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Confirmation Sampling and Analysis Plan for Spill Site No. 1

Eaker Air Force Base
Blytheville, Arkansas

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

Air Force Base Conversion Agency/DA
Eaker Air Force Base, Arkansas

July 1998

PARSONS
PARSONS ENGINEERING SCIENCE, INC.

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FINAL

CONFIRMATION SAMPLING AND ANALYSIS PLAN FOR SPILL SITE NO. 1

EAKER AIR FORCE BASE
BLYTHEVILLE, ARKANSAS

Prepared for:

Air Force Center for Environmental Excellence
Brooks Air Force Base, Texas

and

Eaker AFBCA
Eaker Air Force Base, Arkansas

July 1998

Prepared by:

Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, Colorado 80290

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ACRONYMS AND ABBREVIATIONS

°C	degrees centigrade
$\mu g/kg$	micrograms per kilogram
$\mu g/L$	micrograms per liter
ACL	alternative corrective action limit
ADEQ	Arkansas Department of Environmental Quality
AFB	Air Force Base
AFBCA	Air Force Base Conversion Agency
AFCEE	Air Force Center for Environmental Excellence
ASTM	American Society for Testing and Materials
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAL	corrective action limit
COPC	chemical of primary concern
CMS	corrective measures study
DO	dissolved oxygen
ft/ft	foot per foot
HNUS	Haliburton NUS
IDW	investigation-derived waste
MCL	maximum contaminant levels
mg/kg	milligrams per kilogram
MP	monitoring point
NFRAP	No Further Response Action Planned
OD	outside diameter
ORP	oxidation/reduction potential
PAH	polynuclear aromatic hydrocarbon
Parsons ES	Parsons Engineering Science, Inc.
PID	photoionization detector
ppmv	parts per million, by volume
QA/QC	quality assurance/quality control
RBCA	risk-based corrective action
RBSL	risk-based screening level
redox	reduction oxidation
RNA	remediation by natural attenuation
SAP	Sampling and Analysis Plan
SSL	soil screening level
TCO	total chromatigraphable organics
TVH	total volatile hydrocarbons
TVPH	total volatile petroleum hydrocarbons
TVHA	total volatile hydrocarbon analyzer
USEPA	US Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
VW	vent well

SECTION 1

INTRODUCTION

This confirmation sampling and analysis plan (SAP) for Spill Site No. 1, Eaker Air Force Base (AFB), Arkansas has been prepared by Parsons Engineering Science, Inc. (Parsons ES) for submittal to the US Air Force Center for Environmental Excellence (AFCEE), Brooks AFB, Texas, and Eaker Air Force Base Conversion Agency (AFBCA), Arkansas. This SAP is intended to guide soil, soil gas, and groundwater sampling at Spill Site No. 1 to document the effectiveness of bioventing for the remediation of petroleum-hydrocarbon-contaminated soils and to provide data for a risk-based assessment of contaminants remaining in site soils and groundwater. Spill Site No. 1 is the location of a release of jet fuel from former underground storage tanks (USTs) and/or associated product piping. The site is part of a solid waste management unit (SWMU) that includes the former UST system fuel pipeline and several other sites. Closure activities for this entire SWMU will be performed by Haliburton NUS (HNUS) at a later date.

In 1995, Spill Site No. 1 was selected as a pilot-test site for the AFCEE Extended Bioventing Program. This ongoing program involves more than 50 *in situ* bioventing sites at 32 military installations nationwide and provides funding for pilot- and full-scale bioventing system installation, extended operation of installed bioventing systems, and completion of confirmatory soil sampling and site closure documents, if extended bioventing testing results indicate adequate site remediation has been achieved.

The pilot-scale bioventing system was installed and initial pilot testing was performed in March/April 1996 (Parsons ES, 1996). Following initial testing, the bioventing system was optimized, and system operation was continued for 1 year. One-year testing was performed in May/June 1997. The purpose of the pilot test at Spill Site No. 1 was to evaluate the effectiveness of bioventing in remediating unsaturated soils contaminated with petroleum hydrocarbons thought to have resulted from jet fuel released from the former USTs and/or associated piping. Based on the results of the extended bioventing test, *in situ* bioventing appears to have reduced petroleum hydrocarbon contamination in vadose zone soils sufficiently to meet target risk-based concentrations outlined in the American Society for Testing and Materials (ASTM, 1995) *Standard Guide for Risk-Based Corrective Action (RBCA) Applied at Petroleum Release Sites*.

The objective of the confirmation sampling described in this SAP is to document the effectiveness of soil remediation at Spill Site No. 1 and to demonstrate compliance with ASTM (1995) RBCA guidance for future site closure. The proposed confirmation sampling described in Section 4 targets vadose zone soils, soil gas, and groundwater in the vicinity of former Pumphouse No. 4. Soil and groundwater data will be used to prepare a streamlined risk-based assessment of remaining petroleum hydrocarbon contamination at the site, and groundwater data also will be used to evaluate the rate of natural chemical attenuation occurring in groundwater. The sampling effort is being performed as part of the AFCEE Extended Bioventing project. It is anticipated that analytical results will support an Air Force-directed no-further-response-action-planned (NFRAP) decision for this site.

This SAP consists of nine sections, including this introduction. Section 2 includes a site description, site history, and summaries of previous investigation and remediation activities. Section 3 summarizes current ASTM risk-based screening levels (RBSLs) and provides a brief discussion of anticipated RBCA requirements. A detailed SAP is presented in Section 4. Analytical results will be presented in a confirmation sampling report as described in Section 5. Section 6 lists Eaker AFBCA support requirements, and Section 7 presents the proposed project schedule. Air Force and contractor points of contact are provided in Section 8, and the cited references are provided in Section 9.

SECTION 2

SITE DESCRIPTION

2.1 SITE LOCATION AND HISTORY

The location of Spill Site No. 1 relative to the Base is shown on Figure 2.1. The site layout is shown in Figure 2.2. Spill Site No. 1 is located near former Pumphouse No. 4 (Building 1020), between Pumphouse No. 2 and the southeastern terminus of the flight apron. Four 50,000-gallon underground storage tanks (USTs) containing jet propulsion fuel grade 4 (JP-4), and one 2,000-gallon JP-4 waste collection UST were formerly located northeast and southwest of Pumphouse No. 4.

Six- and 10-inch diameter pipelines were used to transfer fuel from the four 50,000-gallong tanks to the aircraft fueling hydrants on the flight apron. Pressure testing of the fuel hydrant system, performed in 1973, indicated the presence of a leak in the 6-inch fuel line, northwest of Pumphouse No. 4 (US Air Force, 1995), and the system was subsequently taken out of service. During the subsequent pipeline repair, petroleum-contaminated soils were observed in the shallow excavation. The time-frame and amount of fuel released are unknown. The USTs and Building 1020 were removed in 1994, and the fuel lines were abandoned in place (Ogden Environmental and Energy Service [Ogden], 1994). The tank excavation was backfilled with clean soil and seeded with grass. The site is currently vacant and inactive.

2.2 SITE GEOLOGY AND HYDROGEOLOGY

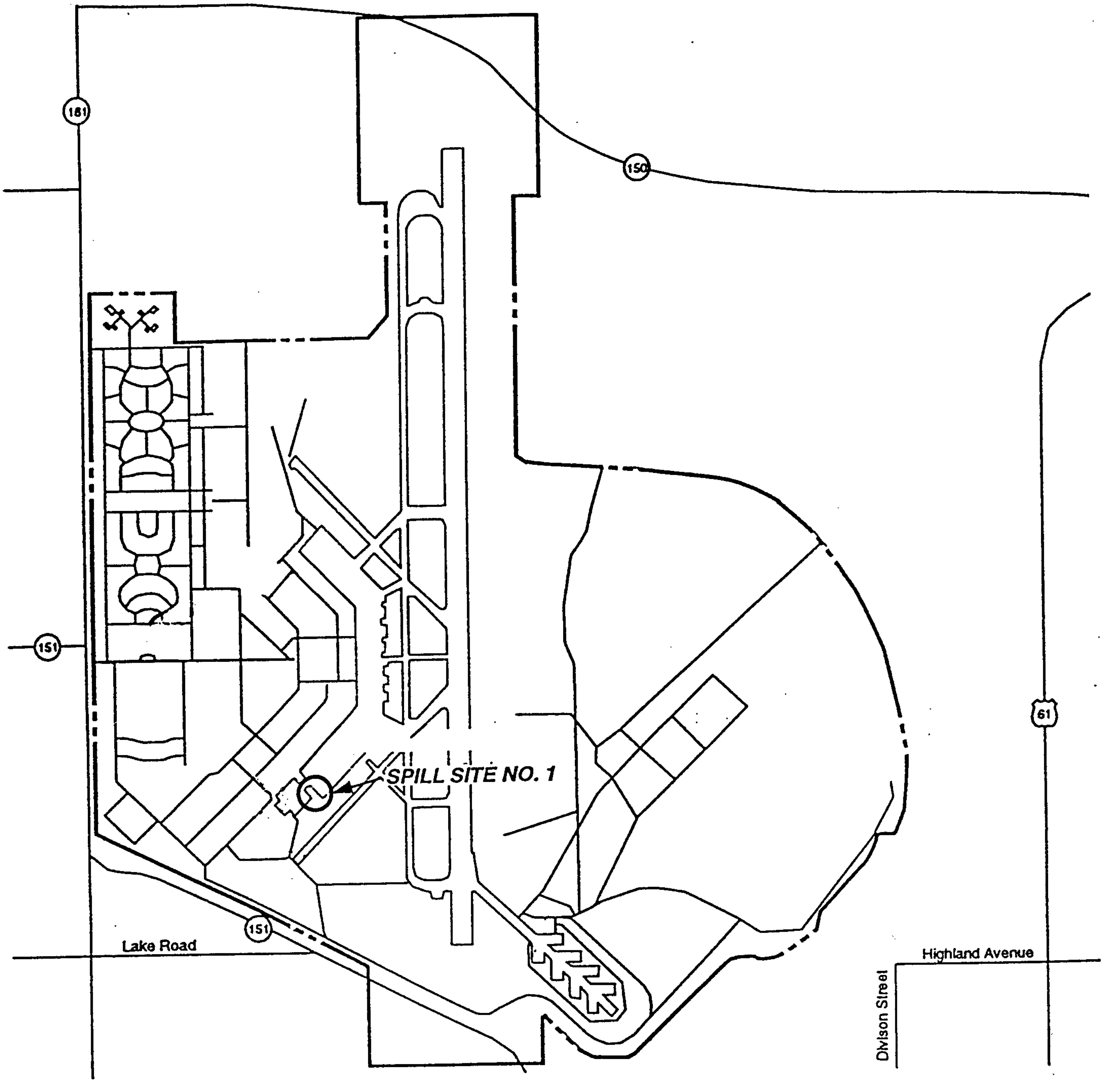
Unsaturated soils at the site consist of approximately 4 to 6 feet of dense silty clay, overlying 6 to 8 feet of clayey silt with traces of sand. In the vicinity of the former USTs, clean fill material consists of a mixture of clay, silt, and sand. There are no permanent bodies of surface water in the immediate vicinity of Spill Site No. 1.

Groundwater has been observed within a fine silty sand material that is encountered at depths of approximately 8 to 23 feet below ground surface (bgs), depending on the location. At Spill Site No. 1, shallow groundwater occurs under water table (unconfined) conditions. In April 1997, groundwater was measured in the VWs at depths of approximately 12.5 to 14.5 feet bgs, prior to air injection bioventing.

2.3 PREVIOUS INVESTIGATIONS

2.3.1 1994 Tank Removal

In September 1994, Ogden Environmental performed tank removal activities at Pumphouse 4 (Spill Site No. 1). A total of four soil samples for analysis of total



Source: US Air Force, 1995.

FIGURE 2.1

SITE LOCATION WITH RESPECT TO EAKER AFB

Eaker AFB, Arkansas

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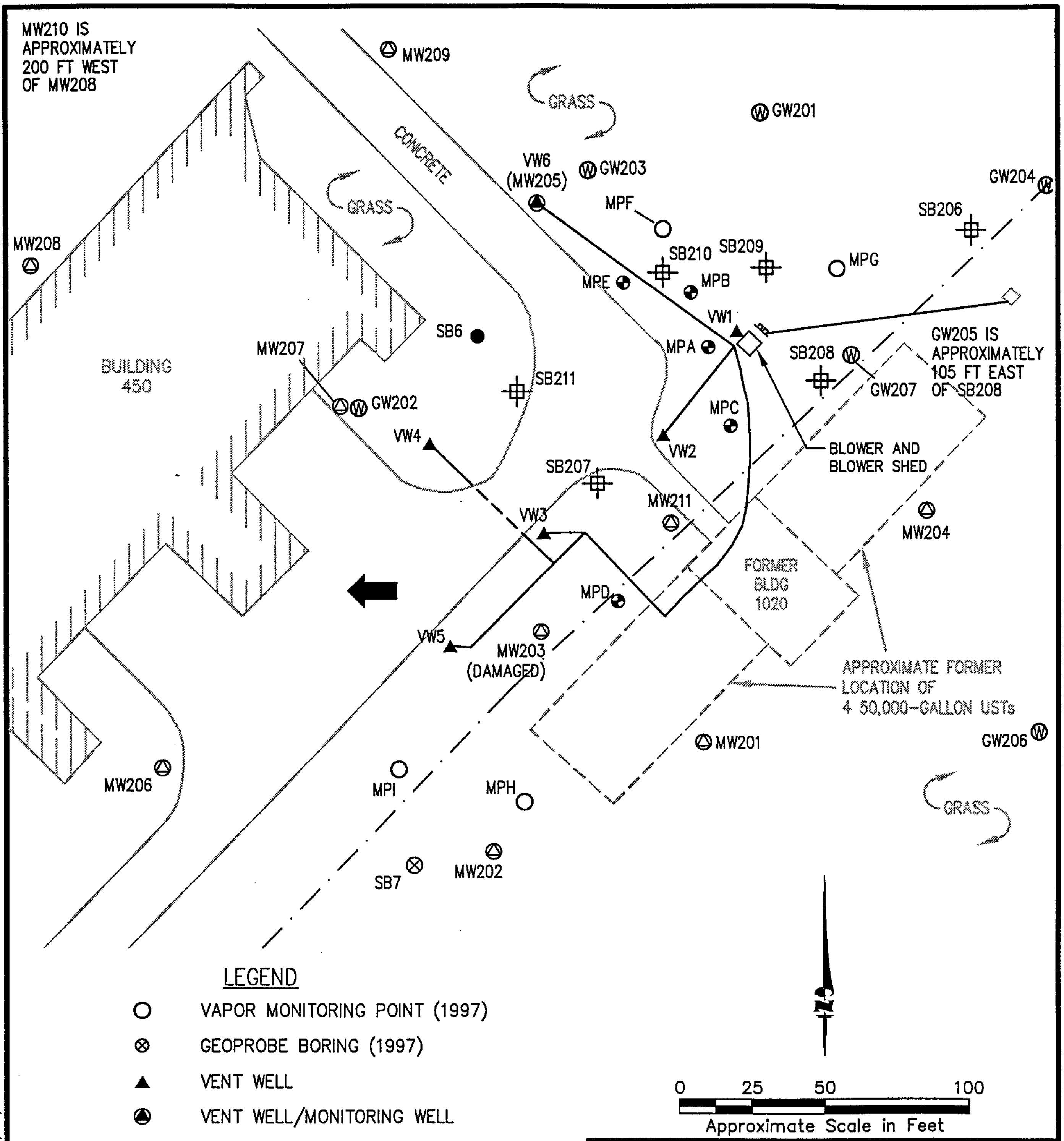

LEGEND

○	VAPOR MONITORING POINT (1997)
⊗	GEOPROBE BORING (1997)
▲	VENT WELL
◭	VENT WELL/MONITORING WELL
◬	MONITORING WELL
◕	VAPOR MONITORING POINT (1996)
●	GEOPROBE BORING (1996)
⌖	SOIL BORING (1992)
Ⓦ	GROUNDWATER GRAB SAMPLE (1992)
⬅	GROUNDWATER FLOW DIRECTION
— · —	FUEL LINE (ABANDONED)
———	2" PVC AIR INJECTION PIPE (BURIED)
- - - - -	2" GALVANIZED STEEL PIPE (BURIED)

FIGURE 2.2

SITE LAYOUT

Spill Site No. 1
Eaker AFB, Arkansas

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chromatographable organics (TCO) were collected from the excavation side walls at a depth of 15 feet bgs (corresponding to the bottom of the excavation). The highest TCO concentration, 34 milligrams per kilogram (mg/kg), was detected in a sample collected from the northeast sidewall. Approximately 1,300 cubic yards of soil was removed from the excavation, and subsequently transported to the Base landfarm for treatment. The excavation was backfilled with clean material and the pipeline was abandoned in place (Ogden, 1994). Soil analytical results from previous and subsequent investigations are presented in Table 2.1, and the estimated extent of soil contamination at Spill Site No. 1 is shown on Figure 2.3.

2.3.2 1988-1995 HNUS Site Investigations

During 1988 through 1995, HNUS directed several site investigation activities at Spill Site No. 1. Previous site investigation activities have included:

- Spring 1988
    - Collection of three soil samples during installation of three groundwater monitoring wells (MW201 through MW203), and collection of groundwater samples from wells MW201 and MW203. Analytical results from MW203 indicated high concentrations of benzene, ethylbenzene, and xylenes (Table 2.2). This well was damaged during tank removal activities (1994).
- Late 1991
    - Completion of 35-point soil gas survey during initial site investigations, which indicated high concentrations of volatile organic compounds (VOCs) immediately northwest of the USTs (Target Environmental Services, 1992).
- May 1992
    - Collection of 18 soil samples from six boreholes (SB206 through SB211) and collection of seven groundwater grab samples from Geoprobe® points GW201 through GW207. Analytical results from GW202 (near MW207) indicated high concentrations of benzene, ethylbenzene, and xylenes (Table 2.2).
- Spring/Summer 1995
    - Collection of four soil samples (MW204 through MW207) during installation of eight groundwater monitoring wells (MW204 through MW211), and collection of groundwater samples from existing wells MW201 and MW203, and newly installed wells MW204 through MW211. Soil and groundwater analytical results indicated that the dissolved contaminant plume had not migrated further than 120 feet from the suspected source area. Groundwater samples from all site wells were analyzed for total volatile petroleum hydrocarbons (TVPH) by United States Environmental Protection Agency (USEPA) Method 8015M, benzene, toluene, ethylbenzene, and xylenes (BTEX) by USEPA Method SW8020, semi-volatiles by USEPA Method SW8270, and several geochemical parameters including nitrate/nitrite, sulfate, and alkalinity.

TABLE 2.1
SOIL LABORATORY ANALYTICAL RESULTS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

			Laboratory Analytical Data				
Sampling Location	Sampling Depth (feet bgs)[b]	Sampling Date	TVPH[a] (mg/kg)[c]	Benzene (µg/kg)[d]	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Xylenes (µg/kg)
Bioventing Sampling Results							
VW2	9-10	3/22/96	8,800	<560[e]	<560	54,000	160,000
VW4	10-10.5	3/22/96	280	<57	<57	810	2,000
VW5	9.5-10.5	3/22/96	4,400	<570	<570	19,000	30,000
MPB	9-9.5	3/20/96	620	<56	<56	1,800	7,600
MPB	9.5-10	3/20/96	3,200	<230	<230	12,000	41,000
MPC	10-11	3/20/96	11,000	<1,100	<1,100	85,000	180,000
MPD	9-10	3/20/96	7,800	<550	<550	50,000	46,000
MPF	7.5-8.5	6/15/97	----[f]	<1.0	<2.0	<2.0	<2.0
MPG	5-6	6/15/97	----	<1.0	<2.0	<2.0	<2.0
MPI	8-9	6/15/97	----	<1.0	<2.0	36.2	49.1
SB7	6.5-8	6/15/97	----	8.1	4.4	44.8	32.4
Select Site Investigation Results							
MW201	8-9	4/28/88	ND[g]	ND	ND	ND	ND
MW202	6-8	4/28/88	ND	ND	ND	ND	ND
MW203	7-8	4/29/88	575	ND	ND	3,200	12,100
MW204	NA[h]	4/10/95	ND	ND	ND	ND	ND
MW205 (VW6)	9.7-10.2	4/9/95	ND	ND	ND	22	16
MW206	11.3-11.8	4/12/95	ND	ND	ND	ND	ND
MW207	9.5-10	4/10/95	ND	ND	ND	7.5	ND
SB206	7	5/20/92	ND	ND	ND	ND	ND
SB206	12.5	5/20/92	ND	ND	ND	ND	ND
SB207	6.5	5/21/92	ND	14	32	35	85
SB207	10-10.5	5/21/92	7,400	7,000J[i]	ND	60,000	170,000
SB208	5.5	5/21/92	590	2,100J	ND	13,000	50,000
SB208	9	5/21/92	9,500	3,200	ND	62,000	230,000
SB209	6	5/21/92	ND	ND	ND	ND	ND
SB209	9.5	5/21/92	ND	42J	ND	ND	ND
SB209	13.5	5/21/92	ND	160	ND	ND	ND
SB210	6.0	5/21/92	ND	42J	ND	ND	5
SB210	18.0	5/21/92	ND	7	ND	14	18
SB211	5.5	5/21/92	ND	ND	ND	ND	ND
SB211	10	5/21/92	50	ND	ND	1,800	5,900
GW202	15-18	5/9/92	---	690	ND	8,500	15,000

Note: March 1996 and June 1997 sampling was performed by Parsons ES (August 1996). 1988, 1992, and 1995 sampling was performed by Haliburton NUS.

[a] TVPH = total volatile petroleum hydrocarbons by USEPA Method SW8015M.

[b] bgs = below ground surface.

[c] mg/kg = milligrams per kilogram.

[d] µg/kg = micrograms per kilogram. Benzene, toluene, ethylbenzene, and xylenes results by USEPA Method SW8020.

[e] < = compound analyzed for, but not detected. Number shown represents the practical quantitation limit.

[f] ---- = not analyzed.

[g] ND = Compound not detected above the method detection limit.

[h] NA = Not available.

[i] J = compound detected above method detection limit and less than practical quantitation limit. Reported concentration is a laboratory estimate.

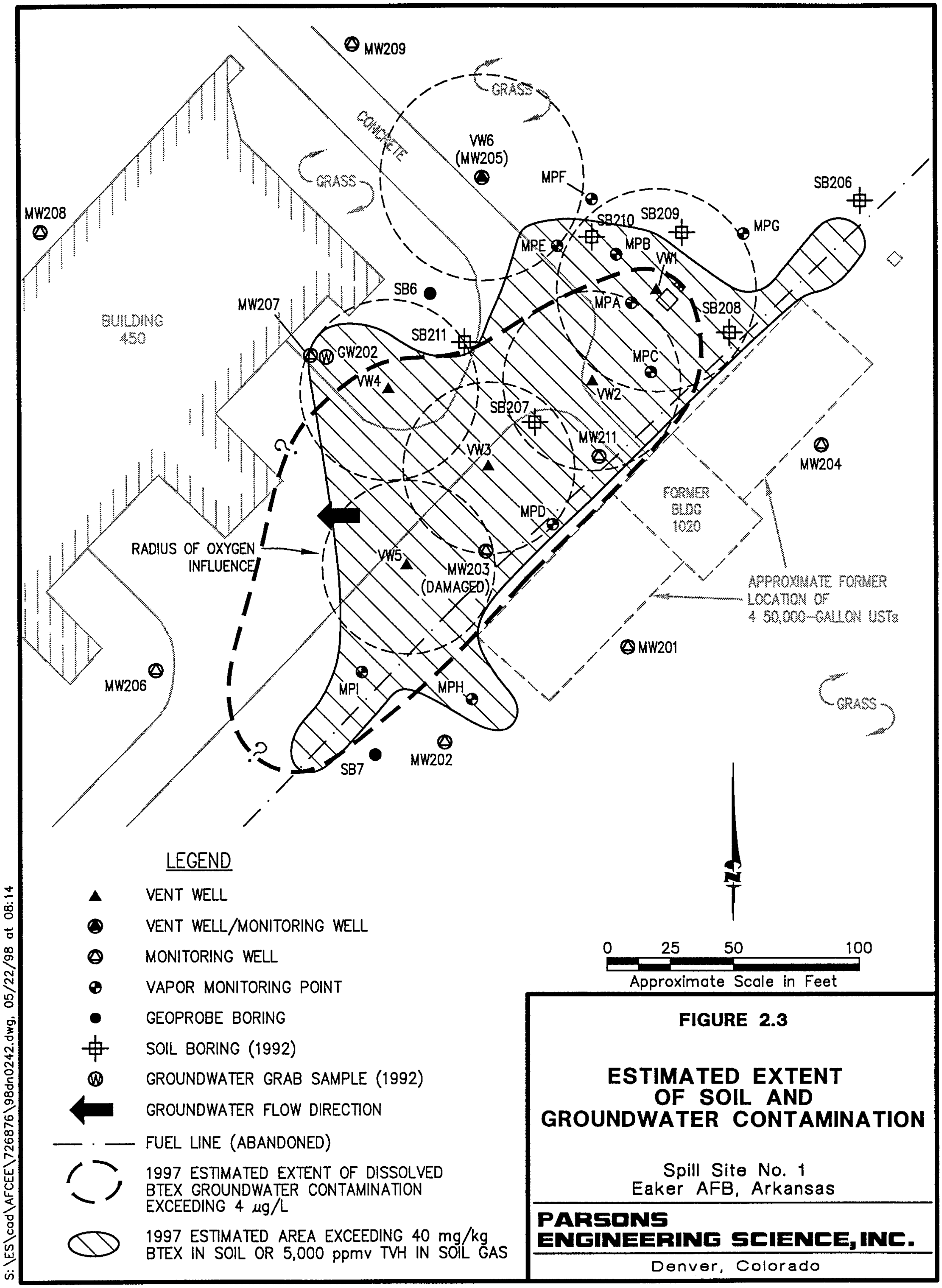

FIGURE 2.3

ESTIMATED EXTENT OF SOIL AND GROUNDWATER CONTAMINATION

Spill Site No. 1
Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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Findings indicated significant TVPH concentrations in groundwater and soil near the abandoned pipeline. Because soil TVPH concentrations were present above the former Arkansas Department of Environmental Quality (ADEQ) corrective action limit (CAL) of 100 mg/kg, a pilot-scale bioventing system was installed to treat vadose zone soils at Spill Site No. 1. Soil and groundwater analytical results from the HNUS investigations are included on Tables 2.1 and 2.2, respectively.

2.3.3 Parsons ES Investigation and Bioventing Pilot Test

In March/April 1996, Parsons ES installed a pilot-scale bioventing system at Spill Site No. 1 to assess the potential of air injection bioventing for remediating the hydrocarbon contamination identified in vadose zone soils. The primary objectives of the pilot test were: 1) to assess the potential for supplying oxygen throughout the contaminated soil interval; 2) to determine the rate at which indigenous microorganisms would degrade fuel when supplied with oxygen-rich soil gas; and 3) to evaluate the potential for sustaining fuel biodegradation rates until fuel contamination was remediated to concentrations below regulatory standards.

The pilot-scale bioventing system was installed in the vicinity of the former pumphouse and consisted of five vent wells (VWs) (VW1 through VW5), five vapor monitoring points (MPs) (MPA through MPE), one Geoprobe® soil boring (SB6), and a blower unit (Figure 2.2). One existing groundwater monitoring well (MW205) was plumbed to the blower system using 2-inch diameter PVC pipe, and was designated as air injection VW6. During installation of the pilot-scale system, soil and soil gas sampling, and respiration and air permeability testing were performed. Based on oxygen influence and air permeability testing performed during installation of the pilot-scale system, the long-term radius of oxygen influence around the VWs was expected to exceed 32 feet at depths below 5 feet bgs. From this information, it was determined that the multiple-well bioventing system was capable of delivering oxygen throughout the targeted area, making installation of a larger bioventing system unnecessary. A detailed description of the pilot-scale bioventing system design and initial testing results are provided in the Interim Pilot Test Results report prepared by Parsons ES (1996) for this site.

Following completion of pilot-scale system installation and testing, the system was started, optimized, and operated continuously until May 1997. In May, Parsons ES conducted oxygen influence monitoring at the site to confirm that the targeted soil zone was being provided with an adequate supply of oxygen. Following oxygen influence monitoring, the system was shut down for 1 month to allow soils and soil gas to come to equilibrium in order to compare initial and 1-year conditions. Soil gas, soil, and groundwater samples were collected, and *in situ* respiration testing was performed from 15 June through 21 June 1997 following 13 months of system operation.

To further define the extent of contamination and to evaluate the potential for remediation by natural attenuation (RNA) of dissolved organics in groundwater, soil and groundwater samples were collected at the site. During the June 1997 field event, Parsons ES advanced five Geoprobe® soil borings (MPF, MPG, MPH, MPI, and SB7) to varying depths corresponding to the smear zone. Four of the Geoprobe® borings were converted for use as soil vapor MPs (MPF-8.5, MPG-6, MPH-8, and MPI-8). Parsons ES also collected five groundwater samples from site wells MW204, MW206, MW207, MW208, and MW211, and one sample from background well MW010.

TABLE 2.2
GROUNDWATER LABORATORY ANALYTICAL DATA SUMMARY
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

		Well Number																			
		GW202	MW201	MW202	MW203	MW203	MW203	MW204	MW204	MW205	MW206	MW206	MW207	MW207	MW207D[a]	MW208	MW208	MW209	MW210	MW211	MW211
Parameter (Units)	Date Sampled	5/9/92	6/15/95	6/15/95	6/9/88	7/17/91	12/14/91	6/15/95	6/19/97	6/15/95	6/15/95	6/20/97	6/16/95	6/19/97	6/19/97	6/16/95	6/19/97	6/26/95	6/26/95	8/25/95	6/18/97
Organics																					
USEPA Method SW8015 (mg/L)[b]																					
Total Volatile Petroleum Hydrocarbons (TVPH)		----[c]	13	< 0.4[d]	5.9	ND [e]	0.7	< 0.4	----	< 0.4	< 0.4	----	< 0.4	----	----	< 0.4	----	< 0.4	< 0.4	< 0.4	----
USEPA Method SW8020 (µg/L)[f]																					
Volatile Aromatic Hydrocarbons																					
Benzene		690	< 2	< 2	1,500	210	680	< 2	< 0.4	< 2	< 2	< 0.4	< 2	< 0.4	< 0.4	< 2	< 0.4	< 2	< 2	5.5	130
Toluene		ND	< 2	< 2	ND	ND	ND	< 2	< 0.4	3.2	< 2	< 0.4	< 2	< 0.4	< 0.4	< 2	< 0.4	< 2	< 2	< 2	< 0.4
Chlorobenzene		----	----	----	----	----	----	----	< 0.4	----	----	< 0.4	----	< 0.4	< 0.4	----	< 0.4	----	----	----	9.5
Ethylbenzene		8,500	< 2	< 2	550	15	21	< 2	< 0.4	< 2	< 2	< 0.4	< 2	< 0.4	< 0.4	< 2	< 0.4	< 2	< 2	< 2	110
Total Xylenes		15,000	< 5	< 5	1,210	ND	13	< 5	< 0.4	< 5	< 5	< 0.4	< 5	0.4	0.4	< 5	< 0.4	< 5	< 5	< 5	58
Total BTEX		24,190	< 11	< 11	3,260	225	714	< 11	< 1.6	12.2	< 11	< 1.6	< 11	1.6	1.6	< 11	< 1.6	< 11	< 11	14.5	298
1,3,5-TMB[g]		----	----	----	----	----	----	----	< 0.4	----	----	< 0.4	----	0.7	0.7	----	< 0.4	----	----	----	27
1,2,4-TMB		----	----	----	----	----	----	----	< 0.4	----	----	< 0.4	----	1.3	1.3	----	< 0.4	----	----	----	250
1,2,3-TMB		----	----	----	----	----	----	----	< 0.4	----	----	< 0.4	----	1.2	1.2	----	< 0.4	----	----	----	40
1,2,3,4-TEMB[h]		----	----	----	----	----	----	----	< 0.5	----	----	< 0.5	----	< 0.5	< 0.5	----	< 0.5	----	----	----	31
MTBE[i]		----	----	----	----	----	----	----	< 1.6	----	----	< 1.6	----	< 1.6	< 1.6	----	< 1.6	----	----	----	2.4
USEPA Method SW8270 (µg/L)																					
Semivolatile Aromatic Hydrocarbons																					
Naphthalene		< 11	----	< 10	----	----	----	< 11	----	< 11	< 11	----	< 11	----	----	< 10	----	< 12	< 11	< 10	----
Benzo(a)pyrene		< 11	----	< 10	----	----	----	< 11	----	< 11	< 11	----	< 11	----	----	< 10	----	< 12	< 11	< 10	----
Laboratory Geochemical Parameters																					
USEPA Method 354.1 (mg/L)																					
Nitrogen, Nitrite		0.01	----	0.03	----	----	----	0.03	----	0.02	0.01	----	<0.01	----	----	0.04	----	0.05	0.02	0.01	----
Nitrogen, Nitrate		1.52	----	0.09	----	----	----	7.76	----	0.08	< 0.01	----	<0.01	----	----	0.03	----	< 0.01	0.01	< 0.01	----
USEPA Method 375.3 (mg/L)																					
Sulfate		7	----	6	----	----	----	14	----	3	4	----	2	----	----	5	----	47	42	2	----
USEPA Method 310.1 (mg/L)																					
Alkalinity		210	----	250	----	----	----	270	----	800	820	----	710	----	----	700	----	720	690	270	----

Notes: 1988, 1991, 1992, and 1995 sampling was performed by Haliburton NUS (HNUS).
Monitoring well MW201 was sampled on 6/8/88, 7/17/91 and 12/14/91; however, no VOCs were detected. Monitoring well MW203 is damaged.

[a] Field duplicate sample.

[b] mg/L = milligrams per liter.

[c] ---- = not analyzed.

[d] < = compound analyzed for, but not detected. Number shown represents the practical quantitation limit.

[e] ND = not detected above the method detection limit.

[f] µg/L = micrograms per liter. Sample GW202 was analyzed for VOCs by USEPA Method SW8260.

[g] TMB = trimethylbenzene.

[h] TEMB = tetramethylbenzene.

[i] MTBE = methyl tertiary-butyl ether.

Groundwater samples were analyzed in the field for electron acceptors and other geochemical parameters to assess the degree of natural attenuation occurring in groundwater at the site.

The blower system was restarted following 1-year testing to continue bioventing treatment of site soils. Initial and 1-year soil and soil gas sampling results, groundwater sampling results to date, and respiration testing results have been provided by Parsons ES (1997) to AFCEE and Eaker AFBCA and are summarized below.

2.3.3.1 Soil Sampling Results

During installation of the pilot-scale bioventing system, soil samples were collected from the VW and MP boreholes to determine the extent of petroleum hydrocarbon contamination in the vicinity of the former pumphouse (Figure 2.2). Seven soil samples collected at VW2, VW4, VW5, MPB, MPC and MPD boreholes, from depths of 9 to 11 feet bgs, were submitted for laboratory analysis of TVPH and BTEX. As shown in Table 2.1, high concentrations of TVPH, ethylbenzene, and xylenes were detected in soil samples collected from each borehole, except VW4. Contaminated soils were encountered in all VW and MP boreholes, with the highest contaminant concentrations occurring in VW2, MPC, and MPD boreholes. TVPH concentrations of 8,800 mg/kg, 11,000 mg/kg, and 7,800 mg/kg were detected at VW2, MPC, and MPD, respectively. Xylenes were detected at a maximum concentration of 180 mg/kg at MPC from a depth of 10-11 feet bgs. Benzene was not detected in any of the seven soil samples (Table 2.1). No visible or olfactory evidence of vadose zone contamination was observed at Geoprobe® boring SB6.

During June 1997, Parsons ES collected four soil samples from Geoprobe® borings MPF, MPG, MPI, and SB7, at depths corresponding to the smear zone. One soil sample from each boring was analyzed for BTEX using USEPA Method SW8020. Only SB7 contained low detectable concentrations of each BTEX compound. Photoionization detector (PID) results for the headspace of a sample collected at 8 feet bgs from MPH, and laboratory soil gas total volatile hydrocarbon (TVH) results indicate that this location is within the full-areal extent (FAE) of petroleum contamination.

2.3.3.2 Soil Gas Sampling Results

Soil gas sampling was performed prior to, and following, 1 year of air injection bioventing to determine relative changes in TVH, BTEX, and oxygen concentrations. Initial soil gas field-screening results at all the VWs and MPs indicated depleted oxygen concentrations and high TVH concentrations, and suggested that air injection would oxygenate contaminated soils and enhance biodegradation of residual petroleum hydrocarbons. As can be seen from the field-screening results presented in Table 2.3, static oxygen concentrations in soil gas have increased slightly at all MP locations except the shallow screened MP intervals (5 feet bgs) with continued bioventing at the site.

During the June 1997 sampling event, static soil gas oxygen concentrations were below 5 percent at all MPs, except MPC-5, indicating that significant oxygen demand still exists in the soils, and that aerobic biodegradation is still occurring at significant rates. High oxygen levels at VW2, VW3, VW4, and VW5 are the result of

TABLE 2.3
SOIL GAS FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

			Field Screening Data			Laboratory Analytical Data[a/]				
Sampling Location	Screen Depth (feet bgs)[c/]	Sampling Event[d/]	Oxygen (percent)	Carbon Dioxide (percent)	TVH[b/] (ppmv)[e/]	TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzene (ppmv)	Xylenes (ppmv)
VW1	4-14	Initial	2.5	8.7	>20,000 [f/]	---- [g/]	----	----	----	----
		13-Month[h/]	----	----	----	----	----	----	----	----
VW2	4.5-14.5	Initial	0.0	17.0	>20,000	60,000	670	190	120	120
		13-Month	17.8	0.7	760	----	----	----	----	----
VW3	4.5-14.5	Initial	0.0	19.0	>40,000	32,000	230	110	51	25
		13-Month	17.5	2.1	220	----	----	----	----	----
VW4	5-20	Initial	1.5	17.0	>40,000	22,000	100	130	58	71
		13-Month	20.2	1.0	42	----	----	----	----	----
VW5	4.5-14.5	Initial	20.8	0.4	260	----	----	----	----	----
		13-Month	16.9	6.2	380	----	----	----	----	----
VW6	9.1-19.1	Initial	3.2	19.0	>40,000	17,000	74	160	51	44
(MW205)		13-Month	2.5	10.2	370	----	----	----	----	----
MPA	9	Initial	1.4	15.0	>20,000	5,900	43	48	24	50
		13-Month	3.4	1.0	14,400	2,000	<0.22 [i/]	0.95	1	11
MPB	5	Initial	20.4	0.1	2,000	----	----	----	----	----
		13-Month	0.9	5.0	6,800	----	----	----	----	----
MPB	8.5	Initial	0.8	15.2	>20,000	6.6 [j/]	0.024 [j/]	0.07 [j/]	0.031 [j/]	0.27 [j/]M[k/]
		13-Month	1.2	5.0	6,400	5,700	1.2	17	7.4	41
MPC	5	Initial	20.5	0.7	4,200	----	----	----	----	----
		13-Month	14.2	6.0	26,000	12,000	12	19	20	140
MPC	9	Initial	2.2	12.1	>20,000	16,000	110	87	51	50
		13-Month	Purged water			----	----	----	----	----
MPD	5	Initial	Purged water			----	----	----	----	----
		13-Month	2.8	15.8	>40,000	----	----	----	----	----
MPD	9	Initial	1.5	14.2	>20,000	20,000	63	92	39	11
		13-Month	3.0	5.0	10,000	7,400	22	12	13	16
MPE	9.5	Initial	1.3	15.2	>40,000	1,600 [j/]	34 [j/]	140 [j/]	39 [j/]	42 [j/]
		13-Month	2.0	5.2	6,000	44,500 [l/]	59 [l/]	130 [l/]	45.5 [l/]	225 [l/]
MPF	8.5	13-Month	0.0	5.0	1,600	1,400	4.6	4.9	0.35	1.2
MPG	6	13-Month	0.0	4.8	200	----	----	----	----	----
MPH	8	13-Month	0.0	9.0	>40,000	68,000	200	91	34	110
MPI	8	13-Month	0.2	10.8	>40,000	54,000	150	77	31	140 M

TABLE 2.3 (Continued)
SOIL GAS FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

			Field Screening Data			Laboratory Analytical Data[a]				
Sampling Location	Screen Depth (feet bgs)[c]	Sampling Event[d]	Oxygen (percent)	Carbon Dioxide (percent)	TVH[b] (ppmv)[e]	TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzene (ppmv)	Xylenes (ppmv)
MW201	7-22	Initial	9.1	8.0	1,000	----	----	----	----	----
		13-Month	8.7	7.0	94	----	----	----	----	----
MW202	6.6-21.6	Initial	8.5	4.3	4,800	----	----	----	----	----
		13-Month	Purged water			----	----	----	----	----
MW203 (Damaged)	6-21	Initial	4.2	11.2	>10,000	----	----	----	----	----
		13-Month	1.0	15.0	>40,000	----	----	----	----	----
MW204	NA	Initial	19.8	1.6	150	----	----	----	----	----
		13-Month	15.9	4.0	90	----	----	----	----	----
MW206	NA	13-Month	20.8	0.05	0	----	----	----	----	----
MW207	11.5-21.5	Initial	0.0	12.0	6,000	----	----	----	----	----
		13-Month	0.4	10.9	4,800	----	----	----	----	----
MW211	9-19	Initial	18.9	2.3	>10,000	----	----	----	----	----
		13-Month	Purged water			----	----	----	----	----

[a] Laboratory analysis of soil gas performed using USEPA Method TO-3. Laboratory TVH referenced to jet fuel (MW=156).

[b] TVH = total volatile hydrocarbons.

[c] bgs = below ground surface.

[d] Soil gas sampling performed in March 1996 (initial event) and June 1997 (13-month event).

[e] ppmv = parts per million, volume per volume.

[f] > = denotes field measurement greater than maximum meter reading.

[g] ---- = not analyzed.

[h] 13-month soil gas samples were collected approximately 1 month following blower shut down. The blower operated almost continuously from April 4, 1996 until May 13,1997.

[i] < = compound analyzed for, but not detected. Number shown represents the sample quantitation limit.

[j] Laboratory result is suspect based on field soil gas measurements and/or soil analytical results.

[k] M = reported laboratory value may be biased due to apparent matrix interferences.

[l] Average of the primary and duplicate laboratory sample results.

long-term air injection at these wells; most of the fuel contamination initially present at these locations has been aerobically biodegraded or has volatilized and migrated away from the injection point via soil gas advection. At all of the initially installed MP locations, June 1997 field TVH levels in soil gas remained high, ranging from 6,000 to greater than 40,000 ppmv.

Generally, field soil gas TVH concentrations have decreased at most deep MPs (8-9 bgs), however, it appears that volatile organic compounds (VOCs) are being driven up into the shallow clay zone (5 feet bgs), based on the increased TVH concentrations at MPB-5 and MPC-5. Fuel residuals in shallow soils will gradually biodegrade as injected air and atmospheric oxygen diffuse into the shallow soils. Also, precipitation percolating through the tight, shallow soils will leach residual contaminants out of the clayey soil matrix and into the deeper more permeable silty clay zone, which is sufficiently oxygenated. Field TVH concentrations at or exceeding 10,000 ppmv were detected at six MP sampling locations, indicating that significant levels of volatile petroleum hydrocarbons remain in site soils.

At all locations except MPA-9 and MPF-8.5, laboratory soil gas TVH concentrations in soil gas were high, ranging from 5,700 to 68,000 ppmv. Although TVH levels remained high in some locations, significant decreases in soil gas BTEX concentrations were noted at MPA-9 (92-percent reduction) and MPD-9 (69-percent reduction). These data indicate that although TVH levels at Spill Site No. 1 are very high, the risk-driving BTEX compounds are being preferentially biodegraded by bioventing system operation.

2.3.3.3 Respiration Test Results

Observed *in situ* microbial respiration (oxygen utilization) rates have increased slightly at Spill Site No. 1. As can be seen from the results presented in Table 2.4, increases occurred in both respiration and fuel biodegradation rates following the first year of system operation. Average 1-year respiration rates for MPA-9 and MPB-9 were measured 11 percent higher than the initial values. Similar increases also are evident in calculated fuel biodegradation rates for these two MPs. Soil moisture content likely was higher during the June 1997 testing, so actual biodegradation rates at MPA-9, MPB-9, and MPD-9 may have been slightly lower than those indicated during the initial testing. Oxygen utilization and fuel biodegradation rates typically decrease with continued bioventing as the lighter, more readily biodegraded hydrocarbons are preferentially destroyed over more biologically recalcitrant, higher-molecular-weight hydrocarbons. At Spill Site No. 1, groundwater fluctuations may have "smeared" additional substrate (i.e., fuel hydrocarbons) onto soils at depths of 9 feet bgs, thereby maintaining high biodegradation rates at the deep vapor MPs.

2.3.3.4 Natural Attenuation Monitoring

During the June 1997 field event, Parsons ES collected groundwater samples from five site monitoring wells (MW204, MW206, MW207, MW208, and MW211) and one offsite monitoring well (MW010) to evaluate the RNA of jet fuel constituents in groundwater. Table 2.2 summarizes site laboratory analytical data for groundwater

TABLE 2.4
RESPIRATION TEST RESULTS AND FUEL BIODEGRADATION RATES
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Sampling Location-Depth (feet below ground surface)	Initial (March 1996)			13-Month (June 1997)		
	O_2 Utilization Rate (K_o) (% O_2/hour)	Biodegradation Rate (mg/kg/year)[a]	Soil Temperature (°F)	O_2 Utilization Rate (K_o) (% O_2/hour)	Biodegradation Rate[b] (mg/kg/year)	Soil Temperature (°F)
VW2-4.5-14.5	0.97	1,300	NM[c]	NM	NC[d]	NM
MPA-9	1.08	1,740	NM	1.30	2,090	NM
MPB-9	1.10	1,775	NM	1.16	1,870	NM
MPC-9	1.25	2,010	NM	NM	NC	NM
MPD-9	1.11	1,790	NM	2.68[e]	4,310[e]	NM
MPG-6 [f]	NM	NC	NM	NM	NC	60.5

---

[a] Milligrams of petroleum hydrocarbons per kilogram of soil per year.

[b] Assumes soil moisture content is equal to March 1996 values. Actual moisture content likely was higher during the June 1997 testing.

[c] NM = not measured.

[d] NC = not calculated.

[e] The air injection period for the 13-month test was double that of the initial respiration test, thereby possibly affecting the oxygen utilization rate.

[f] MPG was installed on June 15, 1997.

samples. Groundwater samples also were analyzed by Parsons ES personnel in the field for alkalinity, conductivity, dissolved oxygen (DO), ferrous iron, free carbon dioxide, pH, oxidation/reduction potential (ORP), nitrate, soluble manganese, sulfate, and temperature. The results of these geochemical analyses are provided in Table 2.5. Groundwater samples were collected and analyzed according to the protocol developed for the AFCEE Natural Attenuation Initiative (Wiedemeier *et al.*, 1995).

Groundwater geochemical data collected during June 1997 indicated that groundwater contaminants are being naturally biodegraded. DO concentrations were observed to decrease from 5.67 mg/L at upgradient well MW204 to 0.58 mg/L at source area well MW211. DO concentrations at other contaminated well locations were below 1.15 mg/L. These patterns indicate that DO was being utilized by indigenous aerobic bacteria for the biodegradation of dissolved hydrocarbons as DO was continually replenished from upgradient groundwater sources. Redox potentials measured throughout the site were relatively high (ranging from 94.7 to 520.1 mV) and consistent with the range of values expected for aerobic biodegradation processes to occur.

Nitrate and sulfate are electron acceptors utilized for anaerobic biodegradation of fuel hydrocarbons via the processes of nitrate and sulfate reduction, respectively. Concentrations of these electron acceptors were reduced at wells within the groundwater plume relative to background well MW204, which indicate the occurrence of nitrate or sulfate reduction. The metabolic byproducts ferrous iron and methane also were elevated above background levels and are produced from the anaerobic biodegradation of fuel hydrocarbons through iron reduction or methanogenesis under very reducing conditions. DO concentrations do not support the occurrence of any anaerobic biodegradation processes because DO concentrations above 0.5 mg/L (as observed at Spill Site No. 1) generally are toxic to anaerobic bacteria. Furthermore, the ORP of groundwater was quite high and not indicative of highly reducing conditions needed for anaerobic biodegradation (typically below 0 mVs).

Aerobic and anaerobic biodegradation processes may co-exist at Spill Site No. 1. Standard monitoring screened intervals of 10 to 15 feet at the site will mix waters from different vertical zones. If different biodegradation processes are occurring at different zones in the aquifer, then it may be possible to see a mixture of biodegradation processes occurring at the same horizontal well location. High precipitation or groundwater recharge rates may have temporarily shifted biodegradation processes toward the aerobic groundwater conditions that were observed in June 1997. The presence of reduced nitrate and sulfate, or increased ferrous iron and methane may have been residual concentrations indicative of the previous anaerobic biodegradation of fuel hydrocarbons at the site.

2.3.4 Results Summary

2.3.4.1 Soil

Based on the results of the previous investigations, the fuel product piping has been identified as the probable source of the petroleum hydrocarbon contamination at Spill Site No. 1. Figure 2.3 shows the estimated extent of soil contamination at Spill Site No. 1 that historically exceeded 40 mg/kg of total BTEX in soils, and/or 5,000 ppmv of TVH in soil gas. Because soil contamination appeared to exceed regulatory

TABLE 2.5
GROUNDWATER GEOCHEMICAL DATA
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Sampling Location	Sampling Date	Temperature (°C)[a]	Conductivity (µS/cm)[b]	Dissolved Oxygen (mg/L)[c]	Total Alkalinity (mg/L)	pH	Redox Potential (mV)[d]	Sulfate (mg/L)	Ferrous Iron (mg/L)	Nitrate (mg/L)	CO_2 (mg/L)	Mn^{2+} (mg/L)	Methane (Lab) (mg/L)
MW204 (Background)	6/19/97	19.5	725	5.67	300	5.98	272.0	79.62	0.13	5.10	11.75	ND[e]	< 0.0012 [f]
MW211	6/18/97	19.0	1384	0.58	740	6.34	520.1	51.69	5.10	ND	16.0	ND	7.5
MW207	6/19/97	22.3	949	1.15	620	6.46	224.0	5.27	0.07	0.08	11.3	1.3	0.0074
MW207D [g]	6/19/97	22.3	949	1.15	620	6.47	224.0	4.82	0.08	0.08	11.0	1.2	0.0070
MW208	6/19/97	18.2	1218	0.97	720	6.76	94.7	7.90	5.10	0.05	11.0	2.8	NA[h]
MW206	6/20/97	17.9	1370	1.66	820	6.60	231.2	6.71	0.02	0.13	10.75	3.4	NA
MW010 [i] (Background)	6/19/97	16.6	528	1.54	300	6.68	270.0	21.77	0.10	0.32	12.5	0.9	NA

[a] °C = degrees Celsius.

[b] µS/cm = microsiemens per centimeter.

[c] mg/L = milligrams per liter.

[d] mV = millivolts.

[e] ND = Compound not detected above the method detection limit (MDL).

[f] < = Compound analyzed for, but not detected. Number shown represents the sample quantitation limit.

[g] Duplicate sample.

[h] NA = Not analyzed.

[i] Background monitoring well MW010 is located approximately 1,200 feet southeast of Spill Site No. 1.

requirements in the area northwest of the former pumphouse, a bioventing pilot-scale system was installed. Field screening and analytical results of soil samples collected during installation of the monitoring wells (HNUS, 1988; 1992; and 1995) and during bioventing field activities (Parsons ES, 1996 and 1997) indicated that the majority of the vadose zone contamination has been limited to the soils near to and east of VW1, VW2, VW3, and VW5.

Initial and 1-year bioventing pilot test results indicate the effective treatment area of the bioventing system encompasses most of the contaminated vadose zone soil identified on Figure 2.3. Considering the expected age of the contamination (pre-1974) and the length of bioventing treatment (approximately 2 years), BTEX and PAH concentrations in vadose zone soils at Spill Site No. 1 are not expected to exceed ASTM risk-based screening levels (RBSLs). Based on this expectation, AFCEE recommended that planning for confirmation sampling be initiated while the bioventing system continues to operate.

2.3.4.2 Groundwater

Table 2.2 summarizes most of the historic site analytical data for groundwater samples collected at Spill Site No. 1. Of seven groundwater grab samples collected by HNUS in 1992, only sample GW202 (near MW207) contained detectable concentrations of VOCs. Historically well MW203 contained BTEX concentrations that exceeded federal maximum contaminant levels (MCLs) for groundwater, however, this well was damaged during tank removal activities (US Air Force, 1995). Analytical results from the June 1997 sampling event indicate that groundwater contamination is likely limited to the area immediately northwest of the former pumphouse (Figure 2.3). To further delineate the extent of contamination and to determine a rate of natural attenuation of groundwater at the site, additional groundwater sampling will be performed at the site, as described in Section 4.3.

SECTION 3

SITE CLEANUP REQUIREMENTS

3.1 SAMPLING OBJECTIVES

The objective of the confirmatory sampling is to support an eventual Air Force NFRAP decision for the soils and groundwater that were contaminated by jet fuel released from the former USTs and/or associated piping, and to meet cleanup goals. This sampling plan targets unsaturated soils and groundwater in the vicinity of the former pumphouse, and groundwater immediately downgradient from the site.

3.2 STATE SOIL AND GROUNDWATER CLEANUP GOALS

The ASTM (1995) has developed a tiered, RBCA approach for petroleum-hydrocarbon-contaminated sites. This iterative approach allows first for screening of contaminant concentrations against generic RBSLs, followed (if necessary) by the development of site-specific target levels (SSTLs) based on an analysis of site data and receptors that could potentially be exposed to chemical contamination at, or downgradient from, the release site. As approved by the ADEQ (formerly Arkansas Department of Pollution Control and Environment), Parsons ES and Eaker AFBCA will reference the ASTM RBCA standard for soil and groundwater cleanup goals. Because RBCA criteria are based on current or foreseeable land uses and human receptor exposure scenarios, a review of available information is provided below.

3.2.1 Land Use and Potential Receptors

The site is currently vacant and land use adjacent to the site is commercial/industrial. The site is bordered by former aircraft hangers on the northwest and west, and a former flight apron on the north. A specific future land use for Building 450 has not been established, but will be predominantly commercial and industrial. The former flight apron is used as a training course for truck drivers.

Based on the future industrial land use assumption and the site description presented in Section 2, current and future onsite workers are likely to represent the primary potential human receptors. Because the jet fuel release was subsurface, and the contaminated area is developed, no ecological receptors are likely to be exposed to contaminants in site media under current or anticipated future land uses.

Groundwater within Eaker AFB property is not currently used as a potable water source; moreover, site groundwater impacts from the jet fuel releases appear to be minimal (Table 2.2). Therefore, exposure of onsite and off-site human receptors to site contaminants through ingestion or inhalation of, or dermal contact with, contaminants in groundwater extracted for potable use is unlikely. Soil sample results from previous investigations (Table 2.1) indicate that soil contamination appears to be significant only within soils located near wells VW1, VW2, VW3, and VW5, and near the northwestern edge of the former pumphouse (adjacent to the fuel pipeline) at depths greater than 5 feet bgs.

Based on this information, it is anticipated that the most significant contaminant migration pathways resulting from soil contamination at Spill Site No. 1 are the leaching of contaminants from soil to groundwater and the volatilization of fuel vapors into soil gas. Volatilization of fuel hydrocarbons from soil and/or groundwater and vapor migration into onsite or off-site structures is expected to be the most significant potential exposure pathway resulting from contamination at the Spill Site No. 1.

3.2.2 Cleanup Goals

The ASTM (1995) RBCA standard RBSLs for soil, presented in a look-up table, are utilized in the Tier 1 evaluation of site contaminant concentrations. The RBSLs are not intended as cleanup goals, but serve as conservative values against which to compare site contaminant concentrations. If site contaminant concentrations are lower than the RBSLs, then the RBCA standard suggests that no further corrective action is required. If site contaminant concentrations exceed the RBSLs, then SSTLs can be developed through a Tier 2 evaluation.

BTEX and other petroleum contaminant (e.g., PAH and TVPH) concentrations in soil at Spill Site No. 1 will be determined from the soil samples (to be collected and analyzed in accordance with Section 4) in order to compare these values with ASTM RBSLs, and to compare to pre-treatment soil analytical results. If the detected site contaminant concentrations do not exceed the most stringent RBSLs, the compounds should not be considered chemicals of potential concern (COPCs), and should not be retained for further Tier 2 evaluation. Under these circumstances, no additional remediation would be warranted for such compounds in order to protect potential receptors. If a detected site contaminant exceeds the appropriate RBSL, the compound will be identified as a COPC and retained for further quantitative fate and transport and risk analyses.

For the purpose of comparison, generic RBSLs for commercial/industrial land use and maximum TVPH and BTEX soil concentrations detected during previous site investigations (Section 2.3) are presented in Table 3.1. Table 3.2 presents similar data for groundwater. The generic RBSLs from the ASTM (1995) *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* and soil screening levels (SSLs) from the USEPA (1996) *Soil Screening Guidance: Technical Background Document* are presented. As previously mentioned, leaching of hydrocarbon contaminants from soil to groundwater and volatilization of hydrocarbon contaminants from groundwater and vapor intrusion to buildings are likely to represent the most significant contaminant migration and potential receptor exposure pathway represented by soil and groundwater contamination, respectively.

TABLE 3.1
SOIL CONTAMINANT LEVELS COMPARED TO RISK-BASED SCREENING LEVELS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

			ASTM[a/]		USEPA[b/]			
	Units[c/]	Detected Site Maximum Concentration	Comm/Indus Vapor Intrusion RBSL[d/]	Comm/Indus Leachability RBSL[e/]	Ingestion SSL	Inhalation SSL	Groundwater Migration SSL (20 DAF)[f/]	Groundwater Migration SSL (1 DAF)[g/]
TVPH	mg/kg	11,000	NA[h/]	NA	NA	NA	NA	NA
Benzene	mg/kg	7J[i/]	0.0169	0.0578	22	0.8	0.03	0.002
Toluene	mg/kg	<1.1[j/]	54.5	361	16,000	650	12	0.6
Ethylbenzene	mg/kg	85	90.8	1,610	7,800	400	13	0.7
Xylenes	mg/kg	230	RES[k/]	RES	160,000[l/]	410[l/]	190[l/]	9[l/]
Naphthalenes	mg/kg	NS[m/]	107	64.2	3,100	NA	84	4
Benzo(a)pyrene	mg/kg	NS	RES *	1.85 *	0.09	NA	8	0.4
Acenaphthene	mg/kg	NS	---[n/]	---	4,700	NA	570	29
Anthracene	mg/kg	NS	---	---	23,000	NA	12,000	590
Fluoranthene	mg/kg	NS	---	---	3,100	NA	4,300	210
Flourene	mg/kg	NS	---	---	3,100	NA	560	28
Pyrene	mg/kg	NS	---	---	2,300	NA	4,200	210
Benz(a)anthracene	mg/kg	NS	---	---	0.9	NA	2	0.08
Chrysene	mg/kg	NS	---	---	88	NA	160	8
Benzo(b)fluoranthene	mg/kg	NS	---	---	0.9	NA	5	0.2
Benzo(k)fluoranthene	mg/kg	NS	---	---	9	NA	49	2
Dibenzo(a,h)anthracene	mg/kg	NS	---	---	0.09	NA	2	0.08
Benzo(g,h,i)perylene	mg/kg	NS	---	---	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	mg/kg	NS	---	---	0.9	NA	14	0.7

TABLE 3.1 (Continued)
SOIL CONTAMINANT LEVELS COMPARED TO RISK-BASED SCREENING LEVELS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Notes: The corrective action limits or target concentrations exceeded by the maximum site concentration detected are shown in gray.

The target concentrations that are lower than the method detection limit, and may potentially exceed the screening level are shown in a box.

* Indicates that the compound is a carcinogen, and the RBSL is based on an excess lifetime cancer risk of 10^{-6} resulting from the specified exposure.

The RBSLs for compounds that have not been classified as carcinogens are based on a hazard quotient (HQ) equal to 1.

[a] Risk-based screening levels (RBSLs) from Table X2.1 (ASTM, 1995).

[b] Generic soil screening levels (SSLs) from Table A-1 (USEPA, 1996).

[c] mg/kg = milligrams per kilogram.

[d] Values shown represent example Tier 1 Risk-Based Screening Levels (RBSLs) for commercial/industrial receptor scenario considering soil-vapor intrusion from soil to buildings (ASTM, 1995).

[e] Values shown represent example Tier 1 Risk-Based Screening Levels (RBSLs) for commercial/industrial receptor scenario considering soil-leachate to protect groundwater ingestion target level (ASTM, 1995).

[f] Generic SSL values for the migration to groundwater pathway developed using a default dilution-attenuation factor (DAF) of 20 to account for natural processes that reduce contaminant concentrations in the subsurface.

[g] Generic SSLs for the migration to groundwater pathway developed assuming no dilution or attenuation between the source and the receptor well (i.e., DAF = 1). Note that the 20 DAF values are not exactly 20 times the 1 DAF values because each SSL is calculated independently with the final value rounded to two significant figures for values greater than 10, and one significant figure if the value is less than 10.

[h] Target data concentrations not available in the sources which are referenced.

[i] J = compound detected above method detection limit and less than the practical quantitation limit. Reported concentration is a laboratory estimate.

[j] < = analyte concentration less than laboratory reporting limit shown.

[k] RES = Selected risk level is not exceeded for pure compound present at any concentration (ASTM, 1995).

[l] SSL data provided is for *o*-Xylene which has the most conservative SSLs of the three xylene isomers.

[m] NS = not sampled for polynuclear aromatic hydrocarbon analysis.

[n] A RBSL for many of the polynuclear aromatic hydrocarbon compounds is not provided in Table X2.1 (ASTM, 1995). If concentrations of these compounds are detected above the RBSL for benzo(a) pyrene, then a chemical-specific screening level will be calculated based on ASTM guidance.

TABLE 3.2
GROUNDWATER CONTAMINANT LEVELS COMPARED TO RISK-BASED SCREENING LEVELS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

	Units[b]	1995-1997 Maximum Detected Site Concentration	Federal MCL[c]	ASTM[a] Comm/Indus Vapor Intrusion RBSL[d]
Benzene	µg/L	130	5	73.9
Toluene	µg/L	3.2	1,000	85,000
Ethylbenzene	µg/L	110	700	>S[e]
Xylenes	µg/L	58	10,000	>S
Naphthalenes	µg/L	<12[f]	NA[g]	12,300
Benzo(a)pyrene	µg/L	<12	NA	>S

Note: The maximum contaminant level or screening level exceeded by the maximum site concentration detected are shaded.

[a] Risk-based screening levels (RBSLs) from Table X2.1 (ASTM, 1995).

[b] µg/L = micrograms per liter.

[c] Federal maximum contaminant level (MCL).

[d] Values shown represent Tier 1 RBSLs for commercial/industrial receptor scenario considering vapor intrusion from groundwater to buildings (ASTM, 1995).

[e] >S = selected risk level is not exceeded for all possible dissolved levels (less than or equal to solubility of pure component) (ASTM, 1995).

[f] < = analyte concentration less than laboratory reporting limit shown.

[g] NA = target data concentration not available in the source which was referenced.

As can be seen in Table 3.1, each BTEX compound except toluene exceeded its respective ASTM (1995) RBSL or USEPA (1996) SSL. While not readily apparent, toluene concentrations at MPC during 1996 also may have exceeded the USEPA groundwater migration SSLs because the analytical method detection limit shown is higher than the target screening level. However, following more than 2 years of air injection bioventing, residual petroleum hydrocarbon contamination in vadose zone soil is likely to be less than the screening levels.

As shown in Table 3.2, since the 1992 (HNUS) sampling event, benzene is the only groundwater contaminant detected at the site exceeding its ASTM (1995) RBSL. The risk-based criteria for groundwater shown in Table 3.2 represent dissolved concentrations of BTEX, naphthalene, and benzo(a)pyrene that potentially could cause adverse indoor air concentrations resulting from contamination vapor intrusion. These values represent a worst-case scenario, as no buildings currently are located directly above the area affected by the release (Figure 2.3).

SECTION 4

SITE CONFIRMATION SOIL AND GROUNDWATER SAMPLING AND ANALYSIS PLAN

The following SAP describes the sampling locations and procedures, and the analytical methods proposed to collect sufficient data to verify remediation of Spill Site No. 1 soils and groundwater to acceptable cleanup levels, to determine the extent to which natural attenuation processes are reducing contaminant mass in groundwater, and to provide information that will support future decision making regarding this site (which is a portion of a larger SWMU).

As described in Section 2, soil contamination at Spill Site No. 1 was characterized during the 1988 through 1997 investigations. Based on results from these investigations, petroleum hydrocarbon contamination exceeding the former ADEQ TVPH CAL of 100 mg/kg (prior to initiation of in situ bioventing) appear to have been confined to vadose zone soils within the area adjacent to the former pumphouse, and smear zone soils downgradient of the site. To confirm that petroleum hydrocarbon contaminants in site soils have been remediated to within acceptable levels, Parsons ES proposes to sample soils in the vicinity of the former pumphouse and within the area of previously identified contamination.

To further assess the presence or absence of dissolved BTEX at the site, groundwater samples for laboratory BTEX analysis will be collected from two plume wells (VW3 and MW211), one upgradient monitoring well (MW204), two cross-gradient wells (MW202 and MW205), and two downgradient wells (VW4 and VW5). Groundwater samples from wells VW3 and MW211 also will be analyzed for PAHs. In addition, samples from these seven wells will be collected and analyzed onsite for various geochemical parameters including electron acceptors. The geochemical/electron acceptor data will be used to further assess the degree of natural chemical attenuation that is occurring in the groundwater and to assess the groundwater assimilative capacity for natural chemical attenuation of the remaining concentrations of petroleum hydrocarbon compounds or polynuclear aromatic hydrocarbons, if present.

The bioventing system will be turned off approximately 1 month prior to the confirmation soil and groundwater sampling field event. After confirmation soil, soil gas, and groundwater samples are collected, and respiration testing is performed, the blower system will be restarted and should continue to operate until a decision has been made by the Base to cease cleanup operations at the site.

4.1 SOIL SAMPLING

This section describes the scope of work required for collecting confirmation soil samples at Spill Site No. 1. An estimated ten Geoprobe® locations will be sampled within the area where TVPH results exceeded the former ADEQ CAL of 100 mg/kg. If field screening results at sampling point CBJ indicate significant contamination (*i.e.*, PID screening results 100 ppmv above background) then an additional Geoprobe® location may be sampled 20 feet southwest of the proposed location. Proposed Geoprobe® sampling locations are shown on Figure 4.1.

Soil sampling will be conducted by qualified Parsons ES scientists and technicians trained in the conduct of soil sampling, records documentation, and chain-of-custody procedures. In order to provide complete documentation of the sampling event, detailed records will be maintained by the Parsons ES field engineer. In addition, sampling personnel will have thoroughly reviewed this SAP prior to sample collection and will have a copy available onsite for reference.

4.1.1 Soil Sampling Procedures

Ten Geoprobe® locations will be sampled in the vicinity of the former pumphouse at the approximate locations shown on Figure 4.1. At borings CBA, CBB, CBC, CBD, and CBG a sample will be collected from each borehole at depths corresponding to the vadose zone (9 to 11 feet bgs), and submitted for analysis of BTEX, TVPH, and PAHs. The locations chosen represent the locations sampled during previous site investigations and bioventing system installation. At borings CBE, CBF, CBH, CBI, and CBJ, one sample will be collected from a depth corresponding to the "smear" zone, and submitted for laboratory analysis. Subsurface soil samples will be collected using a truck-mounted, hydraulically powered Geoprobe® percussion/probing machine capable of advancing sampling tools through unconsolidated soils. The Geoprobe® system provides for the rapid collection of soil samples at shallow depths while minimizing the generation of investigation-derived waste (IDW) materials.

Soil samples will be collected using a probe-drive sampler. The probe-drive sampler serves as both the driving point and the sample collection device, and is attached to the leading end of the probe rods. To collect a soil sample, the sampler is pushed or driven to the desired sampling depth, the drive point is then retracted to open the sampling barrel, and the sampler is subsequently pushed into, and thus collecting the undisturbed soils. The soil cores are retained within clear acetate liners inside the sampling barrel. The probe rods are then retracted, bringing the sampling device to the surface. The soil sample can then be extruded from the liners for lithologic logging, or the liners can be capped, and the undisturbed samples can be submitted to the analytical laboratory for testing. Soil samples will be screened with a PID or a total volatile hydrocarbon analyzer (TVHA).

Samplers, drive rods, and other sampling equipment will be cleaned before use and between sampling locations to prevent cross-contamination. All sampling equipment will be washed with Alconox® detergent and rinsed with tap water. Between sampling events, the probe-drive sampler will be cleaned with Alconox®, followed by successive potable and distilled water rinses.

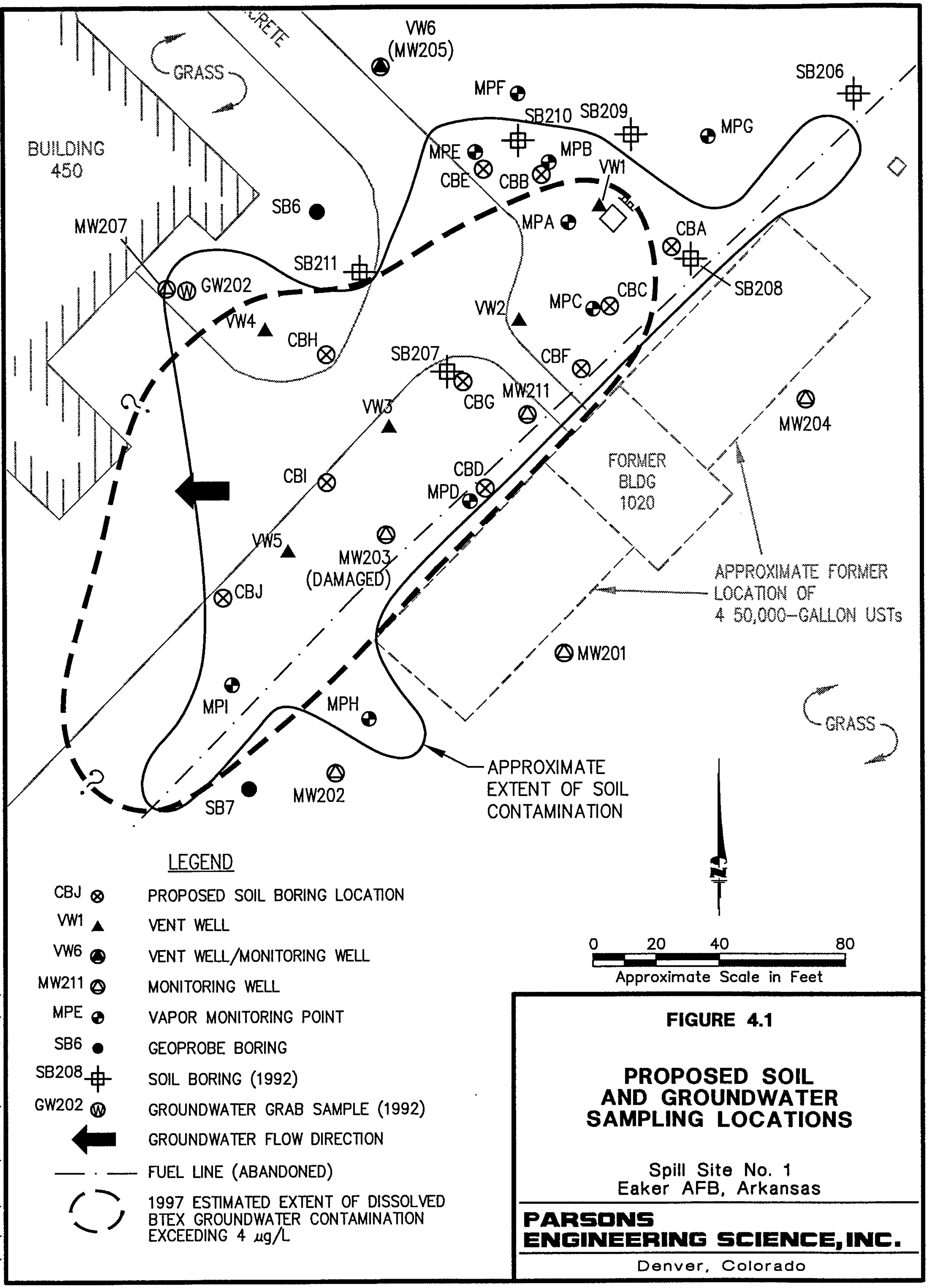

FIGURE 4.1

PROPOSED SOIL AND GROUNDWATER SAMPLING LOCATIONS

Spill Site No. 1
Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

S:\ES\cad\AFCEE\726876\98DN0243, 04/13/98 at 12:38

Geoprobe® pushes will extend to no more than 12 feet bgs. Relatively undisturbed soil samples, suitable for chemical analysis, will be collected from depths of 8 to 10 feet bgs and/or 10 to 12 feet bgs, depending on borehole location and depth to groundwater. Soil types will be classified according to the Unified Soil Classification System and described in accordance with the standard Parsons ES soil description format. All soil samples will be visually examined and field analyzed using a PID or a TVHA. The acetate liners containing the sample will be cut into 6-inch sections, and the ends of the sections will be screened with a PID or TVHA. Based on field screening results, one sample with the greatest apparent contamination from each boring will be selected and submitted for laboratory analysis of BTEX, PAHs, and/or TVPH (Table 4.1).

In preparation for laboratory submittal, the ends of the selected section will be covered with Teflon® sheets and plastic end caps. The samples will be labeled with the site name and borehole number, sample depth, date of collection, project name, and other pertinent data. The samples will be sealed in plastic bags and immediately placed in an insulated cooler containing ice. The soil samples will be maintained in a chilled condition until delivered to the analytical laboratory. Chain-of-custody records will be prepared in the field and will accompany the samples to the analytical laboratory.

Following sampling, boreholes will be abandoned using granular bentonite. The granular bentonite will be placed in 3-foot lifts and hydrated. The upper 1 foot of each borehole will be filled with excess soil sample.

4.1.2 Soil Sample Analyses

The number of primary and field quality assurance/quality control (QA/QC) samples are listed in Table 4.2. All samples will be analyzed by a State of Arkansas-certified and AFCEE-approved laboratory. Proposed soil sample analytical methods and corresponding reporting limits are presented in Table 4.3. Parsons ES proposes to analyze samples from Spill Site No. 1 for PAHs by USEPA Method SW8310 and BTEX by USEPA Method SW8021B. Samples collected from Geoprobe® locations near the bioventing MPs and former borehole locations will also be analyzed for TVPH (by USEPA Method SW8015, modified for diesel-range organics) so that a comparison to pre-treatment soil samples can be made. QC samples also will be analyzed to assess laboratory methods. The laboratory will perform analyses on one matrix spike, one laboratory control, and one laboratory blank for each specific analytical method requested.

4.2 SOIL GAS SAMPLING

To gather information on site soil gas chemistry and to provide data against which the progress of bioventing may be evaluated, and to monitor any potential VOC migration, soil gas samples for field analysis will be collected from each of the VWs, MPs, and groundwater monitoring wells at the site. The existing blower system will be turned off 30 days prior to soil gas sampling to allow subsurface conditions to stabilize. Soil gas sampling will be performed using Option 1 funding allocated for Spill Site #1. Each soil gas sample will be analyzed in the field for initial oxygen, carbon dioxide, and TVH concentrations. Based on results of field analyses, up to eight soil gas samples will be collected in evacuated SUMMA® canisters and forwarded

TABLE 4.1
SUPPLEMENTAL SOIL AND GROUNDWATER CHARACTERIZATION ACTIVITIES
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Sample Location	Soil Analytes [a/]	Groundwater Analytes	Maximum Number of Samples[b/]	Rationale
CBA, CBB, CBC, CBD, and CBG	TVPH, BTEX, and PAHs	none	5	•assess presence of BTEX and PAHs in unsaturated soils •assess TVPH reductions in unsaturated soils after 2 years of bioventing
CBE, CBF, CBH, CBI, and CBJ	BTEX and PAHs	none	5	•assess impact of upgradient release on vadose zone soils
MW211 and VW3	None	BTEX, PAHs, and geochemical suite [c/]	2	•assess the stability of dissolved contaminant plume •ascertain the presence of PAHs in groundwater
VW4, VW5, MW202, MW204, and MW205	None	BTEX and geochemical suite [c/]	5	•assess the stability of dissolved contaminant plume

[a/] BTEX = benzene, toluene, ethylbenzene, and xylenes. TVPH = total volatile petroleum hydrocarbons. PAH = polynuclear aromatic hydrocarbons.

[b/] See Sections 4.1 and 4.2 for a detailed description of sampling that will be performed for each location.

[c/] The geochemical suite includes nitrate/nitrite, pH, temperature, oxidation-reduction potential, dissolved oxygen, ferrous iron, manganese, and sulfate.

TABLE 4.2
FIELD SAMPLING OVERVIEW AND QUALITY ASSURANCE SUMMARY
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Matrix	No. of Samples	Analytical Parameter Method [a/]	No. of Field/Trip Blanks	No. of Rinseate Blanks	No. of Duplicates	No. of MS/MSD[b/]	Total Max. No. of Analyses
Groundwater	7	BTEX USEPA SW8021B	1 per cooler	1	1	1	10
Groundwater	2	PAHs USEPA SW8310	0	1	1	1	5
Groundwater	7	Dissolved oxygen Field meter	0	0	0	0	7
Groundwater	7	pH field meter	0	0	0	0	7
Groundwater	7	Temperature Field meter	0	0	0	0	7
Groundwater	7	Oxidation-reduction potential Field meter	0	0	0	0	7
Groundwater	7	Ferrous iron Colorimetric (Hach Method #8146)	0	0	1	0	8
Groundwater	7	Manganese Colorimetric (Hach Method #8034)	0	0	1	0	8
Groundwater	7	Sulfate USEPA E300	0	0	1	1	9
Groundwater	7	Nitrate/nitrite USEPA E300	0	0	1	1	9
Soil	10 max	BTEX USEPA SW8021B	0	0	1	1	12
Soil	5 max	TVPH USEPA SW8015m	0	0	1	1	7
Soil	10 max	PAHs USEPA SW8310	0	0	1	1	12
Soil Gas	8 max	BTEX and TVH USEPA TO-3	0	0	1	0	9
Soil Gas	25 max	TVH field meter	0	0	0	0	25
Soil Gas	25 max	carbon dioxide field meter	0	0	0	0	25
Soil Gas	25 max	oxygen field meter	0	0	0	0	25

[a/] BTEX = benzene, toluene, ethylbenzene, and xylenes. USEPA = U.S. Environmental Protection Agency; TVPH = total volatile petroleum hydrocarbons. PAH = polynuclear aromatic hydrocarbons. TVH = total volatile hydrocarbons.

[b/] MS = matrix spike; MSD = matrix spike duplicate.

NOTE: If dedicated sampling equipment is used, (e.g., dedicated bailers), then rinseate blanks will not be collected.

TABLE 4.3
PROPOSED SOIL SAMPLE ANALYTICAL METHODS AND REPORTING LIMITS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Analytical Method	Maximum Reporting Limit[a]	Units[b]	Field or Fixed-Base Laboratory
USEPA Method SW8015 Modified			
Gasoline-Range Organics	1	mg/kg	Fixed-base
USEPA Method SW8310			
Acenapthene	1,200	µg/kg	Fixed-base
Acenaphthylene	1,540	µg/kg	Fixed-base
Anthracene	440	µg/kg	Fixed-base
Benzo(a)anthracene	9	µg/kg	Fixed-base
Benzo(a)pyrene	15	µg/kg	Fixed-base
Benzo(a)fluoranthene	12	µg/kg	Fixed-base
Benzo(g,h,i)perylene	50	µg/kg	Fixed-base
Benzo(k)fluoranthene	11	µg/kg	Fixed-base
Chrysene	100	µg/kg	Fixed-base
Dibenzo(a,h)anthracene	20	µg/kg	Fixed-base
Fluoranthene	140	µg/kg	Fixed-base
Fluorene	140	µg/kg	Fixed-base
Indeno(1,2,3-cd)pyrene	30	µg/kg	Fixed-base
Naphthalene	1,200	µg/kg	Fixed-base
Phenanthrene	420	µg/kg	Fixed-base
Pyrene	180	µg/kg	Fixed-base
USEPA Method SW8021B			
Benzene	2	mg/kg	Fixed-base
Toluene	2	mg/kg	Fixed-base
Ethylbenzene	2	mg/kg	Fixed-base
Xylenes	2	mg/kg	Fixed-base

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[a] Project reporting limit as specified in subcontract for analytical services.

[b] mg/kg = milligrams per kilogram; µg/kg = micrograms per kilogram.

to Air Toxics, Ltd. in Folsom, California for analysis of jet fuel-range TVH and BTEX by USEPA Method TO-3. These samples will be collected from MPA-9, MPB-8.5, MPC-5, MPC-9, MPD-9, MPE-9.5, and two other locations exhibiting the greatest contaminant concentrations.

Prior to collecting soil gas samples from the VWs and groundwater monitoring wells, depth to groundwater will be measured. If the well screen is completely submerged under perched groundwater, then an attempt will be made to collect a soil gas sample for field analysis following well purging for groundwater sampling. Soil gas samples for laboratory analysis will not be collected from well screens that are completely submerged under groundwater.

4.3 NATURAL ATTENUATION MONITORING AND GROUNDWATER SAMPLING

Groundwater sampling will be performed at the site to further define the FAE of contamination in groundwater, and to qualitatively determine the effects of RNA of dissolved BTEX and PAHs, if present in groundwater. As with soil sampling, groundwater sampling will be conducted by qualified Parsons ES scientists and technicians in accordance with the procedures outlined in this SAP. The following subsections describe the rationale for targeting selected geochemical parameters for analysis, and present the recommended groundwater sampling strategy for the site.

4.3.1 Well Purging, Sample Collection, and Decontamination

This section describes the scope of work required for collecting groundwater samples at each of five existing groundwater monitoring wells (Figure 4.1). All water samples collected from groundwater monitoring wells will be obtained using either disposable bailers, decontaminated Teflon® bailers, or a thoroughly decontaminated peristaltic pump. In order to maintain a high degree of QC during this sampling event, the procedures described in the following sections will be followed.

4.3.1.1 Equipment Decontamination

All portions of sampling and test equipment that will contact the sample will be thoroughly cleaned before each use. This equipment includes the peristaltic pump and tubing, Teflon® bailers, water-level probe and cable, oil/water interface probe and cable, lifting line, test equipment for onsite use, and other equipment or portions thereof which will contact the samples. Based on the types of sample analyses to be conducted, the following decontamination protocol will be used:

- Clean with potable water and phosphate-free laboratory detergent;
- Rinse with potable water;
- Triple rinse with distilled or deionized water;
- Air dry the equipment prior to use.

If precleaned, dedicated sampling equipment is used, the decontamination protocol specified above will not be required. Laboratory-supplied sample containers will be cleaned and sealed by the laboratory.

4.3.1.2 Water Level Measurements and Well Purging

Prior to removing any water from the well, the static water level will be measured. An electrical water level probe decontaminated prior to use will be used to measure the depth to groundwater below the datum to the nearest 0.01 foot. After measuring the static water level, the water level probe will be lowered slowly to the bottom of the well, and the total well depth will be measured to the nearest 0.01 foot. Based on these measurements, the volume of water to be purged from the well will be calculated, and three times the calculated volume will be removed from the well. The pH, temperature, and specific conductivity will be monitored before, during, and after well purging and recorded on well sampling forms. Purged water will be containerized in 55-gallon drums, and temporarily stored on-site until transfer to the waste water treatment plant.

4.3.1.3 Sample Extraction

Either disposable, polyethylene bailers, reusable Teflon® bailers, or a thoroughly decontaminated peristaltic pump will be used to extract groundwater samples from the well. The extraction equipment will be lowered into the water gently to prevent splashing and extracted gently to prevent excessive vacuum in the well. The sample will be transferred directly to the appropriate sample container. The water sample will be transferred from the bottom of the bailer using a bottom-emptying device to allow a controlled flow into the sample container. Water from the peristaltic pump can be directly discharged into the sample container. The water will be carefully poured down the inner walls of the sample bottle to minimize aeration of the sample. Unless other instructions are given by the analytical laboratory, sample containers will be completely filled so that no air space remains in the container.

4.3.2 Natural Attenuation Monitoring and Field Measurements

Microorganisms obtain energy for cell production and maintenance by facilitating thermodynamically advantageous reduction/oxidation (redox) reactions involving the transfer of electrons from electron donors to available electron acceptors. This results in the oxidation of the electron donor and the reduction of the electron acceptor. Electron donors at the site include natural organic carbon and fuel hydrocarbon compounds. Fuel hydrocarbons are completely degraded or detoxified if they are used as the primary electron donor for microbial metabolism (Bouwer, 1992). Electron acceptors are elements or compounds that occur in relatively oxidized states, and include oxygen, nitrate, ferric iron, sulfate, manganese, nitrogen gas, and carbon dioxide.

Microorganisms use electron acceptors preferentially while metabolizing fuel hydrocarbons (Bouwer, 1992). DO is used first as the prime electron acceptor. After the DO is consumed, anaerobic microorganisms typically use electron acceptors in the following order of preference: nitrate, manganese, ferric iron hydroxide, sulfate, nitrogen gas, and finally carbon dioxide. Environmental conditions and microbial competition ultimately determine which processes will dominate. As a result of the occurrence of biodegradation processes, concentrations of electron acceptors (e.g., DO, nitrate, and sulfate) become depleted in the plume area, and concentrations of metabolic byproducts of biodegradation processes (e.g., methane and ferrous iron) are enhanced.

Other geochemical indicators that allow assessment of whether subsurface conditions are favorable for biodegradation to occur include ORP, temperature, and pH. ORP is a measure of the relative tendency of a solution or chemical reaction to accept or transfer electrons, and can be used as a crude indicator of which redox reactions may be operating at a site. Temperature affects the types and growth rates of chemical-degrading bacteria that can be supported in the groundwater environment, and pH affects the presence and activity of microbial populations. Microbes capable of degrading petroleum hydrocarbon compounds generally prefer pH values varying from 6 to 8 standard units (Wiedemeier *et al.*, 1995).

4.3.2.1 Onsite Chemical Parameter Measurement

Many of the groundwater chemical parameters will be measured onsite by Parsons ES personnel (Table 4.4). Some of the measurements will be made using direct-reading meters, while others will be made using a Hach® portable colorimeter in accordance with specific Hach® analytical procedures. These procedures are described in the following subsections.

All glassware or plasticware used in the analyses will have been cleaned prior to sample collection by thoroughly washing with a solution of Alconox® and water, and rinsing with deionized water and ethanol to prevent interference or cross contamination between measurements. If concentrations of an analyte are above the range detectable by the titrimetric method, the analysis will be repeated by diluting the groundwater sample with double-distilled water until the analyte concentration falls to a level within the range of the method. All rinseate and sample reagents accumulated during field groundwater analysis will be discharged onto the ground surface at the site. Sample reagents to be used for field analysis are composed of innocuous salts, and only a few grams of the reagents will be required.

Dissolved Oxygen Measurements. DO is an important electron acceptor in the aerobic biodegradation of dissolved fuel hydrocarbons. DO measurements will be made using a meter with a downhole oxygen sensor or a sensor in a flow-through cell. Measurements will be taken before and following groundwater sample acquisition. When DO measurements are taken in monitoring wells that have not yet been sampled, the existing monitoring wells will be purged until DO levels stabilize. Measured values will be recorded in the groundwater sampling record.

pH, Temperature, and Specific Conductance. Because the pH, temperature, and specific conductance of a groundwater sample can change significantly within a short time following sample acquisition, these parameters will be measured in the field in unfiltered, unpreserved, "fresh" water collected by the same technique as the samples taken for laboratory analyses. The measurements will be made in a clean glass container separate from those intended for laboratory analysis, and the measured values will be recorded in the groundwater sampling record.

TABLE 4.4
PROPOSED GROUNDWATER SAMPLE ANALYTICAL METHODS AND REPORTING LIMITS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Analytical Method	Reporting Limit[a]	Units[b]	Field or Fixed-Base Laboratory
USEPA Method SW8310			
Acenaphthene	18	μg/L	Fixed-base
Acenaphthylene	23	μg/L	Fixed-base
Anthracene	6.6	μg/L	Fixed-base
Benzo(a)anthracene	0.1[c]	μg/L	Fixed-base
Benzo(a)pyrene	0.2[c]	μg/L	Fixed-base
Benzo(b)fluoranthene	0.18	μg/L	Fixed-base
Benzo(g,h,i)perylene	0.76	μg/L	Fixed-base
Benzo(k)fluoranthene	0.17	μg/L	Fixed-base
Chrysene	0.2[c]	μg/L	Fixed-base
Dibenzo(a,h)anthracene	0.3	μg/L	Fixed-base
Fluoranthene	2.1	μg/L	Fixed-base
Fluorene	2.1	μg/L	Fixed-base
Indeno(1,2,3-cd)pyrene	0.4[c]	μg/L	Fixed-base
Naphthalene	18	μg/L	Fixed-base
Phenanthrene	6.4	μg/L	Fixed-base
Pyrene	2.7	μg/L	Fixed-base
USEPA Method SW8021B			
Benzene	2	μg/L	Fixed-base
Toluene	2	μg/L	Fixed-base
Ethylbenzene	2	μg/L	Fixed-base
Xylenes	2	μg/L	Fixed-base
USEPA E300.0			
Sulfate	0.2	mg/L	Fixed-base
USEPA E300.0			
Nitrate/Nitrite	0.04	mg/L	Fixed-base
Hach Method 8000 Series[d]			
Ferrous Iron	---	---	Field
Manganese	---	---	Field

TABLE 4.4 (Continued)
PROPOSED GROUNDWATER SAMPLE ANALYTICAL METHODS AND REPORTING LIMITS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Analytical Method	Reporting Limit[a]	Units[b]	Field or Fixed-Base Laboratory
Direct Reading Meter			
pH	---	---	Field
Conductivity	---	---	Field
Temperature	---	---	Field
Dissolved Oxygen	---	---	Field
Oxidation/Reduction Potential	---	---	Field

[a] Project reporting limit as specified in subcontract for analytical services.

[b] µg/L = micrograms per liter; mg/L = milligrams per liter.

[c] Number shown represents proposed or promulgated federal maximum contaminant level (MCL) for groundwater. Laboratory reporting limits for these and all other analytes will be less than or equal to MCLs.

[d] "Hach" refers to methods described in the Hach Company catalog, 1990.

Other Electron Acceptor Measurements. Ferrous iron and manganese concentrations in groundwater act as a potential electron acceptors for fuel hydrocarbon degradation under anaerobic conditions. These analytes will be measured by experienced Parsons ES scientists via colorimetric analysis using a Hach® portable colorimeter according to the appropriate Hach® methods (Table 4.4).

Oxidation/Reduction Potential. The ORP of groundwater is an indicator of the relative tendency of a solution to accept or transfer electrons. Redox reactions in groundwater often are biologically mediated; therefore, the redox potential of a groundwater system depends upon and influences rates of biodegradation. ORPs can be used to provide real-time data on the location of the contaminant plume, especially in areas undergoing anaerobic biodegradation. The ORP of a groundwater sample can change significantly within a short time following sample acquisition and exposure to atmospheric oxygen. Therefore, this parameter will be measured in the field in unfiltered, unpreserved, "fresh" water collected by the same technique as the samples taken for laboratory analyses. The measurements will be made as quickly as possible in a clean glass container separate from those intended for laboratory analysis.

4.3.2.2 Sample Handling

Sample containers and appropriate container lids will be provided by the laboratory. The laboratory will add any necessary chemical preservatives prior to shipping the containers to the site. The sample containers will be filled as described in Section 4.2.1.3, and the container lids will be tightly closed. The sample bottles will be labeled with the site name and well number, sample depth, date of collection, project name, and other pertinent data. Samples will be properly prepared for transportation to the laboratory by placing the samples in a cooler containing ice to maintain a shipping temperature of approximately 4 degrees centigrade (°C). Chain-of-custody records will be prepared in the field and will accompany the samples to the analytical laboratory.

4.3.3 Groundwater Analyses

This section describes the analytical protocols for laboratory analysis of groundwater samples by a State of Arkansas-certified and AFCEE-approved laboratory. Parsons ES proposes to analyze groundwater samples from Spill Site No. 1 for BTEX by USEPA Method SW8021B; for PAHs by USEPA Method SW8310; for nitrate/nitrite by USEPA Method E300; and for sulfate by USEPA Method SW9056. Proposed groundwater sampling locations are shown on Figure 4.1, and the groundwater analytical methods and corresponding reporting limits are presented in Table 4.4.

Samples from seven existing wells (MW202, MW204, MW205, MW211, VW3, VW4, and VW5) will be sent to the laboratory for BTEX analysis. Samples from these seven wells will be analyzed in the field or at a laboratory for a suite of geochemical indicator parameters to assess aerobic and anaerobic biodegradation of fuel constituents dissolved in groundwater. Samples from wells MW211 and VW3 also will be analyzed for PAHs. Previous results from samples collected at GW202, MW202, and MW204 through MW211 indicate that naphthalene and benzo(a)pyrene (potential COPCs) are not likely present in groundwater above method detection limits (Table 2.2).

Summaries of proposed groundwater sampling activities, and primary and QA/QC samples are presented in Tables 4.1 and 4.2, respectively.

4.4 CHAIN-OF-CUSTODY CONTROL

After the samples for laboratory analysis have been collected, chain-of-custody procedures will be followed to establish a written record of sample handling and movement between the sampling site and the laboratory. Samples collected for onsite field analyses will not require chains-of-custody. Each shipping container will have a chain-of-custody form completed in triplicate by the sampling personnel. One copy of this form will be kept by the sampling contractor after sample delivery to the analytical laboratory, and the other two copies will be retained at the laboratory. One of the laboratory copies will become a part of the permanent record for the sample and one will be returned with the sample analytical results. The chain-of-custody record will contain the following information:

- Site name and address;
- Sample identification number;
- Sample collector's printed name and signature;
- Date and time of collection;
- Place and address of collection;
- Type of sample (e.g., composite, grab, etc.);
- Sample matrix (soil, soil gas, or groundwater);
- Chemical preservatives added;
- Analytical laboratory to be utilized;
- Analyses requested;
- Signatures of individuals involved in the chain of possession; and
- Inclusive dates of possession.

The chain-of-custody documentation will be placed inside the shipping container so that it will be immediately apparent to the laboratory personnel receiving the container, but will not be damaged or lost during transport. The shipping container will be sealed so that it will be obvious if the seal has been tampered with or broken.

4.5 FIELD QA/QC SAMPLES

Field QA/QC samples will include duplicates/replicates, equipment rinseates, and combination field/trip blanks (Table 4.2). Other QA/QC procedures will include decontamination of all equipment that contacts the sample medium before and after each use, use of analyte-appropriate containers, and chain-of-custody procedures for sample handling and tracking, as detailed in this SAP. All samples to be transferred to the analytical laboratory will be clearly labeled to indicate sample number, location, matrix (e.g., groundwater), and analyses requested. Samples will be preserved in accordance with the analytical methods to be used, and water sample containers will be packaged in coolers with ice to maintain a temperature of as close to 4 °C as possible.

All field sampling activities will be recorded in a bound, sequentially paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature.

4.6 WASTE MANAGEMENT PLAN

The IDW that will be generated during the confirmation sampling include solid materials, and water produced during decontamination of sampling equipment, and purged groundwater.

Because the Geoprobe® system will be utilized to collect soil samples, minimal quantities of excess soil will be generated. The probe-sampling device generates no soil cuttings. The sampler is 24 inches long and 1.25 inches in diameter. Typically, 6 inches of the sample are sent to the laboratory for analysis. The remaining sample material will be used to fill the upper portion of the abandoned boreholes and/or spread on the ground surface at the site. The estimated total volume of excess soil sample is 0.5 cubic foot. Water generated during decontamination of sampling equipment also will be spread on the ground surface, near the former USTs. An estimated 10 gallons of decontamination water will be generated.

Groundwater removed from the wells during purging will be collected in 55-gallon drums and temporarily stored at the site. After completion of field activities, the purged groundwater shall be disposed of by Eaker AFBCA at the Base water treatment plant. It is anticipated that 3 drums of water will be generated during groundwater sampling activities.

SECTION 5

SITE CONFIRMATION SAMPLING REPORT FORMAT

Following receipt of the laboratory analytical results, draft and final versions of a confirmation sampling report will be prepared and submitted to Eaker AFBCA, and AFCEE. Comments received on the draft report will be incorporated into the final report, which is planned for incorporation into a Corrective Measures Study (CMS) report that will be prepared by HNUS.

The report will contain the following information for Spill Site No. 1:

- Site plot plan showing sampling locations;
- Summary of field activities;
- Comparison of confirmation sampling and testing results to pre-treatment results;
- Assessment of soil and groundwater analytical results in comparison to applicable ASTM RBCA RBSLs for PAHs and BTEX;
- Assessment of analytical results in comparison to applicable ASTM RBCA groundwater cleanup criteria for PAHs and BTEX;
- Assessment of the potential for RNA in groundwater;
- ADEQ-required information, including ADEQ site-specific monitoring well elevation data (based on area benchmarks or topographic maps), and depth to groundwater (referenced to the tops of monitoring well casings or ground level);
- Laboratory analytical reports and chain-of-custody forms;
- Borehole logs; and
- Conclusions and recommendations for future NFRAP decision, additional cleanup action, or continued monitoring.

SECTION 6

EAKER AFBCA SUPPORT REQUIREMENTS

The following Eaker AFBCA support is needed prior to the arrival of the Parsons ES team:

- Assistance in obtaining a digging permit.
- Arrange soil borehole survey locations, if desired by Eaker AFB.
- Assistance in handling/disposal of purge groundwater, in accordance with Section 4.6.
- Provision of a potable water supply for drilling and decontamination activities.
- Use of telephone and facsimile machine.

SECTION 7

PROJECT SCHEDULE

The following schedule is contingent upon timely approval of this confirmation SAP and fulfillment of the Eaker AFBCA support requirements outlined in Section 6.

Event	Start Date	End Date	Duration (working days)
Submit Draft SAP to AFCEE and Eaker AFBCA	NA	22 May 1998	NA
Review Period	26 May 1998	19 June 1998	19 days
Respond to Comments on Draft Work Plan	22 June 1998	26 June 1998	14 days
Submit Draft Final SAP to AFCEE, and Eaker AFBCA*	NA	26 June 1998	NA
Submit Work Permit (digging permit) Request	NA	26 June 1998	NA
Review Period	29 June 1998	17 July 1998	15 days
Respond to Comments on Draft Final Work Plan	20 July 1998	24 July 1998	10 days
Submit Final SAP to AFCEE and Eaker AFBCA*	NA	24 July 1998	NA
Oxygen Influence Monitoring/Turn Blower Off	27 July 1998	27 July 1998	1 day
Soil Gas Sampling	14 September 1998	14 September 1998	1 day
Soil and Groundwater Sampling/ Respiration Testing	14 September 1998	23 September 1998	8 days
Prepare Confirmation Sampling Report	26 October 1998	4 December 1998	50 days
Submit Draft Confirmation Sampling Report to AFCEE and Eaker AFBCA	NA	4 December 1998	NA
Review Period	7 December 1998	4 January 1999	28 days
Respond to Comments on Draft Confirmation Sampling Report	4 January 1999	22 January 1999	15 days
Submit Final Confirmation Sampling Report to AFCEE, and Eaker AFBCA	NA	25 January 1999	NA

*Copies of SAP for ADEQ will be sent to Eaker AFB for distribution.

SECTION 8

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SECTION 9

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