fairchild AFB will notify EPA and Ecology as soon as possible but no later than 60 days prior to the transfer, sale or lease of any property subject to LUCs.

All use and activity restrictions and controls set forth will remain in place until concentrations of hazardous substances at the sites are shown to be at levels allowing for unrestricted exposure and unlimited use. Where appropriate, signs will be displayed at certain locations to warn of potential hazards.

Fairchild AFB will notify EPA and Ecology if any land use change is proposed for a site that is inconsistent with use restrictions if any anticipated action may disrupt the effectiveness of LUCs or if any action might alter or negate the need for LUCs.

For areas where contaminated groundwater has moved off-base, the objective of LUCs is to prevent exposure to contaminated groundwater. Because such areas are not owned by the

USAF, the LUCs for the off-base areas with contaminated groundwater principally are administered through the authorities of the following agencies:

- The Washington Department of Health (WDOH) Drinking Water Program regulates the operations of Group A and Group B public water supply systems, including source water quality monitoring. WDOH also issues permits for Group A and Group B systems, including the siting and approval of new water supply sources.
- The Spokane Regional Health District Environmental Health Program provides inspection and source water quality sampling services for private water supply wells.
- The Ecology Water Resources Program regulates the siting, construction, and decommissioning of groundwater wells, including water supply and resource protection or monitoring wells.

The USAF's role in administering off-base LUCs is to periodically communicate with these agencies regarding the water quality monitoring data collected through the long term operations and monitoring programs, including the residential well monitoring program, and to regularly solicit information from these agencies on the status of any new water supply systems proposed for the area or modifications of existing systems which may affect the quality or movement of groundwater affected by the contaminant plume. The Fairchild AFB LUC Plan establishes the specific requirements for this exchange of information and for documenting that the exchange takes place as specified.

6.4 Site Inspections

Fairchild AFB inspects all IRP sites where ICs remain in place at least once per year in accordance with the base's LUC Plan. Additional site inspections have been performed regularly at those sites where RA-O activities have occurred since the last Five-Year Review and during quarterly landfill cap inspections at CRL. For this Five-Year Review, formal inspections of those sites where RA was required in the RODs were performed by Fairchild AFB and their contractor (CH2M HILL) and were accompanied by a contractor representing EPA (TechLaw) on 4 December 2012; the following 13 sites were inspected:

- Site SW-8 (LF002) – Craig Road Landfill
- Site SW-1 (LF001) – Old Base Landfill
- Site PS-2 (SS018) – Refueling Pit Area
- Site PS-8 (SS026) – Underground Fuel Line Area
- Site FT-1 (FT004) – Former Fire Training Area
- Site WW-1 (WP003) – Industrial Wastewater Lagoons
- Site IS-3 (OT016) – Reciprocating Engine Test Cell, Bldg 2150
- Site IS-4 (OT017) – Jet Engine Test Cell, Bldg 3000
- Site PS-1 (ST006) – Bulk Fuel Storage Area
- Site PS-5 (SS009) – Heating Oil Tank Area, Wherry Housing
- Site PS-7 (ST010) – Fuel Oil Storage Tanks
- Site PS-10 (SD031) – Fuel Truck Maintenance, Bldg 1060
- Site FT-2 (FT032) – Old Fire Training Area

A Site Inspection Report for these sites is included as Appendix A, and pertinent site inspection information is incorporated into Sections 4.1 through 4.4 of this five-year review.

Photographs of each of the above sites (taken during site inspections on 4 December 2012) are provided in Photographs 1 through 13 of Appendix A.

6.5 Interviews

Fairchild AFB restoration program staff were consulted for this Five-Year Review during site inspections and follow-up discussions and telephone calls regarding contaminant history, remedial actions, ICs, and changes that have occurred for each OU since the last Five-Year Review. Interviews were conducted in March 2013 with Craig Schwyn (the RAB Community co-chair) and with Steve Holderby (Spokane County Health District Environmental Programs Manager). Pertinent information obtained from these interviews is provided in Appendix B.

7. Technical Assessment

The following technical assessment follows EPA guidance provided in Exhibit 3-3 of the *Comprehensive Five-Year Review Guidance* (EPA, June 2001) and is designed to incorporate all elements of the updated (EPA 2011) guidance and accompanying form. The technical assessment requires that three questions be addressed:

- **Question A:** Are the remedies functioning as intended by the decision documents?
- **Question B:** Are the exposure assumptions, toxicity data, CULs, and remedial action objective used at the time of remedy selection still valid?
- **Question C:** Has any other information come to light that could call into question the protectiveness of the remedies?

7.1 OU-1 Technical Assessment – CRL (LF002)

7.1.1 Functionality of Remedy – Question A

Remedies as implemented at CRL are functioning as intended by the decision documents.

Human consumption of TCE-contaminated groundwater above the federal MCL is being prevented through LUCs implemented by Fairchild AFB and state law, which does not allow construction of water supply wells with 1,000 feet of a landfill. Additionally, all residential areas downgradient of CRL are within the City of Airway Heights public water supply service area. The landfill caps prevent human exposure to contaminants within landfill materials. No activities have been observed that violated established LUCs. The landfill caps continue to control infiltration through landfill areas to minimize migration of contaminants to groundwater. Contaminated groundwater in the upper aquifer continues to be restored through contaminant removal by the GETS, and more recently with implementation of SVE and ISCO at the site. The performance of the GETS (i.e., increased contaminant mass removal) also has been enhanced through periodic batch treatment operations (idling).

The ROD identified a restoration timeframe for the upper aquifer (on site) that ranged from less than 10 years to as much as 75 years. Despite not achieving CULs by the earlier timeframe, progress is being made toward restoration. Although the lateral extent of the TCE plume for 2012 is very similar to that identified in the *Second Five-Year Review*, it is known that significant TCE mass has been treated through pump and treat, SVE, and ISCO operations. It is anticipated that further reductions to TCE concentrations and mass as a result of these operations will continue to be observed in 2013 and beyond. The forthcoming post-ROD treatability study report will establish how source area technologies have impacted (i.e., reduced) the estimated time to reach RAOs established in the CRL ROD.

In the majority of monitoring wells, both on- and off-site, TCE concentrations have declined since the last five-year review or have stabilized below its MCL, with one notable exception, MW-63 (located in the northeast corner of the site). TCE concentrations in MW-63 have fluctuated between 23 and 66 µg/L since 2001. Limited natural attenuation processes appear

to be occurring within the on-site portion of the plume. Field parameters (such as dissolved oxygen and oxidation-reduction potential) generally do not indicate an anaerobic environment that is favorable for TCE degradation. However, cis-1,2-DCE (one of the initial degradation products of TCE) is detected regularly in on-site wells.

Off-site migration of TCE-contaminated groundwater has continued to be controlled by the GETS (Figures 3-1f and 3-1g). However, off-base concentrations of TCE at MW-118, while trending downward from 430 µg L in 2008 to 170 µg/L in 2012, continue to be orders of magnitude above the MCL. This is a natural attenuation remedy that is not clearly identified in the ROD and requires a more systematic plan for monitoring natural attenuation and mass reduction. It is also not clear that institutional controls have been fully implemented to ensure that no unacceptable risks will occur to off-site receptors in the long term or that RAOs are being met for off-site well MW-141. Following ISCO implementation in 2011 and 2012, operation of the GETS was reduced. To maximize ISCO effectiveness, sodium permanganate needs to remain in the aquifer as long as possible. To avoid withdrawing the sodium permanganate prematurely, extraction wells will be taken off-line where the presence of permanganate is observed. A ROD amendment to address operational changes (SVE and/or ISCO operations) will be prepared.

Average annual routine O&M costs for CRL during the last five years are approximately $175,000. This amount includes direct costs for routine CRL operations and monitoring, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning, data validation, and reporting activities. Routine O&M costs have been reduced significantly during the last five-year period due to reduced labor necessary (further automation and upgrades at the groundwater treatment plant were completed near tail-end of last five-year period), reduced operations due to batch treatment, and through overall cost reductions in program management. Amortized annual costs (spread across five years) to implement source reduction investigations and operations (SVE and ISCO in particular) are approximately $420,000.

7.1.2 Validity of ROD Assumptions – Question B

No new exposure pathways have been identified, there are no significant changes in land or resource use on or near the site, and there are no physical site conditions that would call into question the short term protectiveness of the selected remedies. There have been no changes to standards affecting the protectiveness of the remedy and no changes to pertinent ARARs as outlined by the ROD.

While exposure assumptions have not changed, toxicity data underlying CULs and RAOs used at the time of remedy selection have been updated during the five-year review period. Specifically, EPA finalized a review of TCE toxicity in 2011 (discussed in Section 7.4), but given the remedy at CRL, protectiveness is not affected in the short term. A review of the human health risk assessment and the ecological risk assessment methodology and results presented in the ROD shows that the OU-1 methodologies applied remain protective in the short term (see Appendix D).

7.1.3 New Information – Question C

No new information has come to light that would call into question the protectiveness of the remedy for CRL.

7.1.4 Technical Assessment Summary

The remedy as implemented at CRL is considered protective of human health and the environment in the short-term. Remedial activities at CRL continue to progress toward meeting RAOs in accordance with the ROD and governmental LUCs on base prevent exposure to contaminated groundwater (see Section 6.3.5). There have been no significant changes in land or resource use on or near the site, or physical changes to site conditions that would call into question the short term protectiveness of the selected remedies. As described in Section 6.3.4, a potential VI exposure pathway exists in the vicinity of MW-118 if land use were to change at the existing sand and gravel quarry in the future. Although no post-ROD definitive timeframe has been established to determine when CULs will be achieved for the upper aquifer, substantial progress has been made to enhance TCE removal and reduce TCE concentrations in the on-base portion of the upper aquifer with implementation of periodic GETS idling, SVE, and ISCO. However, additional information and evaluation of the remedy related to the off-site plume is needed for the remedy to remain protective in the long term. Additionally, long-term protectiveness requires that LUCs be enhanced as discussed in Section 9.1. Upon completion of the post-ROD treatability study report, a ROD amendment for CRL will be prepared subsequent to finalization of this Third Five-Year Review to include such remedial optimizations and any other substantive changes to the selected remedy for CRL.

7.2 OU-2 Technical Assessment – On-Base Priority One Sites

7.2.1 Functionality of Remedy – Question A

The remedies as implemented at OU-2 are functioning as intended by the decision documents. Details concerning remedy functionality at each of the five OU-2 sites where remedial action was required in the ROD are provided below.

7.2.1.1 Site SW-1 (LF001) – Old Base Landfill

Potential exposure to contaminated media has been and continues to be prevented by the non-engineered, natural soil landfill cover and through other base LUCs. No activities have been observed that violated established LUCs.

Concentrations of TCE in groundwater (the COC at Site SW-1) have been below its 5 µg/L MCL since 2005. Groundwater sampling was last conducted in June 2012, when samples were collected from six site wells. TCE concentrations were non-detect in three site wells and ranged from 0.59 to 2.8 µg/L in the other three wells. Given these results, the RAO prescribed in the ROD appears to have been met at Site SW-1.

7.2.1.2 Site PS-2 (SS018) – Refueling Pit Area

Potential exposure to contaminated groundwater has been and continues to be prevented by the asphalt and concrete pavement at the site, flightline access constraints, and other base LUCs. No activities have been observed that violated established LUCs.

Concentrations of benzene in groundwater (one of two COCs at Site PS-2) have been below its 5 µg/L MCL since 2009 (Table 6-4 and Figure 6-5). Groundwater LTM was last conducted in March 2012, when samples were collected from eight site wells (MW-55, -109, -176, -222, -223, -370, -371, and -372) and nearby Site SS-39 well MW-408. Benzene concentrations were non-detect at four site wells (and at all three downgradient wells); benzene detects ranged

from 0.64 to 2.8 µg/L at the other four wells (Table 6-4). Free product was last observed in Site PS-2 recovery wells in 2008. Given these results, the RAO prescribed in the ROD has been met at Site PS-2 for benzene and free product recovery.

Concentrations of TPH-D generally have declined but remained above the ROD CUL of 1,000 µg/L (and the current MTCA Method A CUL of 500 µg/L) in two wells at concentrations up to 2,000 µg/L in 2012 (Table 6-5 and Figure 6-6). As detailed in Section 6.3.2.2, a 95% UCL evaluation was performed for TPH-D in Site PS-2 groundwater. Sufficient recent TPH-D data only are available for one well, MW-109, for which a 95% UCL of 1,517 µg/L was calculated. The remaining wells with TPH-D CUL exceedences either lack recent sample data (MW-110, last sampled in 2002) or only have two sample results (MW-370 and MW-371) (see Table 6-5). Although biodegradation is a well-known process that will reduce TPH-D concentrations in Site PS-2 groundwater over time, no formal assessment of biodegradation has been conducted for TPH, which is not a formal COC identified by its ROD. Given existing LUCs that prevent consumption of contaminated groundwater, the protectiveness of in-place remedies is not affected.

Due to the lack of free product recovered during this five-year review period (0.5 gallon), the frequency of FPR has been reduced with concurrence of Ecology from quarterly through 2010, semi-annually in 2011, and annually in 2012. Annual FPR now occurs in March, which typically is the time of year when water levels are at their highest at Site PS-2.

7.2.1.3 Site PS-8 (SS026) – Underground Fuel Line Area

Potential exposure to contaminated groundwater has been and continues to be prevented by the asphalt and concrete pavement at the site, flightline access constraints, and other base LUCs. No activities have been observed that violated established LUCs.

Concentrations of benzene (the COC at Site PS-8) have not exceeded its MCL of 5 µg/L since 2006. Groundwater sampling was last conducted in March 2012, when samples were collected from five site wells. Benzene concentrations were non-detect at three site wells and ranged from 0.4 and 1.6 µg/L at the other two wells. Given these results, the RAO prescribed in the ROD appears to have been met at Site PS-8.

7.2.1.4 Site FT-1 (FT004) – Former Fire Training Area

Potential exposure to contaminated groundwater and soil has been and continues to be prevented by base LUCs. No activities have been observed that violated established LUCs.

Significant progress has been made at Site FT-1 toward meeting the remedial action objectives identified in the ROD for benzene contamination in soil and groundwater. Groundwater has been restored to drinking water quality with respect to benzene and other VOCs, and soils have been remediated with respect to benzene to levels that are protective of groundwater. However, with respect to TPH (which was not identified as a COC for Site FT-1), both groundwater and (possibly) soil contain elevated concentrations above MTCA Method A CULs. TPH biodegradation is a well-known process and thus declining trends are important to the protectiveness determination. The lower groundwater CUL for TPH-D likely will increase the time until CULs are achieved, but given existing LUCs that prevent consumption of contaminated groundwater, the protectiveness of in-place remedies is not affected.

Benzene concentrations in groundwater have been below its MCL in all site wells since 1999 and less than 1 µg/L since 2002 (Table 6-7 and Figure 6-8). The RAO prescribed in the ROD has been met for benzene. Other contaminants of potential concern identified in Site FT-1 groundwater are vinyl chloride and TPH-D. Vinyl chloride previously exceeded its MCL of 2 µg/L in five site wells, but all vinyl chloride concentrations have been below the MCL since 1999 and less than 0.5 µg/L since 2001 (Table 6-8 and Figure 6-9). TPH-D concentrations generally declined from 2007 through 2012, but remained above the MTCA Method A CUL of 500 µg/L in three of ten wells at concentrations up to 980 µg/L in March 2012 (Table 6-9 and Figure 6-10a). As detailed in Section 6.3.2.2, a 95% UCL evaluation was performed for TPH-D in Site FT-1 groundwater. For the four wells with sufficient data to perform this evaluation, the 95% UCLs ranged from 539 to 2,481 µg/L. The well with the greatest TPH-D concentrations at Site FT-1, MW-3, has an apparent downward concentration trend, and as shown in the simple trendline for these data in Figure 6-10b, TPH-D concentrations could fall below 500 µg/L as early as 2013.

The in-situ bioventing treatment system and air sparge curtain were shutdown indefinitely in 2006 with concurrence of Ecology (USAF, 6 December 2006) following their review of an RPO evaluation (CH2M HILL, October 2006). Through this evaluation, it was determined that these systems collectively had achieved their purposes of preventing movement of mobile TPH fractions into groundwater and treating shallow groundwater.

In June 2008, approximately 1,500 tons of soil were excavated from two areas at Site FT-1. While substantial TPH-contaminated soil was removed, some contamination remained above MTCA Method A CULs as detailed in Section 4.2.8.2. The goals of allowing for continued industrial (active base) land use were met, and TPH soil concentrations reported in 2008 above current MTCA Method A CUL for unrestricted future land use at Site FT-1 will continue to attenuate naturally.

7.2.1.5 Site WW-1 (WP003) – Industrial Wastewater Lagoons

Potential exposure to contaminated groundwater has been and continues to be prevented by base LUCs, and specific site access restrictions are enforced by Fairchild AFB. No activities have been observed that violated established LUCs.

TCE concentrations in groundwater (the site COC) have been below the MCL of 5 µg/L in all Site WW-1 wells since 2003 except for off-base well MW-120 and on-base well MW-102 (Table 6-10). The last TCE exceedence at MW-102 (13 µg/L) occurred in March 2011, but was 1.1 µg/L just one month later. In the last seven monitoring events through December 2012, all TCE concentrations at MW-102 have been well below the MCL.TCE concentrations in alluvial MW-120 have been above its MCL for all but two sampling events since 2007, ranging in concentration up to 24 µg/L.

In the 2008 Fourth Quarter and Annual Remedial Operations report, annual monitoring of MW-244 was recommended for elimination, as "MW-244 is a Basalt A well and is screened 30 feet below adjacent well MW-120. TCE concentrations in MW-244 have ranged from non-detect to 0.2 µg/L since 2005, and never above 1.5 µg/L. Annual monitoring of two other Basalt A wells at the site (MW-99 located upgradient on base, and MW-257 located down-gradient at the eastern edge of the site) will continue to be monitored. Historical and recent data continue to support that shallow alluvial aquifer is the impacted resource for WW-1, and not the deeper Basalt A aquifer." The deeper Basalt A aquifer underlying Site WW-1 is

separated from overlying alluvial groundwater by a thick layer of dense silty clay up to 25 feet thick, so migration of contaminants to the Basalt A aquifer at Site WW-1 is unlikely. However, given the continued persistence of TCE in alluvial MW-120, resampling of MW-244 may be warranted to reaffirm that migration to the basalt aquifer has not occurred since 2008.

Other contaminants of potential concern identified in Site WW-1 groundwater are the degradation products of TCE (including vinyl chloride) and arsenic. In 2011 and 2012, the vinyl chloride MCL of 2 µg/L was exceeded in three site wells (Table 6-11). Arsenic has been detected above its federal MCL of 10 µg/L in three on-base and four off-base site wells (Table 6-12 and Figure 6-13a). Vinyl chloride and arsenic have never exceeded MCLs in any residential well (CH2M HILL, June 2008 through November 2012). The greatest arsenic concentrations have been observed in MW-102, where the highest ever, historical base-wide total recoverable arsenic concentration of 4,840 µg/L was measured in 2001; dissolved and total recoverable arsenic has since ranged from 47 to 220 µg/L. In 2012, arsenic concentrations ranged from 12 to 130 µg/L at six site wells (Table 6-12 and Figure 6-13b).

Because arsenic was identified as a contaminant in some of drums removed from the TCE source area via excavation in 2000 (see Figure 6-13b), it remains unclear whether any residual arsenic from possible former source materials removed in October 2000 (CH2M HILL, December 2001) are present, or whether arsenic is detected as a result of mobilization of naturally-occurring arsenic from site soils and aquifer materials secondary to the desirable subsurface reducing conditions that enhance dechlorination and destroy the primary COC, TCE. As part of the ESD for Site WW-1, the distribution of naturally-occurring arsenic in groundwater will be reviewed throughout Fairchild AFB to better understand its occurrence at Site WW-1 in support of setting an RAO for arsenic.

The Site WW-1 GETS has not been operated since July 2006. In 2011, Ecology concurred with a recommendation that the provisional requirement to operate the GETS can be eliminated (Ecology, 29 June 2011).

7.2.1.6 OU-2 Operation and Maintenance Costs

Average annual routine O&M costs for OU-2 sites for this last five-year period are $85,000. This amount includes direct costs for RA-O, LTM, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning, data validation, and reporting.

7.2.2 Validity of ROD Assumptions – Question B

There are no significant changes in land or resource use on or near the OU-2 sites, and there are no physical site conditions that would call into question the short or long term protectiveness of the selected remedies.

While exposure assumptions have not changed, toxicity data underlying CULs and RAOs used at the time of remedy selection have been updated during the five-year review period. Specifically, EPA finalized a review of TCE toxicity in 2011 (discussed in Section 7.4), but given the implemented remedies for OU-2, protectiveness is not affected (see Appendix D). A review of the human health risk assessment and the ecological risk assessment methodology and results presented in the ROD shows that the methodologies applied remain protective in the short and long term.

The MTCA Method A CULs for TPH-D in soil and groundwater have changed since the ROD for OU-2 was signed in 1993. CULs specified in the ROD were 200 mg/kg for soil and 1,000 µg/L in groundwater; revised MTCA Method A CULs are 2,000 mg/kg for soil and 500 µg/L in groundwater. The lower groundwater CUL for TPH-D likely will increase the time until CULs are achieved at some OU-2 sites, but given existing LUCs that prevent consumption of contaminated groundwater, the protectiveness of in-place remedies is not affected. The updated soil TPH CUL is ten times less conservative than the RAO specified in the ROD, and therefore, protectiveness is not in question due to this change.

7.2.3 New Information – Question C

No new information has come to light that would call into question the protectiveness of the remedy for OU-2.

7.2.4 Technical Assessment Summary

The remedies implemented at OU-2 are protective in the short term. However, some areas of the OU require additional actions to remain protective in the long-term. The remedies as implemented for Site SW-1, Site PS-2, Site PS-8 and Site FT-1 are protective of human health and the environment. Remedial activities continue to progress toward meeting remedial action objectives for OU-2 sites in accordance with the ROD, although definitive timeframes for cleanup of COC at some sites have not yet been established. For several sites TPH is the remaining COC or constituent of interest and this is discussed further in Section 7.4.2. The remedy at WW-1 is also protective in the short-term because potential exposure to contaminated groundwater continues to be prevented by base LUCs (see Section 6.3.5). There have been no newly identified exposure pathways or any significant changes in land or resource use on or near the sites, or physical changes to site conditions that would call into question the short term protectiveness of the selected remedies. However, in order for the remedy to remain protective in the long-term, an ESD should be completed to include: 1) vinyl chloride and arsenic as COCs for groundwater, 2) an evaluation of TCE concentration trends at MW-120 and nearby wells to determine whether natural attenuation should be added as a remedy component, and 3) enhancement off-base LUCs.

7.3 OU-3 Technical Assessment – Priority Two Sites

7.3.1 Functionality of Remedy – Question A

The remedies as implemented at OU-3 are functioning as intended by the decision documents. Details concerning remedy functionality at each of the seven OU-3 sites where remedial action was required in the ROD are provided below.

7.3.1.1 Sites IS-3, IS-4, PS-5, PS-10, and FT-2

At OU-3 Sites IS-3, IS-4, and FT-2, the selected remedies identified in the ROD have been fully implemented, and NFA determinations have been made by Ecology and/or EPA. For Site PS-5, Ecology agreed that groundwater monitoring could be discontinued (EA Engineering, December 1998). For Site PS-10, the selected remedies indentified in the ROD have been implemented, and no further soil monitoring for TCE or TPH-D contaminated soil has been required since March 1998 (EA Engineering, October 1999). TCE contamination in groundwater at PS-10 has been deferred to Site SS-39 (OU-5). Potential remaining soil contamination will be investigated in 2013 now that a change in site

conditions (e.g., demolition of Building 1060) in late 2012 made further assessment possible. The long-term protectiveness of the remedy for soil at PS-10 will be assessed at that time. LUCs will be maintained at Sites IS-3, IS-4, PS-5, PS-10, and FT-2 until a multi-site or OU-wide RACR is prepared under joint DOD/EPA guidance (2005) and approved by regulatory agencies.

7.3.1.2 Site PS-1 (ST006) – Bulk Fuel Storage Area

Potential exposure to contaminated soil or groundwater has been and continues to be prevented by base LUCs. No activities have been observed that violated established LUCs.

Benzene concentrations in groundwater at Site PS-1 have been well below its MCL since 2000, and no benzene has been detected since June 2006. TPH-D concentrations in groundwater have been less than the ROD CUL of 1,000 µg/L since 2004. Even in light of the MTCA Method A reduction noted in Section 7.4.2, the current MTCA Method A CUL of 500 µg/L was only exceeded at one well (MW-208) in 2012 where the concentration was 620 µg/L. As detailed in Section 6.3.3.2, the calculated 95% UCL values for TPH-D are less than both the ROD CUL and the current Method A CUL in an evaluation that parallels Ecology's analysis for FT-2 under WAC 173-340-720(9)(d) as outlined in Section 4.3.14.3. In all other site wells, TPH-D concentrations ranged up to 310 µg/L in 2012, and thus meet both the ROD CUL of 1,000 µg/L and the current MTCA Method A CUL of 500 µg/L. A June 2012 VOC analysis also was conducted (see second quarter results presented in CH2M HILL 2012c, Table A-3): all VOCs met MTCA Method A CUL, including being non-detect for all petroleum-related VOCs including naphthalene). Thus, the trend of PS-1 TPH concentrations and absence of petroleum-related VOCs suggest the TPH remedy remains protective. Based on this analysis, the response for TPH-D in groundwater at this site is complete and will be documented in a future multi-site RACR under the joint DOD/EPA (2005) guidance. Thus, the groundwater remedy remains protective at PS-1.

Although TCE is not a formal site COC, TCE was detected in the course of routine LTM above its MCL at MW-195 in the majority of samples collected from 2002 through 2007. TCE concentrations have been less than its MCL in all samples collected at MW-195 since September 2007, most recently at 2.8 µg/L in June 2012. TCE concentrations in this well continue to be monitored twice per year. Since TCE at PS-1 has been less than the MCL for the past five years, protectiveness is not in question, and it is not necessary to add TCE as a COC for this site.

A soil bioventing system at Site PS-1 was shut down indefinitely in December 2006 with concurrence from Ecology (USAF, 6 December 2006), and subsurface soil sampling has not been conducted at the site since 2005. Soil monitoring for potential TPH-D contamination may be resumed if access to the Vet Road area or beneath the entire tank farm can be achieved, when the tank farm is no longer in use. Since the TPH-D MTCA Method A CUL (for unrestricted land use) is now 2,000 mg/kg (in contrast to the previous TPH-D CUL of 200 mg/kg), and bioattenuation has continued, no issues relating to protectiveness of the PS-1 soil remedy remain. Based on this analysis, the response for TPH-D in soil at this site will be documented in a future multi-site RACR under the joint DOD/EPA (2005) guidance. Thus, the soil remedy remains protective at Site PS-1.

7.3.1.3 Site PS-7 (ST010) – Fuel Oil Storage Tanks

Potential exposure to contaminated soil or groundwater has been and continues to be prevented by base LUCs. No activities have been observed that violated established LUCs.

In 1992, three USTs and 400 cubic yards of petroleum-contaminated soil were excavated at Site PS-7. At that time, contaminated soil was believed to extend beneath Building 1350. Following demolition of Building 1350, which occurred in January 2013, Fairchild AFB plans to conduct additional soil sampling to determine if additional remedial action is required at Site PS-7. Since this change in site conditions occurred after the Third Five-Year Review data collection period ended in September 2012, the follow-on actions at PS-7 will be reviewed in the next five-year review period.

Based on groundwater sampling conducted from 1996 through 1998 in which TPH-D concentrations were well below state CULs (and below the current MTCA Method A CUL of 500 µg/L), Ecology agreed that groundwater monitoring at Site PS-7 could be discontinued (EA Engineering, December 1998).

7.3.1.4 OU-3 Operation and Maintenance Costs

Average annual routine O&M costs for OU-3 sites for this last five-year period are $19,000. This amount includes direct costs for RA-O, LTM, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning, data validation, and reporting.

7.3.2 Validity of ROD Assumptions – Question B

No new exposure pathways have been identified, there are no significant changes in land or resource use on or near the OU-3 sites, and there are no physical site conditions that would call into question the short or long term protectiveness of the selected remedies.

While exposure assumptions have not changed, toxicity data underlying CULs and RAOs used at the time of remedy selection have been updated during the five-year review period (see Appendix D). Specifically, EPA finalized a review of TCE toxicity in 2011 (discussed in Section 7.4), but given the implemented remedies for OU-3, protectiveness is not affected. A review of the human health risk assessment and the ecological risk assessment methodology and results presented in the ROD shows that the methodologies applied remain protective in the short and long term.

The MTCA Method A CULs for TPH-D in soil and groundwater have changed since the ROD for OU-3 was signed in 1995. CULs specified in the OU-3 ROD were 200 mg/kg for soil and 1,000 µg/L in groundwater; revised MTCA Method A CULs are 2,000 mg/kg for soil and 500 µg/L in groundwater. Given the assessments for each OU-3 site in Sections 6.3.3.2 and 7.3.1, recent groundwater data support compliance with the lower groundwater CUL for TPH-D, and thus protectiveness related to meeting the new MTCA Method A CUL is achieved. Existing LUCs also continue to prevent consumption of contaminated groundwater, the protectiveness of in-place remedies is not affected. The updated soil TPH CUL is ten times less conservative than the RAO specified in the ROD, and therefore, protectiveness is not in question due to this change.

7.3.3 New Information – Question C

No new information has come to light that would call into question the protectiveness of the remedy for any site within OU-3.

7.3.4 Technical Assessment Summary

The remedy at OU-3 is protective in the short term, because some areas of the OU require additional actions to remain protective for the long-term. The remedies as implemented for all sites are protective of human health and the environment in the short term. Remedial activities continue to progress toward meeting RAOs for OU-3 sites in accordance with the ROD. The remedies as implemented for OU-3 sites remain protective.

There have been no newly identified exposure pathways, or any significant changes in land use on or near the sites, or physical changes to site conditions during the five-year data review period that would call into question the short or long term protectiveness of the selected remedies. With the exception of PS-7 and PS-10 the remedies are functioning as intended and all human and ecological risks are under control and are anticipated to be under control in the future. Additional evaluation of soil beneath the former Building 1350 at PS-7 is needed to confirm whether additional remedial action is needed in the future.

At Site PS-10, for the remedy to remain protective in the long-term, additional evaluation of soil beneath recently demolished Building 1060 is needed to determine if concentrations exceed levels that may contribute to groundwater contamination that is being addressed in OU-5 (Site SS-39).

7.4 Compliance with ARARs

State and federal chemical-specific ARARs were used to develop cleanup goals for each site as specified in the OU-1, OU-2, and OU-3 RODs. Appendix C presents a compilation of ARARs identified in the RODs for these sites. Key specific state and federal ARARs for all of these sites include:

- Safe Drinking Water Act (SDWA), 42 USC Sections 300f et seq., and 40 CFR Part 141, MCLs for public drinking water supplies
- MTCA, Chapter 173-304 Washington Administrative Code (WAC), Methods A CULs for soil and groundwater

Other than updates to the MTCA Method A CULs in December 2007, no newly promulgated or modified standards for chemicals of concern that would impact remediation activities at Fairchild AFB have occurred since the *Second Five-Year Review*. Changes that may have a future impact on remediation activities are discussed below.

7.4.1 TCE Toxicity

EPA updated toxicity information for TCE in the Integrated Risk Information System (IRIS) on September 28, 2011, which had previously been absent. This new toxicity information was compared with the toxicity values available during the previous five-year review (see Table D1 of Appendix D).

TCE is characterized as carcinogenic to humans by all routes of exposure. The current IRIS toxicity values include oral cancer potency factors and inhalation unit risks for three kinds

of cancer: kidney tumors, non-Hodgkin lymphoma, and liver cancer. EPA now also considers TCE as a mutagen and that exposures to TCE in early-life may result in higher lifetime cancer risks than a comparable duration adult exposure. Appendix D provides additional discussion on EPA's guidance changes for mutagenic compounds. TCE is also known to cause a wide range of non-cancer adverse health effects.

For TCE, the inhalation carcinogenic and oral non-cancer toxicity values became less conservative, while the oral carcinogenic and inhalation non-cancer toxicity values became more conservative (see Appendix D). TCE was classified as a mutagen by EPA in November 2011 (EPA, May 2013). These toxicity changes for TCE have not led to a change in the MCL of 5 µg/L or the MTCA Method A CUL (see Appendix D).

Since the RAOs and risk management decisions associated with groundwater are based on the MCL, these changes in toxicity values do not automatically affect the protectiveness of the groundwater remedies at Fairchild AFB. In the case of soil remedies at Fairchild AFB, the MTCA Method A CUL for TCE also was updated during the five-year review period. Specifically, November 2007 changes to soil CUL under MTCA Method A (Ecology, November 2007) were recommended after the data review period closed for the *Second Five-Year Review*. However, this change affects only soils at PS-10, which continues to be investigated in conjunction with the SS-39 (OU-5) TCE plume investigation. Therefore, the remedy set forth in the OU-3 ROD (which includes Site PS-10) remains protective, pending the ongoing PS-10 supplemental investigations discussed in Section 8.3 and 9.3.2.

7.4.2 MTCA Cleanup Regulation Updates: TPH

Since the RODs for OU-2 and OU-3 were signed in 1993 and 1995 respectively, the MTCA Method A CULs for TPH-D have changed. Unlike individual hazardous substances, petroleum hydrocarbon mixtures such as diesel fuel are comprised of thousands of chemical compounds. The concentration of the diesel mixture is measured as TPH-D to represent the expected range of the materials in the "diesel range." In reality, these measured concentrations are the collective concentrations of the individual petroleum compounds. Because thousands of chemicals are represented (and Ecology's MTCA regulation covers several key components as indicator or surrogate chemicals to approximate toxicity of diesel fuel), the basis for the MTCA TPH-D CUL change in December 2007 is more complex than a single chemical's toxicity value change. For soil, the MTCA Method A CUL for TPH-D was raised from 200 to 2,000 mg/kg: the updated TPH CUL is ten times less conservative than the RAO specified in the RODs, and therefore, protectiveness is not in question due to this change. For groundwater, the MTCA Method A CUL was lowered from 1,000 to 500 µg/L. These revised CULs may be applicable to IRP Sites at Fairchild AFB, if protectiveness were impacted. However, Section 7.3 establishes that protectiveness of the remedies is not in question.

The technical basis for the MTCA Method A CUL for TPH is not straightforward and not linked solely to new science or toxicity factor changes. Specifically, Ecology indicated the following with regard to their basis for the MTCA Method A TPH changes:

- Revisions to the MTCA rule effective November 12, 2007 (Ecology, December 2007), which was after the cutoff date for data analysis to support the *Second Five-Year Review* at Fairchild AFB (USAF 2008) involved a complex compilation of changes to multiple (inhalation and oral) references doses that changed for several petroleum fractions and

individual hazardous substances. Additional and more detailed information regarding the nature and basis for these changes can be found summarized in Section 3.4 and Appendix F of the TPH MTCA update (Ecology, December 2007) and are not repeated here. Ecology's December 2007 TPH CUL revisions table entitled "Revised Properties of Chemicals Commonly Found at Petroleum Contaminated Sites" shows revisions to toxicity values related to six of the extractable petroleum fractions, each of which numerically changed the TPH CULs.

- Previous changes in 2006 (after the cutoff date for data analysis to support the *Second Five-Year Review* at Fairchild AFB) included several changes were made to the table of physical and chemical properties and the toxicological information for several petroleum fractions and individual hazardous substances. These changes affected the calculation results, and (in part) explain why the groundwater TPH-D CUL decreased. Since scientific variability surrounding each of these parameters exists, and the actual physical properties of chemicals have not changed since the ROD was signed, this element of the change to TPH CUL is not thought to render CUL set in the RODs unprotective.

As explained in Section 3.4 of Ecology's *MTCATPH User's Guide* (Ecology, December 2007), examples of the toxicity value changes included the following:

- The Ecology 2007 Appendix F update included a change to the carcinogenic toxic equivalency factor (lowered to indicate it is less potent than previously thought) for dibenzo(a,h)anthracene from 0.4 (old version) to 0.1 (new version). This change resulted in a higher (less protective) cleanup level when this compound is present at the site, and (in part) explains why the soil TPH-D CUL increased as compared to the ROD-selected TPH-D CUL.

- Another Ecology change in 2007 included individual 1-methylnaphthalene and 2-methylnaphthalene assessments rather than the state's prior TPH methodology, which had previously allowed naphthalene to represent a total value for naphthalene, 1-methyl naphthalene, and 2-methyl naphthalene. The methylated naphthalenes, now individually assessed, are more toxic than naphthalene itself, which contributed to the decrease in the groundwater TPH-D CUL as compared to the ROD-selected CUL, as TPH containing 1-methylnaphthalene and 2-methylnaphthalene would now be calculated to pose a greater health risk.

In the case of TPH, however, biodegradation is a well-known process and thus declining trends are important to the protectiveness determination. The time since the TPH-D release is also important for consideration of the December 2007 changes to the TPH CUL under MTCA Method A, because specifically, in the case of groundwater containing TPH-D, the likelihood of any 1-methylnaphthalene or 2-methylnaphthalene in a weathered TPH release is negligible. These releases have volatilized and biodegraded since the ROD was signed, with less composition attributed by these lighter end petroleum compounds.

The lower groundwater CUL for TPH-D likely will increase the time until CULs are achieved at some sites, but given existing LUCs that prevent consumption of contaminated groundwater, the protectiveness of in-place remedies is not affected. As a practical matter, given current conditions and concentrations of remaining TPH-D, the CUL set for groundwater at Fairchild AFB in previous RODs is still protective. The MTCA regulation allows for more detailed assessment of the TPH fractions on a site-specific basis (such as

was done in Section 4.3.14.3), so where sites in LTM contain groundwater with TPH-D concentrations above the lower 500 µg/L MTCA Method A CUL adopted by Ecology in 2007, detailed evaluation of the site-specific TPH composition to determine compliance with MTCA will be required as the sites progress toward Response Complete in the future multi-site RACR.

8. Issues

Issues identified during this Five-Year Review are presented below for each OU. Recommendations and follow-up actions to address these issues are presented in Section 9.

8.1 OU-1 Issues – CRL (LF002)

Table 8-1 summarizes issues identified for CRL during this Third Five-Year Review. Recommendations to address these issues are provided in Table 9-1.

TABLE 8-1
OU-1 Issues - Craig Road Landfill

	Issue	Affects Protectiveness	
		Current (Y/N)	Future (Y/N)
1.	To reduce the time until remedial action objectives are met at CRL, source treatment (via ISCO and SVE) was pilot tested during the review period. To maximize ISCO effectiveness, groundwater extraction has been temporarily reduced to avoid withdrawing treatment substrate from the aquifer, potentially impacting the hydraulic control element of the remedy.	N	Y
2.	TCE concentrations in an off-site monitoring well (MW-118) located downgradient of CRL are decreasing but remain above the MCL.	N	Y
3.	Recent optimization and treatment activities (i.e., SVE and ISCO) are not included in the CRL ROD. If selected for long-term addition to the remedy to reduce the time to RAOs, a draft Proposed Plan and ROD amendment will be prepared to adopt one or both of these source treatment activities.	N	N
4.	Secondary impacts from ISCO operations may include potential increases in dissolved chromium concentrations, which exceed the MCL.	N	Y
5.	Current off-base LUCs to prevent the use of contaminated groundwater will need to be supplemented. However no off-base exposures are occurring.	N	Y

8.2 OU-2 Issues – Priority One Sites

Table 8-2 summarizes issues identified for OU-2 during this Five-Year Review. Recommendations to address these issues are provided in Table 9-2.

TABLE 8-2
OU-2 Issues – On-Base Priority One Sites

	Issue	Affects Protectiveness	
		Current (Y/N)	Future (Y/N)
1.	**Site WW-1 (WP003).** Vinyl chloride and arsenic exceed their respective MCLs in shallow alluvial groundwater on-site and off-site, and while regularly monitored at this site, these constituents are not identified in the ROD as site COCs.	N	Y
2.	**Site WW-1 (WP003).** TCE concentrations in off-base well MW-120 continue to exceed the MCL.	N	Y
3.	**Site WW-1 (WP003).** Current off-base LUCs to prevent the use of contaminated groundwater will need to be supplemented. However, no off-base exposures are occurring.	N	Y

8.3 OU-3 Issues – Priority Two Sites

Table 8-3 summarizes issues identified for OU-3 during this Five-Year Review. Recommendations to address these issues are provided in Table 9-3.

TABLE 8-3
OU-3 Issues – On-Base Priority Two Sites

Issue	Affects Protectiveness	
	Current (Y/N)	**Future (Y/N)**
1. Site PS-10 (SD031). Residual TCE contaminated soil may remain in areas not previously addressed during soil removal activities completed in 1996.	N	Y

9. Recommendations and Follow-up Actions

The following tables provide recommendations and follow-up actions for each OU to address the issues identified in Section 8. Additional (un-numbered) recommendations that are not linked to the specific issues identified in Section 8 also are presented.

9.1 OU-1 Recommendations – CRL (LF002)

Table 9-1 provides recommendations to address the issues identified in Section 8.1. Discussion of these recommendations is provided following this table in Section 9.1.1. Additional recommendations to optimize RA-O are provided in Section 9.1.2.

TABLE 9-1
OU-1 Recommendations for Identified Issues – Craig Road Landfill

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1.	Evaluate reductions to GETS operations following ISCO with regard to hydraulic control. Present evaluation results in a post-ROD treatability study report and annual RA-O reports.	USAF	EPA	November 2013	N	Y
2.	Evaluate TCE concentrations at MW-118 and off-site LUCs in a ROD amendment.	USAF	EPA	August 2016	N	Y
3.	Prepare a draft Proposed Plan and ROD amendment to select one or more remedial optimization (source reduction) techniques as potential remedy components at CRL.	USAF	EPA	August 2016	N	N
4.	Evaluate chromium background concentrations and potential increases in dissolved chromium that may result from ISCO operations.	USAF	EPA	November 2014	N	Y

9.1.1 OU-1 Recommendations Discussion for Identified Issues

The following discussion concerns recommendations for OU-1 presented in Table 9-1.

1. **Evaluate CRL GETS operation reductions with respect to hydraulic control following ISCO operations.** To reduce the time until remedial action objectives are met at CRL, source treatment (via ISCO and SVE) was pilot tested during the review period. Performance monitoring has indicated that some oxidant (permanganate) has remained in site groundwater for over one year following injections (CH2M HILL, November 2012a and CH2M HILL, March 2013). To further enhance continued treatment through oxidation, groundwater extraction wells that contain permanganate are not operated.

The non-pumping of certain extraction wells, because of their specific locations or extraction rates, may result in periods where hydraulic containment of the residual on-site plume is not verifiable. The impacts of these groundwater extraction reductions should be evaluated and presented in a post-ROD treatability study and ongoing annual RA-O reports.

2. **Evaluate TCE concentrations at MW-118 and off-site land use in ROD amendment.** TCE concentrations in MW-118 since 2008 have ranged from a high of 430 µg/L to 170 µg/L in September 2012. Although this well is located approximately 2,000 feet downgradient of CRL, its TCE concentrations remain the highest of any off-site monitoring well. As such, semi-annual monitoring of this well is recommended to continue. Off-site LUCs also will be evaluated in the ROD amendment and enhanced as needed. Enhancements could include initial and frequently recurring communication with the local government entities involved in review and disposition of applications to drill water wells, with similar outreach provided to local well-drillers, to property owners in the vicinity, and other stakeholders.

3. **Prepare Draft Proposed Plan and ROD amendment.** A ROD amendment will be prepared to document supplemental remedy components that have been evaluated during optimization, which may include ISCO, SVE, and GETS idling. Although SVE was identified in the ROD as a component of the selected remedy for CRL, SVE was not initially implemented based on rationale provided in an ESD (USAF, April 1996). The reevaluation and implementation of SVE (which was successfully piloted from 2010 to the present) will be discussed in the forthcoming ROD amendment.
   - As part of the ROD amendment, LTM results should be evaluated to estimate timeframe for CULs to be achieved. The ROD predicted that the timeframe required to achieve groundwater CULs in the upper aquifer within the landfill boundaries to be *from less than 10 years to more than 75 years, depending on the source control alternative selected.* The multiple remedial actions currently being implemented at CRL (SVE, ISCO, and ongoing but reduced groundwater extraction) are anticipated to reduce the time to achieve CULs; the impacts of these multiple variables (summarized in the *2012 Annual RA-O report* (CH2M HILL, July 2013) can be updated in the ROD amendment to provide a reasonable estimate of when CULs will be achieved.

4. **Evaluate secondary impacts from ISCO operations, including increasing chromium concentrations**. Secondary groundwater impacts of ISCO may include increased inorganics, such as dissolved chromium, in groundwater. To support the ROD amendment for CRL, adding ISCO as a possible supplemental remedy element, future groundwater samples from injection wells and selected upgradient and downgradient monitoring wells should be analyzed for chromium to determine the magnitude and extent of potential chromium concentrations increases. A background assessment of chromium in groundwater near CRL is recommended to determine whether inorganic COCs should be added when the Proposed Plan and ROD amendment is prepared.

9.1.2 OU-1 Additional Recommendations to Optimize RA-O

- As described in Section 6.3.1.1, SVE and ISCO operations have substantially reduced TCE concentrations and mass in the vadose zone and groundwater. Routine

performance monitoring should continue to evaluate long-term impacts and potential rebound that may be attributable to residual contaminant sources in the vadose zone or as DNAPLs in groundwater. Evaluation of these data also should support future estimates of the timeframe to achieve CULs.

- Optimize monitoring program based on evaluation of LTM results. Annual evaluation of LTM results has led to the optimization of the LTM program on a routine basis as documented in Annual RA-O reports. These evaluations should continue to ensure that adequate monitoring is conducted based on ongoing remedial actions. As a result of these evaluations, the number of wells monitored and the monitoring frequencies could be decreased or increased.
- Further evaluation of TCE concentrations at offsite well MW-141 (located northeast of CRL) may be necessary as they continue to exceed its MCL, though concentrations are steadily declining.
- The status of two possible water supply wells east of CRL (the SCAFCO and Jensen wells shown in Figure 3-1c) is unknown. The USAF will investigate the status of these wells. If these wells are found to exist, the USAF will contact the land owners and arrange for possible sampling.

9.2 OU-2 Recommendations – Priority One Sites

Table 9-2 provides recommendations to address the issues identified in Section 8.2. Discussion of these recommendations is provided following this table in Section 9.2.1. Additional recommendations to optimize RA-O are provided in Section 9.2.2.

TABLE 9-2
OU-2 Recommendations for Identified Issues – On-Base Priority One Sites

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1.	**Site WW-1 (WP003).** Prepare an ESD to include vinyl chloride and arsenic as COCs for groundwater. Conduct a base-wide background study for arsenic, including an evaluation of potential arsenic mobilization under reducing conditions.	USAF	EPA	March 2015	N	Y
2.	**Site WW-1 (WP003).** Evaluate TCE and vinyl concentration trends at MW-120 and nearby wells to determine whether natural attenuation should be added as a remedy component.	USAF	EPA	August 2018	N	Y

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
3.	**Site WW-1 (WP003).** Revise residential monitoring program and enhance off-base LUCs with an ESD.	USAF	EPA	March 2015	N	Y

9.2.1 OU-2 Recommendations Discussion for Identified Issues

The following discussion concerns recommendations for OU-2 presented in Table 9-2.

Site WW-1 (WP003)

1. **Include vinyl chloride and arsenic as COCs for Site WW-1.** USAF is preparing an ESD to include vinyl chloride and arsenic as site COCs. The MCL for arsenic is 10 µg/L. A background study will be performed to determine area background for arsenic. If the area background is determined to be above the MCL, then the CUL for arsenic will default to background. Protectiveness is not impacted, as these two analytes have and will continue to be regularly monitored at Site WW-1 (see CH2M HILL, December 2012 for current program) and no exposures are occurring. The ESD will be deferred until completion of an arsenic background study (based on a statistical approach for existing wells) to set an appropriate RAO for arsenic.

2. **Evaluate TCE concentration trends at MW-120 and nearby wells to determine whether natural attenuation should be added as a remedy component.** As described in Section 6.3.2.2 and shown in Table 6-10 and Figure 6-11a, TCE concentrations in a single off-base well, MW-120, have increased since 2007 and generally remained above the MCL through 2012. Since extensive source removal activities were completed on-base in 2000 (CH2M HILL, December 2001), and groundwater extraction and treatment was stopped in 2006, natural attenuation needs be evaluated to determine whether it should be added as a remedy component. In addition, specific annual monitoring plan revisions should include MW-244 (a weathered basalt monitoring well near MW-120) to establish more lines of evidence relating to protectiveness. Although the deeper Basalt A aquifer underlying Site WW-1 is separated from overlying alluvial groundwater by a thick layer of dense silty clay up to 25 feet thick, migration of contaminants to the Basalt A aquifer is possible. If exposure were to occur in the future, it may more likely be with basalt-intercepting private off-base wells than in alluvial (shallow) wells that would not comply with health codes.

3. **Revise residential monitoring program and enhance off-base LUCs.** EPA has expressed a concern that if ever in the future a privately owned well were found to contain analytes above MCLs, current off-base ICs may not be sufficiently robust to preclude potential exposure to contaminated groundwater. This issue is a challenge for any plume that impacts third party landowners. The USAF will layer several administrative ICs to enhance their overall effectiveness and document those off-base ICs being relied upon to prevent exposure to contaminated groundwater. Enhancements could include initial and frequently recurring communication with the local government entities involved in review and disposition of applications to drill water wells, including notification to these agencies of the extent, levels, and location of contamination present

in groundwater, with similar outreach provided to local well-drillers, to property owners in the vicinity, and other stakeholders. A first step towards this enhancement will involve review of the nature and extent of vinyl chloride and arsenic on off-base maps (Figures 6-12d and 6-13b) with property owners. ICs will be further enhanced in the forthcoming ESD, when the RAO for the new COCs (vinyl chloride and arsenic) are set.

The LUC Management Plan will clearly articulate the substantive restrictions that are needed for off-site properties to achieve overall RAOs along with the roles and responsibilities for implementing, maintaining, and enforcing ICs. As appropriate, Air Force will notify adjacent landowners of their obligations under CERCLA (42 USC § 9607(q)(1)(A)) to comply with land use restrictions and not impede the effectiveness or integrity of institutional controls relied upon in connection with Air Force response actions.

9.2.2 OU-2 Additional Recommendations to Optimize RA-O

Site PS-2 (SS018)

- **Continue LTM and annual evaluation of LTM results.** In four consecutive annual monitoring events (from 2009 through 2012), benzene concentrations in groundwater have been below the MCL of 5 µg/L in all site wells. TPH-D concentrations in groundwater remain above or near applicable CULs in several site wells, which is likely due to previous fuel spills at the site. As shown in Figure 6-6, historical TPH-D concentration data do not suggest discernible concentration trends. As such, routine LTM for site wells should continue.
    - **LTM Network.** Prior to 2012, the LTM network for Site PS-2 included six shallow alluvial wells. For this five-year review, sampling was expanded to include nine shallow wells in 2012. Based on these results and the groundwater flow direction, future LTM should be conducted for six site wells: MW-55, MW-109, MW-222, MW-370, MW-371, and MW-372. These wells have had benzene and/or TPH concentrations exceeding CULs within the last six years. Further evaluation of the downgradient extent of elevated TPH concentrations (including biodegradation assessments) may be necessary to evaluate timeframes to achieve RAOs and could include additional well installations.
    - **Reduce frequency of BTEX analyses at Site PS-2.** Because benzene concentrations have been below the MCL for four consecutive years, BTEX analyses should be completed for at least one more year. If benzene concentrations remain below the MCL in 2013, then future BTEX analyses could be eliminated.

Site FT-1 (FT004)

- **Evaluate the timeframe to achieve CULs in the upper aquifer for petroleum.** Benzene concentrations in groundwater have been below its MCL of 5 µg/L in all site wells since 2000. In potential preparation for site closure, TPH-D analyses were added to the groundwater LTM program in 2007. Since then, at least one, and up to three wells have exceeded the current MTCA Method A CUL of 500 µg/L each year. As shown in Figure 6-10a, the historical TPH-D concentration data do not suggest discernible concentration trends. As such, routine LTM should be continued.

- **LTM Network.** Prior to 2012, the LTM network for Site FT-1 included five shallow alluvial wells (MW-1, -3, -227, -247, and -248) that were analyzed for TPH-D only. For this five-year review, LTM was expanded to include four additional shallow wells (MW-50, -155, -225, -226, and -246) in 2012 to further evaluate BTEX and TPH-D concentrations across the site. Based on 2012 results, future LTM should include annual monitoring for TPH-D in five site wells: MW-3, MW-226, MW-227, MW-247, and MW-248. This group of five wells includes one well that was added in 2012 (MW-226) and where the TPH-D concentration exceeded the CUL, and removes MW-1, where TPH-D concentrations have not exceeded the CUL since 2007. Further evaluation of downgradient TPH concentrations may be necessary if future (near-term) TPH concentrations at site boundary well MW-226 continue to exceed the TPH CUL.

- **Develop an overall site management strategy.** Given residual TPH contamination in site soil and groundwater, past performance of remedial systems, soil removals, and ongoing natural attenuation processes, an overall site management strategy should be developed. Remedial action objectives have been achieved for benzene (the site COC) in soil and groundwater, but TPH concentrations remain above state CULs. A major component of this work may include reevaluation of potential site risks, based on the types and levels of remaining contamination (longer-chained hydrocarbons in soil) versus benzene (as the COC) that largely drove risk assessment during the RI/FS. Annual respiration testing and biodegradation assessments were conducted as a part of annual soil LTM through 2004 at FT-1 (when last completed). Benzene, the site COC in groundwater, has met RAOs. However residual TPH in soil likely remains and TPH in groundwater has not met state CULs across the site.

Site SW-1 (LF001)

- **Maintain LUCs and collect groundwater samples to support continuing Five-Year Reviews.** TCE concentrations in groundwater have not exceeded the MCL since March 2005, and remedial action objectives for Site SW-1 have been achieved. However, since Site SW-1 is a landfill, LUCs should remain in place until the landfill meets all state/county closure requirements for discontinuing LUCs in accordance with USAF policies. Consistent with Ecology's previous determination that annual groundwater monitoring was no longer necessary at this site (Ecology, 4 June 2009), groundwater monitoring at Site SW-1 will only need to be performed in support of continuing Five-Year Reviews, with the next samples collected by September 2017.

9.3 OU-3 Recommendations – Priority Two Sites

Table 9-3 provides recommendations to address the issues identified in Section 8.3. Discussion of these recommendations is provided following this table in Section 9.3.1. Additional recommendations to optimize RA-O are provided in Section 9.3.2.

TABLE 9-3
OU-3 Recommendations for Identified Issues – On-Base Priority Two Sites

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1.	**Site PS-10 (SD031).** Conduct additional soil investigations to evaluate whether site soils remain an ongoing source of TCE contamination in groundwater associated with Site SS-39.	USAF	EPA and Ecology	September 2013	N	Y

9.3.1 OU-3 Recommendations Discussion for Identified Issues

The following discussion concerns recommendations for OU-3 presented in Table 9-3.

Site PS-10 (SD031)

1. **Conduct additional soil investigations to evaluate whether site soils remain an ongoing source of TCE contamination in groundwater.** As described in Section 4.3.12, approximately 140 cubic yards of TCE-contaminated soil were excavated from the drainage swale near the OWS discharge in 1996. Confirmation soil samples collected following excavation showed TCE detects that ranged from 0.16 to 0.85 mg/kg – below the CUL cited in the ROD of 91 mg/kg. Additional soil samples were collected at the site in 1996, 1997, and 1998 for analysis of TPH-D and other compounds to apply Ecology's Interim TPH Policy. Following review by Ecology, PS-10 was considered to have met the Interim TPH cleanup levels, and no additional soil monitoring was required after March 1999 (EA Engineering, October 1999). TCE-contaminated groundwater associated with Site PS-10 has been deferred to Site SS-39 (OU-5).

   In groundwater samples collected near the drainage ditch, TCE concentrations have been up to 3,410 µg/L (at injection well A1-IW2 in October 2010). Following ISCO pilot testing in this area later in 2010, TCE concentrations declined substantially, but have since rebounded in several wells, which may indicate that residual TCE remains in site soils. Based on reviews of historical and existing as-built drawings for Building 1060, several potential point-source release locations have been identified that may have contributed to observed groundwater contamination in the PS-10 vicinity. Additional soil and groundwater investigations will be completed in the Building 1060 vicinity in 2013 to characterize potential remaining TCE sources in this area. This data collection effort also will establish modern soil concentrations at PS-10 in light of toxicity value changes for TCE highlighted in Section 7.4.1.

9.3.2 OU-3 Additional Recommendations to Optimize RA-O

Sites IS-3 (OT016), IS-4 (OT017), PS-5 (SS009), PS-1 (ST006), and FT-2 (FT032) – Recommendation Unrelated to Protectiveness

- **Prepare RACR for Response Complete status concurrence from Ecology and EPA.** As summarized in Table 1-1 and discussed in Sections 4.3 and 6.3.3, NFA determinations have been made for three of these OU-3 sites (IS-3, IS-4, and FT-2) and groundwater

monitoring was discontinued at PS-5 with Ecology concurrence in 1998. For Sites IS-4, PS-5, and PS-7, where TPH-D in groundwater is a COC, TPH-D concentrations were less than both the ROD CUL of 1,000 µg/L and the current MTCA Method A CUL of 500 µg/L prior to cessation groundwater sampling. At Site IS-3, where the site COC was PCBs, no PCBs were detected in soil samples collected around the Building 2150 sump following its removal. For Site PS-1, Section 6.3.3.2 explains the details of a preliminary assessment under WAC 173-340-720(9)(d), demonstrating that the ROD-required response is complete, and that present-day groundwater concentrations also comply with the modern (lower) MTCA Method A CUL outlined in Section 7.4.2. To seek Response Complete under joint DOD/EPA guidance (2005), a RACR will be prepared in the future. Since a RACR is most efficiently conducted on a multi-site or OU basis for all sites within an OU, this RACR has been deferred until in the last remaining OU-3 site (PS-10) can be evaluated. The future multi-site RACR also will establish whether additional measures are recommended to achieve UU/UE (including removal of LUCs to allow unrestricted future land use).

10. Protectiveness Statements

10.1 OU-1 Protectiveness Statement – CRL (LF002)

The remedies as implemented for OU-1 are protective of human health and the environment in the short-term because potential exposure to contaminated groundwater continues to be prevented by base LUCs and off-site monitoring of water supply wells provides no evidence of exposure to contaminated groundwater. For the remedy to remain protective in the long-term, off-site LUCs will be enhanced to prevent potential exposure to contaminated groundwater.

10.2 OU-2 Protectiveness Statement – Priority One Sites

The remedies implemented at OU-2 are protective in the short term. However, some areas of the OU require additional actions to remain protective in the long-term. The remedies as implemented for Site SW-1, Site PS-2, Site PS-8 and Site FT-1 are protective of human health and the environment. These remedies are functioning as intended and all human and ecological risks are under control and are anticipated to be under control in the future.

The remedy as implemented for Site WW-1 is protective of human health and the environment in the short term because potential exposure to contaminated groundwater continues to be prevented by on-base LUCs and off-base monitoring of water supply wells provides no evidence of exposure to impacted groundwater. For the remedy to remain protective in the long-term, off-base LUCs should be enhanced to prevent potential exposure to contaminated groundwater.

10.3 OU-3 Protectiveness Statement – Priority Two Sites

The remedies as implemented for OU-3 are currently protective of human health and the environment and will be protective of human health and the environment upon attainment of remedial action objectives. In the interim, LUCs exist that prevent exposure to contaminated media.

11. Next Review

The next five-year review is expected to be completed by August 2018, five years following the anticipated completion date of this report.

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Tables

Table 1-1
Installation Restoration Program (IRP) Sites, Fairchild AFB, Washington

Priority Grouping / ROD	OU	AF Code	Base Code	Site Name	Site Status when ROD Signed [b]	Current Status [c]
Craig Road Landfill [a]	1	LF002	SW-8	Craig Road Landfill	RA required	Groundwater LTM, groundwater extraction and treatment, SVE, ISCO, landfill cap maintenance
On-Base Priority One Sites [a]	2	LF001	SW-1	Old Base Landfill	RA required	Groundwater LTM discontinued; groundwater monitoring to support Five-Year Review
		SS018	PS-2	Refueling Pit Area	RA required	Groundwater LTM, free-product monitoring and removal (not observed since 2008)
		SS026	PS-8	Underground Fuel Line Area	RA required	Groundwater LTM discontinued; groundwater monitoring to support Five-Year Review
		FT004	FT-1	Former Fire Training Area	RA required	Groundwater LTM
		WP003	WW-1	Industrial Wastewater Lagoons	RA required	Groundwater LTM
		SD005	IS-1	Bldg 1034 French Drain System	NFA	NFA
		SS027	PS-6	Defueling Tank Area	NFA	NFA
Priority Two Sites [a]	3	OT016	IS-3	Reciprocating Engine Test Cell, Bldg 2150	ICs required	NFA, 1997 (EPA and Ecology)
		OT017	IS-4	Jet Engine Test Cell, Bldg 3000	RA required	NFA, 2010 (Ecology only)
		ST006	PS-1	Bulk Fuel Storage Area	RA required	Groundwater LTM
		SS009	PS-5	Heating Oil Tank Area, Wherry Housing	RA required	Groundwater LTM discontinued in 1998 and monitoring wells decommissioned in 1999.
		ST010	PS-7	Fuel Oil Storage Tanks	RA required	Groundwater LTM discontinued in 1998 and monitoring wells decommissioned in 1999. LUCs remain in place until petroleum-contaminated soil beneath Bldg. 1350 is fully evaluated and/or remediated.
		SD031	PS-10	Fuel Truck Maintenance, Bldg 1060	RA required	Soil removal completed in 1996, soil LTM completed in 1998. Additional soil investigation to be performed in 2013. Groundwater contamination deferred to SS-39.
		FT032	FT-2	Old Fire Training Area	RA required	NFA, 2010 (Ecology only)
		SS030	IS-2	Civil Engineering Storage Facility	NFA	NFA
		SS007	PS-3	Area C Pumphouse	NFA	NFA
		SS008	PS-4/9	Aircraft Crash Site	NFA	NFA
		DP020	SW-2	Waste Disposal Area NE of Wherry Housing	NFA	NFA
		DP021	SW-3	Waste Disposal Area SW of POL Bulk Storage	NFA	NFA
		DP022	SW-4	Former Bulk Coal Storage Area N of Bldg 2451	NFA	NFA
		OT023	SW-5	Incinerator at DRMO Yard	NFA	NFA
		DP024	SW-7	Waste Disposal S of Taxiway #10	NFA	NFA
		RW025	SW-9	Radioactive Waste Disposal at WWTP	NFA	NFA
		DP012	SW-10	Disposal Area Near WANG Test Cell	NFA	NFA
		DP013	SW-11	Disposal Area at Warrior Park	NFA	NFA for environmental issues; LUCs for safety issues remain in place
		DP014	SW-12	Disposal Area East of WSA	NFA	NFA
		WP029	WW-2	Wastewater Treatment Plant	NFA	NFA
Priority Three Sites [a]	4	AOC01	AOC-1	Vehicle Maintenance Facility, Bldg. 2115	-	Soil, sediment, and groundwater sampling completed, NFA recommended
		AOC02	AOC-2	Propulsion Shop, Bldg. 2163	-	Soil and groundwater sampling completed, NFA recommended
		RW011	SW-6	WSA - Radioactive Waste Disposal Areas	-	Beta and gamma sampling completed, NFA recommended
		OT015	SW-13	EOD Range	-	Soil, sediment, and trench sampling completed, NFA recommended
		SS033	SS-33	Waste Storage Area in WSA, Bldg. 1419	-	Soil excavation completed, NFA recommended
		SD034	SD-34	Waste Fuel Operations, Bldg. 1012	-	Soil excavation completed, NFA recommended
		ST035	ST-35	Bldg. 2165, Fuel Transfer Facility	-	Soil excavation completed, NFA recommended
		WP036	WP-36	Holding Lagoon and Imhoff Tank	-	Ecological risk assessments completed; sediments may require RA
		SD038	SD-38	Basewide Ditches, Piping and Culverts	-	Soil excavation completed, NFA recommended
	5	SS039	SS-39	TCE Orphan Plumes	RA Required	CSM Update complete. Pilot testing to support groundwater treatment remedial design complete. VI evaluation scheduled for 2013.
	7	SD037	SD-37	Basewide Oil/Water Separators	-	Systematic planning in progress to address data gaps prior to remedial design

Notes:
ROD: Record of Decision; OU: Operable Unit; LTM: long-term monitoring; LTO: long-term operation of remedial systems
[a] Craig Road Landfill ROD signed February 1993; On-Base Priority One sites ROD signed July 1993; Priority Two sites ROD signed December 1995; Site SS-39 Interim ROD signed August 2011. RODs for remaining Priority Three sites OU-4 and OU-7 are anticipated to be completed in 2014-15 (as such, these sites are not addressed by this Five-Year Review). OU-6 is reserved for the final Site SS-39 ROD.
[b] Status of site when ROD was signed. RA Required: remedial action required; NFA: no further action; ICs: Institutional Controls
[c] Current status as of September 2012; LUCs remain in place for sites with ongoing remedial action.

Table 4-1
Sites Evaluated in Third Five-Year Review: COCs, Status Summary

OU	AF Priority	AF Code	Base Code	Site Name	COCs	Remedial Activities Completed	Current Status [a]
1	One	LF002	SW-8	Craig Road Landfill	TCE (groundwater and soil)	landfill capped (1995), groundwater extraction and treatment system (GETS) operational in 1995	- GETS operational - soil vapor extraction (SVE) - in-situ chemical oxidation (ISCO) - groundwater LTM - landfill cap maintenance
2	One	LF001	SW-1	Old Base Landfill	TCE (groundwater)	groundwater LTM (through 2008)	- routine groundwater LTM discontinued - samples collected in 2012 for 5-Year Review - TCE concentrations < MCL in all wells since 2005
		SS018	PS-2	Refueling Pit Area	benzene and TPH-D (groundwater)	free-product recovery (last observed 2008)	- annual free-product monitoring and recovery (if present) - groundwater LTM - benzene concentrations < MCL in all wells since 2009 - TPH-D concentrations remain > CUL in two wells
		SS026	PS-8	Underground Fuel Line Area	benzene (groundwater)	groundwater LTM (through 2008)	- routine groundwater LTM discontinued - samples collected in 2012 for 5-Year Review - benzene concentrations < CUL in all wells since 2006
		FT004	FT-1	Former Fire Training Area	benzene and TPH-D[b] (groundwater); benzene and TPH-D[b] (soil)	soil bioventing and groundwater air sparging (indefinite shutdown 2006), soil LTM (discontinued in 2008)	- groundwater LTM - benzene concentrations < CUL in all wells since 1999 - no other VOCs detected above CULs - TPH-D above MTCA Method A CUL in three wells
		WP003	WW-1	Industrial Wastewater Lagoons	TCE, TCE degradation products[c], arsenic[c] (groundwater)	groundwater GETS (indefinite shutdown 2006), source area investigation completed in 2000	- groundwater LTM - TCE concentrations < CUL in all wells except offsite well MW-120 - vinyl chloride and arsenic above federal MCLs in some monitoring wells
3	Two	OT016	IS-3	Reciprocating Engine Test Cell, Bldg 2150	PCBs (sediment)	Sump removed and Bldg. 2150 demolished (1996)	NFA, 1997 (EPA and Ecology)
		OT017	IS-4	Jet Engine Test Cell, Bldg 3000	TPH-D (soil)	soil monitoring (through 2006), groundwater LTM (through 2010)	NFA, 2010 (Ecology only)
		ST006	PS-1	Bulk Fuel Storage Area	TPH-D and benzene (groundwater); TPH-D (soil)	soil bioventing (indefinite shutdown 2006), soil LTM (discontinued in 2008)[d]	- groundwater LTM - benzene concentrations < CUL in all wells since 2000 - TPH-D > MTCA Method A CUL in three wells
		SS009	PS-5	Heating Oil Tank Area, Wherry Housing	TPH-D (groundwater and soil)	groundwater LTM (through 1998)	Groundwater LTM discontinued in 1998 and monitoring wells decommissioned in 1999.
		ST010	PS-7	Fuel Oil Storage Tanks	TPH-D (groundwater and soil)	groundwater LTM (through 1998)	Groundwater LTM discontinued in 1998 and monitoring wells decommissioned in 1999. LUCs remain in place until petroleum-contaminated soil beneath Bldg. 1350 is fully evaluated and/or remediated.
		SD031	PS-10	Fuel Truck Maintenance, Bldg 1060	TCE and TPH-D (soil)	excavation and offsite incineration of TCE-contaminated soils completed in 1996, soil monitoring (through 1998), Bldg 1060 demolished and remaining OWS removed in 2012	- soil removal completed in 1996, soil LTM completed in 1998 - additional soil investigation to be performed in 2013. - groundwater issues deferred to Site SS-39 (OU-5)
		FT032	FT-2	Old Fire Training Area	TPH-D (groundwater and soil)	soil monitoring (through 2006), groundwater monitoring (through 2010)	NFA, 2010 (Ecology only)

Notes:
OU: Operable Unit; COC: contaminant of concern identified in ROD or IROD; ROD: record of decision; IROD: interim record of decision; CUL: cleanup level; LTM: long-term monitoring; GETS: groundwater extraction and treatment system; NFA: no further action; ICs: institutional controls
TCE: trichloroethene; TPH-D: total petroleum hydrocarbons - diesel range; CTC: carbon tetrachloride; DCE: dichloroethene
OU-2 includes two additional sites (IS-1 and PS-6) for which no further action (NFA) was determined when the ROD was signed -- these sites are not listed above.
OU-3 includes 13 additional sites (IS-2, PS-3, PS-4/9, SW-2, SW-3, SW-4, SW-5, SW-7, SW-9, SW-10, SW-11, SW-12, and WW-2) for which NFA was determined when the ROD was signed -- these sites are not listed above.
[a] Current status as of September 2012.
[b] At Site FT-1, TPH-D was not established as a COC in the ROD but is a known contaminant in soil and groundwater at this site at concentrations above current MTCA Method A CULs.
[c] At Site WW-1, only TCE was established as a COC in the ROD; however, vinyl chloride (a TCE degradation product) and arsenic occur in groundwater at concentrations above MCLs. An ESD will address these potential COCs.
[d] Routine soil monitoring at Site PS-1 discontinued in 2005; soil monitoring may be resumed if access to the Vet Road area or beneath the entire tank farm can be achieved, when the tank farm is no longer in use.

Table 6-1a
CRL Historical TCE Concentrations – Extraction Wells

Sample Date	EW-2	EW-3	EW-4	EW-5	EW-6	EW-7	EW-9	EW-10	EW-11	EW-12	EW-13	EW-14
Mar 1995	**62**		**93**	**66**	**360**	**190**						
Sep 1995	**31**		**89**	**30**	**220**	**200**	**2900**	**2400**	**400**	1.5	**40**	**2400**
Mar 1996			**100**	**34**	**170 J**	**180 J**	**310 J**	**2700 J**	**350 J**	**11**	**44**	**400 J**
Oct 1996	**43**		**57**	**29**	**70**	**160**	**99**	**1700**	**330**	**14**	3	**250**
Mar 1997	**32**		**63**	**13**	**77**	**140**	**400**	**1600 J**	**94**	3.4	3.5	**210**
Sep 1997	**42**		**59**	**17**	**48**	**140**	**95**	**1800 J**	**88**	4.7	3	**230**
Mar 1998	**34**		**100**	**18**	**18**	**130**	**52**	**1000**	**72**	**13**	2.5	**200**
Sep 1998	**46 J**		**76 J**	**34 J**	**13**	**130 J**	**17**	**1100 J**	**97 J**	**15**	5	**180 J**
Mar 1999	**27**		**94**	**22**	**25**	**170**	**81**	**800 J**	**140 J**	**22**	**7.9**	**220**
Sep 1999	**18**	**122**	**90**	**15**	**13**	**165**	**15**	**1051**	**99**	**12**	4	**127**
Mar 2000	**18**	**81 J**	**82 J**	**17.21**	**18.56**	**105 J**	**74 J**	**384 J**	**71 J**	**16.79**	4.23	**101 J**
Sep 2000	**13**	**93 J**	**83 J**	**15.8**	**17.48**	**114 J**	**25 J**	**384 J**	**49 J**	**12.09**	3.93	**121 J**
Mar 2001	**11**	**75**	**68**	**14**	**6**	**100**	**30**	**505**	**33**	**14**	3	**81**
Sep 2001	**10**	**68**	**66**	**11**	4	**108**	**14**	**414**	**67**	**16**	**6**	**94**
Mar 2002	**8**	**54**	**64**	**9**	**11**	**109**	**97**	**417**	**73**	**14**	**8**	**119**
Sep 2002	**9**	**53**	**60**	**9**	**10**	**102**	**41**	**723**	**33**	**11**	**11**	**93**
Mar 2003	**8**	**47**	**57**	**10**	**10**	**89**	**66**	**507**	**57**	**14**	**10**	**95**
Jun 2003		0.22 J										
Sep 2003	**8.1**	**40**	**53**	**9.7**	**9.4**	**90**	**44**	**613**	**43**	**11**	3.7	**85**
Mar 2004	**7.9**	**38**	**49**	**9.6**	**13.6**	**84**	**94**	**397**	**45**	**14**	**5.1**	**71**
Sep 2004	**7.6**	**46**	**48**	**10.4**	**9.0**	**82**	**21**	**581**	**35**	**9**	3.3	**73**
Mar 2005	**6.4**	**46**	**51**	**10.0**	**5.7**	**83**	**39**	**420**	**21**	**10**	3.2	**69**
Sep 2005	2.4	**36**	**47**	**11.3**	4.45	**58**	**22**	**356**	**29**	**13**	**6.9**	**62**
Mar 2006	**5.9**	**19**	**44**	**8.8**	**12**	**77**	**140**	**320**	**43**	**9.7**	**6.4**	**100**
Sep 2006	**5.8**	**40**	**41**	**12**	**15**	**60**	**530**	**4100**	**14**	5	2	**100**
Oct 2006							**460**	**4400**				
Dec 2006							**220**	**3500**				**240**
Apr 2007	**11**	**41**	**34**	**17**	**15**	**56**	**370**	**3100**	**11**	5	1.2	**300**
Jun 2007						**58**	**440**	**3000**				**180**
Sep 2007	**13**	**62**	**43**	**21**	**12**	**58**	**180**	**2400**	**11**	2.9	0.4 J	**510**
Dec 2007						**57**	**170**	**2600**				**420**
Mar 2008	**15**	**63**	**58**	**25**	**13**	**57**	**95**	**840**	**16**	4.5	0.62	**460**
Jun 2008						**54**	**200**	**1100**				**310**
Sep 2008	**20**		**53**	**20**	**18**	**40**	**630**	**1700**	**8.5**	1.5	1.1	**240**
Dec 2008						**54**	**130**	**1200**				**290**
Mar 2009	**17**	**57**	**24**	**25**	**24**	**48**	**180**	**970**	**8.1**	2.1	0.57	**420**
Jun 2009						**53**	**120**	**580**				**340**
Sep 2009	**17**	**44**	**42**	**24**	**33**	**55**	**78**	**700**	**14**	1.5	0.48 J	**390**
Dec 2009						**34**	**110**	**770**				**250**
Mar 2010	**18**	**26**	**35**	**21**	**30**	**44**	**63**	**560 J**	**13**	0.95	0.65	**440**
Jun 2010						**44**		**270**				**330**
Sep 2010	**5.3**	**160**	**29**	**13**	**7.3**	**32**		**220**	**140**	0.6	0.49 J	**210**
Dec 2010						**38**	**73**	**440**				**330**
Mar 2011	**15**	**27**	**41**	**15**	**35**	**43**	**55**	**280**	**20**	1.2		**320**
Jun 2011						**42**	**76**	**390**				**390**
Sep 2011	**7.3**		**43**	**12**	**25**	**31**	**110**	**74**	**12**	0.68		**220**
Dec 2011						**34**	*0.05*	*0.05*	**36**			2.6 J
Mar 2012	**17**	**34**	**36**	**18**	**74**	**30**	*0.05*	*0.05*	**22**	1.2		*0.05*
Jun 2012						**37**	**35**	**14**	4.6			**30**
Sep 2012	**8.2**	**29**	**41**	**31**	**7**	**22**	**94**	**85**	**16**	1.2		**29**
screened formation	Basalt A (top-mid)	Basalt A (top-basal)	Basalt A (mid)	Basalt A (basal)	Basalt A (mid-basal)	Basalt A (mid-basal)	Basalt A (mid-basal)	Basalt A (mid-basal)	Basalt A (mid)	Basalt A (top-basal)	Basalt A (top-basal)	Basalt A (mid-basal)

Notes:
Concentrations reported as µg/L
MCL: 5 µg/L - exceedences highlighted **bold red**
J: concentration estimated

Table 6-1b
CRL Historical TCE Concentrations – Monitoring Wells

Sample Date	MW-63	MW-74	MW-75	MW-96	MW-140	MW-77	MW-83	MW-85	MW-116	MW-135	MW-78	MW-80	MW-82	MW-118	MW-139	MW-141
Apr 1989	380															
Jul 1989	370															
Jun 1990	190	10	84			ND		1900			ND	ND				
Aug 1990	390	8	82					890				ND				
Feb 1991		4	75			4		2300			4	ND				
Apr 1991				370			ND	2800	ND				5	490		
Mar 1995		ND		180	53	3	ND	51	1.3	ND	4	9.1	43	440	2.1	41
Sep 1995		2.1		97	62	2.8	ND	63	ND	ND	33	41	30	550	1.4	22
Mar 1996		ND		150 J	30	ND	ND	26	ND	ND	28	40	24	690 J	ND	37
Oct 1996		ND		120	32	5.3	ND	21	ND	ND	2.2	30	21	740 J	ND	36
Mar 1997		ND		110	19	6.1	ND	12	ND	ND	ND	14	17	480	ND	28
Sep 1997				67	25	7.8	ND	12		ND		12	19	510 J		32
Mar 1998		ND		68	18	7.7	ND	ND	ND	ND		6.2	16	340	ND	30
Sep 1998		0.3		76 J	26 J	12	ND	9	0.3	ND	0.8	11	ND	390 J	0.7	41
Mar 1999		ND		68	23	13	0.84	8.9	0.3 J	ND	0.9	5.8	16	410 J	0.79	35
Sep 1999		ND		63	23	12	ND	7.8	ND	ND	0.67 J	3.05	14	308.1	0.52 J	29
Mar 2000		0.31 J		52 J	22 J	11	0.31 J	8.2	0.54 J	ND	0.73 J	2.95	17	169 J	0.94 J	29 J
Sep 2000		2.13		57 J	25 J	12	0.48 J	8.5	0.58 J	ND	1.12	2.27	14	255 J	0.92 J	30 J
Mar 2001	38		0.67	42	15	9.3	0.43 J	6.9			0.75	1.6	11	300	0.98	26
Sep 2001	35	0.3 J		38	13	8.3	0.42 J	6.1	0.45 J	0.29 J	0.62	1.4	9.1	339	0.63	23
Mar 2002	38		0.91	39	15	8.7	0.47 J	6.2			0.51	1.5	8.5	233	0.76	25
Sep 2002	31	0.28 J	0.48 J	32	6.2	8	0.54	4.79	0.36 J	ND	0.8	1.28	6.3	97	0.55	22
Mar 2003	33		0.42 J	36	7.0	9.1	0.54	5.2			0.42 J	1.15	5.8	78	0.6	24
Sep 2003	30	0.42 J		31	6.8	7.1	0.59	4.63	0.35 J	0.06 J	0.46 J	0.78	4.92	137	0.62	22
Mar 2004	25			30	7.4	8.0	0.46 J	4.79			0.27 J	0.68 J	4.16	256	0.53 J	24
Sep 2004		0.3 J		27	7.7	6.3	0.58	3.78			0.38 J	0.35 J	3.12	337	0.45 J	22
Mar 2005	23			25	6.7	6.0	0.5	3.44		ND	0.38 J	0.34 J	2.6	347	0.38 J	20
Sep 2005		0.27 J		27	5.2	6.0	0.32 J	3.49	0.29 J		0.48 J	0.34 J	2.64	303	0.41 J	
Mar 2006	23			30	4.4	4.7	1.1	2.7		ND	0.37 J	0.26 J	2.3	250	0.32 J	24
Sep 2006		ND		23	4	5.2	1.1	2.4	0.28 J				1.6	320	0.29 J	22
Mar 2007	26		8.6	22	4.6	5.3	1.2	4		ND	0.91	0.69	1.8	390	0.45 J	19
Jun 2007	27		0.4 J			4.7	1.4	2.5			0.95		1.6			
Sep 2007	26	ND	0.24 J	21	3.6	4.3	1.2	2.3	0.33 J		0.8		1.5	400	0.41 J	20
Dec 2007	49		0.43 J			5.7	1.1	2.9			1		1.6			
Mar 2008	23		0.26 J	19	2.9	5.4	1.1	2.6		ND	0.7	0.92	1.5	430	0.38 J	18
Jun 2008	50		0.47 J			4.2										
Sep 2008	66	ND	5	20	3	4.8	0.9	2.8	0.23 J		0.95		1.9	370	0.33 J	20
Dec 2008	50		0.73			3.9										
Mar 2009	59 J		1.1	20	2.2	4.1	0.9	2.5		ND	0.78	1.2	1.9	270	0.43 J	21
Jun 2009	50		0.56													
Sep 2009	45	ND	0.78	21	2.5	4.2		2.4	0.25 J					300	0.5	
Dec 2009	54		8.2													

Table 6-1b
CRL Historical TCE Concentrations – Monitoring Wells

Sample Date	MW-63	MW-74	MW-75	MW-96	MW-140	MW-77	MW-83	MW-85	MW-116	MW-135	MW-78	MW-80	MW-82	MW-118	MW-139	MW-141
Mar 2010	**54**		0.86	**19**	2.3	4.1	0.79	2.2		*ND*		1.2		**230**	0.43 J	**20**
Jun 2010	**46**		0.65													
Sep 2010	**41**	*ND*	4.4	**17**	2.2	**5.1**		2.7	0.21 J		0.86			**240**	0.39 J	
Dec 2010	**45**		2.1													
Mar 2011	**45**		0.86	**20**	2.3	3.9	0.82	1.9		*ND*		0.97	2.2	**270**	0.35 J	**18**
Jun 2011	**34**		0.63													
Sep 2011	**33**	0.13 J	**9.5**	**16**	2	3.9		2.1	0.16 J		1			**200**	0.27 J	
Dec 2011	**35**		1.6													
Mar 2012	**27**		0.96	**15**	1.8	4.3	0.77	1.3		*ND*		0.5	2.6	**160**	0.34 J	**16**
Jun 2012	**39**		0.61													
Sep 2012	**44**	*ND*	**8**	**14**	1.8	4		1.7	0.25 J		1			**170**	0.4 J	
location/use	Source Area	Source Area	Source Area	Source Area	Source Area	Contain Compli	Nearby Unaffected	Contain Compli	Nearby Unaffected	Nearby Unaffected	Off-Site Contam	Off-Site Contam	Off-Site Contam	Off-Site Contam	Off-Site Contam	Off-Site Contam
screened formation	Basalt A (mid)	Basalt B (top)	Basalt A (mid)	Basalt A (basal)	Basalt A	Basalt A (mid)	Basalt A (basal)	Basalt A (mid)	Alluvium	Basalt B	Basalt A (mid)	Basalt A (mid)	Basalt A (mid)	Basalt A (mid)	Basalt B	Basalt A

Notes:
Concentrations reported as µg/L
MCL: 5 µg/L - exceedences highlighted **bold red**
ND: not detected
J: concentration estimated

Table 6-1c
CRL Historical Chromium Concentrations

Well	Apr 1989	Jun 1989	Jul 1989	Jun 1990	Aug 1990	Feb 1991	Apr 1991	Sep 2011	Dec 2011	Mar 2012	Oct 2012
MW-17	*0.04 U*										
MW-18	*0.04 U*		*0.04 U*								
MW-19	*0.04 U*		*0.04 U*								
MW-20	*0.04 U*		*0.04 U*				0.067				
MW-21	*0.04 U*		*0.04 U*								
MW-22	*0.04 U*										
MW-23	*0.04 U*		*0.04 U*								
MW-63	*0.04 U*		*0.04 U*	*0.013 U*	*0.013 U*						
MW-69		*0.04 U*	*0.04 U*	*0.013 U*	*0.013 U*						
MW-70		*0.04 U*	*0.04 U*	*0.013 U*	*0.013 U*						
MW-74				*0.013 U*	*0.013 U*	0.004					
MW-75				*0.013 U*	*0.013 U*	0.004					
MW-76				*0.013 U*	*0.013 U*	0.006					
MW-77				*0.013 U*	*0.013 U*	0.005		*0.00066 U*			
MW-78				*0.013 U*	*0.013 U*	*0.004 U*					
MW-79							*0.004 U*				
MW-80				*0.013 U*	*0.013 U*	*0.006 U*					
MW-82							*0.004 U*				
MW-83							*0.004 U*				
MW-84				*0.013 U*	*0.013 U*	*0.004 U*					
MW-85				*0.013 U*	*0.013 U*	*0.004 U*	*0.004 U*				
MW-94						0.021	0.012				
MW-95						*0.004 U*	*0.004 U*				
MW-96						*0.004 U*	*0.004 U*				
MW-97						*0.004 U*	*0.004 U*				
MW-101						*0.004 U*					
MW-114							*0.004 U*				
MW-116							*0.004 U*				
MW-117							*0.004 U*				
MW-118							*0.004 U*				
MW-126							*0.004 U*				
EW-4											
EW-5											
EW-9									**0.13**	0.079	
EW-10									**0.14**	0.057	
EW-14									0.04	0.05	
NDA-1											0.027
NDA-3											*0.001 U*
NDA-5											0.006 J
NDA-6											0.019
NDA-7											*0.001 U*
NDA-8											0.02
NDA-9											*0.001 U*

Table 6-1c
CRL Historical Chromium Concentrations

Well	Apr 1989	Jun 1989	Jul 1989	Jun 1990	Aug 1990	Feb 1991	Apr 1991	Sep 2011	Dec 2011	Mar 2012	Oct 2012
NDA-10											*0.001 U*
NDA-11											*0.001 U*
NDA-12											0.017
NDA-13											*0.001 U*
RW-2								0.00078 J	*0.00066 U*		
RW-3								0.00082 J			
RW-4								*0.00066 U*			
RW-5								*0.00066 U*	0.00069 J	0.00092 J	
RW-6								**0.16**	0.045	0.1	
RW-7								0.034	0.0093 J	0.013	
RW-8								**0.41**	**0.24**	**0.18**	
RW-9								**0.3**	**0.3 M**	**0.13**	
RW-10								**0.31**	0.1	0.034	
RW-11								**0.18**	0.093	0.056	
RW-12								*0.00066 U*	0.001 J		
RW-13								0.014	0.0025 J	0.0042 J	
RW-14								**0.13**	**0.21**	**0.17**	
RW-15								0.031	0.0098 J	0.0031 J	
RW-16								0.1	**0.13**	**0.12**	
RW-17								*0.00066 U*	0.0093 J	0.011	
RW-18											
VMP-09B								*0.00066 U*			
VMP-12B								*0.00066 U*			
VMP-28B								*0.00066 U*			

Notes:
Concentrations reported as mg/L
Maximum of filtered/non-filtered sample data shown
Exceedences of the 0.1 mg/L MCL highlighted **bold red**
Exceedences of the 0.05 mg/L MTCA Method A CUL highlighted red
U: analyte not detected at the detection limit shown
J: concentration estimated
M: matrix interference
Well IDs:
MW: monitoring well
EW: extraction well
NDA: northeast disposal area remediation well
RW: southwest disposal area remediation well
VMP: southwest disposal area vapor monitoring point/remediation well

Table 6-2
Site SW-1 Historical TCE Concentrations in Groundwater [a]

Sample Date	MW-90/ MW-309 [b]	MW-128	MW-131	MW-132	MW-166	MW-167	MW-168
Aug 1990	**10**						
Feb 1991	4.0						
Apr 1991	**11**						
Jun 1991		ND	**18**	**6.0**			
Dec 1991	**8.0**	0.5	**11**	**12**		ND	ND
Feb 1994	**6.3**		4.2	ND			
May 1994	3.4	0.5	**7.9**	1.9			
Aug 1994	**7.4**		3.5	1.8			
Nov 1994	**6.5**	1.6	**5.1**	1.0	ND		
Apr 1995	**8.8**		**10**	ND	ND		
Jun 1995	**14**		**9.2**	1.0	ND		
Sep 1995	**10**		**9.0**	ND	ND		
Dec 1995	**9.2**		**9.0**	ND	ND		
Mar 1996	**10**		4.0	ND			
Sep 1996	**7.2**		**5.8**	ND	ND		
Mar 1997	**8.7**		**6.0**	ND	ND		
Sep 1997	**8.0**		**6.0**	ND	ND		
Mar 1998	**5.0**		4.0	0.90			
Sep 1998	**10**		4.0	0.80			
Mar 1999	**7.3**		3.5	0.72 F			
Sep 1999	**5.7**		3.5	< 2			
Mar 2000	**7.8**		2.0	0.88 F			
Sep 2000	**9.2**		4.5	1.3 F			
Mar 2001	**6.7**		2.7	0.43 F			
Sep 2001	**6.8**		1.9	1.6			
Mar 2002	**11**		**6.6**	0.96 F			
Sep 2002	**8.3**		**6.3**	1.1			
Mar 2003	**7.8**		3.5	0.54			
Sep 2003	**8.7**		3.4	0.34 F			
Mar 2004	**5.8**		2.2	0.37 F			
Sep 2004	**5.5**	0.14	2.4	0.43 F			
Mar 2005	0.77		1.7	0.76			
Sep 2005	1.3			0.88			
Mar 2006	1.6		0.73	0.32			
Sep 2006	1.9		2.1	0.75			
Sep 2007	1.7		1.2				
Sep 2008	1.4		0.94				
Jun 2012	1.2	ND	2.8	0.59		ND	ND

Notes:
[a] Pre-2003 data reported by MWH (2003); only available results are shown
[b] MW-90 was abandoned in Dec. 2004 due to grout intrusion and replaced with MW-309; results shown after are for MW-309.
F: Analyte detected at concentrations less than the reporting limit (RL), but greater than the method detection limit (MDL)
TCE concentrations above the 5 µg/L MCL highlighted **bold**

Table 6-3
Site PS-2 Annual Free-Product Recovery

Year	MW-228	MW-228A
2000	2.05	3.12
2001	12.9	14.5
2002	3.1 (a)	8.3 (a)
2003	1.37 (a)	1
2004	0.12	2.35
2005	0	3
2006	0.14	1.25
2007	0.125	0.008
2008	0.53	0
2009	0	0
2010	0	0
2011	0	0
2012	0	0

Notes:
Volumes reported as gallons
a = product/water emulsion
Approximately 10 gallons of free-product recovered from 1996-1999.

Table 6-4
Site PS-2 Historical Benzene Concentrations in Groundwater

Sample Date	MW-55	MW-109	MW-110	MW-176	MW-179	MW-222	MW-223	MW-370	MW-371	MW-372	MW-408
Apr 1989	**15**										
Jul 1989	**29**										
Jun 1990	**12**										
Aug 1990	**53**										
Feb 1991		**150**	*ND*								
Apr 1991		**34**	*ND*								
Jan 1992	**25**										
Feb 1992		**40**									
Feb 1994	**18**	**55**	*ND*		*ND*						
Apr 1994	**32**					**52**					
May 1994		**44**									
Aug 1994	**20**										
Nov 1994	**11**	**10**	2.7		*ND*						
Apr 1995	**16**	**23**	2.2		*ND*						
Jun 1995	**34**	**81**	1.2		*ND*						
Sep 1995	**18**	**12**	*ND*		*ND*						
Dec 1995	**21**	**50**	1.3								
Mar 1996	**17**	**28**	*ND*		*ND*						
Sep 1996	**25**	**61**	*ND*		*ND*	**110**					
Mar 1997	**16**	**41**	*ND*		*ND*	**53**					
Sep 1997	**11**	**67**	*ND*		*ND*	**83**					
Mar 1998	**24**	**8**	1.0		*ND*	**59**					
Sep 1998	**24 J**	**19**	*ND*			**62 J**					
Mar 1999	**25**	**11 J**	1.21 J		*ND*	**30 J**					
Mar 2000	**15**	**6.6 J**	*ND*		*ND*	**56**					
Apr 2001	**11**	4.3	*ND*		*ND*	**52**					
Mar 2002	**10**	**22**	0.68		*ND*	**13**					
Apr 2003	**12**	1.3	*ND*		*ND*	**17**					
Apr 2004	**8.8**	1.6	*ND*		*ND*	**11**					
Apr 2005	4.7	0.83	*ND*		*ND*	3.6					
Mar 2006	**8.9**	2.4			*ND*	**6.6**					
Mar 2007	1.5	1.2 J				4.1					
Mar 2008	2.7	1.3				**13**					
Mar 2009	0.96	1				2.3					
Mar 2010	*ND*	1.9				3.6					
Apr 2011	0.45	0.87				*ND*		*ND*	0.14 J	*ND*	
Mar 2012	1.8	1.2		2.8		*ND*	0.64	*ND*	*ND*	*ND*	*ND*

Notes:
Concentrations reported as µg/L
MCL = 5 µg/L - exceedences highlighted **bold red**
ND: not detected; J: estimated value

Table 6-5

Site PS-2 Historical TPH-Diesel Concentrations in Groundwater

Sample Date	MW-55	MW-109	MW-110	MW-176	MW-179	MW-222	MW-223	MW-370	MW-371	MW-372	MW-408
Feb 1994		**9,100**									
Apr 1995		**5,300**	720		270						
Jun 1995	320	**5,900**	660		*ND*						
Sep 1995	280	**5,200**	520		*ND*						
Mar 1996	*ND*	**2,100**	260		*ND*						
Sep 1996	*ND*	**1,100**	330		*ND*						
Mar 1997	*ND*	**1,100**	300		*ND*	*ND*					
Sep 1997	390	**2,700**	380		*ND*	400					
Sep 1998	*ND*	900	390			*ND*					
Mar 1999	*ND*	206	*ND*		*ND*	*ND*					
Mar 2000		701									
Apr 2001		**1,500**									
Mar 2002			640								
Mar 2006		**1,300**									
Mar 2007		**1,300**									
Mar 2008		**1,400**									
Mar 2009		760									
Mar 2010		**1,500**									
Apr 2011		**1,500**						**1,600**	990	490	
Mar 2012	200	**1,500**		420		120	410	**2,000**	410	170	330

Notes:

Concentrations reported as µg/L

The ROD cleanup level for TPH is 1,000 µg/L - exceedences highlighted **bold red**

The current MTCA Method A cleanup level for TPH-D is 500 µg/L - exceedences highlighted red

ND: not detected

Table 6-6
Site PS-8 Historical Benzene Concentrations in Groundwater

Sample Date	MW-67	MW-68	MW-183	MW-184	MW-31
Jan-92	-	-	-	**5.0**	
Feb-94	-	-	-	3.1	
May-94	-	-	-	**6.5**	
Aug-94	-	-	-	**16**	
Nov-94	-	-	-	**11**	
Apr-95	-	-	-	3.4	
Jun-95	-	-	-	2.4	
Sep-95	-	-	-	**26**	
Dec-95	-	-	-	0.50	
Mar-96	*ND*	*ND*	*ND*	**17**	
Sep-96	*ND*	*ND*	*ND*	**25**	
Mar-97	*ND*	*ND*	*ND*	1.9	
Sep-97	4.0	1.0	*ND*	**6.0**	
Mar-98	1.0	*ND*	*ND*	**51**	
Sep-98	2.0	*ND*	*ND*	**10**	
Mar-99	2.7	0.73	*ND*	3.4	
Mar-00	1.2	*ND*	*ND*	**9.3**	
Mar-01	-	-	-	**20**	
Sep-01	**17**	**6.71**	*ND*	**9.6**	
Mar-02	**23**	*ND*	*ND*	3.4	
Sep-02	**22**	*ND*	*ND*	**8.4**	
Dec-02	**26**	*ND*	*ND*	3.4	
Apr-03	1.2	*ND*	*ND*	**37**	
Sep-03	0.75	*ND*	*ND*	**5.1**	
Apr-04	1.2	*ND*	*ND*	0.13	
Sep-04	1.4	*ND*	*ND*	*ND*	
Apr-05	*ND*	*ND*	*ND*	1.1	
Sep-05	0.60	*ND*	*ND*	**5.5**	
Mar-06	0.77	*ND*	*ND*	*ND*	
Sep-06	1.1	*ND*	*ND*	*ND*	
Mar-07	0.74	-	*ND*	0.67	
Sep-07	-	-	-	3.0	
Mar-08	0.83	-	*ND*	0.40	
Sep-08	-	-	-	0.83	
Mar-12	0.39 J	*ND*	*ND*	1.6	*ND*

Notes:
Concentrations reported as µg/L
MCL: 5 µg/L - exceedences highlighted **bold red**
ND: not detected
J: concentration estimated

Table 6-7
Site FT-1 Historical Benzene Concentrations in Groundwater

Sample Date	MW-1	MW-3	MW-226	MW-227	MW-247
Nov 1986	*ND*	1.5			
Nov 1987	*ND*	*ND*			
Apr 1989	**43**	**79**			
Jul 1989	*ND*	**170**			
Apr 1991	**8**	**66**			
May 1991	*ND*				
Apr 1995	1.5	**220**			
Jun 1995	*ND*	**210**			
Sep 1995		**290**			
Oct 1995				*ND*	
Dec 1995	*ND*	**290**	*ND*		
Mar 1996	3	**57**	3.7		
Jun 1996			**50**		
Sep 1996	*ND*	**200**	2.1	1.8	
Dec 1996	*ND*	**240**	1.3	4.9	
Mar 1997	3.4	**36**	**13**	**6**	
Jun 1997		**150**	4.3	1.8	
Sep 1997		**180**	1	1	**6**
Dec 1997			*ND*	*ND*	1
Sep 1998			4	2	**10**
Dec 1998		**11**	*ND*	*ND*	1
Mar 1999	*ND*	1.93 J	0.78 J	**5.73**	1.33 J
Jun 1999		*ND*	1.01 J	0.95 J	**5.9**
Sep 1999		*ND*	*ND*	*ND*	2.18
Dec 1999		0.84 J	*ND*	0.55 J	0.42 J
Mar 2000	*ND*	*ND*	0.63 J	0.57 J	2.81
Jun 2000		*ND*	0.62 J	0.86 J	1.49 J
Sep 2000		*ND*	0.61 J	0.6 J	1.17 J
Dec 2000		0.31 J	0.51 J	0.7 J	1.54 J
Apr 2001	*ND*	*ND*	0.47	0.78	1.7
Jun 2001		*ND*	0.45	0.47	1.8
Sep 2001		*ND*	0.54	0.44	0.84
Mar 2002	*ND*	*ND*	0.39 J	0.21 J	0.96
Jun 2002		0.12 J	0.35 J	0.27 J	0.59
Sep 2002		0.24 J	0.23 J	0.25 J	0.51
Dec 2002		0.22 J	*ND*	0.31 J	0.87
Sep 2005		*ND*	*ND*	*ND*	0.43
Dec 2005		*ND*	*ND*	*ND*	0.49
Feb 2006		*ND*	*ND*		
Mar 2006	*ND*			*ND*	0.37 J
Sep 2006		*ND*	*ND*	*ND*	0.29 J
Mar 2007		*ND*	*ND*	*ND*	*ND*
Mar 2008		*ND*	*ND*	*ND*	*ND*
Mar 2012	*ND*	*ND*	*ND*	*ND*	*ND*

Notes:
Site FT-1 wells with previous MCL exceedences shown
Concentrations reported as ug/L. Benzene MCL = 5 ug/L. Exceedences highlighted bold.
MCL = 5 ug/L - exceedences highlighted **bold red**
J: concentration estimated
ND: not detected

Table 6-8
Site FT-1 Historical Vinyl Chloride Concentrations in Groundwater

Sample Date	MW-1	MW-3	MW-50	MW-100	MW-226	MW-227	MW-247	MW-248
Nov 1986	ND	**35.9**						
Nov 1987	ND	ND						
Apr 1989	ND	**16**	ND					
Jul 1989	ND	**40**	ND					
Jun 1990			ND					
Aug 1990			ND					
Feb 1991				ND				
Apr 1991	ND	ND		**9**				
May 1991	ND							
Apr 1995	ND	**36**	ND	**4**				
Jun 1995	ND	**44**	ND	**4.2**				
Sep 1995		**49**	ND	**2.9**				
Oct 1995						**3.2**		
Dec 1995	ND	**49**	ND	**2.8**	1.3			
Mar 1996	ND	**4.9**	ND	**2.8**	1.8			
Jun 1996	ND	**25**	ND	2	**13**	**23**		
Sep 1996	ND	**31**	ND	**2.5**	**14**	**14**		
Dec 1996	ND	**27**	ND	**2.7**	**7.1**	**18**		
Mar 1997	ND	**6**	ND	1.5	**14**	**10**		
Jun 1997		**22**	ND	**2.2**	**9.1**	**6.2**		
Sep 1997		**25**	ND	2	**10**	**9**	**20**	ND
Dec 1997		**12**	ND	ND	2	ND	**24**	ND
Sep 1998					**7**	**5**	**5**	ND
Dec 1998		2			ND	**3**	**5**	ND
Mar 1999	ND	ND	ND	ND	ND	ND	1.9 J	ND
Jun 1999		ND			0.56 J	ND	0.58 J	
Sep 1999		ND			ND	ND	ND	
Dec 1999		ND			ND	ND	1.64 J	
Mar 2000	ND	ND	ND	0.75 J	0.72 J	0.5 J	ND	ND
Jun 2000		ND			1.24 J	0.81 J	0.8 J	
Sep 2000		ND			ND	ND	ND	
Dec 2000		ND			ND	ND	0.48 J	
Apr 2001	ND	ND	ND	0.31 J	0.33 J	0.32 J	0.37 J	ND
Jun 2001		ND			0.37 J	0.24 J	0.32 J	
Sep 2001		ND	ND	0.38 J	0.31 J	ND	0.34 J	ND
Mar 2002	ND	ND	ND	0.37 J	0.36 J	ND	ND	ND
Jun 2002		ND			ND	ND	0.15 J	
Sep 2002		ND	ND	0.31 J	ND	ND	ND	ND
Dec 2002		ND			ND	ND	ND	
Sep 2005		ND	ND	ND	ND	ND	ND	ND
Dec 2005		ND			ND	ND	ND	
Feb 2006		ND		ND	ND			
Mar 2006	ND		ND			ND	ND	ND
Sep 2006		ND	ND	ND	ND	ND	ND	
Mar 2007		ND	ND	ND	ND	ND	ND	
Mar 2008		ND	ND	ND	ND	ND	ND	

Notes:
Concentrations reported as µg/L
MCL = 2 µg/L - exceedences highlighted **bold red**
Current MTCA Method A cleanup level = 0.2 µg/L - exceedences highlighted red
J: concentration estimated
ND: not detected

Table 6-9
Site FT-1 Historical TPH-D Concentrations in Groundwater

Sample Date	MW-1	MW-3	MW-50	MW-155	MW-225	MW-226	MW-227	MW-246	MW-247	MW-248
Mar 2007	220	**2000**					440		**1900**	**1300**
Mar 2008	91 J	**3100**					190		**510**	59 J
Mar 2009	110	**1800**					410	*ND*	470	*ND*
Mar 2010	110	**2000**					500		**1200**	130
Mar 2011	77 J	410					**630**		**980**	110
Mar 2012	120 J	**980**	260	99	150	**590**	310	120	**960 J**	140

Notes:
Concentrations reported as ug/L
TPH was not identified in the ROD as a COC for Site FT-1, so a ROD cleanup level was not established. The current MTCA Method A CUL for TPH-D is 500 ug/L - exceedences highlighted **bold red**.
J: concentration estimated
ND: not detected

Table 6-10
Site WW-1 Historical TCE Concentrations in Groundwater

Sample	On-Base							Off-Base (Near)			Off-Base (Mid)				Off-Base (Far)					
Date	MW-11	MW-12	MW-99	MW-102	MW-103	EW-3	WP-01	MW-147	MW-241	MW-242	MW-120	MW-243	MW-244	OW-2	MW-245	MW-254	MW-255	MW-256	MW-257	MW-258
Nov 1986	ND																			
Nov 1987	ND	20																		
Apr 1989		33																		
Jul 1989	ND	180																		
Feb 1991					ND															
Apr 1991	ND	72		190	ND						19									
Nov 1991		14		58				29			38									
Apr 1995	ND	97		130	ND			7.0			61									
Jun 1995	ND	115		315	ND			14			42									
Sep 1995	ND	45		12	ND			16			36									
Dec 1995	ND	3.8		4.4	6.3			25			69									
Feb 1996		4.0		300				31	1.0		69				9.0					
Mar 1996	ND	ND	ND	220	ND	3.5	12	18	0.4	ND	45	3.2	1.5		3.5					
Jun 1996	ND	ND	ND	71	ND	1.0	47	14	1.8	1.0	46	3.0	1.1		5.9					
Sep 1996	ND	ND	ND	6.0	ND	1.2	3.3	29	0.4	1.1	57	2.8	1.2		3.8					
Dec 1996	ND	ND	ND	190	ND	3.1	11	16	1.0	2.4	52	3.3	1.1		7.6					
Mar 1997	ND	170	ND	830	ND	49	2.2	18	22	1.5	45	3.3	1		2.2					
Jun 1997		1.6		170		16	1.9	20	33	8.2	45	2.1	ND		2.0					
Sep 1997		1.0		31		1.0	110	8.0	2.0	4.0	24	2.0	1.0		5.0					
Dec 1997		0.6		3.0		0.7	44	19	0.90	1.0	18	2.0	0.8		4.0					
Mar 1998		0.4	ND	56		ND	47	27	2.0	1.0	30	2.0			3.0		8.0	4.0	0.70	0.70
Jun 1998		0.4		1.0		ND	44	30	0.70	1.0	23	2.0			3.0		7.0	4.0	0.80	0.50
Sep 1998		1.0		3.0	ND	2.0	17	29	0.60	0.90	27	2.0			2.0		10	6.0	0.70	0.60
Dec 1998		ND		2.0		2.0	9.0	17	ND	ND	25	2.0			1.0	ND	6.0	4.0	ND	ND
Mar 1999	ND	1.5	ND	362	0.41 J	4.0	44	4.4	2.4	0.97	20	2.3	0.74 J		2.2	ND	3.2	3.5	0.68	0.61
Jun 1999		ND		1.3		0.67	112		ND		20						3.7	3.3	ND	
Sep 1999	ND	ND		ND		1.7	9.5	22	ND	ND	28	1.4	0.626 J		1.3	ND	5.9	3.1	0.50	ND
Dec 1999		0.71		4.0		0.49	5.9		ND		24						3.2	2.6		
Mar 2000	ND	ND	ND	66	ND	ND	40	5.7	0.44	0.73	22	1.9	0.64 J		2.2	ND	2.8	3.1	0.72	0.56
Jun 2000		0.32		2.0		ND	41		ND								2.8	3.0		
Sep 2000		0.88		1.2		0.55	9.5	9.8	ND	0.70	3.9		ND		1.7	ND	3.5	2.6	1.1	ND
Dec 2000		0.72		9.1		0.48	13		0.45			2.5					3.5	2.4		
Mar 2001	ND	0.31	ND	1.0	ND	ND	8.8	3.9	ND	0.49	9.8	3.9	0.44 J		1.4	ND	1.1	1.2	0.61	0.34
Jun 2001		ND		0.74		0.45	1.8		ND								1.8	2.3		
Sep 2001		ND		0.45		0.45	1.3	2.6	ND	ND	1.5	4.4			0.98	ND	3.4	1.2	0.49	ND
Dec 2001		0.89		1.3		0.60	2.3		0.49								2.6	2.2		
Mar 2002	ND	ND	ND	2.6	ND	0.40	0.54	3.7	0.32	0.56	2.4	8.5	0.48 J		2.6	ND	0.36	2.1	0.95	0.53
Jun 2002		ND		1.0		ND	2.1		0.41								0.78	2.4		
Sep 2002		0.35		0.67		0.48	1.3	3.0	0.40	0.72	2.5	2.3			1.5	ND	4.1	2.4	1.0	0.44
Dec 2002		0.31		2.1		ND	1.2		ND								0.71	1.3		
Mar 2003	ND	0.14	ND	2.2	0.11 J	0.22	1.4	2.0	0.78	0.40	1.5	2.1	0.33 J		1.8	0.17 J	0.47	1.4	0.82	0.52
Jun 2003		0.21		0.55		0.22	0.94	2.0	0.74			1.6					1.1	1.8		
Sep 2003		0.35		0.62		0.50	0.82	2.0	0.42	0.43	1.5	1.3			0.9	0.23 J	3.5	1.8	0.76	0.33
Dec 2003		0.26		10		0.36	1.0		0.28								0.63	1.3		
Mar 2004	ND	0.08	ND	0.84	ND	0.19	0.73	1.9	0.72	0.40	1.6	2.6	0.25 J	3.5	2.0	0.1 J	ND	1.0	0.92	0.43
Jun 2004				4.0		1.9	0.50					1.9		3.5						
Sep 2004		0.27		0.47		0.32	0.61	1.7	0.27	0.36	1.3	1.5		2.7	0.92	0.19 J	2.3	1.3		0.38
Dec 2004				0.35		0.21	0.67					2.3			ND					
Feb 2005				0.52			2.1													
Mar 2005	ND	0.15	ND	1.4	ND	0.34	1.6	1.9	0.09	0.32	1.3	1.8	0.18 J	2.9	0.90	ND	0.14	0.85	0.82	0.28
May 2005				6.0			2.3													
Jun 2005				0.61			0.43					2.2								
Aug 2005				0.94			2.3													
Sep 2005		0.33		1.8		0.48	2.9	1.6	0.29	0.30	1.3	2.2		2.6	0.68	0.15 J	2.8	1.4		0.40
Nov 2005				ND			2.2													
Dec 2005				1.6		0.46	2.4					0.23								
Jan 2006				20			1.9													
Feb 2006				0.26			1.2													
Mar 2006	ND	0.19	ND	1.8	ND	0.20	2.1	1.3	0.34	0.41	1.2	2.2	ND	2.1	0.60	ND	ND	1.2	0.49	0.34
May 2006				5.5			2.1													
Jun 2006				0.54			1.2													

Table 6-10
Site WW-1 Historical TCE Concentrations in Groundwater

Sample Date	On-Base							Off-Base (Near)			Off-Base (Mid)				Off-Base (Far)					
	MW-11	MW-12	MW-99	MW-102	MW-103	EW-3	WP-01	MW-147	MW-241	MW-242	MW-120	MW-243	MW-244	OW-2	MW-245	MW-254	MW-255	MW-256	MW-257	MW-258
Aug 2006				0.40			2.4													
Sep 2006		0.28		0.20		0.43	2.8													
Nov 2006				1.0			2.9													
Dec 2006				0.28			2.3	1.7	*ND*	0.40	1.3	1.8		2.3	0.84		*ND*	1.0		0.40
Jan 2007				2.9			3.0													
Mar 2007	*ND*	0.18	*ND*	1.8	*ND*	0.57	3.4	1.6	0.27	0.32	1.2	2.0	0.2 J	2.5	0.63	*ND*	0.16	1.1	0.61	0.33
May 2007				0.32			3.1													
Jun 2007				1.3			2.7					1.4								
Aug 2007				2.0			2.9													
Sep 2007		0.38		0.27		0.59	2.8	1.2	0.21	0.32	**15**	1.6		2.2	0.56		2.7	1.4		0.33
Oct 2007											**15**									
Nov 2007				0.31			3.4													
Dec 2007				0.17			3.1				3.4	2.2								
Feb 2008				0.18			3.1													
Mar 2008	*ND*	0.18	*ND*	2.4	*ND*	0.63	2.6	1.5	*ND*	0.26	**5.5**	2.1	*ND*	2.2	1.5	*ND*	*ND*	0.73	0.92	0.41
Apr 2008				3.2			3.0													
Jun 2008				1.0			3.2				**6.0**	1.6								
Sep 2008		0.28		0.30			2.1	1.2	0.16	*ND*	**11**	1.4		2.1	0.48		3.2	1.2		
Oct 2008				0.25			2.4													
Nov 2008				0.24			3.0													
Dec 2008				0.22			3.0				**6.6**	2.1								
Jan 2009				0.24			3.0													
Mar 2009		0.11	*ND*	2.4		0.93	2.6	1.4	0.13	0.22	**5.3**	1.7		1.9	0.39		0.13	0.68	0.89	0.25
Apr 2009				0.76			3.3													
Jun 2009				0.24			3.3				**16**	1.5								
Sep 2009				0.26			3.4				**17**	1.3		2.0	0.40		*ND*	1.1		
Dec 2009				1.4			3.2				**14**	1.9								
Mar 2010		0.21	*ND*	0.35		0.98	3.3	1.4	*ND*	0.20	3.3	1.6		1.9	0.48		0.35	0.77	0.66	0.24
Jun 2010				1.1			2.9				**12**	1.4								
Sep 2010				0.25			3.9	1.3			**20**	1.6		1.8	0.40		4.5	1.1		
Dec 2010				0.50			3.2				**16**									
Mar 2011		0.22	*ND*	**13**		1.1	3.0	0.92	0.38	0.21	**7.6**	1.5		1.2	0.42		0.22	0.65	0.57	0.20
Apr 2011				1.1			2.8													
Jun 2011				0.43			3.3				**14**						3.3			
Sep 2011				0.26			3.5	1.4			**8.1**	1.1		1.5	0.44		4.6	1.2		
Dec 2011				0.18			3.7				**24**									
Mar 2012		*ND*	*ND*	0.22 J		1.1	3.3	1.5	0.27 J	0.26 J	**19**	1.5		1.8	0.76		0.19 J	0.78	0.76	0.25 J
Jun 2012				0.33 J			3.7				**19**									
Sep 2012				*ND*			3.4	1.1			**14**	1.2		1.6	0.33 J		4.4	1		

Notes:
Concentrations reported as µg/L
MCL = 5 µg/L - exceedences highlighted **bold red**
J: concentration estimated
ND: not detected

Table 6-11
Site WW-1 Historical Vinyl Chloride Concentrations in Groundwater

Sample	On-Base							Off-Base (Near)			Off-Base (Mid)				Off-Base (Far)					
Date	MW-11	MW-12	MW-99	MW-102	MW-103	EW-3	WP-01	MW-147	MW-241	MW-242	MW-120	MW-243	MW-244	OW-2	MW-245	MW-254	MW-255	MW-256	MW-257	MW-258
Apr 1991	ND	ND	ND	ND	ND						ND									
May 1991																				
Apr 1995	ND	9	ND	ND	ND	ND		1.2			ND									
Jun 1995	ND	23	ND	ND	ND			3			ND									
Sep 1995	ND	19	ND	ND	ND	ND		1.3			ND									
Dec 1995	ND	ND	ND	1.7	ND			ND			ND									
Mar 1996	ND	ND	ND	96	ND	ND	ND	3.8	ND	ND	ND	ND	ND		ND					
Jun 1996	ND	ND	ND	40	ND	ND	7.3	1.6	ND	ND	ND	ND	ND		ND					
Sep 1996	ND	ND	ND	3.5	ND	ND	ND	3.5	ND	ND	ND	ND	ND		ND					
Oct 1996						ND														
Dec 1996	ND	ND	ND	8.5	ND	ND	ND	1.2	ND	ND	ND	ND	ND		ND					
Mar 1997	ND	32	ND	2.8	ND		ND	1	ND	ND	ND	ND	ND		ND					
Mar 1997						ND														
Jun 1997		ND		16		1.3	ND	ND	2.2	ND	ND	ND	ND		ND					
Sep 1997		ND		20		ND	7	ND	ND	ND	ND	ND	ND		ND					
Dec 1997		ND		7		ND	2	0.8	ND	ND	ND	ND	ND		ND					
Jan 1998															ND	ND	ND	ND	ND	ND
Mar 1998						ND														
Sep 1998		ND		16	2	ND	ND	3	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND
Dec 1998		ND		7		ND	1	1	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND
Mar 1999	ND	ND	ND	68 J	ND	ND	3.05 J	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Jun 1999		ND		8.5		ND	15 J		ND		ND						ND	ND	ND	
Sep 1999	ND	ND		21 J		ND					ND		ND		ND	ND	ND	ND	ND	ND
Dec 1999		ND		30		ND	ND		ND		ND						ND	ND		
Mar 2000	ND	ND	ND	158	ND	ND	1.05 J	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Jun 2000		ND		49 J		ND	ND		ND								ND	ND		
Sep 2000		ND		33		ND	1.15 J	2.2	ND	ND	ND		ND		ND	ND	ND	ND	ND	ND
Dec 2000		ND		86		ND	5.1		ND			ND					ND	ND		
Mar 2001	ND	ND	ND	173	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Jun 2001		ND		26		ND	1.7		ND								ND	ND		
Sep 2001		ND		47		ND	3.0	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND
Dec 2001		ND		3.7		ND	1.6		ND								ND	ND		
Mar 2002	ND	0.35	ND	167	ND	ND	ND	ND	ND	ND	ND	1.09	ND		ND	ND	ND	ND	ND	ND
Jun 2002		ND		71		ND	12		ND								ND	ND		
Sep 2002		ND		80		ND	15	4.5	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND
Dec 2002		ND		10		ND	3.4		ND								ND	ND		
Mar 2003	ND	ND	ND	37	ND		7.2	0.24 J	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Jun 2003		ND		32			3.0	0.39 J	ND			ND					ND	ND		
Sep 2003		ND		43		ND	11	1.09	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND
Dec 2003		0.19 J		53		ND	3.6		ND								ND	ND		
Feb 2004				52																
Mar 2004	0.53	ND	ND	62	ND	ND	1.02	ND	ND	ND	ND	0.51	ND	10	ND	ND	ND	ND	ND	ND
May 2004				77																
Jun 2004				63		0.71	0.59					0.72		18						
Sep 2004		ND		32		ND	1.65	ND	ND	ND	ND	0.13 J		9.8	ND	ND	ND	ND		ND
Nov 2004				41																
Dec 2004				3		ND	2.4					1.22								
Feb 2005				72			7.4													
Mar 2005	0.34 J	0.18 J	ND	21	ND	ND	4.4	ND	ND	ND	ND	0.35 J	ND	4.8	ND	ND	ND	ND	ND	ND
May 2005				45			3.27													
Jun 2005				26			0.75					2.42								
Aug 2005				38			8.8													
Sep 2005		0.13 J		46		ND	4.7	ND	ND	ND	ND	1.67		1.65	ND	ND	ND	ND		ND
Nov 2005				42			7.1													
Dec 2005				36		ND	5.4					0.24 J								
Feb 2006				150			4.7 J													
Mar 2006	ND	ND	ND	38	ND	ND	12	ND	ND	ND	ND	ND	ND	3.7	ND	ND	ND	ND	ND	ND
May 2006				28			8.6													
Jun 2006				28			6.5													
Aug 2006				33			2.1													
Sep 2006		ND		32		ND	2.5													
Nov 2006				66			2.3													
Dec 2006				20			1.6 J	0.34 J	ND	ND	ND	ND		2.7	ND		ND	ND		ND

Table 6-11
Site WW-1 Historical Vinyl Chloride Concentrations in Groundwater

Sample Date	On-Base							Off-Base (Near)			Off-Base (Mid)				Off-Base (Far)					
	MW-11	MW-12	MW-99	MW-102	MW-103	EW-3	WP-01	MW-147	MW-241	MW-242	MW-120	MW-243	MW-244	OW-2	MW-245	MW-254	MW-255	MW-256	MW-257	MW-258
Jan 2007				**48**			**3.1**													
Mar 2007	ND	ND	ND	**72**	ND	ND	**3**	ND	ND	ND	ND	0.2 J	ND	**2.1**	ND	ND	ND	ND	ND	ND
May 2007				**41**			**3.5**													
Jun 2007				**35**			0.68					**3**								
Aug 2007				**45**			1													
Sep 2007		ND		**43**		ND	0.88	0.21 J	ND	ND	ND	0.63 J		**8.9 J**	ND		ND	ND		ND
Oct 2007											ND									
Nov 2007				**39**			0.69													
Dec 2007				**40**			0.83				ND	ND								
Feb 2008				**12**			0.64													
Mar 2008	0.23 J	ND	ND	**4.6**	ND	ND	1.2	ND	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND
Apr 2008				**37**			0.52													
Jun 2008				**60**			0.49 J				ND	ND								
Aug 2008				**53**			0.4 J													
Sep 2008		ND		**31**		ND	0.43 J	0.14 J	ND	ND	ND	0.55		**10**	ND		ND	ND		
Nov 2008				**45**			0.44 J													
Dec 2008				**18**			0.4 J				0.16 J									
Jan 2009				**52**			0.66													
Mar 2009		0.09 J	ND	**50**		ND	0.76	ND	ND	ND	ND	ND		1.3	ND		ND	ND	ND	ND
Apr 2009				**54**			0.34 J													
Jun 2009				**19**			0.37 J				ND	0.72								
Sep 2009				**19**			ND				ND	0.54		**14**	ND		ND	ND		
Dec 2009				**3.2**			0.3 J				ND	ND								
Mar 2010		ND	ND	**28**		ND	0.35 J	ND	ND	ND	ND	ND		1.1	ND		ND	ND	ND	ND
Jun 2010				1.8			0.21 J				ND	0.55								
Sep 2010				**55**			ND	ND			ND	1.7		**4**	ND		ND	ND		
Dec 2010				1.5			0.13 J				ND									
Mar 2011		ND	ND	0.23 J		ND	0.25 J	ND	ND	ND	ND	ND		0.31 J	ND		ND	ND	ND	ND
Apr 2011				**60**			1.4													
Jun 2011				**52**			0.38 J				0.41 J						ND			
Sep 2011				**13**			0.13 J	**8.5**			0.21 J	0.17 J		1.6	ND		ND	ND		
Dec 2011				**14**			ND				ND									
Mar 2012		ND	ND	**29**		ND	ND	ND	ND	ND	ND	ND		**2.4**	ND		ND	ND	ND	ND
Jun 2012				**3**			ND				ND									
Sep 2012				**8.7**			ND	ND			ND	0.68		**12**	ND		ND	ND		

Notes:
Concentrations reported as µg/L
MCL = 2 µg/L - exceedences highlighted **bold red**
Current MTCA Method A cleanup level = 0.2 µg/L - exceedences highlighted red
J: concentration estimated
ND: not detected

Table 6-12
Site WW-1 Historical Arsenic Concentrations in Groundwater

Sample Date	On-Base			Off-Base (Near)			Off-Base (Mid)			Off-Base (Far)			
	MW-11	MW-12	MW-102	MW-147	MW-241	MW-242	MW-120	MW-243	OW-2	MW-245	MW-255	MW-256	MW-258
Sep 1999	**30.3**			5 F			*0.15*			*ND*	*ND*	3 F	
Mar 2001	**25.5**	**38.5**	**4840**	**16.5**	4.7 F		*0.15*			1.8 F	*ND*	*ND*	*ND*
Sep 2001	**24.7**	**32.6**	**122**	8.3 B	**11**		*0.15*			*ND*	*ND*	*ND*	*ND*
Mar 2002	**18.6**	**32.2**	**203**	**15.4**	9.2		1.8 F			*ND*	3.6 F	3.9 F	3.1 F
Sep 2002	**31 B**	**34.3 B**	**211 B**	**13.3**	8.8		3.7 F			1 F	3 FB	2.2 F	2.6 F
Mar 2003	**33**	**27.1**	**86.1**	**21**	**12**		6.9 F			*ND*	3.1 F	4.4 F	*ND*
Sep 2003	**34.5**	**77.8**	**171**	**17.5**	9.8		2.2 F	7.5		*ND*	1.3 F	2.5 F	1.7 F
Mar 2004	**28**	**45.1**	**103**	7.2	**66.9**	3.3 F	1.6 F	2.4 F				1.7 F	
Mar 2005	**29.49**	**95.1**	**56**	**18.8**	**79.4**	2 F	3.7 F	5.9				2.9 F	
Jun 2005					**24**								
Mar 2006	**21 F**	**27 F**	**140**	**11 F**	**15 F**	*ND*	*ND*	*ND*				4.8 F	
Mar 2007	**21 F**	**62**	**220**	8 F	**23 F**	*ND*	*ND*	*ND*				*ND*	
Mar 2008	**22**	**58**	**87**	**41**	**53 F**	*ND*	*ND*	*ND*	4.8 F			*ND*	
Mar 2009		**62**	**57**	10 F	**23**	1.7 F	1.8 F	2.7 F	1.6 F			1.6 F	
Mar 2010		**87**	**190**	9.2 J	**37**	1.8 J	2.2 J	3.5	1.9 J			1.9 J	
Mar 2011		**28**	**47**	6.7	7.1	1.6 J	1.7	2.7	1.6			1.7	
Mar 2012		**42**	**130**	**12 J**	**46**	**15 J**	**13 J**	3.5 J	1.7 J			1.5 J	
Sep 2012			**73**	**13.7**									
Nov 2012			**130**				1.5						

Notes:
Concentrations reported as µg/L
MCL = 10 µg/L - exceedences highlighted **bold red**
F: analyte detected at a concentration less than the RL, but greater than the MDL
J: concentration estimated
B: analyte detected in the associated blank as well as in the sample
ND: not detected

Table 6-13
Site PS-1 Historical Benzene Concentrations in Groundwater

Sample Date	MW-195	MW-196	MW-207	MW-208	MW-308
Jul 1993				**670**	
Oct 1993		**6.5**		**950**	
Jan 1994		ND		**160**	
Mar 1996	ND	**260**	ND	1.9	
Sep 1996	ND	**12**	ND	**7.7**	
Mar 1997	ND	**88**	ND	1.9	
Sep 1997	ND	4.0	ND	4.0	
Mar 1998	ND	ND	ND	ND	
Sep 1998		5.0		0.60	
Mar 1999	ND	0.61	ND	0.38	
Sep 1999		**5.3**		0.43	
Mar 2000	ND	ND	ND	ND	
Sep 2000		2.6		0.56	
Apr 2001	ND	ND	ND	ND	
Sep 2001		0.50		0.25	
Mar 2002	ND	0.30	ND	ND	
Sep 2002		0.39		0.25	
Apr 2003	ND	0.52	ND	ND	
Sep 2003		0.98		0.13	
Apr 2004	ND	ND	ND	ND	ND
Jun 2004	ND				ND
Oct 2004	ND	ND		ND	ND
Dec 2004	ND				ND
Apr 2005	ND	ND	ND	ND	ND
Jun 2005					
Sep 2005	ND	ND	ND	ND	ND
Dec 2005	ND				ND
Mar 2006	ND	ND	0.36	ND	ND
Jun 2006	ND				ND
Sep 2006	ND	ND		ND	ND
Dec 2006	ND				ND
Mar 2007	ND	ND		ND	ND
Jun 2007	ND				
Sep 2007	ND				
Dec 2007	ND				
Mar 2008	ND	ND		ND	ND
Jun 2008					
Sep 2008	ND				
Dec 2008	ND				
Mar 2009	ND	ND		ND	ND
Jun 2009	ND				
Mar 2010	ND				
Jun 2010	ND				
Mar 2011	ND				
Jun 2011	ND				
Mar 2012	ND				ND
Jun 2012	ND				

Notes:
Concentrations reported as µg/L
MCL: 5 µg/L - exceedences highlighted **bold red**
ND: not detected

Table 6-14
Site PS-1 Historical TCE Concentrations in Groundwater

Sample Date	MW-195	MW-196	MW-308
Sep 1998		ND	
Mar 1999			
Sep 1999			
Mar 2000	ND		
Sep 2000			
Apr 2001	0.26	ND	
Sep 2001		ND	
Mar 2002	**24.6**	ND	
Sep 2002		ND	
Apr 2003	**19**		
Sep 2003			
Apr 2004	**8.3**		
Jun 2004	**10**		
Oct 2004	**8.9**		
Dec 2004	ND		
Apr 2005	ND		
Jun 2005			
Sep 2005	4.6		
Dec 2005	ND		ND
Mar 2006	**8.7**	ND	ND
Jun 2006	**11**		0.29
Sep 2006	**7.4**	ND	0.46
Dec 2006	ND		0.19
Mar 2007	**6.7**	ND	ND
Jun 2007	**5.1**		
Sep 2007	3.0		
Dec 2007	ND		
Mar 2008	ND	ND	ND
Jun 2008	3.8		
Sep 2008	2.8		
Dec 2008	ND		
Mar 2009	2.4		ND
Jun 2009	3.7		
Mar 2010	0.13		
Jun 2010	3.0		
Mar 2011	2.3		
Jun 2011	3.2		
Mar 2012	0.17		0.5
Jun 2012	2.8		

Notes:
Concentrations reported as µg/L
MCL: 5 µg/L - exceedences highlighted **bold red**
ND: not detected

Table 6-15
Site PS-1 Historical TPH-D Concentrations in Groundwater

Sample Date	MW-195	MW-196	MW-207	MW-208	MW-308
Apr 1993				**7000**	
Jul 1993				290	
Oct 1993		ND		**4000**	
Jan 1994		ND		**3100**	
Mar 1996	ND	**3800**	ND	**5200**	
Sep 1996	ND	**1800**	ND	**4000**	
Mar 1997	ND	**1800**	ND	**1300**	
Sep 1997	ND	640	ND	**2700**	
Mar 1998	ND	1000	ND	850	
Sep 1998		750		840	
Mar 1999	ND	50	ND	129	
Sep 1999		**1310**		944	
Mar 2000	76	259	49.6	597	
Sep 2000		**1580**		**2900**	
Apr 2001	47	270	28	760	
Sep 2001		**1110**		923	
Mar 2002	ND	510	ND	740	
Sep 2002		**2300**		820	
Apr 2003	ND	**1400**	ND	ND	
Sep 2003		240		410	
Apr 2004	ND	590	ND	ND	ND
Jun 2004					ND
Oct 2004		ND		ND	ND
Dec 2004					ND
Apr 2005	ND	ND	ND	ND	ND
Jun 2005					
Sep 2005	75	217	ND	473	ND
Dec 2005	ND				ND
Mar 2006	30	130	22	220	24
Jun 2006	240				240
Sep 2006	99	ND		400	47
Dec 2006	36				ND
Mar 2007		190		210	59
Jun 2007					
Sep 2007					
Dec 2007					
Mar 2008		120		220	230
Jun 2008					
Sep 2008					
Dec 2008					
Mar 2009		ND		140	ND
Jun 2009					
Mar 2010					
Jun 2010					
Mar 2011	60				
Jun 2011					
Mar 2012	140	150	310	620	110
Jun 2012					

Notes:
Concentrations reported as µg/L
The ROD cleanup level for TPH is 1,000 µg/L - exceedences highlighted **bold red**
The current MTCA Method A cleanup level for TPH-D is 500 µg/L - exceedences highlighted red
ND: not detected

Table 6-16
Craig Road Landfill – Evaluation of Potential Vapor Intrusion Risks Under Hypothetical Future Land Uses

Well Number	TCE Groundwater Concentration (µg/L)	Calculated Indoor Air Concentration (µg/m^3)	Residential Land Use		Commercial/Industrial Land Use	
			Increased Lifetime Cancer Risk	Non-Cancer Hazard Quotient	Increased Lifetime Cancer Risk	Non-Cancer Hazard Quotient
MW-118	170	7.69	1.8E-05	3.7	2.6E-06	0.9

Notes:

The TCE groundwater concentration is from September 2012, the last sampling event evaluated for this five-year review period.

The TCE indoor air concentration was calculated from groundwater using the USEPA's Johnson and Ettinger model (EPA, 2004). Assumptions used in the modeling are discussed in Section 6.3.4.1.

Estimation of human health risks from the modeled indoor air concentration was performed using EPA's Vapor Intrusion Screening Level (VISL) tool - http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6 - using the VISL defaults.

Commercial/industrial land use is currently in place in this vicinity and is most likely to remain the same in the future. Therefore, there is no unacceptable human health risk from VI near the vicinity of offbase well MW-118.

Table 6-17
Site WW-1 – Evaluation of Potential Vapor Intrusion Risks Under Hypothetical Future Land Uses

Well Number	Chemical	Groundwater Concentration (µg/L)	Calculated Indoor Air Concentration (µg/m^3)	Residential Land Use		Commercial/Industrial Land Use	
				Increased Lifetime Cancer Risk	Non-Cancer Hazard Quotient	Increased Lifetime Cancer Risk	Non-Cancer Hazard Quotient
MW-120	TCE	14	1.8	4.1E-06	0.8	5.9E-07	0.2
OW-2	Vinyl chloride	12	6.8	4.2E-05	0.1	2.5E-06	0.02
			Combined Risks	4.6E-05	0.9	3.1E-06	0.2

Notes:

The TCE and vinyl chloride groundwater concentrations are from September 2012, the last sampling event evaluated for this five-year review.

The TCE and vinyl chloride indoor air concentrations were calculated from groundwater using the USEPA's Johnson and Ettinger model (EPA, 2004). Assumptions used in the modeling are discussed in Section 6.3.4.2.

Estimation of human health risks from the modeled indoor air concentration was performed using EPA's Vapor Intrusion Screening Level (VISL) tool - http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6 - using the VISL defaults.

There is no unacceptable human health risk from VI in the vicinity of off-site wells MW-120 and OW-2 under all future land uses evaluated.

Figures

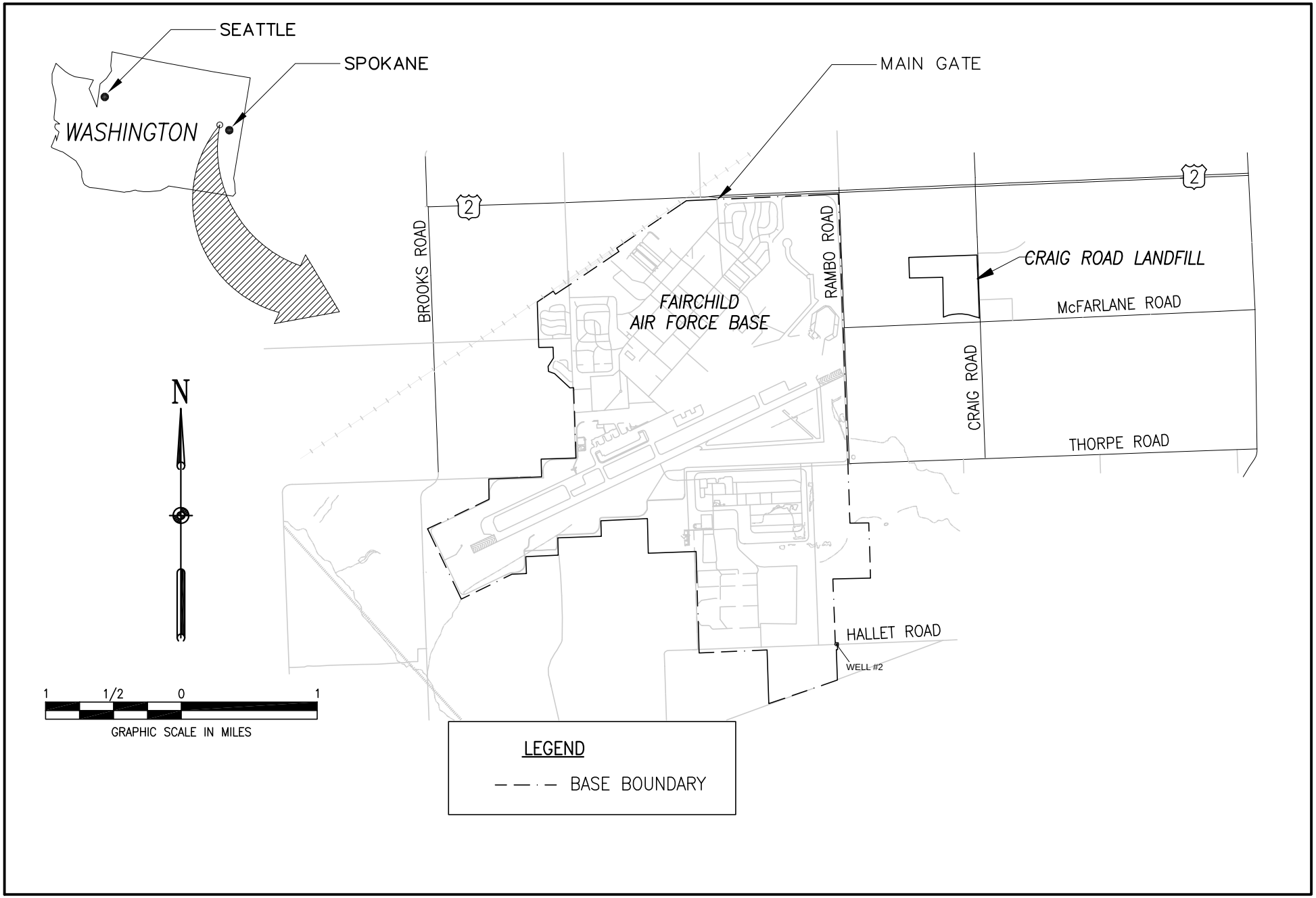
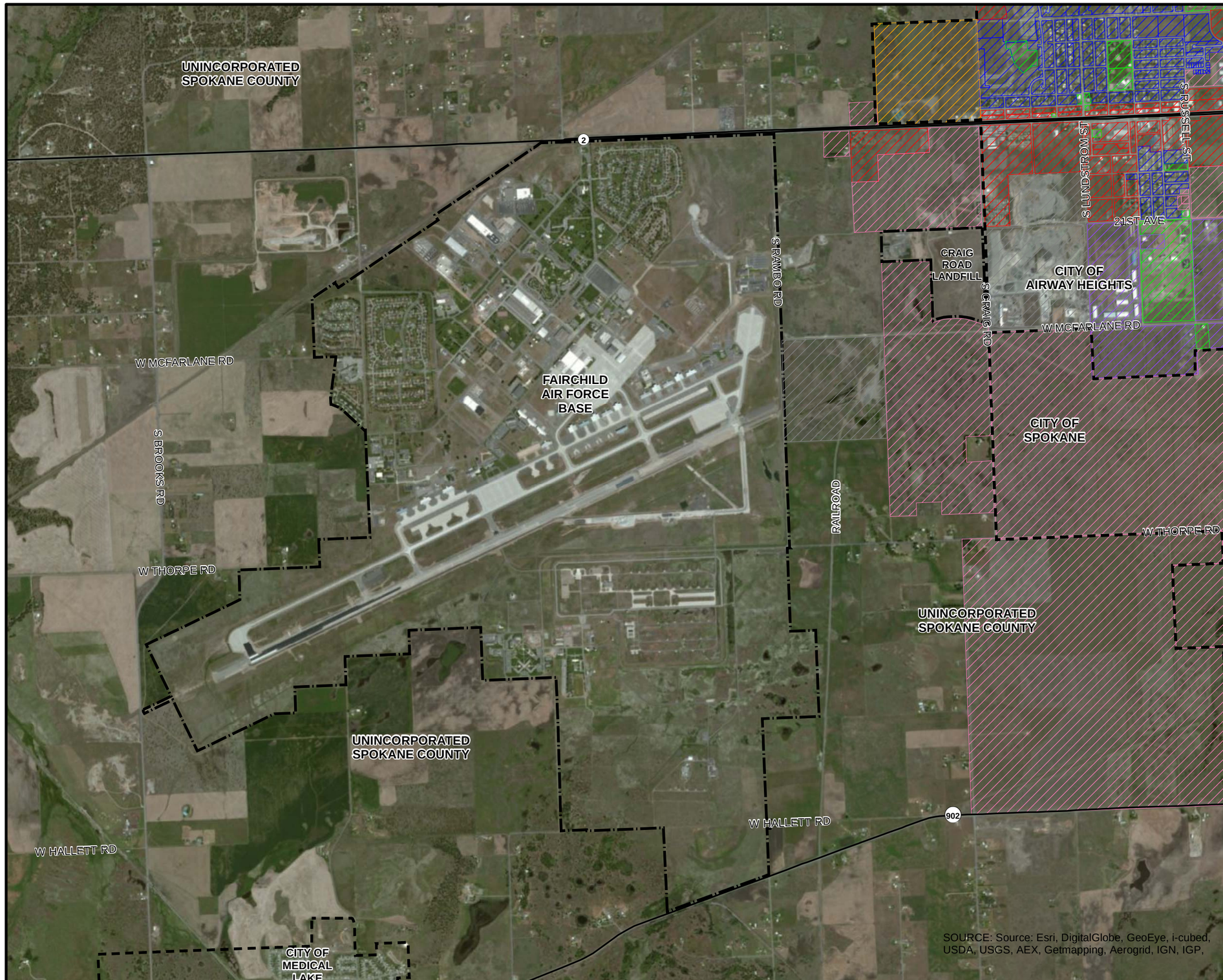


Figure 1-1: Fairchild Air Force Base Location



LEGEND

- MUNICIPAL BOUNDARY
- USAF PROPERTY BOUNDARY
- HIGHWAY

ZONING[a]

- RESIDENTIAL
- COMMERCIAL
- LIGHT INDUSTRIAL
- HEAVY INDUSTRIAL
- RECREATIONAL, OPEN SPACE, PUBLIC
- TRIBAL LANDS
- MINING

ALL OTHER AREAS OUTSIDE USAF PROPERTY BOUNDARIES AND OUTSIDE MUNICIPAL BOUNDARIES LIE WITHIN UNINCORPORATED SPOKANE COUNTY AND ARE ZONED RURAL TRADITIONAL

[a]CITY OF AIRWAY HEIGHTS ZONING DATA PROVIDED BY CITY OF AIRWAY HEIGHTS PLANNING DEPARTMENT.

CITY OF SPOKANE ZONING DATA DOWNLOADED FROM http://www.spokanecity.org/services/gis/data/.

ZONING DATA PRESENTED FOR UNICORPORATED AREAS OF SPOKANE COUNTY WAS DIGITIZED FROM THE SPOKANE COUNTY BUILDING AND PLANNING MAP DOWNLOADED FROM http://www.spokanecounty.org/bp/content.aspx?c=2299.

0 2,500 5,000 Feet

N

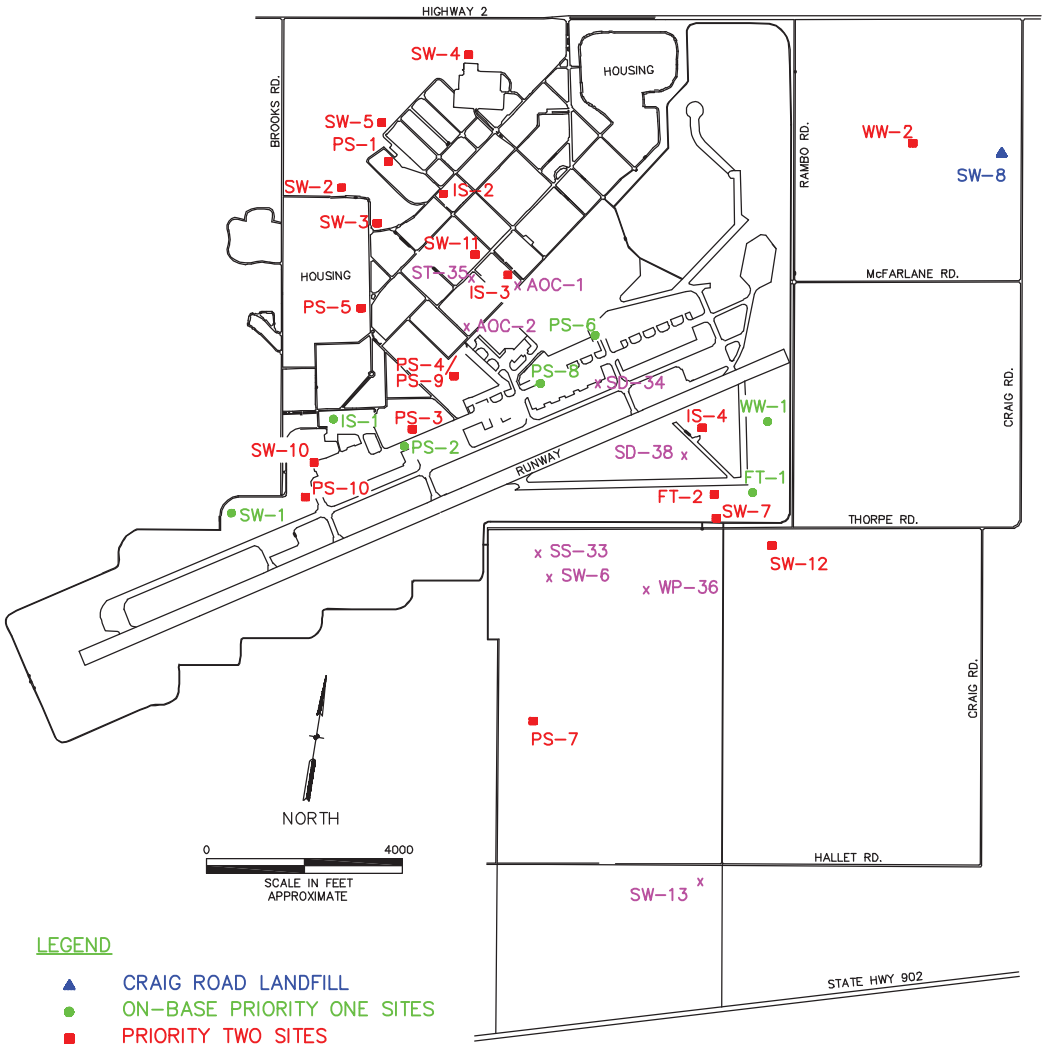
FIGURE 1-2
FAIRCHILD AFB VICINITY AND ZONING

FAIRCHILD AIR FORCE BASE, WASHINGTON

CH2MHILL

O:\AFCEE\COMMONFILES\FAIRCHILDAFB\MAPFILES\BY.FC.BJ.01\FIG01_03_ZONING.MXD 6/13/2013 8:38:04 AM FELHADID

\\bbh\proj\AFCEE\187568\FiveYearReview\CAD\fig01-2-5yr.dwg plotdate: 11-21-05



BASE CODE	(AF CODE)	SITE NAME
SW-8	(LF 002)	CRAIG ROAD LANDFILL
SW-1	(LF 001)	OLD BASE LANDFILL
PS-2	(SS 018)	REFUELING PIT AREA
PS-8	(SS 026)	UNDERGROUND FUEL LINE AREA
FT-1	(FT 004)	FORMER FIRE TRAINING AREA
WW-1	(WP 003)	INDUSTRIAL WASTEWATER LAGOONS
IS-1	(SD 005)	FRENCH DRAIN SYSTEM
PS-6	(SS 027)	DEFUELING TANK AREA
IS-3	(OT 016)	RECIPROCATING ENGINE TEST CELL
IS-4	(OT 017)	JET ENGINE TEST CELL
PS-1	(ST 006)	POL BULK STORAGE AREA
PS-5	(SS 009)	HEATING OIL TANK AREA
PS-7	(ST 010)	FUEL OIL STORAGE TANKS
PS-10	(SD 031)	FUEL TRUCK MAINTENANCE
FT-2	(FT 032)	OLD FIRE TRAINING AREA
SW-11	(DP 013)	DISPOSAL AREA AT WARRIOR PARK
IS-2	(SS 030)	CIVIL ENGINEERING STORAGE FACILITY
PS-3	(SS 007)	AREA C PUMPHOUSE
PS-4/PS-9	(SS 008)	AIRCRAFT CRASH SITE
SW-2	(DP 020)	WASTE DISPOSAL AREA
SW-3	(DP 021)	WASTE DISPOSAL AREA
SW-4	(DP 022)	FORMER BULK COAL STORAGE AREA
SW-5	(OT 023)	INCINERATOR AT DRMO YARD
SW-7	(DP 024)	ASPHALT SOUTH OF TAXIWAY K
SW-9	(RW 025)	RADIOACTIVE WASTE DISPOSAL
SW-10	(DP 012)	DISPOSAL AREA NEAR WANG TEST CELL
SW-12	(DP 014)	DISPOSAL AREA EAST OF WSA
WW-2	(WP 029)	WASTEWATER TREATMENT PLANT
AOC-1	(AOC 01)	VEHICLE MAINTENANCE FACILITY, BLDG. 2115
AOC-2	(AOC 02)	PROPULSION SHOP, BLDG. 2163
SW-6	(RW 011)	WEAPONS STORAGE AREA, RADIOACTIVE WASTE DISPOSAL AREAS
SW-13	(OT 015)	EOD RANGE
SS-33	(SS 033)	WASTE STORAGE AREA IN WSA, BLDG 1419
SD-34	(SD 034)	WASTE FUEL OPERATIONS BLDG. 1012
ST-35	(ST 035)	FUEL TRANSFER FACILITY, BLDG. 2165
WP-36	(WP 036)	HOLDING LAGOON AND IMHOFF TANK
SD-37	(SD 037)	BASEWIDE OIL/WATER SEPERATORS
SD-38	(SD 038)	BASEWIDE DITCHES, PIPING, AND CULVERTS
SS-39	(SS 039)	TCE ORPHAN PLUMES

LEGEND

- ▲ CRAIG ROAD LANDFILL
- ● ON-BASE PRIORITY ONE SITES
- ■ PRIORITY TWO SITES
- x PRIORITY THREE SITES

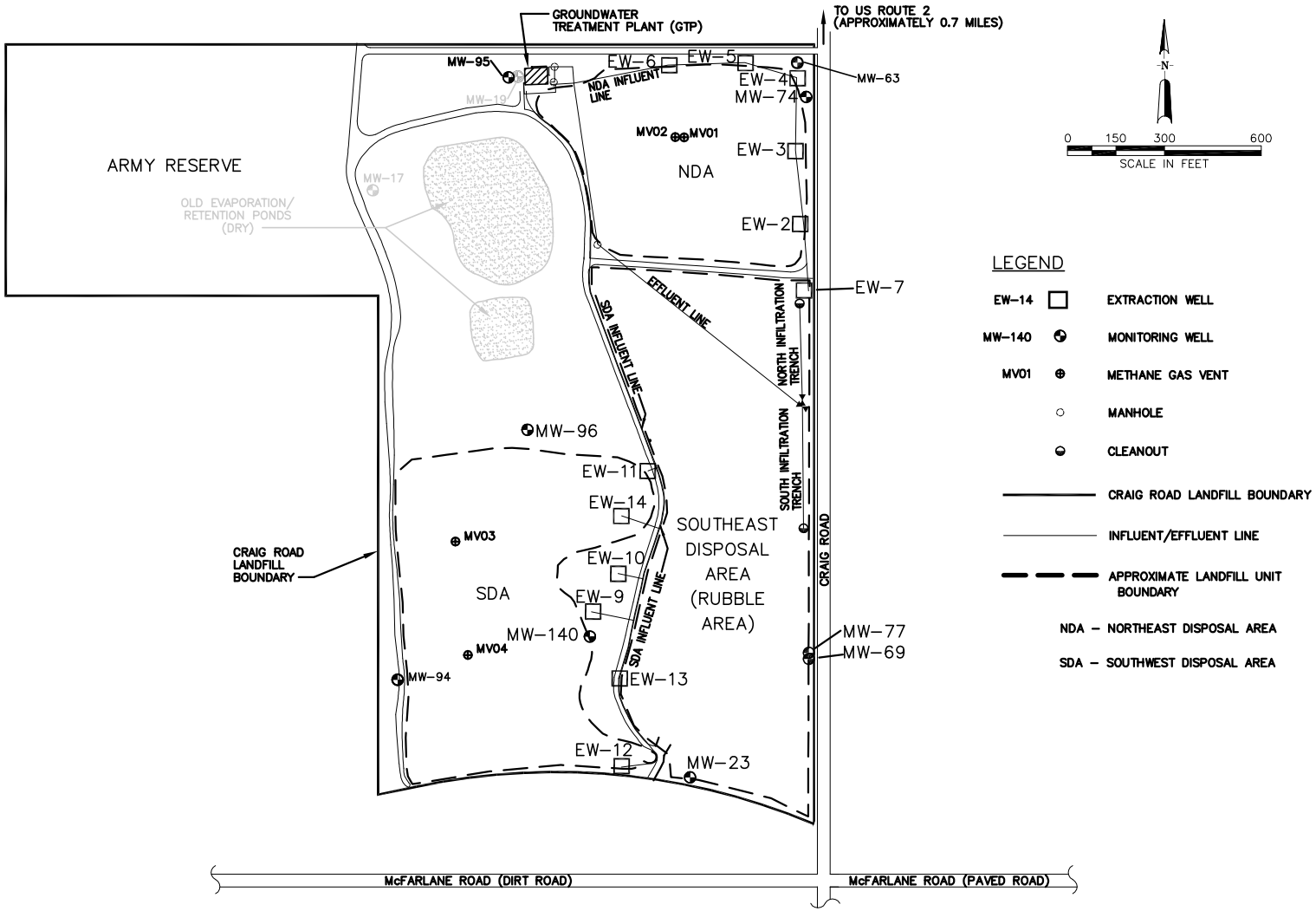
NOTES: SD-37 AND SS-39 ARE BASEWIDE AND THIER LOCATIONS ARE NOT SHOWN.

IRP = INSTALLATION RESTORATION PROGRAM

SOURCE: FAIRCHILD AFB CIVIL ENGINEERING SQUADRON

Figure 1-3: Fairchild Air Force Base IRP Sites

\\bbh\proj\AFCEE\3821665BasePBC\CAD\2010\fig2-12_4Qtr09.dwg plotdate: 04-02-2010



ADAPTED FROM HENSEL-PHELPS (FEBRUARY 1996)

Figure 3-1a: Craig Road Landfill, Site SW-8 (LF002)

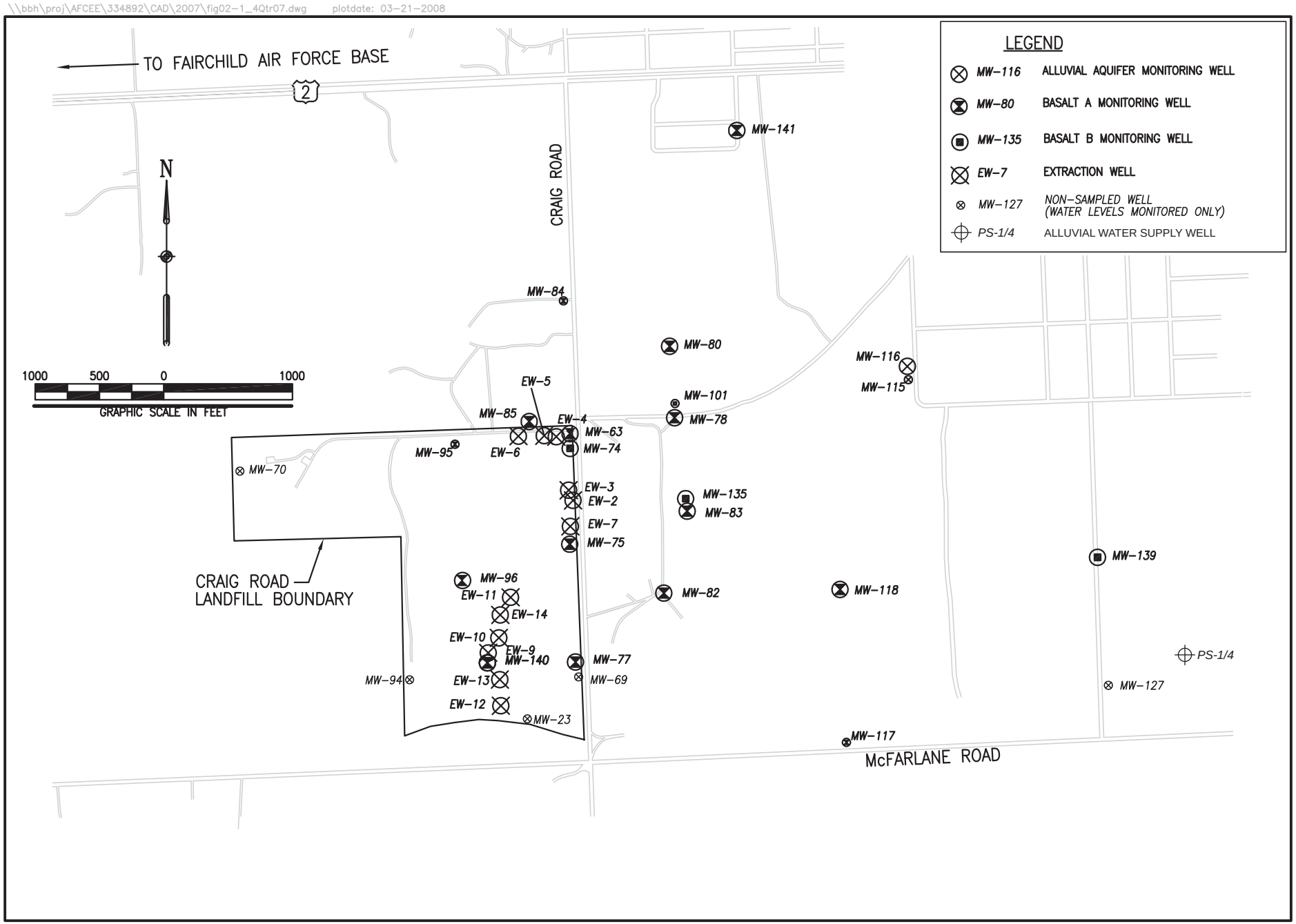
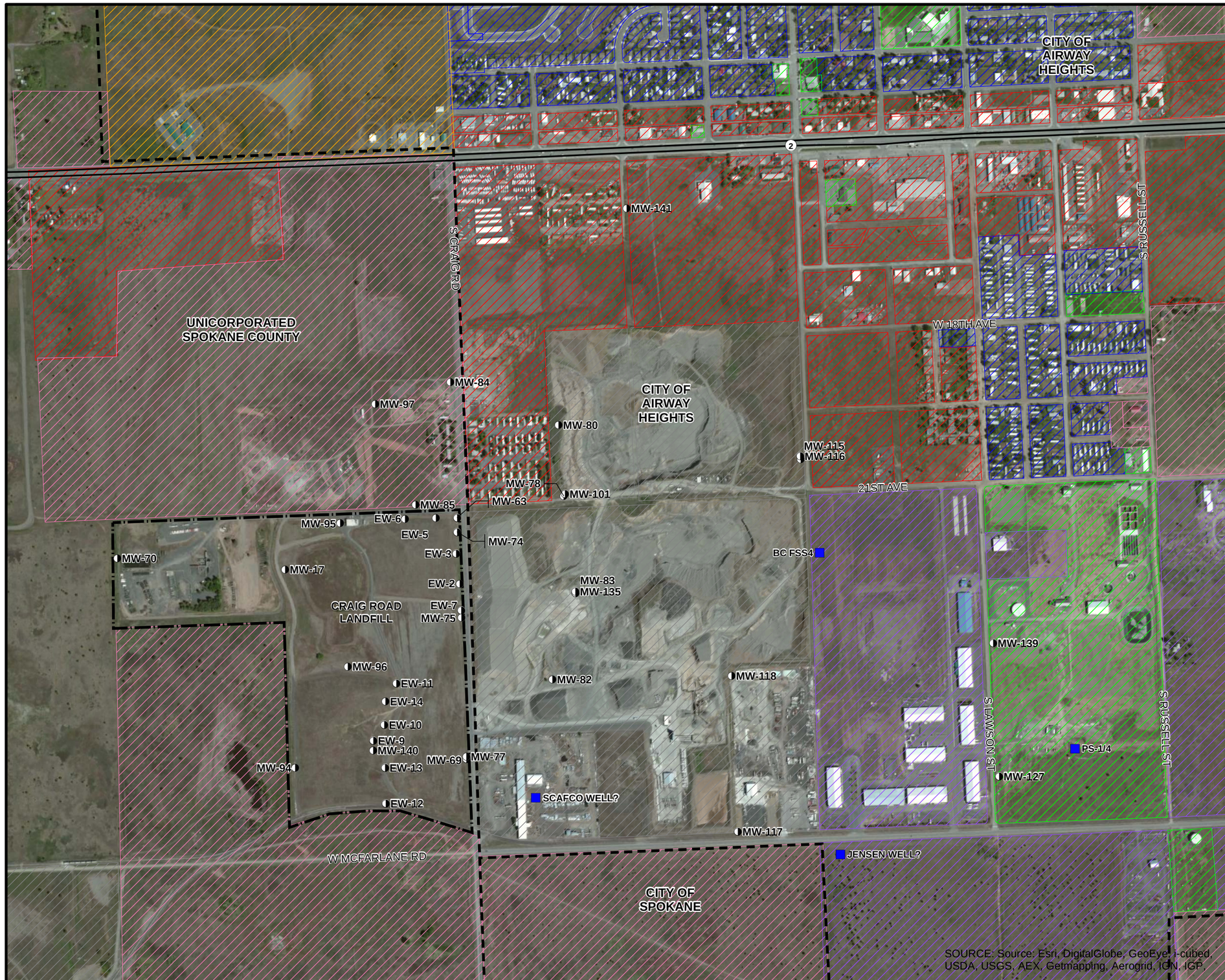


Figure 3-1b: Craig Road Landfill and Vicinity



SOURCE: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP,

LEGEND

- MONITORING WELL
- WATER SUPPLY WELL
- MUNICIPAL BOUNDARY
- USAF PROPERTY BOUNDARY
- HIGHWAY

ZONING

- RESIDENTIAL
- COMMERCIAL
- LIGHT INDUSTRIAL
- HEAVY INDUSTRIAL
- RECREATIONAL, OPEN SPACE, PUBLIC
- TRIBAL LANDS
- MINING

OTHER AREAS OUTSIDE USAF PROPERTY BOUNDARIES AND OUTSIDE MUNICIPAL BOUNDARIES LIE WITHIN UNINCORPORATED SPOKANE COUNTY AND ARE ZONED RURAL TRADITIONAL

[a]CITY OF AIRWAY HEIGHTS ZONING DATA PROVIDED BY CITY OF AIRWAY HEIGHTS PLANNING DEPARTMENT.

CITY OF SPOKANE ZONING DATA DOWNLOADED FROM http://www.spokanecity.org/services/gis/data/.

ZONING DATA PRESENTED FOR UNICORPORATED AREAS OF SPOKANE COUNTY WAS DIGITIZED FROM THE SPOKANE COUNTY BUILDING AND PLANNING MAP DOWNLOADED FROM http://www.spokanecounty.org/bp/content.aspx?c=2299.

0 750 1,500 Feet

N

FIGURE 3-1C
CRAIG ROAD LANDFILL VICINITY AND ZONING

FAIRCHILD AIR FORCE BASE, WASHINGTON

CH2MHILL

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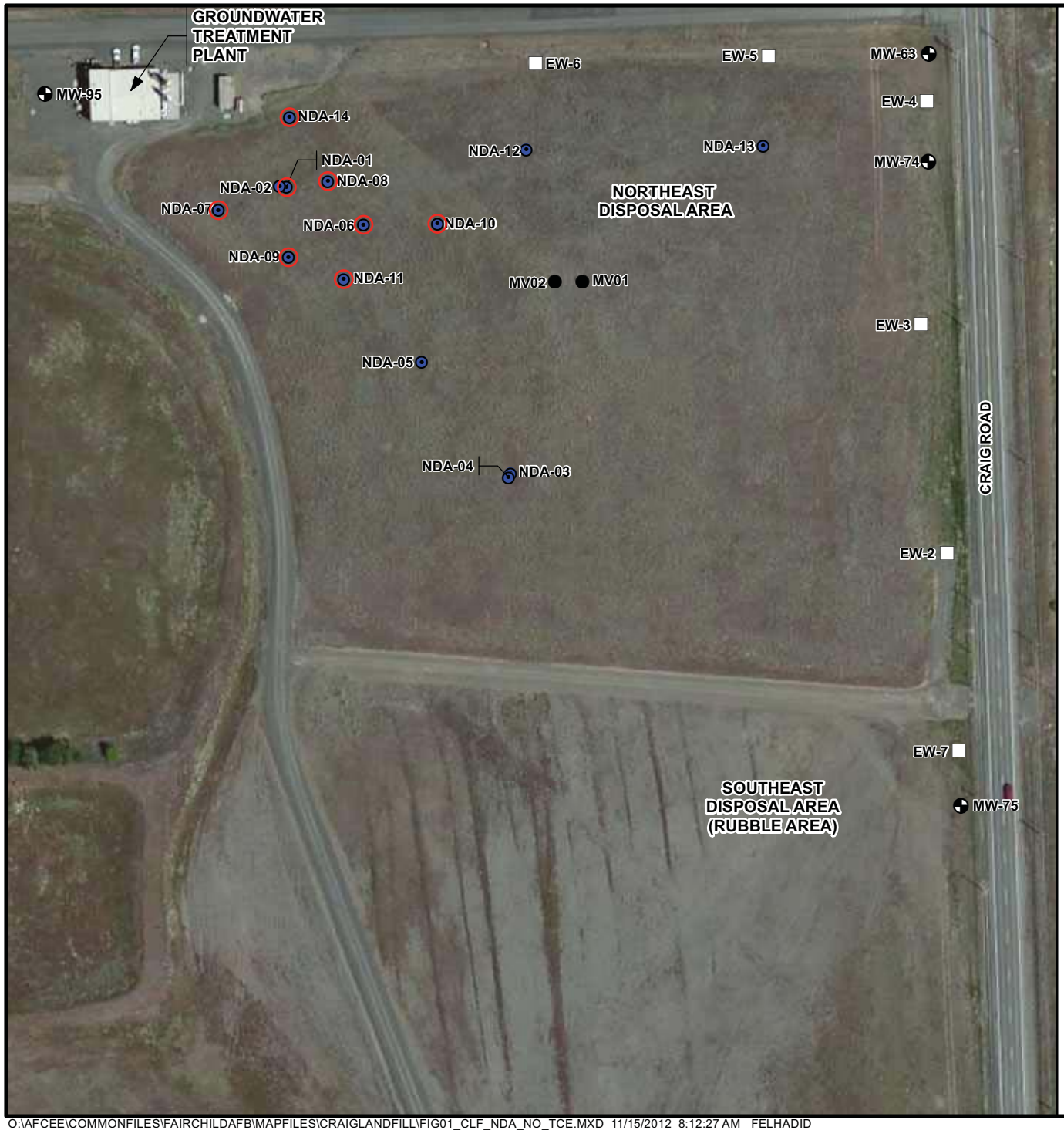


LEGEND

- REMEDIATION WELL
- GROUNDWATER EXTRACTION WELL
- MONITORING WELL
- PASSIVE METHANE GAS VENT
- ISCO INJECTION WELL (OCTOBER 2012)

NOTE:

SOURCE OF AERIAL PHOTOGRAPHY:
(c) 2010 MICROSOFT CORPORATION AND
ITS DATA SUPPLIERS (ESRI, I-CUBED, USDA FSA,
USGS, AEX, GEOEYE, AEROGRID, GETMAPPING, IGP).

N

0 150 300 FEET

FIGURE 3-1d
CRAIG ROAD LANDFILL
NORTHEAST DISPOSAL AREA
FAIRCHILD AIR FORCE BASE, WASHINGTON

CH2MHILL

O:\AFCEE\COMMONFILES\FAIRCHILDAFB\MAPFILES\CRAIGLANDFILL\FIG01_CLF_NDA_NO_TCE.MXD 11/15/2012 8:12:27 AM FELHADID

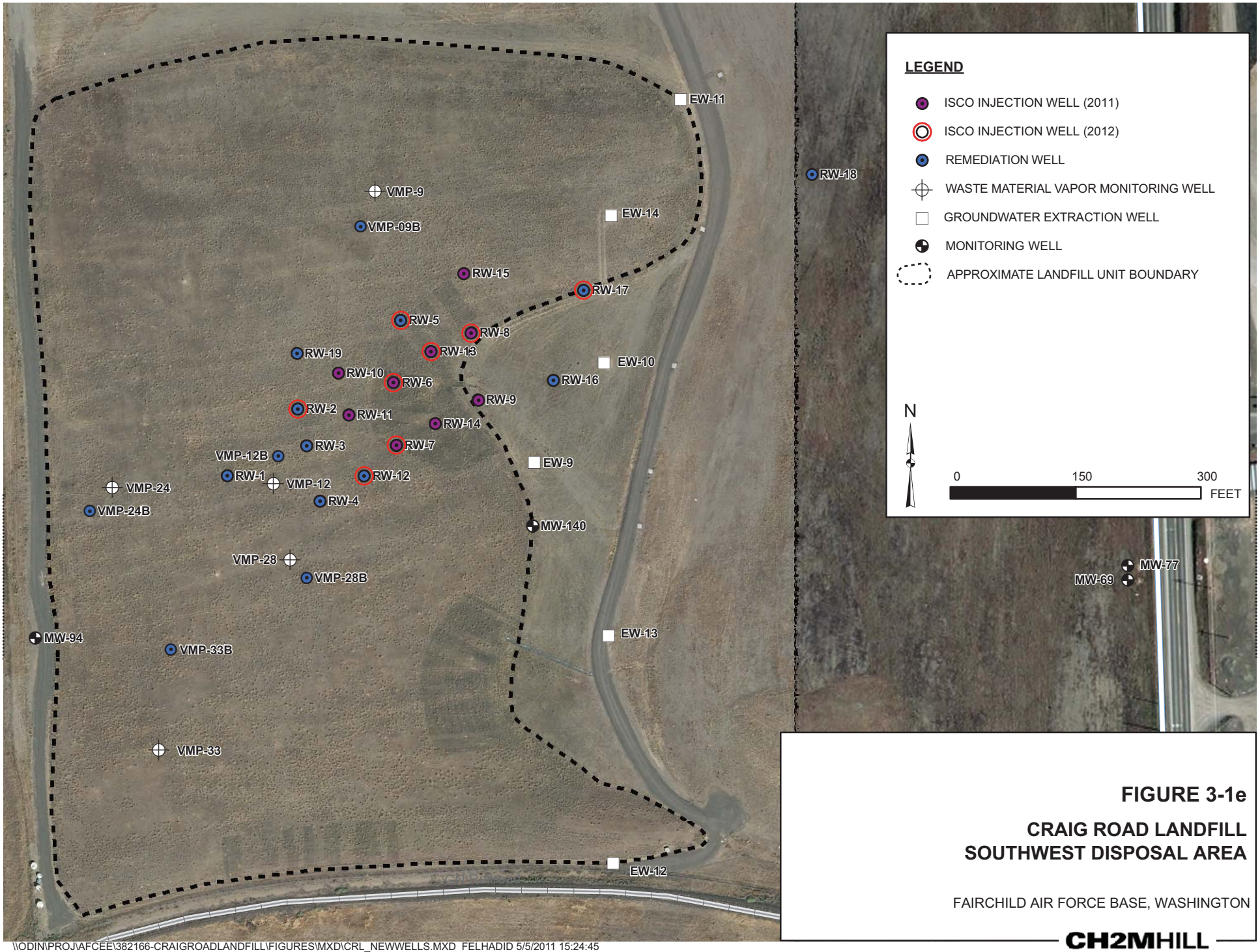


FIGURE 3-1e

CRAIG ROAD LANDFILL
SOUTHWEST DISPOSAL AREA

FAIRCHILD AIR FORCE BASE, WASHINGTON

CH2MHILL

\\ODIN\PROJ\AFCEE\382166-CRAIGROADLANDFILL\FIGURES\MXD\CRL_NEWWELLS.MXD FELHADID 5/5/2011 15:24:45

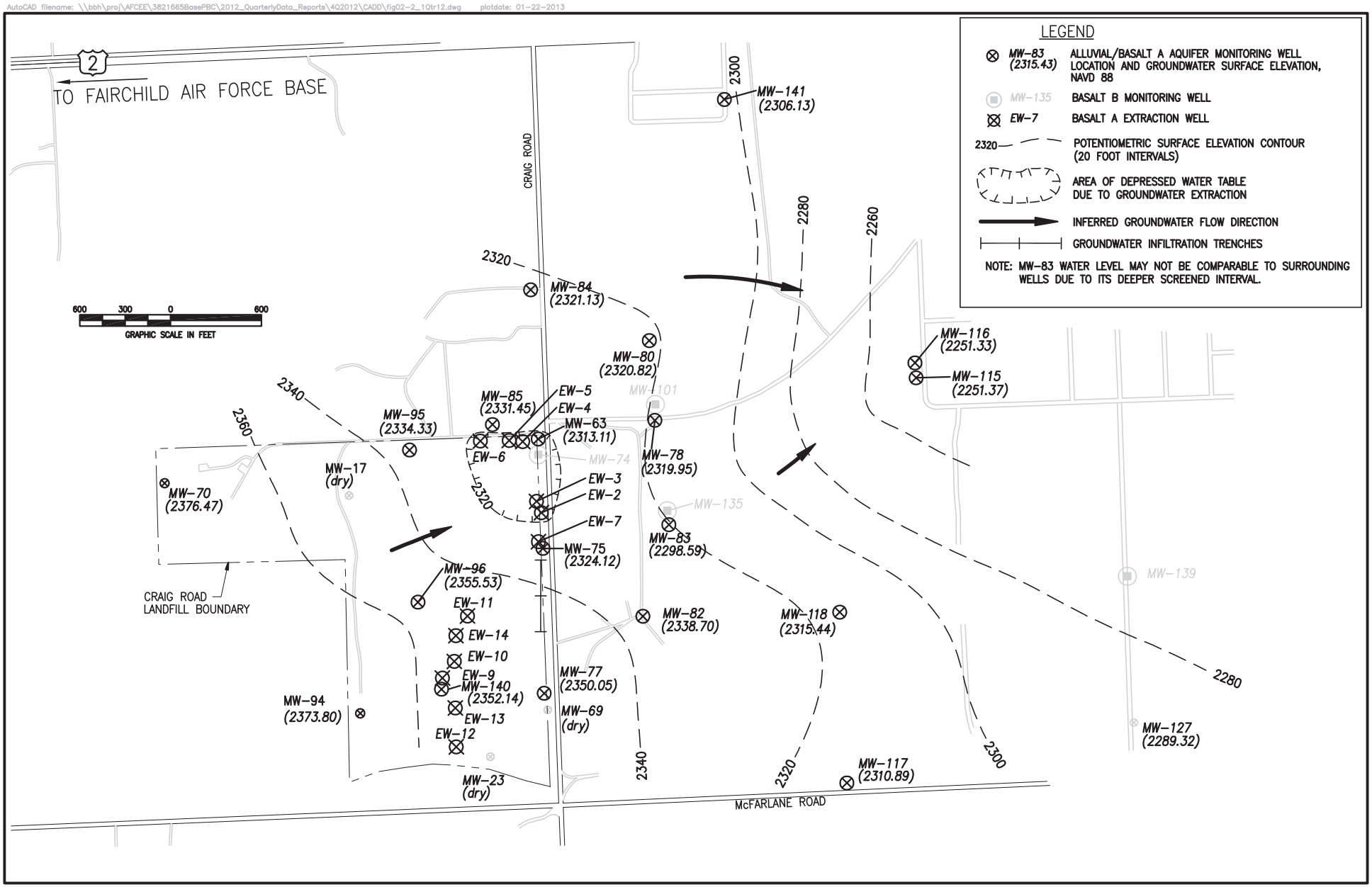
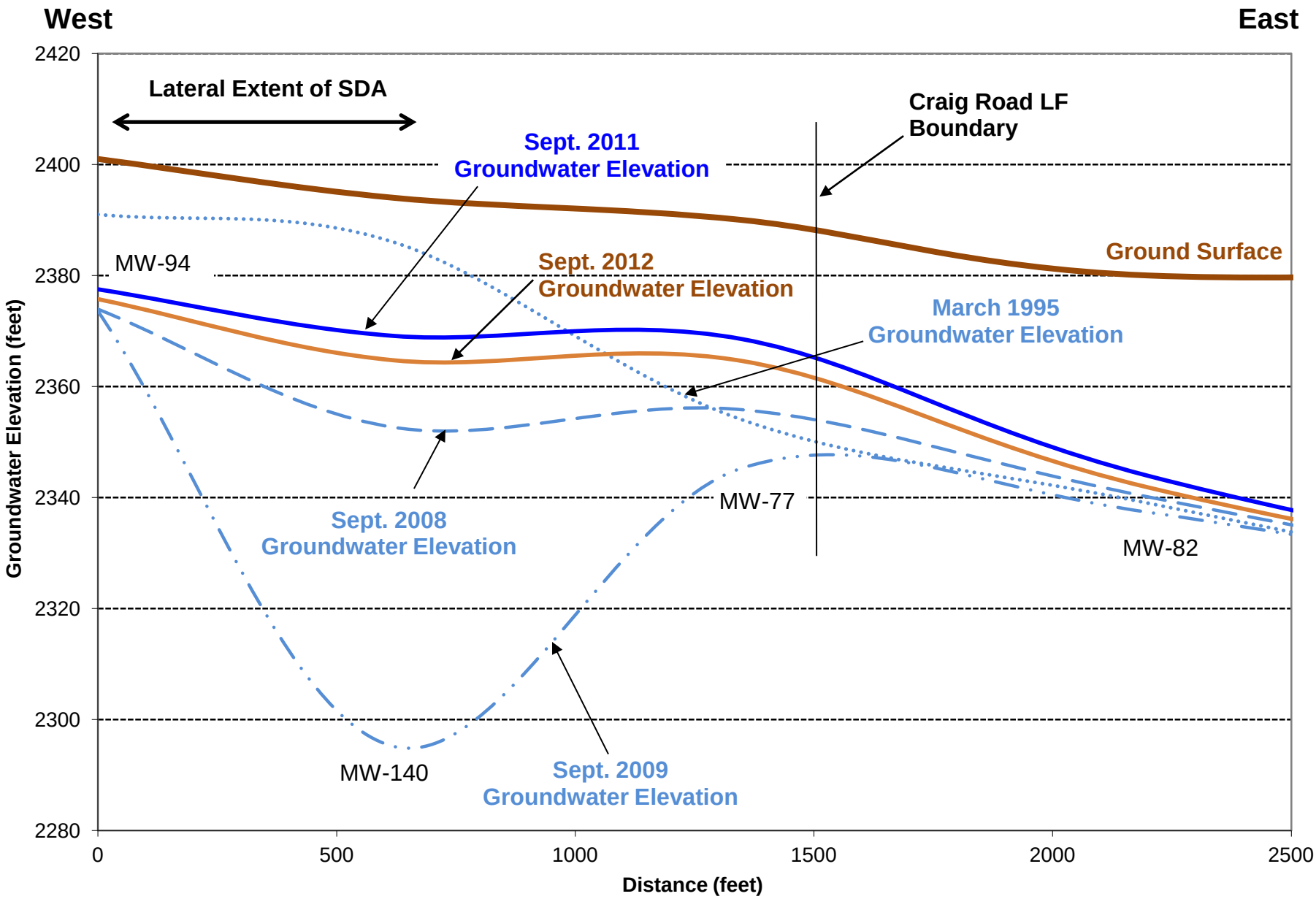


Figure 3-1f: Craig Road Landfill Potentiometric Groundwater Elevations - Alluvial/Basalt A Aquifer, March 2012

Figure 3-1g. Craig Road Landfill Southwest Disposal Area Groundwater Elevation Cross-Section



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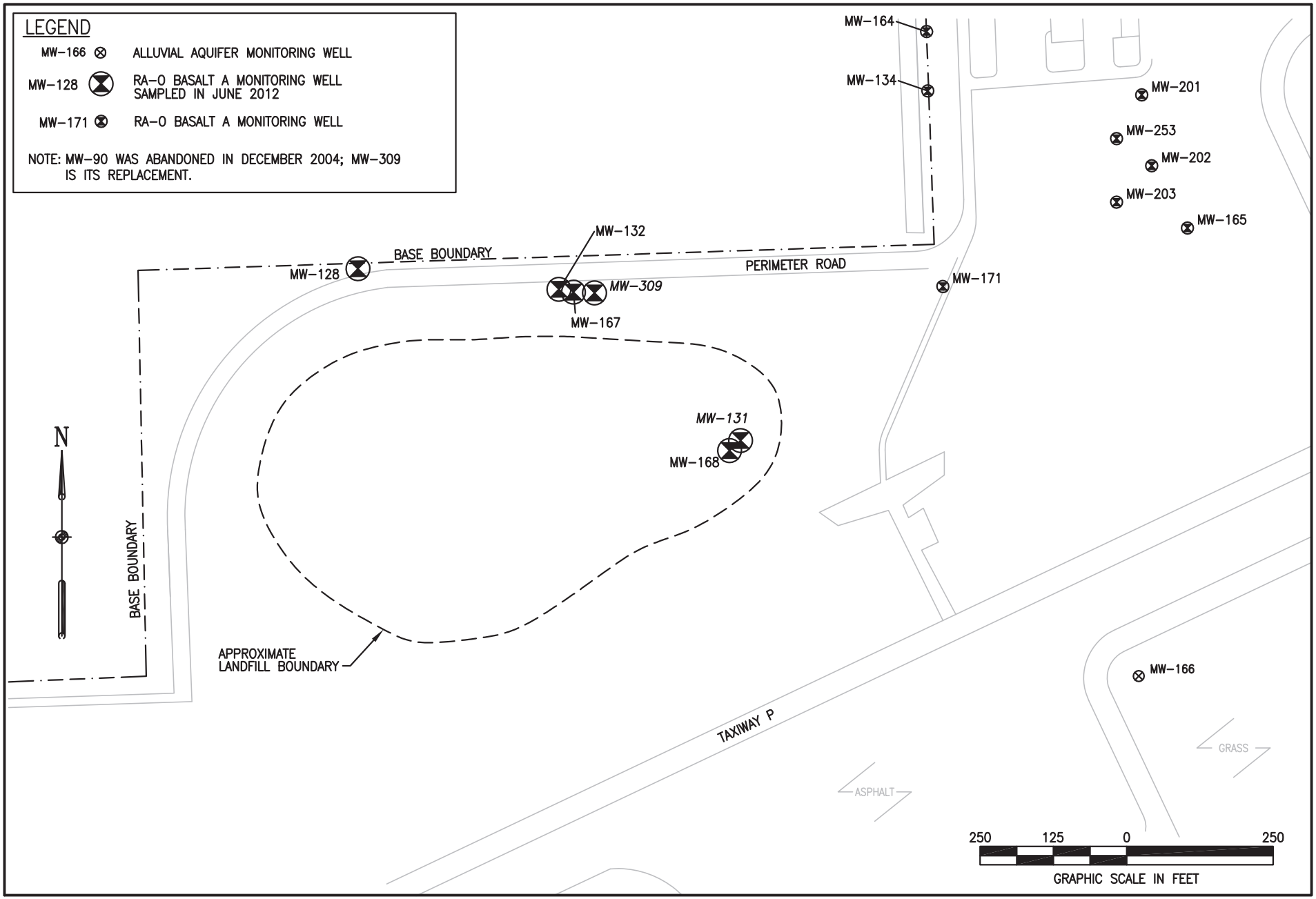

Figure 3-2a: Site SW-1 (LF001) – Old Base Landfill

\\bbh\proj\AFCEE\3821665BasePBC\2012_QuarterlyData_Reports\4Q2012\CADD\fig03-2_2Qtr12.dwg plotdate: 01-22-2013

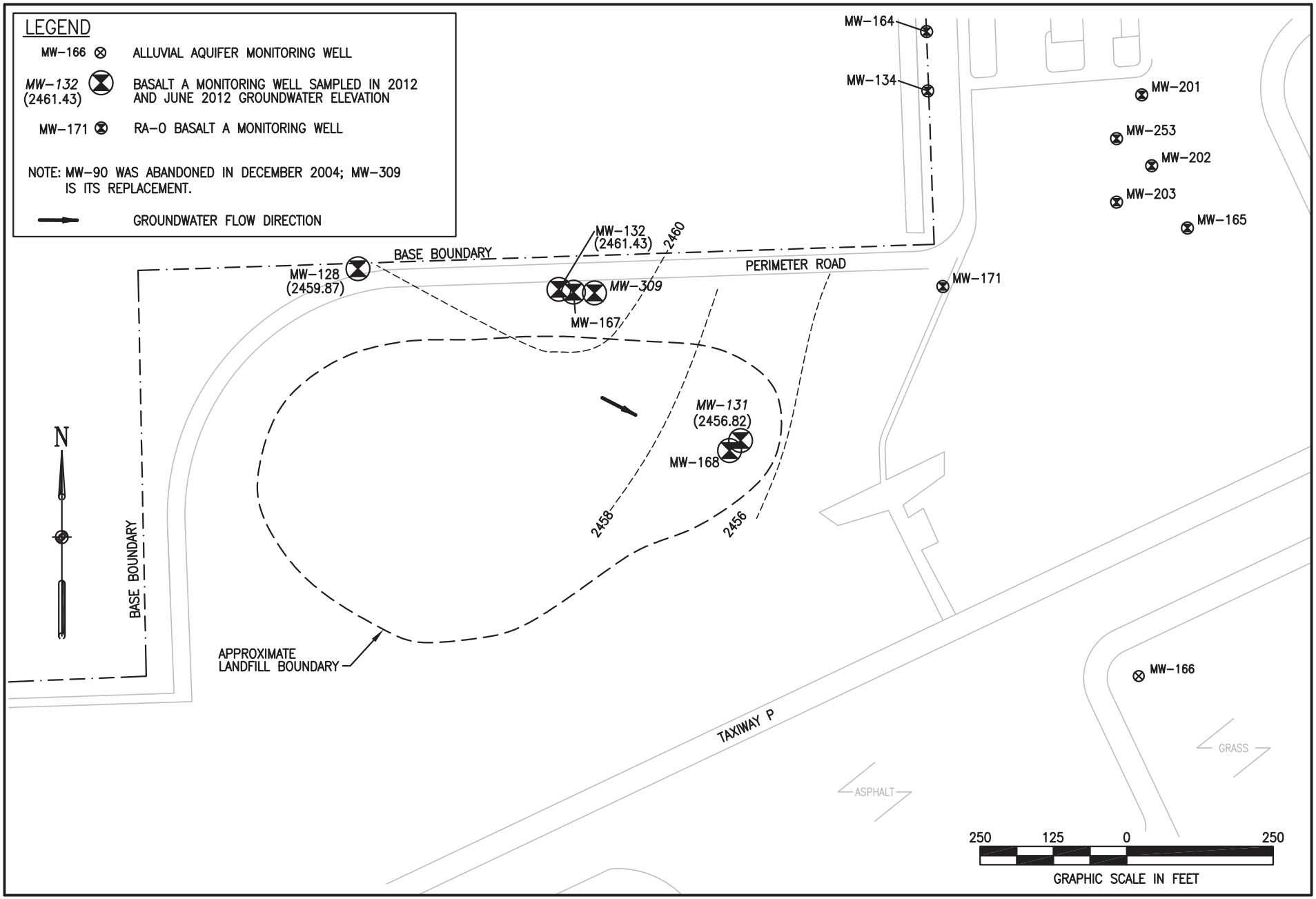

Figure 3-2b: Site SW-1 Potentiometric Groundwater Elevations, June 2012

\\bbh\proj\AFCEE\3821665BasePBC\CAD\2010\fig04-1_4Qtr09.dwg plotdate: 04-02-2010 revised: 11-01-2012

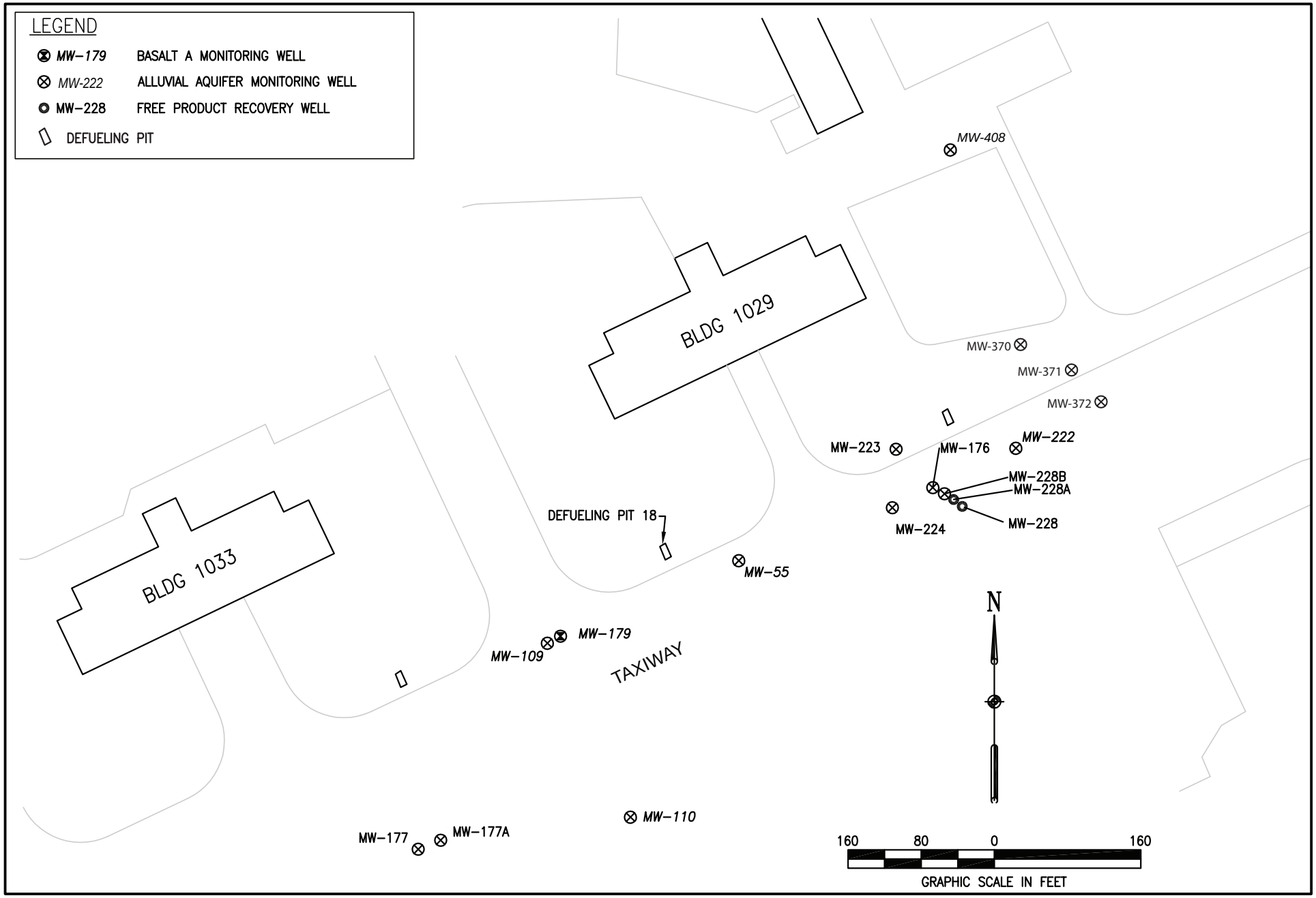

Figure 3-3a: Site PS-2 (SS018) – Refueling Pit Area

AutoCAD filename: \\bbh\proj\AFCEE\3821665BasePBC\2012_QuarterlyData_Reports\4Q2012\CADD\fig04-2_1Qtr12.dwg plotdate: 01-23-2013

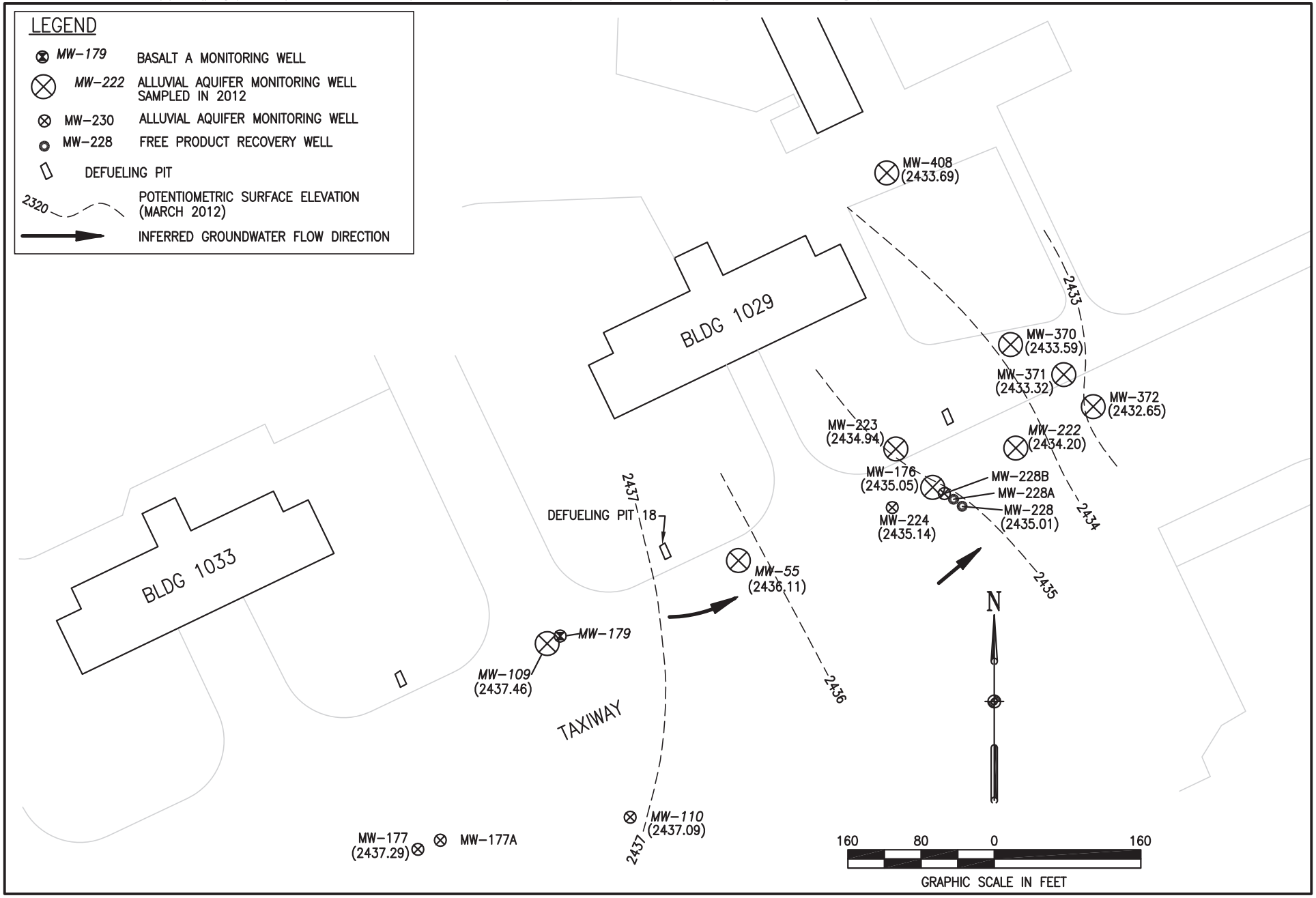

Figure 3-3b: Site PS-2 Potentiometric Groundwater Elevations, March 2012

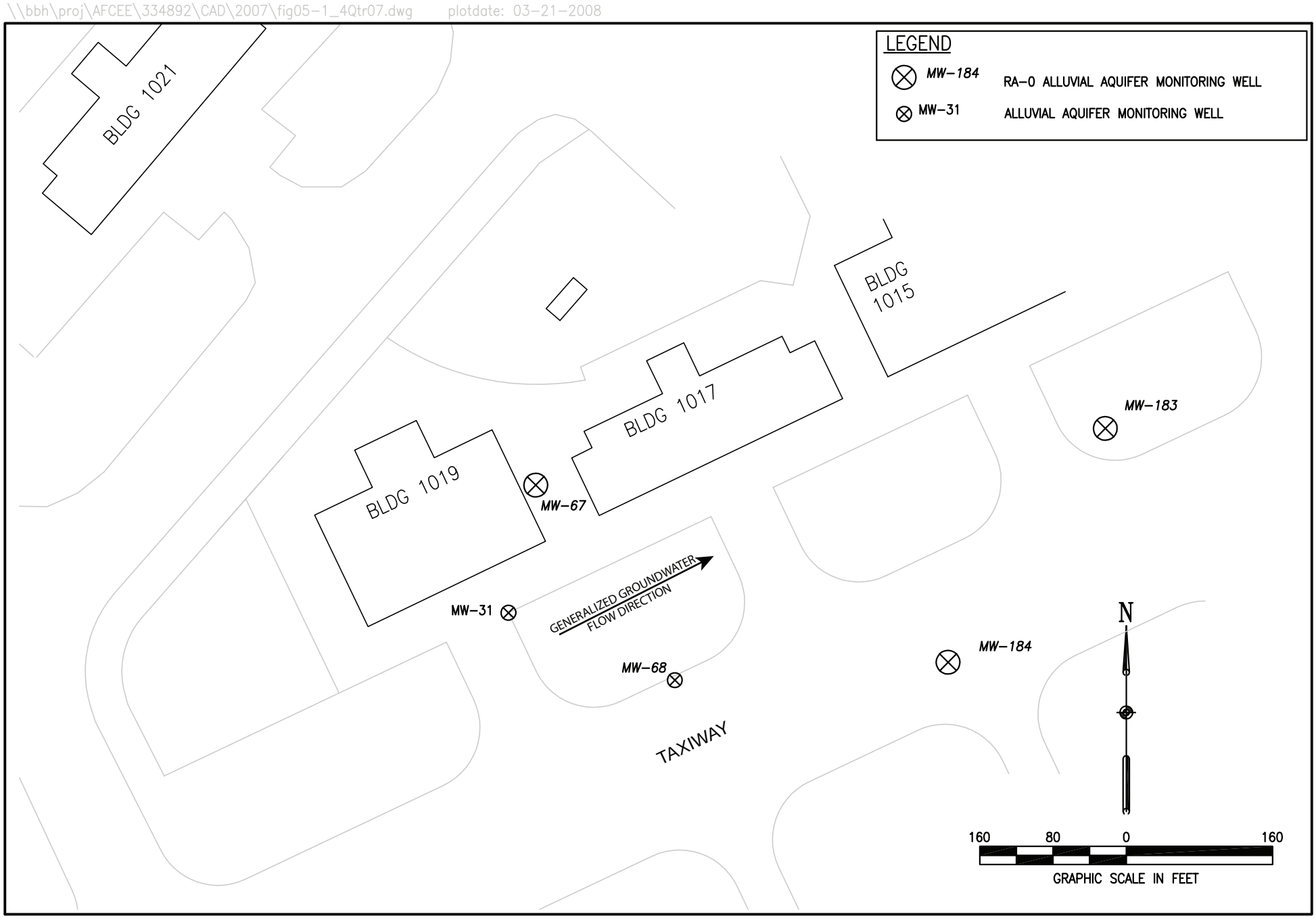

Figure 3-4a: Site PS-8 (SS026) – Underground Fuel Line Area

\\bbh\proj\AFCEE\3821665BasePBC\2012_QuarterlyDataReports\4Q2012\CADD\fig05-2_4Qtr12.dwg plotdate: 03-20-2013

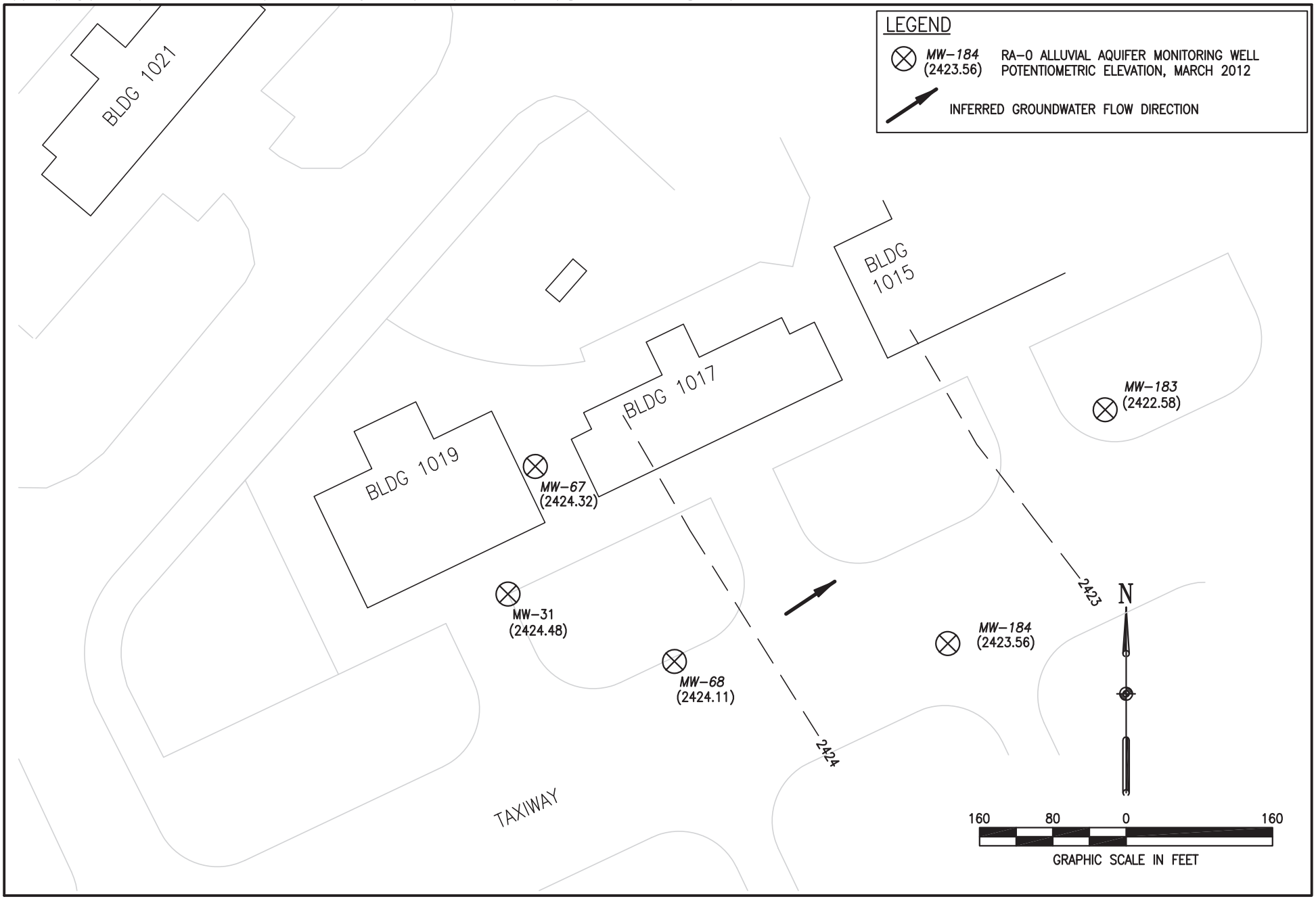

Figure 3-4b: Site PS-8 Potentiometric Groundwater Elevations, March 2012

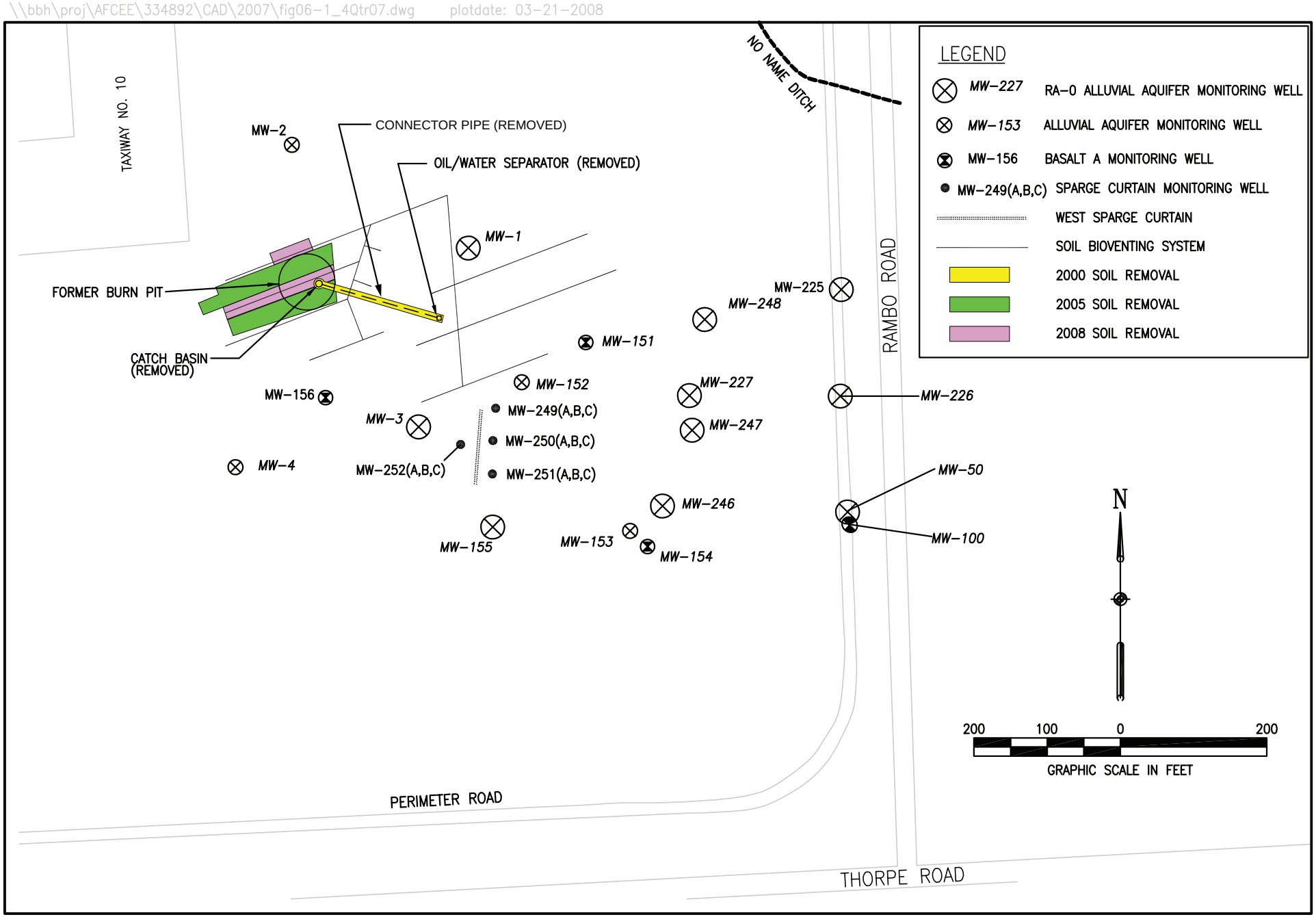

Figure 3-5a: Site FT-1 (FT004) – Former Fire Training Area

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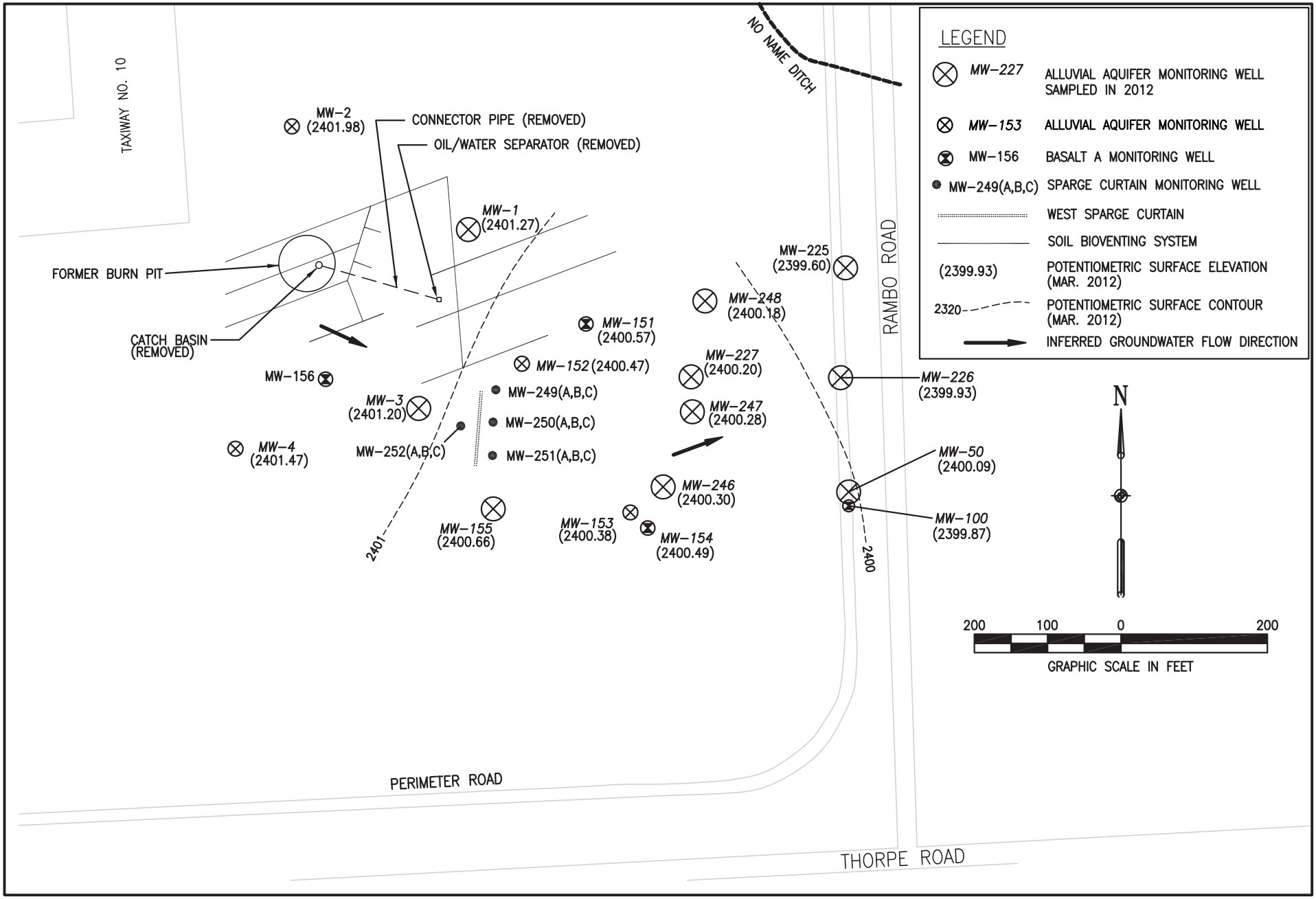


Figure 3-5b: Site FT-1 Potentiometric Groundwater Elevations, March 2012

Autocad filename:\\bbh\proj\AFCEE\433614FAFB5YRReview\Report\CADD\Figure3-8.dwg plotdate: 4/29/2013

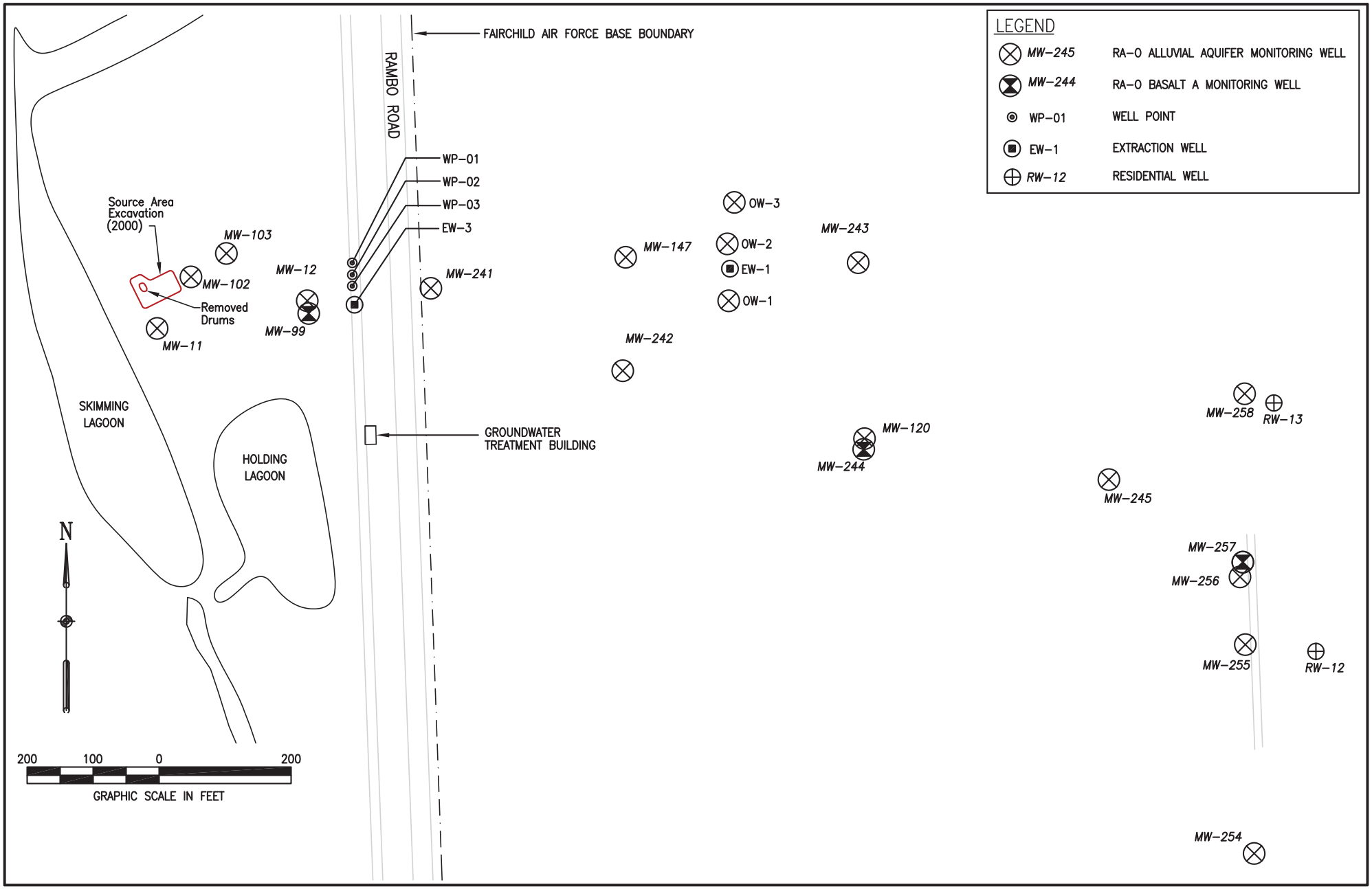
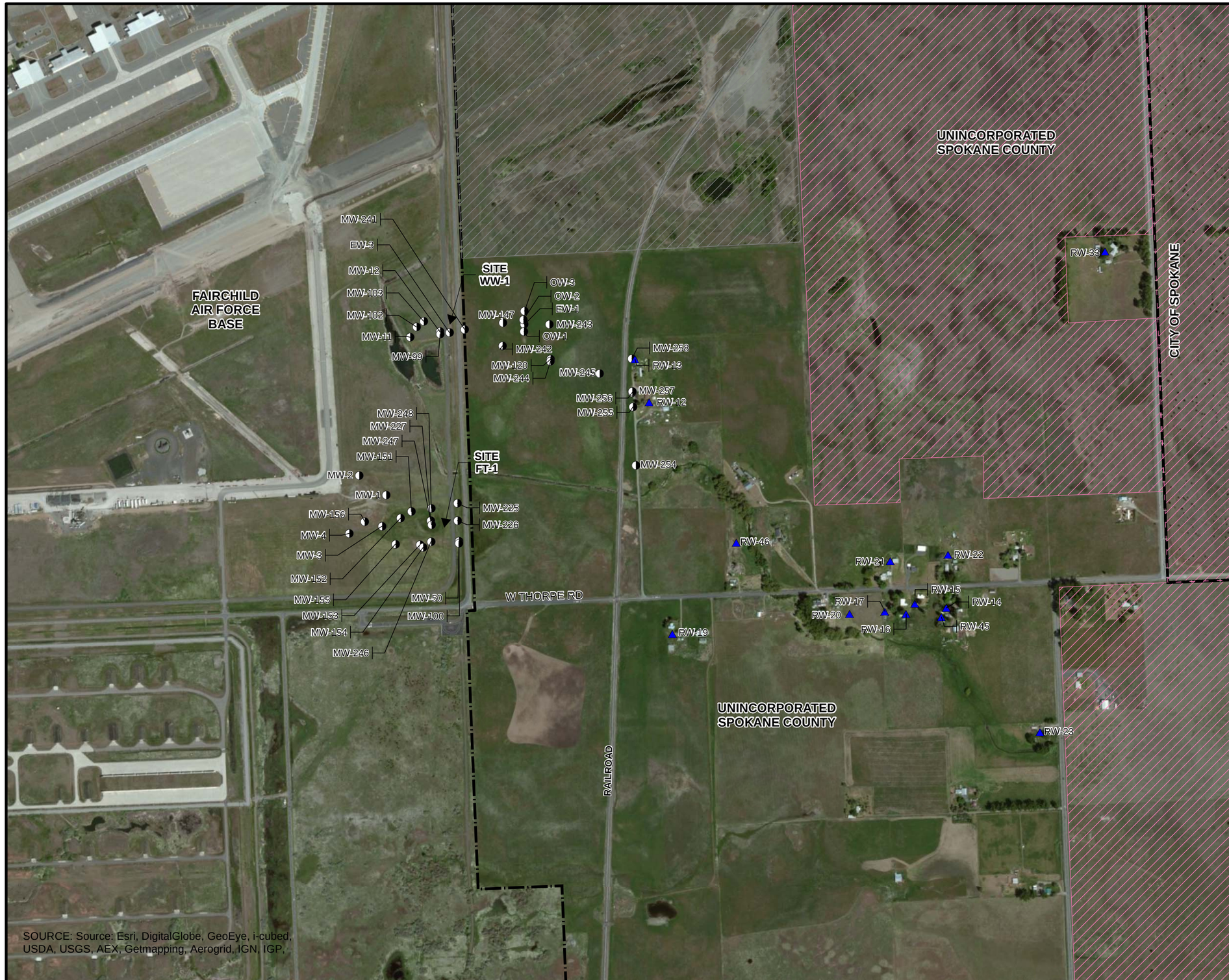


Figure 3-6a: Site WW-1 (WP003) – Industrial Wastewater Lagoons



SOURCE: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP,

LEGEND

- MONITORING WELL
- RESIDENTIAL WATER WELL
- HIGHWAY
- MUNICIPAL BOUNDARY
- USAF PROPERTY BOUNDARY

ZONING

- LIGHT INDUSTRIAL
- MINING

OTHER AREAS OUTSIDE USAF PROPERTY BOUNDARIES AND OUTSIDE MUNICIPAL BOUNDARIES LIE WITHIN UNINCORPORATED SPOKANE COUNTY AND ARE ZONED RURAL TRADITIONAL

[a]CITY OF SPOKANE ZONING DATA DOWNLOADED FROM http://www.spokanecity.org/services/gis/data/.

ZONING DATA PRESENTED FOR UNICORPORATED AREAS OF SPOKANE COUNTY WAS DIGITIZED FROM THE SPOKANE COUNTY BUILDING AND PLANNING MAP DOWNLOADED FROM http://www.spokanecounty.org/bp/content.aspx?c=2299

0 750 1,500 Feet

N

FIGURE 3-6B
SITE WW-1 VICINITY AND ZONING

FAIRCHILD AIR FORCE BASE, WASHINGTON

CH2MHILL

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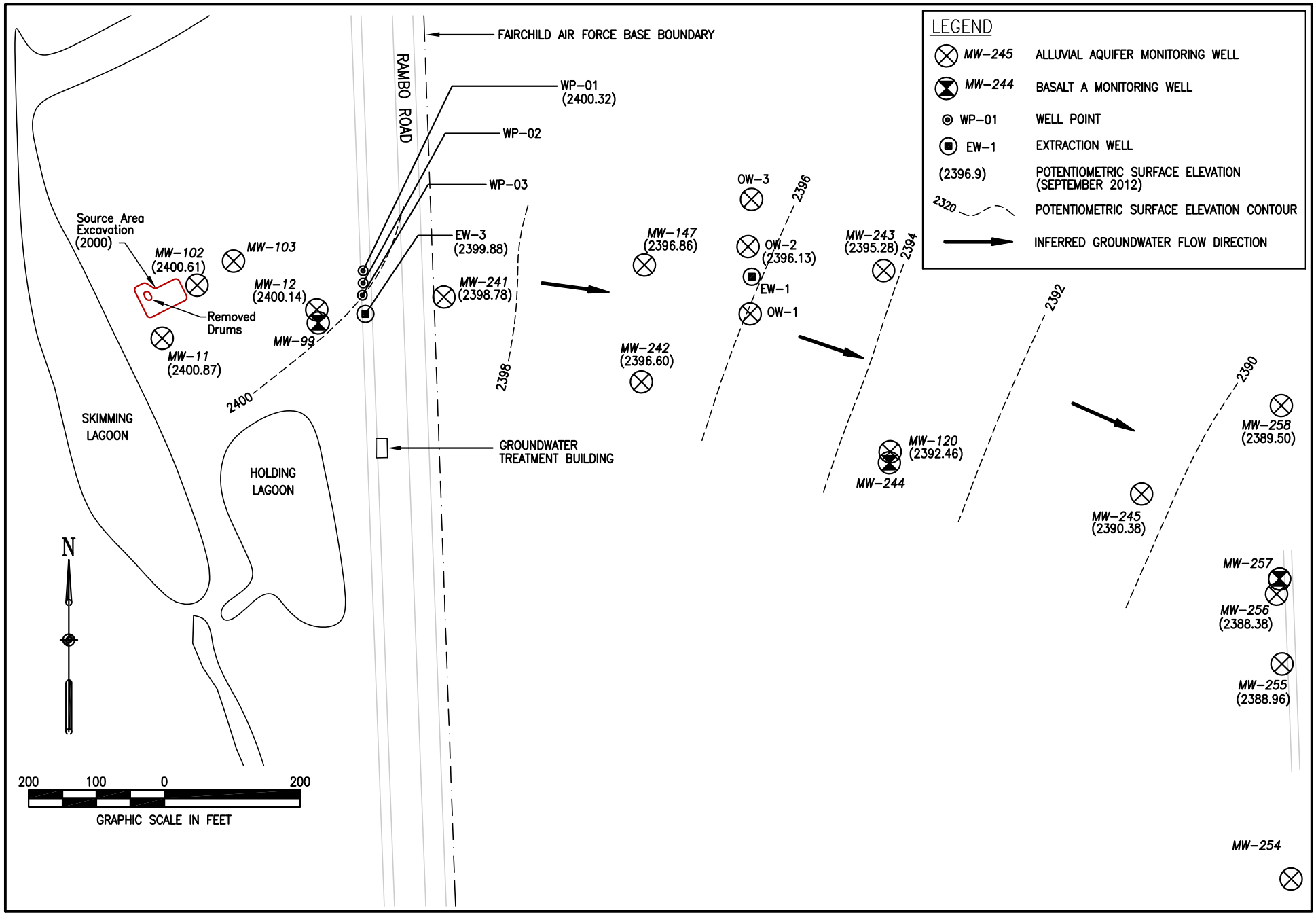

Figure 3-6c: Site WW-1 Potentiometric Groundwater Elevations, September 2012

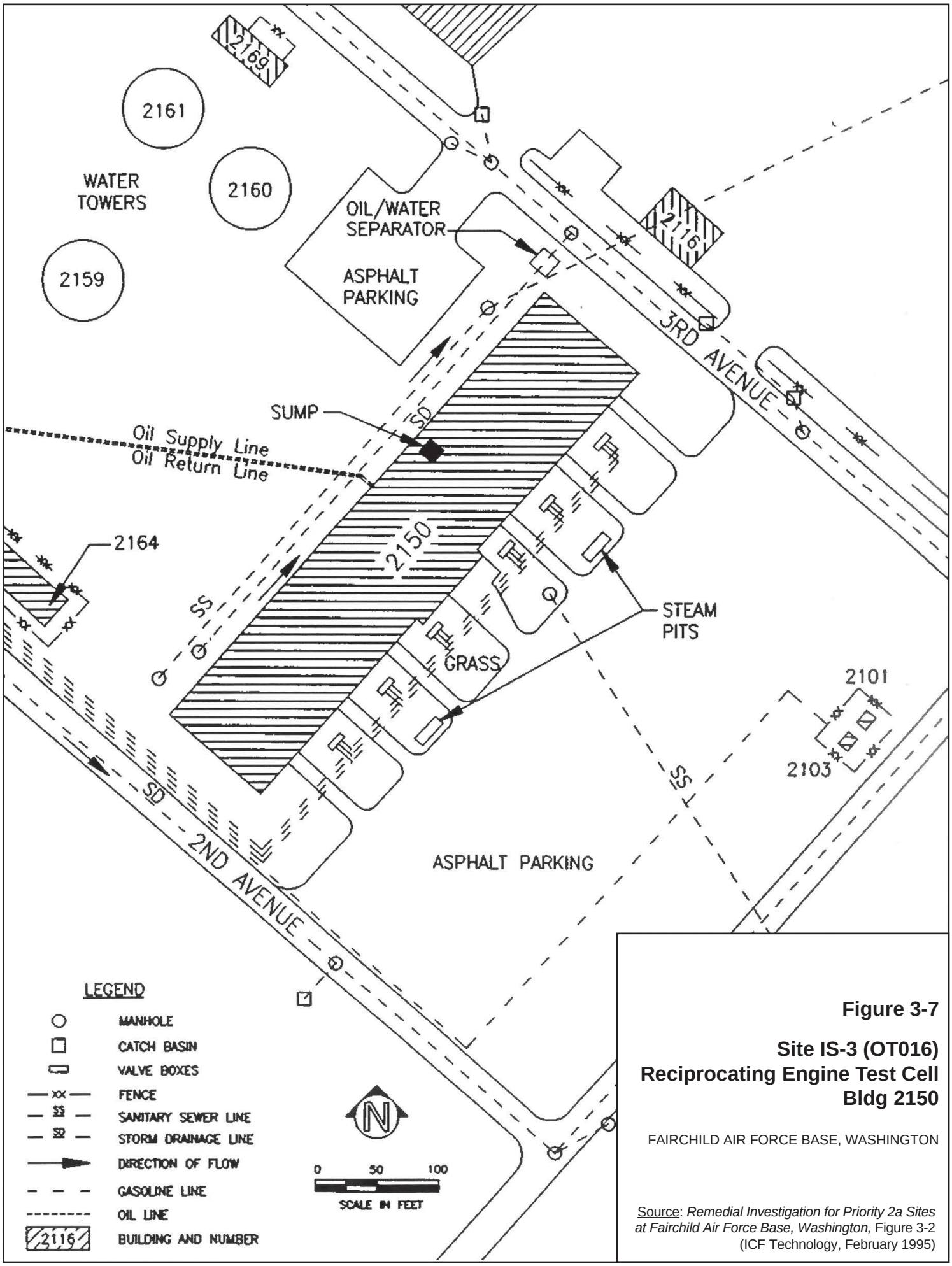

Figure 3-7

Site IS-3 (OT016)
Reciprocating Engine Test Cell
Bldg 2150

FAIRCHILD AIR FORCE BASE, WASHINGTON

Source: *Remedial Investigation for Priority 2a Sites at Fairchild Air Force Base, Washington,* Figure 3-2 (ICF Technology, February 1995)

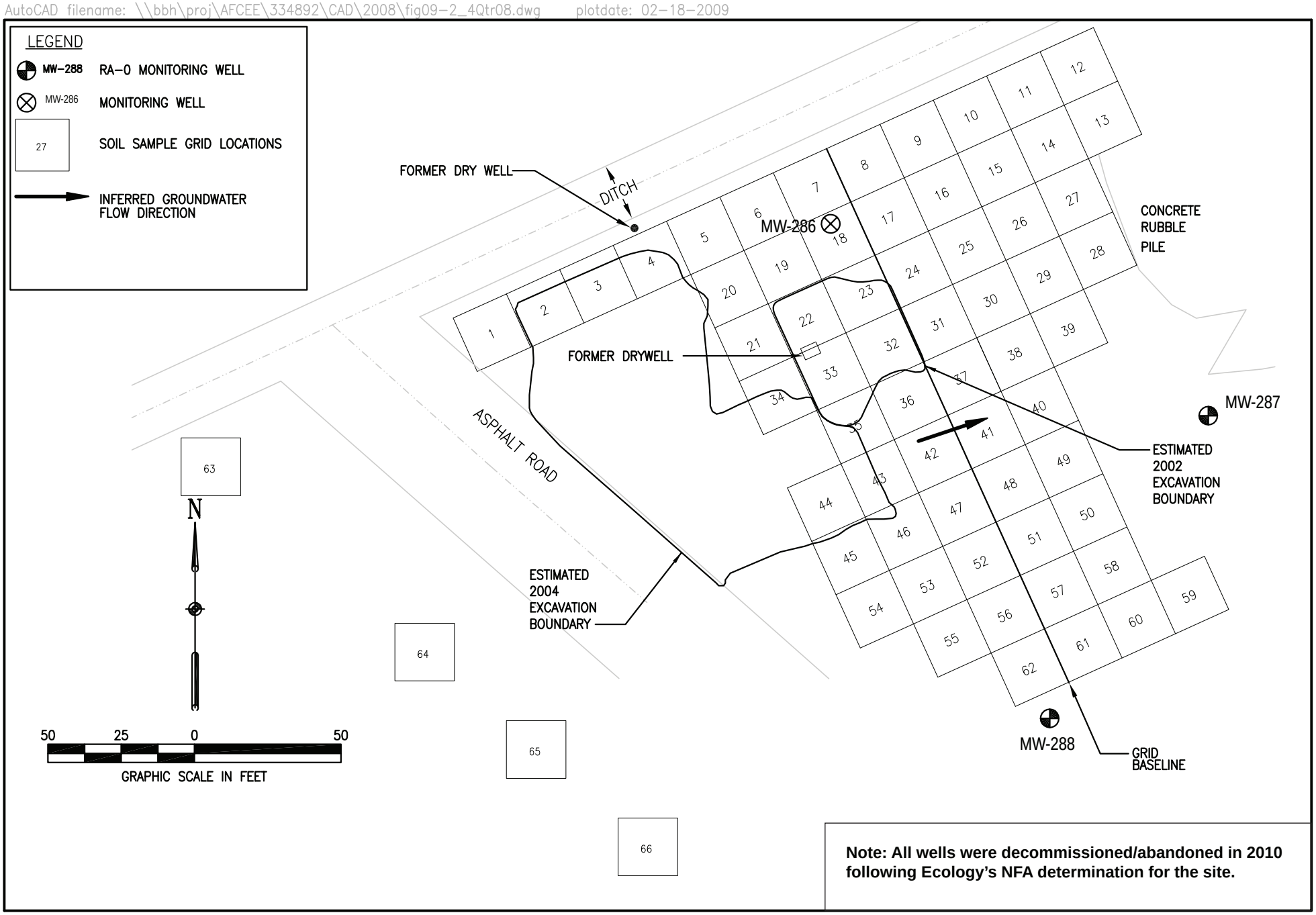

Figure 3-8: Site IS-4 (OT017) – Jet Engine Test Cell Area

\\bbh\proj\AFCEE\334892\CAD\2007\fig08-1_4Qtr07.dwg plotdate: 03-20-2008

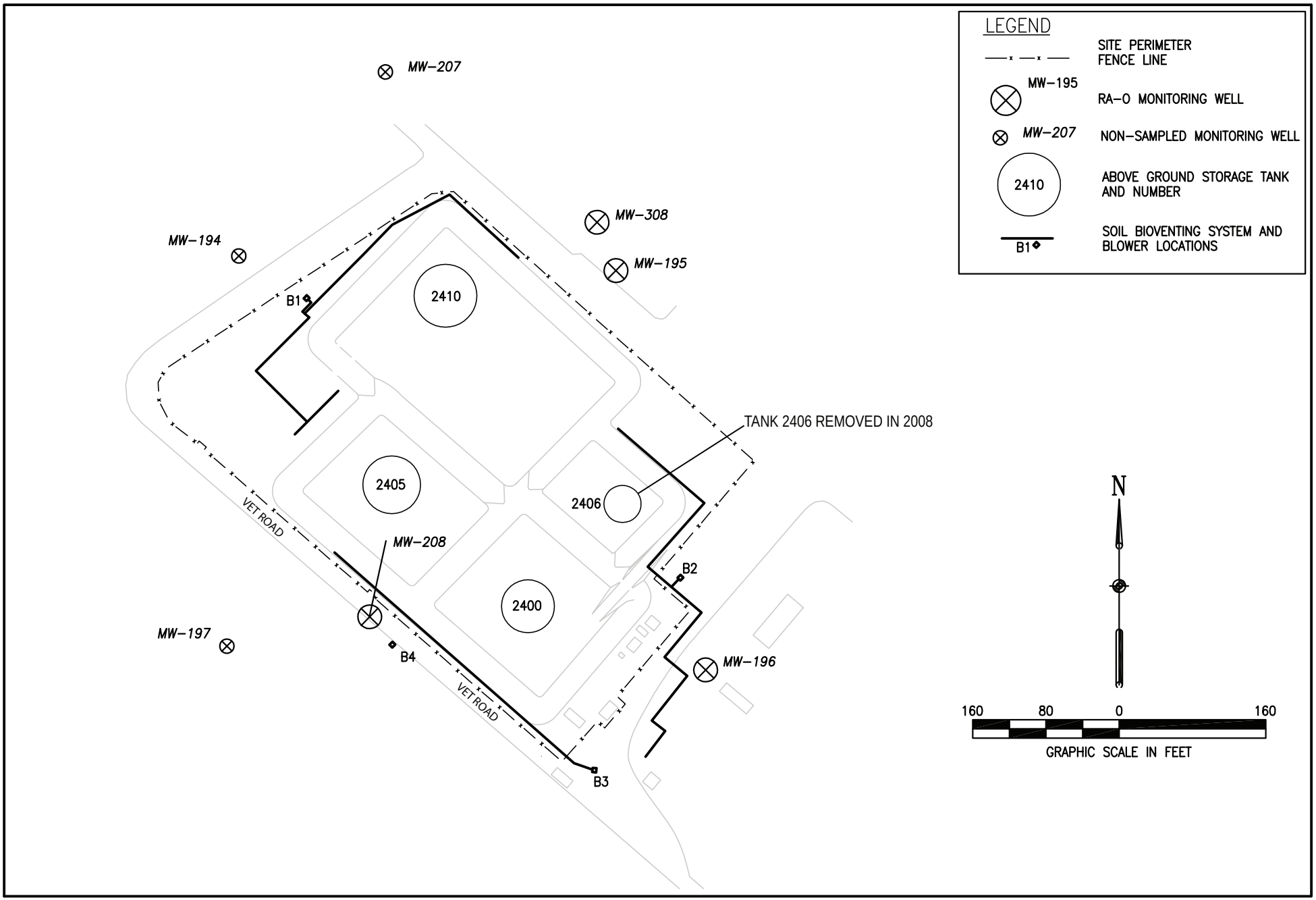

Figure 3-9a: Site PS-1 (ST006) – Bulk Fuel Storage Area

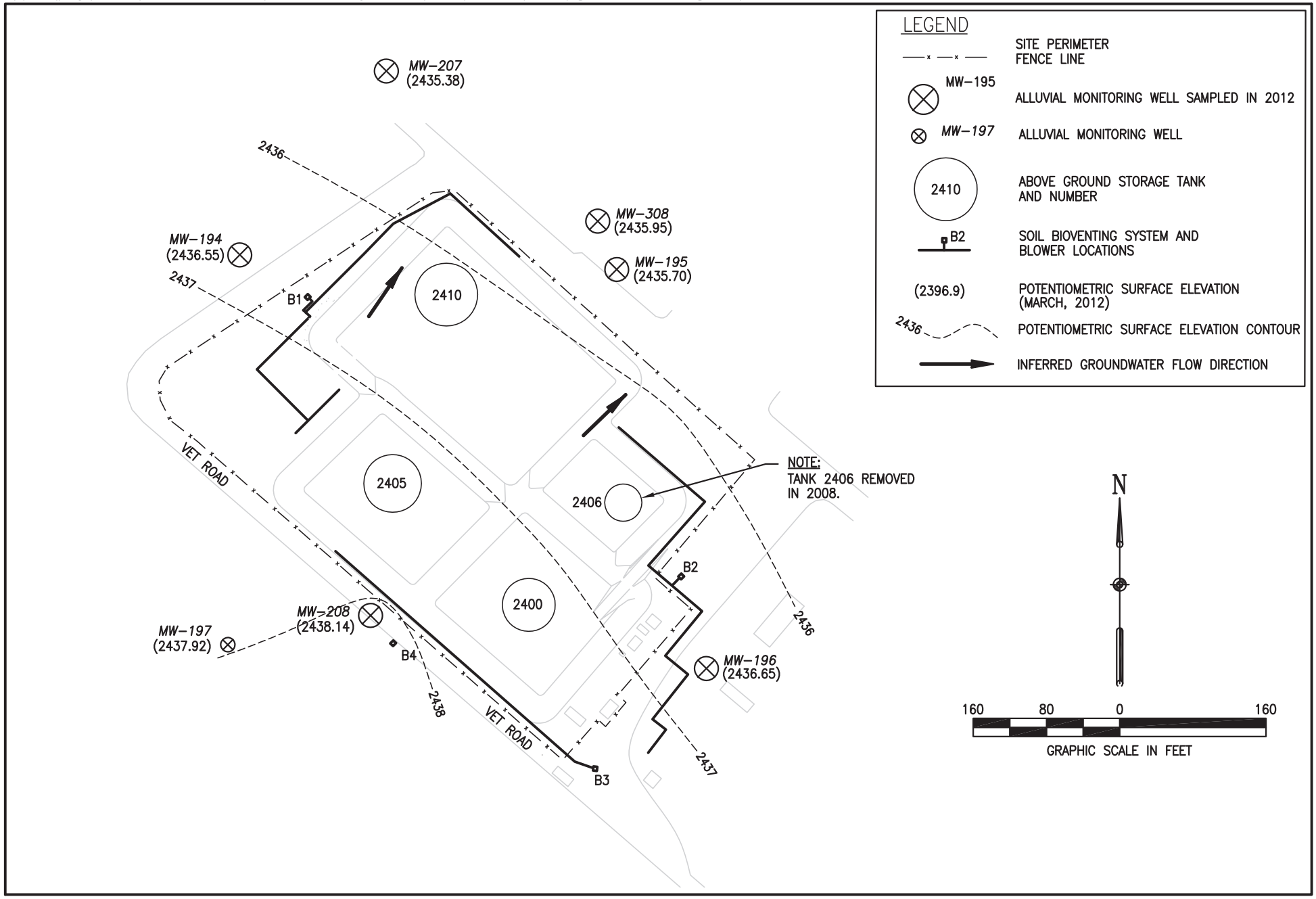

Figure 3-9b: Site PS-1 Potentiometric Groundwater Elevations, March 2012

\\bbh\proj\AFCEE\187568\FiveYearReview\CAD\fig05.4-1-5yr.dwg plotdate: 02-19-2007

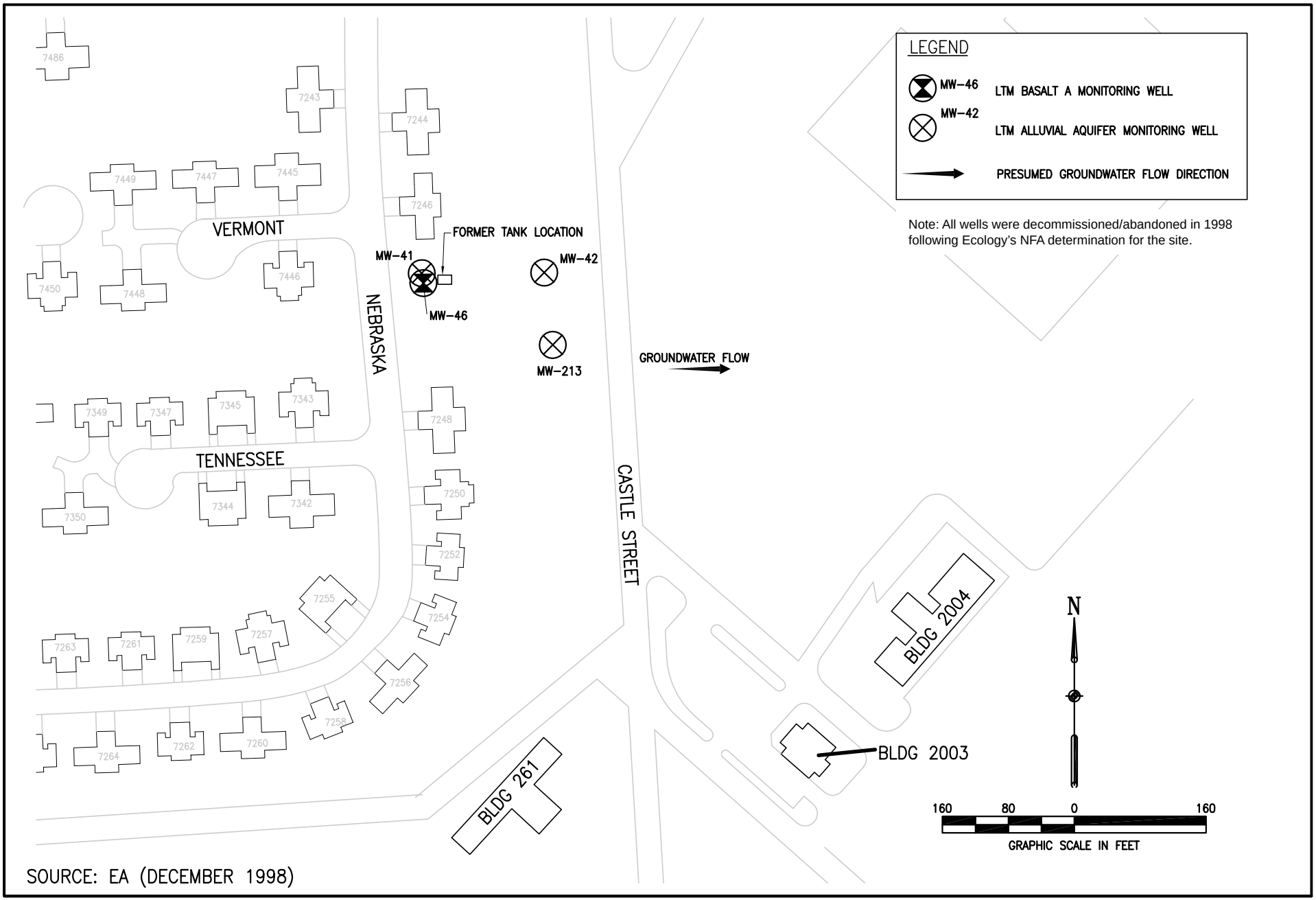

Figure 3-10: Site PS-5 (SS009) – Heating Oil Tank Area

\\bbh\proj\AFCEE\187568\FiveYearReview\CAD\fig05.5-1-5yr.dwg plotdate: 02-19-2007

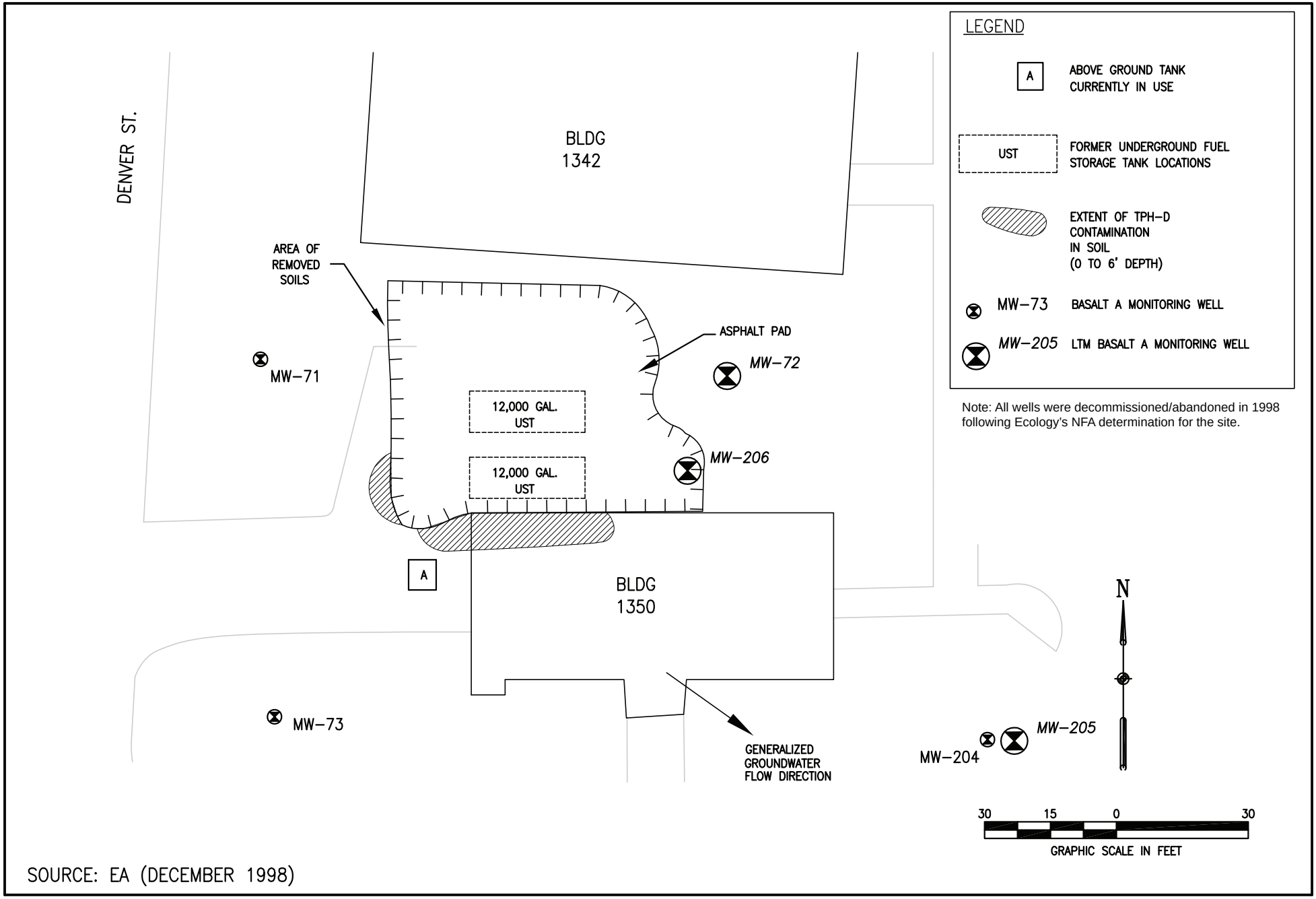

Figure 3-11: Site PS-7 (ST010) – Fuel Oil Storage Tanks

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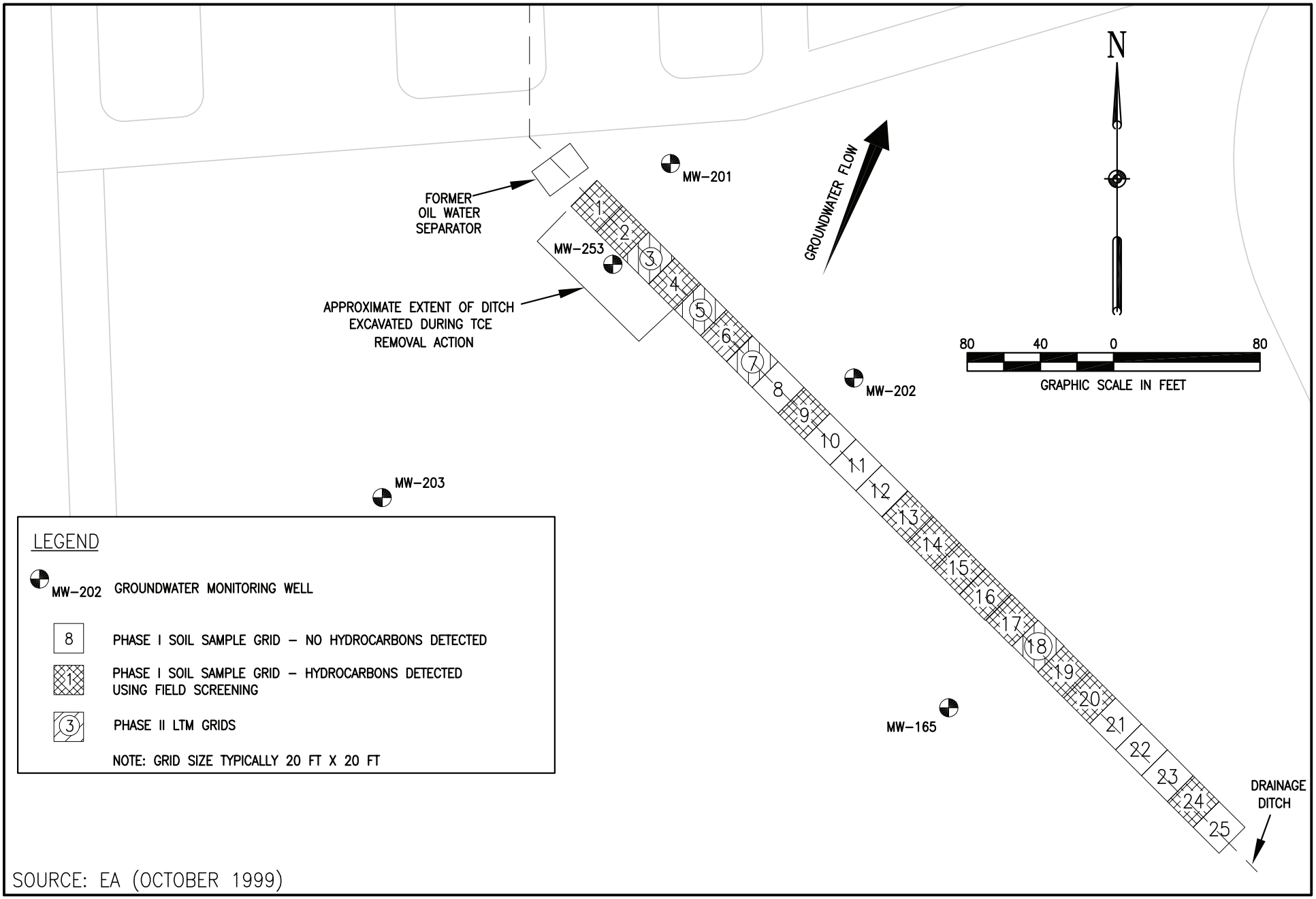

Figure 3-12: Site PS-10 (SD031) – Fuel Truck Maintenance, Bldg 1060

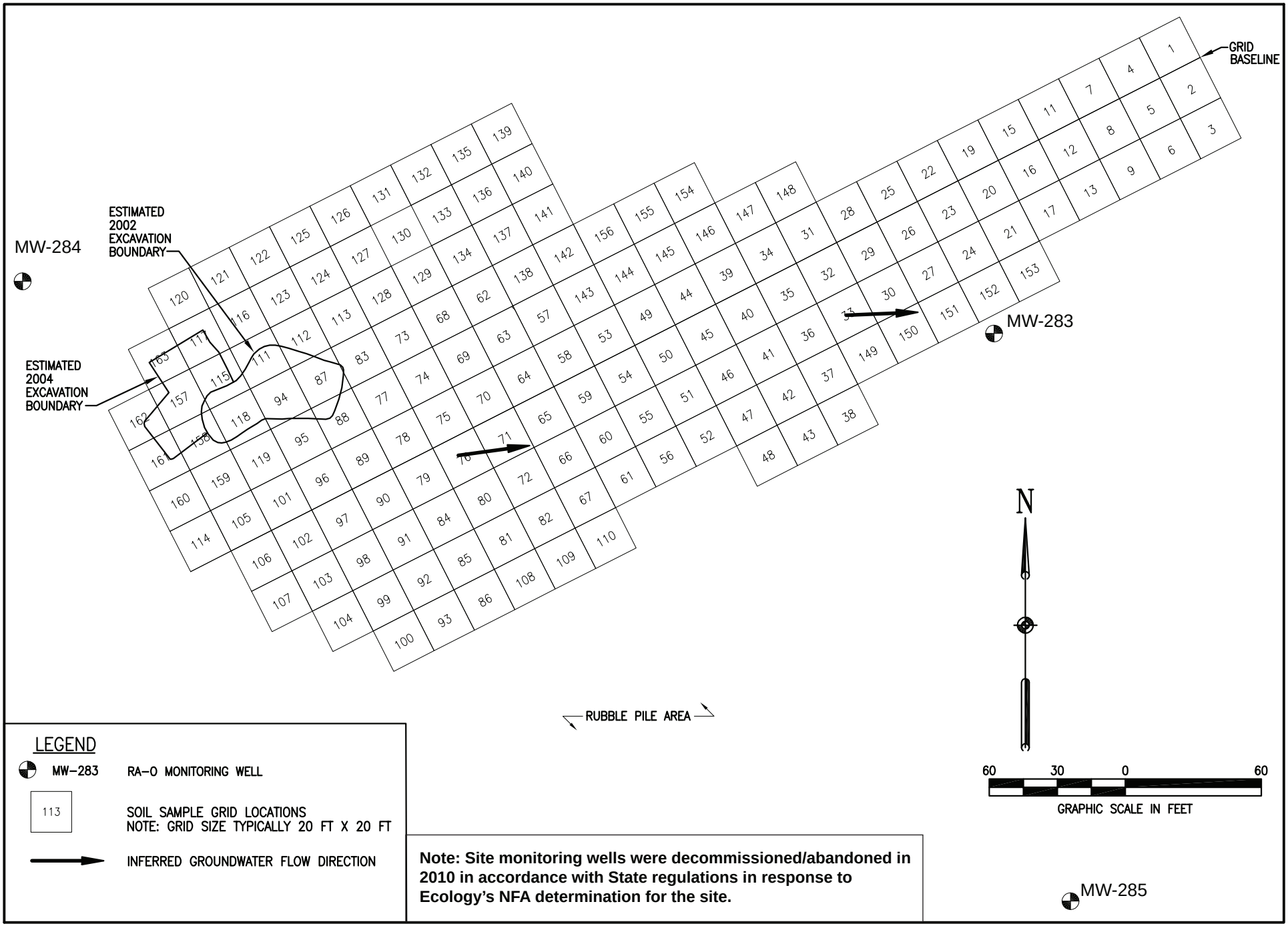

Figure 3-13: Site FT-2 (FT032) – Old Fire Training Area

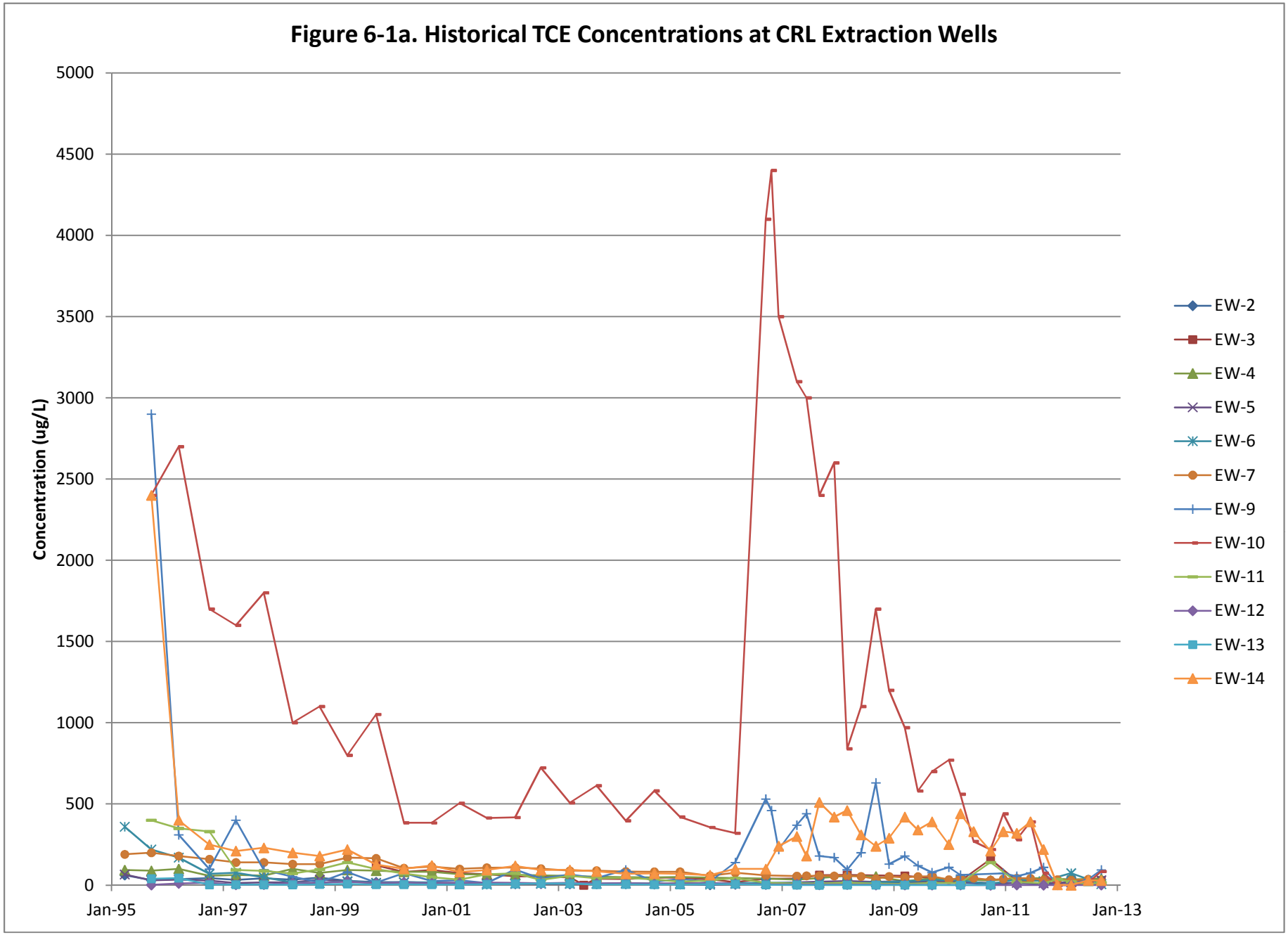
Figure 6-1a. Historical TCE Concentrations at CRL Extraction Wells
Concentration (ug/L)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
Jan-13
EW-2
EW-3
EW-4
EW-5
EW-6
EW-7
EW-9
EW-10
EW-11
EW-12
EW-13
EW-14

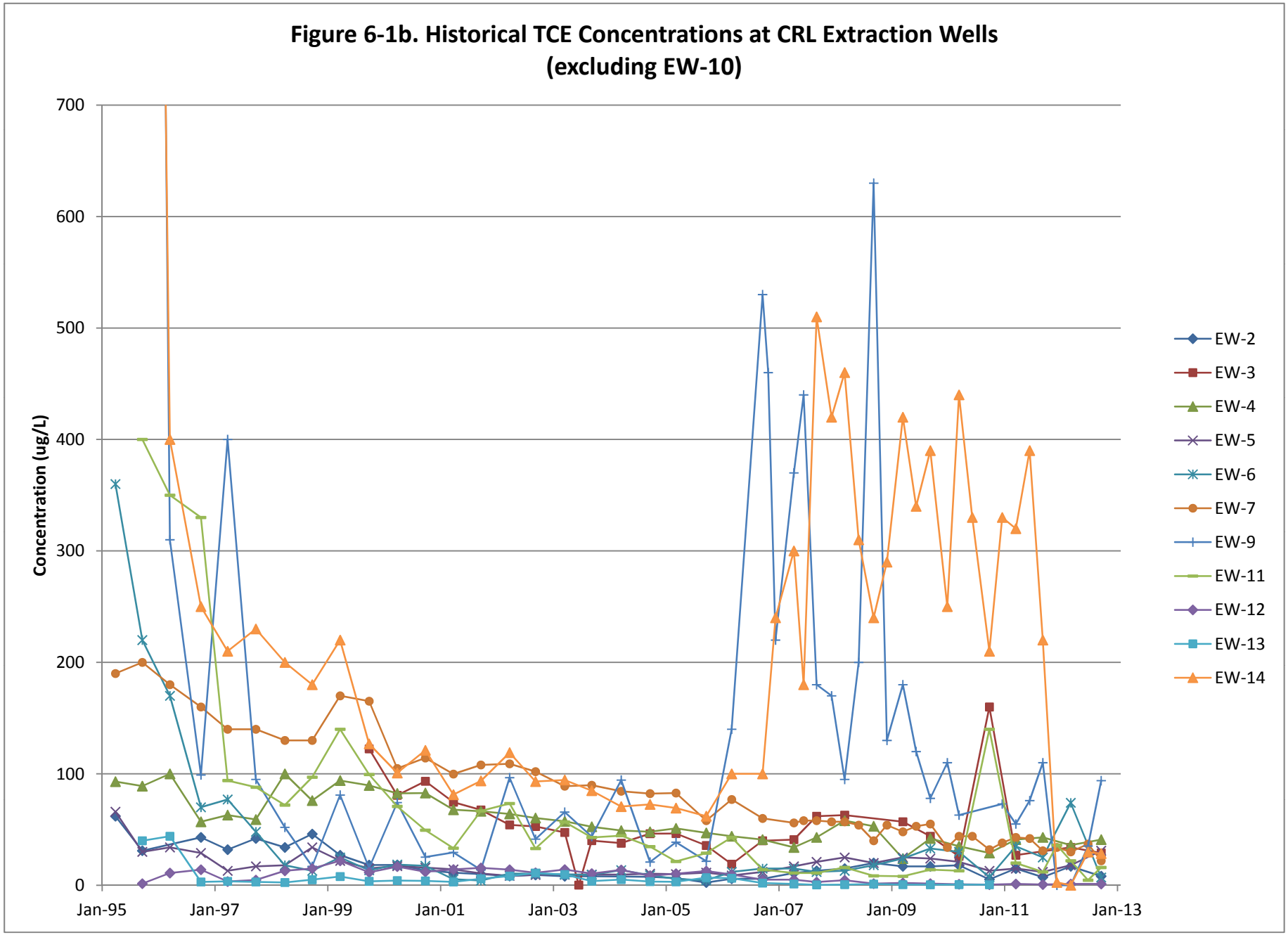
Figure 6-1b. Historical TCE Concentrations at CRL Extraction Wells
(excluding EW-10)
Concentration (ug/L)
700
600
500
400
300
200
100
0
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
Jan-13
EW-2
EW-3
EW-4
EW-5
EW-6
EW-7
EW-9
EW-11
EW-12
EW-13
EW-14

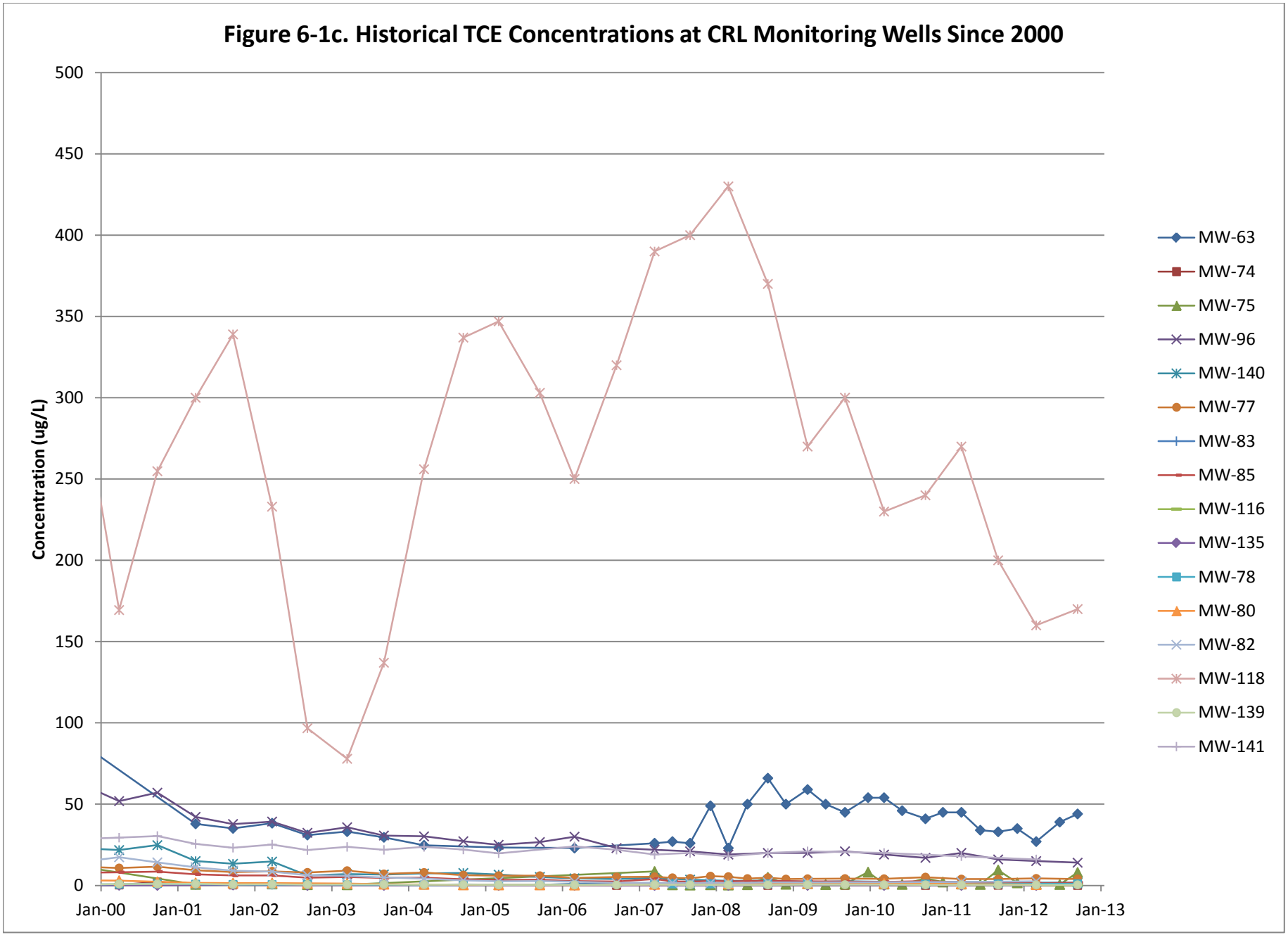
Figure 6-1c. Historical TCE Concentrations at CRL Monitoring Wells Since 2000
Concentration (ug/L)
500
450
400
350
300
250
200
150
100
50
0
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
MW-63
MW-74
MW-75
MW-96
MW-140
MW-77
MW-83
MW-85
MW-116
MW-135
MW-78
MW-80
MW-82
MW-118
MW-139
MW-141

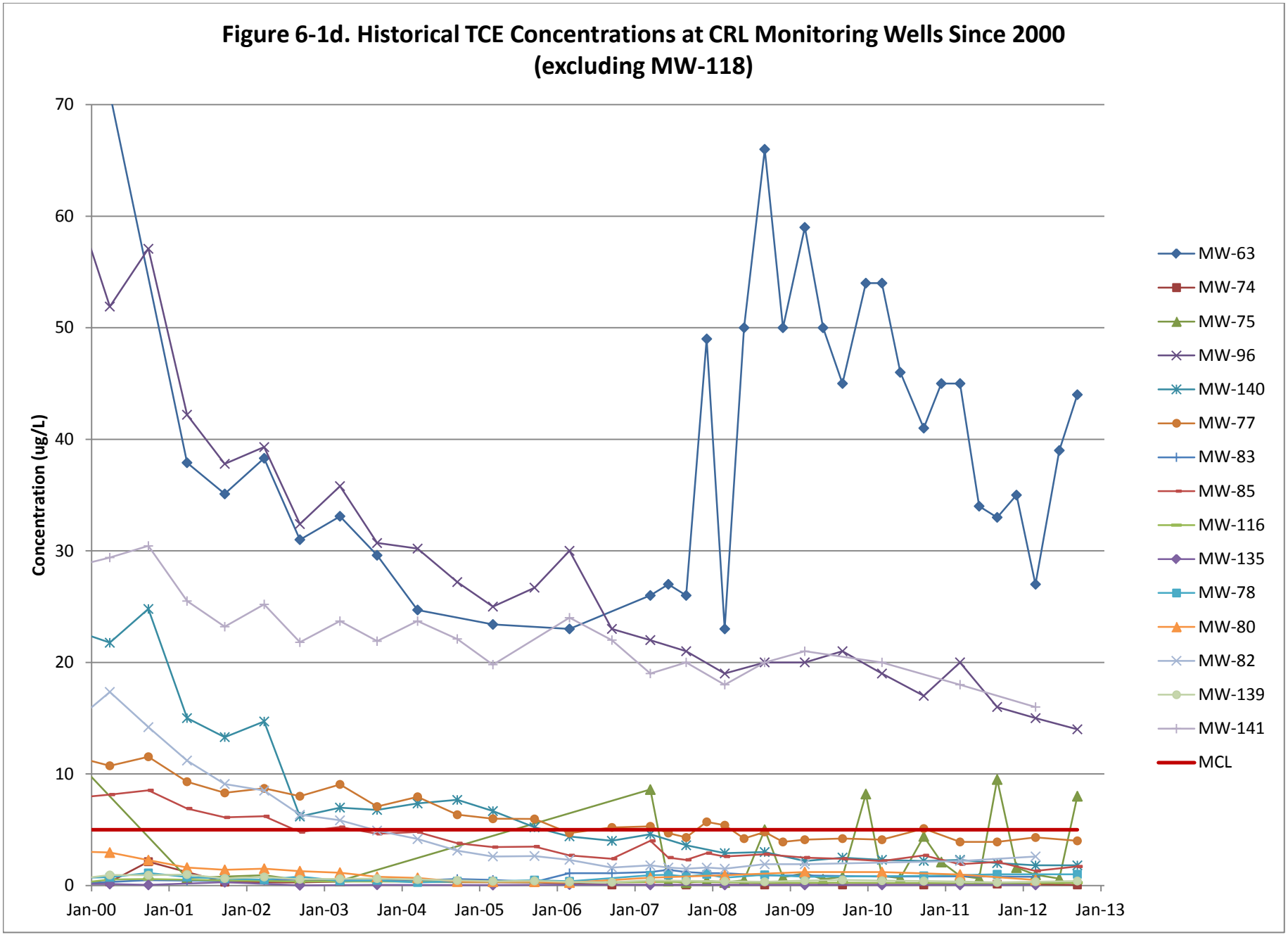
Figure 6-1d. Historical TCE Concentrations at CRL Monitoring Wells Since 2000
(excluding MW-118)
Concentration (ug/L)
70
60
50
40
30
20
10
0
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
MW-63
MW-74
MW-75
MW-96
MW-140
MW-77
MW-83
MW-85
MW-116
MW-135
MW-78
MW-80
MW-82
MW-139
MW-141
MCL

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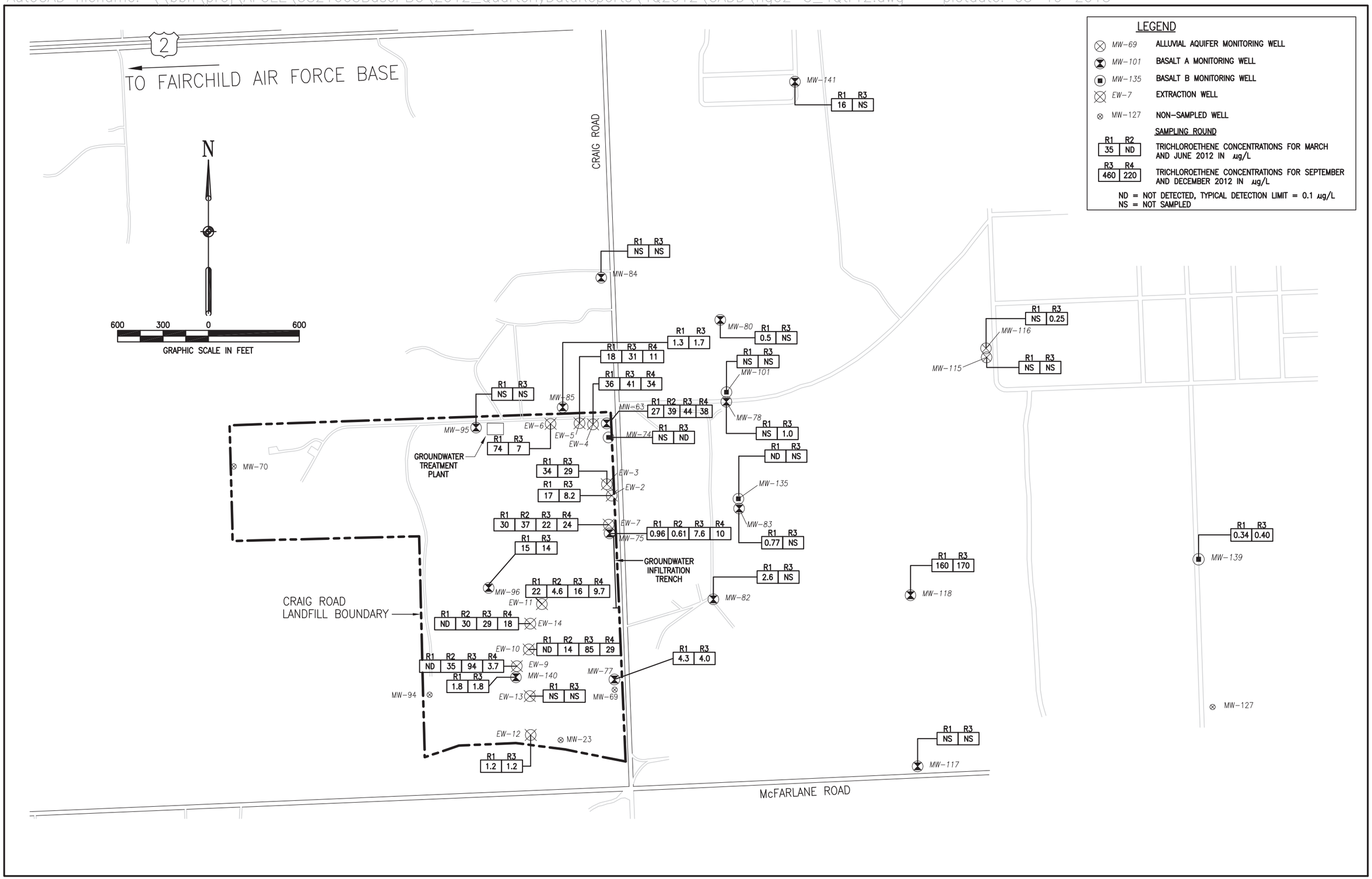
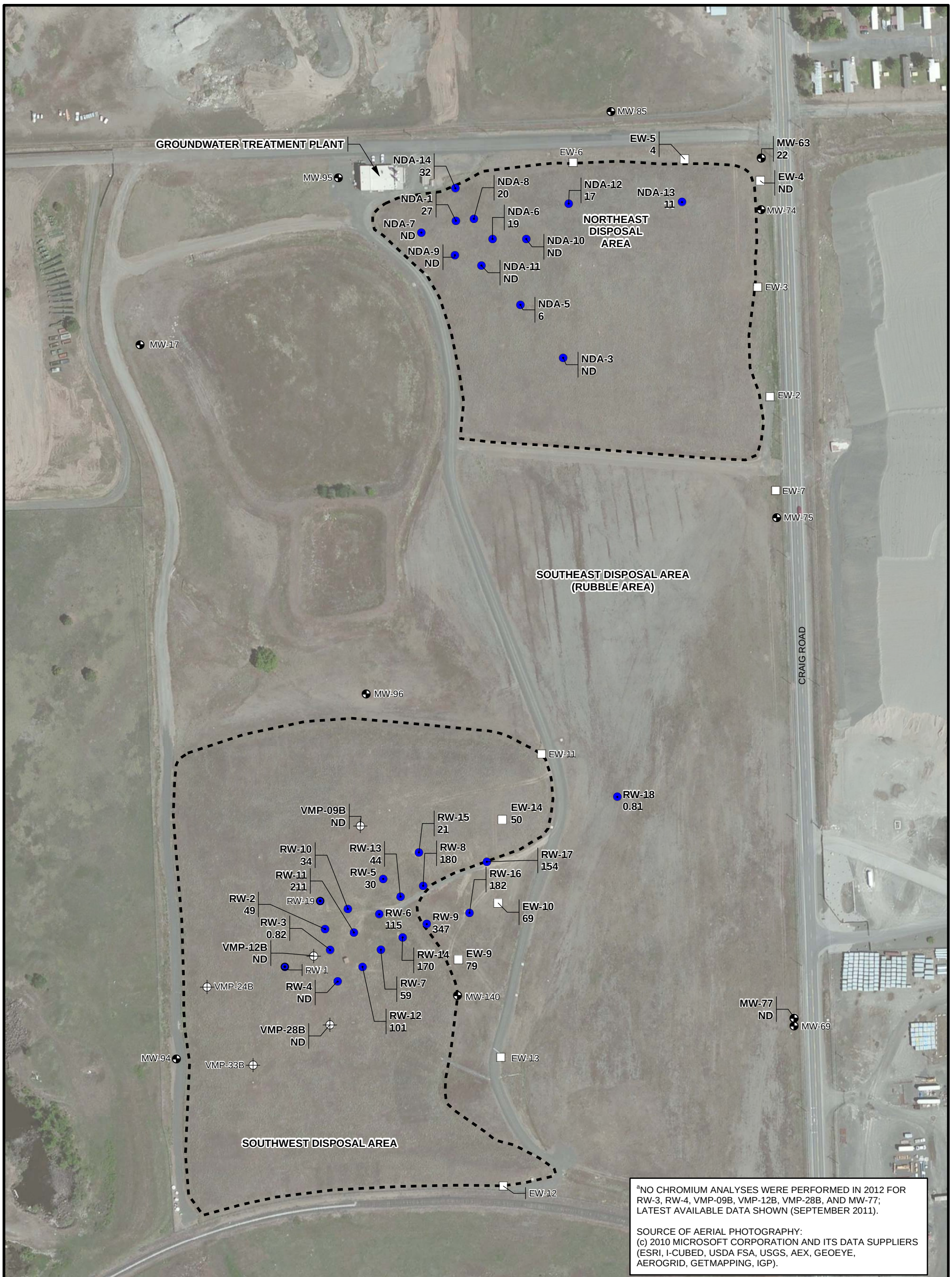


Figure 6-1e: TCE Concentration Extent in CRL Groundwater, 2012



[a]NO CHROMIUM ANALYSES WERE PERFORMED IN 2012 FOR RW-3, RW-4, VMP-09B, VMP-12B, VMP-28B, AND MW-77; LATEST AVAILABLE DATA SHOWN (SEPTEMBER 2011).

SOURCE OF AERIAL PHOTOGRAPHY:
(c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS (ESRI, I-CUBED, USDA FSA, USGS, AEX, GEOEYE, AEROGRID, GETMAPPING, IGP).

LEGEND

- GROUNDWATER MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- REMEDIATION WELL
- VAPOR/GROUNDWATER MONITORING WELL
- **0.82** MAXIMUM 2012 CHROMIUM CONCENTRATION IN GROUNDWATER (µg/L)[a]
- APPROXIMATE LANDFILL UNIT BOUNDARY

N

0 200 400 FEET

FIGURE 6-2
CHROMIUM CONCENTRATION EXTENT IN CRAIG ROAD LANDFILL GROUNDWATER, 2012

FAIRCHILD AIR FORCE BASE, WASHINGTON

CH2MHILL

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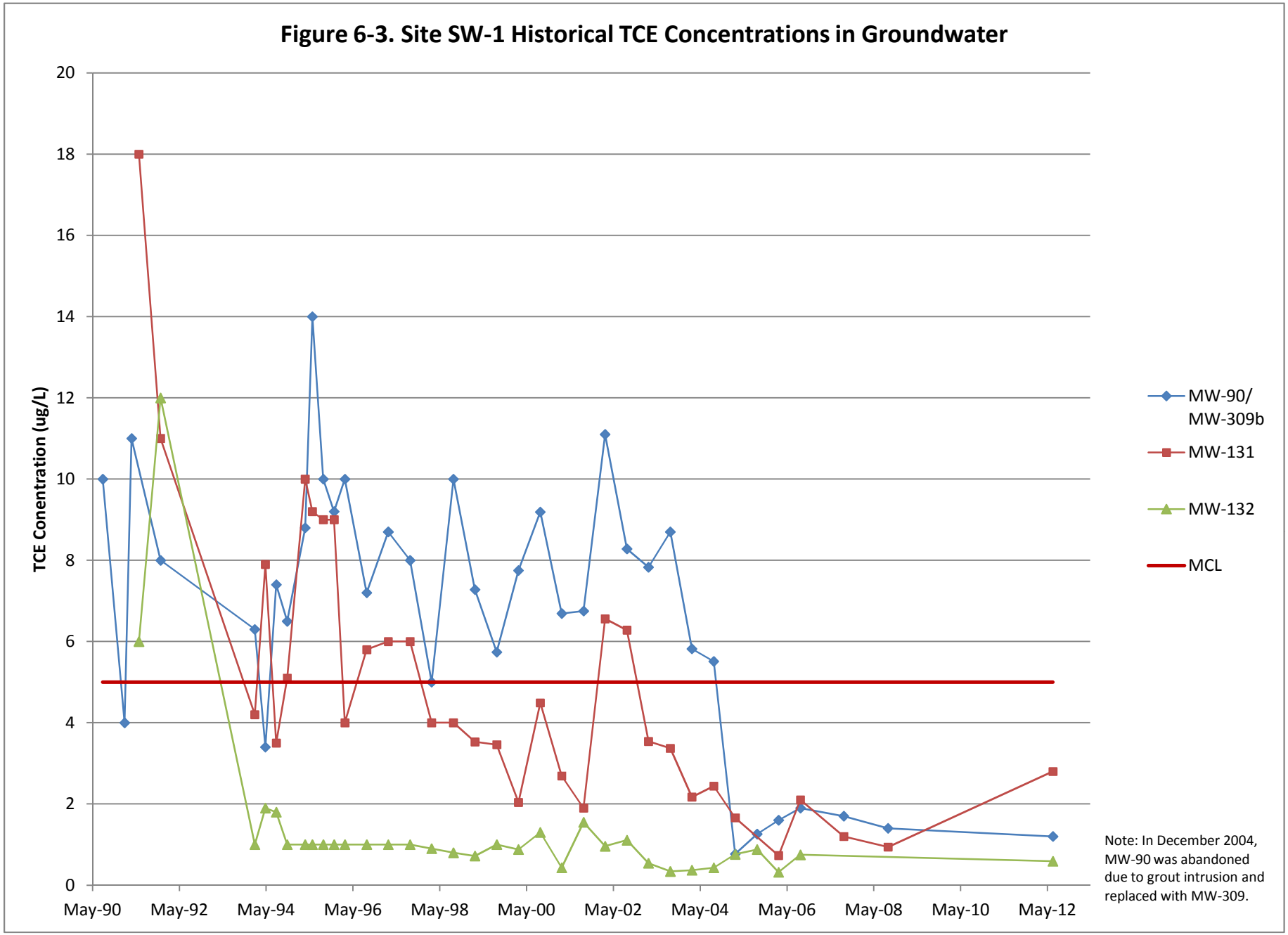
Figure 6-3. Site SW-1 Historical TCE Concentrations in Groundwater
TCE Conentration (ug/L)
20
18
16
14
12
10
8
6
4
2
0
May-90
May-92
May-94
May-96
May-98
May-00
May-02
May-04
May-06
May-08
May-10
May-12
MW-90/ MW-309b
MW-131
MW-132
MCL
Note: In December 2004, MW-90 was abandoned due to grout intrusion and replaced with MW-309.

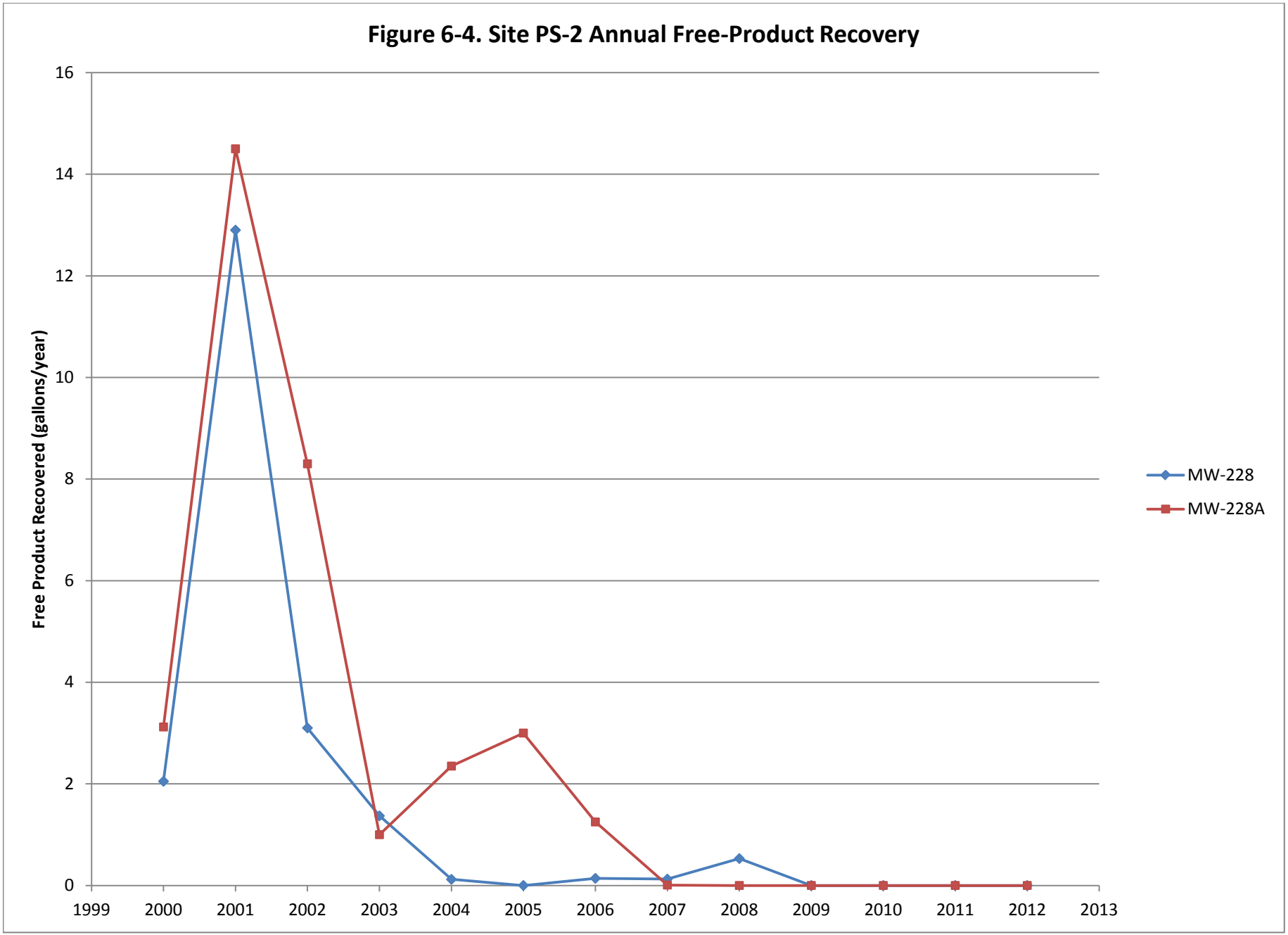
Figure 6-4. Site PS-2 Annual Free-Product Recovery
Free Product Recovered (gallons/year)
16
14
12
10
8
6
4
2
0
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
MW-228
MW-228A

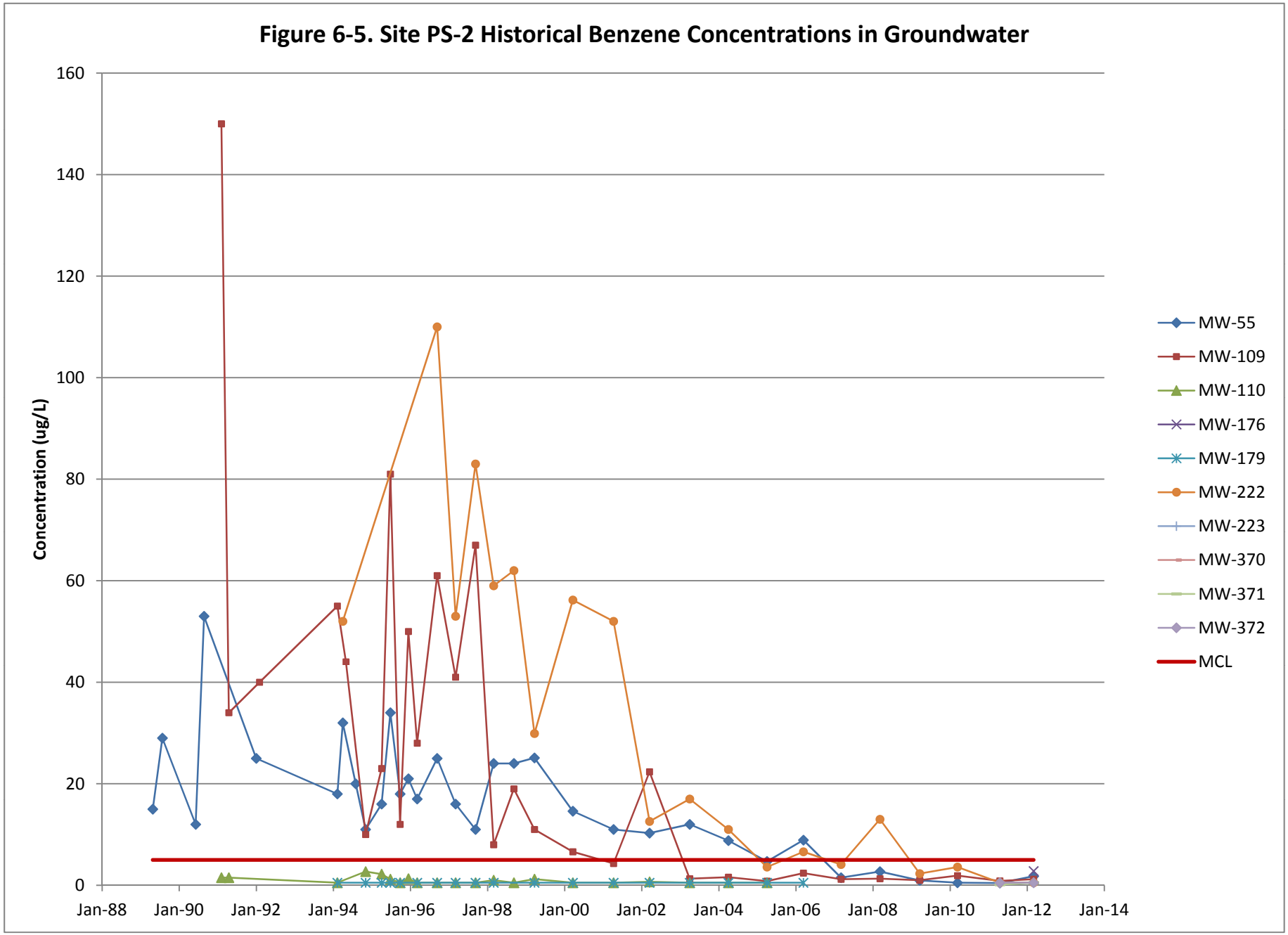
Figure 6-5. Site PS-2 Historical Benzene Concentrations in Groundwater
Concentration (ug/L)
160
140
120
100
80
60
40
20
0
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
MW-55
MW-109
MW-110
MW-176
MW-179
MW-222
MW-223
MW-370
MW-371
MW-372
MCL

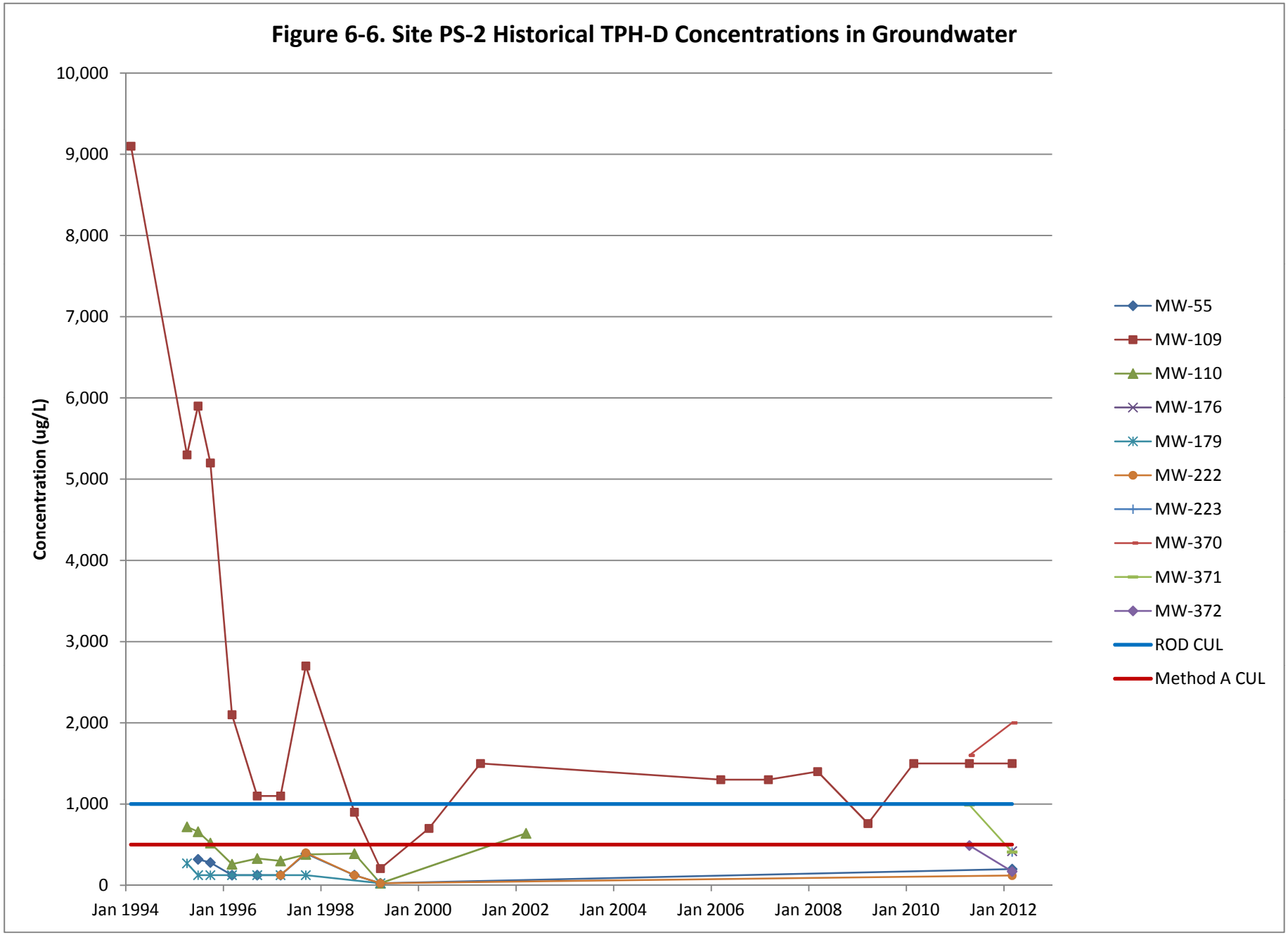
Figure 6-6. Site PS-2 Historical TPH-D Concentrations in Groundwater
Concentration (ug/L)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan 1994
Jan 1996
Jan 1998
Jan 2000
Jan 2002
Jan 2004
Jan 2006
Jan 2008
Jan 2010
Jan 2012
MW-55
MW-109
MW-110
MW-176
MW-179
MW-222
MW-223
MW-370
MW-371
MW-372
ROD CUL
Method A CUL

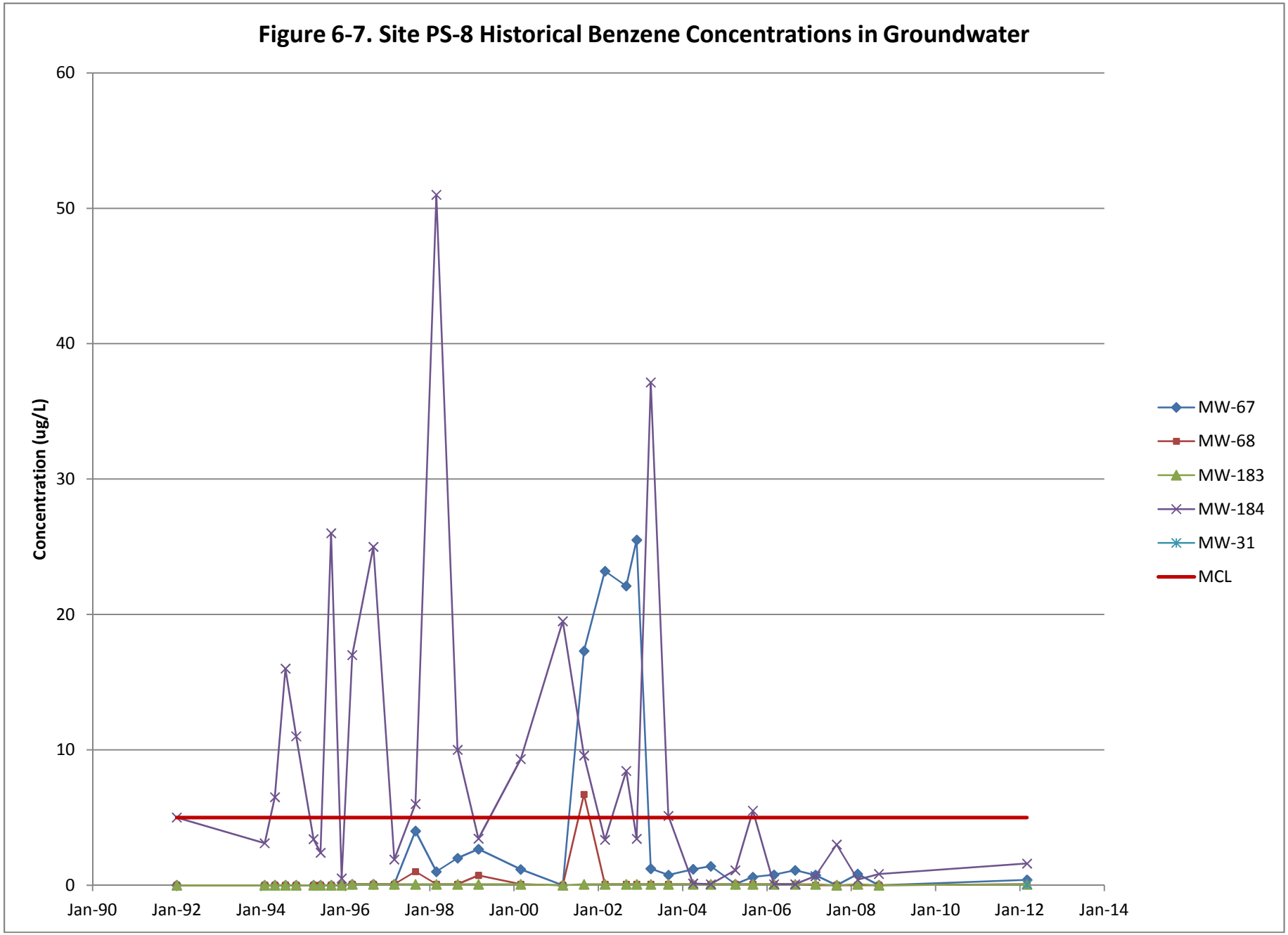
Figure 6-7. Site PS-8 Historical Benzene Concentrations in Groundwater
Concentration (ug/L)
60
50
40
30
20
10
0
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
MW-67
MW-68
MW-183
MW-184
MW-31
MCL

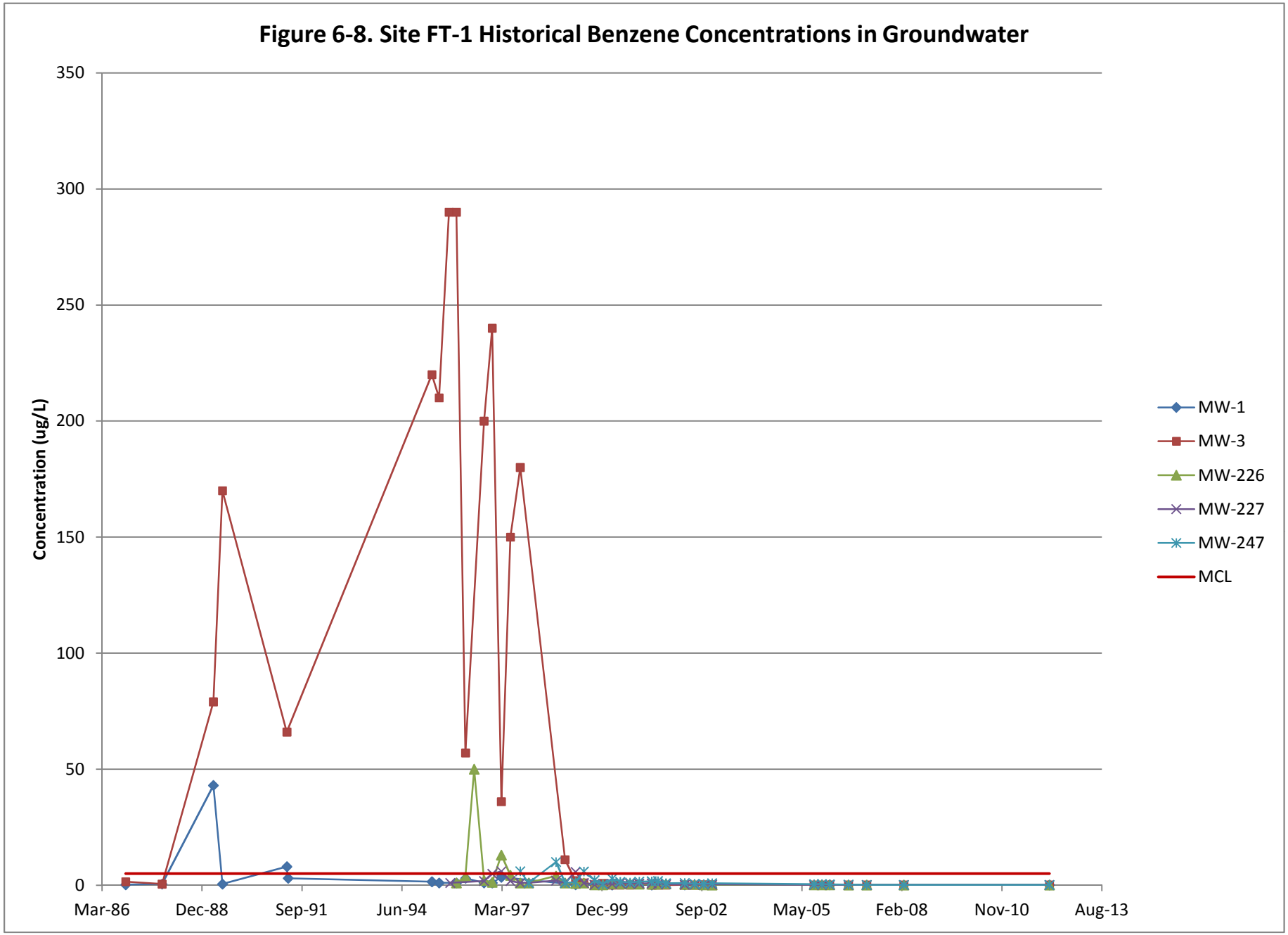
Figure 6-8. Site FT-1 Historical Benzene Concentrations in Groundwater
Concentration (ug/L)
350
300
250
200
150
100
50
0
Mar-86
Dec-88
Sep-91
Jun-94
Mar-97
Dec-99
Sep-02
May-05
Feb-08
Nov-10
Aug-13
MW-1
MW-3
MW-226
MW-227
MW-247
MCL

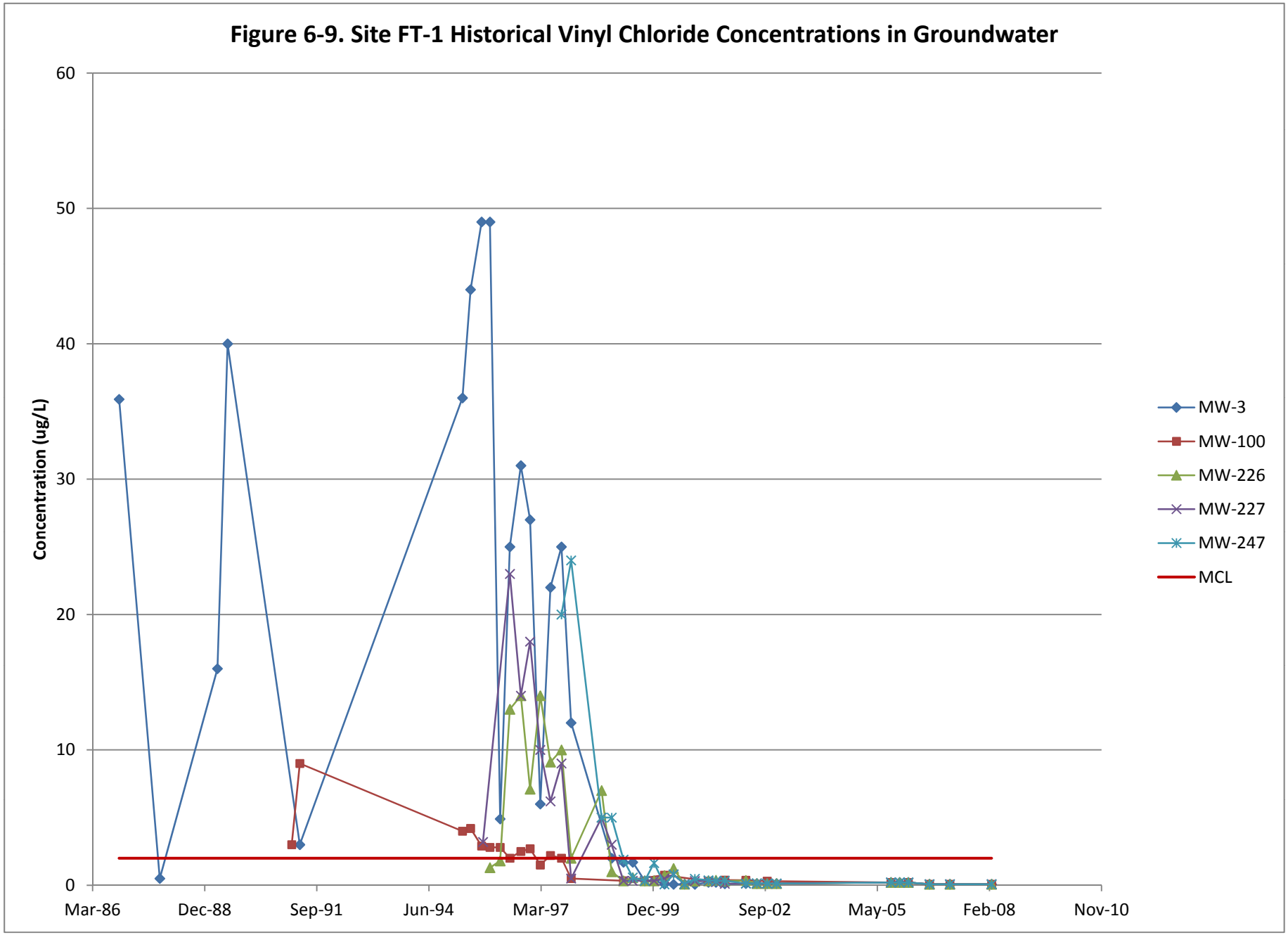
Figure 6-9. Site FT-1 Historical Vinyl Chloride Concentrations in Groundwater
Concentration (ug/L)
60
50
40
30
20
10
0
Mar-86
Dec-88
Sep-91
Jun-94
Mar-97
Dec-99
Sep-02
May-05
Feb-08
Nov-10
MW-3
MW-100
MW-226
MW-227
MW-247
MCL

Figure 6-10a. Site FT-1 Historical TPH-D Concentrations in Groundwater
Concentration (ug/L)
3500
3000
2500
2000
1500
1000
500
0
Jan 2007
Jul 2007
Jan 2008
Jul 2008
Jan 2009
Jul 2009
Jan 2010
Jul 2010
Jan 2011
Jul 2011
Jan 2012
Jul 2012
MW-1
MW-3
MW-50
MW-155
MW-225
MW-226
MW-227
MW-246
MW-247
MW-248
Method A CUL

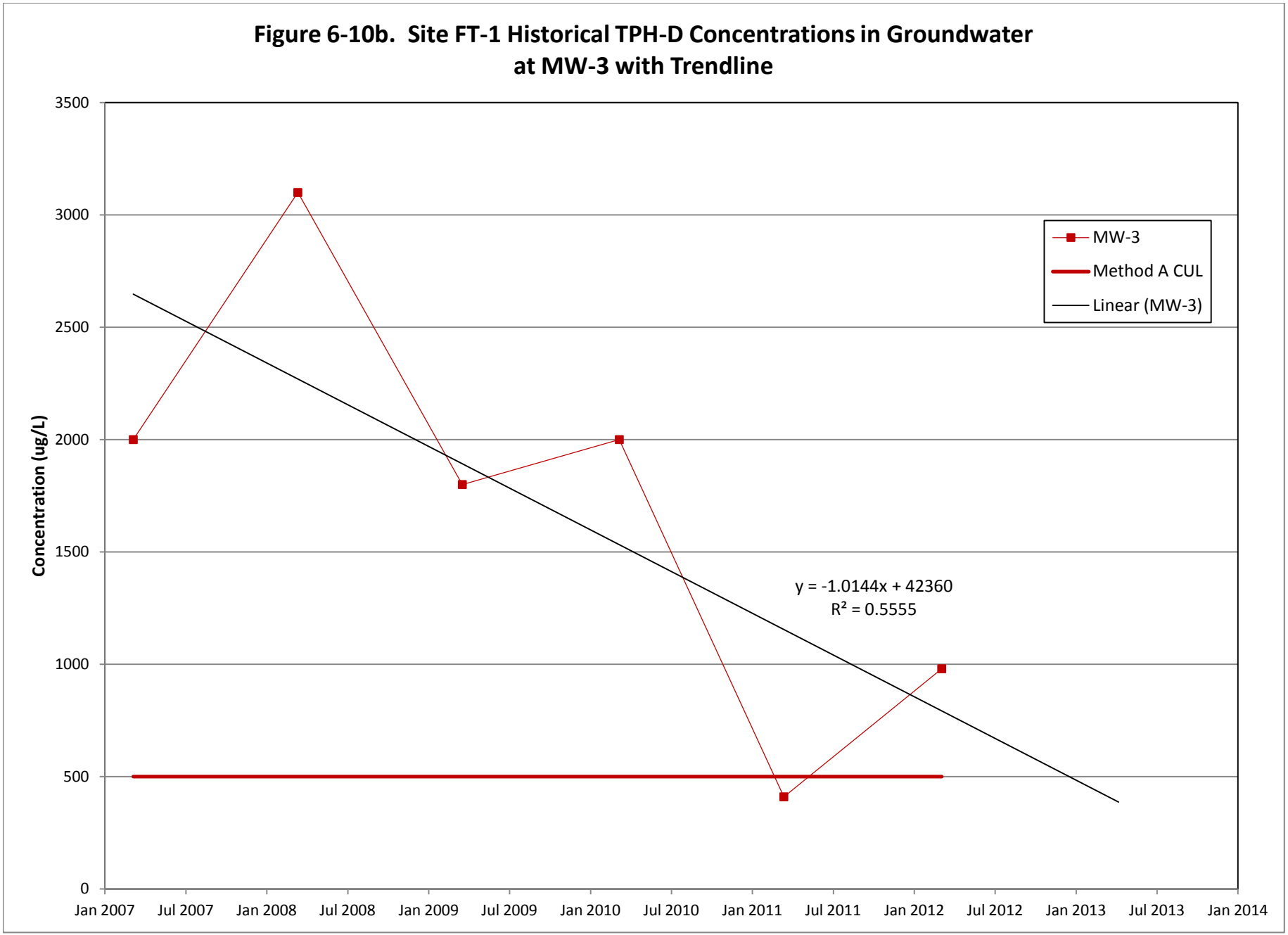
Figure 6-10b. Site FT-1 Historical TPH-D Concentrations in Groundwater at MW-3 with Trendline
Concentration (ug/L)
3500
3000
2500
2000
1500
1000
500
0
Jan 2007
Jul 2007
Jan 2008
Jul 2008
Jan 2009
Jul 2009
Jan 2010
Jul 2010
Jan 2011
Jul 2011
Jan 2012
Jul 2012
Jan 2013
Jul 2013
Jan 2014
MW-3
Method A CUL
Linear (MW-3)
y = -1.0144x + 42360
R² = 0.5555

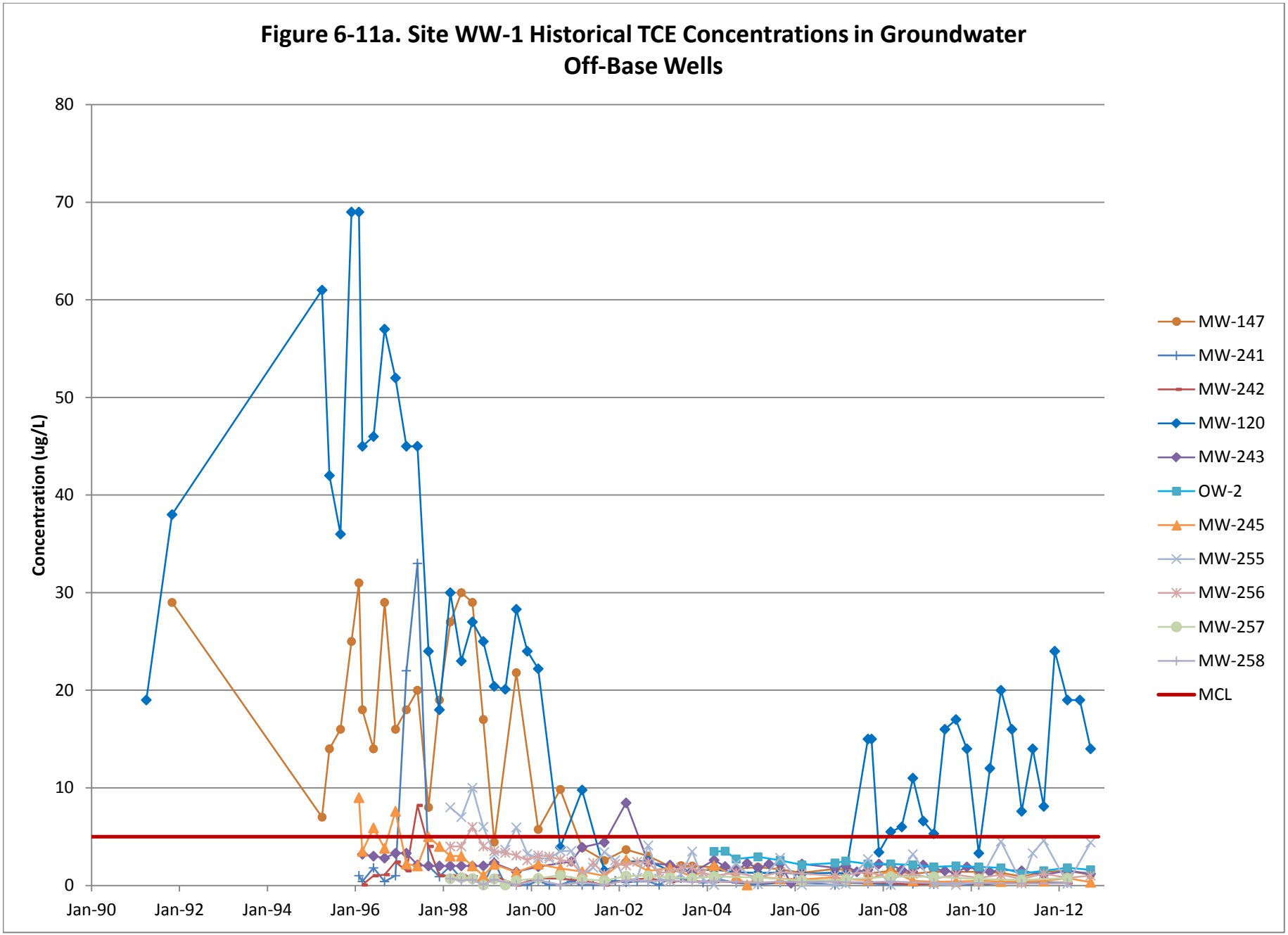
Figure 6-11a. Site WW-1 Historical TCE Concentrations in Groundwater
Off-Base Wells
Concentration (ug/L)
80
70
60
50
40
30
20
10
0
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
MW-147
MW-241
MW-242
MW-120
MW-243
OW-2
MW-245
MW-255
MW-256
MW-257
MW-258
MCL

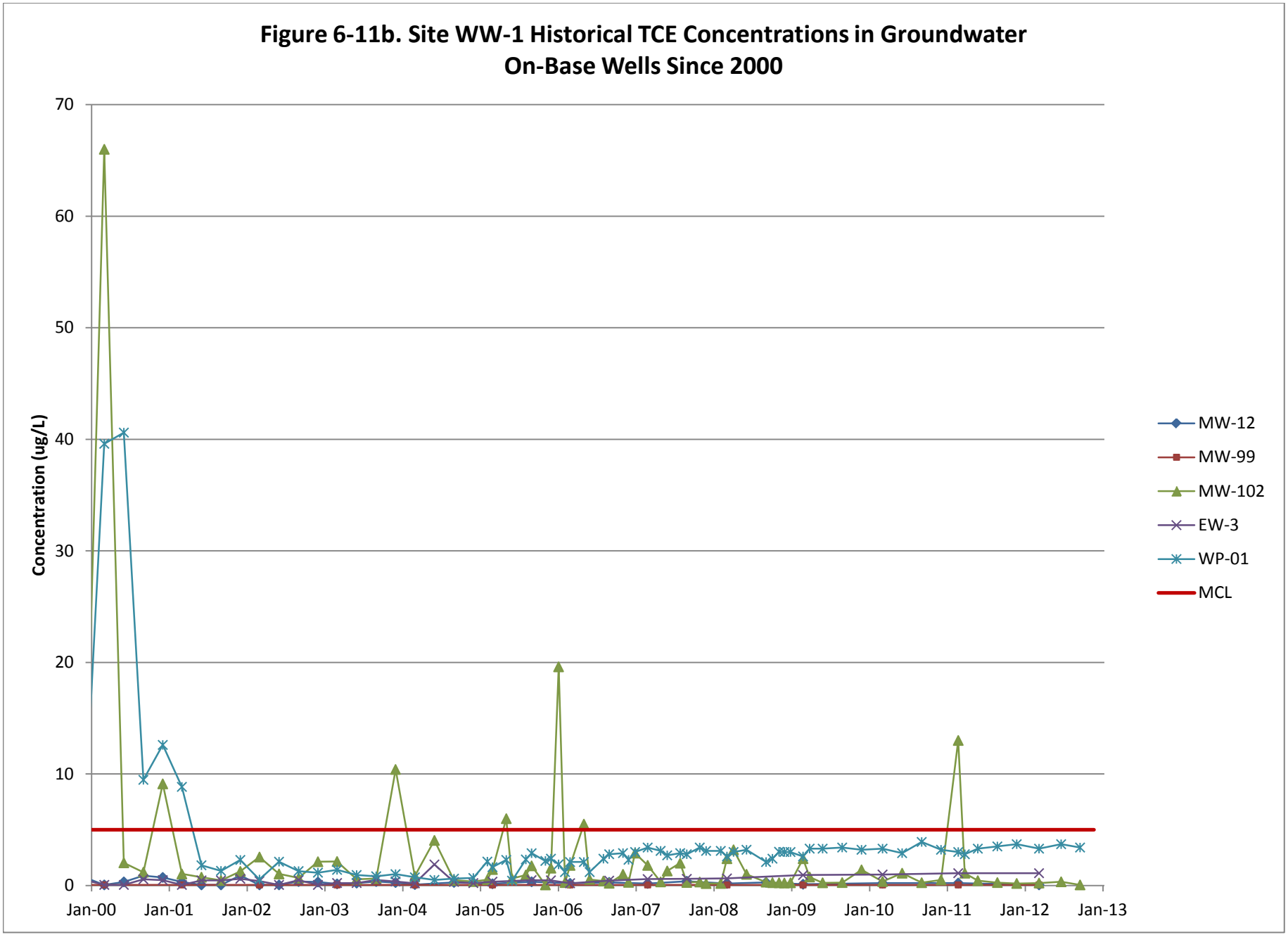
Figure 6-11b. Site WW-1 Historical TCE Concentrations in Groundwater
On-Base Wells Since 2000
Concentration (ug/L)
70
60
50
40
30
20
10
0
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
MW-12
MW-99
MW-102
EW-3
WP-01
MCL

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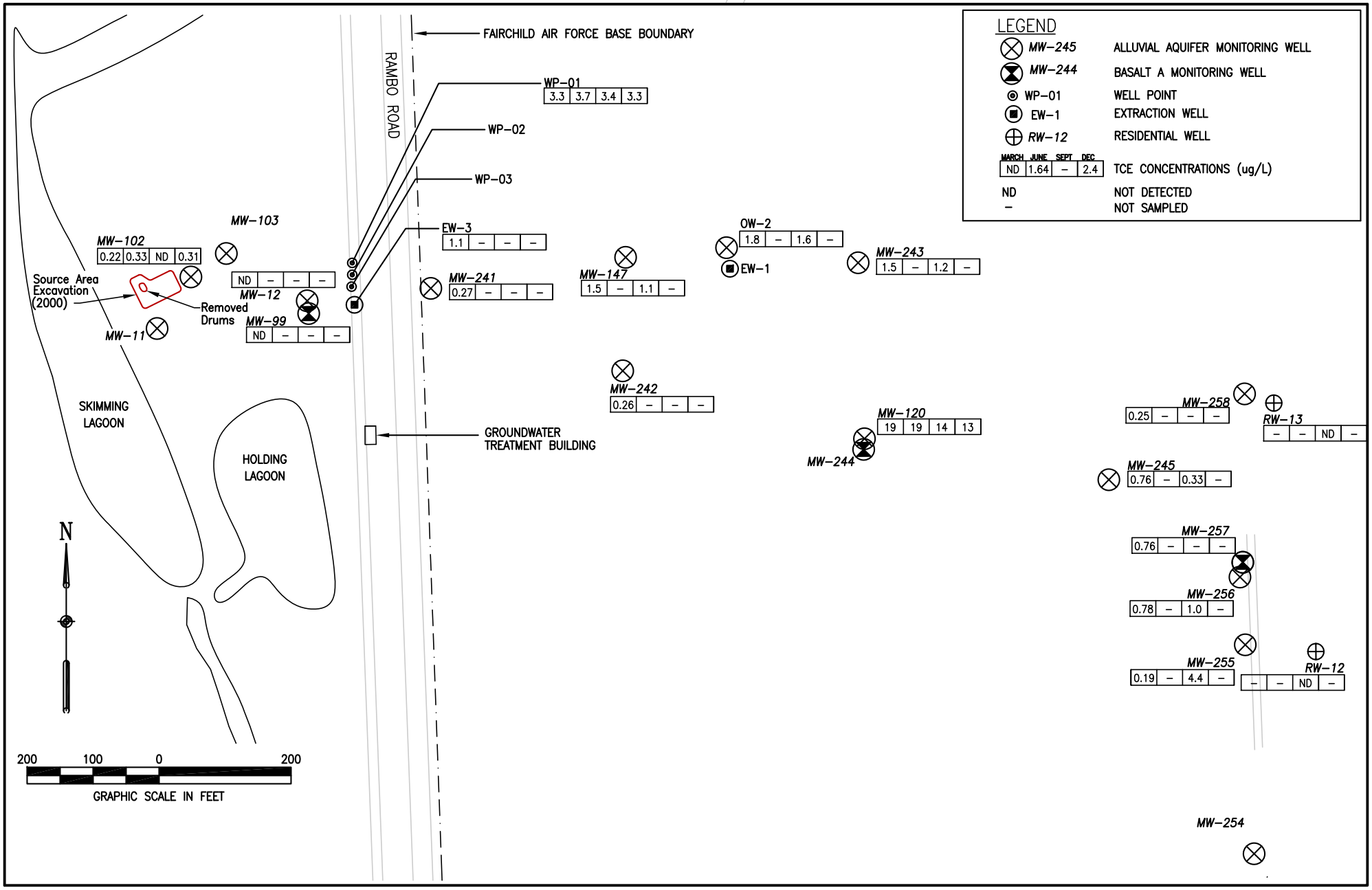

Figure 6-11c: Site WW-1 TCE Concentration Extent in Groundwater, 2012

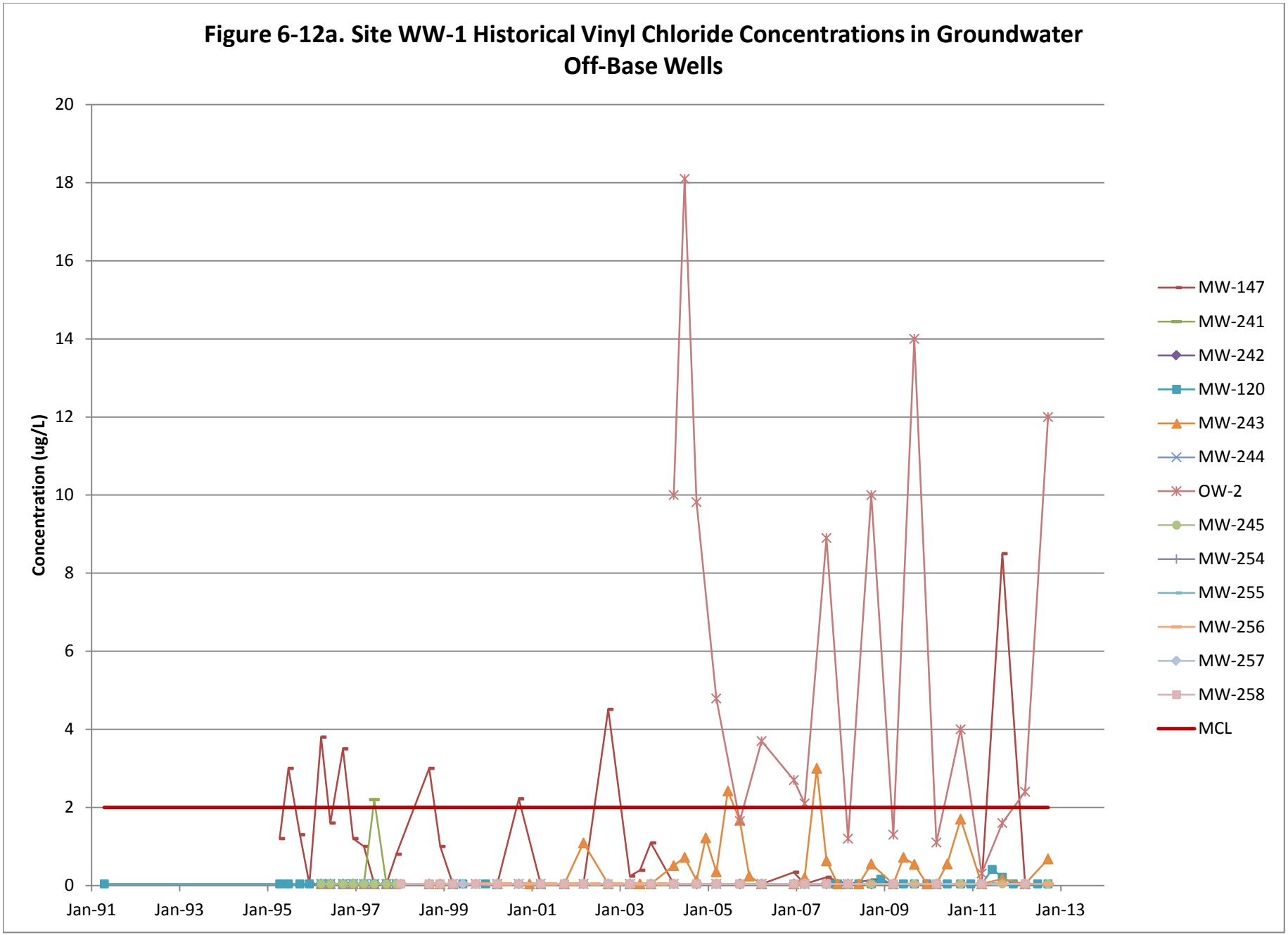
Figure 6-12a. Site WW-1 Historical Vinyl Chloride Concentrations in Groundwater
Off-Base Wells
Concentration (ug/L)
20
18
16
14
12
10
8
6
4
2
0
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
Jan-13
MW-147
MW-241
MW-242
MW-120
MW-243
MW-244
OW-2
MW-245
MW-254
MW-255
MW-256
MW-257
MW-258
MCL

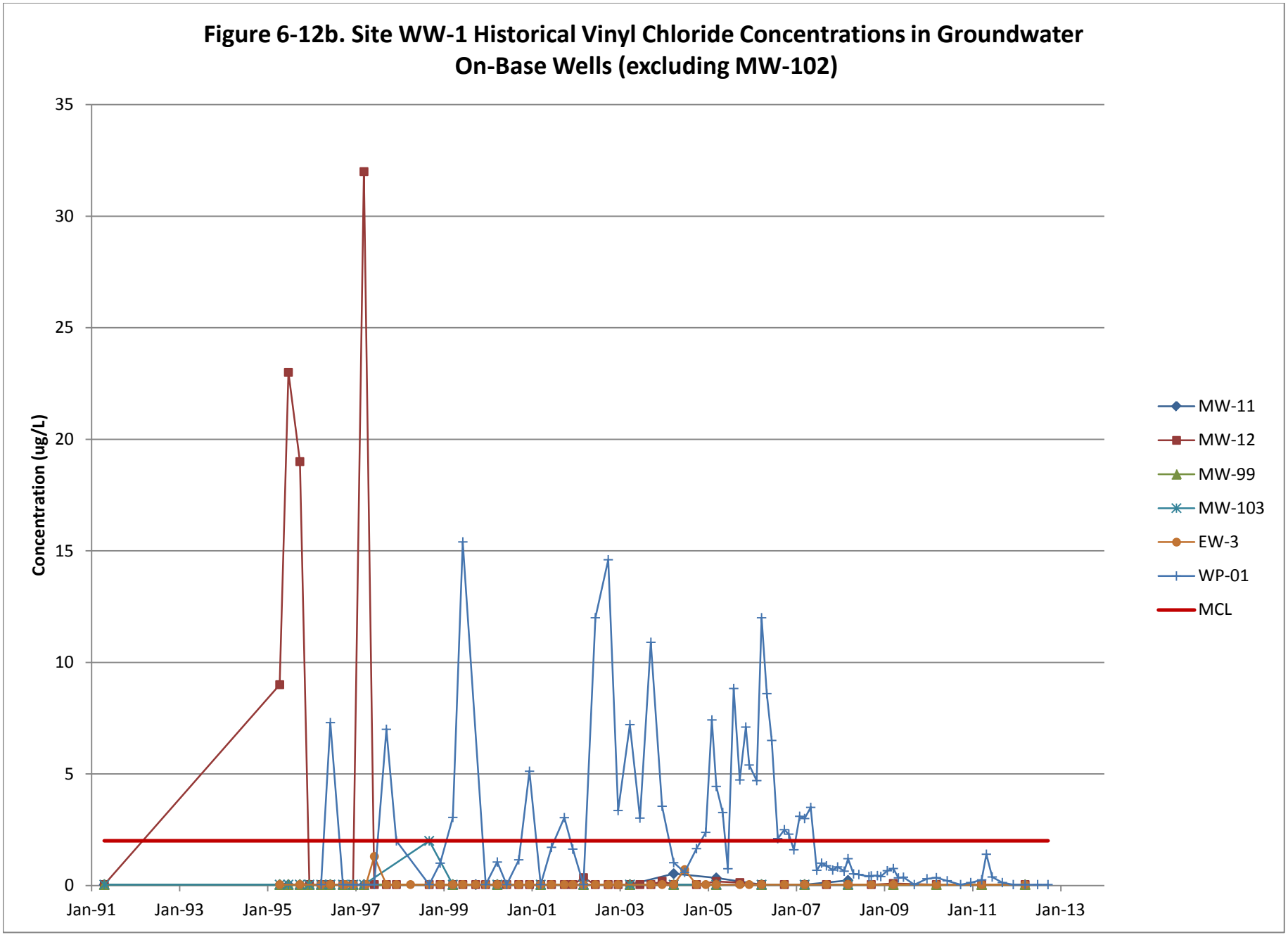
Figure 6-12b. Site WW-1 Historical Vinyl Chloride Concentrations in Groundwater
On-Base Wells (excluding MW-102)
Concentration (ug/L)
35
30
25
20
15
10
5
0
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
Jan-13
MW-11
MW-12
MW-99
MW-103
EW-3
WP-01
MCL

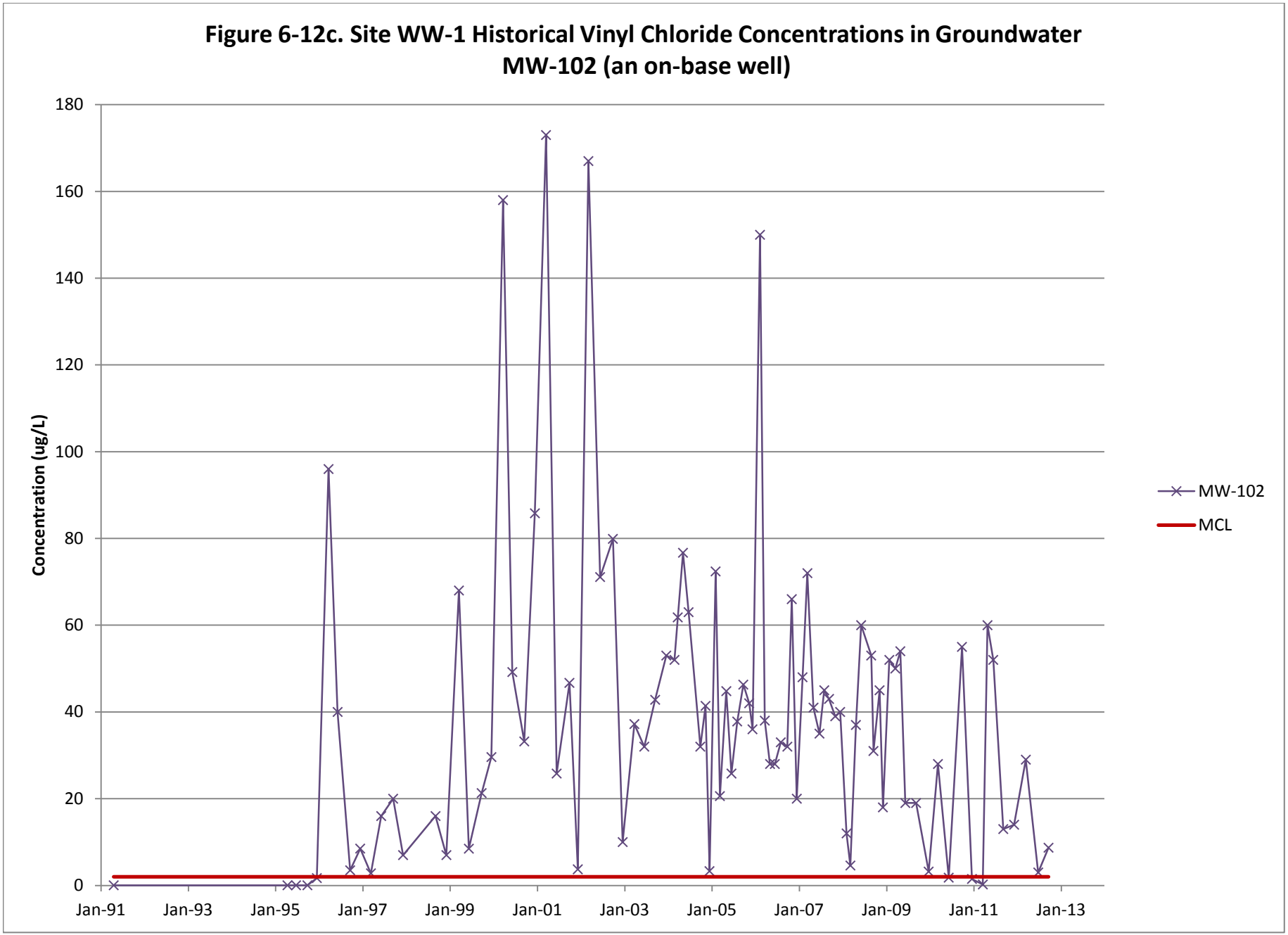
Figure 6-12c. Site WW-1 Historical Vinyl Chloride Concentrations in Groundwater
MW-102 (an on-base well)
Concentration (ug/L)
180
160
140
120
100
80
60
40
20
0
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
Jan-13
MW-102
MCL

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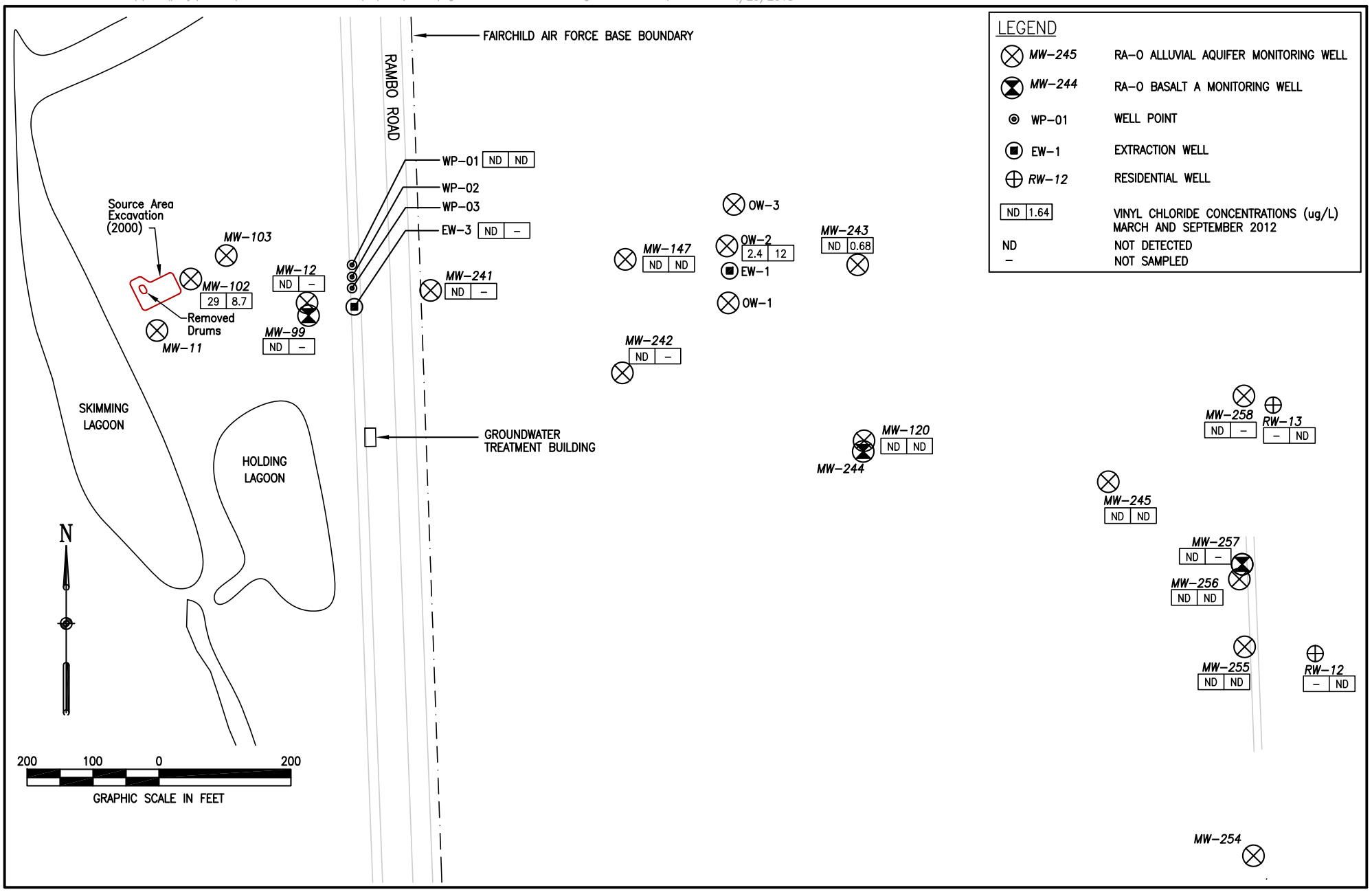

Figure 6-12d: Site WW-1 Vinyl Chloride Concentration Extent in Groundwater, 2012

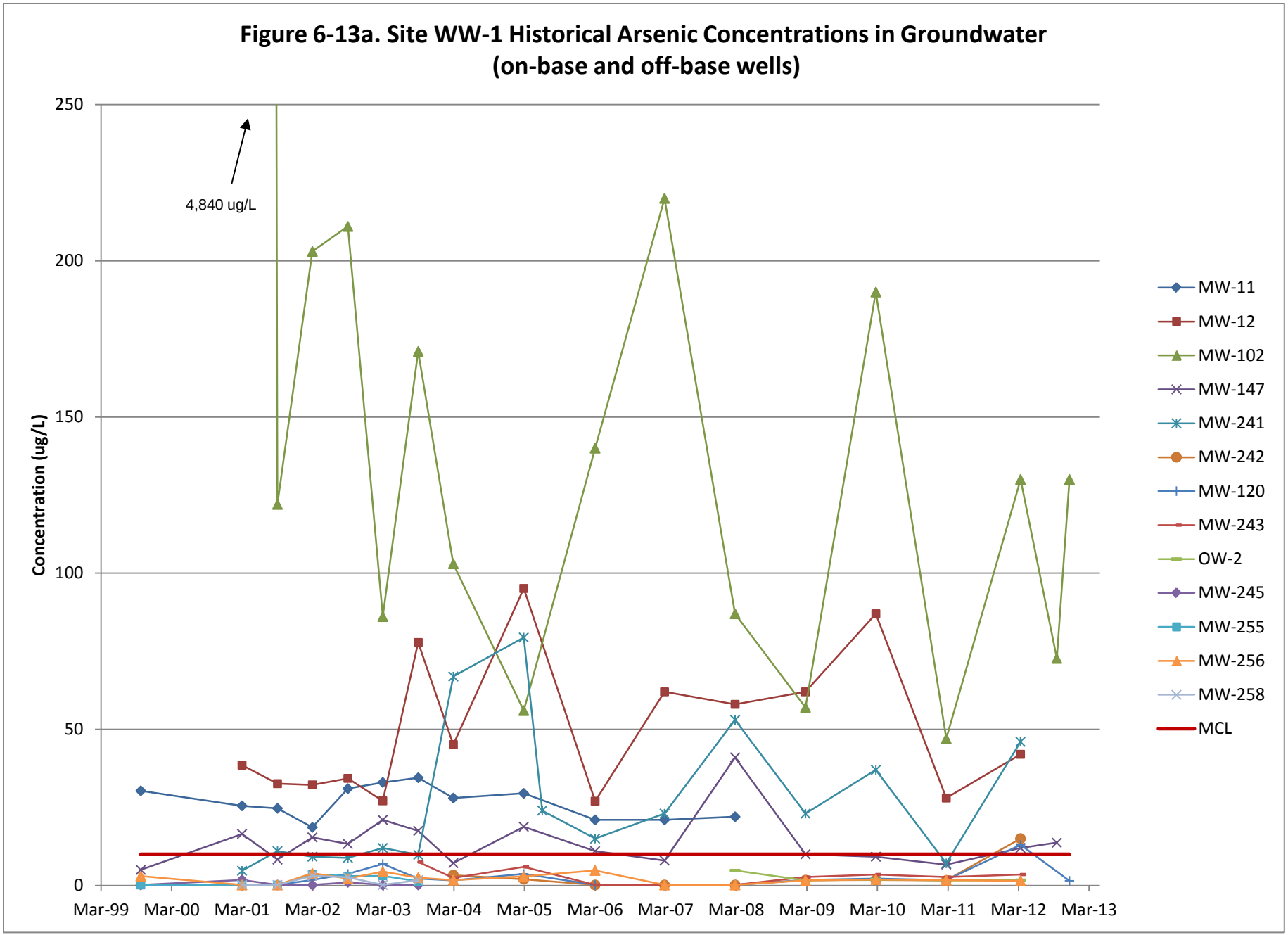
Figure 6-13a. Site WW-1 Historical Arsenic Concentrations in Groundwater
(on-base and off-base wells)
Concentration (ug/L)
250
200
150
100
50
0
4,840 ug/L
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03
Mar-04
Mar-05
Mar-06
Mar-07
Mar-08
Mar-09
Mar-10
Mar-11
Mar-12
Mar-13
MW-11
MW-12
MW-102
MW-147
MW-241
MW-242
MW-120
MW-243
OW-2
MW-245
MW-255
MW-256
MW-258
MCL

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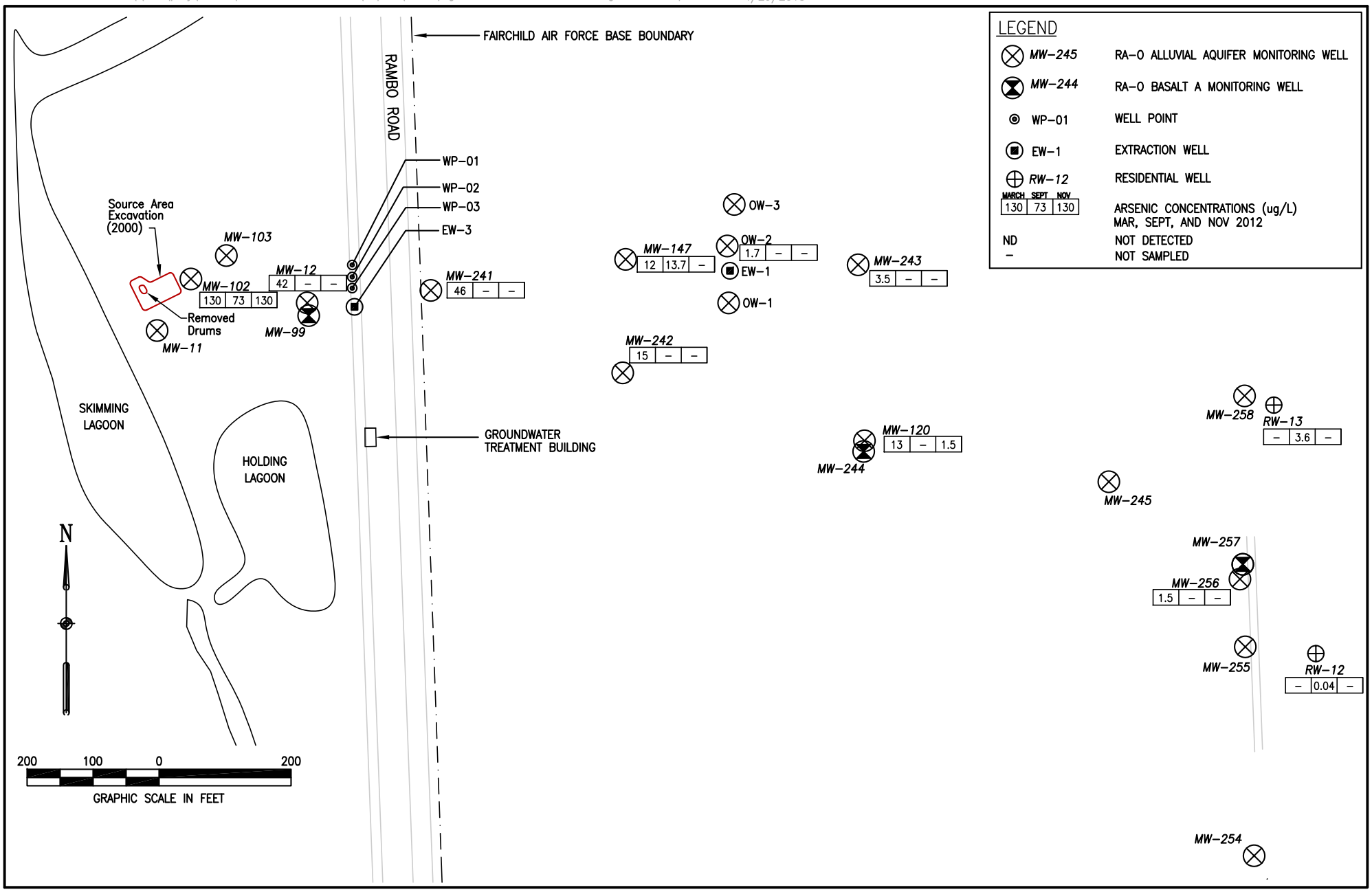

Figure 6-13b: Site WW-1 Arsenic Concentration Extent in Groundwater, 2012

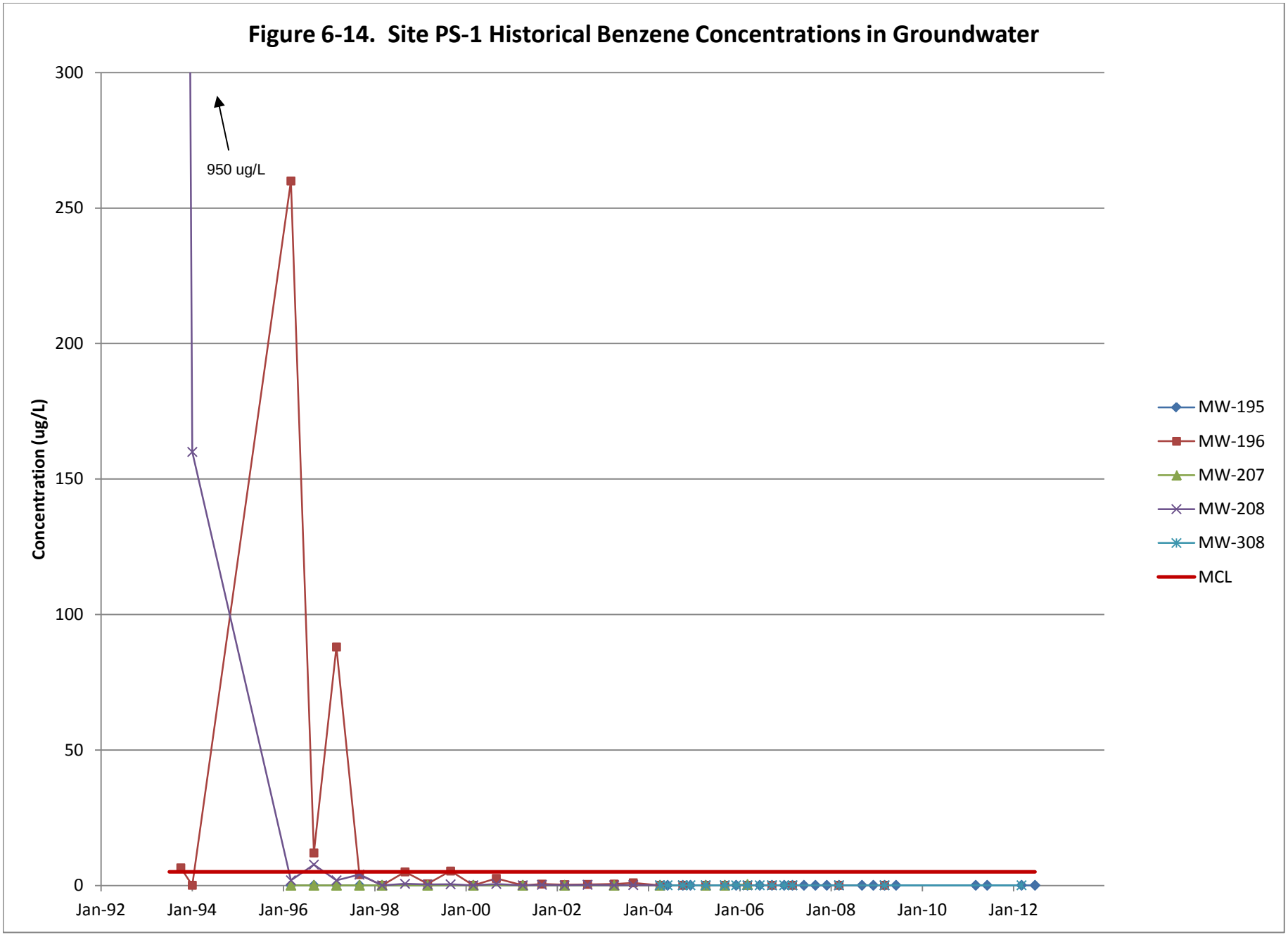
Figure 6-14. Site PS-1 Historical Benzene Concentrations in Groundwater
Concentration (ug/L)
300
250
200
150
100
50
0
950 ug/L
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
MW-195
MW-196
MW-207
MW-208
MW-308
MCL

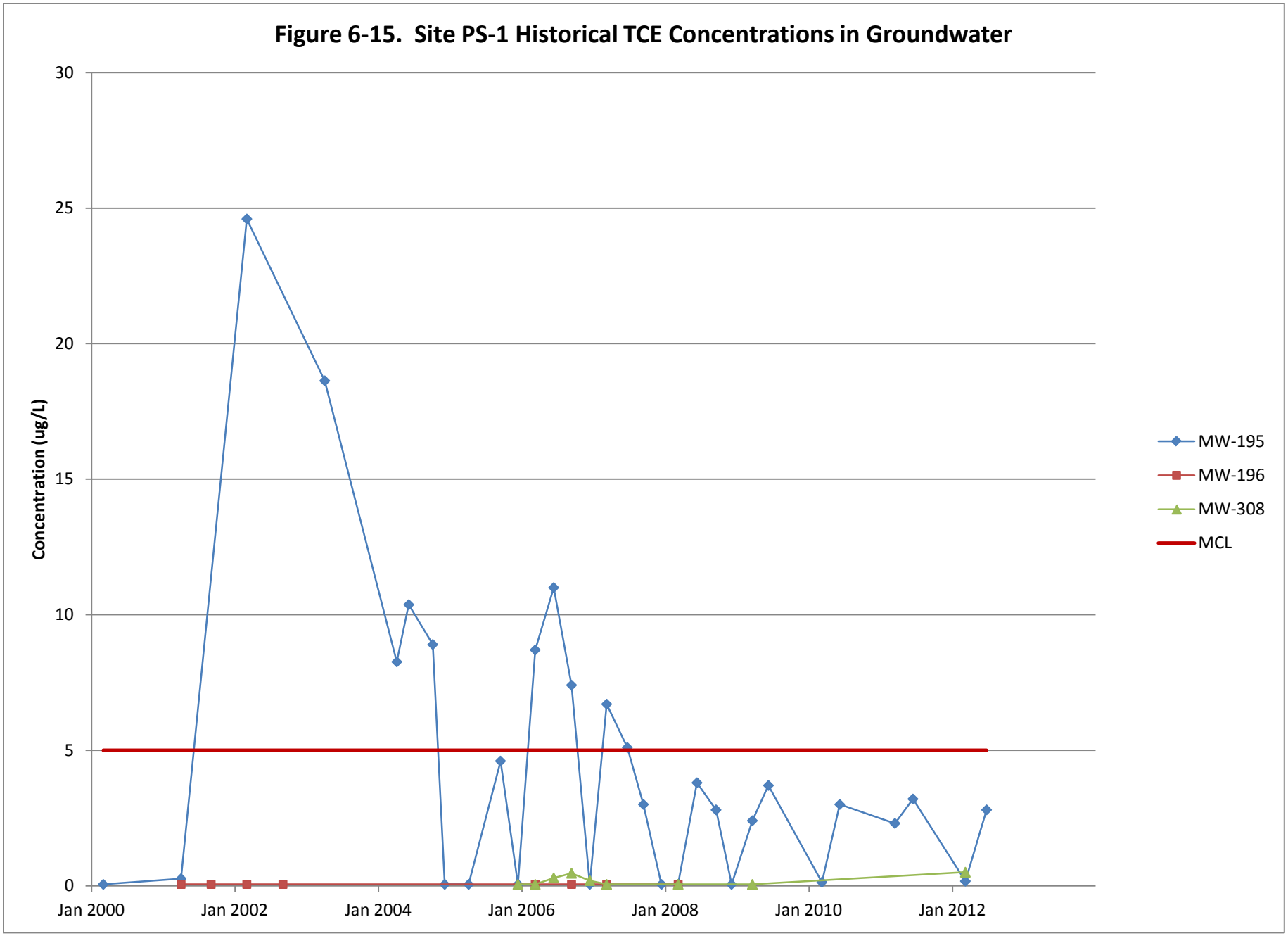
Figure 6-15. Site PS-1 Historical TCE Concentrations in Groundwater
Concentration (ug/L)
30
25
20
15
10
5
0
Jan 2000
Jan 2002
Jan 2004
Jan 2006
Jan 2008
Jan 2010
Jan 2012
MW-195
MW-196
MW-308
MCL

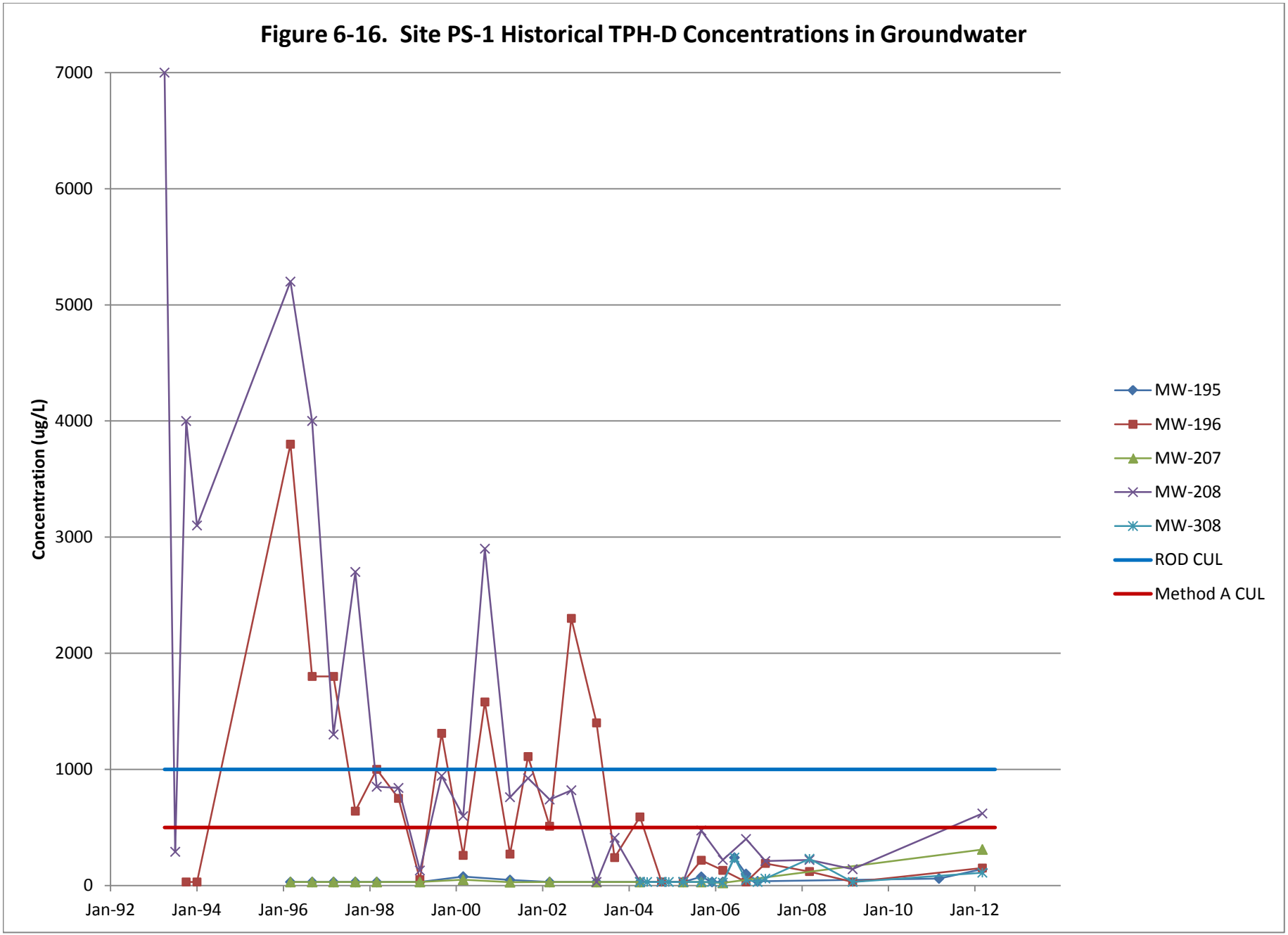
Figure 6-16. Site PS-1 Historical TPH-D Concentrations in Groundwater
Concentration (ug/L)
7000
6000
5000
4000
3000
2000
1000
0
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
MW-195
MW-196
MW-207
MW-208
MW-308
ROD CUL
Method A CUL

Appendix A
Site Inspection Report and Site Photographs

Site Inspection Report to Support the Third Five-Year Review, Fairchild AFB

Introduction

On 4 December 2012, staff from Fairchild AFB, EPA Region 10, and CH2M HILL conducted site inspections for Fairchild IRP sites to support the Third Five-Year Review evaluation. CH2M HILL is the current remedial action-operations/long-term monitoring (RA-O/LTM) contractor at Fairchild AFB.

Prior to conducting the site inspections, a meeting was held at Fairchild AFB at 9:00 am on 4 December to review the scope of the inspections and those sites to be visited. Those in attendance included:

- Kim Prestbo/EPA Region 10 (attended meeting only)
- Amy Dahl/TechLaw (EPA Region 10 contractor)
- Marc Connally/Fairchild AFB
- Danielle Adams/Fairchild AFB
- Mark Henry/CH2M HILL
- Paul Humphreys/CH2M HILL

During this meeting, it was confirmed that only those sites where remedial action was required by a Record of Decision (ROD) would be visited, which included 13 sites among three operable units (OUs): OU-1, OU-2, and OU-3. OU-1 is Craig Road Landfill, an off-base Priority One site. OU-2 includes on-base Priority One sites, and OU-3 includes on-base Priority Two sites. Fairchild AFB and CH2M HILL staff provided the following information to the EPA contractor before and during each inspection:

- A general overview and history of each site
- The contaminants of interest and impacted media
- The selected remedies identified in the ROD and the implemented remedies to date
- An overview of current status including RA-O activities and recent LTM results.
- Issues identified in the last past Five-Year Reviews and potential issues for this five-year review

The role of the Restoration Advisory Board (RAB) and information presented at RAB meetings also was outlined, as well as land use controls (LUCs) the base employs.

Photographs taken during the site inspections are attached.

Site Inspections

OU-1, Craig Road Landfill (LF002)

I. Site Information

Implemented remedies include:

a. Landfill covers

b. Access controls

c. Groundwater extraction and treatment system that provides hydraulic containment and treatment of contaminated groundwater via air stripping

d. Soil vapor extraction (SVE)- operation of temporary systems since 2010

e. In-situ chemical oxidation (ISCO) – three ISCO treatments completed in 2011 and 2012

II. Interviews (see Appendix B)

III. On-Site Documents & Records Verified

a. Site O&M manual (CH2M HILL, 2005) for the GETS is available onsite. The O&M manual will be evaluated for the need to update it in the forthcoming post-ROD treatability study report, given optimizations (e.g., idling of specific wells) completed in 2011-2012. As-built diagrams for the GETS are available onsite in the original Site O&M manual (Hensel Phelps, February 1996). Quarterly RA-O reports include maintenance logs and documentation of site activities.

b. A single health and safety plan covers all RA-O/LTM activities for all sites, with an up-to-date version prepared in 2012 (CH2M HILL, February 2012).

c. O&M Records are included in quarterly RA-O reports; OSHA training records are available upon request.

d. Permits. Although a permit is not required for CERCLA remedies, the USAF must comply with the substantive elements of a permit requirement. For the CRL, an Air Discharge Permit is through Spokane Regional Clean Air Agency (SRCAA) (NOC #646). Fairchild AFB provides SRCAA with a letter report documenting air discharges of regulated constituents from the treatment plant each quarter and from the landfill's passive methane vents annually; these letter reports are included in quarterly RA-O Reports. Note: Prior to implementation of SVE activities in 2010, SRCAA was contacted by CH2M HILL regarding permits for temporary SVE systems. SRCAA indicated that permits were not required because these were CERCLA actions and the systems were not permanent. As part of the post-ROD treatability study report, the ARARs including the need to meet the substantive requirements of a permanent permit will be reviewed to ascertain potential PP and RODA requirements. As the treated water at CRL is recirculated, there are no waste disposal/POTW permit requirements.

e. Groundwater monitoring results are documented in quarterly RA-O reports; annual RA-O reports summarize all LTM and RA-O results for a given year, and are up to date through 2012 (CH2M HILL March 2013).

f. CH2M HILL is on-site daily during the work week; Alfred Samford/CH2M HILL (the treatment plant operator) visually inspects the site daily and keeps a daily maintenance log available for inspection on site, which is also included in quarterly RA-O reports; U.S. Army Reserve staff visit the site regularly to reach their equipment and maintenance area.

IV. O&M Costs

a. O&M was completed during the five-year review period by CH2M HILL under an AFCEC contract. O&M costs were not discussed during the site visit, but are summarized in the *Third Five-Year Review* to be further detailed in the forthcoming post-ROD treatability study report. Craig Road Landfill is the largest IRP site at Fairchild and accounts for approximately 95% of annual O&M costs. No unusually high or unanticipated O&M costs were incurred during this last five-year review period. The largest single O&M cost component is change-out of granular activated carbon (GAC), which is used to remove volatile organic compounds (VOCs) from the groundwater treatment plant's air stripper. A single GAC unit (8,000 pounds of GAC) was changed-out in September 2010 at a cost of approximately $24,000; based on performance monitoring of GAC offgas, the next GAG change-out is not anticipated to be necessary until 2014 at the earliest. GAC change-outs associated with the SVE systems are anticipated to be completed in third quarter 2013. Costs for these will be considerably less because volumes of the SVE GAC are significantly less than that for the GETS.

V. Access and Institutional Controls

a. Site access is restricted by fencing, locked gates, and signage, which remain in place. Access to the site is limited to Air Force personnel (and their designees), CH2M HILL personnel and their subcontractors, and the U.S. Army Reserve.

b. Fairchild AFB maintains LUCs for the site in accordance with the LUC plan (USAF, May 2007). Offsite, the Spokane Regional Department of Health and the Washington Department of Ecology (Ecology) have controls in place to prevent use of contaminated groundwater or drilling of new wells within the site vicinity. No violations of LUCs were identified.

c. No vandalism was evident at Craig Road Landfill. Onsite structures and wells are locked; O&M staff and 92 CES/CEIE staff control all keys. Land use both on the site and on private property in the immediate site vicinity has not changed substantially during the reporting period.

VI. General Site Conditions

a. On-site roads are generally in good condition. Periodic maintenance is required to repair the front gate at the site or to address specific issues such as rutting, primarily due to heavy truck traffic to and from the U.S. Army Reserve facility during wetter spring conditions.

b. A CH2M Hill subcontractor completes noxious weed control spraying once per year, typically in June or July. Prior to application by this licensed professional, herbicides and/or pesticides to be used are identified, and their proposed use (volumes and acreage to be treated) are cleared through Fairchild AFB Civil Engineering staff.

VII. Landfill Covers

a. Two areas at Craig Road Landfill have a landfill cover, the northeast disposal area (NDA) and southwest disposal area (SDA). These landfill covers are visually inspected quarterly in accordance with the O&M plan and results are provided in quarterly RA-O Reports. Periodic maintenance includes filling animal burrows, re-seeding areas on the caps where grass growth is limited, and filling/re-seeding areas where rutting has occurred.

b. The vegetative cover of the landfill caps is adequate to control runoff and prevent substantial erosion. The cover is properly established and does not show signs of stress. See Photo 1.

c. Slope stability has been maintained. Periodically (primarily in the spring), there are some wet areas on the east side of the NDA, but no slope stability problems or water damage were observed during the reporting period.

d. During the past five years, several new penetrations have been made through the landfill covers from soil gas investigations and installation of approximately 40 remediation wells associated with contaminant source investigations and treatment. All wells have been constructed in accordance with Ecology well installation procedures. No evidence of leakage at these penetrations has been observed; these wells are properly secured/locked and in good condition.

e. No landfill gas is collected or treated at the site. There are two passive methane vents located in both the NDA and SDA. These are inspected quarterly and sampled annually in accordance with SRCAA permit requirements. These vents are functioning as designed, and in good condition with no evidence of leakage at penetration.

VIII. Vertical Barrier Walls: Not applicable

IX. Groundwater Remedies

a. 12 extraction wells (6 each on the perimeter of both the NDA and SDA) are located at the site. Operation of these wells and the groundwater treatment system are documented in quarterly RA-O reports. During the last five years, operations modes have included (1) full-time operations, (2) batch treatment operations, and (3) limited batch treatment operations (refer to quarterly RA-O reports). All wells and their discharge piping are inspected routinely, and O&M activities are completed in accordance with the site O&M plan. Periodic repairs include flow meter replacement and flow transmitter replacement (as needed), and occasional extraction well pump/motor replacement. Pumps (EW-14, EW-3, and EW-11) have been replaced during the five-year review period as discussed in quarterly RA-O reports. Extraction well motor/pumps are replaced as necessary; there is no formal replacement schedule for additional pump replacement. Remaining wells are in good condition and operate as necessary.

b. Wellhead plumbing, electrical, extraction system pipelines, valves, valve boxes, and other appurtenances are in good operating condition with no maintenance needs identified. Spare parts and equipment are readily available for key elements of the system. Routine inspection and maintenance are completed in accordance with scheduled O&M procedures.

c. The groundwater treatment system includes air stripping for VOCs and subsequent carbon adsorption (by GAC units operated in series). The system is operated in accordance with the site O&M plan and routine maintenance is detailed in quarterly RA-O reports. The facility is maintained in good condition. The treatment building is in good condition (esp. roof and doorways. Temporary storage of any chemicals is in accordance with material safety data sheets, the site health and safety plan, and base procedures.

d. LTM continues on a quarterly basis at the site, and data is routinely submitted on time and is of acceptable quality. Monitoring data suggests the groundwater plume is effectively contained (with the exception of MW-118) and TCE concentrations are declining.

X. Other Remedies

a. Pilot testing systems using SVE were implemented at Craig Road Landfill in the SDA in 2010 and in the NDA in 2012. For each area, soil vapor is pulled from fractured basalt beneath the waste cells and then treated using GAC units in series. Operational results are provided in quarterly RA-O reports and details will be presented in the post-ROD treatability study report.

b. ISCO treatments were completed in the SDA in August 2011 and July 2012 and in the NDA in October 2012. Planning documents covering this work were approved by Ecology in May 2009; results of these treatments and subsequent performance monitoring are documented in quarterly and annual RA-O reports. A synthesis is forthcoming in a post-ROD treatability study report.

XI. Overall Observations

a. Implementation of the Remedy: Prior to 2006, the remedy was functioning as designed, but the five-year review process affirmed that O&M costs were high relative to the amount of contaminants removed by the groundwater extraction and treatment system. A remedial process optimization report identified batch groundwater treatment operations as a potential way to reduce overall costs, and increase contaminant removal while maintaining hydraulic control. This was pilot tested in late 2006 and fully implemented in 2007. Targeted contaminant source reductions (using SVE and ISCO) were conducted from 2009 through 2012 to treat suspected source areas in the SDA and NDA.

b. Adequacy of O&M: O&M procedures and scope are completed in accordance with the site O&M plan and continue to maintain long-term protectiveness. O&M plans for SVE system operations need to be completed, pending the post-ROD treatability study report.

c. Early Indicators of Potential Remedy Problems: Following ISCO treatments in the SDA and NDA, sodium permanganate (the ISCO oxidizing agent) has been observed in some extraction wells located downgradient of the injections. To maximize ISCO effectiveness, groundwater extraction has been temporarily reduced to avoid withdrawing the treatment substrate (sodium permanganate) from the aquifer, potentially impacting the hydraulic control element of the remedy. The reduced groundwater extraction rates will be evaluated with regard to hydraulic control in the post-ROD treatability study report to establish under which conditions sufficient control is being maintained (e.g., which wells must be operating, and which may be temporarily idled) while minimizing likelihood of interference with the GETS.

d. Optimization: Optimization of ongoing LTM and/or RA-O activities is a routine component of evaluation and reporting in annual RA-O reports.

OU-2, On-Base Priority One Sites

- SW-1 (LF001) Old Base Landfill
- PS-2 (SS018) Refueling Pit Area
- PS-8 (SS026) Underground Fuel Line Area
- FT-1 (FT004) Former Fire Training Area
- WW-1 (WP003) Industrial Wastewater Lagoons

I. Site Information

Remedy includes:

a. Landfill cover (LF001 only, non-engineered soil cap)

b. Institutional controls (all)

c. Groundwater extraction and treatment system (for WP003 only, but operation discontinued in 2006 with Ecology approval)

d. Passive Free Product Recovery (SS018 only)

e. Bioventing and Air Sparging (FT004 only, but discontinued in 2006 with Ecology approval)

II. Interviews: see Appendix B.

III. On-Site Documents & Records Verified

a. Site O&M manuals for WP003 and FT004 are available at Craig Road Landfill, but neither system was operational during the past five years. Quarterly RA-O reports document site activities.

b. A single health and safety plan covers RA-O/LTM activities for all OU-2 sites (CH2M HILL, February 2012).

c. OSHA training records are available upon request.

d. Permits: An air discharge permit for WP003 through SRCAA is inactive.

e. Groundwater monitoring results are documented in quarterly RA-O reports; annual RA-O reports summarize all LTM and RA-O results for a given year.

f. All sites are located on-base which limits access to Air Force and Air-Force authorized (and in some locations, escorted) personnel. The sites are visited by CH2M HILL during monitoring events and are inspected by Fairchild AFB personnel per the LUC Plan (USAF, May 2007).

IV. O&M Costs

a. O&M was completed during the five-year review period by CH2M HILL under an AFCEC contract. O&M costs were not discussed during the site visit, but are summarized in the *Third Five-Year Review*. Minimal O&M costs have been incurred at these sites during the last five years.

V. Access and Institutional Controls

a. All OU-2 sites are located on-base. Entry onto the base is controlled by USAF Security Forces. Access to all sites is further restricted as they all are located within flightline-controlled areas surrounded by fencing and identified with signage. Special flight-line access for WP003, FT004, SS018, and SS026 is acquired by requesting an Entry Authorization Letter obtained through the 92nd Operations Support Squadron with one month advance notice. Authorization is valid for one year. Further, SS026 and SS018 are located within restricted areas that require an Air Force escort for access and requires at least one week advance notice.

b. Fairchild AFB maintains LUCs for the sites in accordance with the LUC plan. Off-base (at WP003 and FT004), the Spokane Regional Department of Health and Ecology have controls in place to prevent use of contaminated groundwater or drill new wells within the vicinity. Specifically, although there is no language in the OU-2 ROD that is specific to LUCs/ICs off-base, there is a commitment to provide point-of-use treatment and/or alternative water supply, as necessary, in the event that concentrations in off-base water supply wells exceed MCLs. The 2008 *Second Five-Year Review* report describes the following as possible governmental controls at WP003 that could help meet the objective of preventing use of contaminated groundwater for drinking:

   Regulatory jurisdictions that may limit or restrict use of groundwater in these areas may be in place under the governance of the City of Airway Heights, Spokane County Health District, or the State of Washington (WAC 173-160-171, Well siting locations as identified in the Minimum Standards for the Construction and Maintenance of Wells). Collectively, these jurisdictions appear to effectually restrict current and future use of any contaminated groundwater associated with the base. A City of Airway Heights water supply well (PS-1/4) is sampled quarterly as part of the base's residential well monitoring program; sampling results from this well are provided to the City for information and review purposes. In addition, information on the status of groundwater contamination within the vicinity of the CRL is routinely presented at Fairchild AFB RAB meetings, which are open to the general public.

   No violations of LUCs have been identified.

VI. General Site Conditions

a. The general conditions were observed to be good at all OU-2 sites.

VII. Landfill Covers

a. LF001 is the old base landfill that has a non-engineered soil cover over the waste unit, consisting of a soil cover. During the inspection, numerous areas of settlement or

uneven terrain. Base personnel perform quarterly inspections of the non-engineered soil cover for runoff potential and ponding issues. There are no requirements to repair the soil cover unless significant issues are found, and none have been identified during the last five years. The remedy as implemented has been demonstrated to be protective.

b. The vegetative cover of the soil cover was observed to be healthy during the site inspection (see Photo 2).

c. No landfill gas is collected or vented at LF001.

VIII. Vertical Barrier Walls: Not applicable

IX. Groundwater Remedies

a. A groundwater extraction and treatment system (GETS) remains present at Site WP003, but has not been operational since 2006. Ecology concurred in 2011 that the conditional requirement to operate the groundwater extraction system under certain triggering conditions can be eliminated (Ecology, June 29, 2011).

b. Passive free product recovery continues at SS018. The frequency of free product checks during the reporting period has varied between quarterly and annually. In 2006, the use of passive canisters (Keck brand) was discontinued and replaced with periodic checks and inspections at two recovery wells. Because no free product has been observed, or recovered since 2009, only annual checks (in the spring when water levels are rising) are currently completed with concurrence of Ecology and EPA (Ecology, June 4, 2009; EPA, October 19, 2012).

c. LTM for OU-2 sites occurred quarterly during the five-year review period at WP003 and annually at SS018 and FT004; at LF001 and SS026, regular LTM was suspended during the past five years, and monitoring only was required in 2012 to support this five-year review. LTM for WP003 includes sampling of on-site monitoring wells, and of off-base monitoring wells and nearby residential wells. Sampling at the other sites is limited to on-site monitoring wells. Results are documented in quarterly RA-O reports.

X. Other Remedies

a. Bioventing and air-sparging systems were operational at FT004 until late 2006 when the systems were shut down with concurrence of Ecology. Shallow groundwater at this site had met remedial action objectives for benzene.

b. An additional dig-and-haul of approximately 1500 tons of soil was completed at FT004 in 2008. This work was completed to address areas of known TPH contamination (heavier fractions) that remained following shutdown of the bioventing system.

XI. Overall Observations

a. Implementation of the Remedy: The remedy components for each site are effective and functioning as designed.

b. Adequacy of O&M: O&M for OU-2 is adequate to ensure the remedy remains protective in the short and long term. LUCs remain in place. Annual evaluation of LTM results is conducted to identify if changed conditions have occurred.

c. Early Indicators of Potential Remedy Problems: No evidence of potential remedy problems were observed during site inspections of OU-2.

d. Optimization: Optimization of ongoing LTM and/or RA-O activities is a routine component of evaluation and reporting in annual RA-O reports.

OU-3, Priority Two Sites

- IS-3 (OT016) Reciprocating Engine Test Cell
- IS-4 (OT017) Jet Engine Test Cell
- PS-1 (ST006) POL Bulk Storage Area
- PS-5 (SS009) Heating Oil Tank Area
- PS-7 (ST010) Fuel Oil Storage Tanks
- PS-10 (SD031) Fuel Truck Maintenance
- FT-2 (FT032) Old Fire Training Area

I. **Site Information**

Remedy includes:

a. Institutional controls (all sites)

b. Bioventing (ST006 only, but discontinued in 2006 with Ecology approval)

II. **Interviews:** see Appendix B

III. On-Site Documents & Records Verified

a. A site O&M manual for ST006 is available at Craig Road Landfill, but the system was not required to be operational during the reporting period.

b. Quarterly RA-O reports document site activities.

c. A single health and safety plan covers RA-O/LTM activities for all OU-3 sites (CH2M HILL, February 2012).

d. OSHA training records are available upon request.

e. Permits – None.

f. Groundwater monitoring results are documented in quarterly RA-O reports; annual RA-O reports summarize all LTM and RA-O results for a given year.

g. All sites are located on-base. The sites are visited by CH2M HILL during monitoring events and are inspected by Fairchild AFB personnel per the LUC Plan (USAF, May 2007).

IV. O&M Costs

a. O&M was completed during the five-year review period by CH2M HILL under an AFCEC contract. O&M costs were not discussed during the site visit, but are summarized in the *Third Five-Year Review*. Minimal O&M costs have been incurred at these sites during the last five years.

V. Access and Institutional Controls

a. All OU-3 sites are located on-base. Entry onto the base is controlled by USAF Security Forces. Access to OT016, OT017, SD031 and FT032 is further restricted as they all are located within flightline-controlled areas surrounded by fencing and identified with signage. Special flight-line access is acquired by requesting an Entry Authorization Letter obtained through the 92nd Operations Support Squadron with one month advance notice. Authorization is valid for one year.

b. Fairchild AFB maintains LUCs for the sites in accordance with the LUC plan. No violations of LUCs have been identified.

VI. General Site Conditions

a. Access to OT016, OT017, SD031 and FT032 is limited to personnel authorized to be on the flightline only. As such, few personnel visit any of the sites on a regular basis outside of Security Forces staff. For the other sites, access by base personnel is not restricted. The general conditions were observed to be good at all OU-3 sites.

VII. **Landfill Covers: Not applicable**

VIII. **Vertical Barrier Walls: Not applicable**

IX. **Groundwater Remedies**

a. LTM results for OU-3 sites are included in quarterly RA-O reports and discussed in annual RA-O/LTM Reports.

X. **Other Remedies**

a. The OU-3 ROD identified institutional controls only for OT016.
b. RA-O activities at SS009 and ST010 were identified as completed by Ecology in 1997. However, further investigation may be necessary for Site ST010 due to the likelihood that petroleum-contaminated soils were found beneath Bldg 1350 but could not be accessed until the building is demolished.
c. Soil removal was completed at SD031 in 1998. However, observed TCE contamination in groundwater at this site was deferred to Site SS-39.
d. Bioventing systems were operational at ST006 until late 2006 when the systems were shut down with concurrence of Ecology. Shallow groundwater at this site had met remedial action objectives for benzene. Residual TPH contamination may be present in site soils, but remains inaccessible due to current operations.

XI. Overall Observations

a. Implementation of the Remedy: The remedy components for each site appear to be effective and functioning as designed.
b. Adequacy of O&M: O&M activities are currently not being conducted for OU-3 sites.
c. Early Indicators of Potential Remedy Problems: No evidence of potential remedy problems were observed during site inspections of OU-3.
d. Optimization: Optimization of ongoing LTM and/or RA-O activities is a routine component of evaluation and reporting in annual RA-O reports.

Photo 1. Site SW-8 (LF002) – Craig Road Landfill South Disposal Area (SDA), looking west-southwest

Photo 2. Site SW-1 (LF001) – Old Base Landfill, looking east-northeast

Photo 3. Site PS-2 (SS018) – Refueling Pit Area, looking north

Photo 4. Site PS-8 (SS026) – Underground Fuel Line Area, near Building 1019, looking west-southwest

Photo 5. Site FT-1 (FT004) – Former Fire Training Area, looking east

Photo 6. Site WW-1 (WP003) – Industrial Wastewater Lagoons (looking south between the holding lagoon on the left and the skimming lagoon on the right)

Photo 7. Site IS-3 (OT016) – Reciprocating Engine Test Cell, former Bldg 2150 area, looking south

Photo 8. Site IS-4 (OT017) – Jet Engine Test Cell, former Bldg 3000 vicinity, looking south-southeast

Photo 9. Site PS-1 (ST006) – Bulk Fuel Storage Area, looking west

Photo 10. Site PS-5 (SS009) – Heating Oil Tank Area, Wherry Housing, looking west

Photo 11. Site PS-7 (ST010) – Fuel Oil Storage Tanks, looking east

Photo 12. Site PS-10 (SD031) – Former Bldg 1060 Area – showing location of former oil-water separator and its drainage swale south of former building, looking south-southwest

Photo 13. Site FT-2 (FT032) – Old Fire Training Area, looking south

Appendix B
Interview Forms

Third Five-Year Review - Interview Record
Fairchild, AFB

Name: Steve Holderby **Date: 25** March 2013

Phone: 509.324.1571 **Representing:** RAB Member, Spokane Regional Health District Environmental Resources Program Manager

Contact Made By: Mark Henry/CH2M HILL via telephone.

Questions:

What is your overall impression of the project? (general sentiment). *Fairchild AFB is doing a good job overall; it works well with the various agencies and keeps the RAB informed.*

What effects have site operations had on the surrounding community? *In recent years, seems that site operations have had minimal effects on the surrounding community, based on a lack of concerns voiced to the Spokane Regional Health District.*

Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details. *Spokane Regional Health District has had some direct interaction with Fairchild AFB Civil Engineering staff, but specific to solid waste issues. There have been other inquiries to his office by the general public regarding nearby areas that some might associate with Fairchild (Graham Road Landfill, AAA Battery FUD on Graham Road, Euclid Road investigation), but none expressed specific to Fairchild AFB restoration projects.*

Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details. *Not aware of any.*

Do you feel well informed about the site's activities and progress? *Yes. The Base continues to make progress on restoration projects, staying the course and generally staying on schedule (despite the various challenges they face [funding constraints, etc.]).*

Do you have any comments, suggestions, or recommendations regarding the site's management or operation? *Sees progress in the overall program and wants to see sites achieve restoration goals. Is concerned of how the federal sequester may impact progress, funding, and time lines to meet restoration goals.*

Third Five-Year Review - Interview Record
Fairchild, AFB

Name: Craig Schwyn **Date:** 18 March 2013

Phone: 509.448.3187 **Representing:** RAB Community Co-Chair for Fairchild AFB and WA Air National Guard

Contact Made By: Mark Henry/CH2M HILL

Questions:

What is your overall impression of the project? (general sentiment). *In comparison to other gov't projects, Fairchild is doing a great job. The Air Force has had its challenges in securing funding, but has been proactive in seeking these to start remediation. The Air Force is not shying away from their responsibility to the community.*

What effects have site operations had on the surrounding community? *Historical issues (Vietzke Village water supply and WW-1 area residential wells) occurred well in the past and community interest has dropped off. Indicated that Site SS-39 issues probably have not caught the attention of the general public just yet, but there could be concerns raised in the future.*

Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details. *Although maybe not directly related to Fairchild operations, public perceptions of how the gov't has handled the Euclid Road investigation is not favorable. The general public does not differentiate this as a military issue specific to a single branch, but that the gov't needs to take responsibility for the issues rather than pass them off among other gov't entities. This likely has contributed to some skepticism by the public that "the gov't" will take care of the issues.*

Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details. *Not aware of any.*

Do you feel well informed about the site's activities and progress? *Yes. However, the RAB meetings to provide the same information over and over, and maybe that is only because it takes time to work through the planning and completion of various activities. If one desires, there definitely is more information available to the public. There is a concern that fewer and fewer community members are attending the RABs. The Air Force should identify ways to stimulate more public involvement.*

Do you have any comments, suggestions, or recommendations regarding the site's management or operation? *For the investigation type activities that the Air Force contracts, feels that the performance-based contracts may not be beneficial, but thinks that time and materials types of contracts would be best suited for the unknown nature of several of the ongoing investigations. Feels the base is moving in positive directions towards completing necessary restoration, but knows that off-base concerns for Site SS-39 may be a focus for future actions.*

Appendix C
Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBCs) for Priority One, Two, and Three Sites

Appendix C. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Materials for Priority One, Two, and Three Sites at Fairchild AFB, Washington			
Regulatory Citation	**Requirement**	**Status/Category**	**Action to attain ARAR**
Safe Drinking Water Act of 1974 (Public Law 93-523, as amended; 42 U.S.C. 300f *et seq*.)., "National Primary Drinking Water Regulations"40 CFR 141 ("Maximum contaminant levels for organic contaminants" 40 CFR 141.61 and "Maximum contaminant level goals for organic contaminants "40 CFR 141.50)	Establishes MCLs and MCLGs as criteria for groundwater and surface water that are or may be used for drinking water. The standards/goals are designed to protect human health from adverse effects of organic contaminants in the drinking water.	Applicable/Chemical	Groundwater remediation and management activities.
Model Toxics Control Act Statute and Regulation (Chapter 70.105D RCW, as amended); "MTCA Cleanup Regulation" Chapter 173-340 WAC "Ground Water Cleanup Standards" WAC 173-340-720. "Method B Cleanup Levels for Potable Ground Water" WAC 73-340-720(4)(b) (i-iii) (A)&(B). "Adjustments to Cleanup Levels"	Groundwater cleanup levels are based on estimates of the highest beneficial use and the reasonable maximum exposure expected to occur under both current and potential future site use conditions. Method B equations (720-1 and 720-2) to calculate groundwater cleanup levels for non-carcinogens and carcinogens, respectively.	TBC/Chemical	Groundwater remediation and management activities.
Model Toxics Control Act Statute and Regulation (Chapter 70.105D RCW, as amended); "MTCA Cleanup Regulation" Chapter 173-340 WAC Table 720-1 Method A cleanup levels for Groundwater	Provides conservative cleanup levels for drinking water beneficial uses at sites undergoing cleanup actions with relatively few hazardous substances.	Applicable/Chemical	Groundwater remediation and management activities.

Appendix C. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Materials for Priority One, Two, and Three Sites at Fairchild AFB, Washington			
Regulatory Citation	**Requirement**	**Status/Category**	**Action to attain ARAR**
Safe Drinking Water Act of 1974 (Public Law 93-523, as amended; 42 U.S.C. 300f *et seq*.)., "Underground Injection Control Program" **40 CFR 144** "Underground Injection Control Program" 40 CFR 144. "Underground Injection Control Program: Criteria and Standards" 40 CFR 146	Establishes criteria and standards for an underground injection control program	Action/Applicable	Groundwater remedial activities that may involve underground injection.
Water Pollution Control (Chapter 90.48 RCW, as amended); "Underground Injection Control Program"; Chapter173-218 WAC, "UIC well classification" WAC 173-218-040	Establishes criteria and standards for an underground injection control program.	Action/Applicable	Groundwater remedial activities that may involve underground injection
Water Well Construction Act of 1971(Chapter 18.104 RCW, as amended); "Minimum Standards for Construction and Maintenance of Wells" Chapter 173-160 WAC. Includes - 161,171,181,400,430,440, 450, and 460.	Identifies the requirements for siting, installation, construction, operation, maintenance, and decommissioning of wells and borings	Action/Applicable	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings

Appendix C. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Materials for Priority One, Two, and Three Sites at Fairchild AFB, Washington			
Regulatory Citation	**Requirement**	**Status/Category**	**Action to attain ARAR**
Model Toxics Control Act Statute and Regulation (Chapter 70.105D RCW, as amended); "MTCA Cleanup Regulation" Chapter 173-340 WAC "Unrestricted Land Use Soil Cleanup Standards" WAC 173-340-740(3)" "WAC 173-340-740-" Table 740-1- Method A Soil Cleanup Levels for Unrestricted Land Uses	Establishes soil cleanup levels where residential land use represents the reasonable maximum exposure under both current and future site use conditions. Cleanup standards require specification of the following: (1) hazardous substance concentrations that protect human health and the environment (clean up levels), (2) location of the site where clean up levels must be attained ("points of compliance"), (3) and other regulatory requirements that apply to the clean up action because of the type of action or location of the site. These requirements are generally established in conjunction with the selection of a specific cleanup action.	Chemical/Applicable	Soil cleanup actions where concentration of hazardous substances in the soil exceed Method B cleanup levels.
Washington Clean Air Act; (Chapter 70.94 RCW, as amended): "General Regulations for Air Pollution Sources", Chapter 173-400 WAC	Defines methods of control to be employed to minimize the release of air contaminants associated with fugitive emissions resulting from materials handling, construction, demolition, or other operations. Emissions are to be minimized through application of best available control technology.	Action/Applicable	Remedial actions performed could result in the emission of hazardous air pollutants and/ or that have the potential to emit visible, particulate, fugitive, and hazardous air emissions and odors.

Appendix C. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Materials for Priority One, Two, and Three Sites at Fairchild AFB, Washington			
Regulatory Citation	**Requirement**	**Status/Category**	**Action to attain ARAR**
Washington Clean Air Act; (Chapter 70.94 RCW, as amended): "Controls for new sources of toxic air pollutants", Chapter 173-460 WAC	Establishes control of new sources emitting toxic air pollutants to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality as will protect human health and safety. Toxic air pollutants include carcinogens and noncarcinogens listed in WAC 173-460-150. Three major requirements of this regulation include (1) implementation of best available control technology for toxics, (2) quantification of toxic air pollutant emissions, and (3) health and safety protection demonstration.	Action/Applicable	Groundwater and soil remediation activities such as treatment systems that have the potential to emit hazardous air emissions and that would be considered a new source.
Hazardous Waste Management Act of 1976 (Chapter 70.105 RCW, as amended); "Dangerous Waste Regulations" WAC 173-303 Includes WAC 173-303-070,073,077,120,140,170, & 200).	Identifies requirements for identification, generation, accumulation, recycling, treatment, and disposal of Dangerous Wastes	Action/Applicable	Investigative and remediation actions that generate Dangerous Wastes, media, and containers.

Appendix D
Risk Assessment Methodology, Exposure Assumption, and Toxicity Factor Evaluation

Fairchild AFB: Risk Assessment Methodology, Exposure Assumption, and Toxicity Factor Evaluation to Support the Third Five-Year Review

Introduction

The main text of the Third Five-Year Review notes that a review of the human health and ecological risk assessments conducted at the time of each Fairchild AFB ROD shows that the methodologies applied remain protective in both the short and long term. This appendix supports Question B of the Section 7 Technical Evaluations, seeking to identify changes in risk assessment methodology, exposure assumptions, and toxicity values since the *Second Five-Year Review*. This effort seeks to answer the question, "Are the exposure assumptions, toxicity data, CULs and RAO's used at the time of the remedy still valid?" If the answer to the question is "No," then the impact on protectiveness would be assessed to evaluate a potential need for an ESD to update the CUL and ensure continued protectiveness of the remedy going forward in light of the new exposure assumption(s) or toxicity data.

To determine if an ESD is needed due to toxicity factor changes, it was important to differentiate whether each ROD specified MCLs (which would only be updated if ARARs changed), or if the ROD-specified CUL were set to the MCL. Specific considerations in arriving at the protectiveness determination are outlined below. In addition, since key COCs (TCE and TPH) are common to all three OUs made a subject of this Third Five-Year Review, they are also specifically addressed in the main text (see Section 7.4). Note that the cutoff date for data evaluation and analysis set for the remainder of this Third Five-Year Review was September 2012, but the November 2012 (most recent available) version of the EPA RSL tables was used in the analysis. The EPA RSL tables are updated twice each year, but a 2013 update has not been issued as of this writing.

Methodology and Exposure Assumption Updates

EPA has published several new and relevant risk assessment guidance documents since the previous five-year review period. The following new guidance documents were reviewed to verify that the remedies at OU-1, OU-2, and OU-3 remain valid:

- EPA. 2009. *Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual – Part F, Supplemental Guidance for Inhalation Risk Assessment*. January.
- EPA. 2011. *Exposure Factors Handbook: 2011 Edition.*

No new exposure pathways have been identified at OUs 1, 2, or 3. There are also no significant changes in land or resource use on or within the influence of these OUs. In addition, there were no physical changes that would call into question the short or long term protectiveness of the remedies selected. During this five-year review period (2008 to 2013), although no major changes to default exposure factors were implemented under RAGS, other key updates to human health risk assessment methodology under RAGS were made. For example, for RODs signed in 1993 and 1995 with risk assessments done prior to that, the risk assessment methodology for assessing inhalation risk has changed significantly, in terms of intake equations (formerly found in *RAGS Part A* and *RAGS Part B*, EPA, 1989, 1991) or default exposure factors (implemented in the RODs from the *Region 10: Supplemental*

Risk Assessment Guidance for Superfund, EPA, August 16, 1991). Within the current five-year review period, the HHRA methodology has shifted to use a concentration in air is used as the exposure metric (e.g., $\mu g/m^3$) rather than mathematically calculating an inhalation intake of a contaminant in air based on ingestion rate and body weight. The updated methodology is found in *RAGS Part F, Supplemental Guidance for Inhalation Risk Assessment* (EPA, 2009). This change in exposure assessment methodology since the risk assessment and CULs were originally developed does not significantly change CULs based on the older methodology because a mathematical interconversion between the two approaches (assuming a default adult body weight of 70 kg and default inhalation rate of 20 m^3/day) is identical for the COCs discussed in this Third Five-Year Review. Thus, no impact on protectiveness is derived from this methodological change.

In addition, another contemporary development in HHRA inhalation risk assessment that was implemented during the five-year review period was EPA's newer recommendation against route-to-route extrapolation for contaminants that lacked an inhalation cancer slope factor (updated to be an inhalation unit risk, IUR) or inhalation reference dose (updated to be a Reference Concentration, or RfC). In the past, inhalation toxicity values were derived for cancer and non-cancer effects by simply taking the oral toxicity value and adjusting for inhalation rate and body weight. Within the past five years, EPA guidance has adapted to include the most current science, which established that this mathematical route-to-route extrapolation done in the past under *RAGS Part A* (EPA, 1989) does not take into account the pharmacokinetic differences between the routes. The end result is that CULs developed in the past based on this route to route extrapolation method would not match those calculated in 2013, if there are no IUR or RfC available for that contaminant now. Generally, the impact of this methodological change would have the impact of raising (increasing) risk-based CUL that include the inhalation pathway that was previously based on route-to-route extrapolation, if no IUR or RfC exists, because now the inhalation portion of the CUL will, in effect, be excluded as a data gap. No COCs at Fairchild AFB fell into this category (as demonstrated with specific COCs, below).

Changes to ecological risk methodology or ecological toxicity values are not relevant for the Fairchild AFB five-year review period, and no special status species changes relevant to protectiveness were identified. OU-1, a constructed former landfill, has engineered caps consisting of a composite soil, geotextile, and 30-mil polyvinyl chloride (PVC) liners in place. These caps provide a barrier preventing direct contact with contaminated soil. Considering this, along with operations and maintenance activities summarized in Appendix A of this Third Five-Year Review, ecological exposure pathways at OU-1 are managed as per the Fairchild Air Force Base Integrated Natural Resources Management Plan (USAF, January 2012). Contaminated media remain only in the subsurface beneath the engineered cap. Periodic maintenance required to maintain the integrity of the remedy includes filling animal burrows and vegetation maintenance.

The majority of OU-2 and all of OU-3 remain on an active Air Force installation regularly disturbed by Base activities, with extensive paving, runways, and hangars, and that do not provide ecological habitat of sufficient quality to support wildlife populations. The portion of OU-2 that includes off-Base sites (e.g., WP003 and FT004) has either subsurface contamination not accessible by ecological receptors or weathered petroleum (in the case of FT004), and have had no land use changes since the ROD was signed that would make them attractive new habitat with new ecological exposure pathways. On base, maintenance includes procedures to control rodents to avoid attracting predators given the risk of Bird Aircraft Strike Hazard (BASH), particularly in the airfield areas. Therefore, potential ecological habitat is regularly controlled on OU-2 and OU-3 (e.g., via mowing and maintenance of landscaping) to ensure the

Air Force mission remains free from BASH risk, which is managed as per the 92 Air Refueling Wing/141 Air Refueling Wing Bird/Wildlife Aircraft Strike Hazard (BASH) Plan (USAF, October 2012).

Toxicity Factor Updates

- Table D1 provides a comparison between the pre-2008 federal toxicity values used to evaluate risk in the OU-1, OU-2, and OU-3 RODs, and the November 2012 toxicity values used to evaluate protectiveness in this Third Five-Year Review. The RSL tables are updated semi-annually by the EPA and are available for download from the following link: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm. DOD follows EPA (2003) for the selection of toxicity factors, so Tier 1 and Tier 2 values appear in Table D1. Where the EPA RSL lists a Tier 3 value, such as toxicity values developed by the California EPA Office of Health Hazard Assessment or values determined by New Jersey Department of Environmental Protection in the absence of a Tier 1 (IRIS) or Tier 2 value, these state-specific Tier 3 values would only be used as candidate toxicity values when it is determined that the scientific validity of the Tier 3 value (and the peer review rigor) was independently confirmed, or an RAO was set in that state. The following items address specific changes between the 2008 and 2012 chemical toxicity values:
- Yellow shading indicates that a new 2012 toxicity value exists while there was no corresponding prior toxicity value.
- Purple shading indicates that a 2012 toxicity value no longer exists, while there was previously a corresponding toxicity value that has since been withdrawn.
- Green shading indicates that the current 2012 toxicity value is less health protective than the corresponding previous value (decrease in cancer potency or increase in noncancer reference values). Red shading indicates current value is more health protective than the corresponding previous value (increase in cancer potency or decrease in noncancer reference values).

Previous five-year reviews included toxicity values in different units. For example, through 2004 when the *Second Five-Year Review* for Fairchild AFB was in preparation, IRIS and the EPA RSLs (previously tabulated as Preliminary Remediation Goals in EPA Region 9, or Risk-Based Concentrations in EPA Region 3) reported RfDi and SFi values (in mg/kg-day and per mg/kg-day, respectively) while the 2012 RSL Tables report only Inhalation Reference Concentration (RfC) and Inhalation Unit Risk (IUR) values (in mg/m^3 and per $\mu g/ m^3$, respectively). Conversion from RfDi to RfC and IUR to SFi was previously mathematically accomplished using the equations recommended before the 2009 release of *RAGS Part F*. Specifically, RfDs are calculated as shown in the following *HEAST* equation (EPA, 1997):

$$[RfC\ (mg/m^3) \times 20\ m^3/day] / 70\ kg = RfD\ (mg/kg*day)$$

Similarly, inhalation slope factors were previously calculated as shown in the following equation taken from *Supplemental Guidance to RAGS: Region 4 Bulletins Human Health Risk Assessment* (EPA, November 1995):

$$\text{Unit risk}\ (\mu g/m^3)^{-1} \times 70\ kg \times (20\ m^3/day)^{-1} \times 1000\ \mu g/mg = SFI\ (mg/kg*day)^{-1}$$

Both conversions resulted in inhalation RfDs and slope factors that are specifically for an adult: uncertainty was previously introduced in residential risk assessments involving children. Utilizing the body weight and inhalation rate of a child versus that of an adult to address this uncertainty was found often to be incorrect due to the methods used to derive the RfC or the IUR. Therefore, the RfC and IUR are used directly in post-2009 HHRA using RAGS Part F and current toxicity factors. Given the COC-

specific analysis for each OU at Fairchild AFB, however, this methodological change does not impact protectiveness for any COC or CUL set in previous RODs at Fairchild AFB.

On March 29, 2005 (occurring during the second five-year review period), EPA issued the revised *Guidelines for Carcinogen Risk Assessment* (EPA, 2005a), along with an associated document entitled *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (EPA, 2005b). These documents provide guidance for assessing carcinogens considered to have a mutagenic mode of action (MOA). If a chemical has been determined to cause cancer by a mutagenic MOA, EPA has noted that it is possible that exposures to that chemical in early-life may result in higher lifetime cancer risks than a comparable duration adult exposure (EPA, 2009). Carcinogenic PAHs [e.g., benzo(a)pyrene and chrysene] and several VOCs (e.g., TCE and vinyl chloride) are chemicals identified at these OUs that have been considered to have a mutagenic MOA, whereas the ROD did not consider this designation. The mutagenic MOA approach only affects early-life stages. Groundwater for residential use at Fairchild AFB does not originate from any areas or aquifers that are impacted by any of these OUs. Therefore, for these OUs, this issue (i.e., child exposures to potential mutagens) only applies to hypothetical future off-Base residential exposures to COCs.

In addition to the federal values revisited in Table D1, changes to state-specific toxicity values under MTCA are explained for the key COCs (TCE and TPH) in Section 7.4 of the Third Five-Year Review text. Ecology began proposing MTCA methodological changes in 2010, but finalization of these proposed statutory revisions was placed on hold through2011 following Executive Order (EO) 10-06. A subsequent Executive Order (EO 11-03) extended EO 10-06 through 2012 which suspended non-critical rule development and adoption during this time period. Therefore, no revisions under MTCA (other than the guidance-related issues discussed in Section 7.4) impact potential protectiveness of the remedies at Fairchild AFB for this five-year review period.

Synthesis by OU

Tables D2 through D4 provide a summary of the changes in chemical toxicity values and corresponding potential direction of the effect on OU-specific CULs set in the ROD for OU-1, OU-2, and OU-3, respectively. The information provided in these tables allow for an informed qualitative assessment of the potential impact to CULs (i.e., expected increase or decrease in CULs) as a result of the change in toxicity values. A recalculation of the OU-specific CULs was not conducted and is not required by EPA or DOD guidance: instead, each ROD was revisited for relevant COCs and is discussed below:

OU-1: Maximum detected groundwater concentrations of TCE, 1,1-DCE, vinyl chloride, and BEHP exceeded their respective screening levels in 1993 when the remedy for the OU-1 CRL was selected, so these analytes were revisited (see Table D2), as were the other regularly monitored analytes, such as the degradation products of TCE. TCE was identified as the COC posing the greatest risk and for which a CUL was established. Protectiveness was not impacted by toxicity value changes, as none of the current toxicity values call into question whether the remedies selected during the ROD and associated CUL were protective.

OU-2: TCE, benzene, ethylbenzene, toluene, xylenes, TPH, carcinogenic PAHs, and a few metals (such as chromium at WW-1 only) were identified as COCs for at least one site in the OU-2 Priority One Sites when the remedy was selected, so these analytes were revisited (see Table D3), as were other regularly monitored analytes, such as the degradation products of TCE and arsenic. TCE, benzene, and TPH were identified as COCs posing the greatest risk and for which CULs were established. Protectiveness was not impacted by toxicity value changes, as none of the current toxicity values call into question whether the

remedies selected during the ROD are protective, although the time necessary to achieve the lower TPH-D CUL could be extended.

OU-3: Maximum detected groundwater concentrations of VOCs (such as fuel-related BTEX and TPH components, as well as carbon tetrachloride, TCE and its degradation products), and a few metals (such as arsenic, chromium, lead, manganese) exceeded their respective screening levels in 1995 when the remedy for OU-3 Priority Two Sites was selected, so these analytes were revisited (see Table D4). TCE, benzene, and TPH were identified as COCs posing the greatest risk and for which CULs were established. Protectiveness was not impacted by toxicity value changes, as none of the current toxicity values call into question whether the remedies selected during the ROD are protective, although the time necessary to achieve the lower TPH-D CUL could be extended.

In addition, no new or emerging toxic analytes requiring supplemental risk assessment have been identified at Fairchild AFB since the RODs were signed.

Table D-1
Comparison Between Prior Toxicity Values (from ROD to 2008 *Second Five-Year Review*) and 2012 Toxicity Values Under EPA (2003) Hierarchy
Third Five-Year Review
Fairchild Air Force Base, Washington

Chemical[a]	Ingestion Exposure								Inhalation Exposure*[b]									
	RfDo				SFo				RfDi (to RfC)					SFi (to IUR)				
	mg/kg-day				$(mg/kg\text{-}day)^{-1}$				mg/kg-day (to mg/m^3)					$(mg/kg\text{-}day)^{-1}$ (to per ug/m^3)				
	Pre-2008 Value	Ref	2012 RSLs	Ref	Pre-2008 Value	Ref	2012 RSLs	Ref	Pre-2008 RfDi	Ref	2012 RSLs RfDi Equivalent*[d]	2012 RfC (mg/m^3)	Ref	Pre-2008 Value	Ref	2012 RSLs SFi Equivalent*[d]	2012 IUR (per ug/m^3)	Ref
Volatiles																		
Benzene	0.004	I	0.004	I	0.055	I	0.055	I	0.0086	I	0.0086	0.03	I	0.027	I	0.027	0.000008	I
Carbon Tetrachloride	None		0.004	I	None		0.07	I	N/A		0.029	0.1	I	N/A		0.021	0.000006	I
Chlorobenzene	0.02	I	0.02	I	None		None		0.014	P	0.014	0.05	P	None		None	None	
Chloroform	0.01	I	0.01	I	None		0.031	C	0.014	E	0.028	0.098	A	0.081	I	0.081	0.000023	I
1,1-Dichloroethene	0.05	I	0.05	I	None		None		0.06	I	0.06	0.2	I	None		None	None	
cis-1,2-Dichloroethene	0.01	P	0.002	I	None		None		None		None	None		None		None	None	
trans-1,2-Dichloroethene	0.02	I	0.02	I	None		None		0.017	P	0.017	0.06	P	None		None	None	
Ethylbenzene	0.1	I	0.1	I	0.011	C	0.011	C	0.29	I	0.29	1.0	I	N/A		0.0088	0.0000025	C**
Isopropylbenzene	0.1	I	0.1	I	None		None		0.011	I	0.11	0.4	I	None		None	None	
Methylene chloride	0.06	I	0.006	I	0.0075	I	0.002	I	0.3	A	0.171	0.6	I	0.0016	I	0.00004	0.00000001	I
Tetrachloroethene	0.01	I	0.006	I	0.54	C	0.0021	I	0.08	A	0.011	0.04	I	0.02	C	0.001	0.00000026	I
Toluene	0.08	I	0.08	I	None		None		1.4	I	1.4	5.0	I	None		None	None	
Trichloroethene	0.0003	E	0.0005	I	0.011	H	0.046	I	0.01	E	0.001	0.002	I	0.017	H	0.014	0.0000041	I
1,2,4-trimethylbenzene	None		None		None		None		0.002	P	0.002	0.007	P	None		None	None	
Vinyl chloride	0.003	I	0.003	I	1.4	I	0.72	I	0.03	I	0.03	0.1	I	0.03	I	0.015	0.0000044	I
Xylenes	0.2	I	0.2	I	None		None		0.03	I	0.03	0.1	I	None		None	None	
Metals																		
Arsenic	0.0003	I	0.0003	I	1.5	I	1.5	I	None		0.000004	0.000015	C**	15.1	I	15.1	0.0043	I
Chromium (VI)	0.003	I	0.003	I	None		0.5	J**	0.00003	I	0.000029	0.0001	I	41	I	294	0.084	S
Lead	Not evaluated through methods using these toxicity parameters (see Section 7.4.2)																	
Manganese	0.14	I	0.14	I	None		None		0.000014		0.000014	0.00005	I	None		None	None	
Semi-volatiles/Petroleum/PAHs																		
Bis(2-ethylhexyl)phthalate	0.02	I	0.02	I	0.014	I	0.014	I	None		None	None		None		0.008	0.0000024	C**
Total Petroleum Hydrocarbons	Not evaluated through methods using these toxicity parameters																	
Benzo[a]anthracene	None		None		0.73	E	0.73	E	None		None	None		None		0.39	0.00011	C**
Benzo[a]pyrene	None		None		7.3	I	7.3	I	None		None	None		3.1	E	3.9	0.0011	C**
Benzo[b]fluoranthene	None		None		0.73	E	0.73	E	None		None	None		None		0.39	0.00011	C**
Benzo[k]fluoranthene	None		None		0.073	E	0.073	E	None		None	None		None		0.39	0.00011	C**
Chrysene	None		None		0.0073	E	0.0073	E	None		None	None		None		0.04	0.000011	C**
Dibenz[a,h]anthracene	None		None		7.3 (2.92)[c]	E	7.3 (0.73)[c]	E	None		None	None		None		4.2	0.0012	C**
Indeno[1,2,3-cd]pyrene	None		None		7.3 (2.92)[c]	E	7.3 (0.73)[c]	E	None		None	None		None		0.39	0.00011	C**
Methylnaphthalene, 1-	None		0.07	A	None		0.029	P	None		None	None		None		None	None	
Methylnaphthalene, 2-	0.004	I	0.004	I	None		None		None		None	None		None		None	None	
Naphthalene	0.02	I	0.02	I	None		None		0.0009	I	0.0009	0.003	I	None		0.12	0.000034	C**

Notes:

[a] Chemicals identified as major contaminants of concern in the OU-1, OU-2, or OU-3 RODs along with chemicals detected in groundwater with toxicity factors changes since the previous five-year review.

[b] Note: Inhalation values listed for non-volatile compounds (e.g., metals) are only applicable to dust inhalation and would not be appropriate for groundwater.

[c] Note: MTCA toxicity factors for DBA differ from EPA and are presented in parentheses.

[d] Value shown is a calculated respective RfDi or Sfi for comparative purpuses: the values were not actually provided in the 2012 RSLs table

Yellow shading indicates current value exists while there was no corresponding pre-2008 value

Green shading indicates current value is less stringent than the corresponding pre-2008 value (decrease in cancer potency or increase in noncancer reference values)

Red shading indicates current value is more stringent than the corresponding pre-2008 value (increase in cancer potency or decrease in noncancer reference values)

Acronyms:

SFi - Inhalation Slope Factor
SFo - Oral Slope Factor
mg/kg-day - milligrams per kilogram per day
RfDi - Inhalation Reference Dose
RfDo - Oral Reference Dose
mg/m^3 - milligrams per cubic meter
Ref - Reference
RSL - Regional Screening Level
ug/m^3 - micrograms per cubic meter
IUR - Inhalation Unit Risk
RfC - Inhalation Reference Concentration

Notes:

* Under RAGS Part A (1989), previous risk assessments, IRIS, EPA screening tables (through 2004) reported RfDi and SFi values (in mg/kg-day and per mg/kg-day, respectively) while the 2012 RSL Tables reflect modern inhalation factors and report only Inhalation Reference Concentration (RfC) and Inhalation Unit Rate Risk (IUR) values (in mg/m^3 and per ug/kg-day, respectively). Conversion from RfDi to RfC and IUR to SFi is calculated using the equations presented in Appendix D.

** Provided for information purposes only. Where the EPA RSL lists a Tier 3 value, such as toxicity values developed by the California EPA Office of Health Hazard Assessment or values determined by New Jersey Department of Environmental Protection in the absence of a Tier 1 (IRIS) or Tier 2 value, these state-specific Tier 3 values would only be used as candidate toxicity values when it is determined that the scientific validity of the Tier 3 value (and the peer review rigor) was independently confirmed, or an RAO was set in that state.

N/A = not applicable: no value existed prior to 2008

References:

2012 RSLs - November 2012 EPA Regional Screening Levels Table. Where a state-recommended (C or J) Tier 3 value is cited, EPA does not provide any value in IRIS, so the Tier 3 value from the EPA RSL table was considered as an example toxicity value.

A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), 2012

C = California EPA (as cited in 2012 RSL tables). For NPL sites not in California, these values are Tier 3 values under the EPA (2003) hierarchy, and should be used with caution.

E = EPA-NCEA Provisional Value 2002 (as cited in 10/2002 RBC Table)

H = Health Effects Assessment Summary Tables (HEAST), 1997

I = Integrated Risk Information System (IRIS), accessed May 2, 2013. These are the most rigorously peer-reviewed (Tier 1) toxicity values in the EPA (2003) hierarchy.

J = Value determined by New Jersey Department of Environmental Protection (NJDEP) as listed in the 2012 EPA RSL Table

M = MTCA (WA Dept of Ecology)

P = EPA's Provisional Peer Reviewed Toxicity Values (PPRTV) 2012

S = Value qualified by footnotes in the User's Guide for the 2012 EPA RSL Table: For chromium VI, inhalation toxicity values are for particulates, not mists and aerosols.

Table D-2

Changes in Standards and Potential Effects to CULs (CULs) - OU1, Craig Road Landfill

Third Five-Year Review, *Fairchild Air Force Base, Washington*

Contaminants	ARARs: Federal MCL, 40 CFR Part 141 (Washington MTCA Method A CUL for GW, Table 720-1) (ug/L or ppb)	EPA Regional Screening Level and Underlying Toxicity Reference Values		OU1	
		Original (1993) OU1 ROD	Changed Since 2008 *Second Five-Year Review*	ROD GW CUL Based on MCL (ug/L or ppb)	Comments
Arsenic	10** (5)	NA	New noncancer inhalation toxicity value	-	Only TCE was a COC with a stated GW CUL in the 1993 ROD as arsenic was below upgradient background. Ongoing O&M at CRL has included evaluation of this analyte during the five-year review period.
Benzene	5 (5)	NA	No change to toxicity factors or ARARs (MCL)	-	In the ROD, benzene was reported at a risk-based level, but the source was not attributed to CRL. Protectiveness of the remedy is not impacted at OU1 as benzene does not exceed MCLs. Only TCE was a COC with stated GW CUL in the ROD, which stated benzene was not carried through the risk assessment. Ongoing LTM at CRL includes evaluation of this analyte.
BEHP	6	NA	No change to MCL; new inhalation cancer potency factor	-	BEHP was included in the original risk assessment, as the ROD cited exceedances of a risk-based concentration (RBC) of the then-current RBC of 6 ug/L which is still the BEHP MCL. Protectiveness is not impacted because BEHP is semivolatile and the affected media (groundwater) does not off-gas BEHP in order to result in inhalation exposure. The new BEHP inhalation cancer potency factor would only impact a soil CUL.
1,1-Dichloroethene (1,1-DCE)	7	NA	No change	-	1,1-DCE was included in the original risk assessment, as the the ROD cited exceedances of a risk-based concentration (RBC) of the then-current RBC of 0.07 ug/L. However, beginning with revised toxicity factors from IRIS in August 2002, the EPA (2012) RSL is currently 260 ug/L, so protectiveness since the 1993 ROD is not impacted. This analyte COC is considered less toxic than thought in 1993.
cis 1,2-Dichloroethene (cis 1,2-DCE)	70	NA	RFDo decreased from 0.01 to 0.002 mg/kg-day	-	Oral toxicity has increased, but CRL concentrations are far below the MCL. Only TCE was a COC with stated GW CUL in the ROD, and protectiveness of the original remedy is maintained.
trans 1,2-Dichloroethene (trans 1,2-DCE)	100	NA	No change	-	Only TCE was a COC with stated GW CUL in the ROD. Recent LTM for CRL includes evaluation of this analyte.
Chromium (total)	100 (50)	NA	No change	-	Only TCE was a COC with stated GW CUL in the ROD as inorganics including chromium were below upgradient background.
Chromium (VI)	50 (50)	NA	New Tier 3 oral cancer potency factor; inhalation potency factor increased	-	For compliance with MTCA Method A, the CUL assumes GW chromium is comprised of the more toxic form (Cr VI) unless it is demonstrated that total chromium is trivalent. Only TCE was a COC with stated GW CUL in the ROD; recent LTM at CRL includes evaluation of this analyte for areas potentially impacted by ISCO treatment.
Tetrachloroethene (PCE)	5 (5)	NA	Oral and inhalation cancer potency decreased as compared to 2008 values	-	PCE was included in the original risk assessment supporting the ROD. PCE cancer potency is predicted to be less toxic than before, so protectiveness is not affected. Only TCE was a COC with stated GW CUL in the ROD; ongoing LTM at CRL includes evaluation of this analyte. PCE has not exceeded the MCL in any monitoring well.
Trichloroethene (TCE)	5 (5)	HEAST values of 0.017 SFi and 0.011 SFo (per mg/kg-day)	Oral cancer potency and inhalation toxicity are greater as compared to ROD values; other toxicity slightly reduced from 1993	5	The 1993 ROD CUL were based on MTCA as promulgated on January 28, 1991, and that "The CUL for TCE is 5 ug/L. In addition, the cumulative excess cancer risk associated with the site will be reduced to at most 1E-05, consistent with MTCA." No impact results from the changed toxicity values, as VI is not an issue, LUCs remain in place that prevent/limit exposure.

Table D-2

Changes in Standards and Potential Effects to CULs (CULs) - OU1, Craig Road Landfill

Third Five-Year Review, *Fairchild Air Force Base, Washington*

Contaminants	ARARs: Federal MCL, 40 CFR Part 141 (Washington MTCA Method A CUL for GW, Table 720-1) (ug/L or ppb)	EPA Regional Screening Level and Underlying Toxicity Reference Values		OU1	
		Original (1993) OU1 ROD	Changed Since 2008 *Second Five-Year Review*	ROD GW CUL Based on MCL (ug/L or ppb)	Comments
Vinyl Chloride (VC)	2 (0.2)	NA	Oral and inhalation cancer potency decreased as compared to 2008 values	-	VC was included in the original risk assessment supporting the ROD. VC is predicted to be less toxic than before, so protectiveness is not affected. TCE was a COC with a stated GW CUL in the ROD; ongoing LTM has indicated that PCE has not exceeded the MCL in any monitoring wells.
References for CULs and Risk Factors				OU-1 ROD: SAIC. 1993. Final—Record of Decision, Craig Road Landfill.February. EPA RSL Table November 2012 (see details in Table D1)	

Notes

"-" indicates None. NA indicates not available in the OU-1 (1993) ROD.

** At the time the 1993 ROD was signed, the federal MCL was 50 ug/L. The date by which public water systems had to comply with the new 10 ug/L standard was January 23, 2006, which was during the review period for the *Second Five-Year Review* .

Table D-3
Changes in Standards and Potential Effects to CULs (CUL) - OU2, Priority One Sites
Third Five-Year Review, *Fairchild Air Force Base, Washington*

Contaminants	ARARs: Federal MCL, 40 CFR Part 141 (Washington MTCA Method A CUL for GW, Table 720-1) (ug/L or ppb)	EPA Regional Screening Level and Underlying Toxicity Reference Values		OU2	
		Original (1993) OU2 ROD	Changed Since 2008 *Second Five-Year Review*	ROD GW CUL Based on MCL (ug/L or ppb)	Comments
Arsenic	10** (5)	NA	New noncancer inhalation toxicity value	-	Only TCE, TPH, and benzene were identified as COCs with stated GW CULs in the 1993 ROD. Ongoing O&M for OU2 sites has included evaluation of this analyte during the five-year review period.
Benzene	5 (5)	NA	No change to toxicity factors or ARARs (MCL)	5	In the ROD, benzene was reported above the MTCA Method B CUL at PS-2, PS-8, and FT-1. Protectiveness of the remedy is not impacted at OU2 as the benzene CUL is consistent with EPA's MCL and MTCA's CUL. Ongoing LTM includes evaluation of this analyte.
1,1-Dichloroethene (1,1-DCE)	7	NA	No change	-	1,1-DCE was included in the original risk assessment, although no exceedances were identified. Changes to toxicity factors since the ROD indicate that this analyte is considered less toxic than thought in 1993.
cis 1,2-Dichloroethene (cis 1,2-DCE)	70	NA	RFDo decreased from 0.01 to 0.002 mg/kg-day	-	Oral toxicity has increased, but OU2 groundwater concentrations are below the MCL. Only TCE, benzene, and TPH were identified as COCs with stated GW CULs in the ROD, and protectiveness of the original remedy is maintained.
trans 1,2-Dichloroethene (trans 1,2-DCE)	100	NA	No change	-	Only TCE, benzene and TPH were identified as COCs with stated GW CULs in the ROD, but ongoing LTM at OU2 includes evaluation of this analyte.
Ethylbenzene	700 (700)	NA	No change to MCL; new Tier 3 inhalation cancer potency factor	-	Only TCE, benzene and TPH were identified as COCs with stated GW CULs in the ROD, but ongoing LTM at OU2 includes evaluation of this analyte.
Polycyclic aromatic Hydrocarbons (carcinogenic)	0.2 (0.1 based on benzo(a)pyrene equivalents)*	NA	Inhalation unit risk factors have been added; however, for NPL sites not in California, these values are Tier 3 values under the EPA (2003) hierarchy, and should be used with caution. The oral slope factor for dibenz(a,h)anthracene differs between MTCA and EPA and the MTCA slope factor has been reduced (lower cancer potency) since 2008. In addition, carcinogenic PAHs are now considered mutagens.	-	Polycyclic aromatic hydrocarbons were only identified as potential COCs at the WW-1 site. No unacceptable risks to human health were determined at the site and no CULs were warranted for PAHs.No impact results from the changed toxicity values, as VI is not an issue, and LUCs remain in place that prevent/limit exposure.
Trichloroethene (TCE)	5 (5)	HEAST values of 0.017 SFi and 0.011 SFo (per mg/kg-day)	Oral cancer potency and inhalation toxicity are greater as compared to ROD values; other toxicity slightly reduced from 1993	5	The 1993 ROD CUL were based on MTCA as promulgated on January 28, 1991, and that "The CUL for TCE is 5 ug/L. In addition, the cumulative excess cancer risk associated with the site will be reduced to at most 1E-05, consistent with MTCA." No impact results from the changed toxicity values, as VI is not an issue, LUCs remain in place that prevent/limit exposure.
TPH-Diesel	NA (500)	NA	*	1,000	Ecology has modified the MTCA Method A CULs for TPH-D since the 1993 ROD. TPH-D is predicted to be more toxic with a new CUL one-half of the value set in the ROD. LUCs in the ROD remain protective, however additional time may be necessary for TPH-D attentuation to reach the new CULs.
Vinyl Chloride (VC)	2 (0.2)	NA	Oral and inhalation cancer potency decreased as compared to 2008 values	-	VC was included in the original risk assessment supporting the ROD. VC is predicted to be less toxic than before, so protectiveness is not affected. Only TCE, benzene, and TPH were identified as COCs with stated GW CULs in the ROD, but ongoing LTM includes evaluation of this analyte. VC has not exceeded the MCL in any monitoring well.
Xylenes	10,000 (1,000)	NA	No change	-	Only TCE, benzene and TPH were identified as COCs with stated GW CULs in the ROD, but ongoing LTM at OU2 includes evaluation of this analyte.
References for CULs and Risk Factors				OU2 ROD: Halliburton NUS Environmental Corporation. 1993. Final—Record of Decision On-Base Priority One Operable Units (Sites SW-1, IS-1, PS-2, PS-6, PS-8, FT-1, and WW-1). June. EPA RSL Table November 2012 (see details in Table D1)	

Notes
"-" indicates None. NA indicates not available in the OU2 (1993) ROD.
* See Section 7.4.2 of main report.
** At the time the 1993 ROD was signed, the federal MCL was 50 ug/L. The date by which public water systems had to comply with the new 10 ug/L standard was January 23, 2006, which was during the review period for the *Second Five-Year Review* .

Table D4
Changes in Standards and Potential Effects to CULs (CUL) - OU3, Priority Two Sites
Third Five-Year Review, *Fairchild Air Force Base, Washington*

Contaminants	ARARs: Federal MCL, 40 CFR Part 141 (Washington MTCA Method A CUL for GW, Table 720-1) (ug/L or ppb)	EPA Regional Screening Level and Underlying Toxicity Reference Values		OU3	
		Original (1995) OU3 ROD	Changed Since 2008 *Second Five-Year Review*	ROD GW CUL Based on MCL (ug/L or ppb)	Comments
Arsenic	10** (5)	NA	New noncancer inhalation toxicity value	-	Only TPH and benzene were identified as COCs with stated GW CULs in the 1995 ROD although arsenic was detected above screening levels. Ongoing O&M has included evaluation of this analyte during the five-year review period.
Benzene	5 (5)	NA	No change to toxicity factors or ARARs (MCL)	5	In the ROD, benzene was reported above the MTCA Method B CUL. Protectiveness of the remedy is not impacted at OU3 as the benzene CUL is consistent with EPA's MCL and MTCA's CUL. Ongoing LTM includes evaluation of this analyte.
Carbon tetrachloride	5	NA	New oral and inhalation cancer potency factor, and oral and inhalation non-cancer toxicity factors are available	-	Only TPH and benzene were identified as COCs with stated GW CULs in the ROD, but ongoing LTM includes evaluation of this analyte.
Ethylbenzene	700 (700)	NA	No change to MCL; new Tier 3 inhalation cancer potency factor	-	Only TPH and benzene were identified as COCs with stated GW CULs in the ROD, but ongoing LTM includes evaluation of this analyte.
Isopropylbenzene	NA	NA	NA	-	Only TPH and benzene were identified as COCs with stated GW CULs in the ROD, but ongoing LTM includes evaluation of this analyte.
Lead	15 (15)	NA	No change	-	Only TPH and benzene were identified as COCs with stated GW CULs in the 1995 ROD although lead was detected above screening levels. Ongoing O&M has included evaluation of this analyte during the five-year review period.
Manganese	NA	NA	No change	-	Only TPH and benzene were identified as COCs with stated GW CULs in the 1995 ROD although manganese was detected above screening levels. Ongoing O&M has included evaluation of this analyte during the five-year review period.
2-Methylnaphthalene	NA (160)	NA	No change	-	Only TPH and benzene were identified as COCs with stated GW CULs in the ROD, but ongoing LTM includes evaluation of this analyte.
Trichloroethene (TCE)	5 (5)	HEAST values of 0.017 SFi and 0.011 SFo (per mg/kg-day)	Oral cancer potency and inhalation toxicity are greater as compared to ROD values; other toxicity slightly reduced from 1995	5	THE 1995 ROD for OU-3 considered TCE a COC only for groundwater associated with PS-10, which has since been mobed from OU-3 to OU-5 under Site SS-39. The CUL for TCE is 5 ug/L. In addition, the cumulative excess cancer risk associated with a site will be reduced to at most 1E-05, consistent with MTCA. No impact results from the changed toxicity values, as VI is not an issue, and LUCs remain in place that prevent/limit exposure
1,2,4-Trimethylbenzene	NA	NA	No change	-	Only TPH and benzene were identified as COCs with stated GW CULs in the ROD, but ongoing LTM includes evaluation of this analyte.
Toluene	NA	NA	No change	-	Only TPH and benzene were identified as COCs with stated GW CULs in the ROD, but ongoing LTM includes evaluation of this analyte.
TPH-Diesel	NA (500)	NA	*	1,000	Ecology has modified the MTCA Method A CULs for TPH-D since the 1993 ROD. TPH-D is predicted to be more toxic with a new CUL one-half of the value set in the ROD. LUCs in the ROD remain protective, however additional time may be necessary for TPH-D attentuation to reach the new CULs.
Xylenes	10,000 (1,000)	NA	No change	-	Only TPH and benzene were identified as COCs with stated GW CULs in the ROD, but ongoing LTM includes evaluation of this analyte.
References for CULs and Risk Factors				OU3 ROD: ICF Technology Incorporated. 1995. Final—Record of Decision for Priority 2 Sites at Fairchild Air Force Base, Washington. September. EPA RSL Table November 2012 (see details in Table D1)	

Notes
"-" indicates None. NA indicates not available in the OU-3 (1995) ROD.
* See Section 7.4.2 of main report.

** At the time the 1995 ROD was signed, the federal MCL was 50 ug/L. The date by which public water systems had to comply with the new 10 ug/L standard was January 23, 2006, which was during the review period for the*Second Five-Year Review* .

Appendix E
Regulatory Agency Review Comment/Response Matrix (reserved)