FINAL

Second Five-Year Review Report for Priority One and Two Sites,

Fairchild Air Force Base, Washington

June 2008

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

SEP 2 5 2008

Mr. Marc B. Connally, P.E.
92 CES/CEVR
100 West Ent Street, Suite 155
Fairchild AFB, Washington 99011

Re: Fairchild Air Force Base Second Five Year Review

Dear Mr. Connally:

EPA Region 10 has reviewed the Second Five Year Review Report for Priority One and Two Sites for the Fairchild Air Force Base Superfund site located in the state of Washington. EPA reviewed this report for technical adequacy, accuracy, and consistency with EPA guidance. Overall, the Five Year Review report is adequate, conforms to guidance and in general, EPA concurs with the protectiveness determinations in this report.

As the Air Force knows, according to the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), this Five Year Review should have been completed in December of 2005 and the Air Force, as the lead agency, has the statutory responsibility for meeting this deadline. While there are a number of factors that caused the extraordinary delay in finalizing this report, EPA finds it unacceptable that this report was submitted over two and one half years past the deadline. In fact, this is the only site in Region 10 where a Five Year Review has missed the submittal deadline by such a large margin. We trust that the problems experienced this time around will be avoided in the future, and the next Five Year Review will be completed in a timely fashion.

One of the reasons for the delay in completing this report had to do with a disagreement over whether or not there was a need to sample groundwater for perchlorate and n-nitrosodimethylamine (NDMA) at Fairchild AFB. The Air Force conducted extensive research in support of its position that perchlorate/NDMA sampling was not warranted and the findings are well-documented in Chapter 7.2 of the report. EPA reviewed the information and documentation provided by the Air Force and has agreed that the Air Force is not required to sample for these potential contaminants of concern. However, EPA reserves the right, as allowed under the Federal Facility Agreement, to sample the groundwater at Fairchild AFB at any time in the future and analyze for perchlorate, NDMA or any other potential contaminant of concern.

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EPA appreciates the efforts the Air Force has made to work with us to reach agreement on the issues and recommendations identified in this Five Year Review report. We look forward to your continued cooperation as we work together to ensure the implementation of this report's findings. If you have any questions, please contact Nancy Harney of my staff at (206) 553-6635.

Sincerely,

Daniel D. Opalski, Director
Office of Environmental Cleanup

cc: Chuck Hinds, WA Dept of Ecology

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Fairchild Air Force Base, Washington

Prepared for:

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June 2008

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Acceptance of the

Second Five-Year Review for

Fairchild Air Force Base – Priority One and Two Sites

This signature sheet documents the United States Air Force acceptance of the Second Five-Year Review for Priority One and Two Sites at Fairchild Air Force Base.

Thomas J. Sharpy

THOMAS J. SHARPY
Colonel, USAF
Commander

12 Aug 08
Date

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Appendix A Additional Information for Craig Road Landfill
Appendix B Additional Information for Individual On-base Priority One Operable Unit Sites
Appendix C Additional Information for Individual Priority Two Sites

Acronyms and Abbreviations

µg/L	micrograms per liter
AFB	Air Force Base
AFCEE	Air Force Center for Engineering and the Environment
AFI	Air Force Instruction
AMC	Air Mobility Command
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLARC	Cleanup Levels and Risk Calculations
COC	contaminant of concern
CRL	Craig Road Landfill
DCE	dichloroethene
DNAPL	dense nonaqueous phase liquid
Ecology	Washington State Department of Ecology
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
ESTCP	Environment Security Technology Certification Program
FFA	federal facilities agreement
FS	feasibility study
FY	fiscal year
GAC	granular activated carbon
gpm	gallons per minute
GTP	groundwater treatment plant
IRA	interim removal action
IRP	Installation Restoration Program
LFI	limited field investigation
LNAPL	light nonaqueous phase liquid
LUC	land use controls
MCL	maximum contaminant level
MG	million gallon(s)
mg/kg	milligram(s) per kilogram
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NCP	National Contingency Plan

NDA	Northeast Disposal Area
NDMA	n-nitrosodimethylamine
NFA	no further action
NPL	National Priorities List
O&M	operations and maintenance
OWS	oil-water separator
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PLC	programmable logic controller
PVC	polyvinyl chloride
RA	remedial action
RAB	Restoration Advisory Board
RD	remedial design
RA-O	remedial action operation
RCRA	Resource Conservation and Recovery Act
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 hydrocarbon(s)
TPH-D	total petroleum hydrocarbons, diesel-range organics
TPH-G	total petroleum hydrocarbons, gasoline-range organics
USAF	United States Air Force
USC	United States Code
UST	underground storage tank
VMP	vapor monitoring points
VC	vinyl chloride
VOC	volatile organic compound
WAC	Washington Administrative Code
WWTP	wastewater treatment plant
yd^3	cubic yard

1.0 Introduction

The United States Air Force (USAF) has conducted a review of the remedial actions implemented at 28 Installation Restoration Program (IRP) sites at Fairchild Air Force Base (AFB), Washington. The USAF has conducted this review pursuant to the following:

- 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) 300.400(f)(4)(ii)
- Executive Order 12580 (January 23, 1987)
- Federal Facility Agreement (FFA) for Fairchild AFB (March 1990)

This report is consistent with the U.S. Environmental Protection Agency's (EPA) *Comprehensive Five-Year Review Guidance* (EPA, 2001). As directed by the FFA, the USAF is the lead agency for restoration projects at Fairchild AFB, with the Washington State Department of Ecology (Ecology) as the lead regulatory agency. EPA Region 10 is a secondary regulatory agency and has participated in this review.

1.1 Purpose and Scope of the Second Five-Year Review

The purpose of this second Five-Year Review is to ensure that in-place remedies, as directed by Records of Decision (RODs) for Priority One and Two sites at Fairchild AFB, remain protective of human health and the environment and are functioning as designed.

The scope of this review covers selected remedies for 28 sites addressed by three RODs:

- Craig Road Landfill (Science Applications International Corporation [SAIC], 1993)
- On-base Priority One Operable Units (Halliburton NUS, 1993)
- Priority Two Sites (ICF Technology, 1995)

Fairchild AFB conducted this second Five-Year Review of the remedial actions implemented at the 28 Priority One and Two sites, based on available data collected through December 2004. The triggering action for the review was the completion of the first Five-Year Review in November 2000, and approval on January 3, 2001.

1.2 Five-Year Review Process

1.2.1 Administrative Components

This second Five-Year Review was conducted by CH2M HILL under contract with the Air Force Center for Engineering and the Environment (AFCEE). The effort was coordinated by Marc Connally, Environmental Restoration Chief for the 92 CES/CEVR, Fairchild AFB. A kickoff teleconference to initiate this review was conducted by Mr. Connally on March 17, 2005, that included representatives of Fairchild AFB, EPA, Ecology, and CH2M HILL.

1.2.2 Community Notification and Involvement

The public was given notice at the September 6, 2005, Fairchild Restoration Advisory Board (RAB) meeting that the base was conducting the second Five-Year Review and that results would be presented in detail at the November 2005 RAB meeting. During the November 29 RAB meeting, results of the Second Five-Year Review for each site were presented and discussed. Copies of the Second Five-Year Review have been made available to the public through placement of the report in the administrative record/information repository at the Spokane Falls Community College Library.

1.2.3 Document Review

Numerous sources of information and documentation have been reviewed and compiled to complete this review for individual sites as cited in Section 8. They include the following:

- Remedial investigation/feasibility study (RI/FS), remedial design (RD) and remedial action (RA), and limited field investigation (LFI) reports
- RODs
- Annual remedial action operation (RA-O) reports that document long-term monitoring sampling results and remedial systems performance
- The first Five-Year Review report
- Remedial process optimization (RPO) scoping documents

1.2.4 Site Inspections and Interviews

Activities and review associated with the preparation of 2004 annual RA-O reports served as site inspections and documentation for nine IRP sites where operations and monitoring are ongoing. Interviews were held with Fairchild staff (Marc Connally and Todd Bennatt) to discuss changes that have occurred since the first Five-Year Review for the 19 sites that have received no further action (NFA) determinations or where only institutional controls remain in place. Site inspection information and comments from these interviews have been incorporated into individual site discussions presented in Sections 3 through 5.

1.3 Installation Overview

Fairchild AFB encompasses approximately 4,300 acres located approximately 12 miles west of Spokane, Washington (Figure 1-1). Established in 1942, the base has served numerous missions ranging from a repair depot for damaged aircraft returning from WWII to its current primary mission as the largest air refueling wing in the USAF.

1.3.1 Environmental Investigations

The base has generated considerable quantities of hazardous waste throughout its 6-decade history as a result of its function 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 as a result of landfilling, discharge to the base wastewater drainage system, fire training exercises, and accidental spills and leaks.

The base initiated investigations of potential hazardous waste releases in September 1984, as part of a four-phase IRP. The IRP was designed for each military branch to 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, an FFA was signed by Fairchild AFB, EPA, and Ecology, outlining appropriate response actions to be taken for sites determined to pose a potential hazard to public health or the environment. Thirty-seven sites and two areas of concern (AOCs) were identified as requiring investigation under CERCLA. The sites were ranked according to their potential hazard and, as a result, 8 received a Priority One ranking (the highest priority), 20 were listed as Priority Two, and 11 as Priority Three.

Table 1-1 lists the IRP sites according to the ROD in which they have been or will be addressed, status at the time the respective ROD was signed, and their status as of June 2007. General locations of these sites are shown in Figure 1-2. IRP sites at the base historically have been referenced in three ways—by their site name, base code, or USAF code. In this report, the sites are addressed by their site name and/or base codes only.

1.3.2 Restoration Advisory Board Role

The Fairchild AFB 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 Second Five-Year Report at the base. RAB meetings are held at least twice a year, and the general public is invited to attend and participate. The RAB comprises 15 board members from the community and is led by the Installation and Community co-chairs.

1.4 Physical Characteristics of the Base Vicinity

The following sections provide a brief overview of the generalized geology and occurrences of groundwater in the vicinity of Fairchild AFB. More detailed descriptions and evaluations of the geology and groundwater occurrences, with respect to the nature and extent of contamination observed at the sites covered by this review, are presented in their respective RI reports or annual RA-O reports (see Section 8 for a list of documents reviewed).

1.4.1 Generalized Geology

The geology in the vicinity of the base consists of three primary strata, described here in order of descending depth. The near-surface geology is characterized by alluvial sediments (primarily sand and gravel with some silt deposits) that generally vary from zero 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. These basalt flows vary from hundreds to thousands of feet in thickness. Interbedded layers of sand, silt, and clay occur between individual basalt flows and range from several feet to over 40 feet in thickness beneath the base. The basalt flows are underlain by massive granitic rock at depth.

The uppermost basalt at the base 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 from approximately 160 to 190 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 and fine-grained with infrequent fractures and low permeability. Interbed A generally consists of a laterally extensive, silty claystone that is approximately 8 to 15 feet thick. Basalt B generally is described as porous and vesicular at the top and is progressively more dense and less vesicular with depth.

1.4.2 Groundwater

The uppermost groundwater at the base is typically encountered from 3 to 12 feet below ground surface (bgs) 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 west to east 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 the alluvium and shallow basalt water-bearing zones. However, 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 is predominantly within the upper and lower portions of the formation where the number of interconnected fractures is highest. Vertical groundwater movement through Basalt A is typically slow because of the tightness of fractures within the center of the basalt formation.

1.4.3 Demographics and Land Use

Approximately 10,000 military personnel and civilians reside and/or are employed on the base. Family housing and dormitory units house approximately 5,300 residents. The City of Airway Heights, located approximately 2 miles east of Fairchild AFB, is the nearest community and has a population of over 4,500 residents. There are fewer than 1,000 rural residences located within a 0.5-mile radius of Fairchild AFB. The base water supply is groundwater that is piped from near the Spokane River and distributed throughout all on-base locations. The City of Airway Heights uses groundwater as its water-supply source, which is pumped from nearby alluvial and basalt aquifers.

Current land use in the vicinity of Fairchild AFB is primarily agricultural. Agricultural use includes cattle grazing and nonirrigated cultivation of wheat and hay. Other land uses include sand and gravel mining and light industrial. Within the base boundaries, land is both developed and undeveloped.

Table 1-1
Fairchild AFB IRP Site Status, June 2007

ROD	Base Code	Site Name	Site Status at time ROD signed[b]	Current Status[b]
Craig Road Landfill[a]	SW-8	Craig Road Landfill	RA required	Groundwater, pump-and-treat system, and landfill cap RA-O
On-Base Priority One Sites[a]	SW-1	Old Base Landfill	RA required	Groundwater RA-O
	PS-2	Refueling Pit Area	RA required	Groundwater RA-O and passive, free-product removal
	PS-8	Underground Fuel Line Area	RA required	Groundwater RA-O
	FT-1	Former Fire Training Area	RA required	Soil and groundwater RA-O
	WW-1	Industrial Wastewater Lagoons	RA required	Groundwater and intermittant pump-and-treat system RA-O
	IS-1	French Drain System	NFA	NFA
	PS-6	Defueling Tank Area	NFA	NFA
Priority Two Sites[a]	IS-3	Reciprocating Engine Test Cell	ICs required	Sump removed and Bldg. 2150 demolished, no further action necessary
	IS-4	Jet Engine Test Cell	RA required	Soil and groundwater RA-O
	PS-1	POL Bulk Storage Area	RA required	Soil and groundwater RA-O
	PS-5	Heating Oil Tank Area	RA required	Groundwater RA-O completed, no further action necessary
	PS-7	Fuel Oil Storage Tanks	RA required	Groundwater RA-O completed, LUCs remain in place until petroleum-contaminated soils beneath Bldg. 1350 are assessed
	PS-10	Fuel Truck Maintenance	RA required	Offsite incineration of TCE-contaminated soils and soil RA-O completed, no further action necessary
	FT-2	Old Fire Training Area	RA required	Soil and groundwater RA-O
	IS-2	Civil Engineering Storage Facility	NFA	NFA
	PS-3	Area C Pumphouse	NFA	NFA
	PS-4/9	Aircraft Crash Site	NFA	NFA
	SW-2	Waste Disposal Area	NFA	NFA
	SW-3	Waste Disposal Area	NFA	NFA
	SW-4	Former Bulk Coal Storage Area	NFA	NFA
	SW-5	Incinerator at DRMO Yard	NFA	NFA
	SW-7	Asphalt South of Taxiway K	NFA	NFA
	SW-9	Radioactive Waste Disposal	NFA	NFA
	SW-10	Disposal Area Near WANG Test Cell	NFA	NFA
	SW-11	Disposal Area at Warrior Park	NFA	NFA, LUCs
	SW-12	Disposal Area East of WSA	NFA	NFA
	WW-2	Wastewater Treatment Plant	NFA	NFA
Priority Three Sites[a]	AOC-1	Vehicle Maintenance Facility, Bldg. 2115	ROD Scheduled for 2008	Soil and groundwater sampling completed, no action recommended as an AOC. Bldg. 2115 combined into Site SD-37.
	AOC-2	Propulsion Shop, Bldg. 2163	ROD Scheduled for 2008	Soil and groundwater sampling completed, no action recommended
	SW-6	WSA - Radioactive Waste Disposal Areas	ROD Scheduled for 2009	Beta and gamma sampling completed, implement LUCs. Additional sampling in progress.
	SW-13	EOD Range	ROD Scheduled for 2008	Soil and trench sampling completed - no action recommended within the IRP program.
	SS-33	Waste Storage Area in WSA, Bldg. 1419	ROD Scheduled for 2008	Dig-and-haul completed, no further action recommended
	SD-34	Waste Fuel Operations, Bldg. 1012	ROD Scheduled for 2008	Dig-and-haul completed, no further action recommended
	ST-35	Bldg. 2165, Fuel Transfer Facility	ROD Scheduled for 2008	Dig-and-haul completed, no further action recommended
	WP-36	Holding Lagoon and Imhoff Tank	ROD Scheduled for 2009	Soil and sediment sampling completed. Implement LUCs. Baseline ecological risk assessment and additional sampling in progress.
	SD-37	Basewide Oil/Water Separators	ROD Scheduled for 2008	RI/FS completed, RA recommended, remedial design sheduled for 2008
	SD-38	Basewide Ditches, Piping and Culverts	ROD Scheduled for 2008	Dig-and-haul completed, no further action recommended
	SS-39	TCE Orphan Plumes	ROD Scheduled for 2008	RI completed in 2006. Work on the FS, Proposed Plan, and ROD are in progress.

Notes:

[a] Craig Road Landfill ROD signed in February 1993; On-Base Priority One sites ROD signed in July 1993; Priority Two sites ROD signed in December 1995; the Priority Three sites RODs are currently scheduled for completion in 2008 and 2009.

[b] Site status as of June 2007. Current status of Priority Three sites based on opinion of Fairchild AFB and Ecology

RA-O - Remedial Action-Operations; RA - remedial action; NFA - no further action; LUCs - land use/institutional controls

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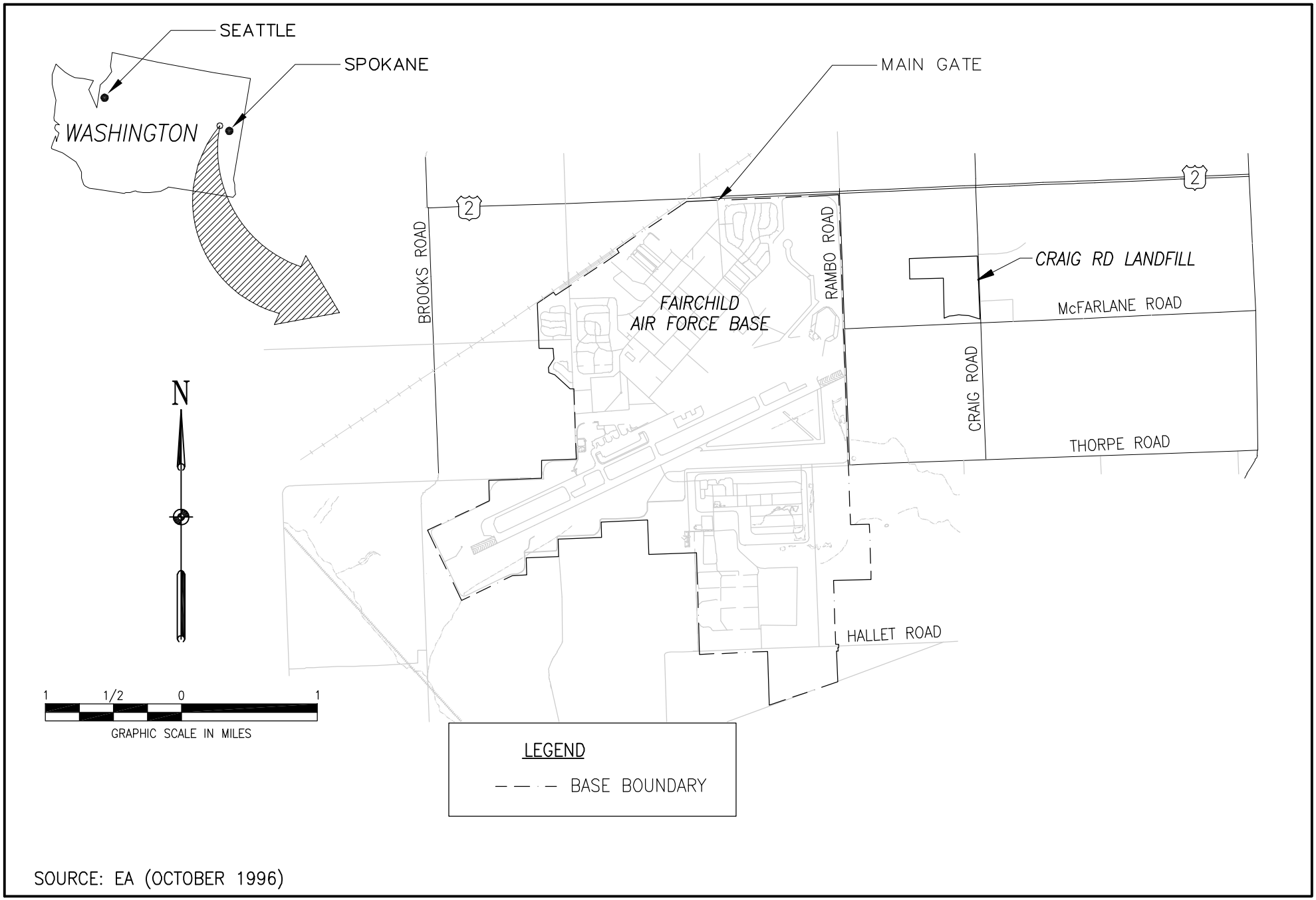

SOURCE: EA (OCTOBER 1996)

FIGURE 1–1: GENERAL LOCATION MAP OF FAIRCHILD AFB

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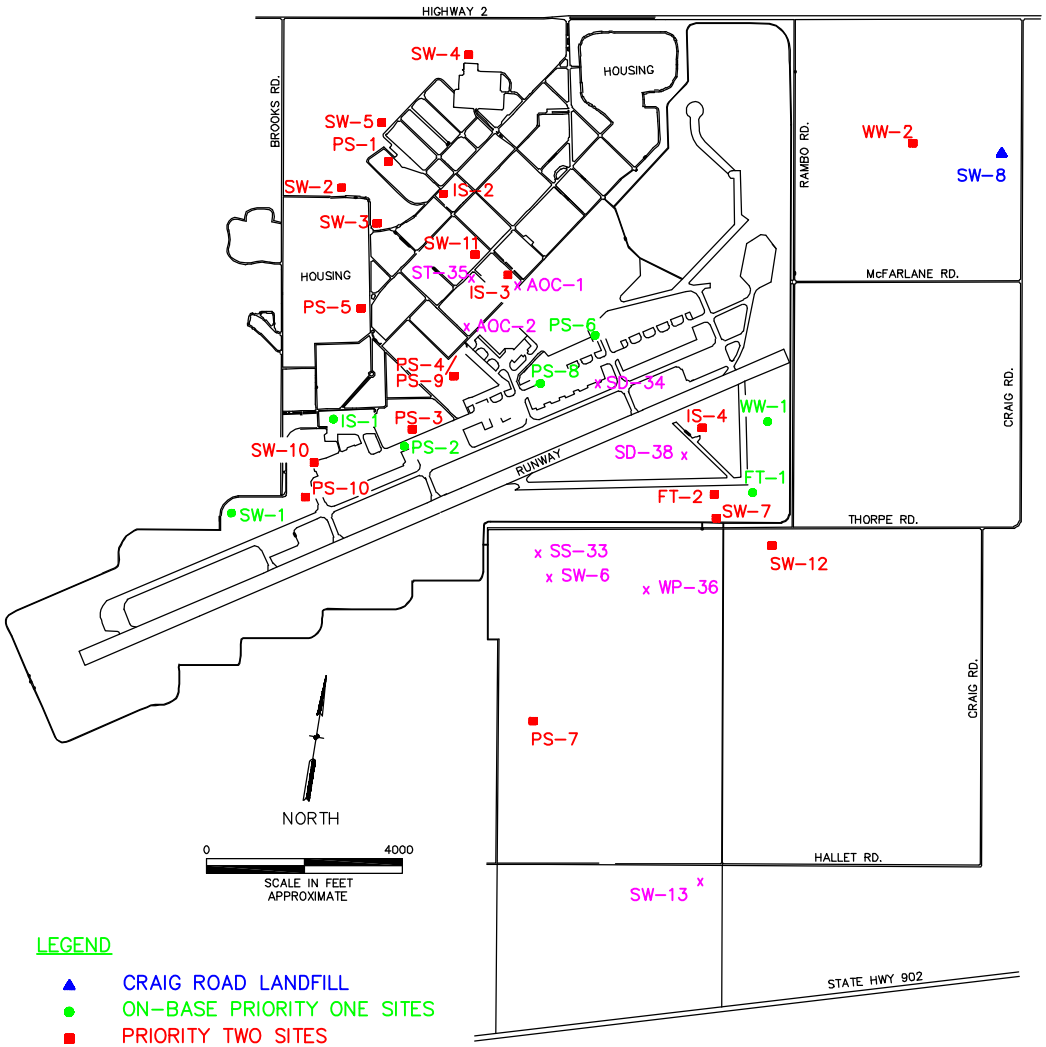

BASE CODE	(AF CODE)	SITE NAME
SW-8	(LF-02)	CRAIG ROAD LANDFILL
SW-1	(LF-01)	OLD BASE LANDFILL
PS-2	(SS-18)	REFUELING PIT AREA
PS-8	(SS-26)	UNDERGROUND FUEL LINE AREA
FT-1	(FT-04)	FORMER FIRE TRAINING AREA
WW-1	(WP-03)	INDUSTRIAL WASTEWATER LAGOONS
IS-1	(SD-05)	FRENCH DRAIN SYSTEM
PS-6	(SS-27)	DEFUELING TANK AREA
IS-3	(OT-16)	RECIPROCATING ENGINE TEST CELL
IS-4	(OT-17)	JET ENGINE TEST CELL
PS-1	(ST-06)	POL BULK STORAGE AREA
PS-5	(SS-09)	HEATING OIL TANK AREA
PS-7	(ST-10)	FUEL OIL STORAGE TANKS
PS-10	(SD-31)	FUEL TRUCK MAINTENANCE
FT-2	(FT-32)	OLD FIRE TRAINING AREA
SW-11	(DP-13)	DISPOSAL AREA AT WARRIOR PARK
IS-2	(SS-30)	CIVIL ENGINEERING STORAGE FACILITY
PS-3	(SS-07)	AREA C PUMPHOUSE
PS-4/PS-9	(SS-08)	AIRCRAFT CRASH SITE
SW-2	(DP-20)	WASTE DISPOSAL AREA
SW-3	(DP-21)	WASTE DISPOSAL AREA
SW-4	(DP-22)	FORMER BULK COAL STORAGE AREA
SW-5	(OT-23)	INCINERATOR AT DRMO YARD
SW-7	(DP-24)	ASPHALT SOUTH OF TAXIWAY K
SW-9	(RW-25)	RADIOACTIVE WASTE DISPOSAL
SW-10	(DP-12)	DISPOSAL AREA NEAR WANG TEST CELL
SW-12	(DP-14)	DISPOSAL AREA EAST OF WSA
WW-2	(WP-29)	WASTEWATER TREATMENT PLANT
AOC-1	(AOC-1)	VEHICLE MAINTENANCE FACILITY, BLDG. 2115
AOC-2	(AOC-2)	PROPULSION SHOP, BLDG. 2163
SW-6	(RW-11)	WEAPONS STORAGE AREA, RADIOACTIVE WASTE DISPOSAL AREAS
SW-13	(OT-15)	EOD RANGE
SS-33	(SS-33)	WASTE STORAGE AREA IN WSA, BLDG 1419
SD-34	(SD-34)	WASTE FUEL OPERATIONS BLDG. 1012
ST-35	(ST-35)	FUEL TRANSFER FACILITY, BLDG. 2165
WP-36	(WP-36)	HOLDING LAGOON AND IMHOFF TANK
SD-37	(SD-37)	BASEWIDE OIL/WATER SEPERATORS
SD-38	(SD-38)	BASEWIDE DITCHES, PIPING, AND CULVERTS
SS-39	(SS-39)	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.

SOURCE: FAIRCHILD AFB CIVIL ENGINEERING SQUADRON

FIGURE 1-2
FAIRCHILD AFB IRP SITE LOCATIONS

2.0 Site Groupings and General Remedies

2.1 Site Groupings

In 1990, Fairchild AFB, EPA, and Ecology signed an FFA that established site cleanup schedules for the base. At that time, three levels of priority were identified that required investigation for potential cleanup action. The sites that posed the greatest potential risk to human health or the environment were listed as Priority One sites. The next group of sites, which posed a lesser relative degree of risk, were identified as Priority Two sites. Priority Three sites were those designated to pose the lowest relative risk to human health and the environment, although some form of remedial action may be warranted.

As identified in Table 1-1, 28 of the 39 IRP sites at Fairchild AFB have been addressed through three RODs as summarized below.

2.1.1 Craig Road Landfill ROD

The Craig Road Landfill (CRL) site (SW-8) was the first IRP site at Fairchild AFB where remedial action was implemented. The CRL was initially identified as a Priority One site by the FFA. However, because of its size and off-base location, it was considered separate from the other On-base Priority One sites. The ROD for the CRL was signed in February 1993; remedial action construction was completed in 1995.

2.1.2 On-base Priority One Operable Units ROD

On-base Priority One Operable Unit sites include 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 RI activities conducted in 1991 and 1992. The ROD for the On-base Priority One Operable Unit sites was signed in July 1993, and concluded that remedial action was required at SW-1, PS-2, PS-8, FT-1, and WW-1. Remedial construction activities for these sites were completed by 1998. This ROD also concluded that NFA was required at IS-1 and PS-6**.** These NFA determinations were based on unlimited use of the sites without limitations or restrictions of future land use. Therefore, sites IS-1 and PS-6 are not addressed in this Five-Year Review.

2.1.3 Priority Two Sites ROD

Twenty IRP sites were identified as Priority Two sites. Initial characterization of these sites was conducted from 1986 to 1989. LFIs were initiated for these sites in 1991 and completed in 1992. Results from the LFIs were used to direct RI activities conducted in 1993 and 1994. The Priority Two sites ROD was signed in December 1995 and concluded that remedial actions were required at IS-3, IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2. The ROD also concluded that NFA was necessary at 13 sites**.** These NFA determinations were based on unlimited use of the sites without limitations or restrictions of future land use. Therefore, these 13 sites are not further addressed in this Five-Year Review.

2.1.4 Priority Three Sites

A Draft Proposed Plan is in process that addresses many of the Priority Three sites. Priority Three sites at Fairchild AFB consist of the following nine sites: SS-33 (Maintenance Shop and Wash Bay, Building 1419), SD-34 (Fuel Cell Maintenance Hanger, Building 1012), ST-35 (Heating Fuel Storage/Transfer Facility, Building 2165), WP-36 (Holding Lagoon/Imhoff Tank, Building 1454), SD-37 (Oil-Water Separators), SD-38 (Ditches, Pipes, and Culverts), RW-11 (Radioactive Waste Site), and OT-15 (also known as SW-13) (Explosive Ordnance Disposal Range), and SS-39 (TCE Plumes).

The Priority Three Sites Draft Proposed Plan addresses only sites SS-33, SD-34, ST-35, SD-37, and SD-38; it presents the preferred remedial alternative for site SD-37 and documents NFA decisions for sites SS-33, SD-34, and SD-38.

Priority Three sites SS-33, SD-34, and SD-38 were determined to require action to remediate soil contamination related to petroleum hydrocarbons, petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAHs), and arsenic, respectively. Soils were excavated and removed for thermal treatment from the site in September and October 1997. In April 1998, EPA indicated that the removal actions for contamination at sites SS-33, SD-34, and SD-38 were adequately protective of human health and the environment. The *Final Closure Report for Installation Restoration Program Sites SS-33, SD-34, ST-35, and SD-38* was approved by Ecology in June 1998 and stated that NFA was necessary at sites SS-33, SD-34, and SD-38 under the Washington State Model Toxics Control Act (MTCA).

Priority Three site ST-35 was determined to require action to remediate soil contamination related exclusively to petroleum hydrocarbons. Soils were excavated and removed for thermal treatment from the site in September and October 1997. In April 1998, EPA indicated that the removal actions for petroleum products at site SS-35 were adequately protective of human health and the environment. The *Final Closure Report for Installation Restoration Program Sites SS-33, SD-34, ST-35, and SD-38* was approved by Ecology in June 1998 and stated that no NFA was necessary at site ST-35 under the Washington State (MTCA. As a non-CERCLA regulated site, site ST-35 is not discussed further in the draft Proposed Plan.

Petroleum hydrocarbons and volatile organic compounds (VOCs) were identified as contaminants of concern (COCs) at site SD-37; they were caused by releases from numerous oil-water separators (OWS) at 11 buildings, as well as a grit trap and underground storage tank (UST) at two additional buildings.

Soil and groundwater assessments have been performed and total petroleum hydrocarbon (TPH) releases were discovered at most of the closed OWS locations. Trichloroethene (TCE) was identified in the shallow groundwater, primarily at building 2447. In order to expedite the presentation of the investigation results and assessment of remedial alternatives at the 13 separate locations, Site SD-37 was subdivided into two areas: “Building 2447” and the remaining affected areas, “other SD-37 locations.”

The feasibility study recommended enhanced in situ anaerobic and aerobic treatment of groundwater contaminated with TCE and low levels of benzene and petroleum

hydrocarbons near Building 2447. Natural attenuation was recommended at the "other SD-37 locations" to address primarily petroleum hydrocarbon contamination. The significant issue at SD-37 involves the dissolved phase VOC plume that extends adjacent to several buildings.

Discussions with state and federal regulators have resulted in increased concern about the potential for data gaps associated with vapor intrusion that could prevent stakeholder concurrence with remedy selection. Improved understanding of risk assessment issues with the regulatory community has resulted in the base initiating a reevaluation of the risk assessment performed and remedial alternatives screened in the original SD-37 feasibility study.

Priority Three Sites WP-36, RW-11, and OT-15 are currently undergoing additional study and evaluation. Site WP-36, Building 1454, is located in the southern portion of the base within a fenced area of the Weapons Storage Area. The building housed a sewage treatment tank (Imhoff tank) that was used for settling and anaerobic digestion of solids. Tank effluent was discharged to the lagoon and flowed to a wetland area via a single outflow channel at the south end of the lagoon. Sampling of lagoon sediments have identified petroleum hydrocarbons and elevated concentrations of metals. A baseline ecological risk assessment is underway at this site.

Site RW-11 is located within the Weapons Storage Area. The site consists of three areas which were designated as storage or disposal areas for low-level radioactive materials. The site includes two USTs for contingency operations and a dry waste burial trench. It is very unlikely the tanks ever received any radioactive liquid wastes. All three areas are surrounded by fenced enclosures posted with appropriate signage. The three areas are undergoing further evaluation to determine appropriate remedial action.

Site OT-15, Explosive Ordnance Disposal (EOD) Range, is located on the southern edge of the base. Earthen berms and troughs were used for containing detonated or burning materials. The significant site features comprise a personnel bunker, 500-gallon fuel oil tank, burial trench, and dirt access road. The site was investigated by reviewing aerial photos, conducting personnel interviews, field sampling, and a geophysical survey. This resulted in a recommendation of NFA. Ongoing EOD operations currently include training operations and periodic emergency munitions disposal. Because EOD operations are currently being performed, a restoration program designation of Response Complete is in-work.

Additionally, the other pre-ROD site at Fairchild AFB is SS-39. An RI conducted in 2002 was not able to adequately characterize the contaminant plume at the site because of unforeseen site conditions. Three data gaps remained to be resolved: 1) the extent of a previously unidentified contaminant plume (carbon tetrachloride), 2) characterization of TCE concentrations in a deep basalt aquifer, and 3) characterization of the leading edge of the groundwater plume. An expedited site assessment technique, the Triad approach, was adopted for use at this site. Because of limited funding, a phase I project was awarded in fiscal year 2004 (FY04). The phase II project awarded in FY05 satisfied the remaining objectives, and the phase II RI conducted in FY05 determined that the TCE groundwater plume had traveled under the Ft. Wright Village housing area. Groundwater sampling results taken from sentinel wells installed at the northern base boundary (both sides of the

front gate) indicate that the TCE groundwater plume has not crossed the base boundary (in levels above the federal maximum contaminant level [MCL] of 5 micrograms per liter [µg/L]).

Fairchild IRP managers created a performance-based contract with the U.S. Army Corps of Engineers to complete a focused feasibility study, proposed plan and ROD under one contract for this site. A key element in this approach has been involving representatives from EPA Region 10 and Ecology to engage the regulatory agencies at the earliest point in the process to address concerns and comments and to garner support for the USAF's cleanup goals.

This approach allows Fairchild to complete the necessary steps in the CERCLA cleanup process in an expedited manner, ensuring that Air Mobility Command (AMC) meets its FY12 Remedy-In-Place goals.

Additional issues remain to be resolved between the USAF and EPA/Ecology for site SS-39:

1) EPA stated that a potential vapor intrusion pathway may exist above acceptable VOC concentrations and atop part of the groundwater plume. This potential pathway may pose an unacceptable risk to human health. However, there is significant disagreement between the USAF and EPA regarding the level of exposure and whether the exposure is unacceptable. This disagreement is primarily based on use of appropriate TCE toxicity values. The USAF recognizes that vapor intrusion may be a potential pathway and is initiating air sampling to evaluate potential exposure.

2) EPA is pursuing groundwater sampling of emerging compounds, specifically perchlorate, n-nitrosodimethylamine (NDMA), and 1,4-dioxane. The USAF complied with the request to sample 1,4-dioxane at sites where TCE is a contaminant of concern, and none was detected. EPA specifically requested perchlorate and NDMA sampling at IRP site SS-39. USAF guidance states that installations will sample sites where there is a reasonable expectation that a perchlorate release has occurred as a result of USAF/Department of Defense activities. No evidence was found of these kinds of activities at site SS-39; therefore, the USAF declined EPA's sampling request.

3) There is disagreement on selection of groundwater cleanup levels for site SS-39. EPA has indicated that MTCA should be utilized; the USAF's position is that the federal MCL is appropriate, since the site cleanup activities are governed under CERCLA.

2.2 Individual Site Discussions

Discussions relating to the Priority One and Two sites identified above are presented in Sections 3 through 5 based on their respective ROD. Information presented for each site follows this format:

- Site Background
- Remedy Selection and Implementation
- Progress Since Last Review

- Technical Assessment (Questions A, B, and C)
- Issues
- Recommendations
- Statement of protectiveness

Supplemental information such as historical contaminant concentration data and/or statistical trend results is included in Appendixes A, B, and C, depending on which ROD addresses an individual site.

2.2.1 General Remedies

Numerous passive and active remedial measures have been implemented at Fairchild IRP sites to meet remedial action objectives and ROD requirements. Two remedies, common to many of the sites, are summarized here: institutional controls, identified as land use controls (LUCs); and natural attenuation augmented with long-term monitoring through RA-O.

2.2.1.1 Institutional and Land Use Controls

Institutional controls have been implemented to minimize or prevent the risk of human contact with contaminated media at Fairchild AFB; they consist of physical and administrative mechanisms used to limit access to and restrict the use of real property to prevent or reduce risks to human health. Physical mechanisms include the fence around the industrial area of the base and controlled entry gates that prevent access to the general public. Administrative mechanisms are described below.

Fairchild AFB will use the Base General Plan as the implementation plan to manage and control current and future land uses at IRP sites. The base will revise the General Plan to include the current land users, current use of the sites, and site-specific use restrictions. The General Plan will contain a map indicating the location and extent of the sites, which LUCs are in effect for those areas, and the reasons and objectives for the LUCs.

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 basewide projects, especially those located in or near IRP sites, including sites that have LUCs. The base will ensure that these or similar processes and procedures remain in place and are complied with for all proposed construction, digging, and subsurface-soil-disturbing activities on the base.

When the LUC plan is approved and in place, the base will conduct land use inspections at least annually and take prompt action to restore, repair, or correct any LUC deficiencies. The base will then prepare an annual monitoring report on the status of LUCs, including maintenance and monitoring thereof and how any LUC deficiencies or inconsistent uses have been addressed. This report will be submitted on an information-only basis to EPA and Ecology, and filed in the Administrative Record.

All of the 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. Signs may be posted as mutually agreed among the project managers.

The base will notify EPA and Ecology, consistent with the requirements of CERCLA §120(h), at least 6 months prior to any anticipated transfer or lease of property that includes any IRP sites (as part of their LUC plan) to a private, local, or state entity, and will provide such regulators the opportunity to discuss with the USAF appropriate provisions in the transfer or lease documents to maintain the land use restrictions and controls. If notice within 6 months is not possible, the USAF will do so as soon as possible, but not later than 60 days prior to such transfer or lease. The USAF will provide similar notice as to federal transfer of property accountability and administrative control, with review and comment opportunities to be provided in accordance with all applicable federal law.

The base will notify EPA and the state in the event that any land use change is proposed for a site that is inconsistent with use restrictions described, if any anticipated action may disrupt the effectiveness of LUCs, or if any action might alter or negate the need for LUCs.

All of these controls are being used at the base to protect the integrity of each site's in-place remedy. Prior to the first Five-Year Review completed in 2000, EPA Region 10 reached a determination that the implementation of institutional controls at federal facilities, including Fairchild AFB, and the remedy descriptions of institutional controls in the RODs did not meet the standards and criteria in accordance with its guidance. Over the past several years, the USAF and EPA have been working to establish LUC policies and protocol that are consistent with both entities' internal policies. As such, development and formal adoption of LUC policies for Fairchild AFB has been delayed and remains in process. When the base's LUC plan is completed and accepted by EPA, additional measures may need to be formalized into each of the base's RODs, in accordance with EPA Region 10 and USAF policies, likely through a vehicle such as an Explanation of Significant Differences (ESD).

2.2.1.2 Long-Term Monitoring and RA-O Programs

Long-term monitoring as a part of RA-O has been instituted at several IRP sites to monitor soil and groundwater contamination regulated under all authorities: Resource Conservation and Recovery Act (RCRA), CERCLA, or MTCA. Updated monitoring plans are produced regularly by base contractors and are subject to review and concurrence by Ecology before implementation.

The primary objective of these programs is to collect representative, media-specific data to document the abatement of contaminant migration and the associated attenuation of COCs in response to the selected cleanup actions, of which natural attenuation may be a component. A secondary objective is to estimate rates of degradation to determine approximate timeframes in which site cleanup may be achieved. Data collected through the RA-O programs generally indicate that the overall contaminant mass for individual IRP sites is being reduced through natural attenuation. However, the data generally are not sufficiently conclusive at this time to clearly establish specific timeframes for achieving cleanup goals at most sites.

In addition to the long-term RA-O programs, the base has conducted residential well monitoring for off-base users in the vicinity of the CRL and along Thorpe Road, east of the WW-1 and FT-1 sites, for over 15 years. Currently, 15 wells (14 residential wells and 1 public water supply well) are sampled at least annually and analyzed for VOCs.

2.3 Compliance with ARARs

State and federal chemical-specific applicable or relevant and appropriate requirements (ARARs) were used to develop cleanup goals for each site as specified in the RODs. Specific state and federal ARARs include:

- Safe Drinking Water Act (SDWA), 40 USC Section 300, and 40 CFR Part 141, MCLs for public drinking water supplies
- MTCA, Chapter 173-304 Washington Administrative Code (WAC), Method A and Method B cleanup levels for soil and groundwater

Specific constituent cleanup levels addressed by each ROD were based on federal MCLs and/or MTCA cleanup standards. According to the On-base Priority One sites ROD, benzene and TCE cleanup levels in groundwater were based on the MTCA Method B cleanup levels of 5 µg/L, which is equivalent to the federal MCL. In contrast, the CRL ROD TCE cleanup level and Priority Two sites ROD benzene cleanup level was based solely on the federal MCL of 5 µg/L. TPH levels in soil and groundwater were addressed in the Priority One and Two sites RODs and were based on MTCA Method A cleanup levels of 200 milligrams per kilogram (mg/kg) and 1,000 µg/L, respectively.

Revisions to MTCA and associated Cleanup Levels and Risk Calculations, Version 3.1, (CLARC) occurred in 2001. Cleanup levels identified in each ROD must meet the requirements of MTCA and not exceed the cancer risk of 1×10^{-5}.

Additionally, EPA has adopted a new arsenic MCL of 10 µg/L in groundwater, which became effective on January 23, 2006. The former arsenic MCL was 50 µg/L. Arsenic is not a listed COC for any Fairchild RA-O site, but it will be evaluated in the technical assessment section of sites where appropriate, namely WW-1.

Impacts of these cleanup level modifications will be evaluated to determine if the remedy is meeting remedial action objectives set forth in the RODs. The evaluation will be included in the technical assessment for each site, where applicable. If the evaluation indicates the remedy is not meeting remedial action objectives, then a determination of protectiveness will be addressed and any necessary corrective actions will be recommended.

3.0 Craig Road Landfill

The Craig Road Landfill (CRL) site (SW-8) was the first IRP site where remedial action was implemented on the base. The CRL initially was identified as a Priority One site by the FFA. However, because of its size and off-base location, it was considered separately from the other On-base Priority One sites. The ROD for the CRL was signed in February 1993; remedial action construction was completed in 1995.

3.1 Background

The CRL was a general-purpose landfill and occupied approximately 39 acres of a 100-acre parcel owned by the USAF. The CRL contained three waste disposal areas. The first was about 6 acres in size and was designated the Northeast Disposal Area (NDA). 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. Following disposal activities, the area was given a natural soil cover and graded. Depths of fill in the NDA exceed 30 feet below natural ground surface. The second disposal area, designated the Southwest Disposal Area (SDA), was located in the southwest corner of the property and occupied approximately 13 acres. 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 solvents, dry cleaning filters, paints, thinners, and coal ash. A third disposal area was located in the southeast corner of the property and occupied 20 acres of land. This area was active in the late 1950s and consisted of surface disposal of construction debris from runway work performed during the base conversion.

While the landfill was active, the base wastewater treatment plant (WWTP) also was operational on part 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. Effluent from the WWTP reportedly was intermittently discharged into landfilling 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.

As early as 1989, groundwater samples collected from nearby offsite wells showed TCE concentrations above its MCL of 5 µg/L. Consequently, the base substituted its own water supply for the impacted water supply system. In 1991, the base initiated an interim removal action (IRA) at CRL for the design and construction of a pump-and-treat system to remove TCE contamination from the upper aquifer and to minimize migration of contaminants

offsite. Nine extraction wells initially were installed in the NDA and SDA as part of the IRA. An air stripping unit was constructed to treat contaminated groundwater. This interim groundwater treatment system started operation in October 1992.

3.2 Current Operations

3.2.1 Remedy Implementation and Remedial Action Operations

Remedial action construction activities were initiated in 1994 and completed by October 1995. The following sections describe components of the selected remedy as implemented.

3.2.1.1 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 transporting contaminants to groundwater. Caps are inspected quarterly and maintained according to the current version of the site's operations and maintenance (O&M) plan. The caps remain functional and intact, requiring little annual maintenance except for occasional repair to landfill cap toe drains.

3.2.2.2 Installation of an Active Soil Vapor Extraction System

A soil vapor extraction (SVE) system was specified in the ROD. However, a post-ROD treatability study, conducted in September 1993, determined that the significant source of groundwater contamination was dense nonaqueous phase liquid (DNAPL) rather than contaminated vadose soils. This determination precluded the effectiveness of an SVE system and, as a result, an ESD was completed in April 1996, noting that the additional cost of implementing an SVE system would not provide any significant decrease in overall risk from contaminants at the site.

3.2.2.3 Groundwater Extraction and Treatment System

The groundwater extraction system was designed to remove TCE from onsite groundwater and to provide hydraulic containment of the onsite portion of the plume, thus preventing further migration of contaminated groundwater. The portion of the TCE plume downgradient of the property boundary would be allowed to naturally attenuate. The final extraction well system consists of 12 extraction wells, 6 each in the SDA and NDA areas. Groundwater from the extraction wells is pumped to the groundwater treatment plant (GTP), where TCE is volatized through air stripping. The resulting offgas is treated (adsorbed) by GAC. Treated water is discharged to the aquifer via two infiltration trenches located along Craig Road, downgradient of the SDA and NDA. The treatment plant began 24-hour operation on September 19, 1995.

Initially, the system extracted an average of approximately 11 million gallons (MG) of groundwater monthly. Extraction rates have gradually declined, to a range of 4.9 to 6.1 MG per month in 2004. This trend is a result of the dewatering of the immediate saturated zone beneath the NDA and SDA, reduced recharge as a result of capping, and limited natural recharge upgradient of the CRL. Water levels in onsite wells have been lowered by as much

as 40 to 100 feet since full-time operation of the system began; they are controlled at those levels. Potentiometric surface maps of the Basalt A aquifer indicate that hydraulic containment of the onsite plume continues, and that the downgradient extent of the capture zone extends beyond the eastern site boundary.

It is estimated that 897 pounds of TCE were been removed by the GTP from September 1995 through December 2004. Approximately 81 percent of the TCE removed sitewide has been from SDA extraction wells, with two extraction wells alone (EW-10 and EW-14) accounting for nearly 64 percent of the removed TCE. The overall site TCE removal rate has declined from over 100 pounds per quarter (lbs/quarter) in late 1995 to 15 lbs/quarter in 1999, and to less than 7 lbs/quarter in 2004. This is primarily a result of reduced extraction rates and declining TCE levels.

Groundwater elevations for site extraction wells and monitoring wells continue to provide supporting data that the extraction system network is maintaining hydraulic control of the onsite TCE plume by maintaining an inward gradient beneath the landfill cells. Examples of this evidence are shown in two figures located in Appendix A, which shows this inward gradient and the cone of depression maintained below the cells. This evidence indicates that the zone of capture of the extraction well network extends to the east of the site, to some distance east of Craig Road.

Overall site RA-O costs continue to be reduced through ongoing optimization efforts completed since 2000, including:

- Modifying treatment processes including pumps, motors, and blowers to more effectively and efficiently treat declining influent flows, including the installation of variable frequency drives, that have resulted in decreased electrical and natural gas usage alone by about $15,000 annually
- Replacing oversized extraction well pumps and motors with more efficient units sized for current conditions
- Continued streamlining for reporting and documentation

3.2.2.4 Monitoring Offsite Water Supply Wells

Offsite water supply wells have been monitored by the base since 1988, as part of their residential well monitoring program. Initially, several water supply wells and select monitoring wells located downgradient of the CRL were monitored quarterly. Because TCE concentrations in these wells were considerably below the MCL, the number of wells has been reduced over time; thus, as of 2004, only one well (a City of Airway Heights production well) is sampled quarterly.

3.2.2.5 Monitoring Groundwater in the Upper and Lower Aquifers

A long-term monitoring program for onsite and offsite monitoring wells in the vicinity of the CRL, for both upper (alluvium and Basalt A) and lower (Basalt B) aquifers, was implemented in 1995. In 2004, this monitoring program consisted of the following:

- Semiannual sampling at 12 onsite extraction wells
- Semiannual sampling at 10 Alluvial/Basalt A aquifer wells and 1 Basalt B aquifer well

- Annual sampling at 6 Alluvial/Basalt A aquifer wells and 3 Basalt B aquifer wells

RA-O data indicate an overall decline in TCE contamination, both onsite and offsite. TCE and cis-1,2-dichloroethene (cis-1,2-DCE) were the primary VOCs detected during RA-O sampling. In 2004, TCE was detected at concentrations exceeding the MCL in all 12 extraction wells and in 5 Basalt A aquifer monitoring wells both onsite and offsite. No Basalt B aquifer monitoring wells exhibited TCE concentrations exceeding the 5 µg/L MCL. SDA wells continued to have higher concentrations of TCE compared to NDA wells, with concentrations up to 940 µg/L (EW-10).

TCE concentrations in three offsite wells located immediately downgradient of the CRL continue to show declining trends. At MW-78 and MW-80, TCE concentrations have been below the MCL during all sampling events since 1999. TCE concentrations in MW-82 have been below the MCL since September 2003. TCE concentrations at MW-118, located approximately 2,000 feet east of the CRL (approximately 1,500 further downgradient from MW-82), are the highest concentrations observed in any offsite monitoring wells. TCE concentrations in MW-118 declined from 310 µg/L in March 2000 to 78 µg/L in March 2003, but increased up to 337 µg/L in 2004. Based on onsite hydraulic control of the TCE plume on the CRL site itself—and no similar increases of TCE concentrations observed at MW-78, MW-80, and MW-82—the data suggest that increased TCE concentrations at MW-118 are not related to CRL RA-O, but could be a result of non-USAF-related activities that have occurred offsite. Significant sand and gravel mining operations have occurred upgradient of MW-118 (and downgradient of the CRL) since 2001. TCE detects at a municipal water supply well located 2,500 feet downgradient from MW-118 have been below the MCL, remaining about 0.5 µg/L during the last several years.

Figure 3-1 shows the lateral extent of the TCE plume exceeding the MCL as of September 2004. Supplemental pertinent data regarding TCE concentrations in site wells are included in Appendix A.

3.2.2.6 Institutional Controls

In addition to the controls outlines in Section 2.2.1.1, specific objectives for on-base LUCs include:

- Prevent any disturbance to the landfill caps, except as necessary for authorized maintenance activities
- Prevent drilling of new wells except for monitoring wells authorized by EPA and Ecology
- 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 the CRL extends from USAF-controlled property. 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.

Specific objectives for off-base LUCs include:

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

3.3 Progress Since Last Review

Remedial action operations have continued throughout the entire review period. The first Five-Year Review stated that all components of the selected remedy had been implemented and determined that the selected remedy was protective of human health and the environment. The report identified two recommendations to optimize systems performance:

- Evaluating the ability to reduce overall pumping volumes by taking certain extraction wells (EW-12 and EW-5) offline or by pulse-pumping the wells
- Evaluating the feasibility of implementing a large-scale in situ remedial action designed to eliminate potential TCE sources within the landfill materials

Overall pumping volumes have been reduced somewhat by taking some extraction wells (namely EW-12) offline during periods of low flow, along with the replacement and resizing of extraction well pumps and motors in 8 of 12 extraction wells. Their original pumps and motors were oversized and operated inefficiently under existing conditions. However, because of an outdated programmable logic controller (PLC) within the GTP, further reductions to the extraction system could not be accommodated. In late 2004, a new PLC system was designed for installation in early 2005 that would greatly enhanced potential manipulations with the extraction and treatment system.

The feasibility of implementing some type of a large-scale in situ remedial action was evaluated in 2001. Because of the high capital costs associated with potentially applicable technologies and the uncertainties of these technologies to definitively eliminate sources of TCE, it was determined that there likely were no viable technologies able to achieve the goals cost-effectively.

Despite limited overall progress on the two recommendations identified in the first Five-Year Review, an average of two to five recommendations to optimize site operations have been identified in each of the CRL RA-O annual reports since 1999 and have been completed or remain in progress.

The number of routine CRL groundwater samples collected has been reduced by about 15 percent from 1999 through 2004 through decreasing sampling frequencies and/or eliminating wells from the monitoring program.

3.4 Technical Assessment

The technical assessment follows EPA guidance and answers the following three questions:

- **Question A**: Is the remedy functioning as intended?
- **Question B**: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives 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 remedy?

3.4.1 Question A: Is the remedy functioning as intended?

A review of available RA-O reports and site inspections indicates that the remedy is functioning as intended by the ROD. The remedial action objectives established by the ROD are being achieved as evidenced by the following:

- Consumption of TCE-contaminated groundwater is being prevented through base LUCs and additional institution controls put in place by Ecology. Additional site LUCs and the landfill caps also prevent human exposure to contaminants located within landfilled materials. No activities have been observed that would have violated these established institutional controls.

- Contaminated groundwater in the upper aquifer is in process of being restored through contaminant removal by the CRL extraction system and limited natural attenuation processes. By 2004, RA-O had been ongoing at the CRL for 9 years. The ROD identified a restoration timeframe for the upper aquifer (onsite) that ranged from less than 10 years to as much as 75 years. Despite not achieving cleanup levels by the earlier timeframe, progress is being made towards eventual restoration. Figure 3-1 shows the estimated lateral extent of the TCE plume exceeding the 5 µg/L MCL cleanup level based on September 2004 data. The lateral extent of the TCE plume has shrunk compared to that observed in 1999. Figure 3-2 shows TCE concentrations for several monitoring wells located at the CRL (just downgradient and about 2,500 feet downgradient of the site). The data clearly indicate that TCE concentrations are on the decline within the Basalt A aquifer. Additionally, there is limited evidence that natural attenuation of TCE is occurring within the onsite portion of the plume. Field parameters (such as dissolved oxygen and oxidation-reduction potential) generally are not indicative of an anaerobic environment that is favorable to promote TCE degradation. However, cis-1,2-DCE (one of the initial degradation products of TCE) is detected regularly in onsite wells.

- Further migration of TCE-contaminated groundwater onsite at the CRL is being controlled by the CRL extraction system. This system maintains hydraulic capture of the onsite TCE plume, to the extent that a cone of depression has been created that does not allow for offsite migration and into lower reaches of the aquifer.
- The landfill caps and groundwater extraction system have worked together to significantly lower groundwater levels beneath the landfill by as much as 100 feet at some locations, thus minimizing any migration of contaminants from the landfilled material to groundwater.

Overall site O&M annual costs were evaluated for this review. The average annual O&M cost for the CRL during this review period was approximately $375,000. This amount included direct costs for 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 documents, data validation, and reporting activities.

3.4.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

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

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

A newly recognized association of the compound 1,4-dioxane (that historically may have been mixed as a stabilizer in TCE-containing mixtures) raises a possibility of its presence in groundwater at the CRL. No analysis for 1,4-dioxane was performed prior to 2004, nor is it specified in the CRL ROD. Although EPA has not established an MCL, the MTCA Method B groundwater cleanup level for 1,4-dioxane is 7.95 µg/L. Aside from this, no other new information has come to light that would call into question the protectiveness of the remedy. Note: influent/effluent samples from the CRL treatment plant were analyzed for 1,4-dioxane in September 2005; 1,4-dioxane was not detected in either sample.

3.4.4 Summary of Technical Assessment

The remedy as implemented at the CRL is currently considered protective. RA-O at the CRL are meeting or are continuing to progress towards meeting all remedial action objectives in accordance with the ROD. However, no definitive timeframe can established at this time to determine when cleanup levels will be achieved for the upper aquifer.

There have been no newly identified exposure pathways or any significant changes in land use on or near the site, or physical site conditions that would call into question the validity of the remedy selection. The potential for finding 1,4-dioxane above MTCA cleanup levels in groundwater could warrant further evaluation of the selected remedy. The USAF acknowledges EPA's concerns regarding 1,4-dioxane and did complete sampling of treatment

plant influent/effluent in September 2005. These results were conveyed to EPA separately from this Five-Year Report.

3.5 Issues

Two issues have identified for the second Five-Year Review for the CRL is listed in Table 3-1.

TABLE 3-1
Craig Road Landfill Issues

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
No definitive timeframe has been established at this time to determine when cleanup levels will be achieved for the upper aquifer	N	N
TCE concentrations in an offsite monitoring well (MW-118) located downgradient of the CRL have increased in recent years to levels approaching 400 µg/L.	N	Y

3.6 Recommendations

All components of the selected remedy have been implemented. Table 3-2 highlights recommendations that address site issues or have the potential to further optimize long-term systems performance. Further discussion of these recommendations is provided below.

TABLE 3-2
Craig Road Landfill Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
The timeframe to achieve cleanup levels in upper aquifer has not been definitively established	Evaluate existing data using statistical means to identify potential timeframes for achieving cleanup levels	Fairchild AFB	Ecology	Ongoing	N	N
Reduce overall operational costs and increase contaminant removal rates	Evaluate the potential to employ batch treatment to maintain hydraulic containment while increasing potential TCE removal	Fairchild AFB	Ecology	Ongoing	N	N
Extraction well pumps and motors may not be sized appropriately	As extraction well pumps and motors fail, replace them with “right-sized” units to match current conditions	Fairchild AFB	None	Ongoing	N	N

Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to reduce some groundwater monitoring by eliminating some wells or reducing sampling frequency	Fairchild AFB	Ecology	Ongoing	N	N
TCE concentrations in MW-118 have increased	TCE concentrations in MW-118 will continue to be evaluated through semi-annual LTM.	Fairchild AFB	Ecology	Ongoing	N	Y

- **Evaluate the timeframe to achieve cleanup levels in the upper aquifer.** Through the annual RA-O reporting mechanism, use available information and statistical means to estimate potential timeframes for achieving cleanup levels for select Basalt A aquifer extraction and monitoring wells.
- **Further evaluate reductions in RA-O operational costs**. Current O&M costs remain near the high end of cost ranges identified by the ROD. Further evaluation of current practices should be continually evaluated. One potential method to reduce overall operational costs and potentially increase contaminant removal is batch treatment. Currently, groundwater levels are maintained approximately 65 to 90 feet below landfill debris. During batch treatment, the extraction system would be shut down for a specified period, and water levels would be allowed to recover to a certain elevation (probably to elevations at or near the landfill debris, but without losing site hydraulic containment). The system would then be turned on and operated until groundwater levels declined to a predetermined level. Prior to implementing this, field data would need to be collected to establish how long the system could be shut down without losing hydraulic containment prior to restart. Computer modeling also should be employed as a means to confirm field results and to provide the ability to evaluate if this method would be effective for increasing contaminant removal. During system shutdown, water levels would be allowed to recover to elevations that might allow greater transfer of dissolved-phase TCE or DNAPL to be transferred to groundwater, thus potentially increasing contaminant mass removal.
- **Extraction well pump and motor optimization**. About one-third of all extraction well pumps and motors operate inefficiently and remain oversized for current conditions. As this equipment fails, it could be replaced with "right-sized" equipment to increase operational efficiency.
- **Reduce RA-O groundwater monitoring**. Based on available monitoring data and current conditions, the following modifications should be made to the RA-O groundwater monitoring program:
  - **Reduce sampling frequency of MW-84 to annual.** TCE concentrations at MW-84 have been non detect (less than 0.5 µg/L) for several years. Groundwater flow directions at this location indicate that the well is located upgradient/cross-gradient when extraction is occurring at the CRL.

- **Reduce sampling frequency at MW-78, MW-80, and MW-83 to annual.** TCE concentrations at these wells downgradient of the CRL have been considerably below the MCL for several years, approaching non detect levels.
- **Reduce sampling frequency of MW-141 to annual.** Several lines of evidence indicate that TCE contamination observed at MW-141 is not associated with the CRL. MW-141 is located cross-gradient to the landfill and not downgradient (based upon potentiometric surface elevation data). Additionally, TCE concentrations in MW-141 have remained relatively constant since remediation at the CRL began, which is in stark contrast to other monitoring wells located downgradient of the landfill where significant declines in TCE concentrations have been observed. Considering these factors, it is apparent that this contamination cannot be linked to the CRL. As such, a reduced sampling frequency is technically justifiable. The presence of TCE at this location, as well as issues previously raised for MW-118, may prompt further regulatory review independent of Fairchild AFB.
- **Discontinue annual sampling at MW-116.** MW-116 is a deep alluvial well where TCE concentrations have been at or near non detect levels for several years. MW-115, a shallower well located adjacent to MW-116, will continue to be sampled annually.

- **Ongoing evaluation of TCE concentrations at MW-118.** TCE concentrations in MW-118 will continue to be evaluated through semi-annual monitoring. TCE concentrations in MW-118, located approximately 2,000 feet downgradient of the CRL, increased from a historic low of 78 µg/L in March 2003 to 337 µg/L in 2004 (and higher since). Several lines of evidence exist that indicate that the CRL extraction system is maintaining hydraulic control of the onsite portion of the TCE plume on the CRL site itself. Therefore, these increasing concentrations may not be related to remedial action operations at CRL, but could be a result of non-USAF-related activities that have occurred offsite where significant sand and gravel mining operations have occurred upgradient of MW-118 (and downgradient of the CRL) since 2001.

3.7 Statement of Protectiveness

The remedy at the CRL is currently protective of human health and the environment, and it is expected to be protective of human health and the environment upon attainment of remedial action objectives. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways.

In order for the remedy to be protective in the long term, the remedial action objective of achieving cleanup levels in the upper aquifer within the timeframes established by the ROD must be further evaluated. If it is determined that the remedy cannot achieve these goals, alternative remedies may need to be explored to optimize restoration of the upper aquifer.

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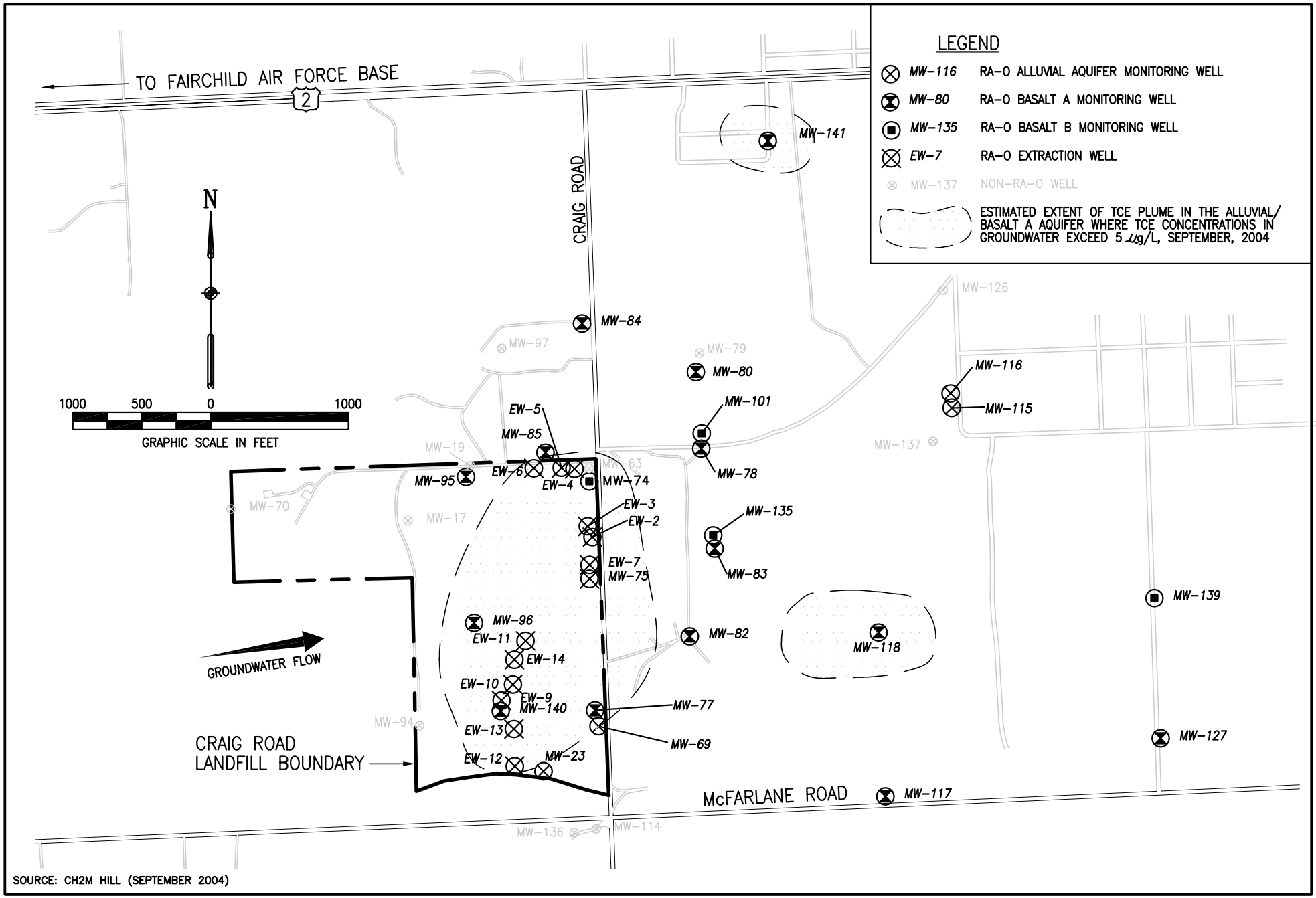
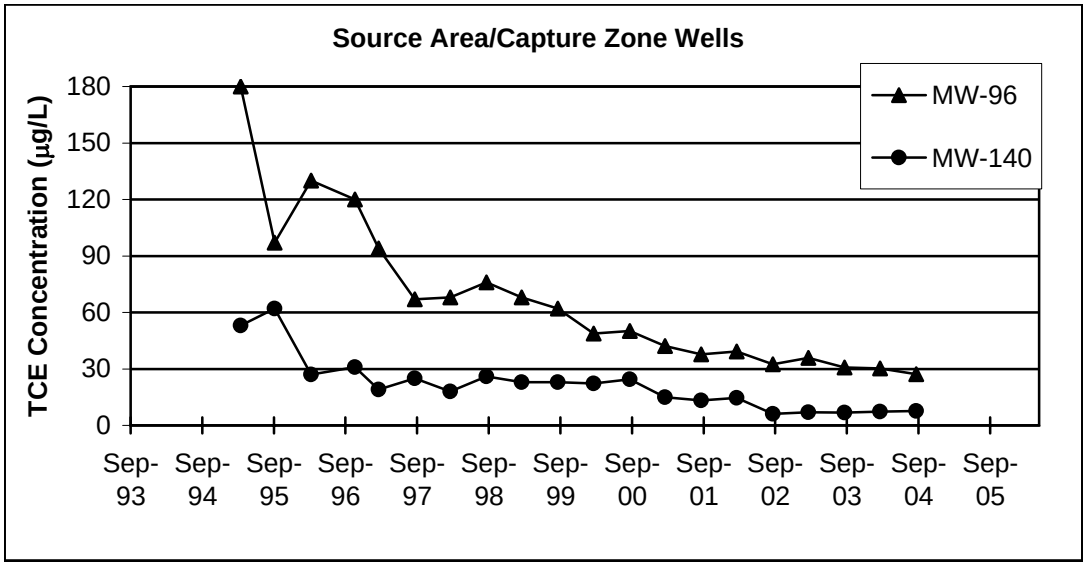
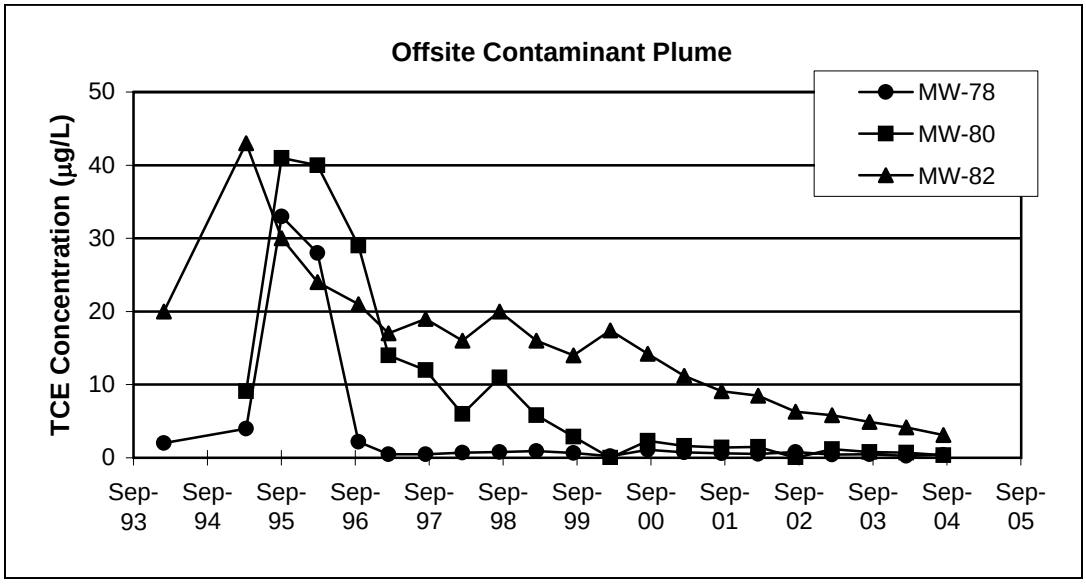


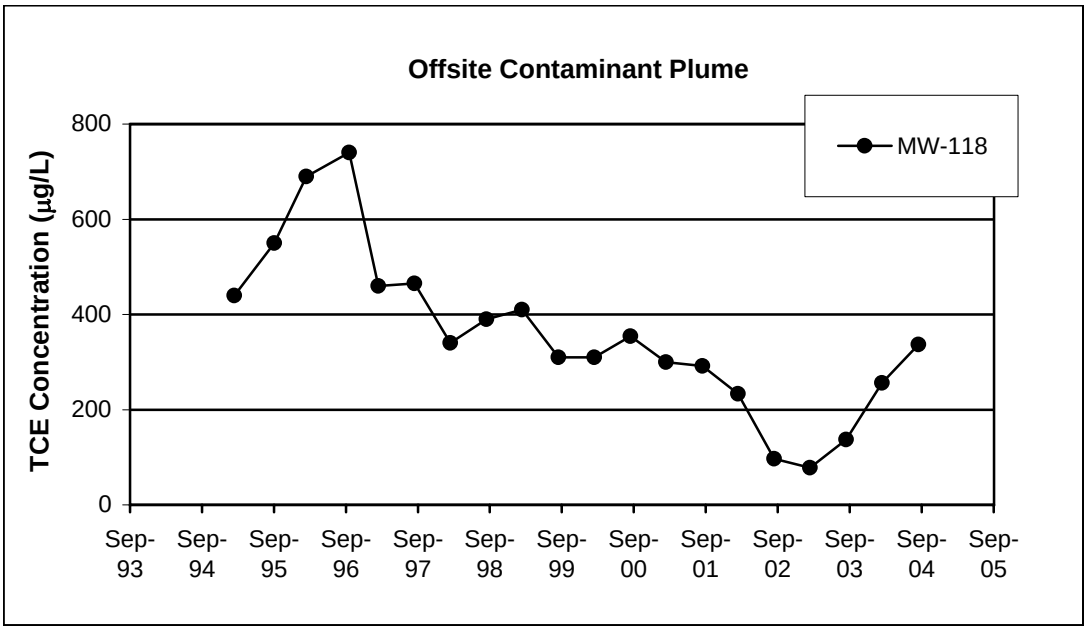
SOURCE: CH2M HILL (SEPTEMBER 2004)

FIGURE 3-1: CRAIG ROAD LANDFILL SITE MAP

Figure 3-2
Historical TCE Concentrations in Select CRL Wells







4.0 On-base Priority One Operable Unit Sites

The On-base Priority One Operable Unit sites include SW-1, PS-2, PS-8, FT-1, WW-1, IS-1, and PS-6. Characterization of these sites began in 1986. Site investigations completed from 1986 to 1990 were used to direct RI activities that were conducted in 1991 and 1992. The ROD for the On-base Priority One sites was signed in July 1993, and concluded that remedial action was required at SW-1, PS-2, PS-8, FT-1, and WW-1. Remedial construction activities for these five sites were completed by 1998.

The ROD also concluded that NFA was required at IS-1 and PS-6**.** These NFA determinations were based on unlimited use of the sites without limitations or restrictions of 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.

4.1 SW-1—Old Base Landfill

Site SW-1, the Old Base Landfill, is located on the western boundary of the base, northeast of Taxiway No. 8, as shown in Figure 4.1-1. The landfill, approximately 16 acres in area, primarily was used for disposal of all base wastes from about 1949 until 1958. Wastes disposed there may have included industrial wastes, plating sludge, lubricating oils, cutting oils and shavings, paint wastes, cleaning solvents, and municipal solid waste. The site contains an estimated 10 to 20 feet of mounded landfill material. Groundwater underlying the site generally flows to the east and is not used as a drinking water source.

Field investigation activities completed prior to 1992 identified TCE as the primary contaminant in groundwater. TCE was detected only in monitoring wells located to the north and northeast of the landfill area.

4.1.1 Basis for Taking Action

The RI Report (Halliburton NUS, 1993) concluded that TCE in groundwater is the COC. The specific source of the TCE contamination was unknown, but the presence of TCE in wells located very close to the landfill indicated that the landfill is, or was, a source of TCE contamination. TCE contamination exceeding the 5 µg/L cleanup level was observed in Basalt A monitoring wells located approximately 600 feet downgradient of SW-1. TCE contamination appears to be limited to the upper portion of the Basalt A aquifer.

4.1.2 Remedial Actions

4.1.2.1 Remedy Selection

The goals of remedial action at SW-1 are to restore groundwater to drinking water quality within a reasonable timeframe and to prevent exposure to landfill materials. To satisfy the remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintain institutional controls that restrict access to the site and prevent on-base usage of TCE-contaminated groundwater until site cleanup levels are achieved
- Monitor groundwater at the site to identify a trend in contaminant concentrations, estimate a timeframe for restoration by natural actions, evaluate the acceptability of this timeframe, and implement a compliance monitoring program to evaluate attainment of cleanup levels
- Monitor offsite water supply wells in the vicinity of the site and provide point-of-use treatment or alternative water supply, if necessary

4.1.2.2 Remedy Implementation and Remedial Action Operations

Remedial action operations were initiated in 1994. The following sections describe components of the selected remedy as implemented.

Institutional Controls

LUCs for this site are intended to prevent exposures to contaminated fill, soils, and groundwater. These LUCs are administered by the USAF as described in Section 2.2.1.1. Specific LUC objectives include:

- Prevent any disturbance to the landfill area, except as necessary for authorized O&M activities
- Prevent drilling of new wells except for monitoring wells as authorized by EPA and Ecology
- Protect existing monitoring wells
- Prevent use of contaminated groundwater for drinking water purposes
- Prevent unauthorized soil excavations at the site
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land

Groundwater Monitoring Program

Long-term RA-O monitoring for site SW-1 groundwater was initiated in 1994, and consisted of quarterly monitoring at ten alluvial/Basalt A aquifer monitoring wells. Based on analytical results through 1997 that showed TCE concentrations in most wells below the MCL, and with concurrence from Ecology and EPA, the monitoring program was reduced to semiannual monitoring in 1998 that consisted of VOC sampling at MW-90, MW-131, and MW-132.

Monitoring Offsite Water Supply Wells

Offsite water supply wells have been monitored by the base since 1988 as part of its residential-well-monitoring program. Initially, several water supply wells in the vicinity of the SW-1 site were monitored. However, because of a lack of detects in these wells and limited access for some locations, routine monitoring of these wells was discontinued prior to 1998. To date, there has been no need to provide point-of-use treatment or an alternative water supply for offsite residences located in the vicinity of SW-1.

4.1.3 Progress Since Last Review

4.1.3.1 RA-O Monitoring Program Results

Remedial action operations have continued throughout the entire review period. The first Five-Year Review stated that all components of the selected remedy had been implemented and determined that the selected remedy was protective of human health and the environment. No recommendations were identified by the report to further modify RA-O at the time.

From 1999 through 2004, TCE was detected in all three RA-O wells, ranging in concentrations from 0.3 to 11.1 µg/L. MW-90 exhibited the highest TCE concentrations, remaining above the MCL during the entire period with concentrations ranging from 5.5 to 11.1 µg/L. TCE detects in MW-131 were all below the cleanup level except for 2002 sampling events when TCE concentrations were over 6 µg/L. Since March 2003, TCE concentrations in MW-131 have declined to almost 2 µg/L. TCE concentrations in MW-132 have remained well below the MCL during this period (Appendix B includes a table showing historical TCE concentrations for SW-1 wells).

Field and analytical data also indicate that some natural attenuation of TCE at SW-1 is occurring—cis-1,2-DCE, a degradation byproduct of TCE, has been detected regularly in all three site RA-O wells. Low dissolved oxygen levels and/or negative oxidation-reduction potentials also have been recorded at MW-90 and MW-132. These field measurements are indicative of reducing conditions, which are favorable for further natural attenuation of TCE.

4.1.3.2 2004 Field Investigations to Evaluate Potential Links between Site SW-1 and SS-39

The primary COC at both SW-1 and SS-39 is TCE in groundwater. In an effort to evaluate any possible link or relationship between observed TCE in shallow groundwater at both sites (located only about 600 feet apart), two additional field activities were completed as part of RA-O during late 2004. The first field investigation consisted of additional groundwater sampling at nine wells located between the SW-1 landfill area and site SS-39. A second investigation consisted of conducting a passive soil gas survey at 33 locations located along four transects between the sites, performed in August and September 2004. Based on the results of these activities (CH2M HILL, 2005a), the data did not indicate that there were any direct links between observed TCE in shallow groundwater for the two sites.

4.1.3.3 MW-90 Assessment

During 2004, an assessment was initiated to evaluate the integrity of MW-90 through review of existing water quality data (both lab and field data) and field observations. Several primary observations were drawn from this assessment:

1. Field pH measurements collected at MW-90 during purging and sampling events over the last several years were very high, regularly in the range of 8 to 11. This compared to historical pH readings for other wells in the immediate vicinity of MW-90 that typically ranged from about 6.5 to 8.5 during the same periods.

2. Observed recharge rates at MW-90 were very slight in comparison to nearby wells.

3. MW-90 was installed during the same "era" as several other base wells where the upper well seal, consisting of bentonite and/or grout, had somehow been compromised. At these wells, pH measurements generally were in the same range as that observed at MW-90, and recharge rates were observed similarly as well.

Based on these observations, it was concluded that MW-90 should be abandoned and replaced. With the concurrence of the base and Ecology, MW-90 was abandoned in December 2004. At the same time, MW-309 (a replacement for MW-90) was drilled and installed at a location approximately 50 feet east of MW-90. MW-309 was drilled and installed to the same depth (45 feet bgs) as MW-90, and was screened over the same interval (35 to 45 feet).

4.1.4 Technical Assessment

4.1.4.1 Question A: Is the Remedy Functioning as Intended?

A review of available RA-O reports and site inspection activities indicate that the remedy is functioning as intended by the ROD. Remedial action objectives established for SW-1 by the ROD are to restore groundwater to drinking water quality within a reasonable timeframe and prevent exposure to landfill materials. These are being achieved as evidenced by the following:

- Potential exposure to landfilled materials is being prevented by the natural soil (non-engineered) landfill cap and through base LUCs. Consumption of TCE-contaminated groundwater also is being prevented through the same LUC processes. No activities have been observed that would have violated these established controls.
- Contaminated groundwater in the upper aquifer is being monitored, and some natural attenuation of TCE has been observed. However, the rate of attenuation observed for some site wells (that is, MW-90 and MW-131) is not sufficient to estimate or establish when cleanup levels will be achieved for site groundwater.

Figure 4.1-2 shows historical TCE concentrations for MW-90, MW-131, and MW-132. TCE concentrations in MW-132 have remained well below the MCL since monitoring was initiated in 1994. For MW-131, TCE concentrations have been below the MCL since 2003 and do exhibit an overall declining trend. Despite a relatively small range in TCE concentrations observed at MW-90, concentrations remain above the MCL and no overall significant declining trend is observable. As such, a timeframe for achieving cleanup levels at MW-90 cannot be estimated at this time. An important caveat to note regarding MW-90 is the assessment of the well's integrity that was completed during 2004. This assessment concluded that MW-90 should be replaced, and with Ecology's concurrence, MW-90 was abandoned. A replacement well, MW-309, was drilled and completed in December 2004 with the same screened interval (35 to 45 feet bgs) as MW-90. TCE concentrations observed in March and September 2005 for MW-309 were 0.77 and 1.26 µg/L.

Overall site O&M costs were evaluated for this review. The average annual O&M cost for site SW-1 during this review period was less than $30,000. This amount included direct costs for SW-1 monitoring and 2004 field investigations, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning documents, data validation, and reporting activities.

4.1.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The cleanup level for TCE, as stated in the ROD, was based on the MTCA Method B cleanup level and federal MCL of 5 µg/L. Additionally, no new exposure pathways have been identified, there are no significant changes in land use on or near the site, and there are no physical site conditions that would call into question the validity of the remedy selection.

4.1.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

A newly recognized association of the compound 1,4-dioxane (that historically may have been mixed as a stabilizer in TCE-containing mixtures) raises a possibility of its presence in groundwater at the SW-1 site. No analysis for 1,4-dioxane was performed prior to 2004, nor is it specified in the On-base Priority One Operable Unit ROD. Although EPA has not established an MCL, the MTCA Method B groundwater cleanup level for 1,4-dioxane is 7.95 µg/L. Aside from this, no other new information has come to light that would call into question the protectiveness of the remedy. Note: a groundwater sample was collected from MW-131 and was analyzed for 1,4-dioxane in December 2006 ; 1,4-dioxane was not detected in the sample.

4.1.4.4 Summary of Technical Assessment

The remedy implemented at site SW-1 is currently considered protective. Site RA-O are meeting, or are continuing to progress towards meeting, all remedial action objectives in accordance with the ROD. However, a reliable estimated remaining time to achieve cleanup levels for the upper aquifer cannot be determined at present. No new exposure pathways have been identified, there are no significant changes in land use on or near the site, and there are no physical site conditions that would call into question the validity of the remedy selection.

4.1.5 Issues

A potential issue identified for this Five-Year Review for the SW-1 site is listed in Table 4.1-1.

TABLE 4.1-1
Site SW-1 Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
No definitive timeframe has been established at this time to determine when cleanup levels will be achieved for the upper aquifer	N	N

4.1.6 Recommendations

All components of the selected remedy have been implemented. Table 4.1-2 highlights recommendations that address site issues or have the potential to further optimize long-term RA-O. Further discussion of these recommendations is provided below.

TABLE 4.1-2
Site SW-1 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
The timeframe to achieve cleanup levels in upper aquifer has not been definitively established	Evaluate existing data using statistical means to identify potential timeframes for achieving cleanup levels	Fairchild AFB	Ecology	Ongoing	N	N
Develop an overall site management strategy	In consideration of TCE levels, general lack of potential receptors, and LUCs in place, potentially revise RA-O program to a level acceptable to the base and regulators	Fairchild AFB	Ecology	March 2009	N	N
Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to reduce groundwater monitoring by eliminating some wells or reducing sampling frequency	Fairchild AFB	Ecology	Ongoing	N	N

- **Evaluate the timeframe to achieve cleanup levels in the upper aquifer.** Through the annual RA-O reporting mechanism, use available information and statistical means to estimate potential timeframes for achieving cleanup levels for the Basalt A aquifer. An evaluation will need to be conducted as to whether post-2004 analytical data from MW-309, the replacement well for MW-90, can be considered as an extension (or subset) of the historical MW-90 data, or must stand alone.
- **Develop an overall site management strategy.** In view of current and historical TCE concentrations in groundwater, ongoing natural attenuation processes, the general lack of potential receptors because of limited exposure routes, no immediately downgradient users, and LUCs in place, working with Ecology is recommended to revise the RA-O program to a level acceptable to both the base and regulators that progresses towards eventual site closure under future potential land-use scenarios.
- **Reduce RA-O groundwater monitoring**. Based on available monitoring data and current conditions, the following modifications should be made to the RA-O groundwater monitoring program:
  - **Reduce sampling frequency of MW-131 to annual.** TCE concentrations in MW-131 are relatively consistent and have been below the MCL since 2003. Annual monitoring of this well should be sufficient.
  - **Discontinue sampling at MW-132.** TCE concentrations in MW-132 have consistently been less than 1 µg/L since 1997. Therefore, routine sampling should be discontinued; periodic monitoring, such as every 3 or 4 years, could be completed.

- **Reduce sampling frequency of MW-309 (MW-90 replacement well) to annual.** Historical data for MW-90 showed that TCE concentrations have been within a historical range of 5 to 14 µg/L since 1994. In looking at data through 2002, there clearly was an increasing trend in concentrations. However, since 2003, concentrations declined significantly. Note: MW-309 was first sampled in March 2005 and then in September 2005. TCE concentrations in MW-309 have been much lower compared to MW-90 (generally 1 to 2 µg/L in MW-309 compared to above-MCL concentrations in MW-90). As such, annual sampling at MW-309 should be sufficient.

4.1.7 Statement of Protectiveness

The remedy for site SW-1, the Old Base Landfill, is currently protective of human health and the environment, and it is expected to be protective of human health and the environment upon attainment of remedial action objectives. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways.

In order for the remedy to be protective in the long term, the remedial action objective of achieving cleanup levels in the upper aquifer within an acceptable timeframe needs to be further evaluated. If it is determined that cleanup levels cannot be achieved within an acceptable timeframe, then alternative remedies may need to be explored to optimize restoration of the upper aquifer.

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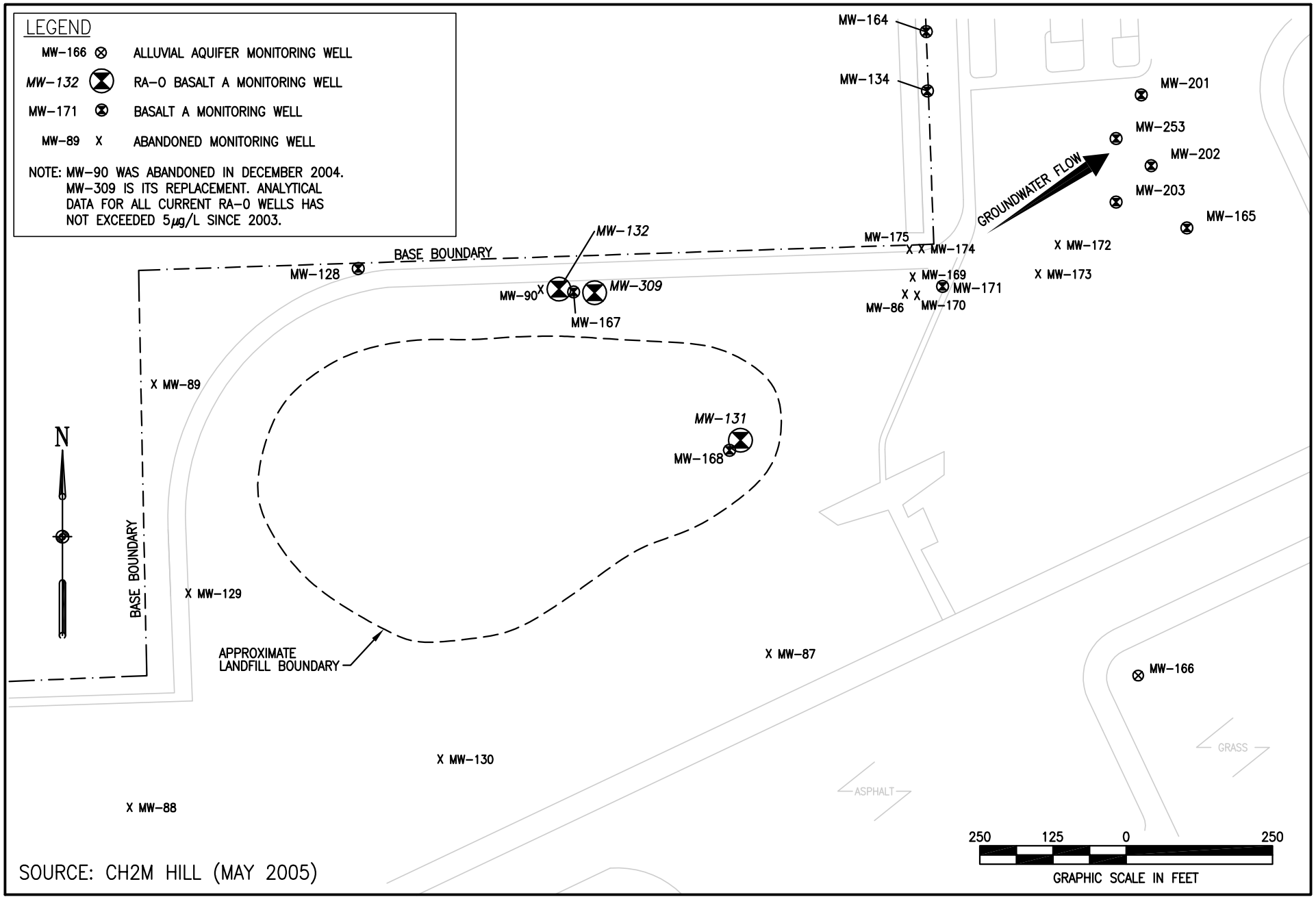
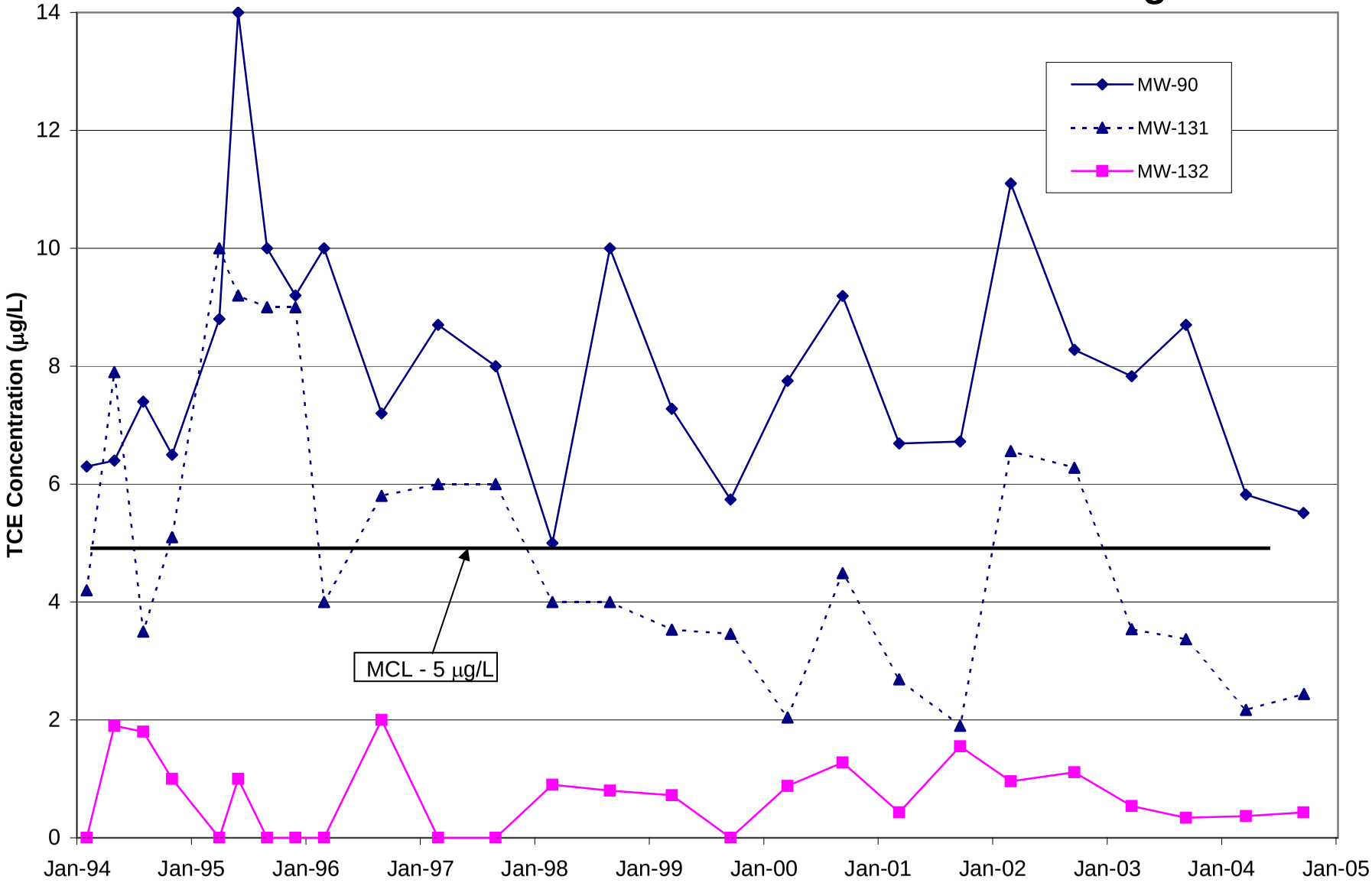


SOURCE: CH2M HILL (MAY 2005)

FIGURE 4.1-1: SW-1 SITE MAP

Figure 4.1-2
Historical TCE Concentrations for SW-1 Monitoring Wells



4.2 PS-2—Refueling Pit Area

Site PS-2 is located on the flightline along Taxiway No. 1, between Buildings 1033 and 1029 (see Figure 4.2-1). 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 near Pit 21, located in front of Building 1037. Approximately 4,000 gallons were recovered in a 4-day cleanup effort, leaving approximately 1,000 gallons that may have entered the stormwater system and soil. Evidence of groundwater contamination was later detected during drilling activities.

Site PS-2 is situated beneath an active aircraft taxiway covered with asphalt and concrete. Historical data indicate that shallow groundwater flows generally to the east, quasi-parallel to the taxiway and flightline orientation.

Field investigation activities completed prior to 1992 identified benzene and TPH, diesel-range organics (TPH-D) as the primary contaminants in shallow groundwater. Benzene was detected in several wells at concentrations exceeding its MCL of 5 µg/L. The maximum benzene concentration detected was 2,600 µg/L. Petroleum hydrocarbons were detected in three wells at concentrations exceeding MTCA Method A cleanup levels of 1,000 µg/L. Free product was observed in two monitoring wells (MW-176 and MW-177) in 1991.

4.2.1 Basis for Taking Action

The RI Report (Halliburton NUS, 1993) concluded that the COCs at PS-2 are benzene and TPH-D in groundwater. The estimated human health risk from these COCs exceeded both federal and state levels. Cleanup levels for benzene and TPH-D in groundwater were set at 5 µg/L and 1,000 µg/L, respectively.

4.2.2 Remedial Actions

4.2.2.1 Remedy Selection

The goal of the remedial action at PS-2 is to restore groundwater to drinking water quality within a reasonable timeframe. To satisfy the remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintain institutional controls that restrict access to the site and prevent on-base usage of benzene and petroleum-contaminated groundwater until cleanup levels are achieved
- Monitor groundwater at the site to identify a trend in contaminant concentrations, estimate a timeframe for restoration by natural attenuation, evaluate the acceptability of the estimated timeframe, and implement a compliance monitoring program to estimate attainment of cleanup levels
- Remove floating fuel product through passive collection, treatment, and recycling recovered product at an offsite facility

4.2.2.2 Remedy Implementation and Remedial Action Operations

Remedial action operations were initiated in 1994. The following sections describe components of the selected remedy as implemented.

Institutional Controls

LUCs for this site are intended to prevent exposure to contaminated soil and groundwater. These LUCs are administered by the USAF as described in Section 2.2.1.1. Specific LUC objectives include:

- Prevent drilling of new wells except for monitoring wells and/or product recovery wells as authorized by EPA and Ecology
- Protect existing monitoring wells
- Prevent use of contaminated groundwater for drinking water purposes
- Prevent unauthorized soil excavations at the site
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land

Groundwater Monitoring Program

Long-term RA-O monitoring for site PS-2 groundwater was initiated in 1994 and consisted of quarterly monitoring of seven alluvial/Basalt A aquifer wells. Based on analytical results through 1998 and with concurrence from Ecology and EPA, the monitoring program was reduced to annual sampling in five monitoring wells since 1999 (MW-55, MW-109, MW-110, MW-179, and MW-222).

Through this second Five-Year Review period, benzene was detected in four of the five RA-O wells and exceeded the 5 µg/L cleanup level in three wells (MW-55, MW-109, and MW-222). In 2000, benzene exceeded the cleanup level in MW-55 at 13.8 µg/L, compared to 8.82 µg/L in 2004. Benzene has been below the cleanup level at MW-109 since 2003, with concentrations of 1.25 µg/L in 2003 and 1.60 µg/L in 2004. Benzene concentrations at MW-222 declined from 56.2 µg/L in 2000 to 11.25 µg/L in 2004. Trend analysis of these data (through 2004) indicates that benzene concentrations in MW-55, MW-109, and MW-222 show declining trends (see Appendix B). These declining trends may be attributable to the reduction of free product, which may act as a source of benzene to groundwater, or the migration of the free product plume beyond (downgradient of) these wells.

TPH-D was only monitored in MW-109 during this review period; results indicate that TPH-D was detected above the 1,000 µg/L cleanup level in 2001 and 2004. Statistical analysis of these data from MW-109 showed a near 100 percent probability of a decreasing trend.

Free Product Recovery

Free product recovery efforts were initiated as part of a treatability study conducted in 1994. Over 80 gallons of free product were recovered at the site during the study from two wells. Routine free product recovery became a part of the RA-O program in 1996 and continued through 2004 in two wells, MW-228 and MW-228A. Five wells were originally installed for free product recovery activities. However, free product recovery was implemented at only two wells during this review period (MW-228 and MW-228A) because free product was not observed in any other site wells. Approximately 30 gallons of product, including oil/water emulsion, were removed from 2000 through 2004, compared to approximately 10 gallons of product removed from the site from 1996 through 1999. The increase in free product recovery during these last 5 years likely is tied to increased frequencies in retrieving the

product recovery canisters (weekly to monthly post-2001 versus quarterly pre-2001), despite declining overall groundwater levels at the site and decreased free-product thicknesses measured during the period.

4.2.3 Progress Since Last Review

Remedial action operations have continued throughout the entire review period. The first Five-Year Review stated that all components of the selected remedy had been implemented. However, the report concluded that the remedy was only partially effective. This was based on only a limited amount of free product that had been recovered, and not being able to estimate a timeframe for achieving attainment of cleanup goals because the data did not support any identifiable trends with respect to benzene attenuation in shallow groundwater.

The report recommended improving the efficiency of free product recovery and adding the existing free product recovery wells to the RA-O monitoring program when product recovery activities were complete. The frequencies of fuel recovery activities increased during this review period and ranged from weekly to monthly, as compared to quarterly recovery during the first 5-year review period. The result was increased fuel recovery, despite overall declining water levels at the site, and decreased thicknesses of measured free product in the two recovery wells.

Progress towards attaining cleanup levels for benzene has been shown, based on statistical analysis of data through 2004 for MW-55, MW-109, and MW-222. (It also is noted that benzene concentrations for the April 2005 sampling event were all below the 5 µg/L cleanup level). Additionally, a declining trend was observed for TPH-D in MW-109. (Appendix B includes pertinent data including historical concentrations for PS-2 wells and statistical analysis trends).

4.2.4 Technical Assessment

4.2.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

A review of available RA-O data and site inspection activities indicate that the remedy is functioning as intended by the ROD. The goal of remedial action at PS-2 is to restore groundwater to drinking water quality within a reasonable timeframe. This is being achieved as evidenced by the following:

- Consumption of groundwater exceeding cleanup levels is prevented through base LUCs. Additional institutional controls are in place preventing any direct contact to potentially contaminated materials through the asphalt and concrete “cap” at the site and flightline access constraints. No activities have been observed that would have violated these established controls.
- Contaminated groundwater is being monitored, and statistically significant trends in attenuation of TPH have been observed for impacted site wells.

The monitoring well and product recovery well networks provide sufficient data to assess the progress of natural attenuation and product recovery within the fuel plume. Concentrations of benzene detected in 2004 are significantly lower than data observed

during the first 5-year review period. Benzene has been detected above the cleanup level in the downgradient well (MW-222) during all sampling events from this review period. However, free product does not appear to be migrating downgradient because it has not been detected in MW-222.

Passive free product removal has removed approximately 30 gallons of product from 2000 to 2004. However, until all free product (that is, the source) is removed, it may be unlikely that benzene in groundwater will be in compliance with the cleanup level despite overall declining trends in concentration of TPH. Thus, a timeframe to achieve cleanup levels for benzene and TPH-D for groundwater restoration by natural attenuation may not be able to be estimated or established at present.

Overall site O&M costs were evaluated for this review. The average annual O&M cost for site PS-2 during this review period was approximately $75,000. This amount included direct costs for PS-2 monitoring and free product recovery efforts, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning documents, data validation, and reporting.

4.2.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The cleanup level for benzene, as stated in the On-base Priority One sites ROD, was based on the MTCA Method B cleanup level and federal MCL of 5 µg/L. The MTCA Method B cleanup level as amended in 2001 is 0.08 µg/L. The federal MCL does not exceed the MTCA cancer risk of 1×10^{-5}. Therefore, the federal MCL for benzene should be retained and will not affect remedial action objectives or the protectiveness of the remedy. Additionally, no new exposure pathways have been identified, there are no significant changes in land use on or near the site, and there are no physical site conditions that would call into question the validity of the remedy selection.

4.2.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

Benzene concentrations in the most downgradient site well, MW-222, remained above the cleanup level through 2004, but have been shown to be statistically declining. The question remains though, is this decline because of natural attenuation or possibly because the plume has migrated further downgradient? Insufficient information is available to fully evaluate this question at this time. However, risks associated with potential exposure to receptors located immediately downgradient of this site are expected to be minimal because of a lack of receptors and through implementation of institutional and LUCs. Aside from this issue, no new information has emerged that would call into question the protectiveness of the remedy.

4.2.4.4 Summary of Technical Assessment

The remedy implemented at site PS-2 is currently considered protective. Site RA-O are meeting, or are continuing to progress towards meeting, remedial action objectives in accordance with the ROD. However, no definitive timeframe can be established at this time to determine when cleanup levels will be achieved for shallow groundwater.

Declining trends observed for benzene concentrations at MW-222, the site's most downgradient well, may be because of natural attenuation or possibly because the plume has migrated further downgradient beyond this well. Insufficient information is available to answer this question at this time. Aside from this issue, no new information has emerged that would call into question the protectiveness of the remedy.

4.2.5 Issues

Issues identified for the PS-2 site during this Five-Year Review site are listed in Table 4.2-1.

TABLE 4.2-1
Site PS-2 Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
No definitive timeframe has been established at this time to determine when cleanup levels will be achieved for the upper aquifer	N	N
It is unknown if contaminants have migrated beyond the most downgradient site well	N	N

4.2.6 Recommendations

All components of the selected remedy have been implemented. Table 4.2-2 highlights recommendations that address site issues or have the potential to further optimize long-term RA-O. Further discussion of these recommendations is provided below.

TABLE 4.2-2
Site PS-2 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
The timeframe to achieve cleanup levels in the upper aquifer has not been definitively established	Further evaluate existing data to identify potential timeframes for achieving cleanup levels in site wells	Fairchild AFB	Ecology	Ongoing	N	N
Determine if contamination has migrated beyond the site's downgradient well	Pursue installation of additional downgradient monitoring wells, subsequent to mission operations command staff approval	Fairchild AFB	Ecology	June 2009	N	N
Develop an overall site management strategy and conceptual site model	In consideration of current TPH levels, general lack of potential receptors, and LUCs in place, potentially revise RA-O program to a level acceptable to the base and regulators	Fairchild AFB	Ecology and EPA	March 2009	N	N

TABLE 4.2-2
Site PS-2 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Refine the frequency of free product recovery efforts	Vary the frequency of free product recovery efforts to better match site conditions	Fairchild AFB	Ecology	Ongoing	N	N
Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to reduce groundwater monitoring by eliminating some wells or reducing sampling frequency	Fairchild AFB	Ecology	Ongoing	N	N

- **Evaluate the timeframe to achieve cleanup levels in the upper aquifer.** Through the annual RA-O reporting process, further evaluate available information and statistical trends to estimate potential timeframes for achieving cleanup levels for impacted groundwater.
- **Determine if groundwater contamination has migrated beyond the site's most downgradient well.** As early as 2002, annual RA-O reports included a recommendation to install additional downgradient wells. Base environmental staff have pursued this, but mission command staff have not granted approval for additional wells to be installed within this active taxiway area at PS-2. Base staff should pursue this again, but may have to default to the next recommendation identified.
- **Develop an overall site management strategy and conceptual site model.** In view of current and historical TPH concentrations in groundwater, ongoing natural attenuation processes, the general lack of potential receptors because of limited exposure routes, no immediately downgradient users, and LUCs in place, working with Ecology is recommended to revise the RA-O program to a level acceptable to the base and regulators that progresses towards eventual site closure under future, potential land-use scenarios. If access to the flightline is not granted for installation of additional monitoring wells, the base may consider injection of a substrate (such as Oxygen Release Compound [ORC®] or a similar compound) to stimulate natural biodegradation rates. Potential wells that could be used for this type of application may include MW-109, MW-222, or MW-224.
- **Refine frequency of free product recovery efforts.** Data reviewed for this review period indicate that the free floating product is only observed periodically and the quantity of product removed depends on removal frequency. Additional efforts to improve the overall efficiency of free product removal need to continue to be evaluated. Efforts to be evaluated could include increasing the free product recovery frequency when product is detected or assessing currently available passive recovery systems that may enhance free-product recovery. As noted, when the frequency was increased from quarterly to monthly and weekly, the quantity of free product removal from the site increased.

- **Reduce RA-O groundwater monitoring**. Based on available monitoring data and current conditions, the following modifications should be made to the RA-O groundwater monitoring program:
  - **Discontinue sampling at MW-110 and MW-179.** Benzene has not been detected in MW-179 since sampling was initiated in 1996. Similarly, benzene only has been detected three times since 1996 at MW-110—none at concentrations even one-third of the cleanup level. As such, routine sampling should be discontinued in both wells; periodic monitoring, such as every 3 or 4 years, could be completed.
  - **Add former free product recovery wells to annual monitoring network**. Once free-product recovery has been completed to the extent practical in recovery wells, these wells should be added to the RA-O program for 1 to 2 years and analyzed for site COCs, benzene, and TPH-D.

4.2.7 Statement of Protectiveness

The remedy at site PS-2 is currently protective of human health and the environment, and it is expected to be protective of human health and the environment upon attainment of remedial action objectives. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways.

In order for the remedy to be protective in the long term, the remedial action objective of achieving cleanup levels within an acceptable timeframe needs to be further evaluated. If it is determined that cleanup levels cannot be achieved within an acceptable timeframe, then alternative remedies may need to be explored to optimize restoration of impacted groundwater. Additionally, there appears to be sufficient technical justification to install additional downgradient monitoring wells at the site to further evaluate if the plume is migrating or if natural attenuation processes are responsible for the observed decline in benzene concentrations. Because this area is within an active taxiway that is critical to support the base's mission, approval from mission operations command staff will be required but possibly could be denied.

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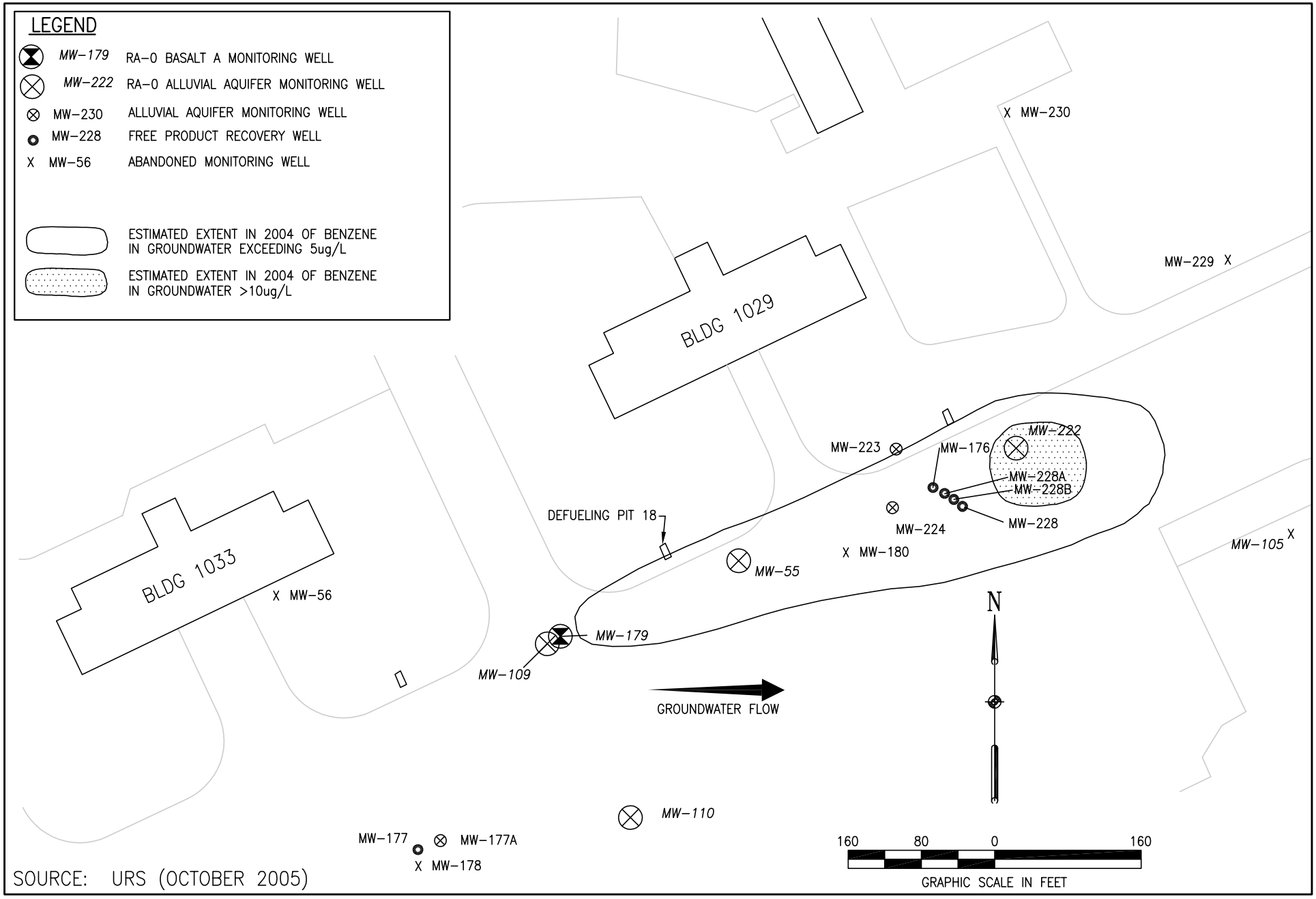

SOURCE: URS (OCTOBER 2005)

FIGURE 4.2-1: PS-2 SITE MAP

4.3 PS-8—Underground Fuel Line Area

Site PS-8 is located on the flightline along Taxiway J, adjacent to Buildings 1015, 1017, and 1019 (see Figure 4.3-1). Petroleum odors were noted in July 1982 during runway soil compaction testing near Building 1019. These petroleum vapors were attributed to leaking underlying jet fuel distribution lines. Site PS-8 is used for aircraft parking, maintenance, fueling, and defueling. Historical data indicate that shallow groundwater flows generally to the east northeast, quasi-parallel to the taxiway and flightline orientation.

Field investigation activities completed through 1992 indicated that fuel line leaks had impacted groundwater in the vicinity of the releases. TPH and benzene, toluene, ethylbenzene, and xylene (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.

4.3.1 Basis for Taking Action

The RI Report (Halliburton NUS, 1993) concluded that the COC at site PS-8 is benzene in groundwater. The estimated human health risk from benzene exceeded both federal and state levels. The cleanup level for benzene was set at 5 µg/L. TPH-contaminated soil did not appear to be a continuous source of groundwater contamination and, therefore, TPH cleanup levels for soil were not developed for PS-8.

4.3.2 Remedial Actions

4.3.2.1 Remedy Selection

The goal of the remedial action at PS-8 is to restore groundwater to drinking water quality within a reasonable timeframe. Groundwater was found to exceed cleanup levels for benzene and TPH, which were set at 5 µg/L and 1,000 µg/L, respectively. To satisfy the remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintain institutional controls that prevent on-base usage of benzene-contaminated groundwater until cleanup levels are achieved
- Monitor groundwater at the site to identify a trend in contaminant concentrations, estimate a timeframe for restoration by natural attenuation, evaluate the acceptability of the estimated timeframe, and implement a compliance monitoring program to estimate attainment of cleanup levels

4.2.2.2 Remedy Implementation and Remedial Action Operations

Remedial action operations were initiated in 1994. The following sections describe components of the selected remedy as implemented.

Institutional Controls

LUCs for this site are intended to prevent exposure to contaminated soil and groundwater. These LUCs are administered by the USAF as described in Section 2.2.1.1. Specific LUC objectives include:

- Prevent drilling of new wells except for monitoring wells as authorized by EPA and Ecology
- Protect existing monitoring wells
- Prevent use of contaminated groundwater for drinking water use at the site
- Prevent unauthorized soil excavations at the site
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land

RA-O Groundwater Monitoring Program

The RA-O program for PS-8 was initiated in 1994 and included quarterly sampling for nine alluvial aquifer monitoring wells. With concurrence of EPA and Ecology, sampling was reduced to semiannually in four wells in 1996. From 1996 to 1999, benzene concentrations exceeded the cleanup level only at MW-184. At that time, the frequency of sampling at the four wells was further reduced to annual sampling, based on recommendations outlined in the first Five-Year Review. However, because sampling results for March 1999 were below the 5 µg/L cleanup level for MW-184, subsequent sampling was increased back to semiannual throughout the duration of this review period. The sampling frequency for the other three wells also was increased to semiannual in 2001, because benzene concentrations in MW-67 and MW-68 exceeded the 5 µg/L cleanup level in September 2001.

During the remainder of this review period, benzene was detected above the cleanup level in MW-67 during four consecutive sampling events from September 2001 to December 2002. Analytical detects ranged from 17.3 µg/L to 25.5 µg/L. In 2003 and 2004, benzene was not detected above the cleanup level from this well. Benzene was detected in six of ten sampling events above the cleanup level from MW-184. Data for this well continue to be highly variable, which is consistent with historical results. In 2004, benzene was not detected above the cleanup level during both sampling events at MW-184. Benzene was detected above the cleanup level at MW-68 only in September 2001. Analytical results from all other sampling rounds for MW-68 during this review period were below the method detection limit. All analytical results for MW-183 were below the method detection limit for the entire review period.

4.3.3 Progress Since Last Review

Remedial action operations have continued throughout the entire review period. The first Five-Year Review stated that all components of the selected remedy had been implemented. However, the report concluded that the remedy was only partially effective at the time because a timeframe for achieving attainment of cleanup goals in shallow groundwater could not be determined. Highly variable benzene concentrations in site wells did not support any identifiable trends with respect to the attenuation of benzene.

The first Five-Year Review recommended increasing the sampling frequency at MW-184 to semiannual and to modify the sampling frequency of remaining site wells to annually in

September. This recommendation was incorporated into the RA-O program in 2000. However, because of benzene detections above the cleanup level in MW-67, MW-68, and MW-184 in September 2001, the sampling frequency was increased to semiannual for 2002.

Benzene was not detected above the cleanup level from any of the four wells sampled in 2004. Because of highly variable benzene concentrations, statistical analyses of this data do not indicate any significant trending. Historical sampling results for current RA-O wells at PS-8 are included in Appendix B.

4.3.4 Technical Assessment

4.3.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

A review of available RA-O data and site inspection activities indicate that the remedy is functioning as intended by the ROD. The goal of remedial action at PS-8 is to restore groundwater to drinking water quality within a reasonable timeframe. This is being achieved as evidenced by the following:

- Consumption of groundwater exceeding cleanup levels is prevented through base LUCs. Additional institutional controls are in place, preventing any direct contact to potentially contaminated materials through the asphalt and concrete "cap" at the site and flightline access constraints. No activities have been observed that violate these established controls.
- Contaminated groundwater is being monitored. Recent data (2004 and available 2005 data) show benzene concentrations have been below the cleanup level in all wells since April 2004. Because of the highly variable data however, a timeframe to achieve cleanup levels for benzene cannot be determined at present.

Overall site O&M costs were evaluated for this review. The average annual O&M cost for site PS-8 during this review period was approximately $30,000. This amount included direct costs for PS-8 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 documents, data validation, and reporting.

4.3.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The cleanup level for benzene, as stated in the On-base Priority One sites ROD, was based on the MTCA Method B cleanup level and federal MCL of 5 µg/L. The MTCA Method B cleanup level as amended in 2001 is 0.08 µg/L. The federal MCL does not exceed the MTCA cancer risk of 1×10^{-5}. Therefore, the federal MCL for benzene should be retained and will not affect remedial action objectives or the protectiveness of the remedy. Additionally, no new exposure pathways have been identified, there are no significant changes in land use on or near the site, and there are no physical site conditions that would call into question the validity of the remedy selection.

4.3.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No new information has emerged that would call into question remedy protectiveness.

4.3.4.4 Summary of Technical Assessment

The remedy implemented at site PS-8 is currently considered protective. Site RA-O are meeting, or are continuing to progress towards meeting, remedial action objectives in accordance with the ROD. However, no definitive timeframe can be established at this time to determine when cleanup levels will be achieved for shallow groundwater. No new information has emerged that would call into question the protectiveness of the remedy.

4.3.5 Issue

An issue identified in the second Five-Year Review for the PS-8 site is listed in Table 4.3-1.

TABLE 4.3-1
Site PS-8 Issue

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
No definitive timeframe has been established at this time to determine when cleanup levels will be achieved for shallow groundwater	N	N

4.3.6 Recommendations

All components of the selected remedy have been implemented. Table 4.3-2 highlights recommendations that address a site issue or have the potential to further optimize long-term RA-O at site PS-8. Further discussion of these recommendations is provided below.

TABLE 4.3-2
Site PS-8 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
The timeframe to achieve cleanup levels in shallow groundwater has not been definitively established	Further evaluate existing data to identify potential timeframes for achieving cleanup levels in site wells	Fairchild AFB	Ecology	Ongoing	N	N
Develop an overall site management strategy and conceptual site model	In consideration of current TPH levels, general lack of potential receptors, and LUCs in place, potentially revise RA-O program to a level acceptable to the base and regulators	Fairchild AFB	Ecology and EPA	March 2009	N	N
Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to reduce groundwater monitoring by eliminating some wells and reducing sampling frequencies for other wells	Fairchild AFB	Ecology	Ongoing	N	N

- **Evaluate the timeframe to achieve cleanup levels in shallow groundwater.** Through the annual RA-O reporting process, further evaluate the highly variable benzene concentration data and statistical trends to estimate potential timeframes for achieving cleanup levels for impacted groundwater.
- **Develop an overall site management strategy and conceptual site model.** In view of current and historical benzene concentrations in groundwater, ongoing natural attenuation processes, the general lack of potential receptors because of limited exposure routes and no immediately downgradient users, and LUCs in place, working with Ecology is recommended to revise the RA-O program to a level acceptable to the base and regulators that progresses towards eventual site closure under future potential land-use scenarios.
- **Reduce RA-O groundwater monitoring**. Based on available monitoring data and current conditions, the following modifications should be made to the RA-O groundwater monitoring program:
  - **Discontinue sampling at MW-183 and MW-68.** MW-183 is the site's most downgradient well. However, benzene has been non detect in MW-183 since sampling was initiated in 1996. For MW-68, benzene has been non detect since March 2002. As such, routine sampling should be discontinued for both wells; periodic monitoring, such as every 3 or 4 years, could be completed.
  - **Decrease sampling frequency at MW-67 to annual**. Reduce sampling frequency to annual from semiannual. MW-67 has shown no benzene detects above the cleanup level since April 2003. If the benzene cleanup level is exceeded, then monitoring should return to a semiannual frequency.

4.3.7 Statement of Protectiveness

The remedy at site PS-8 is currently protective of human health and the environment, and it is expected to be protective of human health and the environment upon attainment of remedial action objectives. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways.

In order for the remedy to be protective in the long term, the remedial action objective of achieving cleanup levels within an acceptable timeframe needs to be further evaluated. If it is determined that cleanup levels cannot be achieved within an acceptable timeframe, then alternative remedies may need to be explored to optimize restoration of impacted groundwater.

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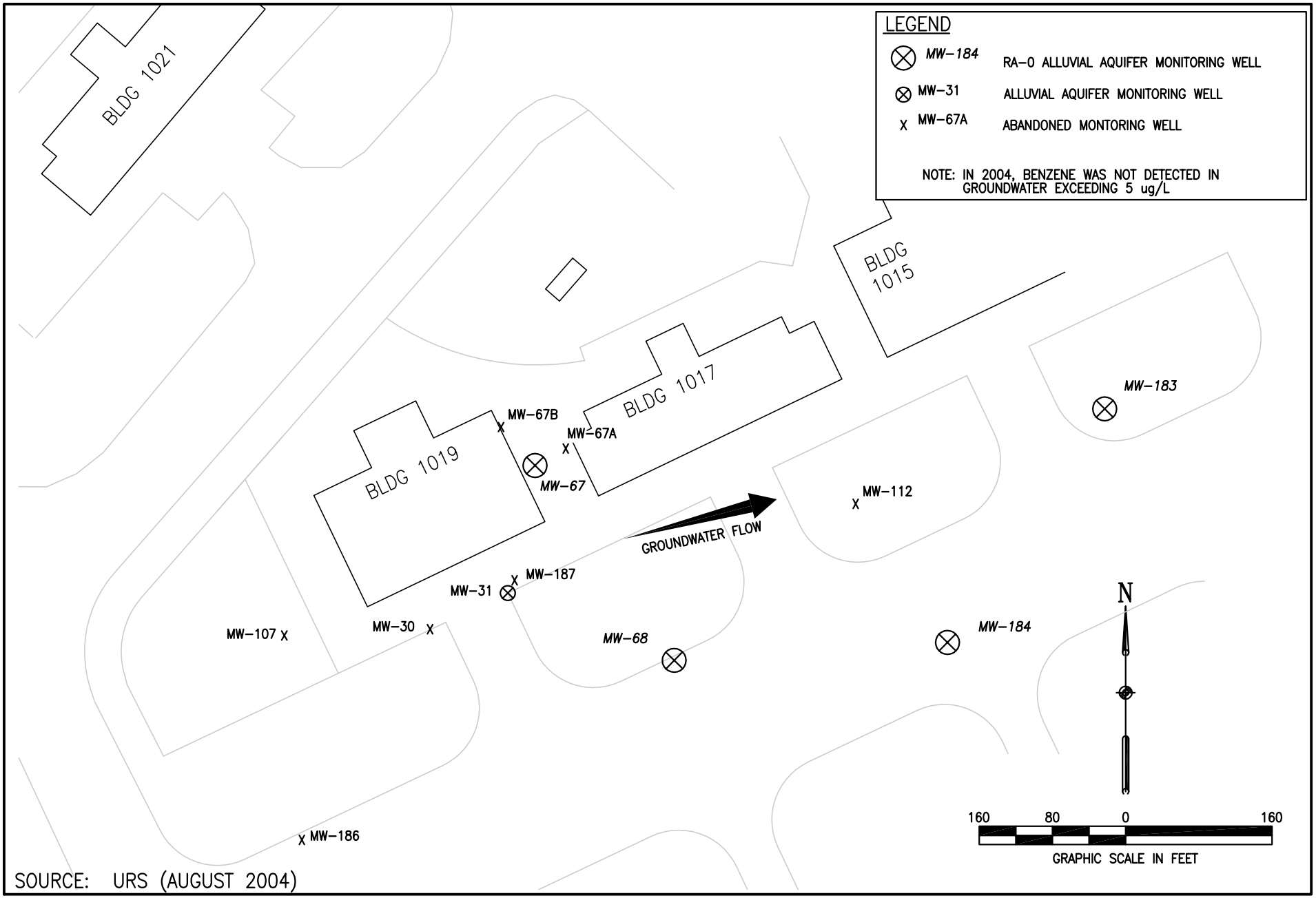

SOURCE: URS (AUGUST 2004)

FIGURE 4.3-1: PS-8 SITE MAP

4.4 FT-1—Former Fire Training Area

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 (see Figure 4.4-1). From the early 1960s to 1991, fire training exercises were conducted 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 UST was pumped onto the surface of the water. The fuel was then ignited and extinguished using film-forming foam. In addition to JP-4, waste oil and solvents also were used. Approximately 300 gallons of JP-4 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 OWS. The OWS discharged into a low area east of the training site. Fuel stains and dead vegetation were observed in this effluent drainage area during the RI.

Field investigation activities conducted at FT-1 through 1992 identified TPH and BTEX as the primary contaminants for soils and BTEX as the primary contaminant in shallow alluvial groundwater. Groundwater underlying the site is not used as a drinking water source; the dominant groundwater flow direction is to the east across the site.

4.4.1 Basis for Taking Action

The RI Report (Halliburton NUS, 1993) concluded that BTEX-contaminated soils are the source of shallow groundwater contamination. The COCs established for site FT-1 are BTEX in soil and benzene in groundwater. The estimated human health risk from benzene exceeded both federal and state levels. The cleanup level for benzene in soil was set at 500 μg/kg. In groundwater, the cleanup level for benzene was set at 5 μg/L.

4.4.2 Remedial Actions

4.4.2.1 Remedy Selection

The goals of remedial action at FT-1 are to remediate soils to levels that are protective of groundwater and to restore groundwater to drinking water quality. To satisfy the remedial action objectives identified by the ROD, the selected remedy included the following:

- Maintain institutional controls that prevent on-base usage of benzene-contaminated groundwater until cleanup levels 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 offsite water supply wells in the vicinity of the site and provide point-of-use treatment or alternate water supply, if necessary

4.4.2.2 Remedy Implementation and Remedial Action Operations

Remedial action operations were initiated in 1996. The following sections describe components of the selected remedy as implemented. Additional data showing historical contaminant concentrations and statistical trend data are included in Appendix B.

Institutional Controls

LUCs for this site are intended to prevent exposure to contaminated soil and groundwater. These LUCs are administered by the USAF as described in Section 2.2.1.1. Specific LUC objectives include:

- Prevent drilling of new wells except for monitoring wells as authorized by EPA and Ecology
- Protect existing monitoring wells
- Prevent use of contaminated groundwater for drinking water use at the site
- Prevent unauthorized soil excavations at the site
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land

Remedial Action Operations

Bioventing Systems and Soil Monitoring Program

An in situ bioventing treatment system was constructed during 1997 and has been fully operational since that time. The system consists of 40 air injection vent wells divided into two groups (the east and west bioventing systems), each having 20 vent wells. The vent wells are located on approximately 50-foot centers and inject air between 3 and 6 feet bgs that supports aerobic biodegradation of hydrocarbons.

Soil monitoring was initiated in 1997 as a part of bioventing systems operation to monitor soil remediation progress. In recent years, annual sampling events have consisted of collecting 25 soil samples from 25 soil borings, at depths ranging from 2 to 4, 4 to 6, or 6 to 8 feet bgs. For the 1999 to 2004 review period, a total of 125 soil samples were submitted for laboratory analyses. Benzene was detected in only six of these samples, five of which were above the cleanup level of 0.5 mg/kg. These cleanup level exceedances ranged in concentration from 0.57 mg/kg to 4.8 mg/kg and were from borings primarily located in the former burn pit area, or north and west of this same area. Benzene was not detected above the cleanup level in any 2004 samples. Toluene and ethylbenzene detections also decreased during the review period. However, xylene, TPH-D, and TPH, gasoline-range organics (TPH-G) detections and concentrations have not shown significant reductions. The highest annual xylene detections during this review period ranged from 57 mg/kg to 2,080 mg/kg. The highest annual TPH-G concentrations ranged from 6,100 mg/kg to 24,000 mg/kg, and the highest annual TPH-D detections ranged from 8,700 mg/kg to 23,000 mg/kg. The soil bioventing system and lateral extent of soils where TPH cleanup levels were exceeded based on 2003 and 2004 data (that is, 100 mg/kg for TPH-G and/or 200 mg/kg for TPH-D or TPH-Jet A) are shown in Figure 4.4-2.

To expedite the remediation process, an abandoned OWS, associated piping, and the surrounding impacted soil were removed in 2000. In February 2005, an additional 1,630 tons of impacted soil were excavated and disposed of offsite at the Graham Road Landfill. These

soils came from varying depths in areas within the burn pit, west of the burn pit, and in areas paralleling existing bioventing air lines that extended west from the east end of the burn pit up to 190 feet away. TPH-G, TPH-D, ethylbenzene, and xylene concentrations exceeded cleanup levels in soils that were left in place adjacent to the existing bioventing lines and vent well locations.

Air Sparge System

Based on pilot-scale results, an air sparge curtain (west) was installed in 1997 for full-time operation; it consisted of 19 air sparge points situated in two offset and adjacent rows. Its purpose was to treat the on-base portion of a benzene plume. 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 of air flow to only 8 of 19 sparge points. The ESTPC 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, the system was operated only to maintain the equipment.

Groundwater Monitoring Program

Long-term RA-O groundwater monitoring was initiated in 1996. Twenty-seven monitoring wells are currently designated for monitoring at FT-1 (quarterly, semiannual, and annual), including 12 air sparge curtain monitoring wells and 15 additional monitoring wells.

From June 1999 through 2004, benzene was not detected above the 5 µg/L cleanup level in any site well. Additional VOCs have been detected at site FT-1, in concentrations exceeding State cleanup levels. Vinyl chloride (VC) was detected above the MTCA Method A cleanup level (0.2 µg/L) in 2000 and 2001 from wells with historical detections of VC (MW-100, MW-152, MW-226, MW-227, and MW-247). However, detections above MTCA Method A for 2002 through 2004 were only from MW-100 and MW-226, with concentrations ranging from 0.21 µg/L to 0.37 µg/L. Additionally, 1,1-dichloroethene (1,1-DCE) has been detected at low levels above the MTCA Method B cleanup level of 0.0729 µg/L.

Statistical trend analysis of sampling results for this review period indicate a near 100 percent probability of declining trends for benzene and VC for all site wells with historical detections.

Residential Well Monitoring Program

Fourteen residential wells, located to the east of FT-1 and WW-1 in the vicinity of Thorpe Road, are monitored regularly 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 7 years. Provisions for providing point-of-use treatment or an alternate water supply have been in place, but have not been required to date.

4.4.3 Progress Since Last Review

Remedial action operations have continued throughout the entire review period.

4.4.3.1 Follow-up to First Five-Year Review Recommendations

The first Five-Year Review stated that all components of the selected remedy had been implemented and determined that the selected remedy was protective of human health and

the environment, despite being only partially effective. The report identified three primary recommendations to meet remedial action objectives and ROD requirements:

- Delaying assessment of the air sparge system effectiveness until 2002, in order to collect additional data prior to modifying the system
- Evaluating the feasibility of removing or actively managing source areas or source materials (that is, removal, dig-and-haul, offsite treatment, or land-farming) compared to anticipated long-term O&M costs
- Adding VC as a site COC for groundwater

Because benzene concentrations in groundwater had been below the cleanup level since 1999, the air sparge modifications were not implemented. Additionally, the 5-year cleanup timeline for benzene in groundwater identified by the ROD was achieved.

Benzene, ethylbenzene, and toluene in soil continue to be remediated. However, no declining concentrations were observed for xylenes and TPH in and adjacent to the former burn pit. Much of this soil was removed as part of a source removal action implemented in February 2005. Approximately 1,630 tons of impacted soil were excavated from the burn pit and areas west of the burn pit. Contaminated soil adjacent to existing bioventing air lines and vent wells was left in place.

VC was not added as a formal site COC during this review period. However, VC continues to be analyzed for in site wells. VC concentrations in groundwater have declined significantly over the past several years in site wells. As such, there appears to be no compelling justification at this time to formally add it as a site COC.

4.4.3.2 Significant Site Remediation Progress Noted

Significant progress towards meeting remedial action objectives has been achieved at site FT-1 through various means, as summarized below:

- Through bioventing, air sparging (early on), natural attenuation processes, and two dig-and-hauls completed in 2000 and 2005, benzene has essentially been eliminated at the site.
  - Since June 1999, no exceedances of the 5 µg/L cleanup level have occurred in groundwater. As such, groundwater (with respect to benzene) has achieved drinking water quality.
  - For benzene in soil, only 6 out of 125 samples collected (less than 5 percent) exceeded the cleanup level of 0.5 mg/kg between 1999 and 2004. The two dig-and-hauls completed in 2000 and 2005 removed over 1,630 tons of contaminated soil from source areas located in and adjacent to the burn pit and to the west.
- Concentrations of VC in groundwater also have been reduced through natural attenuation processes. Since March 2003, there have only been 6 detects of VC(out of 84 samples; 3 of those were from MW-100). Vinyl chloride was only detected in 2003 and 2004 from MW-100 and MW-226 with concentrations ranging from 0.21 to 0.37 µg/L, only slightly above the MTCA Method A cleanup level of 0.2 µg/L.

- Based on 2004 annual soil sampling results, some residual TPH contamination (generally longer-chained hydrocarbons) remained present in soils primarily located in the burn pit area and to the north and west of the burn pit (about 25 percent of soil samples collected in 2003 and 2004 exceeded TPH cleanup levels). However, the dig-and-haul completed in February 2005 removed approximately 1,630 tons of impacted soils located within these same areas. Confirmation sampling indicated that some contaminated soils remained following this dig-and-haul, located immediately adjacent to the bioventing lines and vapor monitoring points (VMP).

4.4.4 Technical Assessment

4.4.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

A review of available RA-O data and site inspection activities indicate that the remedy is functioning as intended by the ROD. The goals of remedial action at FT-1 are to remediate soils to levels that are protective of groundwater and to restore groundwater to drinking water quality. This is being achieved as evidenced by the following:

- Consumption of groundwater exceeding cleanup levels is prevented, and site access is restricted through base LUCs. No activities have been observed that violate these established controls.
- Through bioventing, natural attenuation processes, and two dig-and-hauls, benzene-contaminated soil has been effectively treated to an extent that its potential movement to groundwater has been greatly minimized and potentially eliminated.
- Benzene in groundwater has not been detected above the 5 µg/L cleanup level in any well sampled since 1999. The 5-year cleanup timeframe for benzene in groundwater, as described by the ROD following the air sparge system startup, has been achieved. Additionally, through RA-O and natural attenuation processes, further migration of contaminated groundwater has been prevented.

As stated earlier, bioventing has reduced benzene concentrations in soils throughout the site, to levels where almost all results have been below the cleanup goal of 0.5 mg/kg. However, analytical data indicate that prior to 2005, longer-chained TPH compounds and xylene still were present in some areas of the site at concentrations exceeding cleanup criteria. A source removal action performed in February 2005 removed 1,630 tons of contaminated soil from areas within the burn pit, and to the north and west of the burn pit area, significantly reducing the amount of contaminated soil that remained.

Overall site O&M costs were evaluated for this review. The average annual O&M cost for site FT-1 during this review period was approximately $350,000. This amount included direct costs for monitoring and systems operations, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning documents, data validation, and reporting.

4.4.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The cleanup level for benzene, as stated in the On-base Priority One sites ROD, was based on the MTCA Method B cleanup level and federal MCL of 5 µg/L. The MTCA Method B cleanup level as amended in 2001 is 0.8 µg/L. Because the federal MCL does not exceed the

MTCA cancer risk of 1 x 10^{-5}, the federal MCL for benzene should be retained, which will not affect remedial action objectives or the protectiveness of the remedy. Though not specifically identified in the ROD, additional cleanup criteria that may be applicable to the site for the future include:

- VC in groundwater—MTCA Method A cleanup level of 0.2 µg/L
- 1,1-DCE in groundwater—MTCA Method B cleanup level of 0.0729 µg/L
- Xylenes in soil—MTCA Method A cleanup level of 30 mg/kg
- TPH-G in soil —MTCA Method A cleanup level of 100 mg/kg
- TPH-D and TPH-Jet A in soil—MTCA Method A cleanup levels of 200 mg/kg

Additionally, no new exposure pathways have been identified, there are no significant changes in land use on or near the site, and there are no physical site conditions that would call into question the validity of the remedy selection.

4.4.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No new information has emerged that would call into question remedy protectiveness.

4.4.4.4 Summary of Technical Assessment

The remedy implemented at FT-1 is currently considered protective. Site RA-O currently are meeting or have achieved remedial action objectives identified by the ROD. Benzene concentrations in both soil and groundwater have declined significantly. Some residual soil contamination remains at levels exceeding MTCA Method A cleanup levels for TPH.

4.4.5 Issues

Several issues specifically related to components of the selected remedy for the FT-1 site are listed in Table 4.4-1.

TABLE 4.4-1
Site FT-1 Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Benzene-contaminated soil has been largely remediated through bioventing and dig-and-hauls. Future operation of this system may not be necessary.	N	N
Operation of the air sparging system is not necessary because benzene-contaminated groundwater has been remediated.	N	N

4.4.6 Recommendations

All components of the selected remedy have been implemented. Table 4.4-2 highlights recommendations that address identified site issues or that have the potential to further optimize long-term RA-O. Further discussion of these recommendations is provided below.

TABLE 4.4-2
Site FT-1 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Develop an overall site management/ exit strategy	In consideration of remaining TPH levels in site soils, LUCs in place, revise RA-O program to a level acceptable to the base and regulators	Fairchild AFB	Ecology	March 2009	N	N
Benzene-contaminated soil has been largely remediated through bioventing and dig-and-hauls	Place bioventing system in standby mode	Fairchild AFB	Ecology	December 2006	N	N
Operation of the air sparging system is not necessary because benzene-contaminated groundwater has been remediated	Discontinue operation of air sparge system	Fairchild AFB	Ecology	December 2006	N	N
Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to significantly reduce groundwater monitoring by eliminating some wells, reducing sampling frequency, and adding some additional analyses	Fairchild AFB	Ecology	Ongoing	N	N
Revise RA-O soil monitoring	Consider biennial sampling with a focus on locations near east bioventing system	Fairchild AFB	Ecology	March 2009	N	N
Consider dig-and-haul for remaining soil contamination near bioventing lines in west bioventing system	Identify potential costs to excavate and dispose of remaining contaminated soils near west bioventing lines	Fairchild AFB	Ecology	June 2008	N	N

- **Develop an overall site management/exit strategy.** In view of remaining levels of TPH-related contamination in site soil and groundwater, past performance of remedial systems, ongoing natural attenuation processes, and LUCs in place, working with Ecology is recommended to revise the RA-O program to a level acceptable to the base and regulators that progresses towards site closure. A major component of this work may include reevaluation of potential site risks, based on the types and levels of contamination remaining (longer-chained hydrocarbon compounds in soil) versus

benzene (as the COC) that largely drove risk assessment during the RI/FS. This reevaluation may also identify other cleanup levels that should be achieved prior to site closure.

- **Place bioventing system on standby.** Benzene concentrations in site soils have been greatly reduced (largely eliminated) by the bioventing system, natural attenuation processes, and two dig-and-haul events. Any contamination remaining in site soils generally are longer-chained hydrocarbons for which continued bioventing will largely be ineffective. Therefore, the bioventing system should be placed in standby mode. If the bioventing system is maintained, the operation of east and west bioventing systems should be adjusted to optimize the air flow to vent wells where contamination is present. The removal of vent wells in areas of uncontaminated soils may allocate space to operate all necessary vent wells on one blower and manifold system.
- **Discontinue operation of the air sparging system.** The air sparging system has operated only minimally in recent years, and there is no need to even continue to maintain the system for any future operation or performance monitoring. Benzene has not been detected above its cleanup level in groundwater since 1999. Additionally, the system was determined to be inefficient and ineffective prior to 2000.
- **Reduce RA-O groundwater monitoring.** Significant progress has been made in restoration of site groundwater and soil. Benzene has not been detected above the cleanup level from any site well sampled since 1999. Therefore, monitoring for benzene and other VOCs such as VC and 1,1-DCE should be greatly scaled down. Based on historical data for these compounds, only annual sampling is recommended to be performed at MW-3, MW-227, MW-247, MW-50, MW-100, and MW-226 (analysis using EPA Method 8260). In the event that vinyl chloride and 1,1-DCE are not detected from site groundwater above cleanup levels, this portion of the groundwater monitoring program could be discontinued.
- **Add annual RA-O groundwater monitoring for select wells.** Because some longer-chained hydrocarbon contamination remains in site soils primarily located near the burn pit area, adding additional downgradient groundwater monitoring annually may be appropriate for a group of wells including MW-1, MW-3, MW-227, MW-247, and MW-248. The analytical suite for these wells could include TPH-G, TPH-D, and/or TPH-Jet A.
- **Revise RA-O soil monitoring.** Sampling data for 2003 and 2004 indicated that some contamination remained in site soils located within or near the former burn pit area (about 25 percent of these samples exceeded state cleanup levels for TPH compounds). However, much of this contamination was removed during the dig-and-haul that was completed in February 2005. Because much of any remaining contamination likely is associated with longer-chained hydrocarbons that do not easily degrade through bioventing or attenuate, biennial soil sampling is recommended instead of annual sampling. Over the past several years (primarily 2002 through 2004), soil sampling locations have been more concentrated within the West bioventing system area. Because the 2005 dig-and-haul focused on this area, future sampling locations should be biased toward a greater percentage of samples within the east bioventing system area.

- **Evaluate additional dig-and-hauls**. Much of the site contaminated soil (approximately 1,230 cubic yards [yd^3]) was removed as part of a dig-and-haul project performed in February 2005. The existing bioventing air lines and vent wells were not disturbed in these excavations, leaving some high molecular weight hydrocarbons (that is, TPH-D compounds) remaining. These TPH-D compounds generally degrade very slowly in soils in the absence of amendments, and it may take many years to achieve cleanup levels. As such, the base needs to evaluate the feasibility of removing these soils (and the bioventing lines and VMPs) for offsite disposal, or actively managing them in place long-term. If these soils (and associated bioventing lines) are removed, the bioventing system should be capped off but not replaced.

4.4.7 Statement of Protectiveness

The remedy at site FT-1 is currently protective of human health and the environment, and it is expected to be protective of human health and the environment upon attainment of all remedial action objectives. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways.

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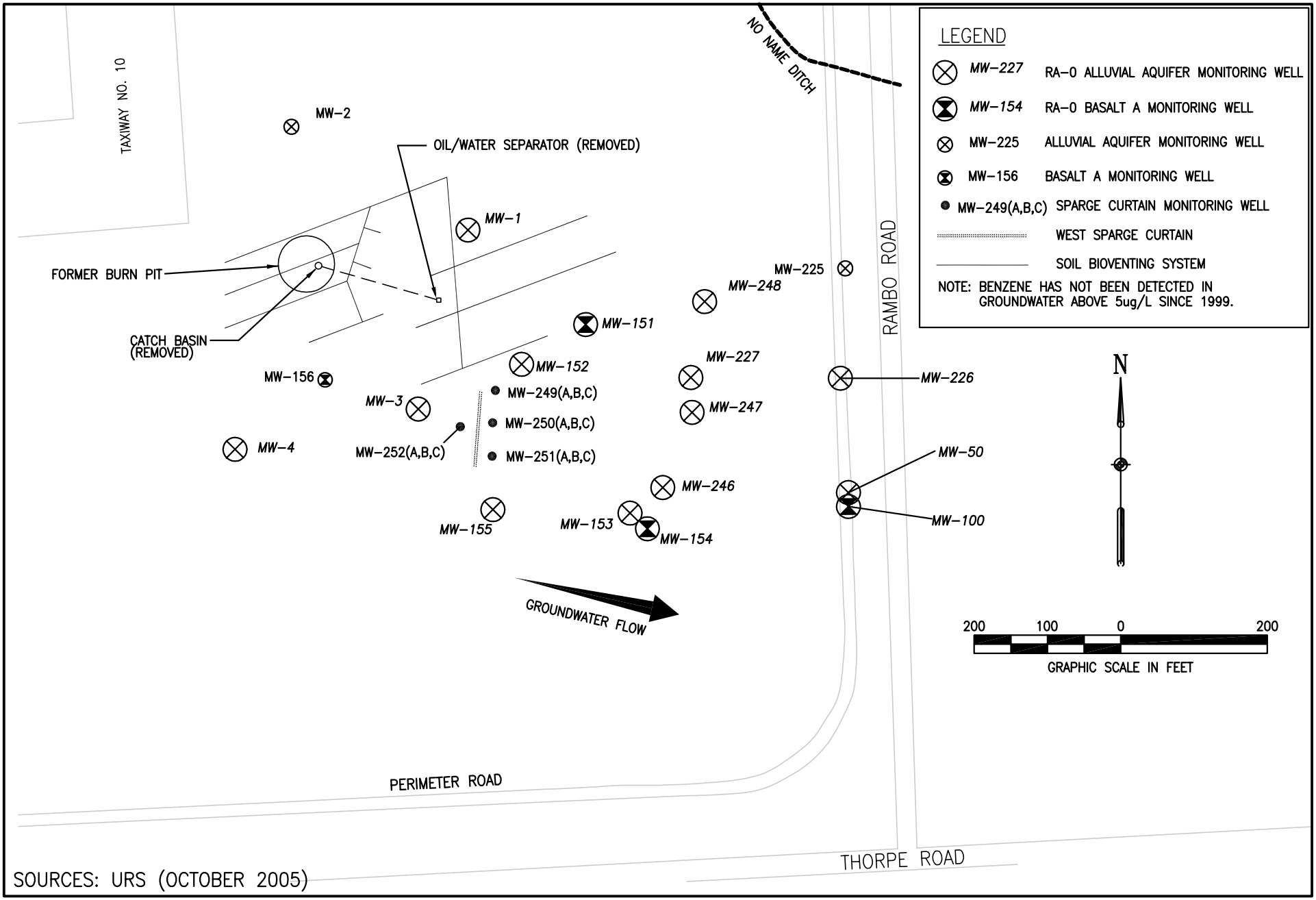
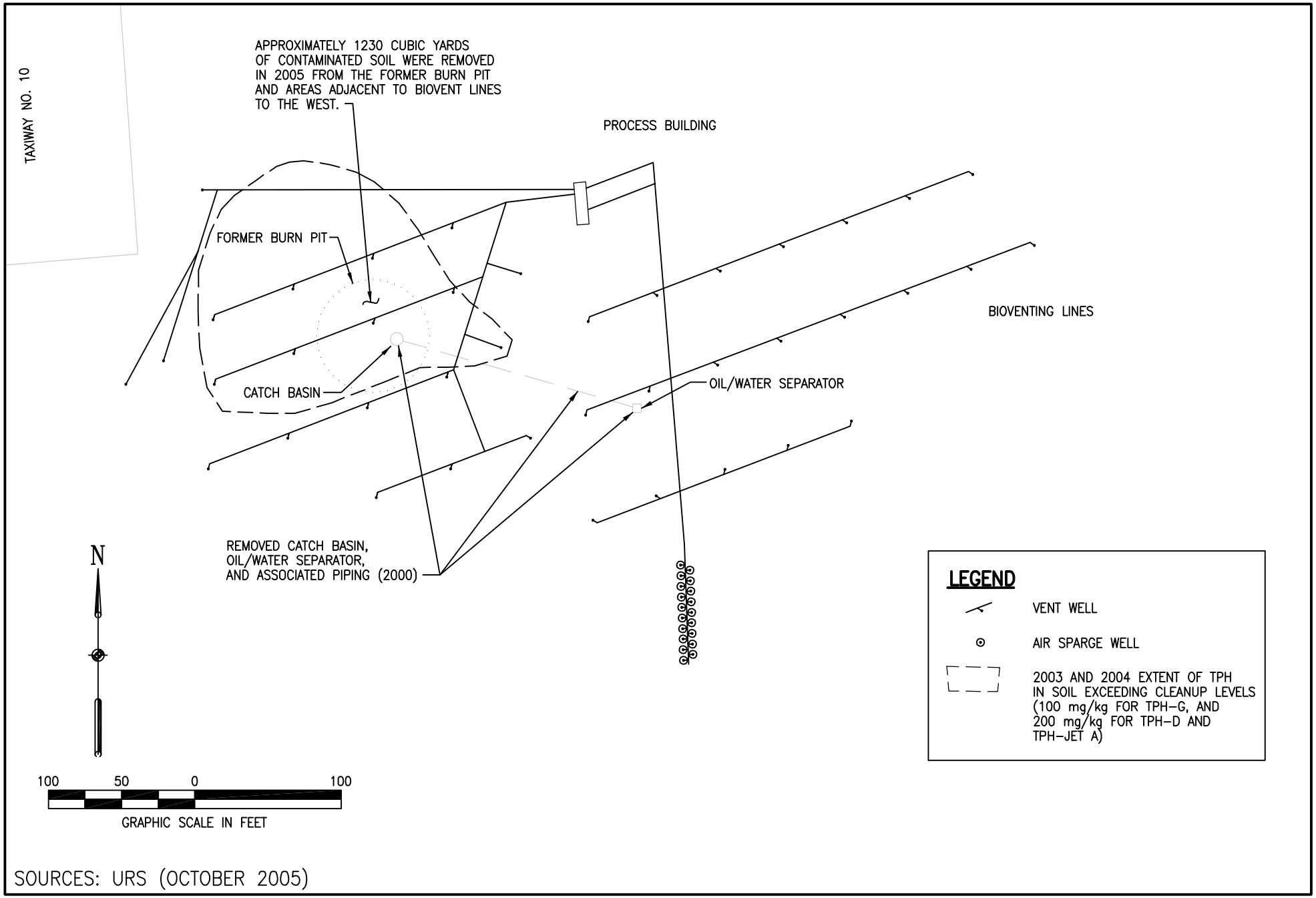


SOURCES: URS (OCTOBER 2005)

FIGURE 4.4-1: FT-1 SITE MAP



SOURCES: URS (OCTOBER 2005)

FIGURE 4.4-2: FT-1 SOIL RA-0

4.5 WW-1—Wastewater Lagoons

The WW-1 site 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 (Figure 4.5-1). The site consists of two interconnected industrial lagoons that were designed to accept industrial wastewater and stormwater that had been treated by OWS and grit chambers located along the flightline and eastern portions of the base. However, the OWS 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 approximately 2 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 OWS have either since been removed or upgraded. In addition, the base's stormwater lines 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 and 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. Groundwater underlying the site is no longer used as a drinking water source in the vicinity of the site. The dominant groundwater flow direction is towards the east-southeast.

4.5.1 Basis for Taking Action

The RI Report (Halliburton NUS, 1993) concluded that TCE in groundwater was the only site COC that would drive cleanup actions. However, the specific location or source of this TCE contamination was never determined. The risk from TCE detected in groundwater exceeded the state level of 1×10^{-5}, which initiated the evaluation of groundwater cleanup alternatives.

4.5.2 Remedial Actions

4.5.2.1 Remedy Selection

The goals of remedial action at WW-1 are to restrict the site from future residential or agricultural uses and to restore groundwater to drinking water quality. To satisfy the remedial action objectives identified by the ROD, the selected remedy included:

- Maintain institutional controls that restrict access to the site and prevent on-base usage of TCE-contaminated groundwater until cleanup levels are achieved
- Conduct additional source investigation activities to identify the source of groundwater TCE contamination
- Implement a groundwater extraction and treatment system 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

4.5.2.2 Remedy Implementation and Remedial Action Operations

Remedial action operations were initiated in 1994. The following sections describe components of the selected remedy as implemented. Additional data showing historical contaminant concentrations at WW-1 are included in Appendix B.

Institutional Controls

In addition to the controls outlined in Section 2.2.1.1, specific objectives for on-base LUCs include:

- Prevent drilling of new wells except for monitoring wells as authorized by EPA and Ecology
- Protect existing monitoring wells
- Prevent use of contaminated groundwater for drinking water purposes at the site
- Prevent unauthorized soil excavations at the site
- Preclude future residential or agricultural uses of the site
- 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 the WW-1 site extends from the base to private properties. Regulatory jurisdictions that may limit or restrict use of groundwater in these areas may be in place under the governance of the 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. Numerous private residential wells located east of the WW-1 site are sampled regularly as a part of the base's residential well monitoring program; sampling results from these wells are provided to the residents for their information and review. In addition, information on the status of groundwater contamination within the vicinity of the WW-1 site is routinely presented at Fairchild AFB RAB meetings which are open to the general public.

Specific objectives for off-base LUCs include:

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

Source Area Investigation

Prior to 2000, no formal additional source investigation activities were conducted at the WW-1 site. Water quality monitoring data reviewed for the site in preparation of the base's first Five-Year Review in 1999 suggested that the source of observed TCE contamination in groundwater likely was contaminated soil that seasonally became saturated. In June 2000,

the base performed depth-specific soil and groundwater sampling in the immediate vicinity of on-base well MW-102. Results of this investigation further indicated that the likely source of the TCE contamination was located west of MW-102 in a thin layer of soil (approximately 1 to 4 feet thick) occurring at a depth of 6 to 10 feet bgs. 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 bgs. 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 offsite (CH2M HILL, 2001c). Approximately 225 yd^3 of TCE and TPH-contaminated soils were removed and landfarmed adjacent to the site. TCE was remediated from the landfarmed soil over the next 6 months. However, TPH concentrations remained above the 200 mg/kg MTCA Method A cleanup level, and thus the base opted to thermally treat the soil at an offsite location in 2001.

Soybean Oil Addition

In early 2001, CH2M HILL completed an evaluation of using various carbon sources to mix with aquifer materials that would enhance TCE biodegradation near MW-102. The results of this evaluation concluded that the application of soybean oil would enhance anaerobic reductive dechlorination of any remaining TCE within groundwater in the former drum disposal area. With concurrence of Ecology, the soybean oil application was completed on June 28, 2001. Using an excavator, approximately 520 gallons of food-grade soybean oil were mixed with saturated aquifer materials in a 84-foot long trench located perpendicular to groundwater flow just downgradient from MW-102. Since 2001, direct and indirect lines of evidence have indicated that anaerobic conditions are present in this area, and biodegradation has occurred such that TCE in groundwater has declined significantly.

Groundwater Extraction and Treatment System

A remedial design 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 treatment system. Objectives of the extraction and treatment system were to establish hydraulic control of the TCE plume to prevent further offsite migration and to treat the contaminated groundwater to levels below the 5 µg/L MCL for TCE. 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 site GTP was designed to treat up to 90 gallons per minute (gpm) using air stripping with offgas GAC treatment. The GTP became operational in February 1996, using one off-base extraction well (EW-1) and one on-base extraction well (EW-3). Another on-base extraction well, EW-2, was later abandoned because of low well yield and limited potential contaminant removal. In December 1997, the system was modified by adding three well points as additional extraction locations. The well points and EW-3 operated using an aboveground vacuum/eductor system, while a submersible pump was installed in EW-1. Clean effluent water from the GTP is discharged into the aquifer through infiltration ditches located north of the extraction zone.

Full-time groundwater extraction and treatment operations continued throughout this review period until December 21, 2004, when the system was idled and placed in standby with concurrence of the base and Ecology. Through a series of technical memorandums

leading up to this point (CH2M HILL, 2004d), it was concluded that full-time operation of GTP was no longer necessary, based on analytical and hydrogeologic data. Specific conditions for triggering idling or restart of the GTP are required and include:

- The GTP system will be idled when sampling data indicate that no above-cleanup level TCE contaminated groundwater is identified at MW-102 or WP-01, coupled with water level elevation trends in onsite 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 quarterly.
- The GTP system will be restarted when sampling data indicate that above-cleanup level TCE contaminated groundwater is identified at MW-102 or WP-01, or when water levels show a dramatic rise (1.5 feet) within a 6- to 7-week period, when the potential for contaminant flushing increases significantly. The GTP system will remain in operation until the condition described above for idling has been met.

RA-O Groundwater Monitoring Programs

A long-term groundwater monitoring program was initiated in 1995, using both on-base and off-base monitoring wells, and by 1999, it had expanded to include 24 wells. The TCE plume was estimated to range up to approximately 200 feet wide, and TCE concentrations were estimated to exceed the MCL for at least 1,500 feet off-base within the shallow alluvial aquifer. On-base, TCE concentrations showed significant variability, ranging from 1 to 830 µg/L at MW-102, which was believed to be located nearest to a yet-to-be-determined source. Off-base, TCE concentrations ranged from non detect to as much as 69 µg/L at MW-120 in 1996, located approximately 700 feet downgradient of the base boundary.

Prior to source removal that occurred in 2000, overall TCE concentrations began to show declining trends in most off-base locations. Once source removal activities were conducted, TCE concentrations began declining quickly. The last time that an off-base monitoring well exceeded the TCE MCL was in March 2002. TCE concentrations at MW-102 declined from 66 µg/L (in March 2000) to 0.35 µg/L (in December 2004). During this time, only on two occasions was TCE detected above the MCL at MW-102 (9.1 µg/L in December 2000 and 10.4 µg/L in December 2003).

Even prior to the soybean oil addition that occurred in June 2001, considerable direct evidence existed that natural attenuation processes were ongoing, as evidenced by the presence of TCE degradation compounds such as cis- and trans-1,2-DCE and VC, being detected in on- and off-base monitoring wells. Concentrations of both cis- and trans-1,2-DCE in off-base monitoring wells did not exceed their 70 µg/L MCLs during this review period. In fact, concentrations of these degradation products generally showed declining trends for the period as well as in off-base monitoring wells.

Residential water supply wells located east and southeast of the WW-1 site have been regularly monitored since 1988. Prior to 2004, at least 15 wells were sampled quarterly with most wells non detect for site contaminants. Occasional detects of TCE were reported for these wells, but generally at concentrations considerably below the 5 µg/L MCL. Based on several years of non detects for TCE in most wells, this monitoring program was significantly downsized in 2004, to only include quarterly monitoring for four wells, semiannual sampling for one well, and annual monitoring for ten other wells. To date, no

point-of-use treatment or alternative water supplies have been initiated in the vicinity of the WW-1 site as a result of site contamination.

4.5.3 Progress Since Last Review

Remedial action operations have continued throughout the entire review period. The first Five-Year Review stated that the selected remedy had been only partially implemented and effective because source investigation activities to locate the source of TCE in groundwater had not been completed. Recommendations from the first Five-Year Review included completing source removal activities, redesigning the groundwater extraction system to establish hydraulic control of the TCE plume if the source of TCE could not be identified, and continuing assessment of monitored natural attenuation (MNA) as a potential remedy component. Because the source of the TCE contamination was identified and remediated, redesign of the groundwater extraction system was not required.

Based on the results of the source removal action and overall natural attenuation processes (whether truly natural or enhanced through the soybean oil addition), significant progress has been made in meeting remedial action objectives. Source removal activities have minimized and prevented movement of contaminants from soil to groundwater, prevented further migration of contaminated groundwater, and resulted in progress towards achieving cleanup goals for the shallow groundwater. Because sufficient progress was made towards achieving cleanup levels in shallow groundwater, the groundwater extraction and treatment system was placed on standby in December 2004.

With significant progress that has occurred, the need for an extensive monitoring network was reduced. The number of wells sampled in 2004 as compared to 1999 was reduced by about 20 percent; the number of analytical parameter groups analyzed was reduced by over 55 percent.

Natural attenuation of TCE and enhanced reducing conditions resulting from the soybean oil addition have created two new issues over the past several years that will require ongoing evaluation. The first issue is the emergence of VC, one of the final degradation compounds of TCE, as a relatively prominent site contaminant. No cleanup level for VC was established by the ROD (the federal MCL for VC is 2 µg/L and the MTCA Method A cleanup level is 0.2 µg/L). From 1998 to 2000, VC only was detected in one off-base monitoring well, MW-147 (located just east of the base boundary), with a maximum concentration of 4.5 µg/L. In 2004, VC was detected in up to eight different off-base monitoring wells with a maximum detect of 18.1 µg/L. However, VC appears to attenuate rapidly at about 1,000 feet east of the base boundary, where groundwater generally changes from an anaerobic (reducing) environment to an aerobic environment within the shallow aquifer. With respect to VC at on-base locations prior to 2000, it was detected as concentrations as high as 158 µg/L at MW-102. In 2004 at MW-102, VC concentrations ranged from 32 to 63 µg/L. VC has never been detected in any off-base residential wells associated with the WW-1 site.

The other issue that has resulted from anaerobic and enhanced reducing conditions near the MW-102 area is the mobilization of arsenic. Under reducing conditions, arsenic can be mobilized into solution until conditions become aerobic again and arsenic becomes stabilized. Based on concentrations in off-base wells not located within the former TCE

plume area, background arsenic concentrations appear to range from less than 0.5 to about 4 µg/L. Since 2001, when sampling for arsenic was initiated, concentrations in on-base wells have ranged up to 4,840 µg/L at MW-102 in March 2001 (note that in six other sample events at MW-102, arsenic ranged only from 86 to 203 µg/L). For off-base wells, arsenic concentrations generally are highest in wells located closer to the MW-102 area. With an exception of one detect of 67 µg/L at MW-241 in March 2004, all other off-base detects have been less than 21 µg/L. The former federal MCL for arsenic was 50 µg/L; however, a revised MCL for arsenic of 10 µg/L became effective in January 2006.

4.5.4 Technical Assessment

4.5.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

A review of available RA-O data and site inspection activities indicate that the remedy is functioning as intended by the ROD. The goals of remedial action are to restrict the site from future residential or agricultural uses and to restore groundwater to drinking water quality. This is being achieved as evidenced by the following:

- Consumption of groundwater exceeding cleanup levels is prevented on-base and site access is restricted through base LUCs. No activities have been observed that violate these established controls, either on- or off-base.
- The source removal/treatment action in combination with natural attenuation processes significantly reduced TCE concentrations, thus only two exceedances of the 5 µg/L MCL occurred between 2002 and 2004. This significant decline of TCE concentrations led to the conditional shutdown of the GTP in December 2004.

Overall site O&M costs were evaluated for this review. Though annual O&M costs for site WW-1 have fluctuated significantly over the review period, from years like 2004 when monitoring and operations costs were rather low compared to 2000, when source removal activities were completed, annual O&M costs averaged approximately $300,000. This amount included direct costs for monitoring and systems operations, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning documents, data validation, and reporting.

4.5.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The cleanup level for TCE, as stated in the On-base Priority One sites ROD, was based on the MTCA Method B cleanup level and federal MCL of 5 µg/L. The MTCA Method B cleanup level as amended in 2001 is 4 µg/L. Because the federal MCL does not exceed the MTCA cancer risk of 1×10^{-5}, the federal MCL for TCE should be retained, which will not affect remedial action objectives or the protectiveness of the remedy.

Arsenic and VC have been detected at concentrations above their respective MCL and MTCA Method A cleanup levels. Neither was identified as a COC, or as a cleanup level established by the ROD. Neither of these contaminants is anticipated to be a long-term issue for the site, as the physical conditions that have allowed them to become relatively prominent (degradation of TCE and enhanced anaerobic conditions) will change as further remediation of shallow groundwater is accomplished.

No new exposure pathways have been identified, nor any changes in land use on or near the site, or physical site conditions that would call into question the validity of the remedy selection.

4.5.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

A newly recognized association of the compound 1,4-dioxane (that historically may have been mixed as a stabilizer in TCE-containing mixtures) raises a possibility of its presence in groundwater at the WW-1 site. No analysis for 1,4-dioxane was performed prior to 2004, nor is it specified in the On-base Priority One Operable Unit ROD. Although EPA has not established an MCL, the MTCA Method B groundwater cleanup level for 1,4-dioxane is 7.95 µg/L. Aside from this, no other new information has come to light that would call into question the protectiveness of the remedy. Note: a groundwater sample was collected from MW-102 in December 2006 and analyzed for 1,4-dioxane. MW-102 is the well that historically has been impacted the most from site contamination. 1,4-dioxane was not detected in the sample.

4.5.4.4 Summary of Technical Assessment

The remedy implemented at the WW-1 site has made considerable progress towards achieving remedial action objectives. TCE concentrations in groundwater have declined significantly to allow for the conditional shutdown of the GTP. Two additional contaminants (arsenic and VC) have been detected above state and federal levels. Neither of these contaminants is anticipated to be a long-term issue for the site, as the physical conditions that have allowed them to become relatively prominent (degradation of TCE and enhanced anaerobic conditions) will change as further remediation of shallow groundwater is accomplished.

4.5.5 Issue

An issue identified for the WW-1 site in this Five-Year Review are listed in Table 4.5-1.

TABLE 4.5-1
Site WW-1 Issue

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Source removal activities and natural attenuation processes have largely remediated TCE-contaminated groundwater. Future operation of the groundwater extraction and treatment system may not be necessary.	N	N

4.5.6 Recommendations

All components of the selected remedy have been implemented. Table 4.5-2 highlights recommendations that address identified site issues or have the potential to further optimize long-term RA-O. Further discussion of these recommendations is provided below.

TABLE 4.5-2
Site WW-1 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Develop an overall site management strategy	In consideration of remaining TCE levels in groundwater, and LUCs in place, revise RA-O program to a level acceptable to the base and regulators	Fairchild AFB, Ecology	Ecology	March 2009	N	N
Future operation of the extraction and treatment system may not be necessary	Continue to proceed with the monitoring mechanisms in place to determine system operations	Fairchild AFB	Ecology	Ongoing	N	N
VC and arsenic exceed some cleanup levels and/or MCLs	Continue to monitor for these constituents to assess restoration of site groundwater	Fairchild AFB	Ecology and EPA	Ongoing	N	N
Soybean oil may have reached its effective lifespan for enhancing reductive dechlorination	Evaluate site conditions and determine if additional substrate addition would be beneficial	Fairchild AFB	Ecology	December 2005	N	N
Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to reduce groundwater monitoring by reducing sampling frequencies	Fairchild AFB	Ecology	Ongoing	N	N

- **Develop an overall site management/exit strategy.** In view of remaining levels of TCE site groundwater, ongoing natural attenuation processes, and LUCs in place, working with Ecology is recommended to revise the RA-O program to a level acceptable to the base and regulators that progresses towards site closure.

- **Extraction and Treatment System Operation.** Source removal activities and natural attenuation processes have largely remediated TCE-contaminated groundwater. Future operation of the groundwater extraction and treatment system may not be necessary. The current mechanisms in place for determining if the plant can remain in standby or must be operational appear to be working well. It may be necessary for the base and Ecology to periodically reevaluate this agreement and make a more permanent determination.

- **VC and arsenic issues.** Neither of these contaminants was identified by the ROD as a site COC, and cleanup levels were not established for them. However, these constituents will continue to be monitored for in site wells to assess restoration of site groundwater.

- **Evaluate if additional substrate could be added to enhance reductive dechlorination.** Based on site conditions observed through mid-2005, CH2M HILL concluded that the

effective lifespan of the soybean oil had been reached and that additional opportunities to stimulate further TCE degradation should be pursued. The substrate selected for this effort was diluted liquid cheese whey. With the concurrence of Ecology, this field effort was initiated in December 2005.

- **Reduce RA-O groundwater monitoring**. Based on available monitoring data and current conditions, the following modifications should be made to the RA-O groundwater monitoring program:
  - **Reduce sampling frequency of EW-3 to annual.** This well is located south of WP-01 (sampled quarterly) and is no longer in the main part of the TCE plume. Therefore, annual monitoring should be sufficient.
  - **Reduce sampling frequency of MW-254 to annual.** TCE detects in this well have been considerably below the MCL. Although not in the main portion of the former TCE plume area, it serves as a "sentinel" well for downgradient locations. As such, annual monitoring at this location should be sufficient.

4.5.7 Statement of Protectiveness

A protectiveness determination for the remedy at site WW-1 cannot be made until further information is obtained concerning arsenic and VC concentrations in groundwater that exceed MTCA Method A cleanup levels and/or federal MCLs. Further analysis of risk from these contaminants may need to be evaluated in order to determine if additional technical or administrative requirements will be necessary. It is expected that a path forward to address these issues may occur by June 2008, at which time a protectiveness determination will be made. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways both for both on base and off base locations.

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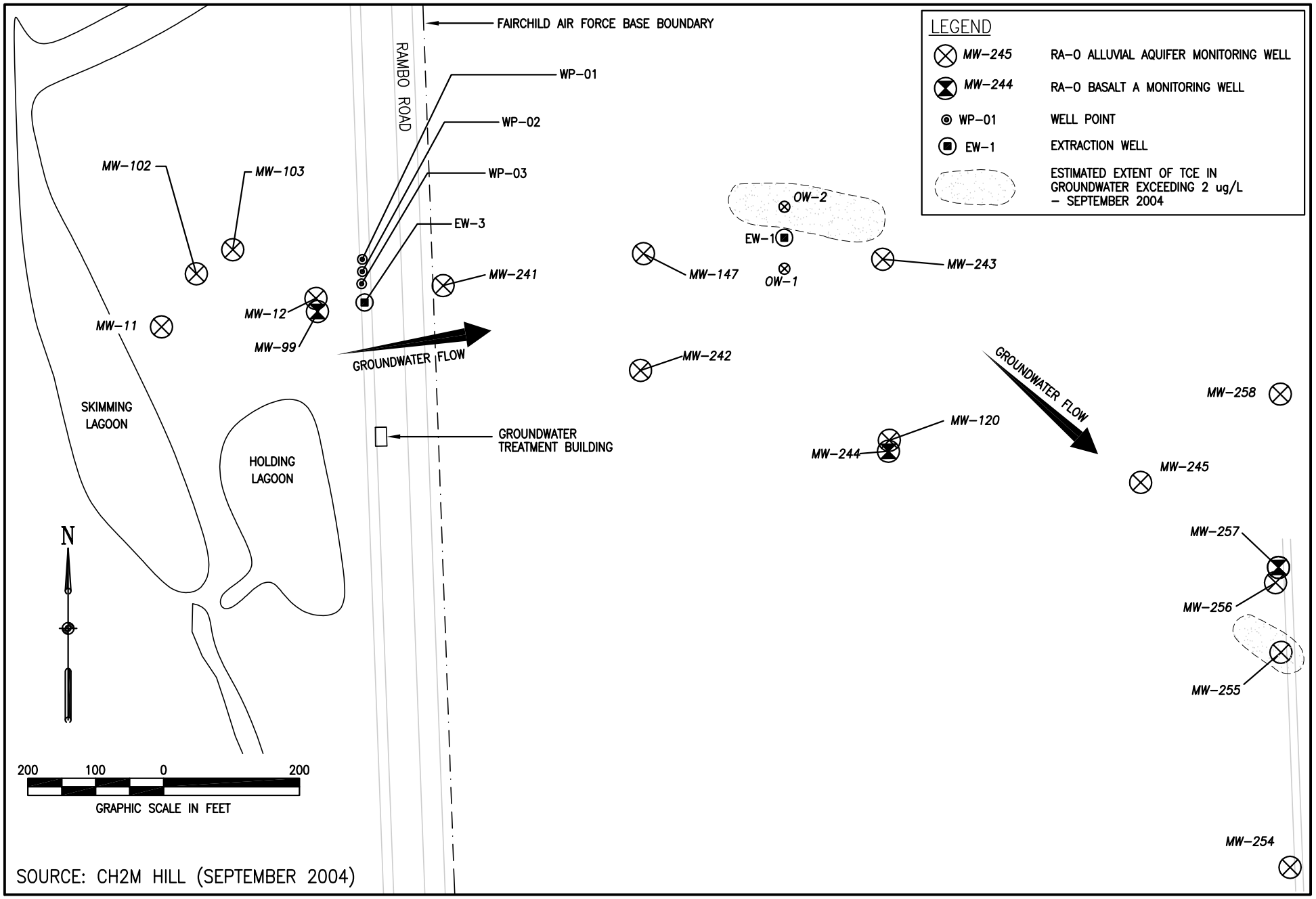

FIGURE 4.5-1: WW-1 SITE MAP

5.0 Priority Two Sites

Twenty IRP sites have been identified as Priority Two sites. Initial characterization of these sites was conducted from 1986 to 1989. LFIs were initiated for Priority Two sites in 1991 and completed in 1992. Results from the LFIs were used to direct RI activities conducted in 1993 and 1994. The Priority Two sites ROD was signed in December 1995, and concluded that remedial actions were required at sites IS-3, IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2.

The ROD also concluded that NFA was required at 13 sites, as identified in Table 1-1**.** These NFA determinations were based on unlimited use of the sites without limitations or restrictions of future land use. Therefore, these 13 sites are not further addressed in this Five-Year Review.

5.1 IS-3—Building 2150 PCB Sump

Site IS-3 is associated with Building 2150, located in the central portion of the base (the general location is shown in Figure 1-2). 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 the basewide 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.

LFI activities completed by 1992 focused on assessing a sump located in the basement of Building 2150 as a possible contaminant release point and on its contents as a possible contaminant source. These activities identified detectable concentrations of fuel-related VOCs, metals, and PCBs in sump sediment samples.

5.1.1 Basis for Taking Action

The RI identified that a release of wastes containing PCBs had taken place within the building, but no evidence was found that any release had occurred outside the building.

5.1.2 Remedial Actions

5.1.2.1 Remedy Selection

The selected remedy identified for IS-3 by the ROD was institutional controls. This decision was based on results of the 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.

5.1.2.2 Remedy Implementation and Remedial Action Operations

Building 2150 was demolished in 1996. Soil and groundwater samples underlying the former building area were collected and evaluated for the presence of PCBs. None were found to exceed federal and state cleanup levels. The sump was found to be intact, and no release to the environment was identified.

5.1.3 Progress Since Last Review

No action has been necessary. The remedy as implemented was determined to be complete. EPA and Ecology have issued letters agreeing that the ROD requirements were satisfied and NFA is required.

5.1.4 Technical Assessment Summary

The remedy as implemented has been determined to be complete. No new exposure pathways have been identified, nor any changes in land use on or near the site, or physical site conditions that would call into question the validity of the remedy. Additionally, no new information has emerged that calls into question the protectiveness of the remedy.

5.1.5 Issues

There are no issues identified for site IS-3 during this review.

5.1.6 Recommendations

There are no recommendations identified for site IS-3 based on this review.

5.1.7 Statement of Protectiveness

The remedy at IS-3 is expected to remain protective of human health and the environment. Potential exposure pathways that could result in unacceptable risks have been controlled.

5.2 IS-4—Jet Engine Test Cell

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 5.2-1). This site is currently inactive and all structures have been demolished. IS-4 presently consists of former engine test cells, a stormwater ditch, and a large rubble pile that once served as a blast shield during testing activities. From 1953 to 1989, the 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; this fuel routinely was washed into a centrally located dry well, which was connected to an OWS that discharged into a stormwater ditch. The base reportedly followed spill prevention procedures for activities conducted after 1979.

Groundwater underlying the site currently is not used as a drinking water source. The dominant groundwater flow direction is to the southeast.

5.2.1 Basis for Taking Action

Based on field investigation activities completed during the LFI and RI, soils at IS-4 were shown to exceed state cleanup criteria for TPH-D. A risk assessment concluded, however,

that although there was no unacceptable risk or hazard associated with exposure to the soil, remedial action was required because the TPH-D in soil could serve as a source for groundwater contamination.

The COC for IS-4 was TPH-D in soil; groundwater contamination observed at IS-4 was determined not to be related to the site and was deferred to the Priority Three sites ROD, specifically Site SD-38.

5.2.2 Remedial Actions

5.2.2.1 Remedy Selection

The goal of remedial action at IS-4 is to remediate soil to achieve state cleanup levels. To satisfy remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintaining institutional controls to restrict site access and require a Work Clearance Permit for intrusive activities until cleanup levels are achieved
- Allowing natural attenuation to reduce the concentration of diesel-range petroleum contamination in soil and monitoring degradation until contamination levels decrease below the state cleanup level of 200 mg/kg

5.2.2.2 Remedy Implementation and Remedial Action Operations

Remedial action operations were initiated in 1996. The following sections describe components of the selected remedy as implemented. Additional data showing historical contaminant concentrations are included in Appendix C.

Institutional Controls

LUCs for this site are intended to prevent exposure to contaminated soil. These LUCs are administered by the USAF as described in Section 2.2.1.1. Specific LUC objectives include:

- Prevent unauthorized soil excavations at the site
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land

Soil RA-O Monitoring Program

Long-term soil monitoring was initiated in 1996. From 1996 through 1998, soil samples were collected semiannually, annually in 1999 and 2000, and again semiannually from 2001 through 2004. In 2000, the soil sampling program included three-point composite samples that were collected from five representative grids at a depth of 0 to 2 feet. In 2001, the soil RA-O program was expanded from five to fifteen samples, with borings advanced to 8 feet. Concentrations of TPH-D exceeded cleanup levels for approximately 15 to 45 percent of all soil samples collected during every sampling event between 2000 and 2004—except for October 2003, when no samples exceeded cleanup levels. The highest TPH-D concentration detected during this review period was 13,000 mg/kg, in April 2003.

With the intent of potentially reducing the time to achieve state cleanup levels for site soils, a soil excavation and landfarming program was initiated in late 2002. Approximately 150 yd^3 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 cleanup levels by September 2004 and was returned to the original excavation. An additional 1,200 yd^3 of contaminated soil were excavated from other hotspots at the site in 2004 and landfarmed onsite in September 2004. These soils have been managed similarly to the initial soils, but have not yet met cleanup criteria (as of September 2005) and so remain in the landfarm.

Soils removed during the September 2004 soil removal effort primarily were located beneath the concrete pad, the former location of the engine test cell building. Soil underneath this building footprint had not been investigated prior to this time. The intention of the excavation and landfarm efforts was to remove only the most impacted site soils and treat them through landfarming, but not to remove all contaminated soil.

Groundwater Monitoring RA-O Program

In 2001, a groundwater monitoring RA-O program was established with the installation of three monitoring wells that since have been sampled semiannually. The ROD does not require groundwater monitoring at this site; however, the wells were installed to provide hydrogeologic and analytical data for eventual site closure. TPH-D results from these wells have been below the method detection limit of 250 µg/L for all sampling events.

5.2.3 Progress Since Last Review

Remedial action operations have continued throughout the entire review period.

5.2.3.1 First Five-Year Review Recommendations

The first Five-Year Review stated that all components of the selected remedy had been implemented and determined that it was protective of human health and the environment. However, the report concluded that the remedy was only partially effective because data indicating the progress of natural attenuation processes were inconclusive. The report recommended that the feasibility of alternative approaches to deal with the soil contamination at IS-4 needed to be evaluated. These approaches included:

- **Maintaining the current program**, but modifying the sampling frequency to annually because higher molecular weight hydrocarbons (that is, TPH-D compounds) degrade very slowly in soils in the absence of amendments, and it may take many years to achieve cleanup levels
- **Actively managing contamination** through enhanced bioremediation techniques
- **Conducting a removal action** of the most contaminated zones (both horizontally and vertically) and then applying Ecology's Interim TPH policy to the remaining site soils to determine if site-specific risks are acceptable

5.2.3.2 Soil Remediation Progress

The alternative selected to be implemented during this review period was a blend of conducting removal actions while actively managing contamination through excavation and enhanced bioremediation via onsite landfarming. Impacted soils were excavated from known hotspots in October 2002 and September 2004. The 2002 impacted soils were successfully remediated by 2004 and returned to the original excavation. A much greater quantity of soil was removed in 2004, but it currently remains in the landfarm, still being remediated.

Prior to the 2004 excavation effort, long-term soil monitoring results exhibited little overall progress towards achieving cleanup through natural attenuation processes. Over 20 percent of the soil samples collected in October 2004 (from locations outside of the September 2004 excavation boundary) had TPH-D and/or TPH-Jet A concentrations above cleanup levels.

Groundwater sampling results for 2001 through 2004 have shown no detects of TPH-D at concentrations above the method detection limit.

Subsurface soils at the site are comprised of inter-bedded sands, gravels, silts, and clays (ICF Technology, 1995). These observations, in tandem with groundwater and overall soil sampling results, suggest that the higher molecular weight hydrocarbons associated with the TPH-D contamination appear to be "locked up" within the soil structure, and they are neither mobilizing to groundwater nor attenuating significantly within the vadose zone.

5.2.4 Technical Assessment

5.2.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

A review of available RA-O data and site inspection activities indicate that the remedy is functioning as intended by the ROD; however, the effectiveness of this remedy is inconclusive at this time.

The goal of remedial action at IS-4 is to remediate soil to achieve state cleanup levels. As required, institutional controls and LUCs are in place to restrict site access. RA-O programs are ongoing to monitor the progress of allowing natural attenuation processes to reduce TPH-D contamination in soil. The first Five-Year Review recommended actions to enhance natural attenuation that have since been implemented. Approximately 150 yd^3 of contaminated soil were excavated and landfarmed in 2002. These soils achieved cleanup levels by 2004 and were returned to the original excavation. An additional 1,200 yd^3 of contaminated soil were excavated from hotspots at the site and landfarmed onsite in September 2004. This soil has been managed similarly to the soil excavated and landfarmed earlier, but has not yet met cleanup criteria (as of September 2005) and remains within the landfarm. Therefore, although significant effort has been made to enhance natural attenuation, a successful conclusion has not been reached.

Overall site O&M costs were evaluated for this review. The average annual O&M cost for site IS-4 during this review period was approximately $60,000. This total includes direct costs for IS-4 soil and groundwater monitoring programs, landfarming activities since 2002, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning documents, data validation, and reporting.

The ROD identified an estimated net present value of $124,000 to complete the remedy as identified (institutional controls and monitoring). Average annual O&M costs have roughly been about two-thirds of this "total remedy" estimated cost.

5.2.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The ROD cleanup level for TPH in soil was based on the MTCA Method A cleanup level. The Method A level at the time of the ROD was 200 mg/kg. The MTCA regulation and

associated cleanup levels were updated in 2001, and the subsequent Method A value was modified. The current Method A cleanup level for TPH in soil is 2,000 mg/kg.

Additionally, no new exposure pathways have been identified, there are no significant changes in land use on or near the site, and there are no physical site conditions that would call into question the validity of the remedy selection.

5.2.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No new information has emerged that would call into question the remedy protectiveness.

5.2.4.4 Summary of Technical Assessment

Prior to 2002, long-term soil monitoring results exhibited little overall progress towards achieving cleanup through natural attenuation processes. The 2002 excavation and subsequent landfarming efforts have successfully remediated approximately 150 yd^3 of soil contaminated with TPH-D. An additional 1,500 yd^3 of contaminated soil were excavated in 2004 and are presently being landfarmed. These two efforts have removed the majority of observed soil contamination at the site and soil remediation is in progress.

Groundwater sampling results for 2001 through 2004 have shown no detects of TPH-D at concentrations above the method detection limit.

Subsurface soils at the site comprise inter-bedded sands, gravels, silts, and clays (ICF Technology, 1995). These observations, in tandem with groundwater and overall soil sampling results, suggest that the higher molecular weight hydrocarbons associated with the TPH-D contamination appear to be “locked up” within the soil structure, and they are neither mobilizing to groundwater nor attenuating significantly within the vadose zone.

5.2.5 Issues

Issues related to components of the selected remedy for the IS-4 site are listed in Table 5.2-1.

TABLE 5.2-1
Site IS-4 Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Data are inconclusive as to whether natural attenuation processes are reducing overall TPH contamination in site soils	N	N
Overall site annual O&M costs are high, especially when compared to the total estimated net present value identified in the ROD for achieving remedial goals	N	N

5.2.6 Recommendations

All components of the selected remedy have been implemented. Table 5.2-2 highlights recommendations that address identified site issues or that have the potential to further optimize long-term RA-O. Further discussion of these recommendations is provided below.

TABLE 5.2-2
Site IS-4 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Develop an overall site management strategy	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	Fairchild AFB	Ecology	March 2009	N	N
Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to reduce groundwater monitoring to annually	Fairchild AFB	Ecology	June 2007	N	N
Revise RA-O soil monitoring	Reduce soil monitoring to annual (or biennial) because remaining soil contamination likely will not attenuate quickly	Fairchild AFB	Ecology	March 2009	N	N
Landfarming activities	Evaluate the cost-effectiveness of the current program versus offsite disposal if landfarm soils do not achieve cleanup levels	Fairchild AFB	Ecology	May 2006	N	N

- **Develop an overall site management strategy.** Subsurface soils at the site comprise inter-bedded sands, gravels, silts, and clays. These observations, in tandem with groundwater sampling results (no detects of TPH-D above detection levels for 4 years) and overall soil sampling results, suggest that the higher-molecular-weight hydrocarbons associated with the TPH-D contamination in soil appear to be "locked up" within the soil structure (whether in-place or within the landfarm at this time). They are neither mobilizing to groundwater nor attenuating significantly within the vadose zone. The ROD concluded that remedial action for soils was required, not based on risk but on the potential for site soils to serve as a source of groundwater contamination. RA-O data indicate that site soils are not serving as a source of groundwater contamination. Working with Ecology is recommended to revise the RA-O program to a level acceptable to the base and regulators, for eventual progress towards site closure. Reevaluation of the site needs to be completed and could possibly involve applying current MTCA guidance (Chapter 173-340 WAC, as amended in 2001). The ROD TPH cleanup level for soil was based on the MTCA Method A value of 200 mg/kg. The amended Method A cleanup level is 2,000 mg/kg.

  Overall site O&M costs are high when compared to the net present value estimated for the entire remedy, as identified by the ROD. Reevaluation of the overall site management strategy needs to address this.

- **Reduce RA-O groundwater monitoring.** Since 2001, there have been no detects of TPH-D above method detection limits from any site well. There appears to be technical justification to eliminate all groundwater monitoring based on analytical results. However, it could continue (at relatively little cost) until site closure is completed. Therefore, groundwater monitoring should be reduced to annually only for the two most downgradient wells, MW-286 and MW-287.
- **Revise RA-O soil monitoring.** Based on soil sampling results, annual sampling or biennial monitoring is sufficient. Analytical results for 2004 indicate that some contamination remains in site soils located outside the 2004 excavation boundary. Because much of any remaining contamination is likely associated with longer-chained hydrocarbons that do not easily degrade, annual (or even biennial) soil sampling is recommended instead of semiannual monitoring to evaluate natural attenuation.
- **Landfarming operations.** Continue to actively manage the onsite landfarm. Soil removed in September 2004 will require aeration and maintenance of sufficient moisture content to promote optimal bioremediation conditions. Sampling will need to be conducted to confirm that TPH-D concentrations have been remediated to below cleanup levels. If landfarmed soils do not meet cleanup levels by summer 2006, the cost-effectiveness of continuing the program versus offsite disposal must be evaluated.

5.2.7 Statement of Protectiveness

The remedy at site IS-4 is currently protective of human health and the environment, and it is expected to be protective of human health and the environment upon attainment of all remedial action objectives. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways.

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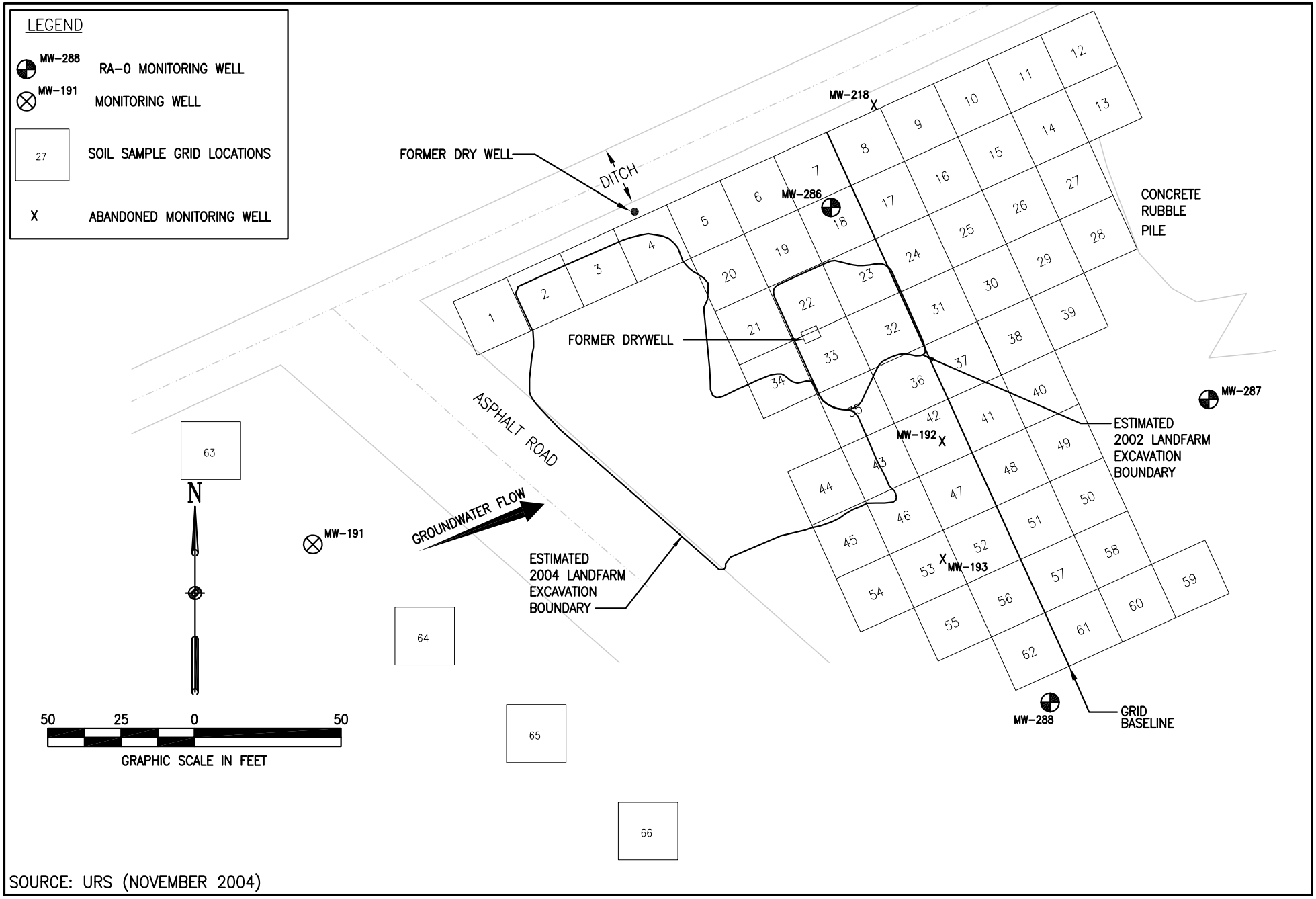

FIGURE 5.2-1: IS-4 SITE MAP

5.3 PS-1—Bulk Fuel Storage Area

The PS-1 site is the location of the main bulk fuel storage facility at the base (Figure 5.3-1), that comprises four aboveground storage tanks that were constructed between 1952 and 1960 to store approximately 3 MG of JP-4 fuel. Originally, fuel was received by rail. Today, most fuel moves to and from the storage tanks via underground pipelines.

Documented evidence shows that three fuel releases have occurred at 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 occurred during an excavation at PS-1, near the transfer pipeline and Building 2404; the base unearthed soil contaminated with an estimated 2,000 gallons of fuel. The third release occurred during road construction in 1993, near the roadbed north of Storage Tank 2410. At this location, the base unearthed fuel-contaminated soil. Additionally, sludge removed from the bottom of the tanks historically was placed in the bermed areas surrounding the tanks.

Groundwater underlying the site currently is not used as a drinking water source; the dominant groundwater flow direction is to the northeast.

5.3.1 Basis for Taking Action

Field investigation activities completed during the LFI and RI at site PS-1 confirmed TPH contamination in soil gas, shallow soils, and groundwater. The sources of this contamination were identified as the JP-4 fuel spills and leaks. Concentrations of TPH-D in soil exceeded MTCA Method A cleanup levels of 200 mg/kg. Based on the RI and a human health risk assessment, benzene in groundwater at PS-1 provided an unacceptable cancer risk for the industrial exposure scenario. Benzene was found at levels above the MCL of 5 µg/L. COCs established for PS-1 are TPH-D in soil and groundwater and for benzene in groundwater.

5.3.2 Remedial Actions

5.3.2.1 Remedy Selection

The goals of remedial action at site PS-1 are to remediate soil to state cleanup levels that are protective of groundwater and to remediate groundwater to state and federal levels. To satisfy remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintain institutional controls to restrict site access and require a Work Clearance Permit for intrusive activities until cleanup levels are achieved
- Implement an in situ bioventing treatment system for soil contaminated with TPH-D until the contamination level decreases below the state cleanup level 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 cleanup level of 1,000 µg/L for TPH-D and MCL of 5 µg/L for benzene

5.3.2.2 Remedy Implementation and Remedial Action Operations

The RA-O program for site PS-1 was initiated in 1996. The following sections describe components of the selected remedy, as implemented. Additional data showing historical contaminant concentrations and statistical trend data are included in Appendix C.

Institutional Controls

LUCs for this site are intended to prevent exposure to contaminated soil and groundwater. These LUCs are administered by the USAF as described in Section 2.2.1.1. Specific LUC objectives include:

- Prevent drilling of new wells except for monitoring wells as authorized by EPA and Ecology
- Protect existing monitoring wells
- Prevent use of contaminated groundwater for drinking water purposes at the site
- Prevent unauthorized soil excavations at the site
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land

Bioventing and Soil RA-O Monitoring Program

Open-system bioventing was selected in the ROD as a viable option for treatment of contaminated soil around the periphery of the fuel tank facility. Startup of a full-scale system began in March 1998, with a prediction of a 3-year operating timeframe to achieve cleanup levels. The bioventing system at PS-1 consists of a four-component system serving 14 vent wells. The purpose of each component is to inject air into the subsurface through vent wells to maintain oxygen levels sufficient to support biodegradation of TPH compounds.

During this review period, the bioventing system was operated and maintained for full-time operation; required emission compliance monitoring for the period met all regulatory limits.

A baseline soil sampling event was completed in 1997, during installation of the bioventing system. Approximately 25 percent of the samples collected exceeded the cleanup level, with concentrations of TPH-D ranging from 280 to 3,200 mg/kg. Since 2001, annual soil sampling has been performed. These sampling events generally have consisted of collecting 25 soil samples from depths of 2 to 6 feet bgs, at borings across the site where allowed (significant underground utilities at the site limit available boring locations). In 2001, TPH-D detections above the cleanup level were found at eight locations located across the site and ranged from 210 mg/kg to 2,100 mg/kg. From 2002 through 2004, TPH-D detections exceeding the cleanup level were primarily located along Vet Road and adjacent to blower BS-1, next to the concrete containment area. TPH-D concentrations at these locations ranged from 210 mg/kg to 6,800 mg/kg. The fact that none of the 2002 to 2004 detections were located within any current bioventing vent well radius of influence is noteworthy.

Groundwater RA-O Program

Long-term groundwater monitoring was initiated in 1996 and consisted of semiannual monitoring at six wells for benzene and TPH-D. Based on recurring nondetects of site COCs through 2000, sampling had been eliminated at two wells (MW-194 and MW-197), reduced to annual at MW-195 and MW-208, and remained semiannual for MW-196 and MW-208.

During 2004, groundwater monitoring consisted of four wells sampled quarterly, semiannually, and annually.

Benzene historically has been identified in samples from MW-196 and MW-208, but concentrations have not exceeded the cleanup level at either well since September 1999. From 2002 through 2004, benzene concentrations in these two wells ranged from nondetect (generally less than 0.1 µg/L) to just below 1 µg/L. RA-O data collected through 2004 indicate that TPH-D concentrations at both MW-196 and MW-208 have declined significantly since 1996. TPH-D concentrations have been below the 1,000 µg/L cleanup level in MW-196 since September 2003, and in MW-208 since April 2001. When groundwater RA-O was initiated at site PS-1 in 1996, TPH-D concentrations in MW-196 and MW-208 were as high as 5,200 µg/L. In 2004, TPH-D concentrations in these two wells ranged from nondetect (three samples at less than 250 µg/L) to one detect of 590 µg/L at MW-196.

TCE is not a formal site COC, but it was detected above the MTCA Method A cleanup level of 3.98 µg/L in MW-195 for five consecutive sampling events between March 2002 and October 2004. Analytical detections exceeding the cleanup level ranged from 8.3 to 25 µg/L. As a result, the monitoring frequency at this well was increased from annual to quarterly in 2004. However, TCE was not detected above the cleanup level in December 2004. Field efforts to identify the potential sources of this TCE were conducted in January 2005. Fifteen direct-push borings were completed in the vicinity of MW-195, located along the perimeter of the facility to the north. However, groundwater was only encountered in three of the borings, and TCE was not detected at any of these locations. Results of this investigation were inconclusive to identify potential sources of the TCE.

An additional well (MW-308) was installed at the site in 2004, and this well was added to the RA-O program as a replacement for MW-195, which was damaged during installation and repair of a water supply line in this area.

Supplementary information is provided in Appendix C regarding historical concentrations in groundwater and statistical analysis results of the data.

5.3.3 Progress Since Last Review

Site RA-O have continued throughout this entire review period. The first Five-Year Review stated that all components of the selected remedy had been implemented and determined that it was protective of human health and the environment. The report recommended that long-term groundwater monitoring continue until TPH-D and benzene concentrations decline to below cleanup levels. Based on RA-O data, concentrations of both of these COCs have since declined significantly to below ROD cleanup levels. Benzene concentrations have not exceeded the 5 µg/L cleanup level since September 1999; TPH-D concentrations have been below the MTCA Method A cleanup level in all site wells since September 2003.

Bioventing operations also have continued throughout the review period. RA-O results indicate that bioventing has significantly reduced TPH-D concentrations in soils at those locations within the systems' radius of influence. Soil within the influence of bioventing systems BS-1 and BS-2 appears to have been remediated below the 200 mg/kg cleanup level.

Because of site constraints, including the concrete containment area surrounding the tanks and numerous underground utilities, limited soil sampling data are available to determine if soils within influence of the BS-3 and BS-4 system have been remediated. Two general areas of soil impacted by TPH-D exceeding the cleanup level were identified, but they are not within the vent well radius of influence of any of the four systems. These areas are adjacent to Vet Road, along the former rail yard and along the concrete containment area next to BS-1. From 2002 through 2004, TPH-D detections exceeding the cleanup level in these areas occurred at these locations and had concentrations ranging from 210 mg/kg to 6,800 mg/kg.

A second recommendation in the first Five-Year Review was to optimize the bioventing system by reducing bioventing in respective areas if soil TPH-D concentrations achieved cleanup levels. No major changes to bioventing systems operations were initiated at PS-1 during this review period.

5.3.4 Technical Assessment

5.3.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

A review of available RA-O data and site inspection activities indicate that the remedy is functioning as intended by the ROD. The goals of remedial action at site PS-1 are to remediate soil to state cleanup levels that are protective of groundwater, and to remediate groundwater to state and federal levels. This is being achieved as evidenced by the following:

- Institutional controls and LUCs are in place that restrict site access and require a Work Clearance Permit for intrusive activities to be completed at the site
- A bioventing system has been installed and is operational. Soil within the influence of bioventing systems BS-1 and BS-2 appears to have been remediated below the 200 mg/kg cleanup level for TPH-D. Two areas of soil contamination exceeding the cleanup level of 200 mg/kg have been identified at the site. However, they are located in areas not under the influence of the current bioventing systems.
- Benzene in groundwater has not been detected above the 5 µg/L cleanup level in any well sampled since 1999. Additionally, TPH-D concentrations in groundwater have been below the state cleanup level of 1,000 µg/L since September 2003.

Overall site O&M costs were evaluated for this review. The average annual O&M cost for site PS-1 during this review period was approximately $110,000. This amount included direct costs for PS-1 soil and groundwater monitoring programs, bioventing activities, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning documents, data validation, and reporting.

5.3.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The Priority Two sites ROD applied the MTCA Method A cleanup level for TPH-D in both soil and groundwater. The Method A levels at the time of the ROD were 200 mg/kg for soil and 1,000 µg/L for groundwater. The MTCA regulation was updated in 2001, and subsequent Method A values were modified. The current Method A cleanup levels for TPH-D in soil and groundwater are 2,000 mg/kg and 500 µg/L, respectively.

Additionally, no new exposure pathways have been identified, there are no significant changes in land use on or near the site, and there are no physical site conditions that would call into question the validity of the remedy selection

5.3.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No new information has emerged that would call into question the protectiveness of the remedy.

5.3.4.4 Summary of Technical Assessment

Significant progress to achieve site cleanup levels has been made at site PS-1 through RA-O and natural attenuation processes. Benzene in groundwater has not been detected above the 5 µg/L cleanup level in any well sampled since 1999. Additionally, TPH-D concentrations in groundwater have been below the state cleanup level of 1,000 µg/L since September 2003.

RA-O soil data indicate that the bioventing system has been successful at reducing TPH concentrations in soil, especially in areas within the influence of bioventing systems BS-1 and BS-2, where TPH-D contamination appears to have been remediated below the 200 mg/kg cleanup level for TPH-D. Two primary areas of soil contamination exceeding the cleanup level of 200 mg/kg remain at the site. They are located in areas outside the influence of the bioventing systems, along Vet Road and beneath the concrete containment area below the tanks. The bioventing system, however, was not designed to remediate soils located in these areas.

5.3.5 Issue

An issue related to the selected remedy for the PS-1 site is listed in Table 5.3-1.

TABLE 5.3-1
Site PS-1 Issue

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
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.	N	N

5.3.6 Recommendations

All components of the selected remedy have been implemented. Table 5.3-2 highlights recommendations that address identified site issues or that have the potential to further optimize long-term RA-O. Further discussion of these recommendations is provided below.

TABLE 5.3-2
Site PS-1 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Develop an overall site management strategy	In consideration of remaining TPH levels in site soils and LUCs in place, revise RA-O program to a level acceptable to the base and regulators	Fairchild AFB	Ecology	March 2009	N	N
The bioventing system has remediated TPH-contaminated soil within the influence of the system as designed	Place bioventing system in standby mode	Fairchild AFB	Ecology	December 2006	N	N
Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to reduce groundwater monitoring because cleanup levels have been achieved	Fairchild AFB	Ecology	Ongoing	N	N
Revise RA-O soil monitoring	Consider biennial (or less frequent) sampling until access to beneath site can be obtained	Fairchild AFB	Ecology	March 2009	N	N

- **Develop an overall site management/exit strategy.** In view of remaining levels of TPH-related contamination in site soils that remain outside of the influence of the bioventing systems, cleanup levels in groundwater that have been achieved, ongoing natural attenuation processes, and LUCs in place, working with Ecology is recommended to revise the RA-O program to a level acceptable to the base and regulators that progresses towards site closure. Reevaluation of the site needs to be completed, and could possibly involve applying current MTCA guidance (Chapter 173-340 WAC, as amended in 2001). The RI risk assessment concluded that no unacceptable risk or hazard associated with exposure to soils at PS-1 existed. The principal source of unacceptable risk identified by the RI was ingestion of groundwater exceeding cleanup criteria. However, site groundwater cleanup levels for benzene and TPH-D have since been achieved (1999 for benzene, and 2003 for TPH-D).
- **Place the bioventing system in standby mode.** RA-O data have indicated that soils located within the influence of bioventing systems BS-1 and BS-2 appear to have achieved cleanup compliance. Two primary areas of soil contamination exceeding cleanup levels remain at the site. They are located in areas outside of the influence of the bioventing system, along Vet Road and beneath the concrete containment area below the tanks. The bioventing system, however, was not designed to remediate soils located in these areas. And potentially similar to site FT-1, remaining TPH contamination in soils

within these areas may comprise longer-chained hydrocarbons, for which bioventing operations likely would be largely ineffective in remediating.

- **Reduce RA-O groundwater monitoring.** Benzene and TPH-D concentrations have achieved cleanup levels identified by the ROD. It is unknown, though, whether natural attenuation processes alone or natural attenuation processes enhanced through bioventing are responsible for the cleanup of groundwater. Therefore, some groundwater monitoring should continue at the site, especially if bioventing is discontinued. Annual sampling for TPH-D and benzene should be continued at MW-196, MW-208, and MW-308 (a "replacement" well for MW-195). Because of historical TCE detects at MW-195, TCE should be monitored annually at MW-308 (MW-195 should be removed from the RA-O sampling program and abandoned or be used only for water level monitoring as it was declared compromised after damage from a water supply line installation project that occurred in 2004). Sampling at MW-194 and MW-207 should be eliminated, based on historical nondetects for COCs.

- **Revise RA-O soil monitoring.** In light of the recommendations identified above and considering locations where contaminated soil remains at the site, the soil monitoring program should be modified. At a minimum, the number of samples should be reduced from the 25 currently collected to approximately 15, and should be focused in areas where impacted soils have been identified. Some consideration also should be given to biennial—or even less frequent—soil sampling.

  Because of physical constraints that prohibit access to much of the contaminated soil (beneath the tank farm and along Vet Road), and because much of the soil contamination remaining likely is longer-chained hydrocarbons that may attenuate very slowly, consideration could be given to eliminating all soil monitoring activities as long as groundwater monitoring is ongoing. Once access to the Vet Road area or beneath the tank farm can be achieved, soil sampling at these locations should be conducted.

5.3.7 Statement of Protectiveness

The remedy at site PS-1 is currently protective of human health and the environment, and it is expected to be protective of human health and the environment upon attainment of all remedial action objectives. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways.

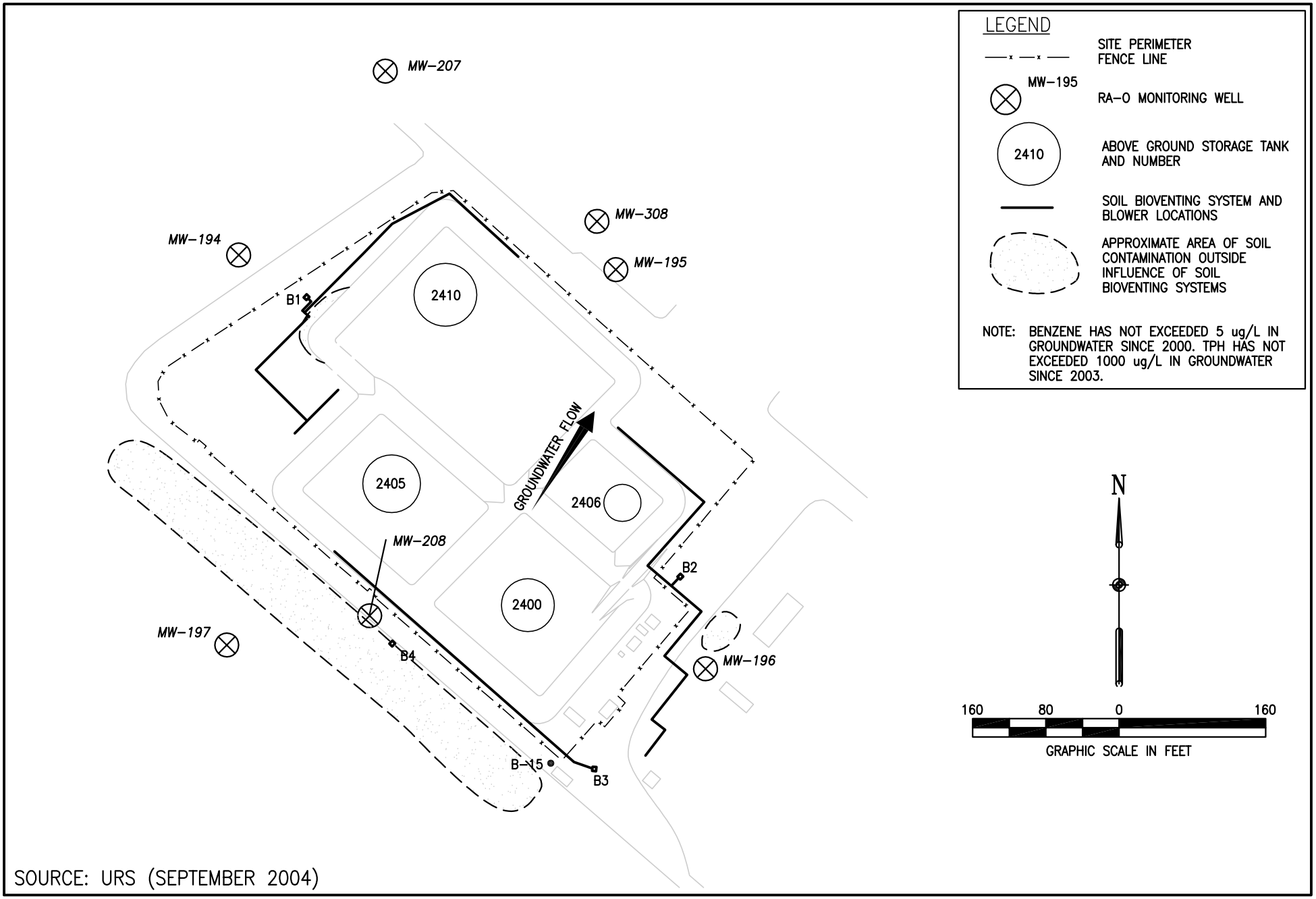

FIGURE 5.3-1: PS-1 SITE MAP

5.4 PS-5—Heating Oil Tank Area

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 (Figure 5.4-1). This site is the former location of a 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 yd^3 (1,150 tons) of petroleum-laden soil. However, during the excavation, an approximate 2-foot layer of medium- to coarse-grain sand, located at the water table, was observed to have considerable fuel oil contamination. In addition, an approximate 1/8-inch-thick light non-aqueous phase liquid (LNAPL) layer of fuel oil was observed at the water table, downgradient of the excavation. The predominant groundwater flow direction at PS-5 is to the east.

5.4.1 Basis for Taking Action

Field investigation activities completed during the RI at site PS-5 confirmed that only limited TPH contamination remained in site soil and groundwater, but concentrations exceeded MTCA cleanup levels (200 mg/kg for TPH-D in soil and 1,000 µg/L in groundwater). The COC identified for site PS-5 was TPH-D in both soil and groundwater.

5.4.2 Remedial Actions

5.4.2.1 Remedy Selection

The goals of remedial action at site PS-5 are to remediate groundwater to state cleanup levels and to remediate soil to state cleanup levels that are protective of groundwater. To satisfy remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintain institutional controls to restrict site access and require a Work Clearance Permit for intrusive activities until cleanup levels are achieved
- Monitor site groundwater and downgradient to assess natural degradation and migration of TPH-D

5.4.2.2 Remedy Implementation and Remedial Action Operations

The RA-O program for site PS-5 was initiated in 1996. The following sections describe components of the selected remedy, as implemented.

Institutional Controls

As described in Section 2.2.1.1, institutional controls and LUCs were implemented and maintained to restrict site access and require a Work Clearance Permit for any intrusive activities until the site received a NFA determination.

Groundwater RA-O Monitoring Program

Long-term groundwater monitoring at PS-5 began in 1996, and included sampling of four monitoring wells. Sampling results for 1996 and 1997 revealed that TPH-D had been reduced below the state cleanup levels. As a result, in 1998 with concurrence from EPA and Ecology, it was agreed that state cleanup levels in the groundwater for the COC (TPH-D) had been achieved, and that long-term groundwater monitoring at PS-5 could be discontinued. Monitoring wells at PS-5 were abandoned in 1998.

5.4.3 Progress Since Last Review

No action has been necessary. The remedy as implemented was determined to be complete. EPA and Ecology have issued letters agreeing that the ROD requirements were satisfied and NFA is required.

5.4.4 Technical Assessment

The remedy as implemented has been determined to be complete. No new exposure pathways have been identified, nor any changes in land use on or near the site, or physical site conditions that would call into question the validity of the remedy. Additionally, no new information has emerged that calls into question the protectiveness of the remedy.

5.4.5 Issues

No issues were identified for site PS-5 during this review.

5.4.6 Recommendations

No recommendations were identified for site PS-5 during this review. The remedy has been determined to be complete.

5.4.7 Statement of Protectiveness

The remedy at site PS-5 is expected to remain protective of human health and the environment. Potential exposure pathways that could result in unacceptable risks have been controlled.

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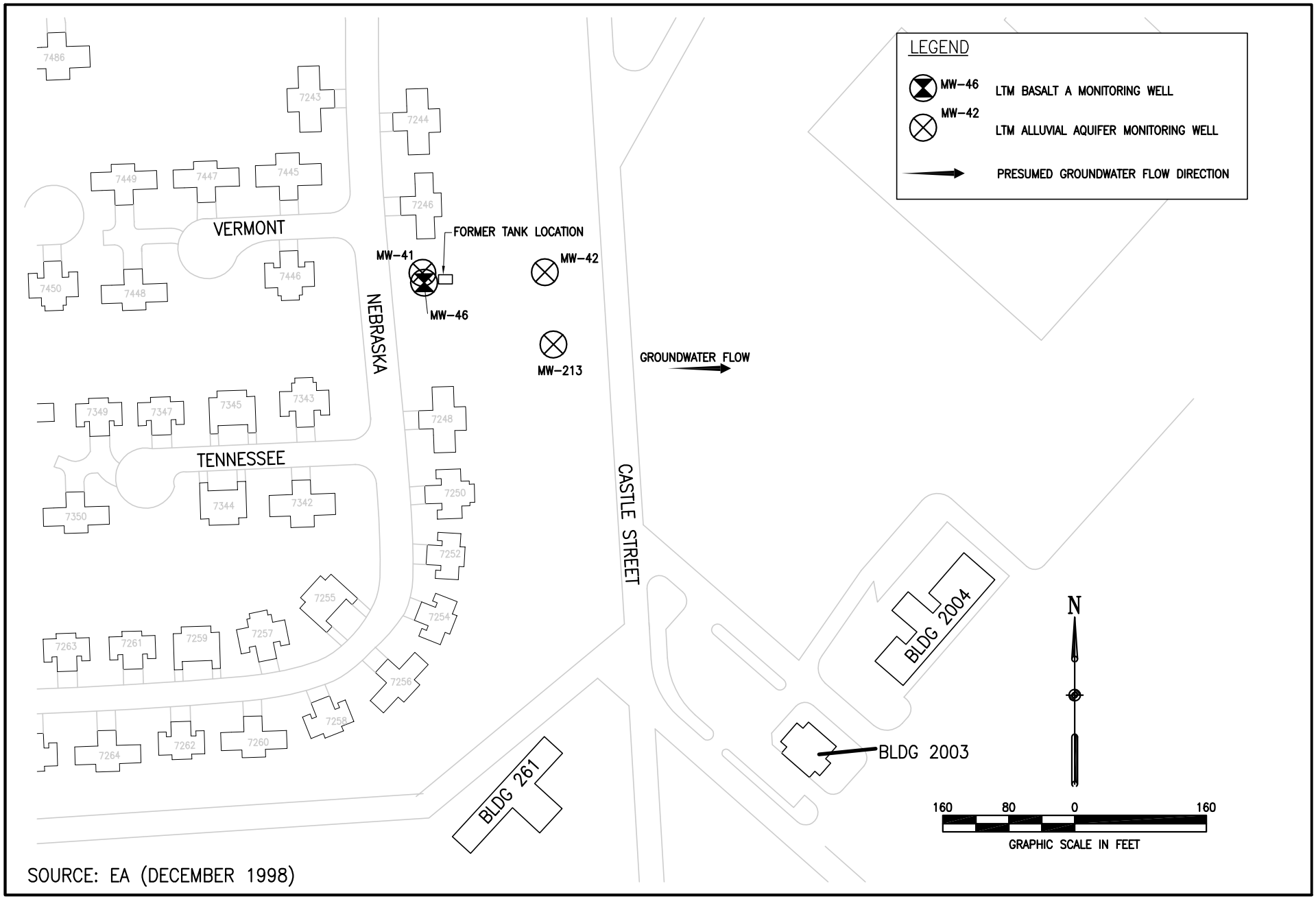

FIGURE 5.4-1: PS-5 SITE MAP

5.5 PS-7—Fuel Oil Storage Tanks

The PS-7 site is located at the USAF survival school in the south-central portion of the base (Figure 5.5-1). The site formerly contained two 12,000-gallon USTs containing No. 6 oil that fueled the two Deep Creek Steam Plant (Building 1350) boilers and one 500-gallon UST containing No. 2 fuel oil for preheating the boilers. Prior to 1982, waste solvents from maintenance activities conducted at the base 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 Building 1350 through cracks in the foundation.

In 1992, the three USTs were removed and 400 yd^3 of petroleum-contaminated soil were excavated and treated offsite. However, contaminated soil and groundwater were suspected to remain onsite. The remaining amount of contaminated soil is believed to remain beneath Building 1350. The predominant direction of groundwater flow at PS-7 is to the southeast.

5.5.1 Basis for Taking Action

Following soil removal activities and based on field investigations completed for the LFI and RI, contaminated soil and groundwater that remained onsite were determined to exceed state cleanup levels. The COC for PS-7 is TPH-D in both soil and groundwater. Applicable cleanup levels were set in accordance with MTCA Method A cleanup levels of 200 mg/kg for soil and 1,000 µg/L for TPH-D in groundwater.

5.5.2 Remedial Actions

5.5.2.1 Remedy Selection

The goals of remedial action at site PS-7 are to remediate groundwater to state cleanup levels and to remediate soil to state cleanup levels that are protective of groundwater. To satisfy remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintain institutional controls to restrict site access and require a Work Clearance permit for intrusive activities until state cleanup levels are achieved. Remaining soil contamination is 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 cleanup level of 1,000 mg/L is achieved.

5.5.2.2 Remedy Implementation and Remedial Action Operations

The following sections describe components of the selected remedy, as implemented.

Institutional Controls

As described in Section 2.2.1.1, institutional controls and LUCs were implemented and maintained to restrict site access and require a Work Clearance Permit for any intrusive activities until the site received an NFA determination. Additionally, these controls need to

remain in place until Building 1350 is demolished and contaminated soils, currently inaccessible beneath a portion of the building, can be assessed.

Groundwater RA-O Monitoring Program

Long-term groundwater monitoring at PS-7 was initiated in 1996, and included sampling of three monitoring wells. Similar to PS-5, results from four rounds of sampling for 1996 and 1997 revealed that TPH-D concentrations were considerably below state cleanup levels. As a result, with concurrence from EPA and Ecology in 1998, it was agreed that state cleanup levels in the groundwater for the COC (TPH-D) had been achieved, and long-term monitoring at PS-7 could be discontinued. PS-7 monitoring wells were abandoned in 1998.

5.5.3 Progress Since Last Review

No action has been necessary because Building 1350 has yet to be demolished. Institutional controls remain in place regarding soils. The remedy as implemented for groundwater was determined to be complete. EPA and Ecology have issued letters agreeing that the ROD requirements for groundwater were satisfied and NFA is required.

5.5.4 Technical Assessment

The remedy as implemented has been determined to be complete for groundwater. No new exposure pathways have been identified, nor any changes in land use on or near the site, or physical site conditions that would call into question the validity of the remedy. Additionally, no new information has emerged that calls into question the remedy protectiveness.

5.5.5 Issues

No issues have been identified for site PS-7 during this review.

5.5.6 Recommendations

No recommendations have been identified for site PS-7 for this review; the remedy has been determined to be complete for groundwater.

Institutional controls remain in place requiring additional work be conducted on site soils once Building 1350 is demolished.

5.5.7 Statement of Protectiveness

The remedy at site PS-7 is expected to remain protective of human health and the environment. Potential exposure pathways for groundwater that could result in unacceptable risks have been controlled. In the interim for soil, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways.

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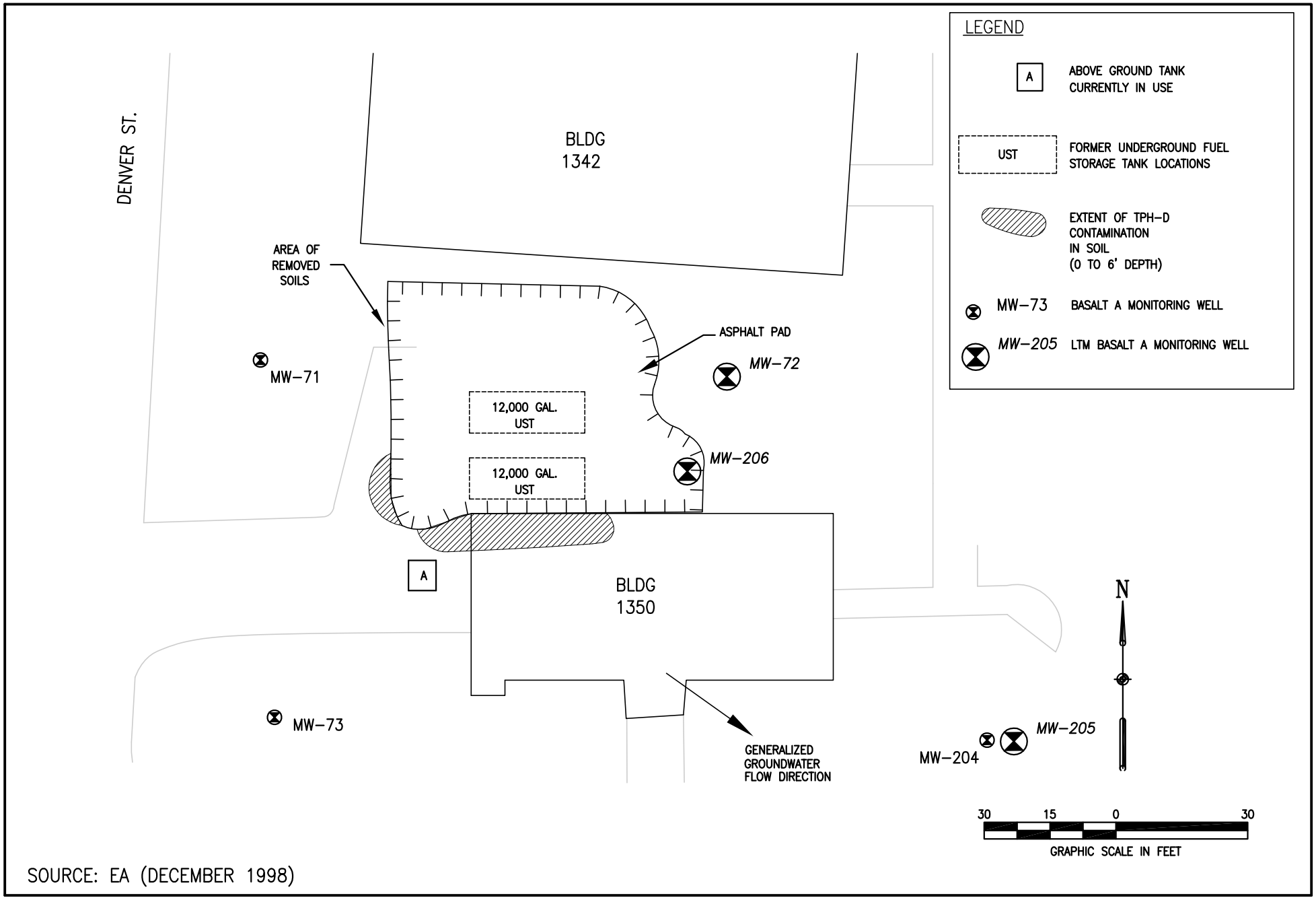

SOURCE: EA (DECEMBER 1998)

FIGURE 5.5-1: PS-7 SITE MAP

5.6 PS-10—Fuel Truck Maintenance Shop

The PS-10 site is located on the west side of the base, south of the fuel truck maintenance shop (Building 1060) and north of Parallel Taxiway 1 (Figure 5.6-1). 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 into an unlined drainage ditch located south of Building 1060. 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 9 years of operation, personnel are estimated to have discharged more than 6,000 gallons of Bruling 815 MX degreasing solution. This solution is water-soluble and may have 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.

During the RI, four monitoring wells were installed at the site. Groundwater was sampled on a quarterly basis, beginning in April 1993. TCE and cis-1,2-DCE were detected in two monitoring wells, at maximum concentrations of 410 µg/L and 830 µg/L, respectively. The predominant groundwater flow direction at PS-10 is to the northeast.

5.6.1 Basis for Taking Action

RI results indicated that TCE was present in soil and groundwater. TCE and its known degradation product (cis-1,2-DCE) were detected in groundwater samples at concentrations greater than MCLs and MTCA Method B cleanup levels. In addition, petroleum was detected above state cleanup levels in the soil. The COCs for PS-10 are TPH-D in soil and TCE in both soil and groundwater.

5.6.2 Remedial Action

5.6.2.1 Remedy Selection

The goal of remedial action at site PS-10 is to remediate soil to state cleanup levels that are protective of groundwater. TCE contamination observed in groundwater at PS-10 was deferred to the Priority Three Operable Unit, namely site SS-39. To satisfy remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintain institutional controls to restrict site access and require a Work Clearance Permit for intrusive activities until cleanup levels are achieved
- Excavate and dispose offsite 67 yd^3 of TCE-contaminated soil. The 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 cleanup level of 200 mg/kg

5.6.2.2 Remedy Implementation and Remedial Action Operations

The following sections describe components of the selected remedy as implemented.

Institutional Controls

LUCs for this site are intended to prevent exposure to contaminated soil and groundwater. These LUCs are administered by the USAF as described in Section 2.2.1.1. Specific LUC objectives include:

- Prevent drilling of new wells except for monitoring wells as authorized by EPA and Ecology
- Prevent use of contaminated groundwater for drinking water purposes at the site
- Prevent unauthorized soil excavations at the site
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land

Soil Removal and Treatment and Monitoring Program

In late 1996, approximately 140 yd^3 (190 tons) of TCE-contaminated soil were excavated from PS-10. This soil was shipped to Utah for treatment using high-temperature incineration and subsequent disposal.

Soil sampling was initiated in 1996. Results from 1996 and 1997 indicated that TPH-D concentrations remained above the 200 mg/kg state cleanup level. Soil samples were collected in March 1998 and analyzed for extractable petroleum hydrocarbons, volatile petroleum hydrocarbons, and PAHs to provide data to apply Ecology's Interim TPH Policy for calculation of a site-specific cleanup level at PS-10. Results of the March 1998 event and application of the subsequent Interim TPH Policy calculations indicated that both the hazard quotient and the risk to groundwater were acceptable. Following review by Ecology, PS-10 was considered to have met the Interim TPH cleanup levels and, as a result, further monitoring was discontinued.

5.6.3 Progress Since Last Review

No action has been necessary. The remedy as implemented was determined to be complete. The removal action for TCE-contaminated soil was effective, and as a result of applying Ecology's Interim TPH Policy, PS-10 has met cleanup levels for TPH, and no further long-term monitoring is required.

5.6.4 Technical Assessment

The remedy as implemented has been determined to be complete. No new exposure pathways have been identified, nor any changes in land use on or near the site, or physical site conditions that would call into question the validity of the remedy. Groundwater contamination issues have been deferred to the Priority Three sites ROD, namely site SS-39. No additional information has emerged that calls into question remedy protectiveness.

5.6.5 Issues

No issues have been identified for site PS-10 for this review.

5.6.6 Recommendations

No recommendations have been identified for site PS-10 for this review; the remedy has been determined to be complete.

5.6.7 Statement of Protectiveness

The remedy at PS-10 is expected to remain protective of human health and the environment. Potential exposure pathways from soil that could result in unacceptable risks have been controlled. Potential exposure pathways from contaminated groundwater that could result in unacceptable risks have been deferred to the Priority Three sites ROD, IRP site SS-39.

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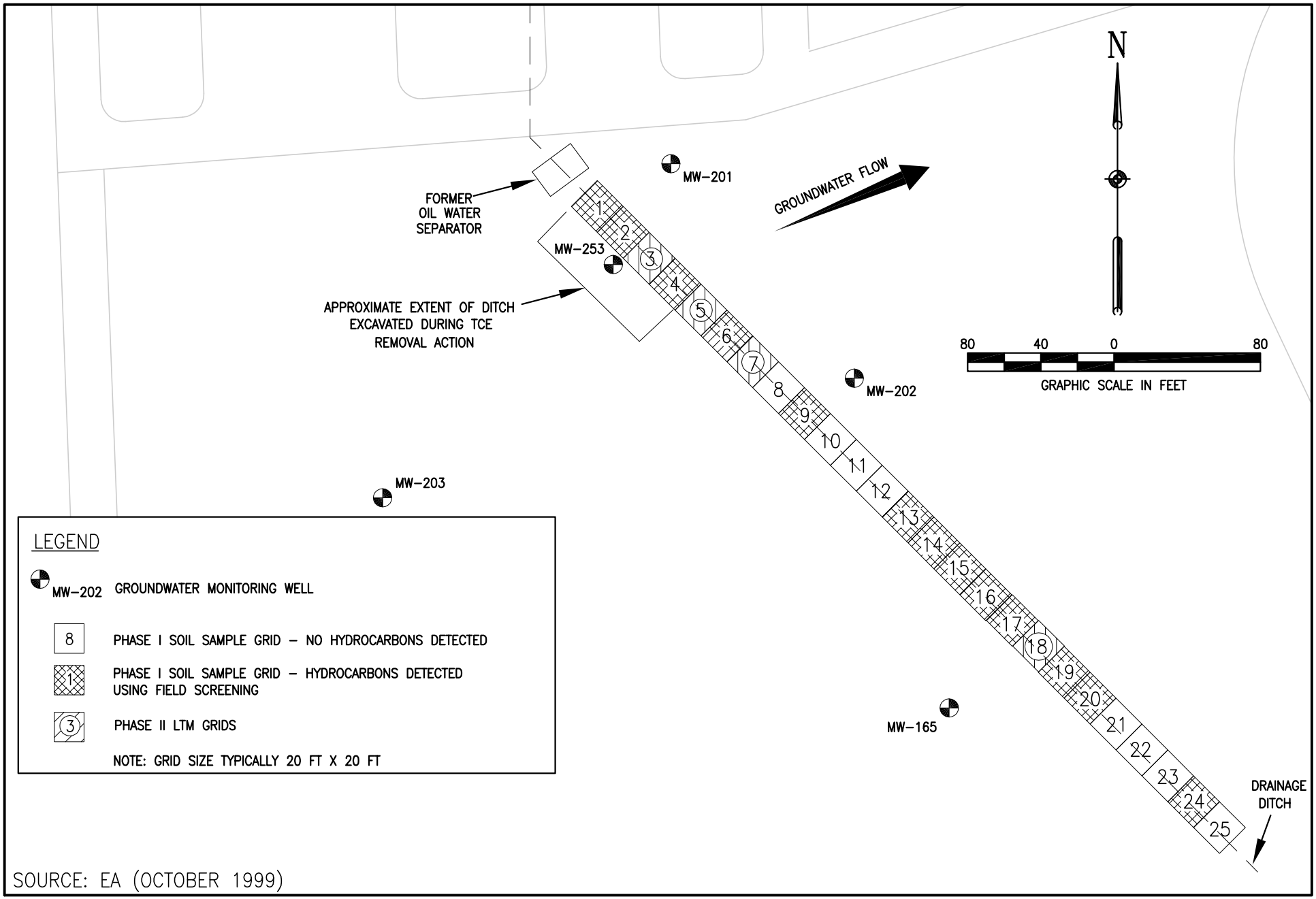


SOURCE: EA (OCTOBER 1999)

FIGURE 5.6-1: PS-10 SITE MAP

5.7 FT-2—Old Fire Training Area

Site FT-2 is an old fire training area used in the 1950s and 1960s that is located on the east side of the base, south of Taxiway No. 10 (Figure 5.7-1). The FT-2 site 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. FT-2 is located northwest of SW-7, within an area of about 0.3 acre.

Field investigations at FT-2 identified stained and discolored soil, petroleum odors, and areas of suppressed vegetation. Soils were found to contain BTEX and numerous refined fuel residues including long-chain hydrocarbons, TCE, 1,1-DCE, cis-1,2-DCE, heavy metals, and pentachlorophenol (PCP). Maximum concentrations of these compounds were located in the suppressed vegetation area in the center of the site. Impacted soils in this area generally have been classified as silty sands.

Contaminants detected in groundwater included petroleum products, chlorinated solvents, and manganese. Groundwater underlying the site is currently not used as a drinking water source. The dominant groundwater flow direction is to the east.

5.7.1 Basis for Taking Action

Based on field investigations completed during the LFI and RI, soils at FT-2 were found to be contaminated with TPH, BTEX compounds, TCE, and metals (cobalt, copper, and lead). Groundwater was primarily contaminated with fuel residues, chlorinated compounds, and manganese. A risk assessment concluded that there were no unacceptable risks or hazards associated with TPH in site soil and groundwater. However, TPH in both soil and groundwater exceeded state cleanup levels. Site COCs established by the ROD are TPH-D and TPH-g for soil and TPH-D in groundwater.

5.7.2 Remedial Actions

5.7.2.1 Remedy Selection

The goals of remedial action at FT-2 are to remediate groundwater and soil to achieve state cleanup levels. To satisfy remedial action objectives identified by the ROD, the selected remedy included the following elements:

- Maintaining institutional controls to restrict site access and require a Work Clearance Permit for intrusive activities until cleanup levels are achieved
- Monitoring site soil and groundwater and downgradient groundwater to assess natural degradation and migration of TPH-D contamination until state cleanup levels of soil (200 mg/kg) and groundwater (1,000 µg/L) are achieved

5.7.2.2 Remedy Implementation and Remedial Action Operations

Remedial action operations were initiated in 1996. The following sections describe components of the selected remedy as implemented. Additional data showing historical contaminant concentrations are included in Appendix C.

Institutional Controls

LUCs for this site are intended to prevent exposure to contaminated soil and groundwater. These LUCs are administered by the USAF as described in Section 2.2.1.1. Specific LUC objectives include:

- Prevent drilling of new wells except for monitoring wells as authorized by EPA and Ecology
- Prevent use of contaminated groundwater for drinking water purposes at the site
- Prevent unauthorized soil excavations at the site
- Ensure that in the event of a transfer of the property to another entity, these restrictions will run with the land

Soil RA-O Monitoring Program

Long-term soil monitoring was initiated in 1996. Soil samples were collected semiannually from 1996 through 1998, annually in 1999 and 2000, and again semiannually from 2001 through 2004. In 2000, the soil sampling program included three-point composite samples collected from five representative grids at a depth of 0 to 2 feet. In 2001, the soil RA-O program was expanded from 5 to 15 samples, with borings advanced to 8 feet. For the period of 2000 through 2004, concentrations of TPH-D exceeded cleanup levels for approximately 20 to 60 percent of all soil samples collected during each sampling event. The highest TPH-D concentration detected during this review period was 4,000 mg/kg, in April 2003.

With the intent of potentially reducing the time to achieve state cleanup levels for site soils, a soil excavation and landfarming program was initiated in late 2002. Approximately 220 yd^3 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 cleanup levels by September 2004 and was returned to the original excavation. An additional 320 yd^3 of contaminated soil were excavated from other hotspots at the site and again landfarmed onsite in September 2004. These soils have been managed similarly to the initial soils but have not yet met cleanup criteria (as of September 2005) and remain within the landfarm.

The intention of the excavation and landfarming efforts was only to remove the most impacted site soils and treat them through landfarming, but not to remove all contaminated site soil.

Groundwater Monitoring RA-O Program

Groundwater monitoring was initiated in 1996 for one well. Following 2 years of successive nondetects 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. These wells were sampled once in 2001, and then were sampled semiannually through 2004. None of these samples exceeded MTCA Method A cleanup levels for TPH-D (1,000 µg/L). Samples from MW-283 and MW-285, both located downgradient from the site, have shown detects of TPH-D for each sampling round, generally decreasing with time and ranging from about 200 to 430 µg/L.

5.7.3 Progress Since Last Review

Remedial action operations have continued throughout the entire review period.

5.7.3.1 First Five-Year Review Recommendations

The first Five-Year Review stated that all components of the selected remedy had been implemented and determined that it was protective of human health and the environment. However, the report concluded that the remedy was only partially effective because data indicating the progress of natural attenuation processes for soil were inconclusive. The report recommended that the feasibility of alternative approaches to deal with the soil contamination at FT-2 needed to be evaluated. These approaches included:

- **Maintaining the current program**, but modifying the sampling frequency to annual because higher molecular weight hydrocarbons (that is, TPH-D compounds) degrade very slowly in soils in the absence of amendments and it may take many years to achieve state cleanup levels
- **Actively managing contamination** through enhanced bioremediation techniques

5.7.3.2 Soil Remediation Progress

The alternative selected for optimization during this review period was similar to site IS-4, a blend of conducting removal actions while actively managing contamination through excavation and enhanced bioremediation via onsite landfarming. Impacted soils were excavated from known hotspots in October 2002 and September 2004. The 2002 impacted soils were successfully remediated by 2004, and were returned to the original excavation. A larger quantity of soil was removed in 2004, but it currently remains in the landfarm and is still being remediated.

Prior to the 2002 excavation effort, long-term soil monitoring results exhibited little overall progress towards achieving cleanup through natural attenuation processes. More than 20 percent of the soil samples collected from 2000 through 2002 had TPH-D and/or TPH-Jet-A concentrations that exceeded state cleanup levels. Groundwater sampling results for 2001 through 2004 have shown no exceedences of TPH-D cleanup levels, but have shown consistent TPH-D concentrations in MW-283 and MW-285 ranging from about 200 to 430 µg/L.

Subsurface soils at the site comprise silty sands. These observations, in tandem with groundwater sampling results and overall soil sampling results, suggest that the higher-molecular-weight hydrocarbons associated with the TPH-D contamination appear to be "locked-up" within the soil structure, and are neither mobilizing to groundwater nor attenuating significantly within the vadose zone.

5.7.4 Technical Assessment

5.7.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

A review of available RA-O data and site inspection activities indicates that the remedy is functioning as intended by the ROD; however, the effectiveness of this remedy is inconclusive at this time.

The goals of remedial action at FT-2 are to remediate groundwater and soil to achieve state cleanup levels. As required, institutional controls and LUCs are in place to restrict site access. RA-O programs are ongoing and are monitoring the progress of allowing natural attenuation processes to reduce TPH-D contamination in soil. Recommendations identified

by the first Five-Year Review to enhance natural attenuation have since been implemented. Approximately 220 yd^3 of contaminated soil were excavated and landfarmed in 2002. These soils achieved state cleanup levels by 2004 and were returned to the original excavation. An additional 320 yd^3 of contaminated soil were excavated from various hotspots at the site and again landfarmed onsite in September 2004. These soils were managed similarly to the initial soils, but they have not yet met cleanup criteria (as of September 2005) and remain within the landfarm. These optimization efforts have resulted, or will result, in the removal and remediation of much of the site contaminated soil. Soil samples collected in October 2004 provide concentration data and indicate locations of remaining contaminated soil. The limited amount of contaminated soil remaining may provide opportunities to facilitate an expedited cleanup and an NFA designation. Despite significant efforts that have been made to enhance natural attenuation, the overall success of these efforts cannot be determined at this time.

Groundwater sampling results have shown zero detects of TPH-D exceeding cleanup levels from 2001 through 2004.

Overall site O&M costs were evaluated for this review. The average annual O&M cost for site FT-2 during this review period was approximately $70,000. This amount included direct costs for FT-2 soil and groundwater monitoring programs, landfarming activities since 2002, plus a portion of shared costs for the other IRP sites managed by the contractor for activities including project management, RAB support, project planning documents, data validation, and reporting.

The ROD identified an estimated net present value of $257,000 to complete the remedy as identified (institutional controls and monitoring). Average annual O&M costs have roughly been about 30 percent of this "total remedy" estimated cost.

5.7.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The ROD cleanup levels for TPH-D in soil and groundwater were based on MTCA Method A cleanup levels. The Method A levels at the time of the ROD were 200 mg/kg for soil and 1,000 µg/L for groundwater. MTCA regulations were updated in 2001, and subsequent Method A values were modified. The current Method A cleanup levels for TPH-D in soil and groundwater are 2,000 mg/kg and 500 µg/L, respectively.

Additionally, no new exposure pathways have been identified, there are no significant changes in land use on or near the site, and there are no physical site conditions that would call into question the validity of the remedy selection.

5.7.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No new information has emerged that would call into question the protectiveness of the remedy. The review of documents and results of the site inspection indicate that the effectiveness of the selected remedy (institutional controls with MNA) was inconclusive during this review period.

5.7.4.4 Summary of Technical Assessment

Prior to the 2002, long-term soil monitoring results exhibited little overall progress towards achieving cleanup through natural attenuation processes. The 2002 excavation and subsequent landfarming efforts have successfully remediated approximately 220 yd^3 of soil contaminated with TPH-D. An additional 320 yd^3 of contaminated soil were excavated in 2004 and currently are being landfarmed. These two efforts have removed the majority of observed soil contamination at the site and are in-process of remediating the soil.

Groundwater sampling results for 2001 through 2004 have shown no detects of TPH-D at concentrations exceeding the ROD cleanup level or the revised MTCA Method A cleanup level.

Subsurface soils at the site are comprised of silty sands. These observations, in tandem with groundwater sampling results and overall soil sampling results, suggest that the higher-molecular-weight hydrocarbons associated with the TPH-D contamination appear to be "locked up" within the soil structure, and are neither mobilizing to groundwater nor attenuating significantly within the vadose zone.

5.7.5 Issues

Table 5.7-1 identifies two issues related to components of the selected remedy for site FT-2.

TABLE 5.7-1
Site FT-2 Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Data are inconclusive as to whether natural attenuation processes are reducing overall TPH contamination in site soils	N	N
Overall site annual O&M costs are high, especially when compared to the total estimated net present value identified in the ROD for achieving remedial goals	N	N

5.7.6 Recommendations

All components of the selected remedy have been implemented. Table 5.7-2 highlights recommendations that address identified issues or that have the potential to further optimize long-term RA-O. Further discussion of these recommendations is provided below.

TABLE 5.7-2
Site FT-2 Recommendations

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Develop an overall site management strategy	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	Fairchild AFB	Ecology	March 2009	N	N
Reduce RA-O groundwater monitoring	Evaluate and receive regulatory approval to reduce groundwater monitoring to annually	Fairchild AFB	Ecology	June 2007	N	N
Revise RA-O soil monitoring	Reduce soil monitoring because remaining soil contamination likely will not attenuate quickly	Fairchild AFB	Ecology	March 2009	N	N
Landfarming activities	Evaluate the cost-effectiveness of the current program versus offsite disposal if landfarm soils do not meet cleanup levels	Fairchild AFB	Ecology	May 2006	N	N

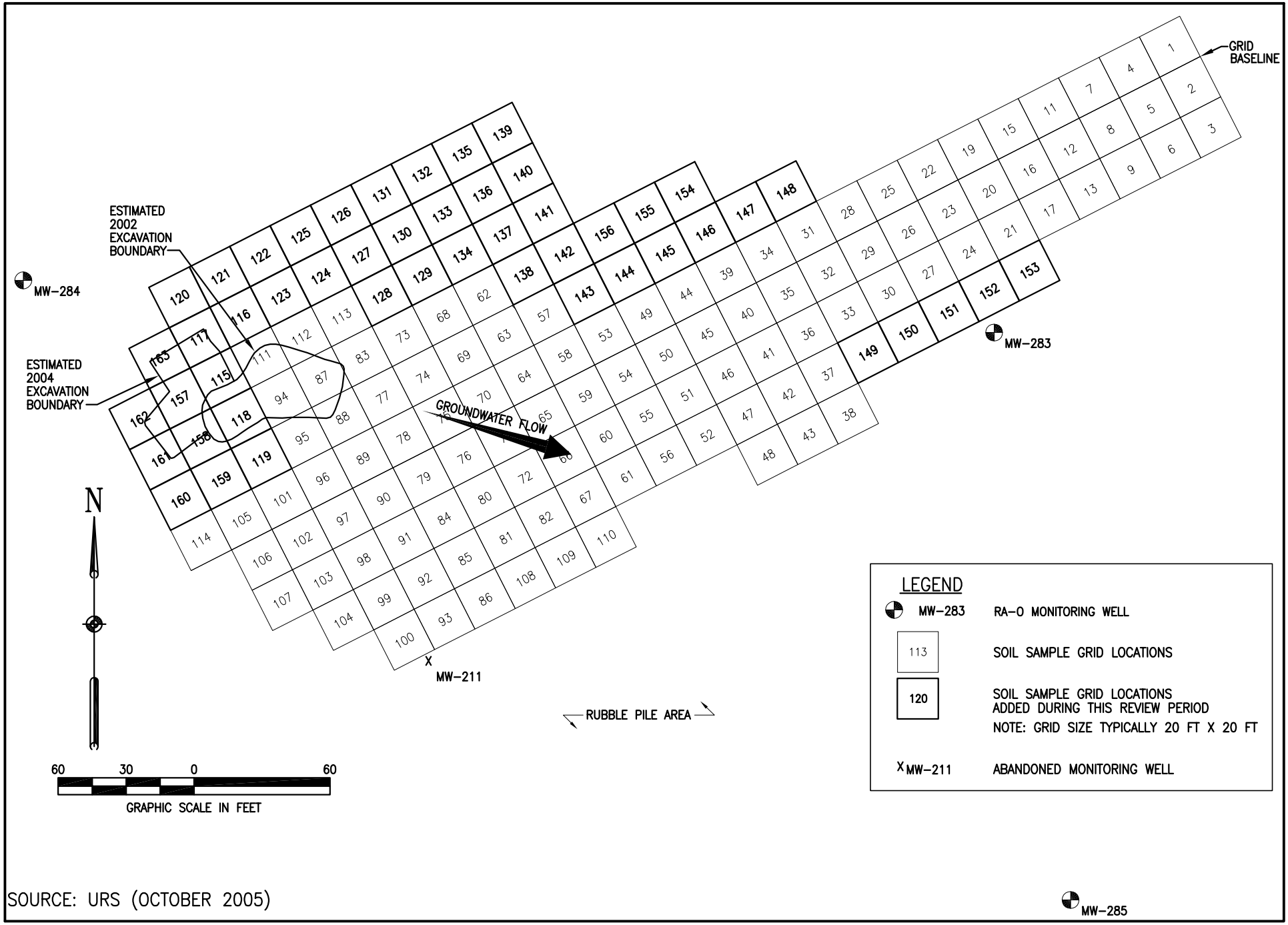
- **Develop an overall site management strategy.** Subsurface soils at the site comprise silty sands. These observations, in tandem with groundwater sampling results (no detects of TPH-D above cleanup levels for 4 years) and overall soil sampling results, suggest that the higher-molecular-weight hydrocarbons associated with the TPH-D contamination in soil appear to be "locked up" within the soil structure (whether in-place or within the landfarm at this time), and are neither mobilizing sufficiently to groundwater that has impacted groundwater quality nor attenuating significantly within the vadose zone. The ROD concluded that remedial action for soils was required, not based on risk but based on the potential for site soils to serve as a source of groundwater contamination. RA-O data indicate that site soils are not serving as a source of groundwater contamination. Working with Ecology is recommended to revise the RA-O program to a level acceptable to the base and regulators that progresses towards site closure. Reevaluation of the site needs to be completed, and could possibly involve applying current MTCA guidance (Chapter 173-340 WAC, as amended in 2001). The ROD TPH cleanup level for soil and groundwater were based on the MTCA Method A values of 200 mg/kg and 1,000 µg/L, respectively. The amended MTCA Method A cleanup levels are now 2,000 mg/kg and 500 µg/L.

  Overall site O&M costs are high when compared to the net present value estimated for the entire remedy, as identified by the ROD. Reevaluation of the overall site management strategy needs to address this.

- **Reduce RA-O groundwater monitoring.** Groundwater monitoring should be reduced to annually, at a minimum. Because no detects of THP-d have been observed in MW-284 since 2001, monitoring at MW-284 should be eliminated. The frequency of groundwater monitoring in MW-283 and MW-285, where some TPH-D detects have been observed, should be reduced to annually.
- **Revise RA-O soil monitoring.** Based on soil sampling results, annual sampling or biennial monitoring is sufficient. Analytical results for 2004 indicate that some contamination remains in site soils located outside excavation boundaries. Because much of any remaining contamination is likely associated with longer-chained hydrocarbons that do not easily degrade, annual (or even biennial) soil sampling is recommended instead of semiannual monitoring to monitor natural attenuation progress.
- **Landfarming operations.** Continue to actively manage the onsite landfarm. Soil removed in September 2004 will require aeration and maintenance of sufficient moisture content to promote optimal bioremediation conditions. A sampling program should be administered to confirm that TPH-D concentrations have been remediated to below the required cleanup level. If landfarmed soils do not achieve cleanup levels by summer 2006, the cost-effectiveness of continuing versus offsite disposal needs to be evaluated.

5.2.7 Statement of Protectiveness

The remedy at site FT-2 is currently protective of human health and the environment, and it is expected to be protective of human health and the environment upon attainment of all remedial action objectives. In the interim, LUCs and institutional controls exist that eliminate current exposure pathways and prevent the potential for completing future exposure pathways.



SOURCE: URS (OCTOBER 2005)

FIGURE 5.7-1: FT-2 SITE MAP

6.0 Priority Three Sites

The current status of the Priority Three sites is summarized in Table 1-1 and described in Section 2.1.4.

7.0 Summary and Next Five-Year Review

7.1 Site Summaries

Twenty-eight IRP sites at Fairchild AFB have been addressed through three RODs. This Five-Year Review is the second review conducted for IRP sites at the base. The selected remedies have been implemented for a period of time ranging from 8 to 11 years and are in various stages of progress. The effectiveness of the selected remedies has been evaluated based on the requirements of the RODs, monitoring results, and/or remedial actions implemented.

Table 7-1 provides a summary for 13 of the sites where some type of remedial action has been required. For each of the 13 sites, Table 7-1 summarizes the contaminated media and COCs, identifies components of the selected remedy as implemented per the respective ROD, provides recommendations to improve remediation progress, and presents an implementation schedule for the recommendations. The 15 Priority One and Two sites that have received an NFA determination based on unlimited use of the sites without limitations or restrictions of future land have not been addressed.

7.2 Potential Contaminants of Concern

The EPA is concerned with heretofore unidentified potential contamination due to emerging compounds of interest, in particular 1,4-dioxane, perchlorate, and N-Nitrosodimethylamine (NDMA). The EPA requested that the Air Force sample for these compounds at sites where historical practices point to the potential for groundwater contamination.

A reasonable potential exists for 1,4-dioxane contamination to be present at sites where chlorinated solvent contamination has been found. The Air Force identified three such IRP sites where TCE has been noted in the Record of Decision as a contaminant of concern; sites LF-01, LF-02, and WP-03. The Air Force conducted additional groundwater sampling specifically for 1,4-dioxane at each of these three sites. In each instance, the analytical results for this requested groundwater sampling for 1,4-dioxane was non-detect. The Air Force considers its response to the EPA's request regarding 1,4-dioxane to be complete.

Research into historic Air Force / DoD activities at Fairchild AFB does not point to a reasonable potential for groundwater contamination resulting from perchlorate or NDMA release. In military applications, perchlorate was used as an oxidizer in solid rocket fuels and propellant. NDMA, on the other hand, is associated with liquid hypergolic fuels, including unsymmetrical dimethyl hydrazine (UDMH). NDMA results from the rapid breakdown of UDMH in the environment. One of the former manufacturing processes used to make UDMH also allowed the formation of NDMA. This process is no longer utilized. The Air Force did not locate any sites where perchlorate or NDMA may have been released into the environment, for which groundwater sampling would be warranted. Specifically, munitions specialists stationed on base and who worked on those munitions with solid

rocket motors indicated that the motors were delivered "capped and totally sealed" and that no maintenance work on the motors were performed on base. Air Force munitions experts also indicated that munitions historically used at Fairchild AFB (e,.g., AGM-28) used liquid petroleum fuels, which would not contain UDMH or NDMA. Therefore, the Air Force has not performed groundwater sampling for perchlorate or NDMA. The Air Force continues to provide open access to Fairchild AFB should the EPA choose to perform groundwater testing for these chemicals.

The following paragraphs summarize information regarding four specific buildings identified in the review of historic Air Force/DoD activities.

1) Building 2096 (currently housing the Explosive Ordnance flight) was identified in a January 1969 drawing as the "Missile Run-Up Shop". The drawing identified features that included a checkout bay, a french drain, and existing pads and a blast deflector. In this instance, the term "Missile Run-Up" entailed the testing and inspection of missile guidance section components only. This has nothing to do with the motor, which is usually only capable for a one-time ignition. If building 2096 was used for this purpose, then the french drain would have been used for run-off of the water used while cleaning the missiles during periodic maintenance intervals. Generally, blast deflectors may have been installed to shield maintenance personnel from blasts associated with accidental rocket motor initiation or accidental warhead detonation. However, the Air Force does not believe that a warhead and/or propellant section of a missile could have been present during maintenance at building 2096 based primarily on the presence of a blast deflector. First, a blast deflector would have been installed as a prescribed safety measure for these types of military buildings in the unlikely event that a missile, due to faulty manufacture, accidentally exploded. However, there are no historical documents indicating that any missile explosion occurred at building 2096, Secondly, military personnel who have worked at Fairchild AFB stated that "There certainly would never be any use for a blast deflector for running missiles since they were never ignited for test on the ground." adding that the only run-up activities were performed on electronic and hydraulic systems, and not on the rocket motor. Finally, building 2096 is located just north of the flightline, and not within the high security areas where warheads used to be routinely handled, e.g. the Weapons Storage Area (WSA) and Conventional Weapons Storage (CWS). For security reasons, it is very unlikely that maintenance on a missile mated to a warhead would have been performed at building 2096.

2) Building 1419 was identified in a November 1992 drawing as the "Alter Missile Shop". The drawing identified features that include a missile loading/unloading & payload exchange area, a missile control area, and a missile testing & checkout area. This facility may have been built to support a 1970's weapon system such as the AGM-69A, a short range attack missile (SRAM). However, the SRAM missile was a fully contained unit and the rocket motor was totally sealed. Maintenance of sealed rocket motors would have been performed at a separate maintenance depot, but not on base.

3) A June 1960 drawing identified building 446 as the "Combination Engineer and Signal Maintenance Shop" and the drawing details an Ordnance Addition that was made to the building. The features identified in the drawing include an ordnance shop area and a special weapons area. Real property documentation dated 1966 briefly describes a property transfer between the Air Force and the Army Air Defense Command of a 5.77 acre parcel. The buildings on the parcel are identified as "Comb. Engineering and Signal Maintenance

Shop" and a "Nike Guided Missile Field Maintenance Shop". The first building clearly is building 446 and the second one is unidentified and its existence has not been verified. The Army may have housed/stored unfueled and unarmed Nike missiles at building 446, but no information is available to confirm the performance of any specific maintenance activities. A 1984 Army report titled Historical Overview of the Nike Missile System provides the following insight; "Nike missiles and warheads were assembled, serviced, and fired at the actual launch area. The launch area was subdivided into specific locations which were suitably equipped for specific operations. Missiles arrived at the launch site partially disassembled, unarmed, and in the case of liquid-fueled stages, defueled. All the operations necessary to make the missile flight-ready were conducted in the launch area." Building 446, located at Fairchild AFB, was not part of any Nike launch areas. The closest Nike launch area is located approximately three miles away from Fairchild AFB. Thus, while the Army may have stored missile bodies (i.e. without the warhead and fuel) at building 446, the building would not have stored solid or liquid rocket fuels from the Nile Ajax or Atlas missiles. Doing so would have presented significant safety and transportation issues not likely to have been addressed at the base. For example, if building 446 had stored the highly toxic liquid rocket propellants, (the 17% UDMH in JP-4 mixture), this would have required the fueled missile to then be trucked out to the remote Nike launch areas, during which the potential for an accident would be great. Additionally, these missile systems were meant to be as light as possible for flight and flight loads. They were not at all designed for transport across roadways while fully fueled and armed.

4) Two engineering drawings dated November 1959 and December 1960 refer to building 2447 and utilize drawing criteria furnished by the Air Force Ballistic Missile Division. The building is identified as "G/M Assembly Building and Warehouse" and the drawings detail the architectural floor plan and the mechanical equipment layout and piping system for a cleaning area. The drawings identified features that include a missile assembly area (including outlines of Atlas missiles), an engine maintenance area, an engine flush/purge area, and a liquid oxygen (LOX) test area. It is likely that the Air Force housed/stored Atlas missiles at building 2447.

Lastly, the EPA requested a response to the following three questions - the Air Force response follows the question.

Question 1; Were static fire test burns ever done at Fairchild? There is no evidence of any static fire test burns ever done at Fairchild AFB. A static fire test is performed to measure the amount of thrust of a rocket motor. The process involves tying the motor down on a large pad and igniting it. Because such tests produce thousands of pounds of thrust, static fire tests were typically performed only at remote facilities covering several thousand acres of open land, equipped with significant infrastructure such as large concrete pads weighing hundreds of tons to withstand that much thrust. This large infrastructure (i.e, the concrete pads) would likely still be identifiable today. Fairchild AFB does not have the sufficient area or infrastructure to support static fire test burns.

Question 2: Was there any disposal of solid rocket motors by open burn/open detonation at Fairchild? There is no evidence of any disposal of solid rocket motors by open burn/open detonation at Fairchild AFB. This base lacks sufficient room for solid rocket motor disposal by open burn/open detonation. This activity was performed at remote facilities and typically components of the solid rocket motor were recovered and reused.

Question 3: Was there any storage of solid or liquid rocket fuels from the Nike Ajax or Atlas missiles at Fairchild? There is no evidence of any storage of solid or liquid rocket fuels from the Nike Ajax or Atlas missiles outside the rocket motors themselves at Fairchild AFB. Solid rocket motors are poured into a casing at the factory. Due to the volatility of the liquid rocket fuels, they were stored in proximity of the launch and typically not at an Air Force base.

The Air Force will continue to research historical activities in order to identify any credible information that could point to a reasonable potential for groundwater contamination resulting from perchlorate or NDMA release.

7.3 Next Five-Year Review

Future Five-Year Reviews will be necessary because contamination remains above levels that allow for unrestricted use and/or unlimited exposure at some IRP sites located at Fairchild AFB. The next Five-Year Review is currently scheduled to be completed by December 2010.

TABLE 7- 1
Fairchild AFB Second Five-Year Review Site Summary
May 2008

ROD	Site Name (Base Code)	Site COCs	Components of the Selected Remedy as Implemented	Abbreviated Summary of Progress Since Last Review	Summary of Issues, Recommendations, and Implementation Schedule [e]
Applicable to all RODs currently in place	Basewide	See individual site entries below	Institutional Controls (ICs) as described below for each site	ICs are being implemented by the base, but do not meet EPA Region 10 guidance for the implementation of institutional controls at federal facilities.	The base's LUC plan needs to be finalized and accepted by EPA; as such, additional measures may need to be formalized into each of the base's RODs, (June 2007)
Craig Road Landfill[a]	Craig Road Landfill (SW-8)	TCE in soil and groundwater	Remedy components were implemented by 1995. They included: – Capping the SDA and NDA landfill units – Treating groundwater via pump-and-treat using air stripping and GAC – Groundwater monitoring of offsite water supply wells and in upper and lower aquifers – ICs to restrict site access and onsite usage of contaminated groundwater	The combination of landfill caps and groundwater extraction is maintaining hydraulic control of the onsite portion of the TCE plume. TCE concentrations in site and offsite groundwater are declining; the offsite portion of the TCE plume directly attributable to the site has almost entirely met the MCL. ICs remain in place.	– Evaluate the timeframe to achieve cleanup levels using statistical means for select wells located in the upper aquifer (ongoing) – Further evaluate long-term RA-O costs—consider batch treatment operations (ongoing) – Continue extraction well pump/motor optimization (ongoing) – Reduce number of wells monitored and reduce sampling frequencies (ongoing) – Ongoing to evaluate increasing TCE concentrations at MW-118 (ongoing)
On-base Priority One Sites[b]	Old Base Landfill (SW-1)	TCE in groundwater	Remedy components were implemented in 1994. They included: – Maintaining ICs to restrict site access and onsite usage of contaminated groundwater – Groundwater monitoring to identify contaminant trends and provide data to evaluate progress of natural attenuation to achieve attainment of cleanup levels – Groundwater monitoring of onsite wells and offsite water supply wells near the site	ICs remain in place. Some natural attenuation of TCE in groundwater has been observed, but the overall rate of attenuation for MW-90 and MW-131 has not been sufficient to estimate when cleanup levels will be achieved.	– Evaluate existing data using statistical means to identify potential timeframes for achieving cleanup levels (ongoing) – Develop an overall site management strategy with Ecology considering current site conditions, general lack of receptors, and ICs in place (March 2009) – Reduce sampling frequency in two wells to annual; discontinue long-term monitoring in one well (ongoing)
	Refueling Pit Area (PS-2)	Benzene and TPH-D in groundwater	Remedy components were implemented in 1994. They included: – Maintaining ICs to restrict site access and onsite usage of contaminated groundwater – Groundwater monitoring to identify contaminant trends and provide data to evaluate progress of natural attenuation to achieve attainment of cleanup levels – Free product recovery through passive collection	ICs remain in place. Benzene and TPH-D in groundwater show statistically significant declining trends; some site wells have met cleanup levels. Approximately 80 gallons of fuel have been recovered from the site since 1994. Data indicate there is little remaining free product in wells designated for such.	– Further evaluate existing data to identify potential timeframes for achieving cleanup levels in site wells (ongoing) – Determine if groundwater contamination has migrated beyond the site's most downgradient well (June 2009) – Develop an overall site management strategy with Ecology considering current site conditions, general lack of receptors, and ICs in place (March 2009) – Vary the frequency of free product recovery to better match site conditions (ongoing) – Revise groundwater monitoring program to discontinue sampling at two wells; add former free product recovery wells to the annual monitoring network (ongoing)
	Underground Fuel Line Area (PS-8)	Benzene in groundwater	Remedy components were implemented in 1994. They included: – Maintaining ICs to restrict site access and on-base usage of contaminated groundwater – Groundwater monitoring to identify contaminant trends and provide data to evaluate progress of natural attenuation to achieve	ICs remain in place. Benzene concentrations for site wells were all below the cleanup level in 2004. However, these concentrations have historically been highly variable, so an estimated timeframe to achieve cleanup levels for some wells cannot be determined at present.	– Further evaluate existing data to identify potential timeframes for achieving cleanup levels in site wells (ongoing) – Develop an overall site management strategy with Ecology considering current site conditions, general lack of receptors, and ICs in place (March 2009) – Revise groundwater monitoring program to discontinue sampling at two wells; decrease sampling frequency at one well to annual (ongoing)

ROD	Site Name (Base Code)	Site COCs	Components of the Selected Remedy as Implemented	Abbreviated Summary of Progress Since Last Review	Summary of Issues, Recommendations, and Implementation Schedule [e]
On-base Priority One Sites[b]	Former Fire Training Area (FT-1)	BTEX in soil and benzene in groundwater	Remedy components were implemented in 1996. They included: – Maintaining ICs to restrict site access and on-base usage of contaminated groundwater – Groundwater monitoring to identify contaminant trends and provide data to evaluate progress of natural attenuation – Construction of an in situ bioventing system for benzene-contaminated soil – Construction of an air sparging system for remediating benzene-contaminated groundwater – Monitoring offsite water supply wells	ICs remain in place. Through bioventing, air sparging, natural attenuation processes, and two dig-and-hauls completed in 2000 and 2005, benzene has essentially been eliminated at the site. Benzene has not been above groundwater cleanup levels in any site well since June 1999. Less than 5 percent of all soil samples collected since 1999 have exceeded benzene cleanup levels for soil. A source removal action in 2005 removed 1,630 tons of contaminated soil from the site. Some residual TPH contamination remains in site soils exceeding MTCA Method A cleanup levels, but this contamination in believed to be associated with longer-chained hydrocarbon compounds that bioventing will likely not treat effectively.	– Develop an overall site exit strategy with Ecology considering current site conditions and ICs in place (March 2009) – Place bioventing system in standby—soils have largely been remediated for benzene (December 2006) – Discontinue operation of air sparging system (December 2006) – Reduce groundwater monitoring significantly—perform only annual monitoring for Method 8260 at six wells (Annually) – Add annual groundwater monitoring for TPH analyses for five wells to evaluate if any remaining soil contamination is migrating to groundwater (June 2007 and annually) – Revise soil sampling frequency to biennial; focus sampling locations in near the east bioventing system area (March 2009) – Evaluate need for additional dig-and-hauls for hot spots (June 2008)
	Industrial Wastewater Lagoons (WW-1)	TCE in groundwater	Remedy components were implemented from 1994 through 1996, except for source investigations activities, which were completed in 2000. Remedy components included: – Maintaining ICs to restrict site access and on-base usage of contaminated groundwater – Groundwater monitoring in site wells and offsite water supply wells – Conducting additional source investigation activities to identify the source of TCE contamination in groundwater – Design and construction of a groundwater extraction and treatment system using air stripping and carbon adsorption	ICs remain in place. Considerable progress has been made toward restoring groundwater to drinking water levels. Source investigation activities were completed in 2000—36 buried drums containing nearly 800 gallons of hazardous wastes were recovered from the subsurface upgradient of MW-102. In 2001, a soybean oil trench was constructed downgradient of this location to enhance reductive dechlorination of any remaining TCE. TCE concentrations in site wells have declined significantly since these actions. TCE concentrations in off-base wells have not exceeded the MCL since March 2002. TCE concentrations in on-base wells have exceeded the MCL only twice from 2000 through 2004. As a result, the groundwater extraction and treatment system was placed in standby in December 2004. Triggering mechanisms remain in place to operate the system if necessary. Through the processes of natural attenuation of TCE and anaerobic conditions, vinyl chloride and arsenic have emerged as potential site COCs; their concentrations have exceeded state and federal cleanup levels and/or MCLs.	– Develop an overall site exit strategy with Ecology considering current site conditions and ICs in place (March 2009) – Continue with current program to determine if extraction and treatment system operation is necessary (ongoing) – Evaluate site conditions and determine if additional substrate addition would be beneficial to enhancing further reductive dechlorination. (December 2005) – Continue to monitor and evaluate concentrations of TCE degradation products in off-base monitoring wells (ongoing)
Priority Two Sites[c]	Reciprocating Engine Test Cell (IS-3)	PCBs in sediment	ICs restricting site access until Building 2150 was demolished	Building 2150 was demolished in 1996. Additional soil investigation of a sump area revealed no remaining contamination. Remedy is complete.	Remedy is complete.
	Jet Engine Test Cell (IS-4)	TPH-D in soil (observed contamination in site groundwater was deferred to the Priority Three sites ROD)	Remedy components were implemented in 1996. They included: – Maintaining ICs to restrict site access, and requiring a work clearance permit for any onsite intrusive activities Soil sampling to monitor natural attenuation of TPH-D until concentrations decreased to below state cleanup levels	ICs remain in place. Prior to 2002, long-term soil monitoring results exhibited little progress towards achieving cleanup levels through natural attenuation. In 2002, 150 yd^3 of known contaminated soil were excavated and landfarmed onsite until cleanup levels were achieved in 2004. In 2004, an additional 1,500 yd^3 of contaminated soil were also excavated and landfarmed— these soils remain in the landfarm at present. Groundwater monitoring results for 2001 through 2004 showed no TPH-D concentrations even above method detection limits. It appears as though any remaining TPH contamination in soil comprises higher-molecular-weight hydrocarbons that are “locked up” within the soil structure, neither mobilizing to groundwater nor attenuating significantly within the vadose zone.	– Develop an overall site management strategy with Ecology considering current site conditions, physical soil conditions, ICs in place, and revised MTCA cleanup levels (March 2009) – Reduce groundwater monitoring to annual for two site wells (June 2007) – Revise soil sampling frequency to annual or biennial—remaining soil contamination likely will not attenuate quickly (March 2009) – Continue current landfarming activities. If landfarmed soils do not meet cleanup levels by summer 2006, the cost-effectiveness of continuing versus offsite disposal needs to be evaluated (May 2006)

TABLE 7- 1
Fairchild AFB Second Five-Year Review Site Summary
May 2008

ROD	Site Name (Base Code)	Site COCs	Components of the Selected Remedy as Implemented	Abbreviated Summary of Progress Since Last Review	Summary of Issues, Recommendations, and Implementation Schedule [e]
Priority Two Sites[c]	POL Bulk Storage Area (PS-1)	TPH-D in soil TPH-D and benzene in groundwater	Remedy components were implemented in 1996 through 1998. They included: – Maintaining ICs to restrict site access and requiring a work clearance permit for any onsite intrusive activities – Groundwater monitoring to identify contaminant trends and provide data to evaluate progress of natural attenuation – Construction of an in-situ bioventing system for soil contaminated with TPH-D located on the periphery of the fuel tank farm	ICs remain in place. Through bioventing and natural attenuation processes, TPH-D concentrations in soils located within the influence of the bioventing system have been significantly reduced. Soil sampling results revealed that concentrations of TPH-D remain in some site soils, but these are mostly located in areas where physical constraints (underground utility piping and concrete containment structures) prevent any access. The bioventing system also was not designed or constructed to treat soils in these same areas. Benzene concentrations in groundwater have not exceeded cleanup levels since 1999. Additionally, TPH-D concentrations in groundwater have been below site cleanup levels since 2003.	– Develop an overall site management strategy with Ecology considering current site conditions and ICs in place (March 2009) – Place bioventing system in standby—soils have largely been remediated where bioventing system is located (December 2006) – Reduce groundwater monitoring. Annual monitoring for TPH-D and benzene should continue for three wells. TCE also should be monitored at one well due to historical detects. Sampling at two wells should be eliminated (ongoing) – Revise soil sampling locations to 15 from 25 and consider biennial—or less frequent—monitoring (March 2009)
	Heating Oil Tank Area (PS-5)	TPH-D in soil and groundwater	Remedy components were implemented in 1996. They included: – Maintaining ICs to restrict site access and requiring a work clearance permit for any onsite intrusive activities – Groundwater monitoring to assess natural attenuation and migration of TPH-D	ICs remained in place through 1998. Groundwater monitoring results for 1996 and 1997 revealed that TPH-D had been reduced to below state cleanup levels. Ecology and EPA concurred in 1998 that further monitoring could be discontinued and that NFA was necessary.	Remedy is complete.
	Fuel Oil Storage Tanks (PS-7)	TPH-D in soil and groundwater	Remedy components were implemented in 1996. They included: – Maintaining ICs to restrict site access and requiring a work clearance permit for any onsite intrusive activities. Address remaining soil contamination beneath Building 1350 when it is demolished. – Groundwater monitoring to assess natural degradation and migration of TPH-D until cleanup levels were met	ICs remained in place through 1998. Groundwater monitoring results for 1996 and 1997 revealed that TPH-D had been reduced to below state cleanup levels. Ecology and EPA concurred in 1998 that further monitoring could be discontinued and that NFA was necessary.	Remedy is complete for soil. ICs need to remain in place until Building 1350 is demolished. Soils beneath Building 1350 should be assessed for petroleum contamination following demolition. Building 1350 currently is not scheduled for demolition in the near future.
	Fuel Truck Maintenance (PS-10)	TCE and TPH-D in soil TCE in groundwater (observed contamination in site groundwater was deferred to the Priority Three sites ROD)	Remedy components were implemented in 1996. They included: – Maintaining ICs to restrict site access and requiring a work clearance permit for any onsite intrusive activities. – Soil monitoring to assess natural attenuation of TPH-D in soil – Excavation and offsite treatment of TCE-contaminated soil	ICs remain in place. Approximately 140 yd^3 of TCE-contaminated soil was removed and treated offsite in 1996. Subsequent soil sampling in 1996 and 1997 indicated that TPH-D concentrations remained above the state cleanup level. Additional soil sampling was performed in 1998; results indicated that no further action was required for site soil based on application of Ecology's Interim TPH Policy.	Remedy is complete.
	Old Fire Training Area (FT-2)	TPH-D in soil and groundwater	Remedy components were implemented in 1996. They included: – Maintaining ICs to restrict site access and requiring a work clearance permit for any onsite intrusive activities – Soil and groundwater monitoring to assess natural attenuation of TPH-D until concentrations decreased to below state cleanup levels	ICs remain in place. Prior to 2002, long-term soil monitoring results exhibited little progress towards achieving cleanup levels through natural attenuation. In 2002, 220 yd^3 of known contaminated soil were excavated and landfarmed onsite until cleanup levels were achieved in 2004. In 2004, an additional 320 yd^3 of contaminated soil were also excavated and landfarmed—these soils remain in the landfarm at present. Groundwater monitoring results for 2001 through 2004 showed no TPH-D concentrations exceeding cleanup levels. It appears as though any remaining TPH contamination in soil comprises higher-molecular-weight hydrocarbons that are "locked up" within the soil structure, neither mobilizing to groundwater nor attenuating significantly within the vadose zone.	– Develop an overall site management strategy with Ecology considering current site conditions, physical soil conditions, ICs in place, and revised MTCA cleanup levels (March 2009) – Reduce groundwater monitoring to annual for two site wells, discontinue monitoring for one well (June 2007) – Revise soil sampling frequency to annual or biennial—remaining soil contamination likely will not attenuate quickly (March 2009) – Continue current landfarming activities. If landfarmed soils do not meet cleanup levels by summer 2006, the cost-effectiveness of continuing versus offsite disposal needs to be evaluated (May 2006)

[a]Record of Decision signed in February 1993
[b]Record of Decision signed in July 1993
[c]Record of Decision signed in December 1995
[d]Groundwater contamination at these sites is not associated with the site and will be included under future site studies for Site SS-39, Orphan TCE Plumes
[e] The USAF will be responsible for implementation of these recommendations, with the Washington State Department of Ecology overseeing implementation by the USAF.
ESD = Explanation of Significant Differences ; ICs = Institutional Controls; NFA = No Further Action

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Appendix A
Additional Information for Craig Road Landfill

Site SW-8, Craig Road Landfill

Historical TCE Concentrations in Selected CRL Monitoring Wells
1995 - 2004

	TCE Concentration (µg/L)																				
Well	**Mar-95**	**Apr-95**	**Sep-95**	**Mar-96**	**Oct-96**	**Mar-97**	**Sep-97**	**Mar-98**	**Sep-98**	**Mar-99**	**Sep-99**	**Mar-00**	**Sep-00**	**Mar-01**	**Sep-01**	**Mar-02**	**Sep-02**	**Mar-03**	**Sep-03**	**Mar-04**	**Sep-04**
EW-2	NS	62	31	NS	43	32	42	34	37	27	18	18.3	13.4	11.3	10	8.3	9.3	8.1	8.1	7.85	7.55
EW-3	NS	11	53	22	45	1.4	33	65	100	12	120	85	119	74.6	67.6	54.2	52.8	47.4	40.1	37.8	46.3
EW-4	NS	93	89	100	57	63	59	100	61	94	90	77.8	97.6	67.8	66.4	64.0	60.4	57.4	52.5	49.1	48
EW-5	NS	66	30	34	29	13	17	18	30	22	15	17.2	15.8	14.3	10.6	8.5	9.4	9.6	9.7	9.57	10.4
EW-6	NS	360	160	150	70	77	48	18	13	25	13	18.6	17.5	5.5	4.2	10.5	10.4	9.6	9.4	13.6	9.03
EW-7	NS	190	180	180	160	140	140	130	130	170	160	128	126	99.8	108	109	102	89	90	84.4	82.3
EW-9	NS	5300	2700	270	99	375	95	52	17	81	15	69.4	29.7	29.5	13.8	96.6	41.4	65.7	43.7	94.4	20.9
EW-10	NS	NS	1800	2500	1700	1600	1800	1000	1100	800	1000	476	940	448	378	417	723	507	613	397	581
EW-11	NS	NS	400	350	330	94	88	72	97	140	99	72.5	77.7	33.3	66.7	73.4	33.0	56.8	42.9	44.5	34.7
EW-12	NS	NS	1.5	11	14	3.4	4.7	13	15	22	12	16.8	12.1	14.2	15.6	14.0	11.2	14.1	10.5	13.8	8.52
EW-13	NS	NS	40	44	3.0	3.5	3.0	2.5	5.0	7.9	3.6	4.2	3.9	3.0	5.9	8.3	11.0	9.7	3.7	5.14	3.34
EW-14	NS	NS	2400	340	250	210	230	200	180	220	130	121	145	81.3	93.7	119	93.1	95	84.9	70.6	72.6
MW-74	ND	NS	2.1	ND	ND	ND	0.2	ND	0.3	ND	ND	ND	2.1	NS	0.31	NS	0.28	NS	0.42	NS	0.30
MW-77	3	NS	2.8	1.0	5.3	6.1	7.8	8.0	12	13	12	10.7	11.5	9.3	8.3	8.7	8.0	9.1	7.1	7.95	6.34
MW-78	4	NS	33	28	2	ND	0.9	0.7	0.8	0.9	0.67	ND	1.1	0.75	0.62	0.51	0.80	0.42	0.46	0.27	0.38
MW-80	9	NS	41	40	29	14	12	6.2	11	5.8	2.9	3.0	2.3	1.6	1.4	1.5	1.3	1.2	0.78	0.68	0.35
MW-82	43	NS	30	24	21	17	19	16	20	16	14	17.4	14.2	11.2	9.1	8.5	6.3	5.8	4.9	4.16	3.12
MW-83	NS	ND	ND	ND	ND	ND	ND	ND	ND	0.8	ND	ND	ND	0.43	0.42	0.47	0.54	0.5	0.59	0.46	0.58
MW-84	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.6	ND	ND	ND	ND	ND	0.18	ND	0.08	NS	ND
MW-85	51	NS	63	26	21	11.5	12	ND	9	8.9	7.8	8.2	8.5	6.9	6.1	6.2	4.8	5.2	4.6	4.79	3.78
MW-96	180	NS	97	120	130	94	67	68	76	68	62	48.8	50.2	42.2	37.8	39.3	32.4	35.8	30.7	30.2	27.2
MW-116	NS	1.3	ND	ND	ND	ND	ND	ND	0.3	0.3	ND	ND	ND	NS	0.45	NS	0.36	NS	0.35	NS	NS
MW-118	440	NS	550	690	740	460	465	340	390	410	310	310	354	300	292	233	96.7	77.9	137	256	337
MW-139	NS	2.0	1.4	1.0	1.0	ND	ND	ND	0.7	0.8	0.52	ND	ND	0.98	0.63	0.76	0.55	0.60	0.62	0.53	0.45
MW-140	NS	53	62	27	31	19	25	18	26	23	23	22.3	24.4	15.0	13.3	14.7	6.2	7.0	6.8	7.35	7.67
MW-141	NS	41	22	37	36	28	29	30	41	35	28	27.7	35.5	25.5	23.2	25.2	21.8	23.7	21.9	23.7	22.1

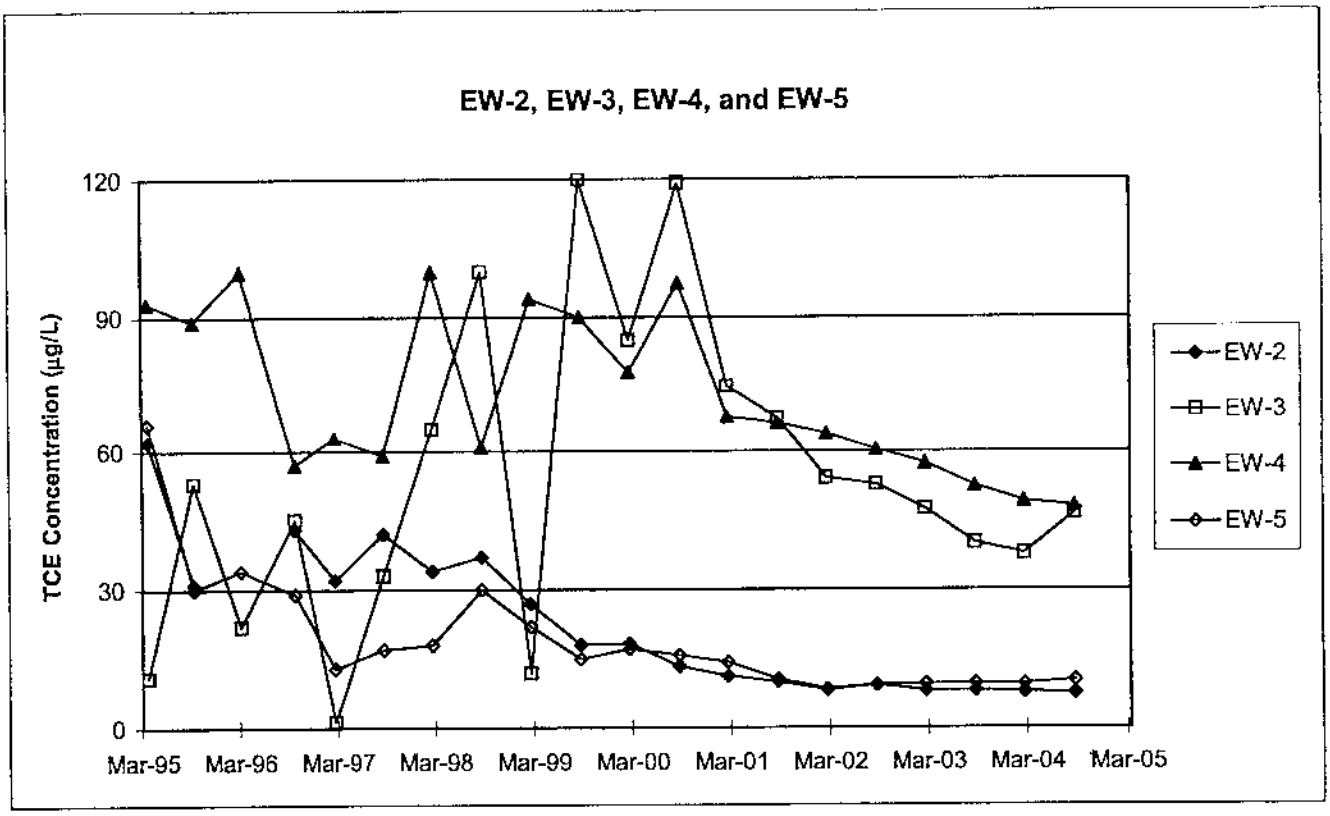
Notes:

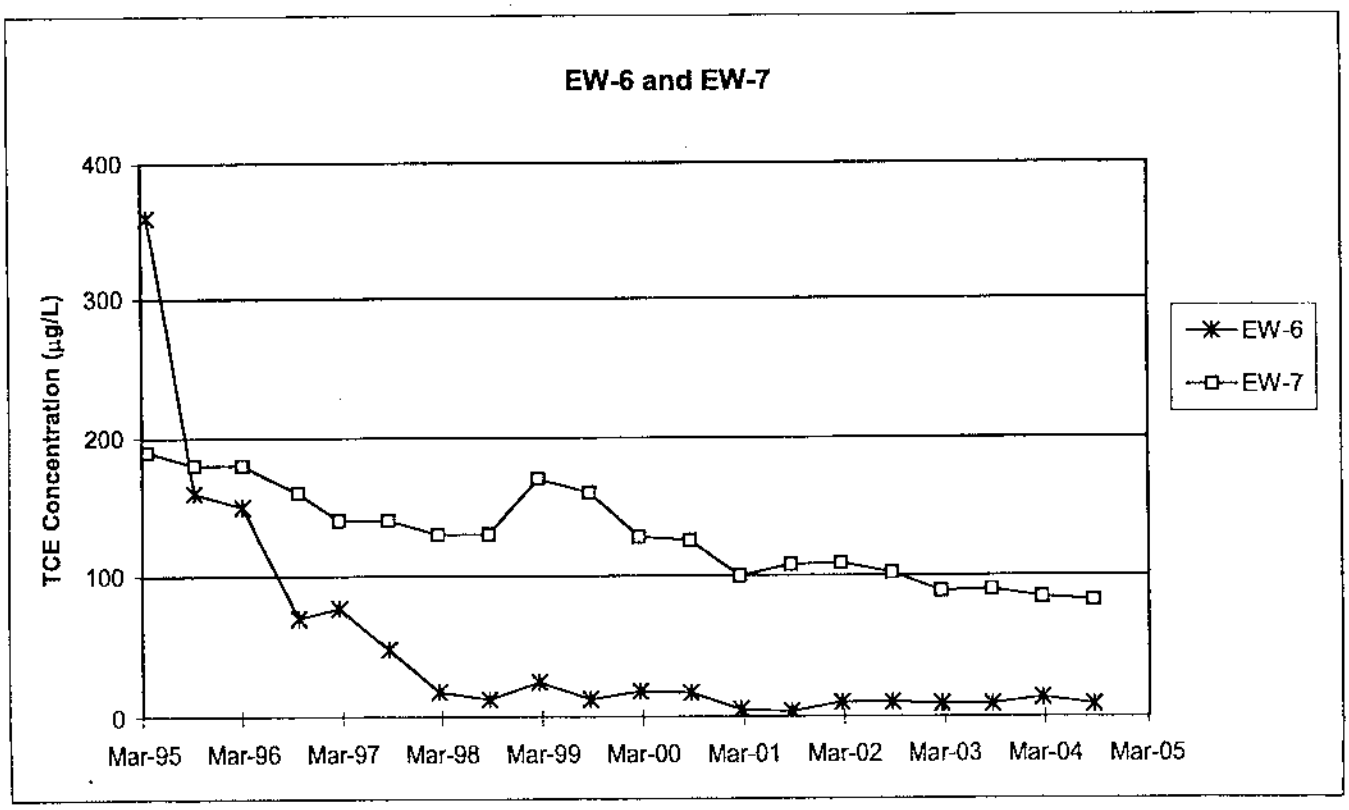
NS = not sampled; ND = not detected (typical method detection limits have varied, and ranged from near 1.0 µg/L pre-1998 to near 0.1 µg/L in 2004)

1995 data reported by EA (August, 1996)

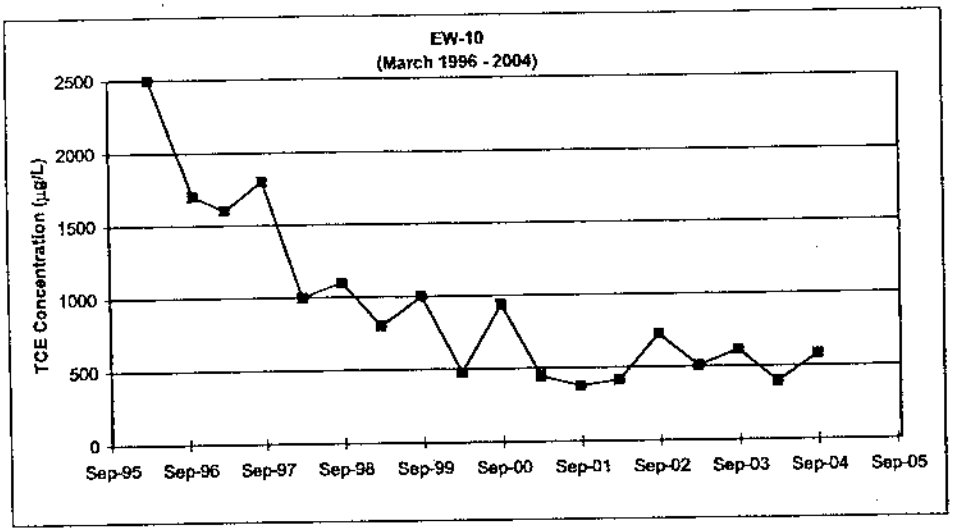
1996-2004 data reported by CH2M HILL

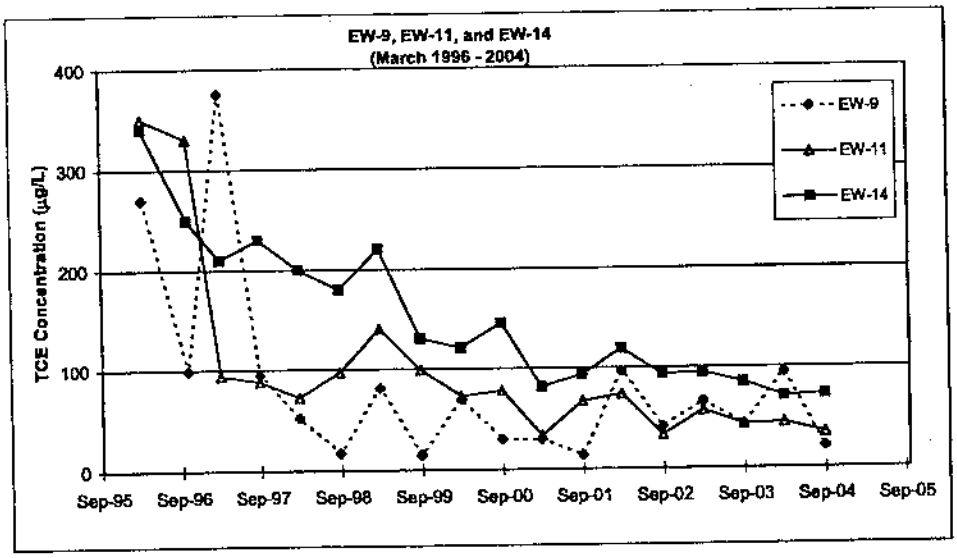
Figures 2-7a and 2-7b
Historical TCE Concentrations
NDA Extraction Wells





Figures 2-8a, 2-8b, and 2-8c
Historical TCE Concentrations
SDA Extraction Wells





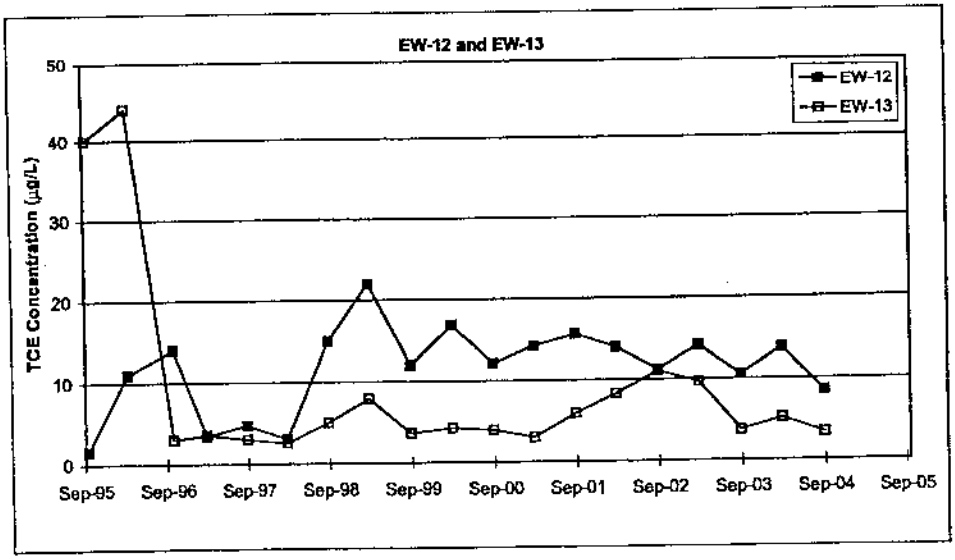


FIG2-2 CRL 2004.dwg FEBRUARY, 2004

NDM 138609

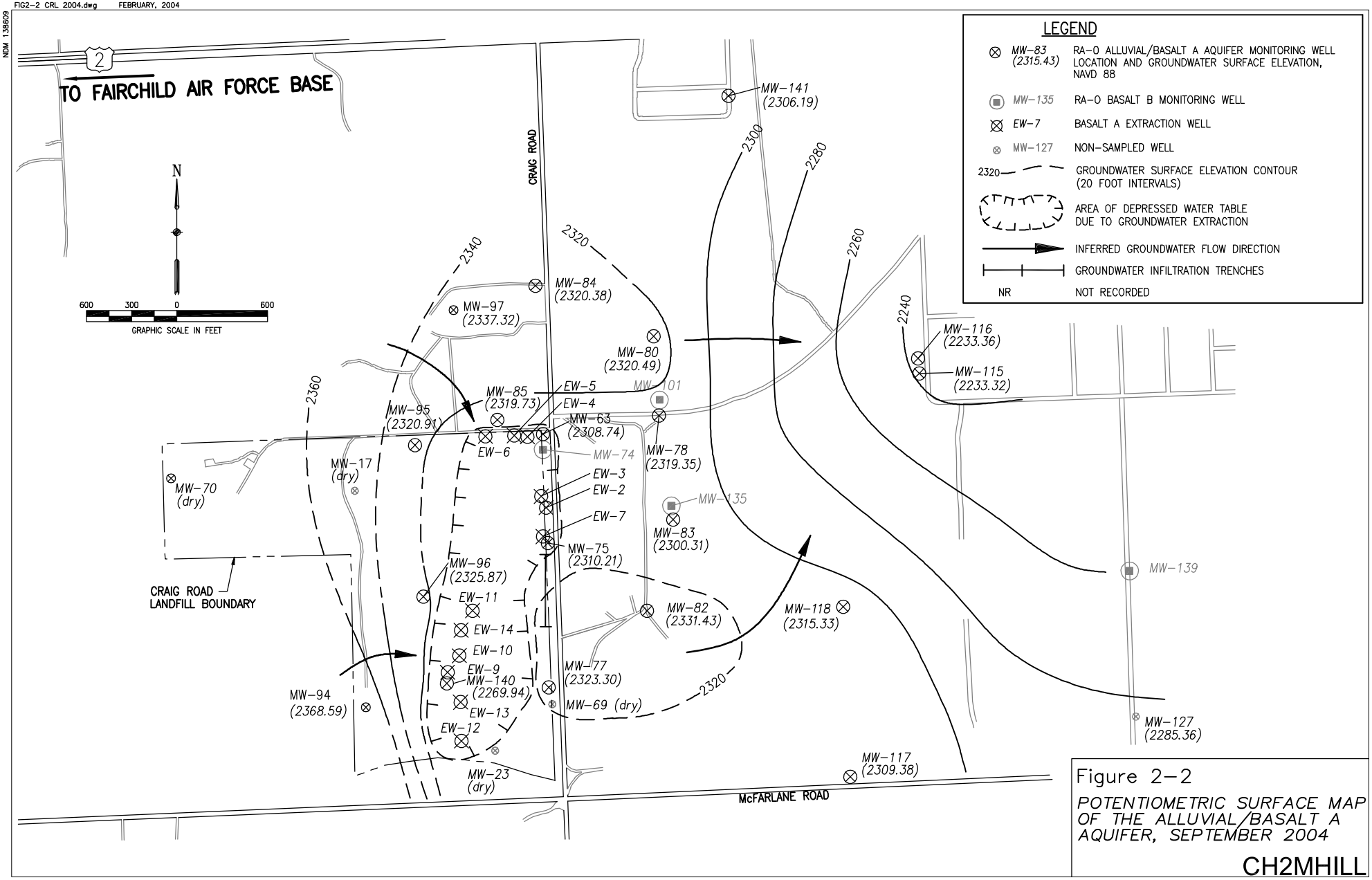
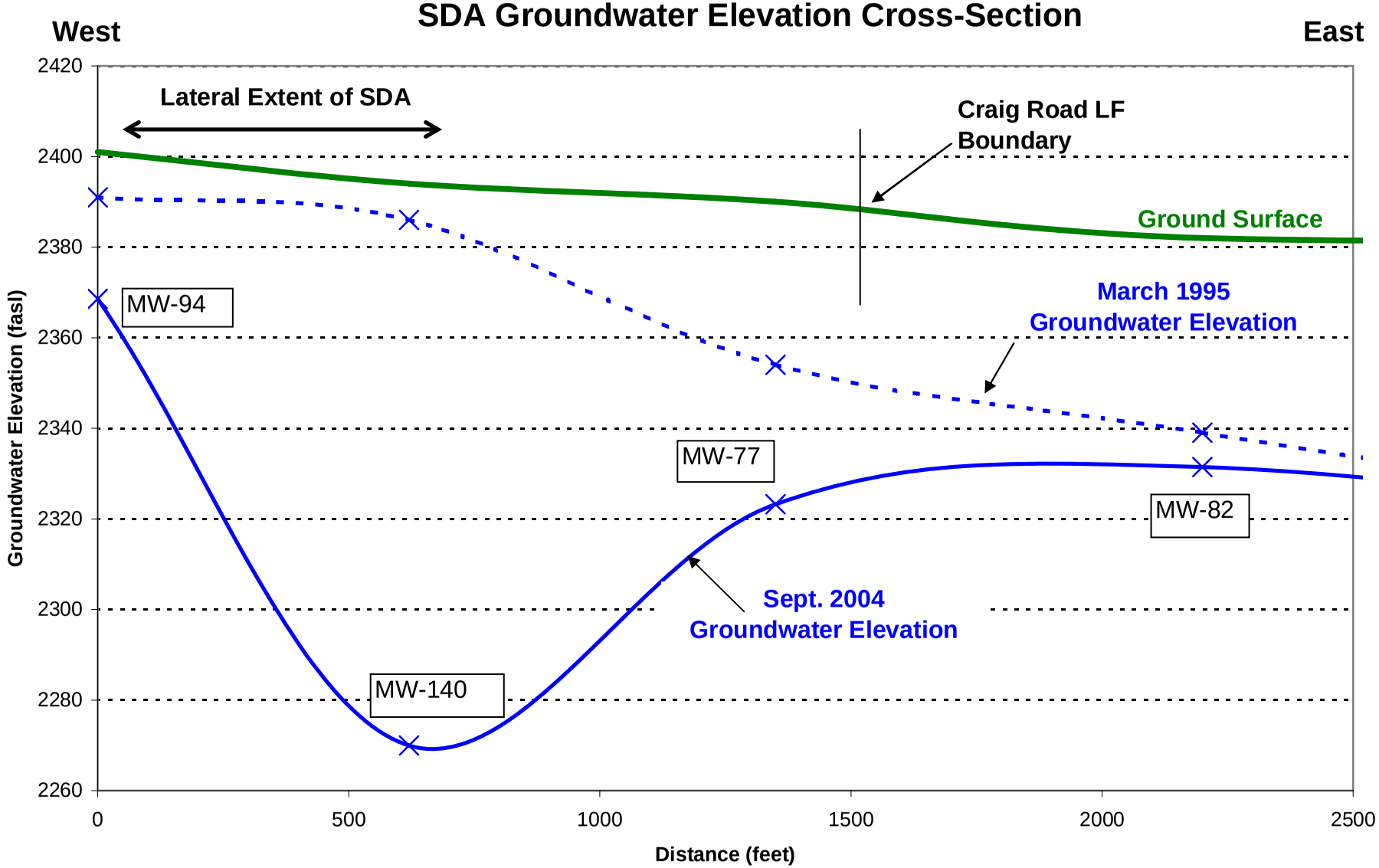


Figure 2-2

POTENTIOMETRIC SURFACE MAP OF THE ALLUVIAL/BASALT A AQUIFER, SEPTEMBER 2004

CH2MHILL

Figure 2-3
SDA Groundwater Elevation Cross-Section



Appendix B
Additional Information for Individual On-Base Priority One Operable Unit Sites

Site SW-1, Old Base Landfill

Historical TCE concentrations for Selected SW-1 Site Monitoring Wells [a]

Date	MW-90	MW-131	MW-132
Aug-90	10	NA	NA
Feb-91	4	NA	NA
Apr-91	11	NA	NA
Jun-91	NA	18	6
Dec-91	8	11	12
Feb-94	6.3	4.2	< 2
May-94	3.4	7.9	1.9
Aug-94	7.4	3.5	1.8
Nov-94	6.5	5.1	1
Apr-95	8.8	10	< 2
Jun-95	14	9.2	1
Sep-95	10	9	< 2
Dec-95	9.2	9	< 2
Mar-96	10	4	< 2
Sep-96	7.2	5.8	2
Mar-97	8.7	6	< 2
Sep-97	8	6	< 2
Mar-98	5	4	0.9
Sep-98	10	4	0.8
Mar-99	7.28	3.53	0.72 F
Sep-99	5.74	3.46	< 2
Mar-00	7.75	2.04	0.88 F
Sep-00	9.19	4.49	1.28 F
Mar-01	6.69	2.69	0.43 F
Sep-01	6.72	1.9	1.55
Mar-02	11.1	6.56	0.96 F
Sep-02	8.28	6.28	1.11
Mar-03	7.83	3.54	0.54
Sep-03	8.7	3.37	0.34 F
Mar-04	5.82	2.17	0.37 F
Sep-04	5.51	2.44	0.43 F

Notes:
a. Pre-2003 data as reported by MWH (2003)
F - Analyte detected at concentrations less than the reporting limit (RL), but greater than the method detection limit (MDL)
NA - No historical TCE results recorded

Figure 2-3
TCE Trend Analysis for MW-90

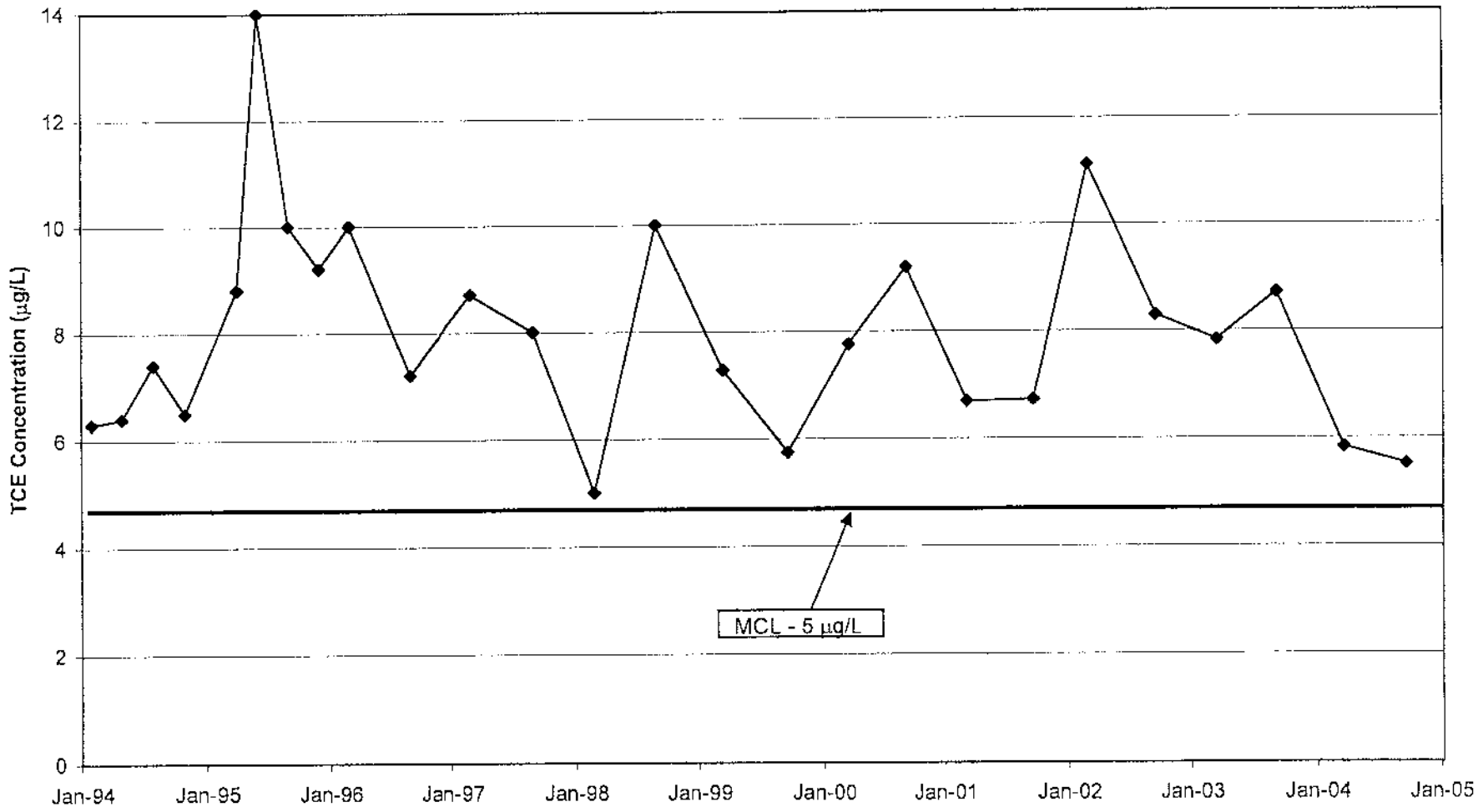


Figure 2-4
TCE Trend Analysis for MW-131

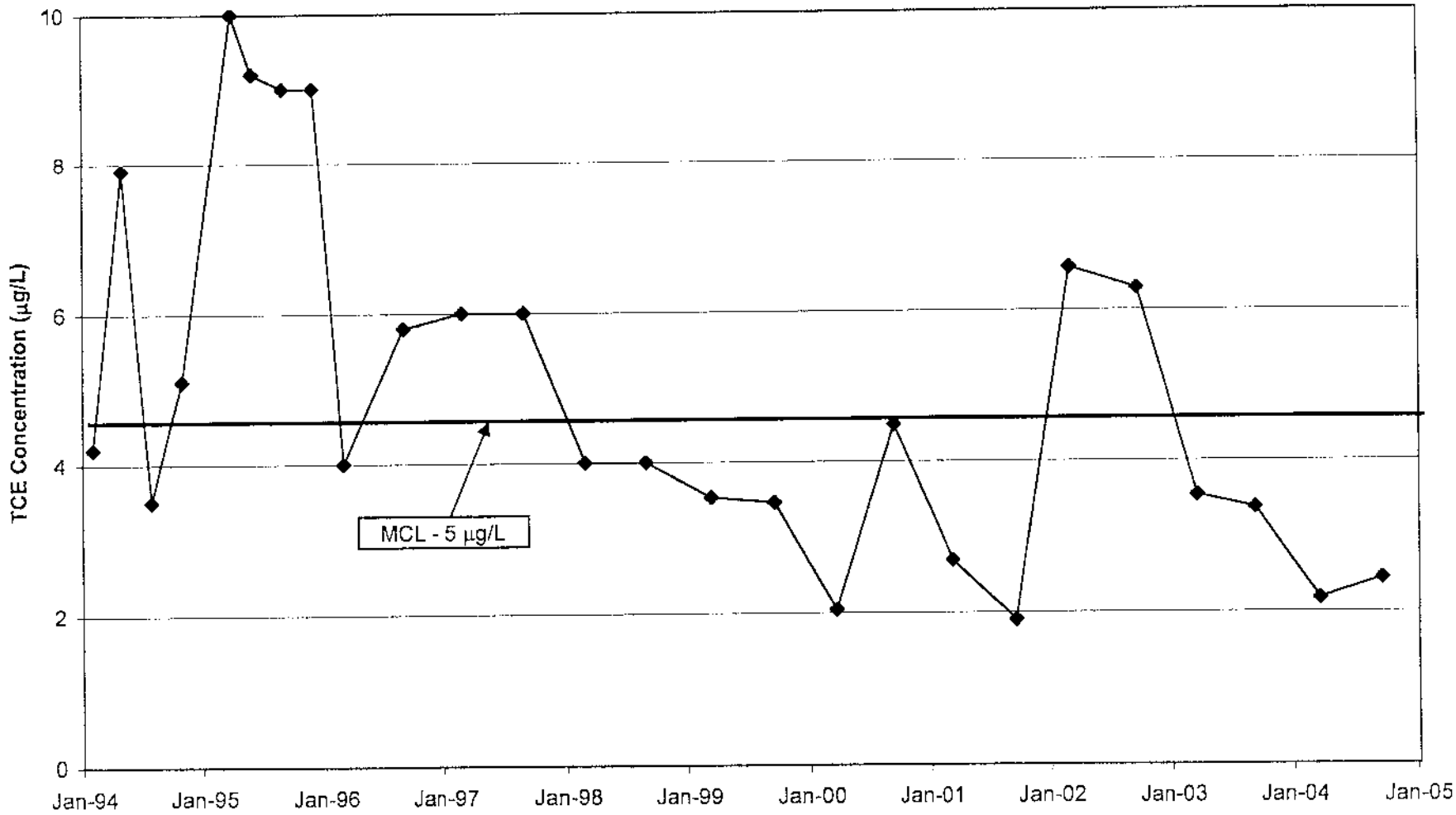
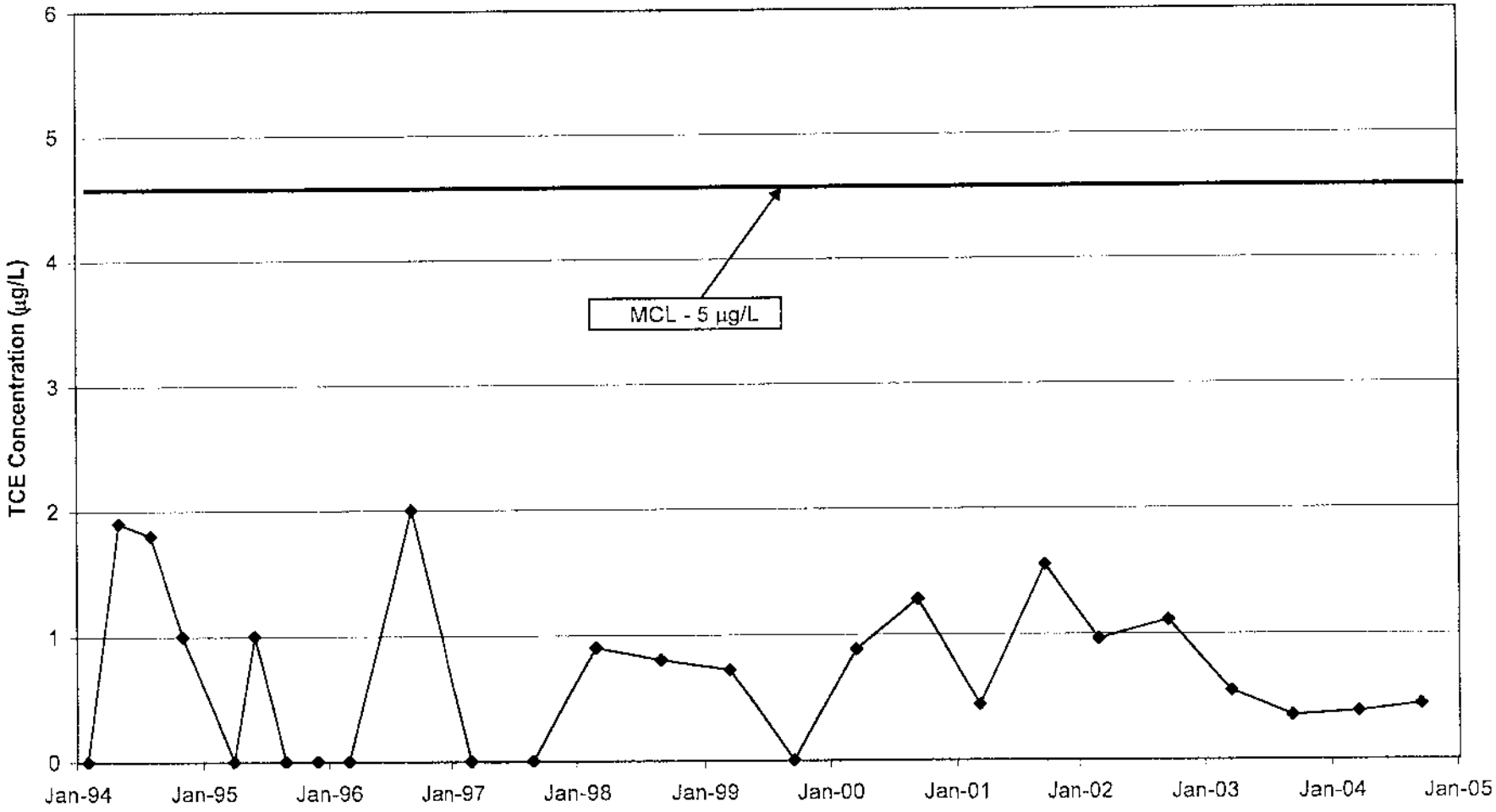


Figure 2-5
TCE Trend Analysis for MW-132



Site PS-2, Refueling Pit Area

Table 3-2: PS-2 FREE PRODUCT GUAGING AND RECOVERY SUMMARY

Date	MW-176	MW-177	MW-228		MW-228A		MW-228B	Comments
	Product Thickness (feet)	Product Thickness (feet)	Product Thickness (feet)	Approximate Product Removed	Product Thickness (feet)	Approximate Product Removed	Product Thickness (feet)	
3/24/2004	None	None	Trace	1 ounce	None	None	None	
4/7/2004	None	None	Trace	6 ounces	None	None	None	
5/5/2004	None	None	None	None	None	None	None	
6/8/2004	None	None	Trace	8 ounces	16 ounces	Trace	None	
7/6/2004	None	None	None	None	None	None	None	
8/3/2004	None	None	None	None	None	None	None	
9/30/04	None	None	None	None	0.1	0.5 gallons	0.01	
10/29/04	None	None	None	None	0.12	0.6 gallons	None	
11/9/04	None	None	None	None	None	0.75 gallons	None	
11/17/04	None	None	None	None	None	0.5 gallons	None	
1/7/05	None	None	None	None	None	0.5 gallons	None	
2/1/05	None	None	None	None	None	None	None	
4/7/05	None	None	None	None	None	0.58 gallons	None	
5/24/05	None	None	None	None	None	0.5 gallons	None	
6/17/05	None	None	None	None	None	None	None	

1 Pure product
2 Oil/water emulsion

The 2004/05 effort also included monthly measurements of free product thickness in five wells. The measured free product thickness was less than observed in previous years. *Table 3.3: PS-2 Yearly Free Product Average Thickness*, presents the annual averages for the recovery wells since 1994. These thickness measurements represent the product within the well casing, which can be quite different from the actual product thickness in the saturated zone away from the borehole. True product thickness can range from one-half to one-sixth the apparent thickness in the well casing (McWhorter and Sunada 1977). The thickest measurement in 2004/05 was 0.14 feet (1.68 inches) in MW-288A. Based on the aforementioned reference, the true free product thickness away from the borehole may be between 0.28 and 0.84 inches. This data indicates that free product may exist as a thin sheen on the water surface. In addition, a black oily residue was observed on the water level probe during several monthly water level measurement events in MW-177.

FPR is generally expected to achieve only up to 50 percent recovery, and is typically less (Nyer and Skladany 1989). Reductions of product thickness are evident at this site and ranged between 100 and 85.3 percent reduction between 1994 and 2004. A graphical representation of the average annual thickness of free product measured since 1994 is presented as Figure 3-5.

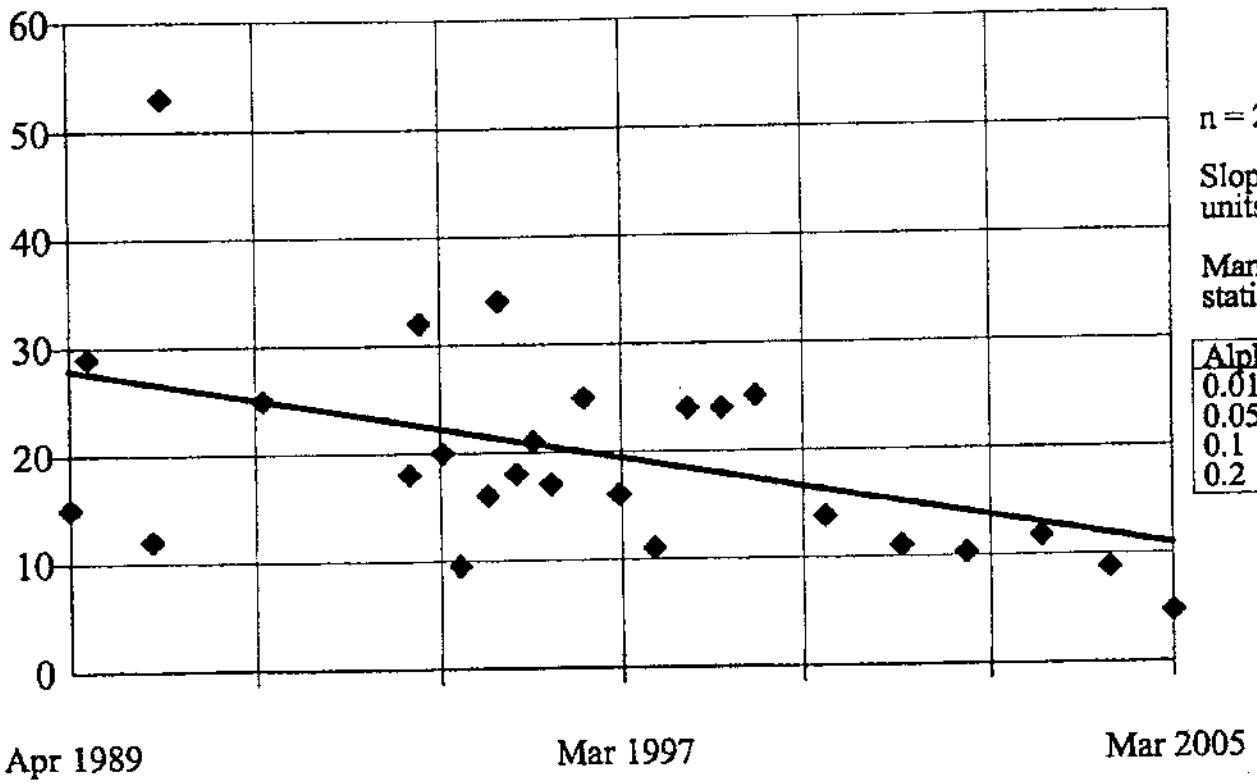
TABLE 3.3: PS-2 YEARLY FREE PRODUCT AVERAGE THICKNESS (feet)

Well	1994	1996	1997	1998	1999	2000	2001	2002	2003	2004	% Reduction 1994 to 2004
MW-176	0.29	0.15	0.01	0.08	0.0	0.0	0.0	0.0	0.0	0.0	100
MW-177	0.10	0.04	0.02	0.03	0.02	0.003	0.001	0.0	0.0	0.0	100
MW-228	0.45	0.16	0.02	0.06	0.06	0.06	0.04	0.11	0.037	0.001	99.8
MW-228A	0.30	0.20	0.05	0.09	0.10	0.10	0.08	0.11	0.05	0.044	85.3
MW-228B	0.0	0.0	0.0	0.0	0.0	0.003	0.0	0.0	0.0	0.0	100

CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-55



n = 26

Slope = -1.069 units per year.

Mann Kendall statistic = -116

Alpha	Critical	Signif.
0.01	-118	No
0.05	-90	Down
0.1	-76	Down
0.2	-60	Down

Constituent: Benzene (ug/L)

Date: 9/15/05

Facility: Site_PS-2_GW

Time: 11:16 AM

Data File: PS2GW05

View: PS-1 GW05

FILE: P:\362980900\Annual\Figures\2004-05 Annual Report\Drawings\PS-2\FIG_3-10.dwg

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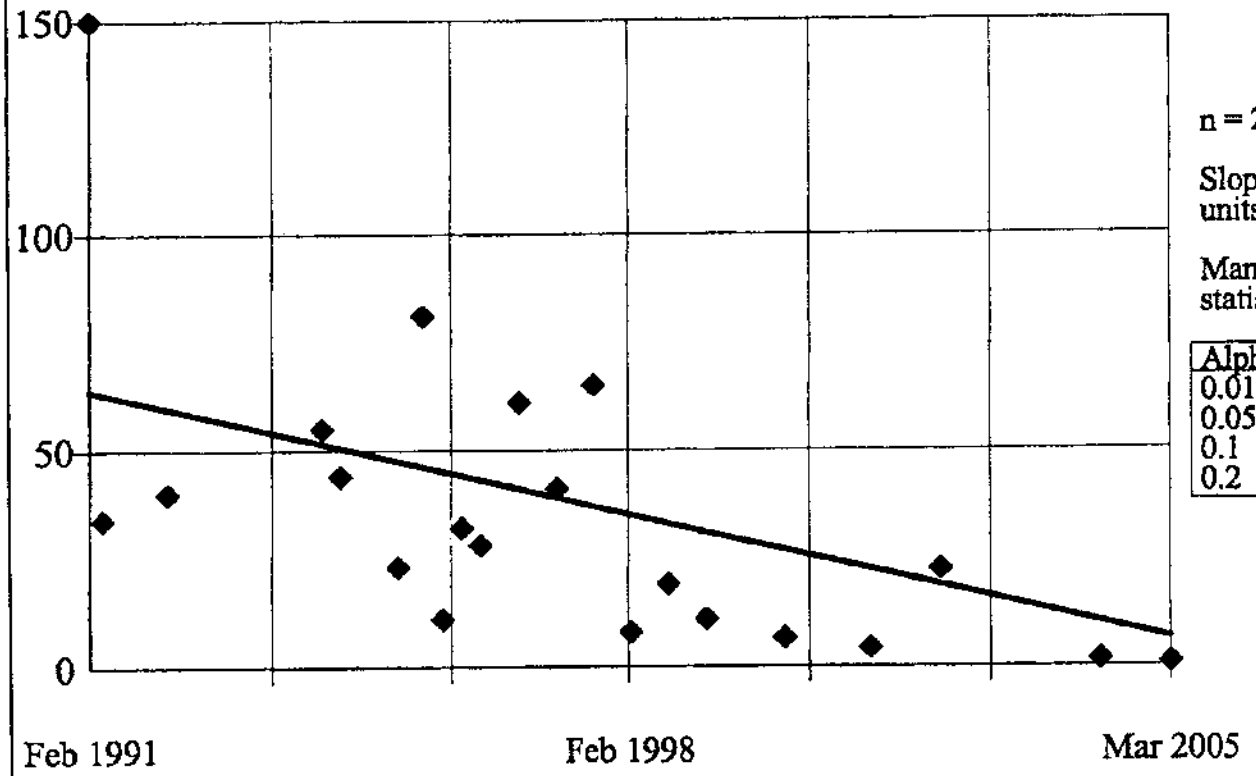
Figure 3–10: Site PS–2 Trend Analysis MW–55, Benzene

FAIRCHILD AIR FORCE BASE

CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-109



n = 21

Slope = -4.066
units per year.

Mann Kendall
statistic = -115

Alpha	Critical	Signif.
0.01	-87	Down
0.05	-66	Down
0.1	-56	Down
0.2	-44	Down

Constituent: Benzene (ug/L)

Date: 9/15/05

Facility: Site_PS-2_GW

Time: 11:16 AM

Data File: PS2GW05

View: PS-1 GW05

FILE: P:\36288090\Annual\Figures\2004-05 Annual Report\Drawings\PS-2\FIG_3-11.dwg

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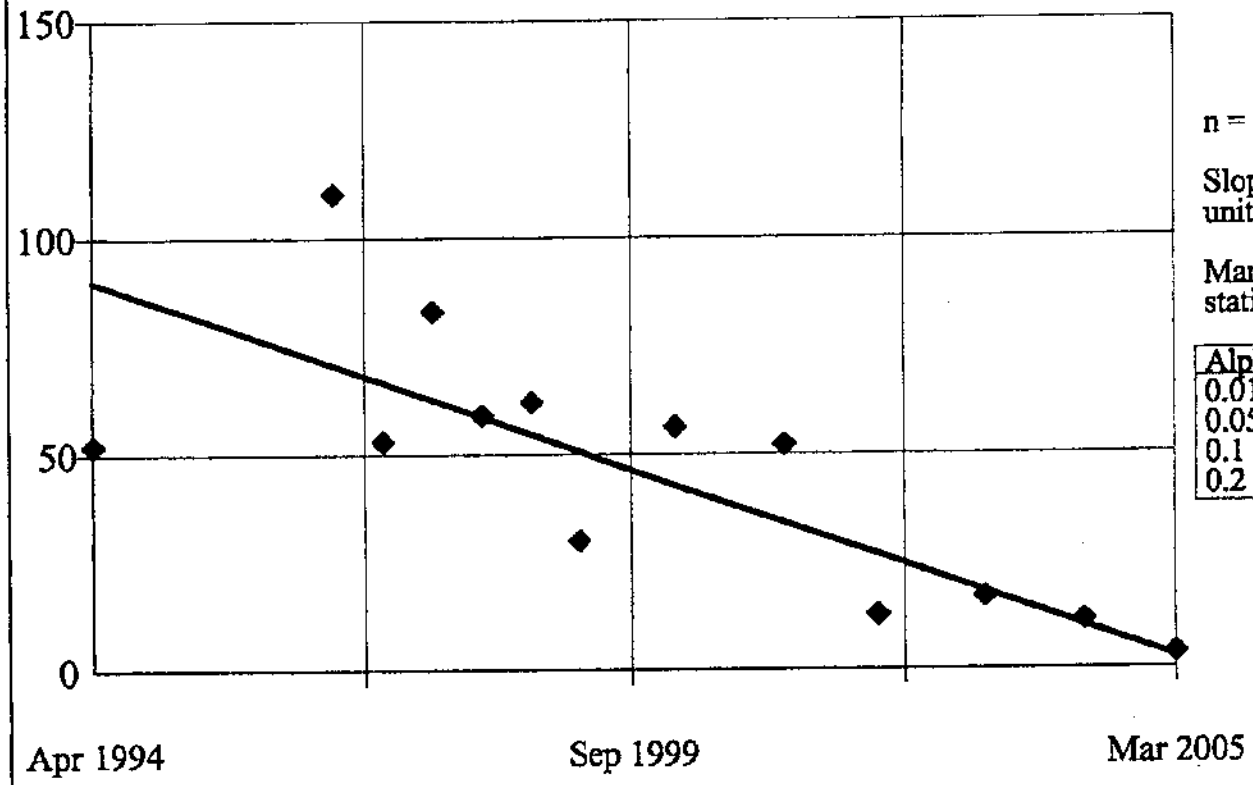
Figure 3-11: Site PS-2 Trend Analysis MW-109, Benzene

FAIRCHILD AIR FORCE BASE

CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-222



n = 13

Slope = -7.994 units per year.

Mann Kendall statistic = -49

Alpha	Critical	Signif.
0.01	-43	Down
0.05	-34	Down
0.1	-29	Down
0.2	-23	Down

Constituent: Benzene (ug/L)

Date: 9/15/05

Facility: Site_PS-2_GW

Time: 11:16 AM

Data File: PS2GW05

View: PS-1 GW05

FILE: P:\362980901\Annual\Figures\2004-05 Annual Report\Drawings\PS-2\FIG_3-12.dwg

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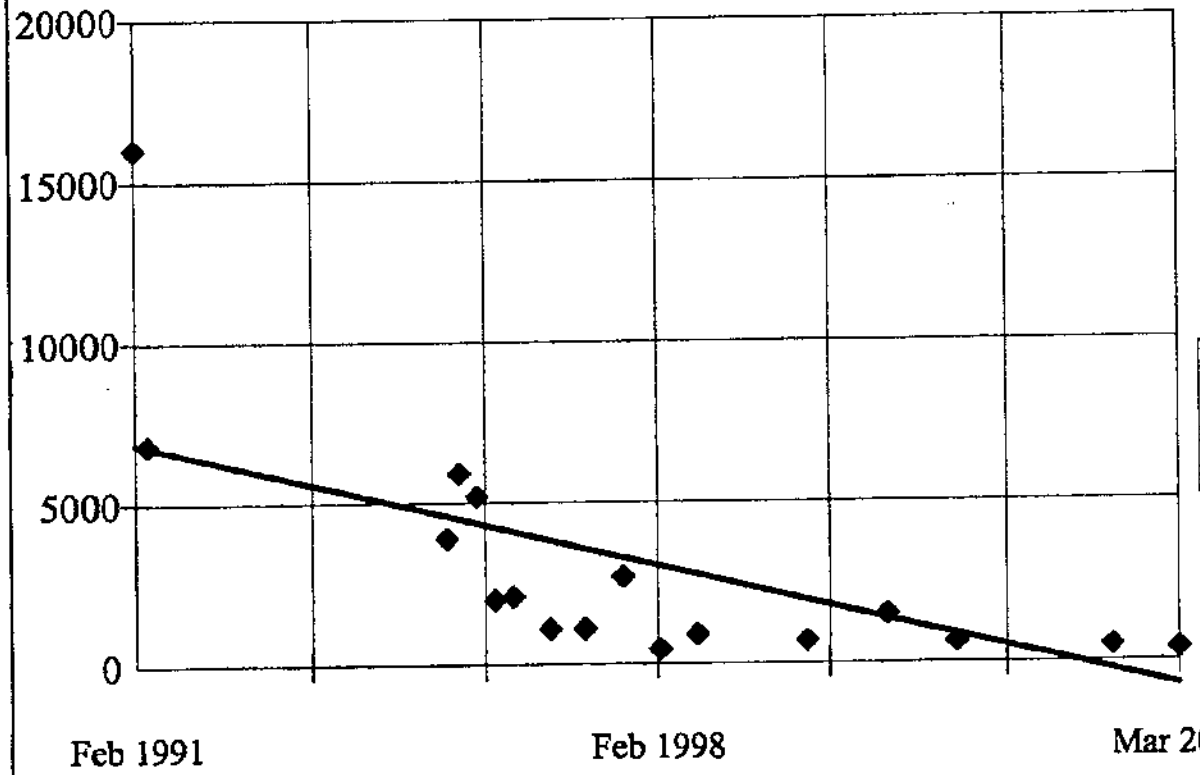
Figure 3-12: Site PS-2 Trend Analysis MW-222, Benzene

FAIRCHILD AIR FORCE BASE

CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-109



n = 17

Slope = -538.375
units per year.

Mann Kendall
statistic = -103

Alpha	Critical	Signif.
0.01	-63	Down
0.05	-49	Down
0.1	-42	Down
0.2	-33	Down

Constituent: TPH-D (ug/L)

Date: 9/15/05

Facility: Site_PS-2_GW

Time: 11:17 AM

Data File: PS2GW05

View: PS-1 GW05

FILE: P:\36298090\Annual\Figures\2004-05 Annual Report\Drawings\PS-2\FIG_3-13.dwg

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Figure 3-13: Site PS-2 Trend Analysis MW-109, TPH-D

FAIRCHILD AIR FORCE BASE

TABLE 3.4: PS-2 HISTORICAL BENZENE AND TPH-D CONCENTRATIONS (µg/L)[1]

Date	MW-55	MW-109			MW-110	MW-179	MW-222
	Benzene	Benzene	Diesel	Diesel as JP4	Benzene	Benzene	Benzene
April-89	**55**[2]	-[3]	-	-	-	-	-
July-89	**29**	-	-	-	-	-	-
June-90	**12**	-	-	-	-	-	-
August-90	**53**	-	-	-	-	-	-
February-91	-	**150**	**16000**	-	-	-	-
April-91	-	**34**	**6800**	-	-	-	-
January-92	**25**	-	-	-	-	-	-
February-92	-	**40**	-	-	-	-	-
February-94	**18**	**55**	-	-	-	-	-
April-94	**32**	-	-	-	-	-	**52**
May-94	-	**44**	-	-	-	-	-
August-94	**20**	-	-	-	-	-	-
November-94	**9.5**	-	-	-	-	-	-
February-95	-	**23**	-	-	-	-	-
April-95	**16**	-	**3900**	-	-	-	-
June-95	**34**	**81**	**5900**	-	-	-	-
September-95	**18**	**11**	**5200**	-	-	-	-
December-95	**21**	**32**	**2000**	-	-	-	-
March-96	**17**	**28**	**2100**	-	<2[4]	<2	-
September-96	**25**	**61**	**1100**	-	<2	<2	**110**
March-97	**16**	**41**	**1100**	-	<2	<2	**53**
September-97	**11**	**65**	**2700**	-	<2	<2	**83**
March-98	**24**	**8**	450	-	1	<2	**59**
September-98	**24**	**19**	900	-	<2	-	**62**
March-99	**25.1**	**11**	206.3[5]	-	1.21[F(6)]	<2	**29.9**
March-00	**13.8**	**6.6**[F]	701	-	<2	<2	**56.2**
March-01	**11**	4.3	**1500**[7]	-	<0.105[8]	<0.105	**52**
March-02	**10.28**	**18.82**	-	-	0.68	<0.10	**12.59**
April-03	**11.8**	1.25	810	270	<0.10	<0.10	**16.69**
April-04	**8.82**	1.6	500	**1400**	<0.10	<0.10	**11.25**
April-05	4.70	0.83	380	990	<0.20	<0.20	3.60
ROD Cleanup Level	5	5	1000	1000	5	5	5

1 – Micrograms per Liter
2 – Bold values exceed ROD Cleanup Level
3 - Not Analyzed
4 - Concentration not detected above the Practical Quantitation Limit (i.e., PQL = 2)
5 - Analyzed by Washington State Extractable Petroleum Hydrocarbons (EPH) method, not WTPH method; data point not used in statistical analysis due to biased EPH result
6 - F: Analyte detected at a concentration less than the PQL, greater than the MDL (flag not used pre-1999)
7 - Result for Jet A
8 - Concentration not detected above the Method Detection Limit (i.e., MDL = 0.105)

Site PS-8, Underground Fuel Line Area

TABLE 4.2: PS-8 HISTORICAL BENZENE CONCENTRATIONS (µg/L)[1]

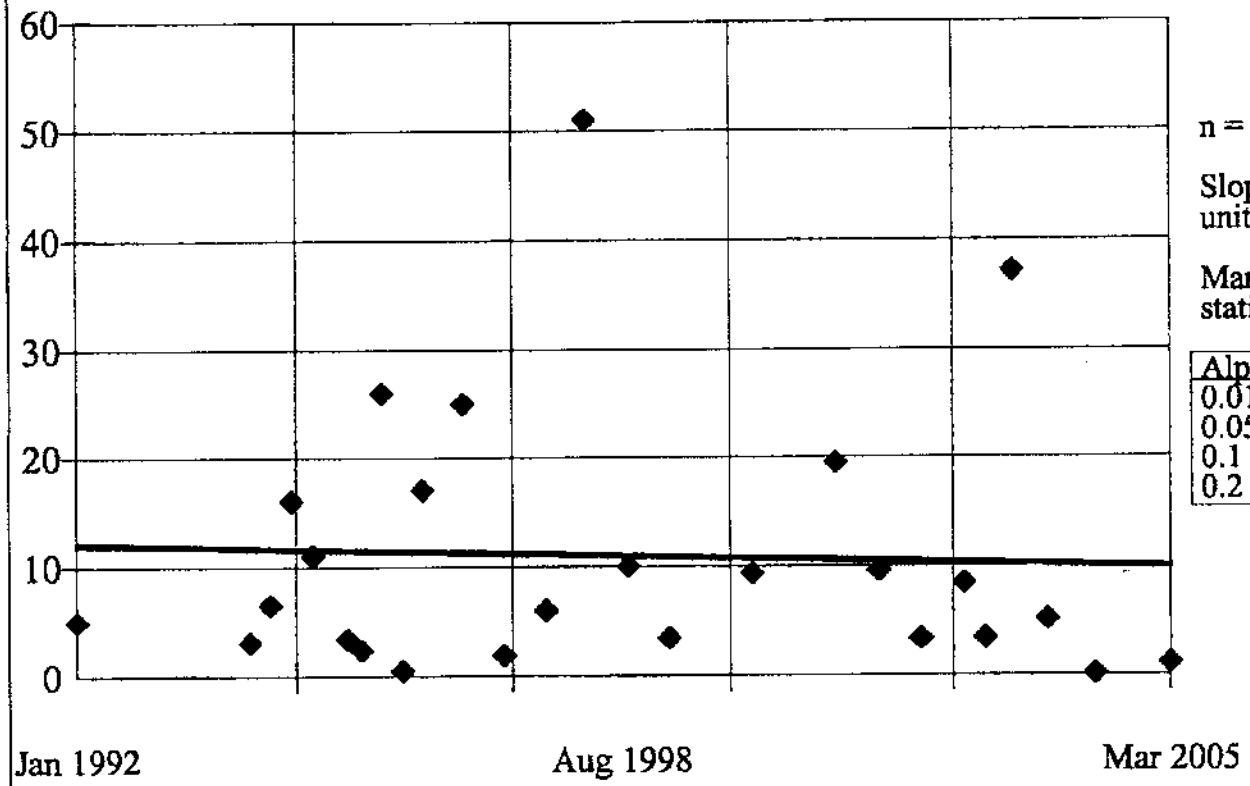
Date	MW-67	MW-68	MW-183	MW-184
Jan-92	-[2]	-	-	**5**[3]
Feb-94	-	-	-	3.1
May-94	-	-	-	**6.5**
Aµg-94	-	-	-	**16**
Nov-94	-	-	-	**11**
Apr-95	-	-	-	3.4
Jun-95	-	-	-	2.4
Sep-95	-	-	-	**26**
Dec-95	-	-	-	0.5
Mar-96	<2[4]	<2	<2	**17**
Sep-96	<2	<2	<2	**25**
Mar-97	<2	<2	<2	1.9
Sep-97	4	1	<2	**6**
Mar-98	1	<2	<2	**51**
Sep-98	2	<2	<2	**10**
Mar-99	2.66	0.73-F[5]	<2	3.44
Mar-00	1.17-F	<2	<2	**9.32**
Mar-01	-	-	-	**19.5**
Sep-01	**17.3-J**[6]	**6.71-J**	<0.5	**9.58-J**
Mar-02	**23.2**	<0.5	<0.5	3.35
Sep-02	**22.1**	<0.5	<0.5	**8.44**
Dec-02	**25.5**	<0.5	<0.5	3.43
Apr-03	1.22	<0.1	<0.1	**37.14**
Sep-03	0.75	<0.1	<0.1	**5.12**
Apr-04	1.18	<0.1	<0.1	0.13
Sept-04	1.40	<0.1	<0.1	<0.1
Apr-05	<0.2	<0.2	<0.2	1.10
ROD Cleanup Level	5	5	5	5

1. ug/L: Micrograms per Liter
2. Not Analyzed
3. Bold text above ROD cleanup level
4. Concentration not detected above the Practical Quantitation Limit (i.e., PQL = 2)
5. F: Analyte detected at a concentration less than the PQL, greater than the MDL (flag not used pre-1999)
6. J: Analyte detected, but the quanitation is an estimation.

CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-184



n = 26

Slope = -0.161 units per year.

Mann Kendall statistic = -23

Alpha	Critical	Signif.
0.01	-118	No
0.05	-90	No
0.1	-76	No
0.2	-60	No

Constituent: Benzene (ug/L)

Date: 9/15/05

Facility: Site_PS-8_GW

Time: 11:29 AM

Data File: PS8GW05

View: PS-8 GW05

FILE: P:\35298090\Annual\Figures\2004-05 Annual Report\Drawings\PS-8\FIG_4-10.dwg

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Figure 4-10: Site PS-8 Trend Analysis MW-184, Benzene

FAIRCHILD AIR FORCE BASE

Site FT-1, Former Fire Training Area

TABLE 2.3: FT-1 HISTORICAL BENZENE CONCENTRATIONS (µg/L)[1]

Date	MW-1	MW-3	MW-4	MW-50	MW-100	MW-151	MW-152	MW-153	MW-154	MW-155	MW-226	MW-227	MW-246	MW-247	MW-248
Benzene MTCA Method A Cleanup Level – 5 µg/L															
Apr-89	-[2]	79	-	-	-	-	-	-	-	-	-	-	-	-	-
Jul-89	-	170	-	-	-	-	-	-	-	-	-	-	-	-	-
May-91	-	66	-	-	-	-	-	-	-	-	-	-	-	-	-
Dec-91	-	280	-	-	-	-	56	-	-	-	-	-	-	-	-
Apr-95	-	220	-	-	-	-	140	-	-	-	-	-	-	-	-
Jun-95	-	210	-	-	-	-	79	-	-	-	-	-	-	-	-
Sept-95	-	290	-	-	-	-	60	-	-	-	-	-	-	-	-
Dec-95	-	290	-	-	-	-	290	-	-	-	-	-	-	-	-
Mar-96	3	57	<2[3]	<2	<2	<2	170	<2	<2	<2	3.7	-	-	-	-
Jun-96	<2	140	<2	<2	<2	<2	120	<2	<2	<2	50	7.5	-	-	-
Sept-96	<2	200	<2	<2	<2	<2	8.9	<2	<2	<2	2.1	0.8	-	-	-
Dec-96	<2	240	<2	1.2	<2	<2	280	<2	-	<2	1.3	4.9	-	-	-
Mar-97	3.4	36	<2	<2	<2	<2	130	<2	<2	<2	13	6	-	-	-
Jun-97	-	150	-	<2	<2	-	70	-	-	-	4.3	1.8	<2	91	4
Sept-97	-	150	-	<2	<2	-	29	-	-	-	1	1	<2	6	<2
Dec-97	-	130	-	<2	<2	-	7	-	-	-	<2	<2	2	1	1
Mar-98	<2	<2	<2	<2	<2	<2	25	<2	<2	<2	0.4	<2	<2	7	2
Jun-98	-	97	-	-	-	-	82	-	-	-	17	86	<2	68	2
Sept-98	-	13	-	-	-	-	6	-	-	-	4	2	<2	10	<2
Dec-98	-	11	-	-	-	-	<2	-	-	-	<2	<2	-	1	-
Mar-99	<2	1.93[F(4)]	<2	<2	<2	<2	3.81[F]	<2	<2	<2	0.78[F]	5.73	<2	1.33[F]	<2
Jun-99	-	<10	-	-	-	-	8.44[F]	-	-	-	1.01[F]	0.95[F]	-	5.9	-
Sept-99	-	<2	-	-	-	-	<2	-	-	-	<2	<2	-	2.18	-
Dec-99	-	0.84[F]	-	-	-	-	0.29[F]	-	-	-	<2	0.55[F]	-	0.42[F]	-
Mar-00	<2	2	<2	<2	<2	<2	4.8	<2	<2	<2	0.63[F]	0.57[F]	<2	2.81	<2
Jun-00	-	<2	-	-	-	-	1.14[F]	-	-	-	0.62[F]	0.86[F]	-	1.49[F]	-
Sept-00	-	<2	-	-	-	-	<2	-	-	-	0.61[F]	0.6[F]	-	1.17[F]	-
Dec-00	-	0.31[F]	-	-	-	-	0.58[F]	-	-	-	0.51[F]	0.7[F]	-	1.54[F]	-
Apr-01	<0.105[5]	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	<0.105	0.47	0.78	<0.105	1.7	<0.105
Jun-01	-	<0.105	-	-	-	-	0.45	-	-	-	0.45	0.47	-	1.8	-

TABLE 2.3 continued: FT-1 HISTORICAL BENZENE CONCENTRATIONS (µg/L)[1]

Date	MW-1	MW-3	MW-4	MW-50	MW-100	MW-151	MW-152	MW-153	MW-154	MW-155	MW-226	MW-227	MW-246	MW-247	MW-248
Benzene MTCA Method A Cleanup Level – 5 µg/L															
Sept-01	-	<0.09[5]	-	<0.09	<0.09	-	<0.09	-	-	-	0.54	0.44	-	0.84	<0.09
Dec-01	-	0.33	-	-	-	-	<0.09	-	-	-	0.23	0.29	-	<0.09	-
Mar-02	<0.10[5]	<0.10	<0.10	<0.10	<0.10	<0.10	0.84	<0.10	<0.10	<0.10	0.39[F]	0.21[F]	<0.10	0.96	<0.10
Jun-02	-	0.12[F]	-	-	-	-	0.29[F]	-	-	-	0.35[F]	0.27[F]	-	0.59	-
Sept-02	-	0.24[F]	-	<0.10	<0.10	-	<0.10	-	-	-	0.23[F]	0.25[F]	-	0.51	<0.10
Dec-02	-	0.22[F]	-	-	-	-	0.21[F]	-	-	-	<0.10	0.31[F]	-	0.87	-
Mar-03	<0.10	0.11[F]	<0.10	<0.10	<0.10	<0.10	0.2[F]	<0.10	<0.10	<0.10	0.33[F]	0.36[F]	<0.10	0.65	<0.10
Jun-03	-	0.11[F]	-	-	-	-	0.21[F]	-	-	-	<0.10	0.2[F]	-	0.39[F]	-
Sept-03	-	0.16[F]	-	<0.10	<0.10	-	0.15[F]	-	-	-	<0.10	0.17[F]	-	0.55	<0.10
Dec-03	-	0.18[F]	-	-	-	-	0.21[F]	-	-	-	<0.10	0.19[F]	-	<0.10	-
Mar-04	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.2[F]	<0.10	<0.10	<0.10	<0.10	0.29[F]	<0.10	0.66	<0.10
Jun-04	-	<0.10	-	-	-	-	0.16[F]	-	-	-	<0.10	<0.10	-	<0.10	-
Sept-04	-	0.13	-	<0.10	<0.10	-	0.14	-	-	-	<0.10	<0.10	-	0.57	<0.10
Dec-04	-	0.18	-	-	-	-	0.11	-	-	-	<0.10	<0.10	-	0.25	-
Mar-05	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.33	<0.20	0.44	<0.20
Jun-05	-	<0.20	-	-	-	-	<0.20	-	-	-	<0.20	<0.20	-	-	<0.20

1 – Micrograms per Liter
2 – Not Analyzed
3 – "<2" Concentration not detected above the Practical Quantitation Limit (i.e., PQL = 2 µg/L)
4 – F: Analyte detected at a concentration less than the PQL, greater than the MDL (flag not used before 1999)
5 – "<0.105", "<0.10" Concentration not detected above the Method Detection Limit (i.e., MDL = 0.105 µg/L) or 0.10 µg/L))

TABLE 2.4: FT-1 HISTORICAL VINYL CHLORIDE CONCENTRATIONS (µg/L)[1]

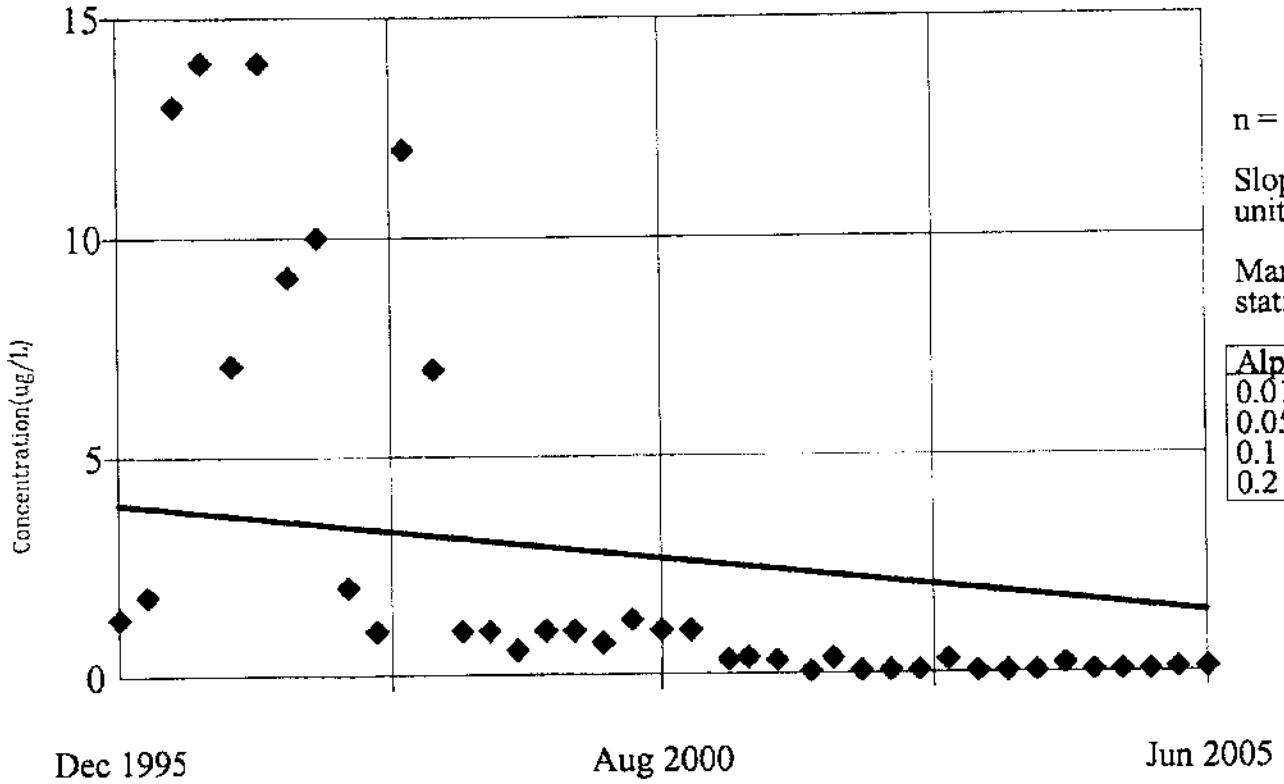
Date	MW-1	MW-3	MW-4	MW-50	MW-100	MW-151	MW-152	MW-153	MW-154	MW-155	MW-226	MW-227	MW-246	MW-247	MW-248
Vinyl Chloride MTCA Method A Cleanup Level – 0.2 µg/L															
Apr-95	-[2]	36	-	-	4	-	10	-	-	-	-	-	-	-	-
Jun-95	-	44	-	-	4.2	-	4.2	-	-	-	-	-	-	-	-
Sept-95	-	49	-	-	2.9	-	5.9	-	-	-	-	-	-	-	-
Dec-95	-	49	-	-	2.8	-	77	-	-	-	1.3	-	-	-	-
Mar-96	<2[3]	4.9	<2	<2	2.8	<2	92	<2	<2	<2	1.8	<2	-	-	-
Jun-96	<2	25	<2	<2	2	<2	40	<2	<2	<2	13	23	-	-	-
Sept-96	<2	28	<2	<2	2.5	<2	<2	<2	<2	<2	14	14	-	-	-
Dec-96	<2	27	<2	<2	2.7	<2	36	<2	<2	<2	7.1	18	-	-	-
Mar-97	<2	6	<2	<2	1.5	<2	32	<2	<2	<2	14	10	-	-	-
Jun-97	-	22	-	-	2.2	-	25	-	-	-	9.1	6.2	<2	7.4	<2
Sept-97	-	25	-	-	2	-	12	-	-	-	10	9	<2	20	<2
Dec-97	-	12	-	-	<2	-	4	-	-	-	2	<2	<2	24	<2
Mar-98	<2	<2	<2	<2	4.1	<2	7	<2	<2	<2	1	<2	<2	14	<2
Jun-98	-	16	-	-	-	-	12	-	-	-	12	6	<2	6	<2
Sept-98	-	2	-	-	-	-	4.1	-	-	-	7	5	<2	5	<2
Dec-98	-	3	-	-	-	-	<2	-	-	-	<2	3	-	5	-
Mar-99	<2	<10	<2	<2	<2	<2	<10	<2	<2	<2	<2	<2	<2	1.9[F]	<2
Jun-99	-	<10	-	-	-	-	<10	-	-	-	0.56[F(4)]	<2	-	0.58[F]	-
Sept-99	-	<2	-	-	-	-	<2	-	-	-	<2	<2	-	<2	-
Dec-99	-	<2	-	-	-	-	<2	-	-	-	<2	<2	-	<1.64[F]	-
Mar-00	<2	<2	<2		0.75[F]	<2	<2	<2	<2	<2	0.72[F]	0.5[F]	<2	<2	<2
Jun-00	-	<2	-	-	-	-	0.72[F]	-	-	-	1.24[F]	0.81[F]	-	0.8[F]	-
Sept-00	-	<2	-	-	-	-	<2	-	-	-	<2	<2	-	<2	-
Dec-00	-	<2	-	-	-	-	<2	-	-	-	<2	<2	-	0.48[F]	-
Apr-01	<0.22[5]	<0.22	<0.22	<0.22	0.31	<0.22	<0.22	<0.22	<0.22	<0.22	0.33	0.32	<0.22	0.37	<0.22
Jun-01	-	<0.22	-	-	-	-	0.24	-	-	-	0.37	0.24	-	0.32	-

TABLE 2.4: FT-1 HISTORICAL VINYL CHLORIDE CONCENTRATIONS (μg/L)[1]

Date	MW-1	MW-3	MW-4	MW-50	MW-100	MW-151	MW-152	MW-153	MW-154	MW-155	MW-226	MW-227	MW-246	MW-247	MW-248
Vinyl Chloride MTCA Method A Cleanup Level – 0.2 μg/L															
Sept-01	-	<0.11[6]	<0.11	<0.11	0.38[F]	-	<0.11	-	-	-	0.31[F]	<0.11	-	0.34[F]	-
Dec-01	-	<0.11	-	-	-	-	<0.11	-	-	-	<0.11	<0.11	-	0.31[F]	-
Mar-02	<0.13[6]	<0.13	<0.13	<0.13	0.37[F]	<0.13	<0.13	<0.13	<0.13	<0.13	0.36[F]	<0.13	<0.13	<0.13	<0.13
Jun-02	-	<0.13	-	-	-	-	<0.13	-	-	-	<0.13	<0.13	-	0.15[F]	-
Sept-02	-	<0.13	<0.13	<0.13	0.31[F]	-	<0.13	-	-	-	<0.13	<0.13	-	<0.13	-
Dec-02	-	<0.13	-	-	-	-	<0.13	-	-	-	<0.13	<0.13	-	<0.13	-
Mar-03	<0.08[6]	<0.08	<0.08	<0.08	0.31[F]	<0.08	<0.08	<0.08	<0.08	<0.08	0.31[F]	0.11[F]	<0.08	<0.08	<0.08
Jun-03	-	<0.08	-	-	-	-	<0.08	-	-	-	<0.08	<0.08	-	<0.08	-
Sept-03	-	<0.08	<0.08	<0.08	<0.08	-	<0.08	-	-	-	<0.08	<0.08	-	<0.08	-
Dec-03	-	<0.08	-	-	-	-	<0.08	-	-	-	<0.08	<0.08	-	0.12[F]	-
Mar-04	<0.12[m]	<0.12[m]	<0.12[m]	<0.12[m]	0.22[m]	<0.12[m]	<0.12[m]	<0.12[m]	<0.12[m]	<0.12[m]	0.21	<0.12[m]	<0.12[m]	<0.12[m]	<0.12[m]
Jun-04	-	<0.12	-	-	-	-	<0.12	-	-	-	<0.12	<0.12	-	<0.12	-
Sept-04	-	<0.12	<0.12	<0.12	0.15	-	<012	-	-	-	<0.12	<0.12	-	<0.12	-
Dec-04	-	<0.12	-	-	-	-	<0.12	-	-	-	<0.12	<0.12	-	<0.12	-
Mar-05	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Jun-05	-	<0.2	-	-	-	-	<0.2	-	-	-	<0.2	<0.2	-	-	<0.2

1 – Micrograms per Liter
2 – Not Analyzed
3 – "<2" Concentration not detected above the Practical Quantitation Limit (i.e. PQL = 2 μg/L)
4 – F: Analyte detected at a concentration less that the PQL, greater than the MDL (flag not used before 1999)
5 – "<0.22" Concentration not detected above the Method Detection Limit (i.e., MDL = 0.22 μg/L)
6 – "<0.11", "<0.13", and "<0.08" Concentration not detected above the Method Detection Limit (i.e., MDL = 0.11, 0.13, or 0.08 μg/L)
m matrix effect present

SEN'S SLOPE ESTIMATOR
MW-226



n = 39

Slope = -0.267
units per year.

Mann Kendall
statistic = -516

Alpha	Critical	Signif.
0.01	-214	Down
0.05	-164	Down
0.1	-138	Down
0.2	-108	Down

Constituent: Vinyl Chloride (ug/L)

Date: 9/15/05

Facility: Site_FT-1_GW

Time: 9:49 AM

Data File: FT-1GW05

View: FT-1O5

FILE: P:\3629B093\Annual\Figures\2004-05 Annual Report\Drawings\FT-1\FIG_2-23.dwg

URS

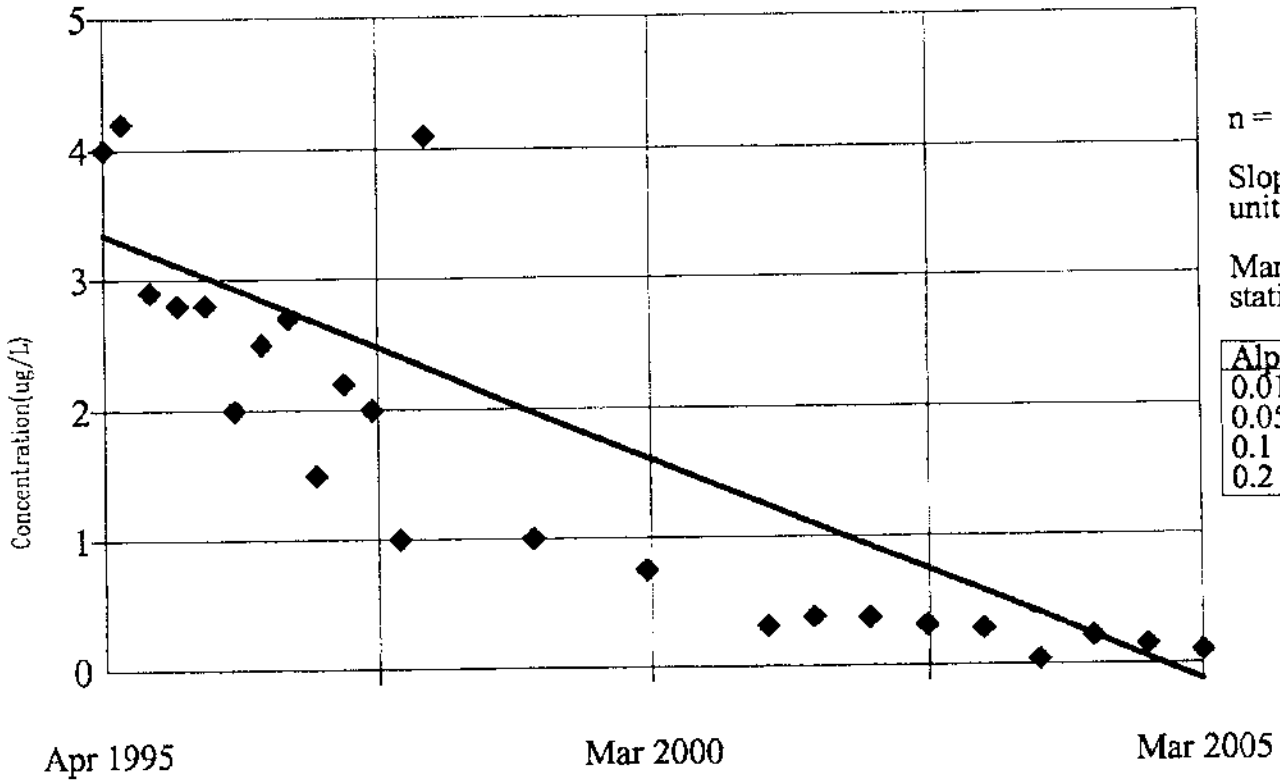
Figure 2-23: Site FT-1 Trend Analysis MW-226 – Vinyl Chloride

FAIRCHILD AIR FORCE BASE

v.1.56. CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-100



n = 24

Slope = -0.349 units per year.

Mann Kendall statistic = -226

Alpha	Critical	Signif.
0.01	-105	Down
0.05	-81	Down
0.1	-68	Down
0.2	-53	Down

Constituent: Vinyl Chloride (ug/L)

Date: 9/15/05

Facility: Site_FT-1_GW

Time: 9:49 AM

Data File: FT-1GW05

View: FT-1O5

File: P:\3629B090\Annual\Figures\2004-05 Annual Report\Drawings\FT-1\FIG. 2-24.dwg

URS

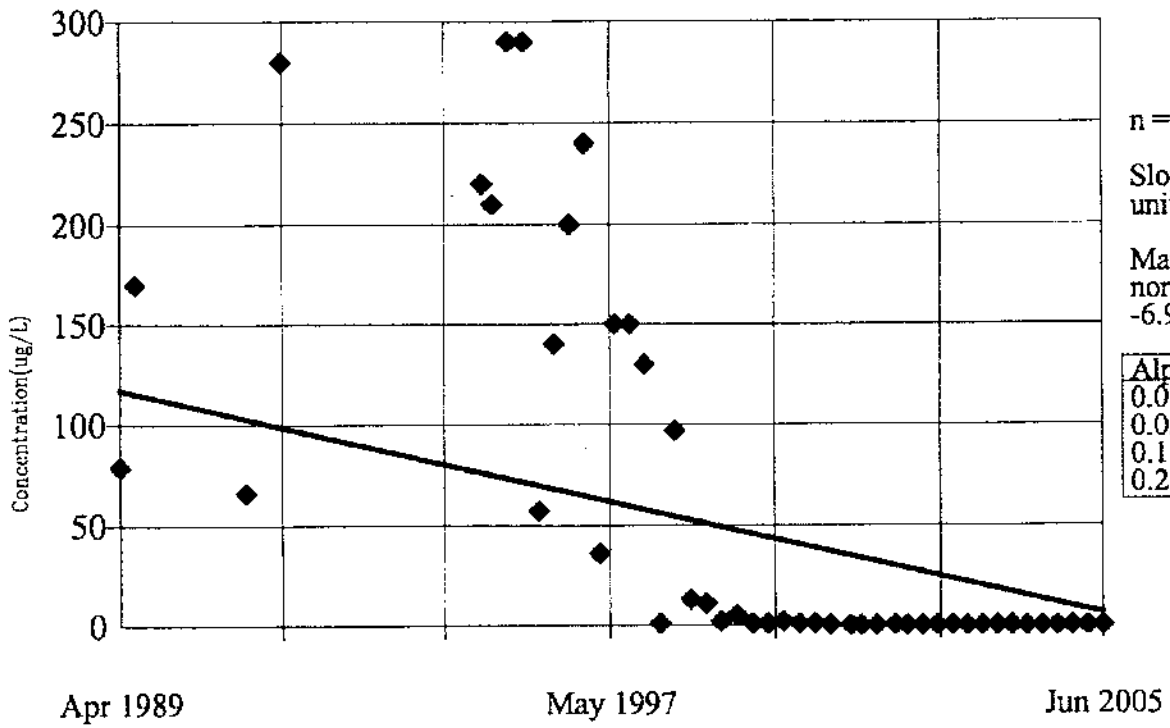
Figure 2-24: Site FT-1 Trend Analysis MW-100 – Vinyl Chloride

FAIRCHILD AIR FORCE BASE

v.1.56. CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-03



n = 46

Slope = -6.855 units per year.

Mann Kendall normal approx. = -6.927

Alpha	Critical	Signif.
0.01	-2.575	Down
0.05	-1.96	Down
0.1	-1.645	Down
0.2	-1.282	Down

Constituent: Benzene (ug/L)

Date: 9/15/05

Facility: Site_FT-1_GW

Time: 9:22 AM

Data File: FT-1GW05

View: FT-1O5

FILE: P:\36298080\Annual\Figures\2004-05 Annual Report\Drawings\FT-1\FIG_2-14.dwg

URS

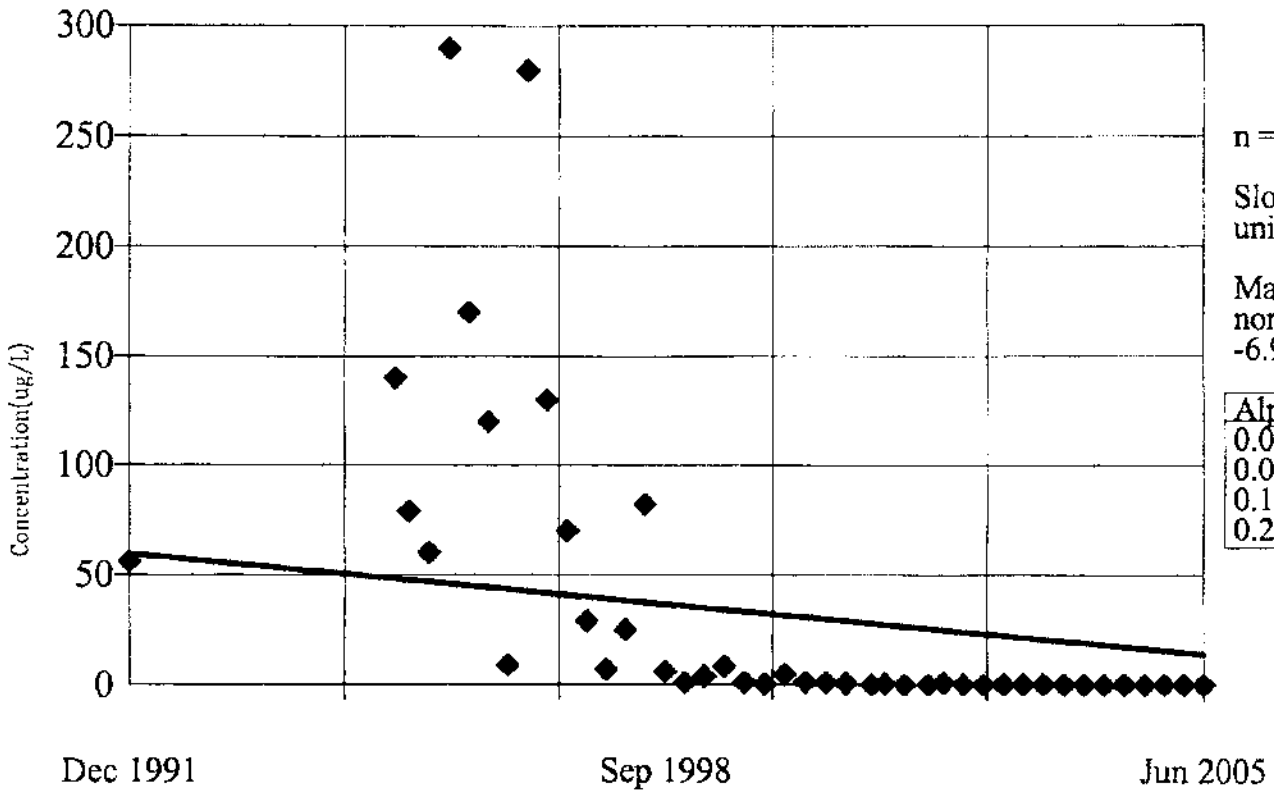
Figure 2-14: Site FT-1 Trend Analysis MW-03 – Benzene

FAIRCHILD AIR FORCE BASE

v. 1.56. CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-152



n = 43

Slope = -3.355 units per year.

Mann Kendall normal approx. = -6.9

Alpha	Critical	Signif.
0.01	-2.575	Down
0.05	-1.96	Down
0.1	-1.645	Down
0.2	-1.282	Down

Constituent: Benzene (ug/L)

Date: 9/15/05

Facility: Site_FT-1_GW

Time: 9:32 AM

Data File: FT-1GW05

View: FT-1O5

File: P:\362980G0\Annual Report\Drawings\FT-1\FIG_2-15.dwg

URS

Figure 2-15: Site FT-1 Trend Analysis MW-152 – Benzene

FAIRCHILD AIR FORCE BASE

TABLE 2.6: SOIL SAMPLING RESULTS-SPRING 2004

Bore-hole	Sample Field Identification	Date Collected	Sample Depth Interval feet bgs	NWTPH-Gx	NWTPH-Dx Diesel	NWTPH-Dx Jet A	Benzene	Ethylbenzene	Xylenes	Toluene	Remarks
			ROD Cleanup Level[6]	100	200	200	0.5	NE[7]	NE	NE	
			MTCA Method A Cleanup Level[8]	100	200	200	0.5	30	20	40	
1	FT1BH014	4/20/2004	2 to 4	4,500	84	200	NA[9]	NA	NA	NA	
1	FT1BH014	6/18/2004	2 to 4	NA	NA	NA	0.02747	0.38176	57.3046-M/J[5]	0.06023	
2	FT1BH024	4/20/2004	2 to 4	310	<5.0	<5.0	NA	NA	NA	NA	
2	FT1BH024	6/18/2004	2 to 4	NA	NA	NA	<0.00025	<0.00037	<0.0005/<0.00037	<0.00046	
3	FT1BH036	4/20/2004	4 to 6	6.1	<5.0	<5.0	NA	NA	NA	NA	
3	FT1BH036	6/18/2004	4 to 6	NA	NA	NA	<0.003	<0.00044	<0.00059/<0.00045	<0.00055	
4	FT1BH046	4/20/2004	4 to 6	<5.7	15	5.2	NA	NA	NA	NA	
4	FT1BH046	6/18/2004	4 to 6	NA	NA	NA	<0.00032	<0.00047	<0.00063/<0.00048	<0.00059	
5	FT1BH054	4/20/2004	2 to 4	<6.3	<5.0	<5.0	NA	NA	NA	NA	
5	FT1BH054	6/18/2004	2 to 4	NA	NA	NA	<0.00025	<0.00037	<0.0005/<0.00038	<0.00047	
6	FT1BH062	4/20/2004	0 to 2	650	1,000	760	NA	NA	NA	NA	
6	FT1BH062	6/18/2004	0 to 2	NA	NA	NA	<0.00085	<0.00125	28.0035-M/J	0.00453-J	
7	FT1BH072	4/20/2004	0 to 2	25	98	32	NA	NA	NA	NA	
7	FT1BH072	6/18/2004	0 to 2	NA	NA	NA	<0.00079	<0.00116	<0.00157/<0.00118	<0.00147	
8	FT1BH082	4/20/2004	0 to 2	6.1	18	<5.0	NA	NA	NA	NA	
8	FT1BH082	6/18/2004	0 to 2	NA	NA	NA	<0.00028	<0.00042	<0.00056/<0.00042	<0.00053	
9	FT1BH094	4/20/2004	2 to 4	8	630	590	NA	NA	NA	NA	
9	FT1BH094	6/18/2004	2 to 4	NA	NA	NA	<0.00026	<0.00038	0.00146-F[9], F	<0.00048	
10	FT1BH5106	4/20/2004	4 to 6	16	18	5.9	NA	NA	NA	NA	Field Duplicate
10	FT1BH5106	6/18/2004	4 to 6	NA	NA	NA	<0.00029	<0.00043	<0.00058/<0.00044	<0.00054	
11	FT1BH0112	4/20/2004	0 to 2	6,100	3,100	8,700	NA	NA	NA	NA	
11	FT1BH0112	6/18/2004	0 to 2	NA	NA	NA	0.00103-J	<0.00035	0.69289-J, J	0.04434-J	
12	FT1BH0122	4/20/2004	0 to 2	4,200	1,000	2,800	NA	NA	NA	NA	

12	FT1BH0122	6/18/2004	0 to 2	NA	NA	NA	<0.00024	<0.00035	<0.00047/<0.00036	<0.00044	
13	FT1BH0132	4/20/2004	0 to 2	**2,100**	**1,400**	**4300**	NA	NA	NA	NA	
13	FT1BH0132	6/18/2004	0 to 2	NA	NA	NA	<0.00025	<0.00036	**20.7176-M/J**	<0.00046	
14	FT1BH0146	4/20/2004	4 to 6	**6.6**	<5.0	<5.0	NA	NA	NA	NA	
14	FT1BH0146	6/18/2004	4 to 6	NA	NA	NA	<0.00027	<0.0004	**0.00085**-F[10]	<0.0005	
15	FT1BH0156	4/20/2004	4 to 6	<6.0	<5.0	**12**	NA	NA	NA	NA	
15	FT1BH0156	6/18/2004	4 to 6	NA	NA	NA	<0.00025	<0.00036	<0.00049/<0.00037	<0.00046	
16	FT1BH0166	4/20/2004	4 to 6	<5.7	<5.0	<5.0	NA	NA	NA	NA	
16	FT1BH0166	6/18/2004	4 to 6	NA	NA	NA	<0.00026	<0.00039	<0.00052/<0.00039	<0.00049	
17	FT1BH0176	4/20/2004	4 to 6	**18**	<5.0	<5.0	NA	NA	NA	NA	MS/MSD[10]
17	FT1BH0176	6/18/2004	4 to 6	NA	NA	NA	<0.00025	<0.00037	<0.0005/<0.00038	<0.00047	MS/MSD
18	FT1BH0182	4/20/2004	0 to 2	<5.8	<5.0	<5.0	NA	NA	NA	NA	
18	FT1BH0182	6/18/2004	0 to 2	NA	NA	NA	<0.00024	<0.00035	<0.00048/<0.00036	<0.00045	
19	FT1BH0194	4/20/2004	2 to 4	<5.7	<5.0	<5.0	NA	NA	NA	NA	
19	FT1BH0194	6/18/2004	2 to 4	NA	NA	NA	<0.00024	<0.00035	<0.00047/<0.00036	<0.00044	
20	FT1BH0206	4/21/2004	4 to 6	<5.4	<5.0	<5.0	<0.00027	<0.0004	<0.00054/<0.00041	<0.0005	
21	FT1BH0214	4/21/2004	2 to 4	**33**	**12**	**26**	<0.00027	<0.00039	<0.00053/<0.0004	<0.00049	
22	FT1BH0226	4/21/2004	4 to 6	<5.6	<5.0	<5.0	<0.00025	<0.00037	<0.0005/<0.00038	<0.00047	
23	FT1BH0234	4/21/2004	2 to 4	<5.7	<5.0	<5.0	<0.00027	<0.00039	<0.00053/<0.0004	<0.00049	
24	FT1BH0244	4/21/2004	2 to 4	<6.2	<5.0	<5.0	<0.00027	<0.00040	<0.00054/<0.0004	<0.0005	Field Duplicate
25	FT1BH0256	4/21/2004	4 to 6	<6.1	<5.0	<5.0	<0.00025	<0.00036	<0.00049/<0.00037	<0.00046	
Quality Control Samples[11]											
15	FT1BH2156	4/21/2004	N/A[12]	<250	<250	<250	NA	NA	NA	NA	Equipment Rinsate
	Trip Blank	4/21/2004	N/A	NA	NA	NA	<0.10	<0.16	<0.21/<0.11	<0.12	Trip Blank
	Trip Blank	4/21/2004	N/A	<250	NA	NA	NA	NA	NA	NA	Trip Blank

1 Soil results reported in milligrams per kilogram (mg/kg)

2 Below ground surface

3 Total Petroleum Hydrocarbons-Gasoline

4 Total Petroleum Hydrocarbons-Diesel

5 First numerical figure represents m,p-xylenes. Second numerical figure

2.3.2 Groundwater Sparge Curtain Wells

During the semi-annual sampling events in 2004 and 2005, benzene was detected at concentrations below the PQL in all sparge curtain wells. In addition, vinyl chloride was not detected in groundwater from any sparge curtain wells. A summary of historical benzene and dissolved oxygen (DO) concentrations for the sparge curtain wells are displayed in Table 2.5: FT-1 Historical Sparge Curtain Well Concentrations.

TABLE 2.5: FT-1 HISTORICAL SPARGE CURTAIN WELL CONCENTRATIONS

Date	MW-249A	MW-249B	MW-249C	MW-250A	MW-250B	MW-250C	MW-251A	MW-251B	MW-251C	MW-252A	MW-252B	MW-252C
Benzene[1] (MTCA Method A Cleanup Level – 5 µg/L)												
Mar-98	<2[2]	<2	<2	7	<2	<2	2	0.4	<2	49	<2	<2
Sept-98	44	8	170	59	26	30	9	35	37	8	8	94
Mar-99	1.83[F(3)]	<2	7.58[F]	3.48[F]	5.22[F]	2.42	0.75[F]	4.4[F]	<2	1.77[F]	0.55[F]	5.1[F]
Sep-99	<2	<2	<2	<2	<2	<2	0.851[F]	1.57[F]	<2	<2	<2	1.51[F]
Mar-00	<2	<2	<20	<10	<2	<2	<2	<2	<2	<2	<2	<20
Sept-00	<2	<2	<10	<2	<2	<10	<2	<10	0.53[F]	<2	<2	<2
Apr-01	<0.105[4]	<0.105	0.36[F]	0.33[F]	0.31[F]	0.33[F]	0.16[F]	<0.105	0.11[F]	0.16[F]	0.16[F]	0.34[F]
Sept-01	<0.09[4]	<0.09	0.34[F]	<0.09	0.21[F]	0.32[F]	0.3[F]	0.27[F]	0.32[F]	<0.09	0.23[F]	0.31[F]
Mar-02	<0.10[4]	<0.10	0.27[F]	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sept-02	<0.10	<0.10	0.33[F]	0.20[F]	0.21[F]	0.25[F]	0.35[F]	0.27[F]	0.24[F]	<0.10	<0.10	0.31[F]
Mar-03	<0.10	<0.10	<0.10	0.15[F]	0.16[F]	0.16[F]	0.11[F]	<0.10	<0.10	<0.10	<0.10	0.13[F]
Sept-03	<0.10	<0.10	0.22[F]	0.17[F]	0.14[F]	0.20[F]	0.20[F]	0.25[F]	<0.10	0.12[F]	0.15[F]	0.25[F]
Mar-04	<0.10	<0.10	0.12[F]	<0.10	<0.10	0.11[F]	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sept-04	<0.10	<0.10	0.16	0.13	0.12	0.17	0.19	0.12	0.12	<0.10	<0.10	0.19
Mar-05	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
DO (mg/L)[5]												
Mar-98	2.07	2.15	2.16	2.65	2.55	2.4	2.63	2.53	2.78	2.38	2.42	2.55
Sept-98	1.59	1.72	1.48	1.67	1.73	1.6	1.81	1.86	1.8	1.67	1.7	1.6
Mar-99	0.02	0.03	0.13	0.0	0.12	0.14	0.14	0.15	0.52	0.08	0.09	0.15
Sept-99	0.18	0.03	0.02	0.02	0	0.06	0	0	0.07	0.11	0.09	0.05
Mar-00	0.485	0.255	0.18	0.085	0.075	1.215	0.125	0.115	1.6	0.24	0.17	0.245
Sept-00	0.105	0.08	0.255	0.41	0.16	0.11	0.15	0.04	0.165	0.205	0.225	0.165
Apr-01	1.9	2.1	1.8	1.0	0.8	1.7	1.7	1.5	1.6	1.9	1.8	1.9
Sept-01	3.7	2.1	2.3	2.3	2.3	2.0	2.1	3.3	2.1	2.0	3.0	2.3
Mar-02	4.5	5.1	3.6	4.2	4.4	4.1	5.6	3.3	8.6	5.0	5.7	4.0
Sept-02	6.2	6.4	3.2	3.2	3.1	4.0	2.3	3.1	3.2	5.3	3.3	1.6
Mar-03	3.6	5.1	6.6	4.1	3.9	4.6	4.5	4.2	8.2	5.0	3.3	3.1
Sept-03	5.4	6.4	3.9	5.8	3.4	2.7	3.4	4.1	3.0	5.3	4.0	2.6
Mar-04	7.6	7.3	5.5	5.1	6.1	5.7	1.6	2.0	4.9	2.5	2.1	0.9
Sept-04	5.5	6.0	4.6	5.1	6.1	4.9	5.5	5.2	5.5	5.3	5.7	5.0
Mar-05	2.45	2.82	2.08	2.05	2.25	2.44	2.35	2.14	2.57	3.75	2.79	3.10

1 – Results in Micrograms per Liter (µg/L)
2 – "<2" Concentration not detected above the Practical Quantitation Limit (i.e., PQL = 2 µg/L)
3 – F: Analyte detected at a concentration less than the PQL, greater than the MDL (flag not used prior to 1999)
4 – "<0.105, <0.09 and <0.10", Concentration not detected above the Method Detection Limit (i.e., MDL = 0.105, 0.09 and 0.10 µg/L)
5 – Milligrams per Liter

Site WW-1, Industrial Wastewater Lagoons

WW-1 Historical TCE Concentrations (µg/L)

Date	MW-11	MW-12	MW-99	MW-102	MW-103	MW-120	MW-147	MW-241	MW-242	MW-243	MW-244	MW-245	MW-254	MW-255	MW-256	MW-257	MW-258	EW-1	EW-3	OW-2	WP-01	WP-02	WP-03
Nov-87	NS	20	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Apr-89	NS	33	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Jul-89	NS	180	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Apr-91	NS	72	NS	190	NS	19	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nov-91	NS	14	NS	58	NS	38	29	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Apr-95	NS	97	NS	130	NS	61	7	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Jun-95	NS	115	NS	315	NS	42	14	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sep-95	NS	45	NS	12	NS	36	16	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Dec-95	NS	3.8	NS	4.4	NS	69	25	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Feb-96	NS	4	NS	300	NS	69	31	1	NS	NS	NS	9	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mar-96	< 2	< 2	< 2	220	< 2	45	18	0.4	< 2	3.2	1.5	3.5	NS	NS	NS	NS	NS	3.7	3.5	NS	12	29	62
Jun-96	< 2	< 2	< 2	71	< 2	46	14	1.8	1	3	1	5.9	NS	NS	NS	NS	NS	1.2	1	NS	47	44	5
Sep-96	< 2	< 2	< 2	6	< 2	57	29	0.4	1.1	2.8	1.2	3.8	NS	NS	NS	NS	NS	28	1.2	NS	3.3	5.6	5.9
Dec-96	< 2	< 2	< 2	190	< 2	52	16	1	2.4	3.3	1.1	7.6	NS	NS	NS	NS	NS	24	3.1	NS	11	4.9	3.6
Mar-97	< 2	170	< 2	830	< 2	45	18	22	1.5	3.3	1.3	2.2	NS	NS	NS	NS	NS	3.3	49	NS	2.2	14	16
Jun-97	NS	1.6	NS	170	NS	45	20	33	8.2	2.1	< 2	2	NS	NS	NS	NS	NS	< 2	16	NS	1.9	34	180
Sep-97	< 2	1	NS	31	NS	24	8	2	4	2	1	5	NS	NS	NS	NS	NS	3	1	NS	110	364	14
Dec-97	NS	0.6	NS	3	NS	18	19	0.9	1	2	0.8	4	NS	NS	NS	NS	NS	2	0.7	NS	44	18	2
Mar-98	NS	0.4	< 2	56	< 2	30	27	2	1	2	1	3	< 2	8	4	0.7	0.7	6	< 2	NS	47	44	2
Jun-98	NS	0.4	NS	1	NS	23	30	0.7	1	2	NS	3	< 2	7	4	0.8	0.5	4	< 2	NS	44	9	1
Sep-98	NS	1	NS	3	NS	27	29	0.6	0.9	2	NS	2	0.3	10	6	0.7	0.6	8	2	NS	17	6	2
Dec-98	NS	< 2	NS	2	NS	25	17	< 2	< 2	2	NS	1	< 2	6	4	< 2	< 2	13	2	NS	9	3	1
Mar-99	< 2	1.52 [F]	< 2	362 [F]	0.41 [F]	20.4	4.44	2.43	0.97 [F]	2.3	0.74	2.16	< 2	3.19	3.53	0.68	0.61 [F]	7.71	4.01	NS	44	3.34	1.7 [F]
Jun-99	NS	< 2	NS	1.28 [F]	NS	20.1	NS	< 2	NS	NS	NS	NS	NS	3.66	3.34	< 2	NS	2.4	0.667 [F]	NS	112	5.35	0.8 [F]
Sep-99	< 2	< 2	NS	< 2	NS	28.3	21.8	< 2	< 2	1.39 [F]	0.626 [F]	1.34 [F]	< 2	5.94	3.07	0.501	< 2	12	1.74 [F]	NS	9.45	2.13	3.79
Dec-99	NS	0.71 [F]	NS	3.98	NS	24	NS	< 2	NS	NS	NS	NS	NS	3.23	2.57	NS	NS	10.4	0.49 [F]	NS	5.94	1.47 [F]	0.91 [F]
Mar-00	< 2	< 2	< 2	66	< 2	22.2	5.74	0.44 [F]	0.73 [F]	1.92 [F]	0.64 [F]	2.18	< 2	2.81	3.08	0.72 [F]	0.56 [F]	10.9	< 2	NS	39.6	3.15	0.55 [F]
Jun-00	NS	0.32	NS	2.03	NS	NS	NS	< 2	NS	NS	NS	NS	NS	2.75	2.97	NS	NS	3.5	< 2	NS	40.6	3.3	0.7 [F]
Sep-00	NS	0.88 [F]	NS	1.19 [F]	NS	3.91	9.84	< 2	0.7 [F]	NS	< 2	1.74 [F]	< 2	3.52	2.64	1.05 [F]	< 2	8.32	0.55 [F]	NS	9.47	1.35 [F]	0.64 [F]
Dec-00	NS	0.72 [F]	NS	9.11	NS	NS	NS	0.45 [F]	NS	2.45	NS	NS	NS	3.54	2.4	NS	NS	9.79	0.48 [F]	NS	12.6	1.61 [F]	0.77 [F]
Mar-01	< 2	0.31 [F]	< 2	1.03 [F]	< 2	9.78	3.86	< 2	0.49 [F]	3.91	0.44 [F]	1.41 [F]	< 2	1.08 [F]	1.16 [F]	0.61 [F]	0.34 [F]	4.92	< 2	NS	8.84	37.7	2.71
Jun-01	NS	< 1	NS	0.74	NS	NS	NS	< 1	NS	NS	NS	NS	NS	1.83	2.31	NS	NS	9.15	0.45 [J]	NS	1.81 [J]	0.84 [J]	1.04 [J]
Sep-01	NS	< 1	NS	0.45 [F]	NS	1.52	2.56	< 1	< 1	4.42	NS	0.98 [F]	< 1	3.42	1.17	0.49 [F]	< 1	2.12	0.45 [F]	NS	1.31	0.9 [F]	0.66 [F]
Dec-01	NS	0.89 [F]	NS	1.26	NS	NS	NS	0.49 [F]	NS	NS	NS	NS	NS	2.58	2.21	NS	NS	5.76	0.6 [F]	NS	2.29	1.86	0.98 [F]
Mar-02	< 1	< 1	< 1	2.55	< 1	2.44	3.67	0.32 [F]	0.56 [F]	8.46	0.46 [F]	2.63	< 1	0.36 [F]	2.05	0.95 [F]	0.53 [F]	5.23	0.4 [F]	NS	0.54 [F]	1.76	9.17
Jun-02	NS	< 1	NS	1.03	NS	NS	NS	0.41 [F]	NS	NS	NS	NS	NS	0.78 [F]	2.42	NS	NS	2.27	< 1	NS	2.13	0.93 [F]	0.37 [F]
Sep-02	NS	0.35 [F]	NS	0.67	NS	2.5	3.01	0.4 [F]	0.72 [F]	2.32	NS	1.48	< 1	4.1	2.36	1	0.44 [F]	3.33	0.48 [F]	NS	1.29	0.86 [F]	0.42 [F]
Dec-02	NS	0.31 [F]	NS	2.13	NS	NS	NS	< 1	NS	NS	NS	NS	NS	0.71 [F]	1.29	NS	NS	2.48	< 1	NS	1.15	0.76 [F]	0.47 [F]
Mar-03	ND	0.14 [F]	ND	2.15	0.11 [F]	1.5	1.96	0.78	0.40 [F]	2.09	0.33 [F]	1.79	0.17 [F]	0.47 [F]	1.41	0.82	0.52	2.35	0.22 [F]	NS	1.4	0.71	0.31 [F]
Jun-03	NS	0.21 [F]	NS	0.55	NS	NS	2.03	0.74	NS	1.64	NS	NS	NS	1.13	1.82	NS	NS	1.85	0.22 [F]	NS	0.94	0.72	0.36 [F]
Sep-03	ND	0.35 [F]	NS	0.62	NS	1.5	1.99	0.42 [F]	0.43 [F]	1.30	NS	0.91	0.23 [F]	3.48	1.83	0.76	0.33 [F]	2.49	0.5 [F]	NS	0.82	0.79	0.38 [F]
Dec-03	NS	0.26 [F]	NS	10.4	NS	NS	NS	0.28 [F]	NS	NS	NS	NS	NS	0.63	1.30	NS	NS	2.40	0.36 [F]	NS	1.01	0.65	0.46 [F]
Mar-04	ND	0.08 [F]	ND	0.84	ND	1.63	1.85	0.72	0.40 [F]	2.59	0.25 [F]	2.02	0.10 [F]	ND	1.01	0.92	0.43 [F]	1.75	0.19 [F]	3.48	0.73	NS	NS
Jun-04	NS	NS	NS	4.04	NS	NS	NS	NS	NS	1.94 [J]	NS	NS	NS	NS	NS	NS	NS	NS	1.88	3.51	0.5	NS	NS
Sep-04	NS	0.27 [F]	NS	0.47 [F]	NS	1.34	1.69	0.27 [F]	0.36 [F]	1.52	NS	0.92	0.19 [F]	2.25	1.31	NS	0.38 [F]	NS	0.32 [F]	2.71	0.61	NS	NS
Dec-04	NS	NS	NS	0.35 [F]	NS	NS	NS	NS	NS	2.27	NS	ND	ND	NS	NS	NS	NS	NS	0.21 [F]	NS	0.67	NS	NS

Notes:

F Analyte detected at a concentration less than the PQL, greater than the MDL (flag not used pre - 1999)

Data through December 2002 obtained from Montgomery Watson Harza (MWH, 2003) (Table 4.3); 2003 and 2004 data collected by CH2M HILL.

ND - compound not detected above the method detection limit (MDL) which was 0.03 µg/L for both cis-1,2-DCE and TCE in 2003, 2004. Non detects prior to 2003 indicated by < symbol.

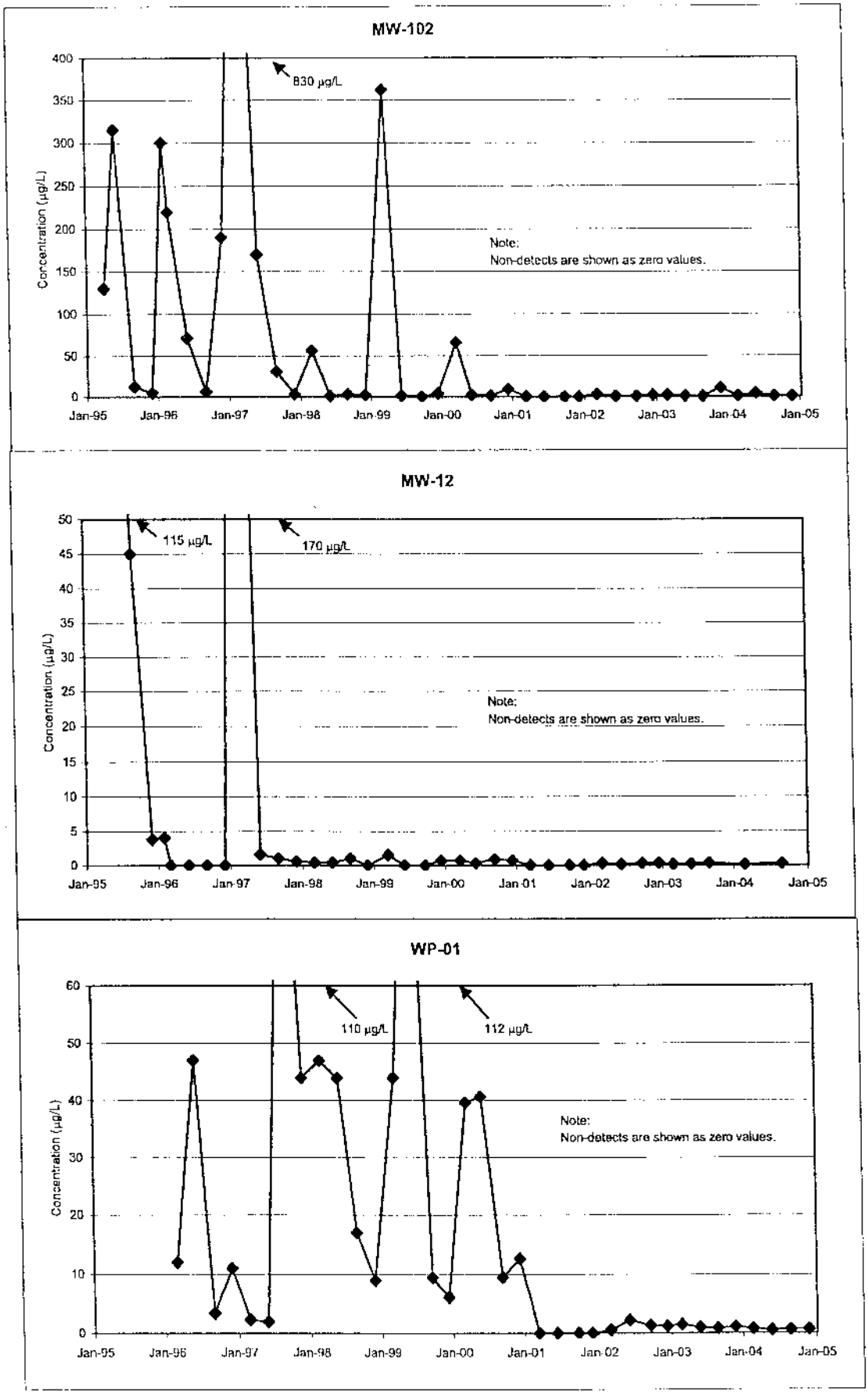
NS - not sampled

Table 2-6
WW-1 Historical Arsenic Concentrations (μg/L)

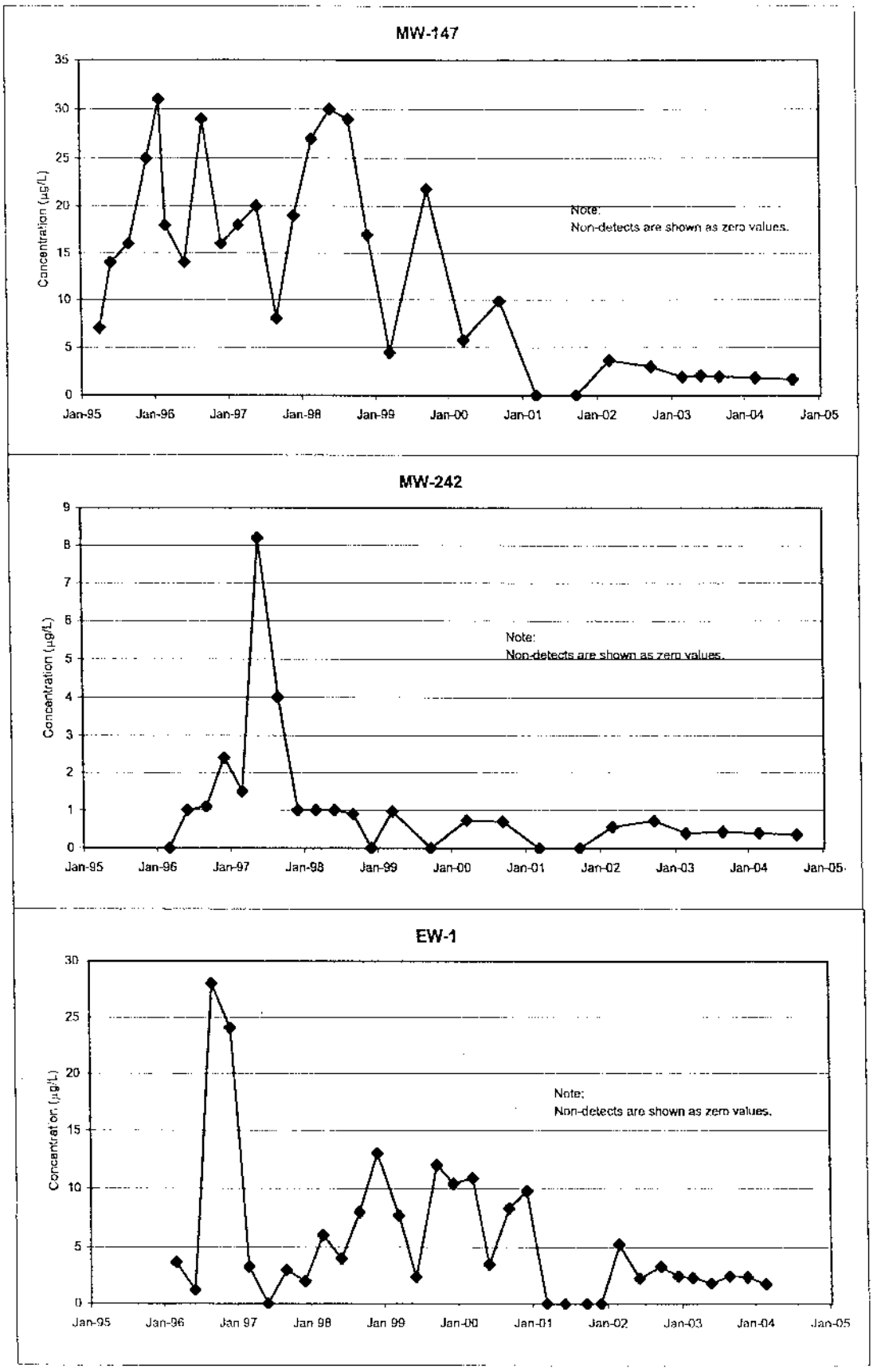
Well	Mar-01	Sep-01	Mar-02	Sep-02	Mar-03	Sep-03	Mar-04
Source Area/Onbase							
MW-11	25.5	24.7	18.6	31[B]	33	34.5	27.95
MW-12	38.5	32.6	32.2	34.3[B]	27.1	77.8	45.08
MW-102	4,840	120	203	211[B]	86.1	171	103
Offbase-near							
MW-147	16.5	8.26[UB]	15.4	13.3	21	17.5	7.18
MW-241	4.66[F]	11.0	9.21	8.83	12.0	9.81	66.9
Offbase-mid							
MW-120	ND	ND	1.8[F]	3.7[F]	5.0[F]	2.2[F]	1.56
MW-243	NS	NS	NS	NS	NS	7.5	2.4
Offbase-far							
MW-245	1.8[F]	NS	ND	NS	ND	NS	ND
MW-255	ND	ND	3.62[F]	3.0[F]	3.1	1.31	ND
MW-256	ND	ND	3.86[F]	2.22[F]	4.4[F]	2.51[F]	1.72
MW-258	ND	ND	3.14[F]	2.57[F]	ND	1.67[F]	ND

Notes:
ND = Not Detected
NS = Not Sampled
[F] Analyte detected at a concentration less than PQL, but greater than MDL
[B] Analyte detected in the associated blank as well as in the sample
[UB] Analyte detected in an associated blank as well as in the sample
- Arsenic was not analyzed for prior to 2001.
- Data through December 2002 obtained from Montgomery Watson Harza; 2003 and 2004 data collected by CH2M HILL

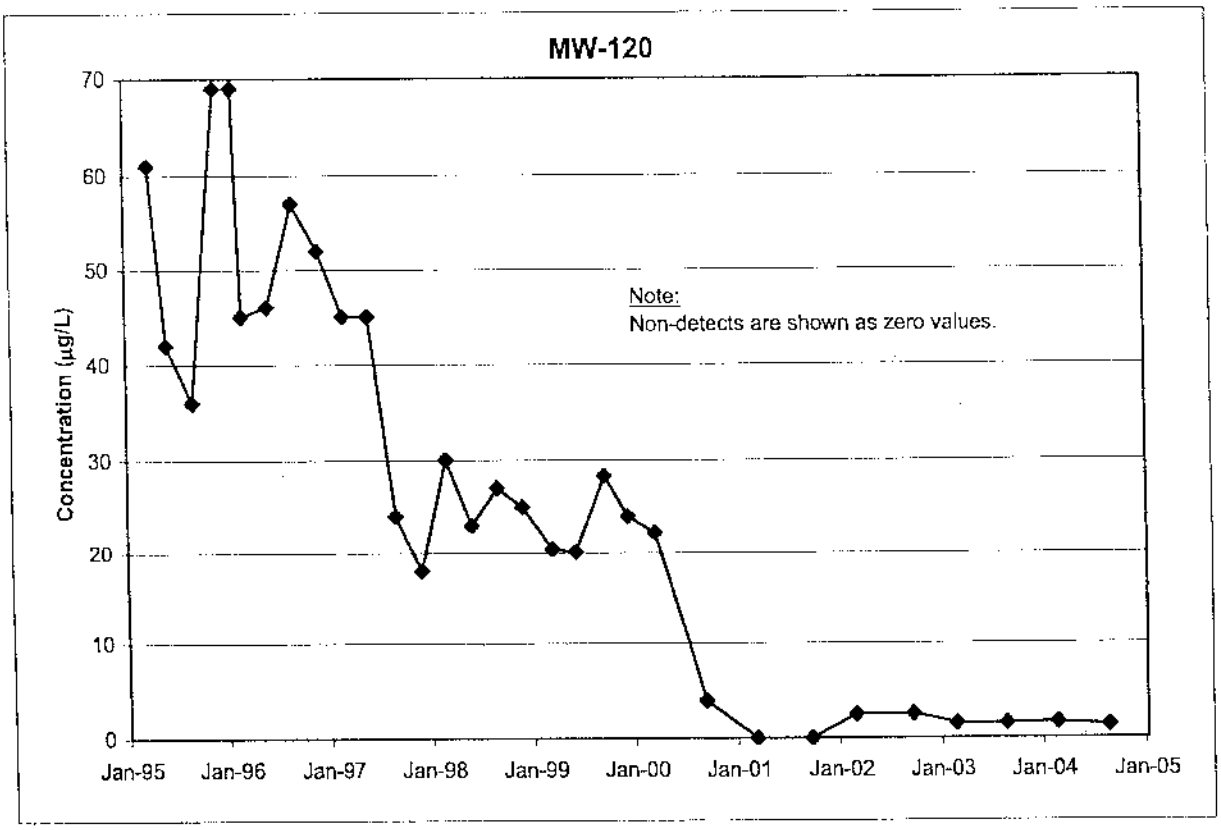
Figures 2-6a, 2-6b and 2-6c
Historical TCE Concentrations
(Source Area / Onbase)

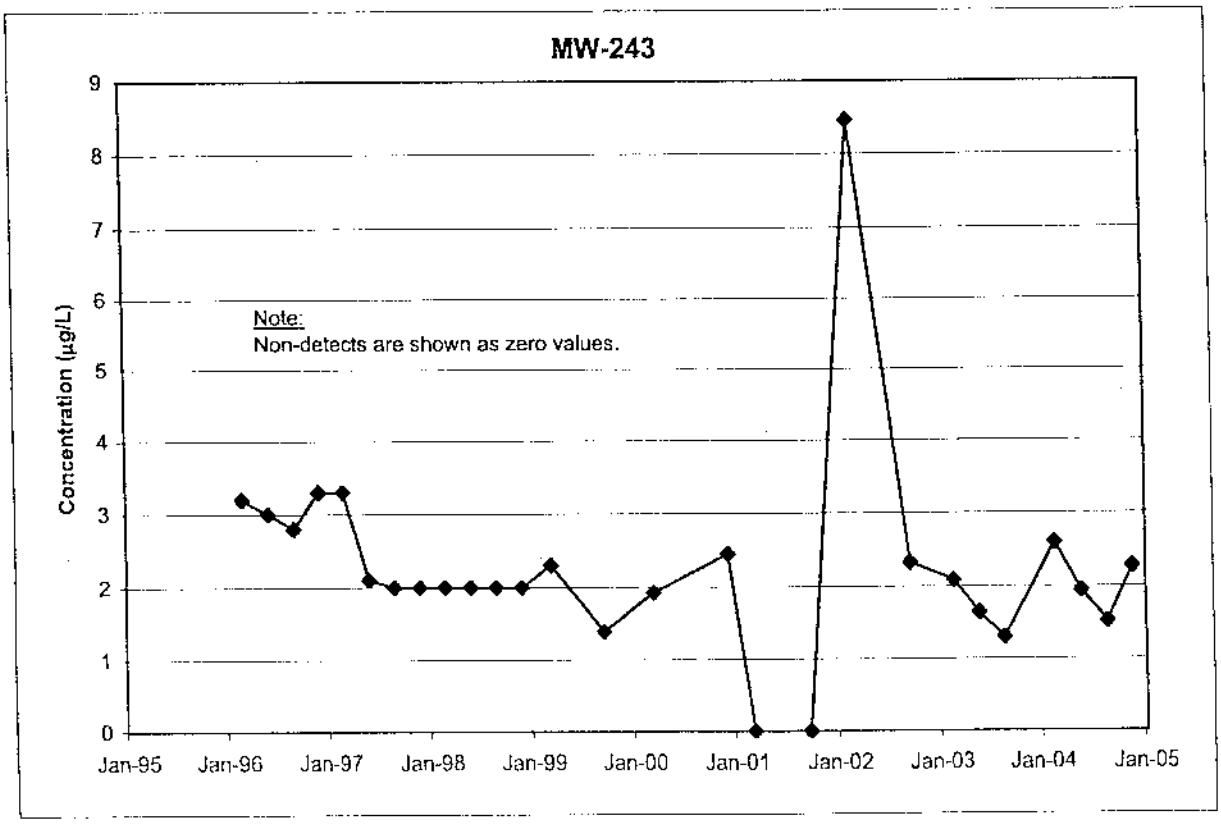


Figures 2-7a, 2-7b and 2-7c
Historical TCE Concentrations
(Offbase-near)

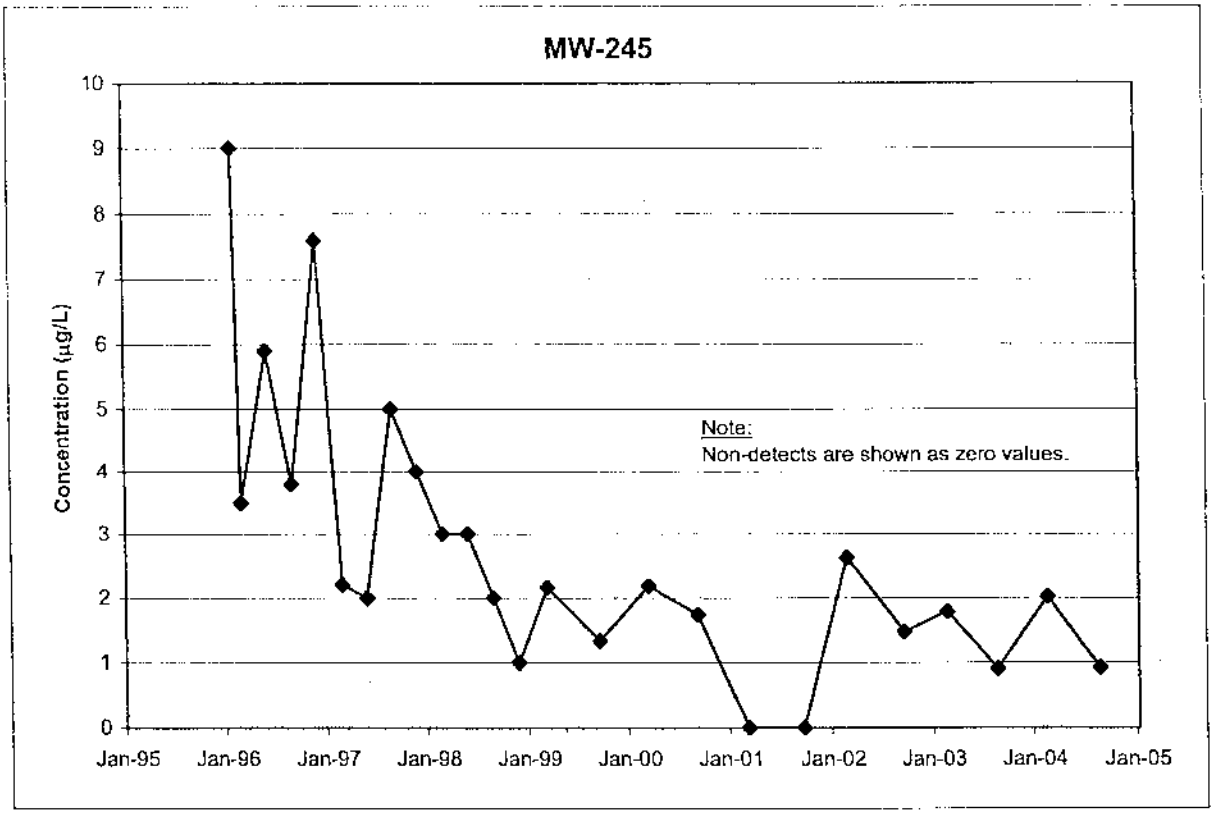


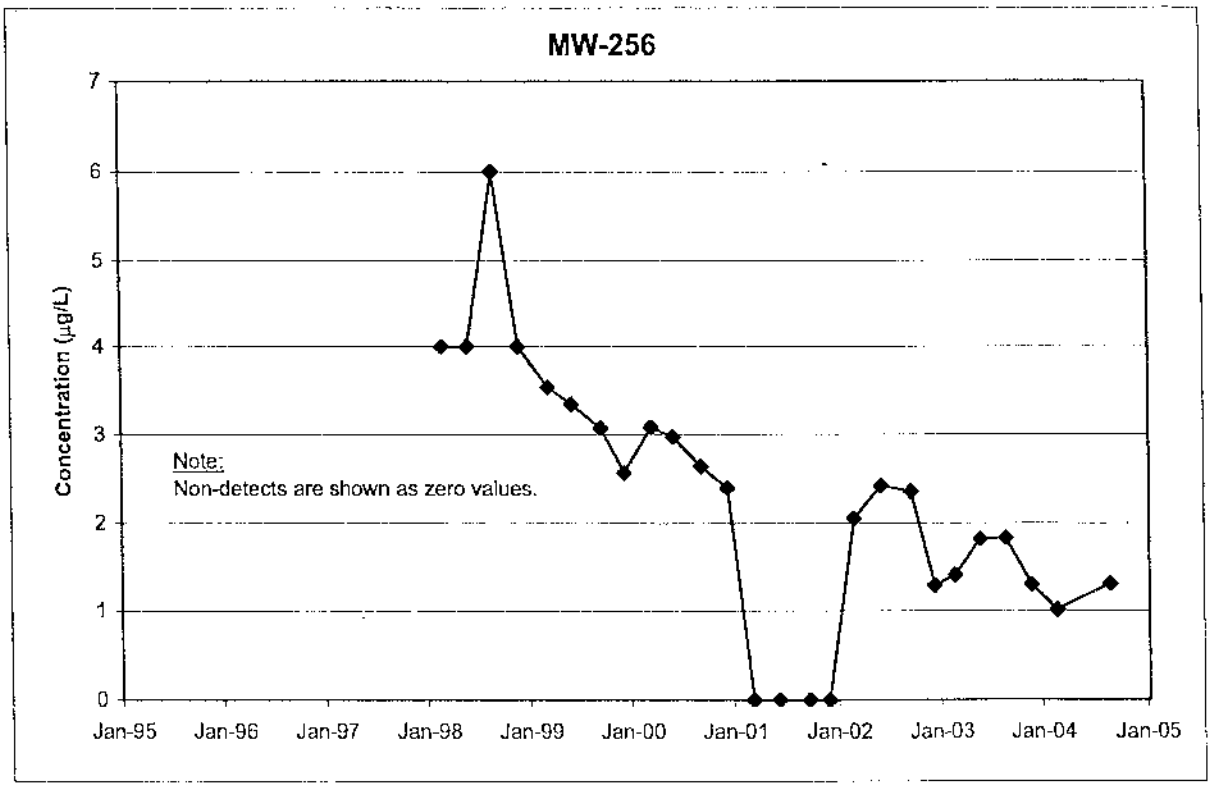
Figures 2-8a and 2-8b
Historical TCE Concentrations
(Offbase-mid)





Figures 2-9a and 2-9b
Historical TCE Concentrations
(Offbase-far)





Appendix C
Additional Information for Individual Priority Two Sites

Site IS-4, Jet Engine Test Cell

TABLE 7.1: IS-4 APRIL 2003 SOIL SAMPLING RESULTS

Grid Number	Sample Field Identification	Date Collected	Sample Depth (feet bgs)1	NWTPH-Dx2 Diesel3 (mg/kg)3	NWTPH-Dx Jet A (mg/kg)	ROD Cleanup Level	Remarks
1	IS4BH016	6/16/2004	4 to 6	<6.24	<6.2-R	200	
2	IS4BH026	6/16/2004	4 to 6	<5.7	<5.7	200	
3	IS4BH036	6/16/2004	4 to 6	130	**300**	200	
4	IS4BH048	6/16/2004	6 to 8	<6.4	9.5	200	
5	IS4BH058	6/16/2004	6 to 8	17	38	200	
19	IS4BH0198	6/16/2004	6 to 8	79	41	200	MS/MSD
20	IS4BH5204	6/16/2004	2 to 4	**4,200**	**3,400**	200	Field Duplicate
21	IS4BH0214	6/16/2004	2 to 4	160	**220**	200	
21N	IS4BH021N6	6/16/2004	4 to 6	77	120	200	
34	IS4BH0346	6/16/2004	4 to 6	**790**	**2,700**	200	
34N	IS4BH034N8	6/16/2004	6 to 8	150	**370**	200	
37	IS4BH0378	6/16/2004	6 to 8	<5.7	<5.7	200	
38	IS4BH0386	6/16/2004	4 to 6	<5.6	<5.6	200	
41	IS4BH0416	6/16/2004	4 to 6	<5.7	<5.7	200	
43	IS4BH0434	6/16/2004	2 to 4	21	9.4	200	
Quality Control Sample				µg/L6	µg/L		
36	IS4BHBH248	6/16/2004	Not Applicable	<250	<250-R	Not Applicable	Equipment Blank

1 - Below ground surface
2 – Northwest Total Petroleum Hydrocarbons-Diesel Extended
3 - Milligrams per kilogram
4 - "<5.0" Concentration not detected above the PQL (i.e., PQL = 5 mg/kg)
5 - Bold value indicates concentration above cleanup level
6 - Micrograms per Liter

7.3.2 October 2004 Analytical Results

Diesel and jet fuel as Jet A were detected above the ROD soil cleanup level in soil samples collected from 3 of the 15 boreholes. Two samples southeast and one sample northeast of the land farm excavation created in September 2004 exceeded the ROD soil cleanup level. Sample locations and analytical results are presented in Figure 7-2 and summarized in Table 7-2.

TABLE 7.2: IS-4 OCTOBER 2004 SOIL SAMPLING RESULTS

Borehole	Sample Field Identification	Date Collected	Sample Depth (feet bgs1)	NWTPH-Dx2 Diesel (mg/kg3)	NWTPH-Dx Jet A (mg/kg)	ROD Method A Cleanup Level	Remarks
1	IS4BH014	10/7/2004	2 to 4	29	7	200	
2	IS4BH024	10/7/2004	2 to 4	46	5.4	200	
3	IS4BH032	10/7/2004	0 to 2	29	<5.24	200	
4	IS4BH042	10/7/2004	0 to 2	<5.2	<5.2	200	
5	IS4BH054	10/7/2004	2 to 4	<5.2	<5.2	200	MS/MSD
6	IS4BH068	10/7/2004	6 to 8	<5.6	<5.6	200	
7	IS4BH076	10/7/2004	4 to 6	**450**	**790**	200	
8	IS4BH086	10/7/2004	4 to 6	**1200**	**4200**	200	
9	IS4BH098	10/7/2004	6 to 8	39	86	200	
10	IS4BH0108	10/7/2004	6 to 8	8.8	<5.8	200	
11	IS4BH0118	10/7/2004	6 to 8	6.6	<5.9	200	
12	IS4BH0128	10/7/2004	6 to 8	39	48	200	
13	IS4BH0138	10/7/2004	6 to 8	10	<5.8	200	
14	IS4BH0142	10/7/2004	0 to 2	**450**	25	200	
15	IS4BH0152	10/7/2004	0 to 2	16	<5.3	200	
Quality Control Sample				µg/L5	µg/L		
12	IS4BH2128	10/7/2004	Not Applicable	<250	<250	Not Applicable	Equipment Blank

1 - Below ground surface
2 – Northwest Total Petroleum Hydrocarbons-Diesel Extended
3 - Milligrams per kilogram
4 - "<5.0" Concentration not detected above the PQL (i.e., PQL = 5 mg/kg)
5 - Micrograms per Liter

Table 7.4: IS-4 LANDFARM EXCAVATION CONFIRMATION SOIL SAMPLING RESULTS – SEPTEMBER 2004

Sample Field Identification	Date Collected	NWTPH-Dx1 Jet A (mg/kg2)	NWTPH-Dx Diesel (mg/kg)	Remarks
ROD Cleanup Level		200	200	
IS4LFW104	9/2/04	600	940	West Wall
IS4LFS104	9/2/04	230	210	South Wall
IS4LFE104	9/2/04	270	160	East Wall
IS4LFB104	9/2/04	<5.0	<5.0	Bottom
IS4LFW204	9/16/04	<6.2	<6.2	West Wall
IS4LFE204	9/16/04	11	<5.9	East Wall
IS4LFN204	9/16/04	21	<5.3	North Wall
IS4LFNE204	9/16/04	13	12	Northeast Wall
IS4LFB204	9/16/04	<6.2	<6.2	Bottom

1 Northwest Total Petroleum Hydrocarbons – Diesel Extended
2 Milligrams per kilogram

Table 7.5: IS-4 LANDFARM SOIL SAMPLING RESULTS – SEPTEMBER 2005

Sample Field Identification	Date Collected	NWTPH-Dx1 Jet A (mg/kg2)	NWTPH-Dx Diesel (mg/kg)	ROD Cleanup Level
IS4LFCOMP1	9/12/05	84	41	200
IS4LFCOMP2	9/12/05	96	97	200
IS4LFCOMP3	9/12/05	280	300	200
IS4LFCOMP4	9/12/05	190	170	200
IS4LFCOMP5	9/12/05	120	140	200
IS4LFCOMP6	9/12/05	210	240	200
IS4LFCOMP7	9/12/05	78	30	200
IS4LFCOMP8	9/12/05	100	99	200
IS4LFCOMP9	9/12/05	300	500	200
IS4LFCOMP10	9/12/05	130	55	200
IS4LFCOMP11	9/12/05	97	20	200
IS4LFCOMP12	9/12/05	130	140	200
IS4LFCOMP13	9/12/05	960	1,900	200
IS4LFCOMP14	9/12/05	73	55	200
IS4LFCOMP15	9/12/05	230	140	200
IS4LFCOMP16	9/12/05	100	36	200
IS4LFCOMP17	9/12/05	95	20	200

1 Northwest Total Petroleum Hydrocarbons – Diesel Extended
2 Milligrams per kilogram

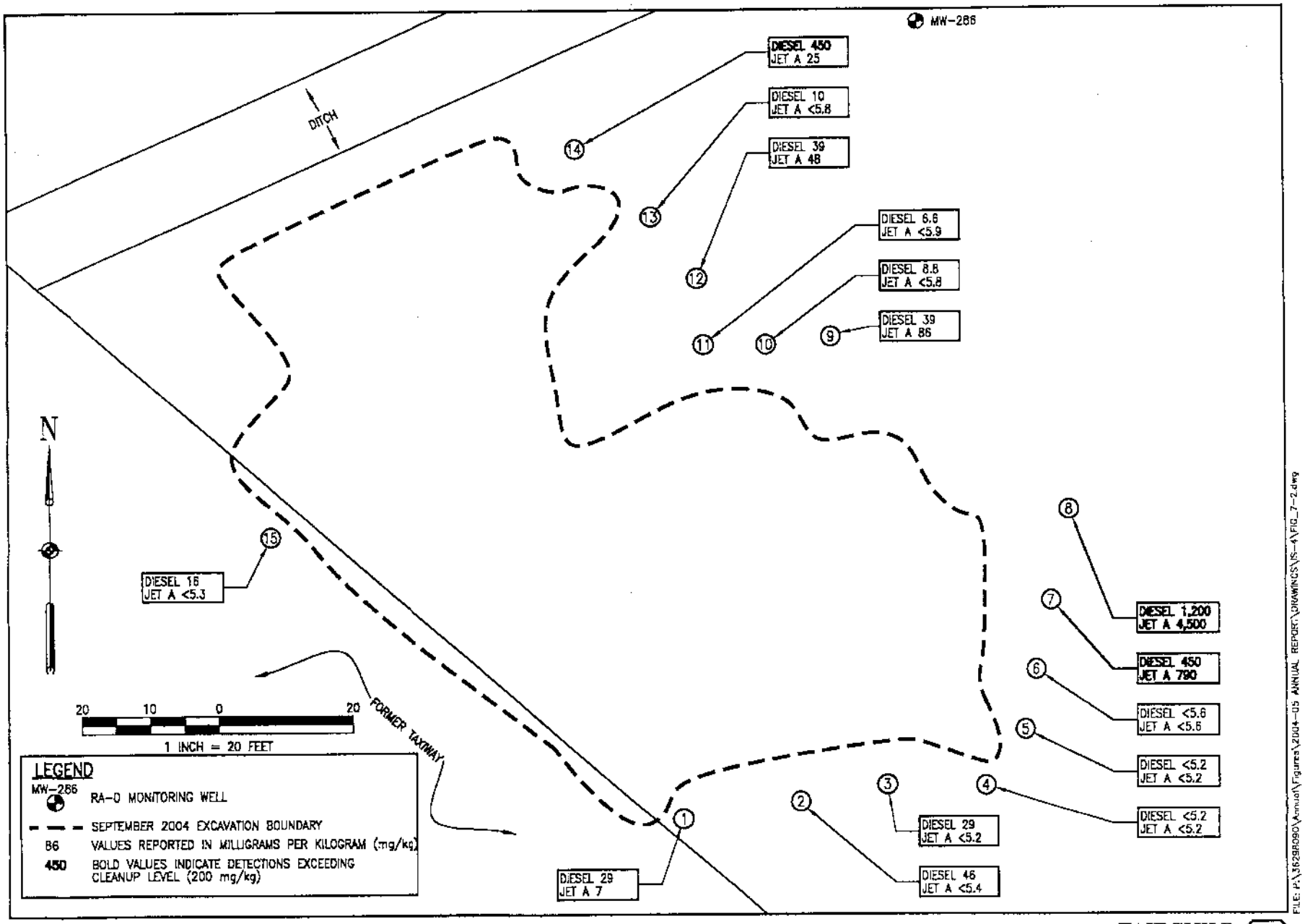


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Figure 7-2: Site IS-4 Soil Sample Locations and TPH-D Concentrations – October 2004

FAIRCHILD AIR FORCE BASE

Site PS-1, POL Bulk Storage Area

TABLE 5.2: PS-1 HISTORICAL BENZENE AND TPH-D CONCENTRATIONS (µg/L)[1]

Date	MW-195		MW-196		MW-207		MW-208	
	Benzene	TPH-D	Benzene	TPH-D	Benzene	TPH-D	Benzene	TPH-D
4/1/1993	-	-	-	-	-	-	-	7000
7/1/1993	-	-	-	-	-	-	670	290
10/1/1993	-	-	6.5	<500[2]	-	-	950	4000
1/1/1994	-	-	<1	<500	-	-	160	3100
3/1/1996	<2	<50	260	3800	<2	<50	1.9	5200
9/1/1996	<2	<50	12	1800	<2	<50	7.7	4000
3/1/1997	<2	<50	88	1800	<2	<50	1.9	1300
9/1/1997	<2	<50	4	640	<2	<50	4	2700
3/1/1998	<2	<50	<1	1000	<2	<50	<2	850
9/1/1998	-	-	5	750	-	-	0.6	840
3/18/1999	<2	<50	0.613-F[4]	<50	<2	<50[5]	0.379-F	129[3]
9/23/1999	-	-	5.32	1310	-	-	0.43-F	944
3/17/2000	<2	76.1-F	<2	259-F	<2	49.6-F	<2	597
9/15/2000	-	-	2.6	1580	-	-	0.56-F	2900
4/1/2001	<0.105	47	<0.105	270	<0.105	28	<0.105	760
9/1/2001	-	-	0.5	1,110	-	-	0.25	923
3/21/2002	<0.10	<250	0.3-F	510	<0.10	<250	<0.10	740
9/16/2002	-	-	0.39-F	2,300	-	-	0.25	820
4/8/2003	<0.10	<250	0.52	1,400	<0.10	<250	<0.10	<250
9/18/2003	-	-	0.98	240	-	-	0.13-F	410
4/2/04	<0.10	<250	<0.10	590	<0.10	<250	<0.10	<250
6/3/04	<0.10	-	-	-	-	-	-	-
10/1/04	<0.10	-	<0.10	<250	-	-	<0.10	<250
12/20/04	<0.10	-	-	-	-	-	-	-
4/6/2005	<0.20	<250	<0.20	<250	<0.20	<250	<0.20	<250
6/22/05	<0.20	-	-	-	-	-	-	-

1 – Micrograms per Liter
2 – < Demotes concentration not detected above the Method Detection Limit (i.e., MDL =0.105 ug/L).
3 – Analyzed by Washington State Extractable Petroleum Hydrocarbons (EPH) method not WTPH method; data point not used in statistical analysis due to biased EPH result
4 – F: Analyte detected at a concentration less than the PQL, greater than the MDL (flag not used before 1999)

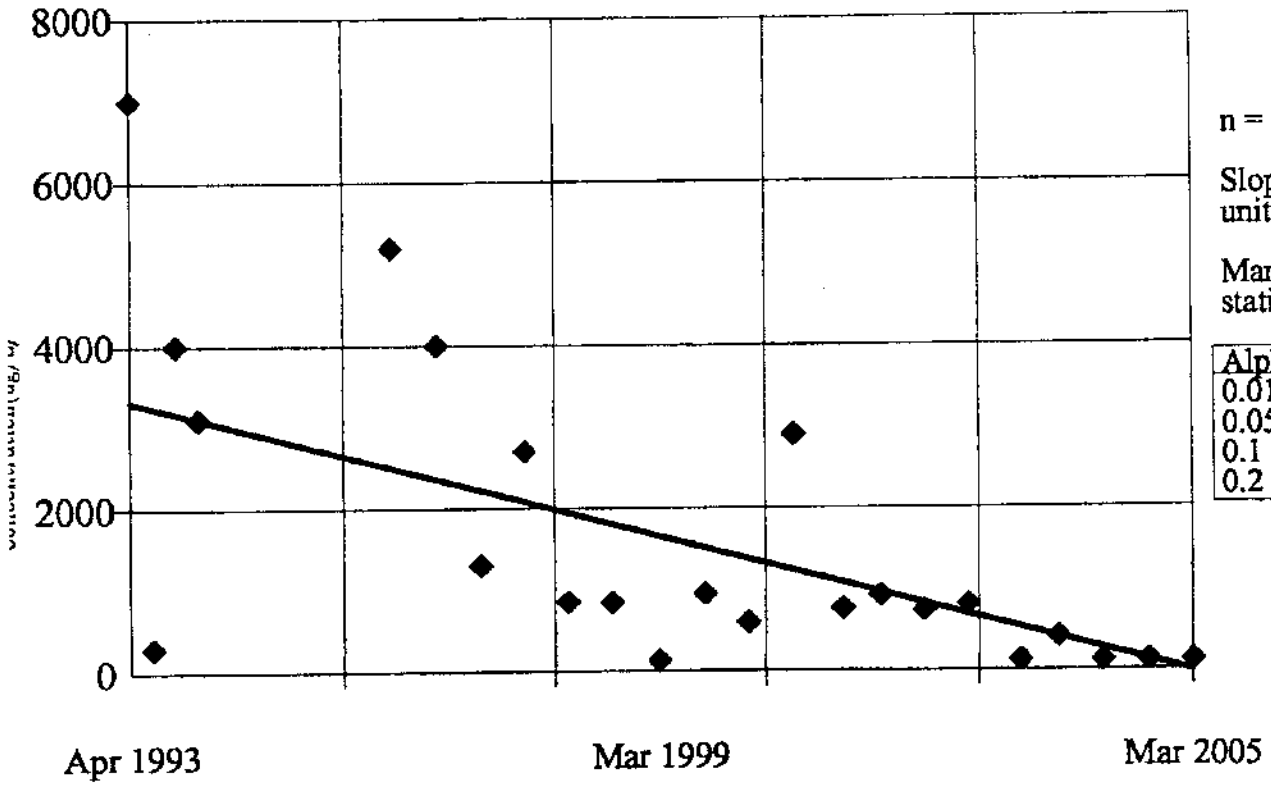
5.3.5 Trend Analysis

The Mann-Kendall statistical analysis for increasing and decreasing trends was performed on MW-196 and MW-208 with historic detects of benzene and TPH-D. Trend analysis was not performed on MW-195 and MW-207 since benzene and TPH-D had been detected in less than 25 percent of sampling events. It is important to note that the slopes generated by the analysis represent a best statistical estimate of the trend and are not actual decay rates.

CAS# n/a

WQStat Plus™

SEN'S SLOPE ESTIMATOR
MW-208



n = 23

Slope = -278.13 units per year.

Mann Kendall statistic = -154

Alpha	Critical	Signif.
0.01	-98	Down
0.05	-76	Down
0.1	-64	Down
0.2	-50	Down

Constituent: TPH-D (ug/L)

Date: 9/15/05

Facility: Site_PS-1_GW

Time: 11:07 AM

Data File: PS1GW05

View: PS-1GW05

FILE: P:\36286060\Annual\Figures\2004-05 ANNUAL REPORT\DRAWINGS\PS-1\FIG_5-18.dwg

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Figure 5-18: Site PS-1 Trend Analysis MW-208 – TPH Diesel

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Site PS-1 Soil Sample Analytical Results[1]

Borehole	Sample Field Identification	Date Collected	Sample Depth Interval feet bgs[2]	NWTPH-Dx[3] Diesel	NWTPH-Dx Jet A	Remarks
			ROD Cleanup Level[4]	200	200	
1	PS1BH514	6/17/2004	2 to 4	**110**	**160**	Field Duplicate
2	PS1BH026	6/17/2004	4 to 6	**1,200**	**5,000**	
3	PS1BH034	6/17/2004	2 to 4	<5.9	**8.2**	
4	PS1BH046	6/17/2004	4 to 6	**200**	**380**	
5	PS1BH556	6/17/2004	4 to 6	**840**	**3,700**	Field Duplicate
6	PS1BH066	6/17/2004	4 to 6	**220**	**760**	
7	PS1BH076	6/17/2004	4 to 6	**180**	**550**	
8	PS1BH084	6/17/2004	2 to 4	**230**	**680**	
9	PS1BH096	6/17/2004	4 to 6	<5.5	<5.5	MS/MSD[5]
10	PS1BH0106	6/17/2004	4 to 6	**290**	**1,700**	
11	PS1BH0114	6/15/2004	2 to 4	**800**	**1,400**	
12	PS1BH0124	6/15/2004	2 to 4	<6.9	<6.9	
13	PS1BH0133	6/15/2004	2 to 3	<6.9	**10**	
14	PS1BH0144	6/15/2004	2 to 4	**760**	**1,200**	
15	PS1BH0153	6/15/2004	2 to 3	<6.7	**7.8**	
16	PS1BH0164	6/15/2004	2 to 4	<6.7	<6.7	
17	PS1BH0173	6/15/2004	2 to 3	**42**	**75**	
18	PS1BH0186	6/17/2004	4 to 6	<5.8	<5.8	
19	PS1BH0196	6/17/2004	4 to 6	<6.3	<6.3	
20	PS1BH0206	6/17/2004	4 to 6	**43**	**65**	
21	PS1BH0216	6/17/2004	4 to 6	<6.6	**7.9**	
22	PS1BH0226	6/18/2004	4 to 6	**490**	**790**	
23	PS1BH0236	6/18/2004	4 to 6	<5.9	<5.9	
24	PS1BH0246	6/18/2004	4 to 6	<5.7	<5.7	
25	PS1BH0256	6/18/2004	4 to 6	<6.0	<6.0	
			Quality Control Sample[6]			
9	PS1BH296	6/17/2004	Not Applicable	<250	<250	Equipment Blank

1 Soil results reported in milligrams per kilogram (mg/Kg)

2 Below ground surface

3 Northwest Total Petroleum Hydrocarbons - Diesel Extended

4 Record of Decision values are from the Final Record of Decision for Priority 2 Sites at Fairchild Air Force Base, September 1995.

5 Matrix Spike/Matix Spike Duplicate

6 Quality control sample reported in micrograms per liter (ug/L)

Note: Bolded numbers indicate detections above the method detection limit but below cleanup levels. Bolded and highlighted numbers indicate detections exceeding cleanup levels.

Site FT-2, Old Fire Training Area

TABLE 6.1: FT-2 APRIL 2004 SOIL SAMPLE ANALYTICAL RESULTS (mg/kg)[1]

Grid Number	Sample Field Identification	Date Collected	Sample Depth (feet bgs[2])	NWTPH-Dx[3] Diesel	NWTPH-Dx Jet A	ROD Cleanup Level	Remarks
44	FT2BH	4/21/2004	2 to 4	**590**	**740**	200	
49	FT2BH	4/21/2004	4 to 6	**310**	**350**	200	
62	FT2BH	4/21/2004	4 to 6	<5.0	<5.0	200	MS/MSD
73	FT2BH	4/21/2004	6 to 8	**580**	**780**	200	
74	FT2BH	4/21/2004	4 to 6	**60**	**9.5**	200	
113	FT2BH	4/21/2004	4 to 6	**1,100**	**1,600**	200	
117	FT2BH	4/21/2004	6 to 8	**170**	**240**	200	
118	FT2BH	4/21/2004	6 to 8	<5.0	<5.0	200	
123	FT2BH	4/21/2004	2 to 4	**400**	**350**	200	
124	FT2BH	4/21/2004	2 to 4	<5.0	<5.0	200	
127	FT2BH	4/21/2004	4 to 6	<5.0	<5.0	200	
144	FT2BH	4/21/2004	2 to 4	<5.0	<5.0	200	
145	FT2BH	4/21/2004	6 to 8	**230**	**260**	200	
157	FT2BH	4/21/2004	4 to 6	<5.0	<5.0	200	
163	FT2BH	4/21/2004	6 to 8	<5.0	<5.0	200	
Quality Control Sample				µg/L[6]	µg/L		
	FT2BH21618		Not Applicable	<250	<250	Not Applicable	Equipment Blank

1 - Milligrams per kilogram
2 – Below ground surface
3 - Northwest Total Petroleum Hydrocarbons-Diesel Extended
4 – "<5.0" Concentration not detected above the PQL (i.e., PQL = 5 mg/kg)
5 – Bold and highlighted values are above the MTCA Cleanup Level
6 - Micrograms per Liter

6.3.2 October 2004 Analytical Results

Diesel and jet fuel as Jet A were detected above the MTCA soil cleanup level in three of 15 soil samples, ranging up to 3,200 mg/kg. Diesel and jet fuel as Jet A were detected below the MTCA soil cleanup level in two additional soil samples ranging from 7 mg/kg to 82 mg/kg. October 2004 TPH-D concentrations are presented in *Table 6.2: FT-2 October 2004 Soil Sample Analytical Results* and illustrated on Figure 6-2.

TABLE 6.2: FT-2 OCTOBER 2004 SOIL SAMPLE ANALYTICAL RESULTS (mg/kg)[1]

Borehole	Sample Field Identification	Date Collected	Sample Depth (feet bgs[2])	NWTPH-Dx[3] Diesel	NWTPH-Dx Jet A	MTCA Method A Cleanup Level	Remarks
1	FT2BH16	10-7-04	4 to 6	<6.7[4]	<6.7	200	
2	FT2BH028	10-7-04	6 to 8	<5.9	<5.9	200	
3	FT2BH038	10-7-04	6 to 8	<6.5	<6.5	200	
4	FT2BH048	10-7-04	6 to 8	**500**[5]	**92**	200	
5	FT2BH058	10-7-04	6 to 8	<5.8	<5.8	200	
6	FT2BH068	10-7-04	6 to 8	<5.7	<5.7	200	
7	FT2BH078	10-7-04	6 to 8	<6.5	<6.5	200	
8	FT2BH088	10-8-04	6 to 8	<5.9	<5.9	200	
9	FT2BH098	10-8-04	6 to 8	<5.8	<5.8	200	
10	FT2BH0108	10-8-04	6 to 8	<6.2	<6.2	200	
11	FT2BH0118	10-8-04	6 to 8	<5.8	<5.8	200	MS/MSD
12	FT2BH0128	10-8-04	6 to 8	**1,400**	**3,200**	200	Field Duplicate
13	FT2BH0136	10-8-04	4 to 6	7	<6.2	200	
14	FT2BH0148	10-8-04	6 to 8	**82**	**76**	200	
15	FT2BH0156	10-8-04	4 to 6	**760**	**860**	200	
Quality Control Sample				µg/L[6]	µg/L		
9	FT2BH298	10-8-04	Not Applicable	<250	<250	Not Applicable	Equipment Blank

1 - Milligrams per kilogram
2 - Below ground surface
3 - Northwest Total Petroleum Hydrocarbons-Diesel Extended
4 - "<6.7" Concentration not detected above the PQL (i.e., PQL = 6.7 mg/kg)
5 - Bold and highlighted values are above the MTCA Cleanup Level
6 - Micrograms per Liter

6.4.3 March 2005 Sampling Event

Groundwater initially purged from MW-283 contained suspended sediment, however, the suspended sediment cleared from the well by the end of purging activities. In addition, groundwater purged from MW-283 had a noticeable petroleum odor. The petroleum odor remained in the well throughout purging and sampling activities.

6.4.4 Groundwater Elevations

Depth-to-water measurements were collected quarterly at FT-2 RA-O wells in 2004 and 2005. Groundwater elevations peaked in April and ranged from 2408.56 to 2411.7 feet and were at their lowest levels in September, ranging from 2403.71 to 2409.72 feet. The June and December groundwater elevations ranged from 2407.39 to 2411.19 feet and 2403.95 to 2410.47 feet, respectively. In 2005 groundwater elevations ranged from 2407.32 to 2410.77 and 2407.28 to 2410.77 in April and June respectively. Based on the April 2004 and 2005 groundwater elevation contours, groundwater at FT-2 generally flows east-southeast at an approximate gradient of 0.0074 and 0.006 respectively. Potentiometric surface maps generated from April, June, September and December 2004 and April and June 2005 data are presented as Figures 6-3, 6-4, 6-5, 6-6, 6-7, and 6-8. The 2004 groundwater elevation data is provided in Appendix C.

6.5 GROUNDWATER ANALYTICAL RESULTS

In 2004/05, no groundwater samples collected from the FT-2 wells were found to contain TPH-D concentrations above the ROD groundwater cleanup level of 1,000 µg/L. Diesel was present in MW-283 and MW-285 in April 2005 at 270 µg/L and 360 µg/L respectively. No TPH-D was detected above the RQL in groundwater samples collected from site wells in September 2004. *Table 6.4: FT-2 April and September 2004 Groundwater TPH-D Concentrations* presents the analytical data from the April and September 2004 and April 2005 sampling events.

TABLE 6.4: FT-2 APRIL & SEPTEMBER 2004 GROUNDWATER TPH-D CONCENTRATIONS

Well Number	Sample Field Identification	Date Collected	NWTPH-Dx[1] Diesel (µg/L[2])	NWTPH-Dx[1] Oil (µg/L[2])	MTCA Method A Cleanup Level
MW-283	FT2MW283GW01	4-1-04	**260**	<250[3]	1000
	FT2MW283GW03	9-27-04	<250	<250	1000
	FT2MW283GW01	4-8-05	<250	**270**	1000
MW-284	FT2MW284GW01	4-1-04	<250	<250	1000
	FT2MW284GW03	9-27-04	<250	<250	1000
	FT2MW284GW01	4-8-05	<250	<250	1000
MW-285	FT2MW285GW01	4-1-04	**270**	<250	1000
	FT2MW285GW03	9-27-04	<250	<250	1000
	FT2MW285GW01	4-8-05	**360**	<250	1000

1 - Northwest Total Petroleum Hydrocarbons-Diesel Extended
2 - Micrograms per Liter

Table 6.5: FT-2 Landfarm Soil Sampling Results – May 2004

Sample Field Identification	Date Collected	NWTPH-Dx[1] Jet A (mg/kg[2])	NWTPH-Dx Diesel (mg/kg)	MTCA Method A Cleanup Level
FT2LFCS01	5-6-04	54	10	200
FT2LFCS02	5-6-04	44	9.9	200
FT2LFCS03	5-6-04	27	9.2	200
FT2LFCS04	5-6-04	35	14	200
FT2LFCS05	5-6-04	120	29	200
FT2LFCS06	5-6-04	55	8.9	200
FT2LF01	5-6-04	64	13	200
FT2LF02	5-6-04	38	7.4	200
FT2LF03	5-6-04	32	9.9	200
FT2LF04	5-6-04	63	40	200
FT2LF05	5-6-04	34	6.3	200
FT2LF06	5-6-04	55	22	200

1 Northwest Total Petroleum Hydrocarbons – Diesel Extended
2 Milligrams per kilogram

Table 6.6: FT-2 Landfarm Soil Sampling Results – September 2004

Sample Field Identification	Date Collected	NWTPH-Dx[1] Jet A (mg/kg[2])	NWTPH-Dx Diesel (mg/kg)	MTCA Method A Cleanup Level
FT2LFWTP404	9-23-04	22	<6.0	200
FT2LFN04	9-23-04	<6.4	<6.4	200
FT2LFE04	9-23-04	**240**	**380**	200
FT2LFS04	9-23-04	**18**	**6.6**	200
FT2LFB04	9-23-04	**66**	**120**	200
FT2LFNW04	9-23-04	<6.2	<6.2	200
FT2LFW04	9-23-04	<6.4	<6.4	200

1 Northwest Total Petroleum Hydrocarbons – Diesel Extended
2 Milligrams per kilogram
3 Bold values indicate above the MTCA cleanup level

Table 6.7: FT-2 Landfarm Soil Sampling Results – September 2005

Sample Field Identification	Date Collected	NWTPH-Dx[1] Jet A (mg/kg[2])	NWTPH-Dx Diesel (mg/kg)	ROD Cleanup Level
FT2LFCOMP1	9/15/05	84	41	200
FT2LFCOMP1	9/15/05	96	97	200
FT2LFCOMP1	9/15/05	**280**	**300**	200

1 Northwest Total Petroleum Hydrocarbons – Diesel Extended
2 Milligrams per kilogram
3 Bold values indicate above the MTCA cleanup level

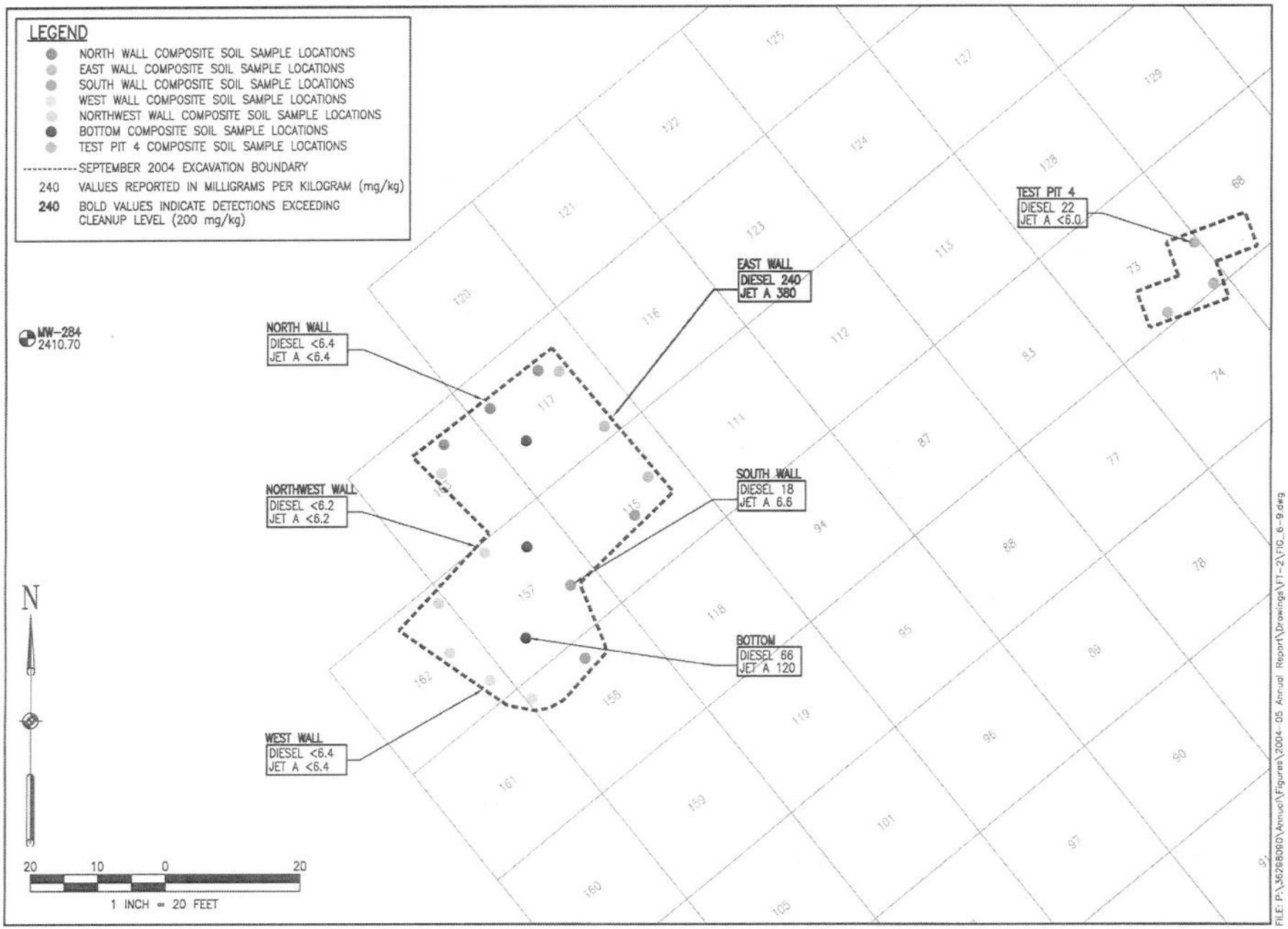

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Figure 6-9: Site FT-2 Excavation and Test Pit Verification Soil Sample Locations and TPH-D Concentrations
September 2004

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