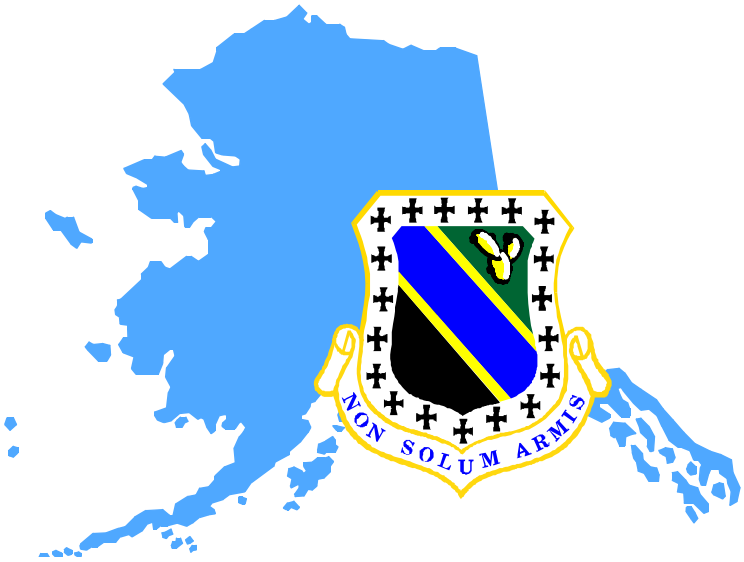

UNITED STATES AIR FORCE
ELMENDORF AIR FORCE BASE, ALASKA

ENVIRONMENTAL RESTORATION PROGRAM

2003 SOIL SAMPLING REPORT
SOIL SAMPLING AT BIOVENTING SYSTEMS
SS43 AND SS10
ELMENDORF AFB, ALASKA

FINAL

JULY 2004

FINAL

2003 SOIL SAMPLING REPORT

SOIL SAMPLING AT BIOVENTING SYSTEMS SS43 and SS10

Elmendorf AFB, Alaska

Prepared for:

3rd Civil Engineer Squadron/Environmental Restoration
and

Air Force Center for Environmental Excellence

Contract No. F41624-03-D-8622/TO 0002
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July 2004

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LIST OF ACRONYMS AND ABBREVIATIONS

ACM	Alaska Cleanup Matrix
ADEC	Alaska Department of Environmental Conservation
ADSA	Asphalt Drum Storage Area
AFB	Air Force Base
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Restoration, Compensation, and Liabilities Act
COC	contaminants of concern
DRO	Diesel Range Organics
EPA	Environmental Protection Agency
FFA	Federal Facilities Agreement
FSP	Field Sampling Plan
GRO	Gasoline Range Organics
mg/Kg	milligrams per kilogram
µg/L	micrograms per liter
NPL	National Priorities List
OU	Operable Unit
PID	Photoionization detector
POL	Petroleum, Oil, and Lubricant
ppm	parts per million
RA-O	Remedial Action – Operation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision

LIST OF ACRONYMS AND ABBREVIATIONS *(Continued)*

RRO	Residual Range Organics
SERA	State-Elmendorf Environmental Restoration Agreement
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TVH	Total Volatile Hydrocarbons
USAF	United States Air Force
UST	Underground Storage Tank

1.0 INTRODUCTION

This Soil Sampling Report presents the results of soil sampling performed during September 2003 at Elmendorf Air Force Base (AFB), Alaska for bioventing system locations SS43 and SS10 to determine the level of contamination remaining at the sites. Sampling was conducted in accordance with the approved, site-specific Field Sampling Plan (FSP) (USAF, 2003a) with a few exceptions, specified in Section 1.2.

1.1 REPORT ORGANIZATION

- Section 1 provides the introduction, report organization, and project scope and objectives;
- Section 2 provides project background, and site summaries;
- Section 3 presents the 2003 soil sampling activities and results;
- Section 4 presents conclusions and recommendations derived from the results; and
- Section 5 lists the references cited in this report.

1.2 SCOPE AND OBJECTIVES

During September 2003, soil samples were collected at six basewide bioventing systems, at the following State Elmendorf Environmental Restoration Agreement (SERA), and Operable Unit (OU) locations:

- SERA Phase I, Site SS43 (5 Bioventing Systems); and
- OU 4, Site SS10

Additional deviations from the approved FSP were made during the field effort in response to findings in the field. The depth at which samples were collected at SS43 were changed from 18 feet below ground surface (bgs) to deeper depths because field screening results suggested remaining contaminant levels were not significant at 18 feet bgs. The 2003 soil samples were collected from locations with the highest contaminant concentrations found during 1994 SERA Phase I Assessment. The boreholes were drilled as close as possible to the former borehole locations. However, in some cases, the presence of utilities, bioventing system piping, and other environmental factors forced the location of the boreholes to be moved slightly from the planned locations. Also, an additional sample was collected for laboratory analysis of contaminants from a soil boring advanced for collection of a total organic carbon (TOC) sample. Field screening results suggested that elevated contaminant levels were present at the location, thought to be outside the contaminated area. These deviations from the FSP are discussed further in Section 3.1 of this report.

The FSP also called for sampling at ST32, Tank 2 during 2003. Since the installation of this bioventing system, the surface around the system has been raised approximately 30 feet to create a horizontal space for new aboveground storage tanks. The area directly above Tank 2 is located on a steep slope that was not accessible using a conventional drill rig. Sampling at this site will be conducted in the future using directional drilling.

The data collected during the 2003 sampling activities were used to (1) determine if contaminant levels have been cleaned up to below cleanup standards; and (2) determine if operation of the bioventing systems should be discontinued.

2.0 PROJECT BACKGROUND

Elmendorf AFB was placed on the United States Environmental Protection Agency (EPA) National Priority List (NPL) in August 1990. This listing designated the facility as a federal NPL site subject to the remedial response requirements of the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA), often referred to as the "Superfund". The United States Air Force (USAF), EPA, and Alaska Department of Environmental Conservation (ADEC) signed a Federal Facilities Agreement (FFA) for Elmendorf AFB on November 22, 1991. The FFA divided contaminated sites at Elmendorf AFB into seven OUs, each to be managed as a separate area and investigated according to a sequenced schedule.

In October 1992, the Air Force developed a cooperative agreement with ADEC to address the assessment and remediation of solid waste and petroleum, oil, and lubricant (POL)-contaminated sites on Elmendorf AFB. This agreement is known as SERA. The nature and extent of contamination and the potential risks to public health and the environment at SERA sites were evaluated by site assessments and the OU 4 Remedial Investigation/Feasibility Study (RI/FS). Fuel and fuel constituents were found to be present at a number of source areas. The treatment method selected for remediation of these source areas was bioventing.

Bioventing systems operate by increasing the flow of air (e.g. oxygen) into soils contaminated with POL. Soils naturally contain microorganisms that decompose POL. Bioventing increases the amount of oxygen available to these microorganisms, which speeds up their growth and enables them to more rapidly decompose POL. The Basewide Bioventing Systems Program is considered Remedial Action – Operation (RA-O) by the USAF.

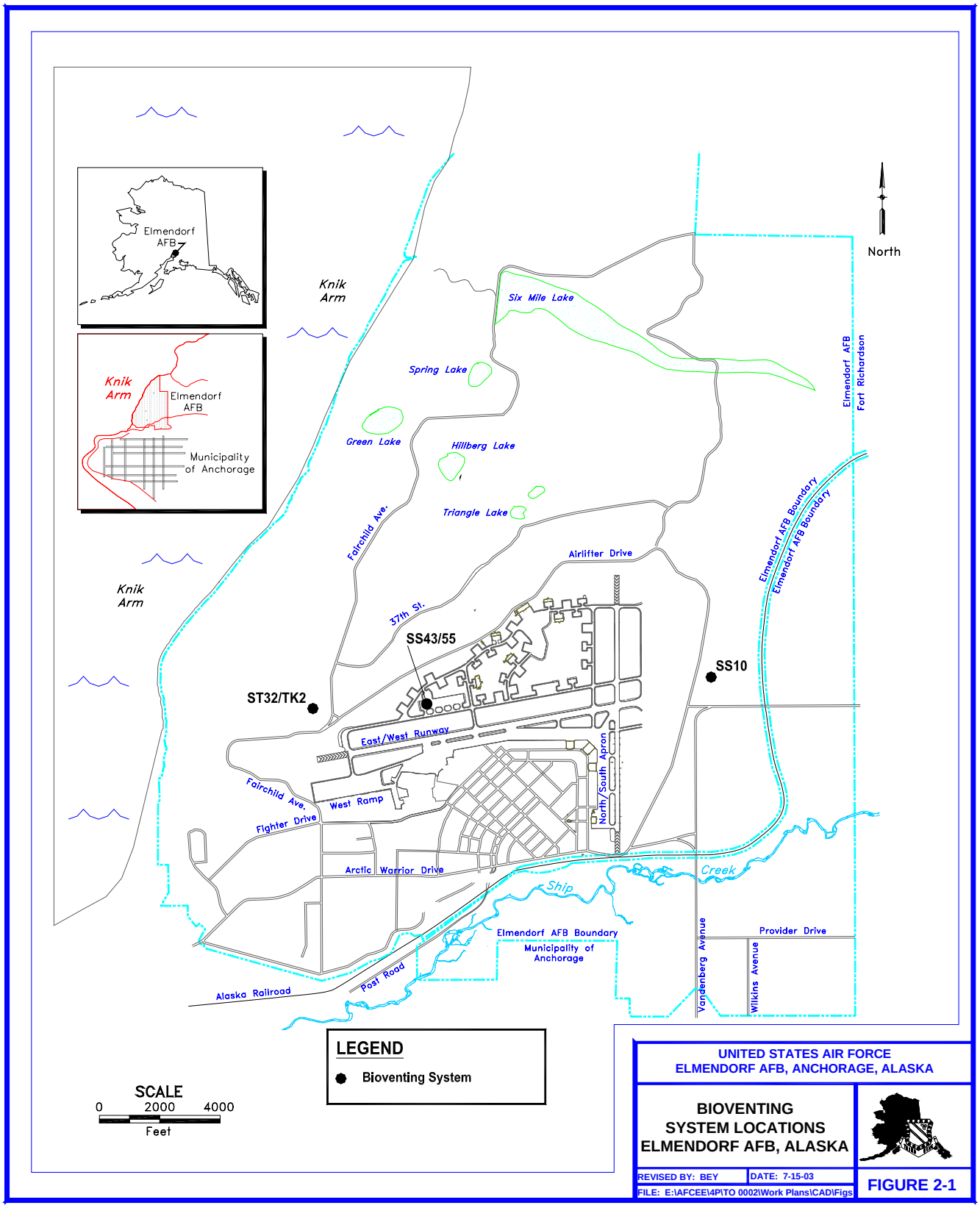
SERA was dissolved on 21 October 2002 by mutual agreement between the USAF and ADEC. The sites and programs formerly addressed by SERA; i.e.; underground storage tanks (UST) and oil and other hazardous substance discharges, will be addressed in accordance with applicable requirements of 18 AAC 78 (Underground Storage Tanks) and 18 AAC 75 (Oil and Other Hazardous Substances Pollution Control).

2.1 INSTALLATION ENVIRONMENTAL SETTING

Elmendorf AFB is the largest Air Force installation in Alaska. The Base is located adjacent to Anchorage, Alaska, the largest population center in the state with associated agricultural, industrial and residential sectors. The Base encompasses approximately 13,103 acres, of which, over half is undeveloped. The developed portion of the Base supports airfield operations, base support operations, personnel housing, and recreational facilities. The locations on Elmendorf AFB of the bioventing systems addressed in this soil sampling effort are shown on Figure 2-1.

2.2 SITE SUMMARIES

The sections below provide a brief background discussion and describe the sampling activities performed at each site.


Elmendorf AFB
Knik Arm
Municipality of Anchorage
North
Six Mile Lake
Spring Lake
Green Lake
Hillberg Lake
Triangle Lake
Fairchild Ave.
Airlifter Drive
37th St.
SS43/55
SS10
ST32/TK2
East/West Runway
West Ramp
North/South Apron
Fighter Drive
Arctic Warrior Drive
Ship Creek
Elmendorf AFB Boundary
Municipality of Anchorage
Provider Drive
Vandenberg Avenue
Wilkins Avenue
Post Road
Alaska Railroad
Elmendorf AFB
Fort Richardson
Elmendorf AFB Boundary
LEGEND
Bioventing System
SCALE
0 2000 4000
Feet
UNITED STATES AIR FORCE
ELMENDORF AFB, ANCHORAGE, ALASKA
BIOVENTING
SYSTEM LOCATIONS
ELMENDORF AFB, ALASKA
REVISED BY: BEY
DATE: 7-15-03
FILE: E:\AFCEE\4P\TO 0002\Work Plans\CAD\Figs
FIGURE 2-1

2.2.1 Bioventing System SS43

Site SS43 was a hydrant refueling area located on the north side of the east/west runway at Elmendorf AFB. The site included two pump house buildings, an underground hydrant fueling system and several aircraft hardstands. Numerous historical spills of JP-4 have been recorded at the site (USAF, 1995b).

According to past and present laboratory and field screening sample results, as discussed in Section 3.1, the majority of remaining contamination at SS43 is confined to the smear zone. The smear zone includes soil that is saturated (covered) by groundwater during some portion of the year as the groundwater rises and falls relative to the surface of the soil. The smear zone at this site is estimated to range from 18 to 24 feet bgs.

The bioventing system was intended to treat contaminated soil within the well screen interval (above the smear zone). Table 2-1, below, provides the screen interval of the SS43 bioventing wells and soil implants.

Table 2-1 SS43 Bioventing Wells and Soil Implant Screen Intervals

Bioventing Well Identification	Drilling Depth (ft. bgs)	Screen Interval (ft. bgs)	Soil Implants[1]	Screen Interval for Soil Implants (ft bgs)
BV-1	24	13-23	1A	18-19
			1B	18-19
			1C	18-19
BV-2	23	12-22	2A	17-18
			2B	17-18
			2C	16-17
BV-3	21	10-20	3A	15-16
			3B	15-16
			2C	16-17

[1] Soil implant 2C is shared by Bioventing wells BV-2 and BV-3; thus, the screened interval was chosen to be between the intervals for 2B and for 3B.

The cleanup standards for SS43 are outlined in Table 2-2. The standards were established in the SERA Phase IA and 1B Site Assessment Report (USAF, 1994) and were based on the ADEC Alaska Cleanup Matrix (ACM), Level B.

Table 2-2 SS43 Soil Cleanup Standards

Contaminant of Concern	Established Cleanup Standard (mg/Kg)
Diesel Range Organics	200
Gasoline Range Organics	100
Benzene	0.02
Toluene	5.4
Ethylbenzene	5.5
Total Xylenes	78

Benzene, toluene, ethylbenzene, and total xylene values from 18 AAC 75 Table B1, Under 40-inch zone criteria.
mg/Kg – milligram per kilogram

2.2.2 Bioventing System SS10

Soils in this former Asphalt Drum Storage Area (ADSA) waste pit were found to be contaminated with tar-like material from 5 feet to 20 feet bgs in 1994. Total petroleum hydrocarbon (TPH) concentrations up to 43,000 milligrams per kilogram (mg/Kg) were found in the subsoil at this location. Bioventing well BV-6 is located inside the confines of the former pit (USAF, 1995a).

Cleanup Standards for SS10 media are delineated in the OU 4 Record of Decision (ROD) and summarized in Table 2-3. The basis for Cleanup Standards for shallow and deep soils is ACM (USAF, 1995d). No exposure assumptions, toxicity data, cleanup standards or Remedial Action Objectives have changed since the time of the remedy selection.

Table 2-3 SS10 Cleanup Standards

Contaminant of Concern	Established Cleanup Standard (mg/Kg)
Diesel Range Organics	2,000
Gasoline Range Organics	1,000
Xylene	100
Jet Fuel	2,000

mg/Kg – milligram per kilogram

3.0 YEAR 2003 SOIL SAMPLING ACTIVITIES AND RESULTS

3.1 SS43

3.1.1 Site Soil Sampling Activities

A total of 27 field soil samples were collected and analyzed for contaminants of concern (COCs) from the area being treated by the SS43 Bioventing System using the split-spoon sampling technique. An additional three boreholes were advanced for collection of background TOC samples, as discussed in the paragraph below. The following table summarizes this data.

Table 3-1 2003 Soil Sample Summary

2003 Soil Samples	Number of Boreholes	Number of Samples
Soil samples collected in the area being treated by the SS43 Bioventing System to document remediation progress.	13	27
Soil samples collected outside the area being treated by the SS43 area for background-TOC samples.	3	3
	16	30

A photoionization detector (PID) was used to screen cuttings and determine the intervals from which samples were taken as per the FSP. Locations where samples were taken and the results at each location are shown on Figure 3-1. The goal was to collect the 2003 soil samples from locations with the highest contaminant concentrations found during the 1994 SERA Phase I Assessment. The boreholes were drilled as close as possible to the former borehole locations. However, in some cases, the presence of utilities, bioventing system piping, and other environmental factors forced the location of the boreholes to be moved slightly from the planned locations. All soil samples were taken from a depth of at least 18 feet bgs since total volatile hydrocarbons (TVH) readings taken above that depth were low and the highest concentration of contaminants has historically occurred below this depth (USAF 1995b). Three additional boreholes (SB-14, SB-15, and SB16) were drilled outside the contaminated area to collect samples for TOC analysis in order to avoid the contaminated area of the smear zone. While drilling SB-14, however, contaminated soil was encountered near the proposed sampling depth. This boring was continued and a soil sample was collected. SB-15 and SB-16 were then advanced to provide TOC data called for in the work plan.

In addition, the work plan specified that one sample from each boring was to be taken from 18 ft bgs, and an additional sample was to be taken between 18 feet bgs and the groundwater table. A sample was taken from each of the initial four borings at 18 feet bgs. However, two of the first four borings had elevated PID readings at 18 feet bgs, and the analytical results from these initial four borings at 18 feet bgs confirmed that the soils in two of them were contaminated with up to 1,180 mg/Kg of gasoline range organics (GRO) and 0.802 mg/kg of benzene. The fourth soil boring had elevated PID readings at 20 feet bgs and the analytical results from this depth confirmed that the soil was contaminated with 101 mg/Kg of GRO and 0.0811 mg/Kg benzene. At this point the field crew decided to collect samples from deeper depths in subsequent boreholes, where field screening results suggested that remaining contaminants were present,

rather than at the planned 18 foot bgs, where field screening results suggested little or no contaminants existed. Table 3-2 summarizes the field screening data collected during the field activities.

Table 3-2 Field Screening Data

Soil Boring	Approximate depth (feet bgs) 0	2	4	6	8	10	12	14	16	18	20	22	24
SB-01		ND		ND	0.3			0.6	0.6	>500	16.3	18	
SB-02		ND	ND	ND	ND	ND	ND		ND	ND			
SB-03		ND	ND	ND ND		ND	ND	24	42	1.8			
SB-04		5.4	6.6						7.3	0.9	182	550	
SB-05		1.8	ND	0.8	ND	ND	ND		ND			172	>1,000
SB-06	ND	ND	1.2		ND	ND	ND		ND	1.1	79.8	895	
SB-07		12.9	ND	ND		ND		1.5		82.1	1,625		
SB-08	ND			67	4.5		4.2		1.7		48.2		>1,000
SB-09		ND	ND		ND							425	>500
SB-10		ND	ND		ND			1.3		ND		1,823	
SB-11		ND	ND			ND		ND			1.3		824
SB-12		ND	ND			ND		ND			6.1	763	
SB-13	ND			ND	125					23.5	43	71.7	
SB-14		ND			ND		ND	>1,000		>400			
SB-15[1]													
SB-16	ND				ND			ND		ND			

All photoionization detector (PID) results are in parts per million.
[1]No PID readings collected on SB-15 soils.
Bgs = below ground surface > = greater than

All drilling equipment was decontaminated prior to drilling each borehole. Samples were submitted for laboratory analysis of GRO by Alaska Method 101, benzene, toluene, ethylbenzene and xylenes (BTEX) by Method SW8021B, diesel range organics (DRO) by Alaska Method 102 and residual range organics (RRO) by Alaska Method 103. All potentially contaminated drill cuttings were drummed and disposed of using thermal treatment. The field notes, boring logs, and surveyed boring locations are provided in Appendix A and Certificates of Destruction for drill cuttings are provided in Appendix B. The laboratory analytical data is provided in Appendix C.

3.1.2 Site Soil Sampling Results

Table 3-3 provides the results of the 2003 soil sampling effort at SS43.

3.1.3 Discussion of Results

The SS43 site exceeds closure criteria for all contaminants of concern except total xylenes at multiple sampling locations. However, the borings and sample results confirm that the remaining contamination is confined to the smear zone which is approximately 18 to 24 feet bgs at this site (Figure 3-1). This is further supported by the respiration test data that generally show the highest TVH readings in the interval between 18 and 19 feet. PID readings during drilling indicate that soils above the smear zone have been remediated. Within the smear zone, however, although data shows that there has been a decreasing level of contaminants since the original 1994 SERA Phase I Assessment, contaminant levels still exceed closure criteria for the site.

Figure 3-1 Bore Hole Sample Locations Source Area SS43

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Table 3-3 Soil Sampling Results at SS43

Location	SS43, SB-01		SS43, SB-02		SS43, SB-03		SS43, SB-04		SS43, SB-05		SS43, SB-06	
Collection Date	9/12/2003		9/12/2003		9/12/2003		9/12/2003		9/12/2003		9/13/2003	9/13/2003
Depth (feet bgs)	18 Ft.	19 Ft.	18 Ft.	18.5 Ft.	18 Ft.	19 Ft.	18 Ft.	20 Ft.	21 Ft.	23.5	21.5 Ft.	22 Ft.
Depth to Groundwater	19		19		19		20.5		24		23	
Benzene (mg/Kg)	**0.802**	0.00367 F	0.00419 F	0.00854	**0.108**	0.0179	0.0152	**0.0811**	**0.0649**	**0.348**	0.0114	**0.104**
Toluene (mg/Kg)	1.77 F	0.0461	0.0474	0.256	2.6	0.294	0.085	2.28	0.264	0.859	0.0501	3.73
Ethylbenzene (mg/Kg)	5.19	0.165	0.0236 F	0.0138 F	1.17	0.159	0.0473	1.2	0.534	2.22	0.13	1.88
Total Xylenes (mg/Kg)	22.27	0.913	ND (0.0848)	0.0494 F	3.88	0.603	0.2109	5.6	1.999	9.15	0.4241	6.66
GRO (mg/Kg)	**1180**	3.91	1.56 F	ND (1.23)	**114**	14.5	1.52 F	**101**	**194**	**898**	15.1	**272**
DRO (mg/Kg)	**512**	8.66 F	3.54 F	5.98 F	133	4.61 F	9.95 F	184	**396**	**255**	46.9	**874**
PID	>500	>500	ND	ND	1.8	1.8	0.9	182	172	>1000	79.8	895

Location	SS43, SB-07		SS43, SB-08		SS43, SB-09			SS43, SB-10		SS43, SB-11
Collection Date	9/13/2003		9/13/2003		9/15/2003			9/15/2003		9/15/2003
Depth (feet bgs)	19 Ft.	22 Ft.	21.5 Ft.	22 Ft.	23 Ft.	23.5 Ft.	24 Ft.	21 Ft.	22 Ft.	24 Ft.
Depth to Groundwater	21		22		24.5			22.7		24.5
Benzene (mg/Kg)	**1.54**	**2.08**	**0.0338**	**0.188**	**0.241**	**0.487**	**0.373**	**0.0281**	0.0157	**0.0436**
Toluene (mg/Kg)	**21.3**	**24.9**	0.104	1.65	**14.5**	**22.3**	**20.7**	0.13	0.647	0.426
Ethylbenzene (mg/Kg)	**17.8**	**16.8**	0.158	0.792	5.07	**13.4**	**10.8**	0.0349	0.0836	0.234
Total Xylenes (mg/Kg)	43.4	62.7	0.85	3.2	25.94	38.66	30.74	0.2207	1.837	2.83
GRO (mg/Kg)	**1080**	**1120**	34.8	80	**575**	**872**	**806**	1.61	36.1	59.1
DRO (mg/Kg)	19.0 F	**1770**	32	20.5 F	**1270**	**477**	**415**	16.8 F	64.5	**448**
PID	82.1	1625	48.2	>1000	425	>500	>500	1823	1823	824

Location	SS43, SB-12			SS43, SB-13		SS43, SB-14
Collection Date	9/16/2003			9/16/2003		9/16/2003
Depth (feet bgs)	20.5 Ft.	21 Ft.	22 Ft.	19.5 Ft.	20 Ft.	16.5 Ft.
Depth to Groundwater	22.3			21.5		16.5
Benzene (mg/Kg)	0.00739	**0.0504 F**	**0.0235**	**0.0394**	0.00964 F	**0.522**
Toluene (mg/Kg)	0.0525	1.77	0.954	0.233	0.0569	0.986
Ethylbenzene (mg/Kg)	0.0138 F	0.423	0.224	0.0462	0.147	11.1
Total Xylenes (mg/Kg)	0.0669 F	3.77	2.228	0.257	0.284	30.36
GRO (mg/Kg)	1.25	90.3	56.1	1.30 F	7.34	**329**
DRO (mg/Kg)	24.5	**287**	**251**	25.30	**513**	**3240**
PID	6.1	763	763	23.5	43	>400

Location	SS43, SB-15	SS43, SB-16
Collection Date	9/16/2003	9/16/2003
Depth (feet bgs)	14.5 Ft.	15 Ft.
Total Organic Carbon	2117	1057
Depth to Groundwater	16	16.5

bgs – below ground surface
GRO – gasoline range organics
mg/Kg – milligrams per kilogram
Bold values exceed closure criteria
DRO – diesel range organics
F – Indicates an estimated value that falls below PQL, but is greater than the MDL
ND – Not detected above method reporting limits (provided in parentheses)

During the 1994 SERA Phase I Assessment, several boreholes were advanced and soil samples were collected from the SS43 area. Table 3-4 provides the 1994 soil sample results. The data shows that the majority of the contamination was confined to the smear zone. Only eleven of the forty samples collected from above the smear zone (less than 18 feet bgs) during 1994 had DRO, GRO, or benzene concentrations above cleanup standards. Eight of these eleven samples were from between 16 and 17.5 ft bgs. In contrast, only three of 36 samples collected in the smear zone, 18 foot bgs or deeper, during 1994 had DRO, GRO, or benzene concentrations not exceeding the cleanup standard. Table 3-5 summarizes this data.

Table 3-4 Comparisons of 2003 Data with 1994 Results

1994 BORING	DEPTH (FT)	DRO	GRO	BENZENE	2003 BORING	DEPTH (FT)	DRO	GRO	BENZENE	PID
1	11	U	U	U						
1	18.5	78	**150**	**0.47**						
2	8.5	U	U	U						
2	16	U	U	U						
3	13	U	U	U	13	19.5	25.3	1.3F	**0.0394**	23.5
3	18	**550**	**1,100J**	**0.54**	13	20	**513**	7.34	0.00964F	43
4	5.5	U	U	U						
4	16	190	**160**	U						
5	8.5	U	U	U						
5	18.5	**810**	**2,800J**	U						
6	13.5	U	U	U						
6	18	**1,900**	**16,000J**	**36**						
7	16	57	**130**	**0.29**						
7	18	13	5	U						
8	5.5	U	U	U						
8	18	**350**	**1,400J**	U						
9	8.5	U	U	U	02	18	3.54F	1.56F	0.00419	ND
9	18	120	**770**	**0.3**	02	18.5	5.98F	1.23U	0.00854	ND
10	6	U	U	U						
10	18	47	**140**	**0.94**						
11	13.5	U	U	U						
11	18.5	**290**	**1,300**	**1**						
12	15.5	U	U	U	01	18	**512**	**1180**	**0.802**	> 500
12	18	**1,000**	**4,900**	**5.4**	01	19	8.66F	3.91	0.00367	>500
13	11	U	U	U						
13	18.5	**360**	**1,700**	**1.3**						
14	18.5	110	**130**	**0.13**	10	21	16.8F	1.61	**0.0281**	1823
14	20.5	**730**	**1,900**	**1.8**	10	22	64.5	36.1	0.0157	1823
15	16	U	5	**0.45**						
15	20.5	**380**	**1,300**	**1.6**						
16	13.5	U	8	**0.091**	11	24	**448**	59.1	**0.0436**	824
16	18	**2,200**	**42,000**	**43**						
17	13.5	U	U	U						
17	18	**2,400**	**24,000**	**56**						
18	15.5	U	U	U	12	20.5	24.5	1.25	0.00739	6.1
18	20	**2,000**	**15,000**	**19**	12	21	**287**	90.3	**0.0504F**	763
					12	22	**251**	56.1	**0.0235**	763
19	6	U	U	U						
19	16	90	34	U						

Table 3-4 Comparison of 2003 Data with 1994 Results (continued)

1994 BORING	DEPTH (FT)	DRO	GRO	BENZENE	2003 BORING	DEPTH (FT)	DRO	GRO	BENZENE	PID
21	3.5	**850**	**450**	**0.12**	08	21.5	32	34.8	**0.0338**	48.2
21	18.5	**390**	**1,200**	**1.5**	08	22	20.5F	80	**0.188**	>1000
22	10.5	**240**	**290**	**0.15**						
22	18	**1,100**	**1,600**	**4**						
23	6	U	U	U						
23	18	130	**680**	U						
24	3.5	U	U	U	09	23	**1270**	**575**	**0.241**	425
24	20.5	**430**	**2,400**	U	09	23.5	**477**	**872**	**0.487**	>500
					09	24	**415**	**806**	**0.373**	>500
25	18	97	36	U						
25	20	**740**	**4,100**	**0.5**						
26	18	130	**250**	**0.083**						
26	21	**4,200**	**11,000**	**26**						
27	16	U	U	**0.28**						
27	18	**290**	**1,100**	**0.89**						
28	3.5	48	51	U						
28	18.5	U	U	**0.03**						
29	16	160	**700**	U						
29	18.5	**1,100**	**3,500**	**6.1**						
30	13	U	U	U						
30	18.5	**3,100**	**14,000**	**23**						
31	3.5	11	48	U						
31	18	**420**	**3,600**	**5.2**						
32	16	**580**	**1,400**	**0.71**						
32	18.5	U	U	U						
33	11	U	U	U						
33	16	U	6	U						
34	13	U	N/A	U						
34	18	**2,800**	**8,500**	U						
35	6	25	61	U						
35	18.5	**240**	**1,000**	U						
36	13.5	U	U	U						
36	16	62	100	U						
37	15.5	170	62	U	03	18	133	**114**	**0.108**	1.8
37	18	**1,700**	**3,400**	U	03	19	4.61F	14.5	0.0179	1.8
43	16	50	**350**	**0.13**						
43	17.5	**230**	**2,600**	U						
46	21.5	**340**	**1,200**	U						
46	23	**4,300**	**7,000**	U						

All results in mg/Kg – milligrams per kilogram
U – Not detected above method reporting limits (provided in parentheses)
Bold values exceed closure criteria

Table 3-5 Summary of 1994 Soil Sample Results

1994 Samples	Total Number of Samples	Number of Samples That Exceed Cleanup Standard	Number of Samples That are Below Cleanup Standard
Above Smear zone	40	11	29
At or below smear Zone	36	33	3
	76		

The goal was to collect the 2003 soil samples from locations with the highest contaminant concentrations found during the 1994 SERA Phase I Assessment. The boreholes were drilled as close as possible to the former borehole locations. However, in some cases, the presence of utilities, bioventing system piping, and other environmental factors forced the location of the boreholes to be moved slightly from the planned locations (Figure 2-2 of the FSP [USAF, 2003a]). Figure 3-1 shows the location where each borehole was advanced.

Table 3-4 provides a comparison of current year data with the 1994 results. The table compares 2003 data with the 1994 sampling results by horizontal location. Samples from each borehole advanced in 2003 are compared to samples from the nearest borehole advanced in 1994, as long as the boreholes are no more than 20 horizontal feet apart. The table also provides 2003 PID field screening data in the intervals sampled. PID field screening data in all intervals is provided in Table 3-2.

3.1.4 ADEC Method 3 Calculator

By using the ADEC Method 3 calculator, it may be determined that less stringent cleanup standards may be required for this site. TOC samples were collected from soil borings 15 and 16 to be used in the calculations. The average fractional organic carbon content was calculated to be 0.0016 (dimensionless) based on these samples. Using this value in the ADEC Method 3 calculator, cleanup levels for each chemical and pathway were determined for SS43. Table 3-6 lists the calculated cleanup levels for each chemical and pathway. The table also lists the previously established cleanup levels, from 18 AAC 75 Table A2 and Table B1, Under 40-inch Zone Migration to Groundwater Criteria, in order to compare to the Method 3 calculated levels. As Table 3-6 shows, the Method 3 calculated cleanup level for benzene is only raised to 0.0209 mg/kg, compared to the established cleanup level of 0.02 mg/kg. DRO and GRO cleanup levels are raised to 404 mg/kg and 453 mg/kg, respectively, compared to the established cleanup levels of 200 mg/kg and 100 mg/kg. Appendix D includes the Method 3 calculation.

Table 3-6 Method 3 Calculated Cleanup Levels

Chemical Name	Ingestion (mg/Kg)	Inhalation (mg/Kg)	Migration to Groundwater (mg/Kg)	Previously Established Cleanup Standard (mg/Kg)
Benzene	1040	12.1	.0209	.02
DRO (Total)	12500	12500	404	200
Ethylbenzene	204000	125	7.54	5.5
GRO (Total)	1400	1400	453	100
Toluene	409000	233	6.85	5.4

The on-line computational screen shots used in this calculation are provided at Appendix D.

3.2 SS10

3.2.1 Site Soil Sampling Activities

A total of 7 field samples were collected at SS10 using the split-spoon sampling technique. A PID was used to screen cuttings and determine the intervals from which samples were taken as per the FSP. Borehole locations where samples were collected and the sample results at each

location are shown on Figure 3-2. Drilling equipment was decontaminated prior to drilling each borehole. Samples analyzed for GRO by Alaska Method 101, BTEX by Method SW8021B, DRO by Alaska Method 102 and RRO by Alaska Method 103. All potentially contaminated drill cuttings were drummed and disposed of using thermal treatment. The field notes, boring logs, and surveyed boring locations are provided in Appendix A and Certificates of Destruction for drill cuttings are provided in Appendix B. The laboratory analytical data is provided in Appendix C.

3.2.2 Site Soil Sampling Results

Table 3-7 provides the results of the 2003 soil sampling effort at SS10.

3.2.3 Discussion of Results

Concentrations of all analytes sampled for were below cleanup standards at SS10. The values for jet fuel were obtained by re-integrating the chromatograms and adding the results from the ranges C8-C10 and C-10 to C16 using the GRO and DRO analysis, respectively. It initially seems anomalous that the integration values with the shortened carbon range are higher than originally reported values with a longer range (full GRO plus DRO). However, the concentrations in GRO and DRO standards are based on a range of peaks, some with larger areas than others. The smaller area peaks, when looked at individually, tend to take up more of the concentration than peaks with larger areas and, thus, "averaging" a disproportionate number of large peaks leads to a larger, more conservative value.

Figure 3-2 Bore Hole Sample Locations Source Area SS10

Table 3-7 Soil Sampling Results at SS10

Location	**SS10, SB-01**	
Depth (feet bgs)	14	20
Sample ID	SS10-01-12-090903	SS10-01-20-090903
Collection Date	9/9/2003	9/9/2003
Benzene (mg/Kg)	.0077 U	0.0063 U
Toluene (mg/Kg)	0.018	0.013 U
Ethylbenzene (mg/Kg)	0.0038 F	0.013 U
Total xylenes (mg/Kg)	0.0198	0.038 U
GRO (mg/Kg)	0.32 F	0.21 F
DRO (mg/Kg)	10 U	10 U
Jet Fuel[1]	NA	NA

Location	**SS10, SB-02**		
Depth (feet bgs)	14	20	22
Sample ID	SS10-02-14-090903	SS10-02-20-090903	SS10-02-22-090903
Collection Date	9/9/2003	9/9/2003	9/9/2003
Benzene (mg/Kg)	0.011 U	0.013	0.0095 U
Toluene (mg/Kg)	0.016 F	0.036	0.019 U
Ethylbenzene (mg/Kg)	0.018	0.034	0.0095 U
Total xylenes (mg/Kg)	0.042 F	0.075	0.0285 U
GRO (mg/Kg)	120	240	30
DRO (mg/Kg)	350	180	10 U
Jet Fuel[1]	498	462	NA

Location	**SS10, SB-03**	
Depth (feet bgs)	14	23
Sample ID	SS10-03-14-090903	SS10-03-23-090903
Collection Date	9/9/2003	9/9/2003
Benzene (mg/Kg)	0.012 U	0.0071 U
Toluene (mg/Kg)	0.011 F	0.014U
Ethylbenzene (mg/Kg)	0.0069 F	0.014 U
Total xylenes (mg/Kg)	0.033 F	0.042 U
GRO (mg/Kg)	3.9	0.32 F
DRO (mg/Kg)	10 U	10 U
Jet Fuel[1]	NA	NA

1 – The values for jet fuel were obtained by re-integrating the chromatograms and adding the results from the ranges C8-C10 and C-10 to C16 using the GRO and DRO analysis, respectively. Because only two samples, both from SB-02, had significant results for GRO and DRO, Jet fuel concentrations were only obtained from them.

bgs – below ground surface
DRO – diesel range organics
F – Indicates an estimated value that falls below PQL, but is greater than the MDL
GRO – gasoline range organics
mg/Kg – milligrams per kilogram
NA – Not Availavle
U – Not detected above method reporting limits (value provided)
Bold values exceed closure criteria

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4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 SS43 CONCLUSIONS

4.1.1 Soil Contamination

The soil sampling results show that contamination is still present in the smear zone at this location with GRO up to 1,180 mg/kg, DRO up to 1,770 mg/kg, benzene up to 2.08 mg/kg, toluene up to 24.9 mg/kg, and ethylbenzene up to 17.8 mg/kg. The contamination remains widespread over the site with only one location (SB-02) of the 13 borings taken in the area being treated by the bioventing systems showing results below ADEC cleanup standards for all contaminants of concern.

A pilot scale bioventing test was performed at SS43 in 1993 (USAF, 1993). This test yielded a respiration rate of 5.16 mg/Kg/day or 1,885 mg/Kg/year. However, these respiration rates were not achieved when the bioventing system was installed in 1996. The latest round of respiration testing was performed in February 2004 (when the groundwater is normally at its lowest annual elevation) so that the maximum amount of contamination at this site was exposed to oxygen from bioventing and therefore the bioventing respiration rate is maximized. The maximum respiration rate is useful in determining whether or not bioventing continues to be an effective treatment technology at this site.

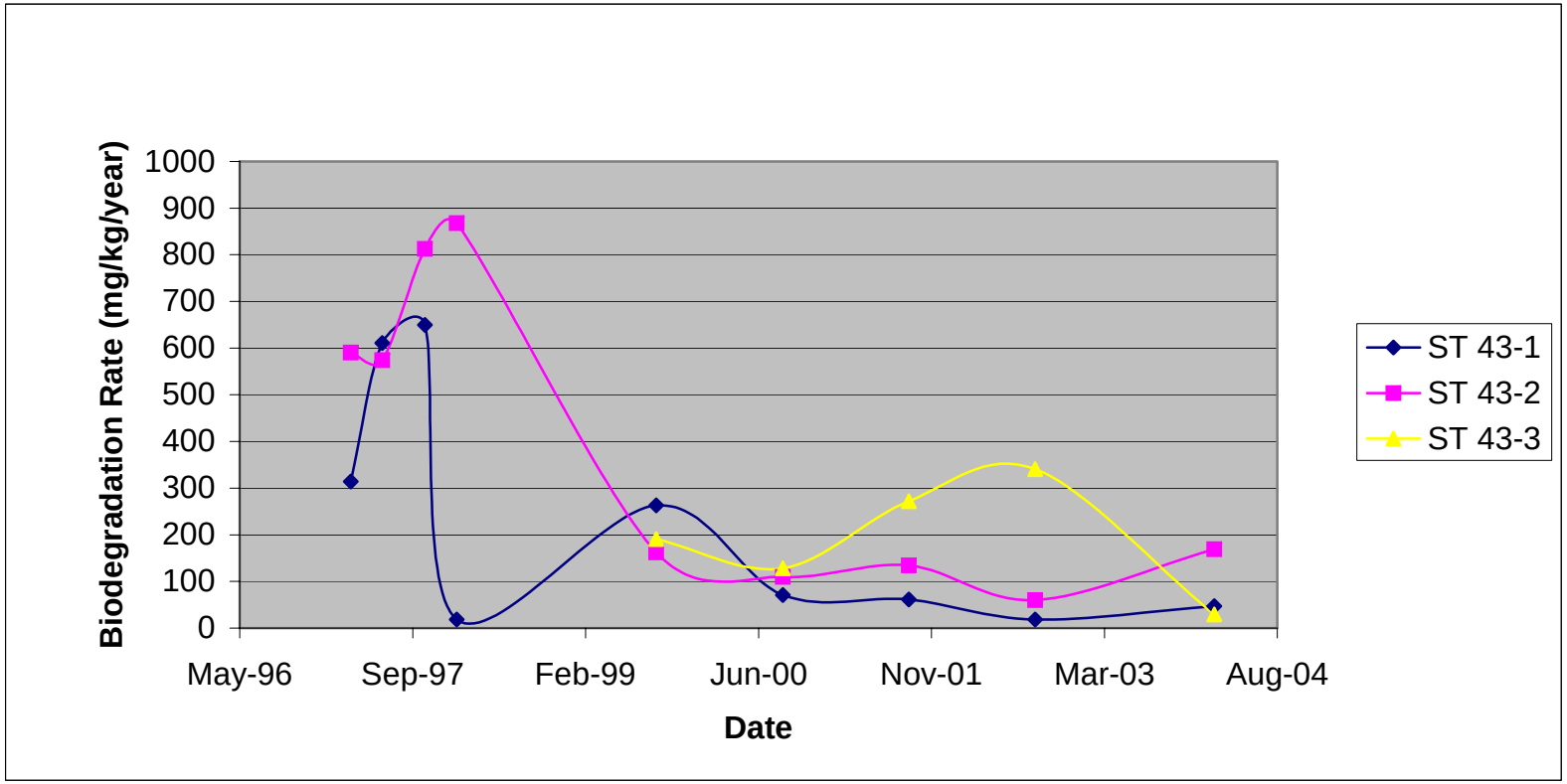
The decrease in the respiration rates from the bioventing system from 1997 through February 2004 are shown in Table 4-1 and Figure 4-1. The current biodegradation rates are approximately 10% of those achieved during the pilot scale test, and less than one third of the respiration rates achieved in 1996. Soil gas readings obtained during 2003 respiration testing also provide an indication of the amount of contamination remaining in the subsurface. Compared to 2002 levels, TVH concentrations decreased at all the sampling points except 43-1C and 43-3A in 2003. TVH max concentrations during the 2003 in-situ respiration tests ranged from 0.1 to 1142 parts per million (ppm).

A more detailed discussion of soil gas readings and respiration test results is provided in the Basewide Bioventing Annual Technical Report (USAF, 2004a). Bioventing is not an effective treatment technology due to the decrease in respiration rates and the remaining contamination on site, with several exceptions, is located between 18 to 24 feet bgs.

Table 4-1 SS43 Historic Biodegradation Rates

	Apr-97	Jul-97	Nov-97	Feb-98	Sep-99	Sep-00	Sep-01	Sep-02	Feb-04
ST43-1	314	611	649	18	263	71	61	18	46.72
ST43-2	590	574	813	868	162	110	134	60	169.36
ST43-3					191	128	272	341	29.2

Figure 4-1 SS43 Historic Biodegradation Rates



SB-14 was proposed as a TOC boring in what was thought to be an uncontaminated area north of the area being treated by the bioventing systems. When SB-14 was advanced, the PID indicated possible contamination in the boring. An analytical sample taken from this location confirmed this contamination. SB-14 is located close to the former fuel line that is shown on Figure 3-1. The contamination discovered at SB-14 could be the result of a leak in the former fuel line.

The majority of remaining contamination at the site is confined to the smear zone, approximately 18 to 24 feet bgs. This is confirmed by the 1994 soil sample results (Table 3-4), the 2003 field screening data (Table 3-2) and 2003 soil sample results (Table 3-3). The contamination discovered at SB-14 is located 16.5 feet bgs, however, this location is approximately 120 feet north of the main contaminated area and groundwater was found at 16.5 feet bgs at SB-14. Thus the contamination at SB-14 is in the smear zone.

4.1.2 Groundwater Contamination

The boundaries of the SS43 Plume (Figure 4-2) are somewhat unclear due to the presence of several sources that were active at various periods of time. In addition, the upgradient Airlifter Plume has likely affected groundwater quality at this location. Sources for the plume include a 50,000-gallon release of JP-4 in 1964 and a 36,000-gallon release in 1980. In addition, releases associated with a pump house and associated valve pits and piping are also suspected.

This plume is actively being remediated by the SS43 Bioventing System and is currently monitored by in-source Wells 43-WL-07 and SP7/10-04, and by downgradient Well SP7/10-01. In addition, Well W-3 is used to measure and remove free product.

Monitoring Well W-3 was taken out of the sampling program in 2002 because of the historical presence of free product. Since the presence of free product can cause dissolved concentrations to fluctuate and can contaminate sampling equipment, it was decided that W-3 would not be sampled until free product was no longer present. It will, however, remain in the free product recovery program within the Elmendorf Basewide Groundwater Monitoring Program. Table 4-2 summarizes the groundwater contaminant history at select SS43 monitoring wells.

Figure 4-3 shows the decrease of benzene concentrations in Well 43-WL-07 from 624 micrograms per liter (µg/L) in May of 1996 to 97.0 µg/L in May of 2002. Historical benzene concentrations in wells SP7/10-01 and SP7/10-04 are depicted in Figure 4-4 and 4-5. Further discussion of the groundwater contamination at this site can be found in the Annual Basewide Groundwater Monitoring Report (USAF, 2004a).

Figure 4-2 SS43 Monitoring Wells

Table 4-2 Groundwater Contaminant History at Select SS43 Monitoring Wells

Well ID	Analyte	Analytical Results (µg/L)														Regulatory Level (b)
		1996		1997		1998		1999		2000		2001		2002	2003	
		Spring	Fall	Spring	Fall	Spring	Fall	Summer	Fall	Summer	Fall	Summer	Fall	Spring	Fall	
43-WL-07	Benzene	624	549	500	460	352	359	320	280	120	170	150	120(R)	97.0	NS	5.0
	Ethylbenzene	3,090	2,050	2,300	1,400	1,780	1,580	1,600	1,600	1,400	1,100	1,400	1,300(R)	1,100	NS	700
	DRO	67,300(d)	251,000(d)	13,000	2,000	12,400f	10,500f	910 B	1,260	1,200	1,100	1,600	1,700	6,600	NS	1,500(c)
	GRO	ND(738)	156,000	31,000	32,000	29,600	34,400	20,000	30,000	21,000	22,000	21,000	19,000	21,000	NS	1,300(c)
SP7/10-04	Benzene	59	69	53	53	37.00	44.40	38.0	24.9 J	26.0	36.0	31.0	27.8 J	19.00	24.00	5.0
	GRO	ND (615)	ND (1,480)	17,000	11,000	8,400	17,200f	12,000	4,100 J	11,000	13,000	11,000	9,600	11,000	12,000	1,300(c)
	DRO	52,900 (d)	105,000 (d)	11,000	10,000	9,540f	6,480f	4,780	6,330	4,300	2,400	3,700	2,800	5,400	3,300	1,500 (c)
SP7/10- 01	Benzene	1.4	ND	ND	ND	0.1	ND(0.062)	ND(0.2)	ND(0.2)	ND(0.11)	ND (0.11)	ND(0.11)	ND(0.11)	ND(0.012)	NS	5.0
	Ethylbenzene	1.3	0.388	NS	NS	0.705 BF	ND(0.11)	ND(0.2)	ND(0.2)	ND (0.1)	ND(0.1)	ND(0.09)	ND(0.09)	ND(0.05)	NS	700
	DRO	ND(44.8)	ND(25.0)	NS	NS	ND(0.025)	ND(0.022)	ND(50)	60	20	60	22 F	ND(21)	ND(20)	NS	1,500(c)
	GRO	ND(12.3)	ND(29.5)	NS	NS	ND (4.27)	ND(10.6)	ND(25)	ND(25)	91	22	26 F	24 F	ND(50)	NS	1,300(c)
W3	Benzene	457	NS	NS	NS	NS	NS	NS	NS	NS	NS	150	140	NS	NS	5.0
	GRO	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	14000	12000	NS	NS	1,300(c)
	DRO	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	47000	4200	NS	NS	1,500(c)

From 1996 to 1998, all diesel, jet fuel, and kerosene results were non-detect; reporting limits listed are those for diesel.
(b) - Regulatory level is primary maximum contaminant level (MCL) from 18 AAC 80.300 unless otherwise noted.
(c) - Groundwater cleanup standard from 18 AAC 75.345, Table C (ADEC, 2003).
(d) - Diesel value was reported as jet fuel.
f - Value has been changed from the 1998 Annual Report. See Section 4.6 of the 2001 Annual Report for details.
B - The analyte was found in the associated blank, as well as the sample.
J (1998-2001 data) - The analyte was positively identified, but the quantitation is an estimate.
F - analyte positively identified but the associated numberic value is below the Reporting Limit.
(R) - The data did not meet certain AFCEE control criteria but the data are not significantly impacted.
( ) - Sample specific detection limit

ID - identification
µg/L - microgram per liter
ND - not detected
NS - Not Sampled

Figure 4-3 Benzene in Well 43-WL-07

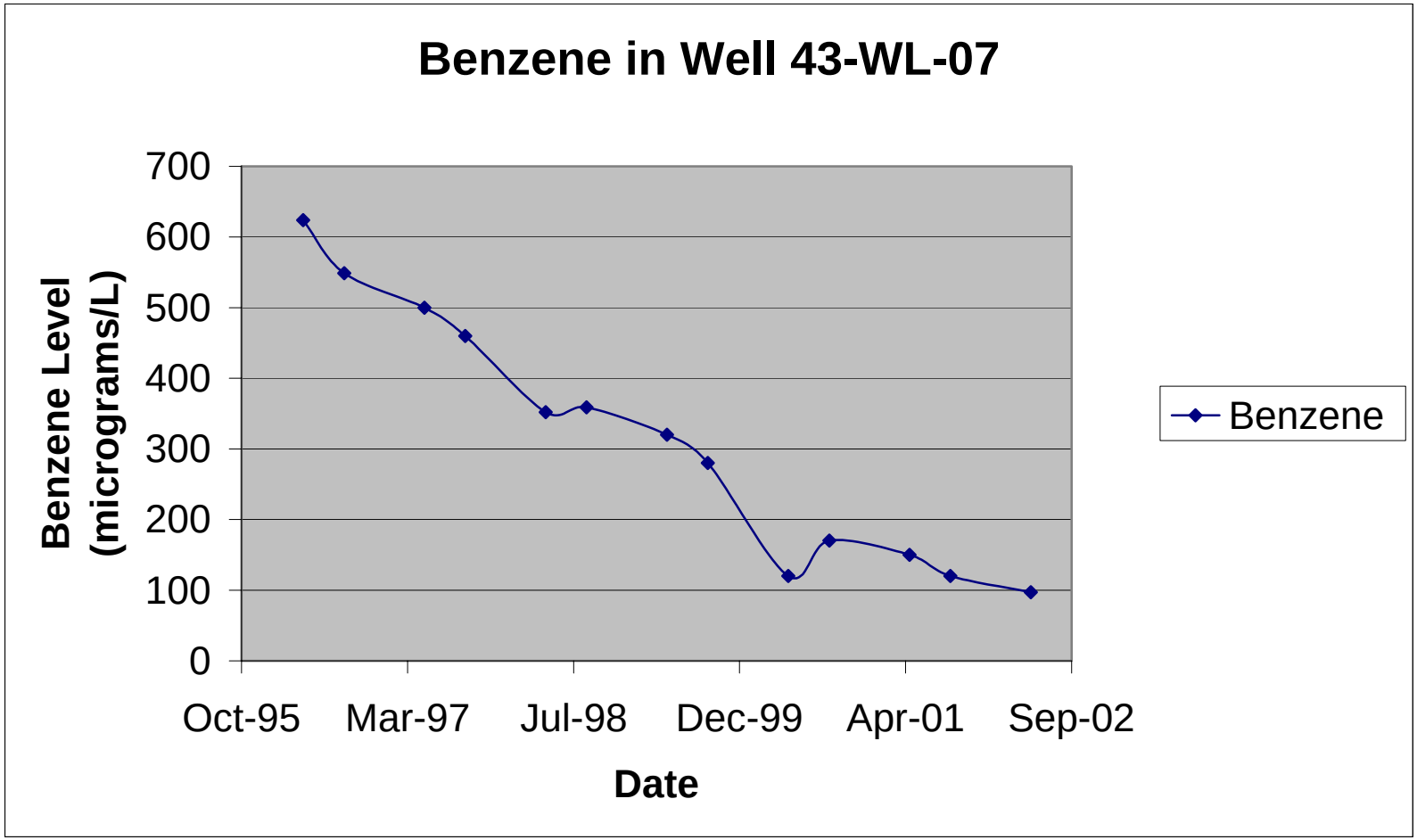


Figure 4-4 Benzene in Well SP7/10-01

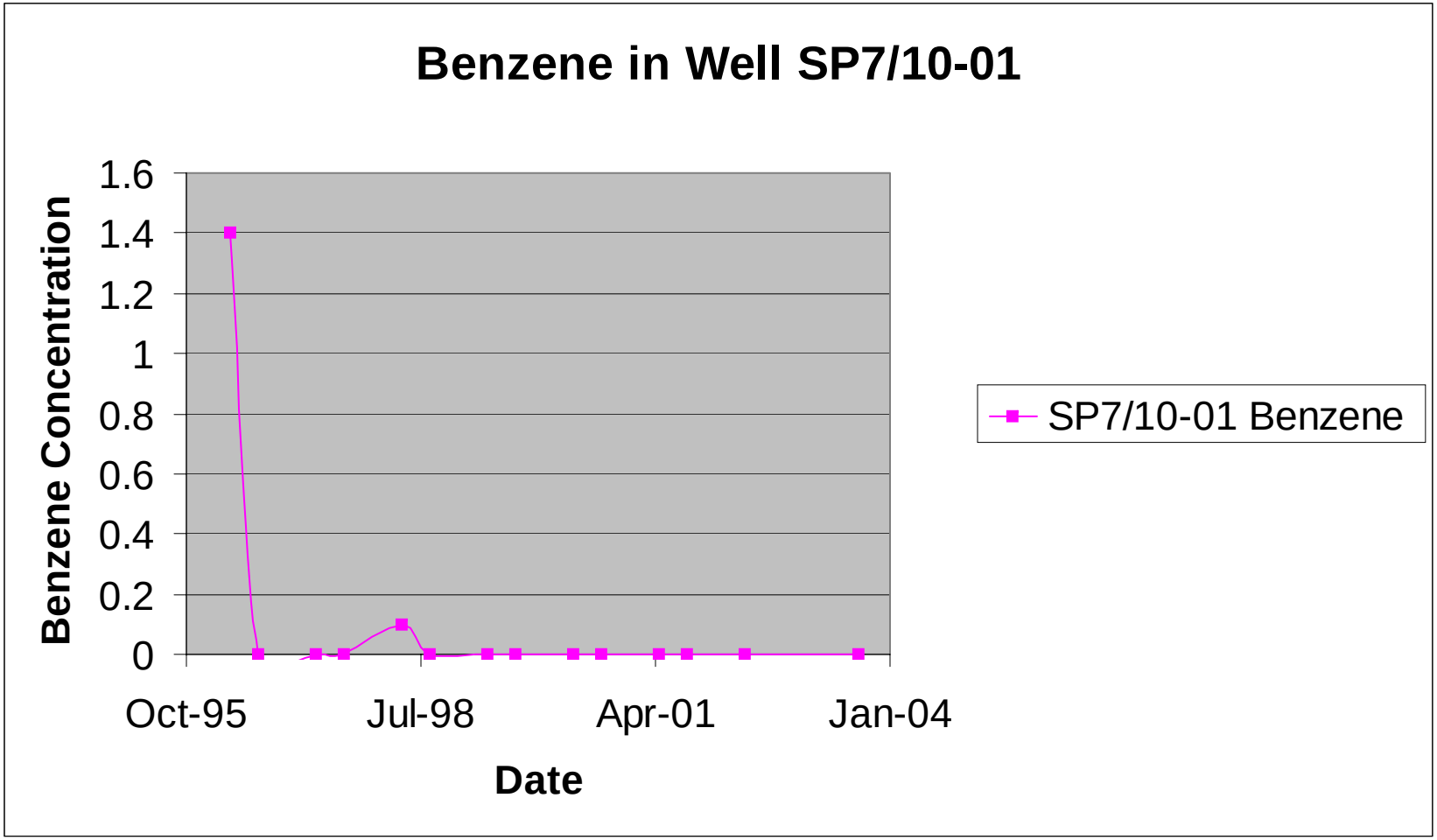
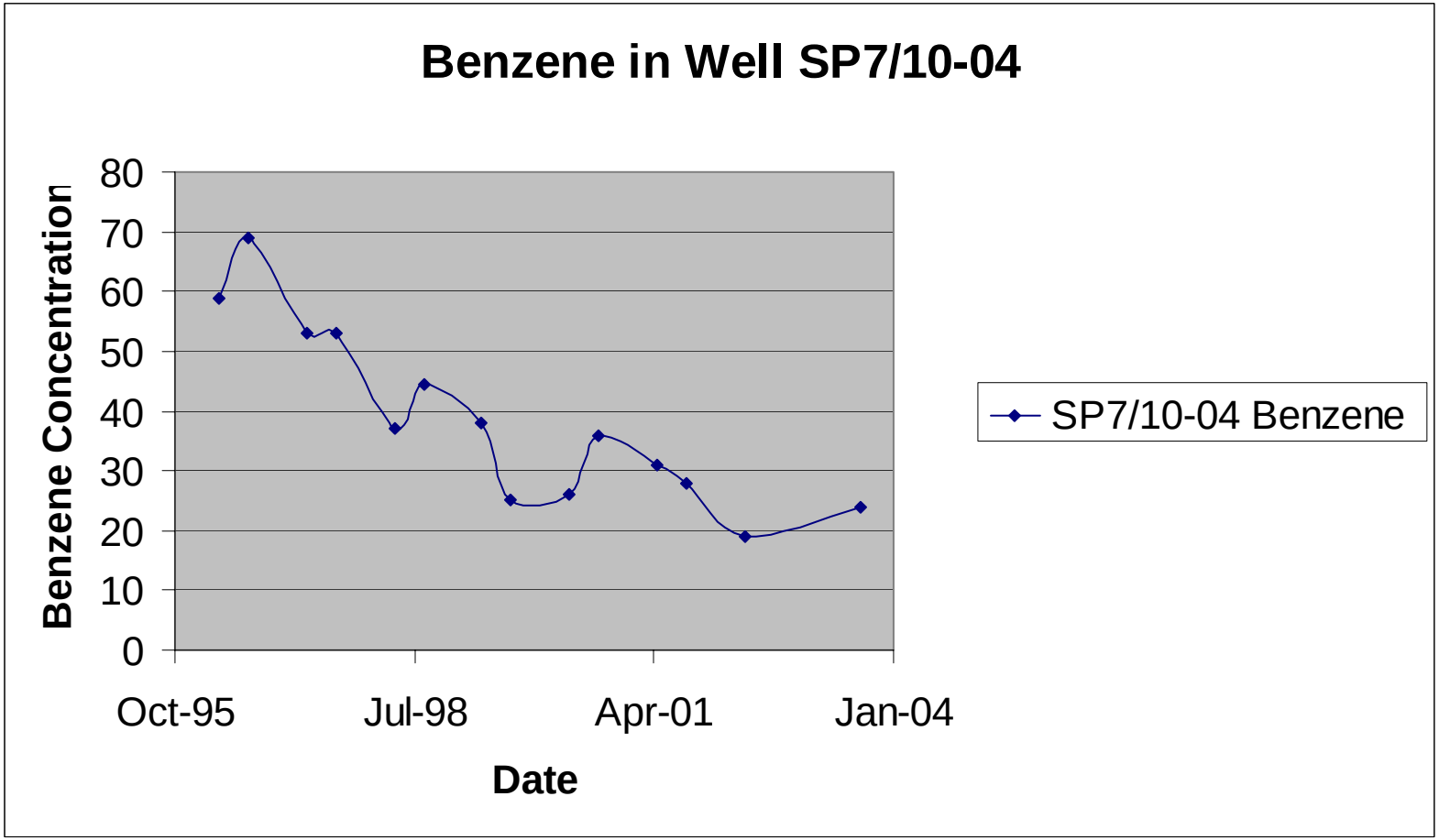


Figure 4-5 Benzene in Well SP7/10-04



4.1.3 Risk Pathways

The following subsections outline the potential risk pathways posed by this site, and whether or not they are complete pathways.

4.1.3.1 Dermal Contact with Contaminant

The majority of remaining contamination at the site is confined to the smear zone, approximately 18 to 24 feet bgs. At this depth the contamination does not present a direct contact hazard except for possible construction workers. This site will continue to have institutional controls to alert construction workers to this fact.

4.1.3.2 Inhalation Contact

The majority of remaining contamination at the site is confined to the smear zone, approximately 18 to 24 feet bgs. At this depth the contamination does not present a possible vapor hazard. There are no occupied buildings at this site where vapors could potentially gather. The contaminated groundwater at this site is not used for bathing or consumption and thus it does not present a possible inhalation hazard.

4.1.3.3 Contact with or Consumption of Groundwater

The contaminated groundwater at site does present a potential risk to human health and the environment. However, because the contaminant plume is not leaving the site, the pathway for potentially affecting the environment is not complete. A Land Use Control preventing the use of groundwater as drinking water is in place at this site, therefore, this is an incomplete exposure pathway.

4.2 SS10 CONCLUSIONS

The highest results from the soil sampling at SS10 are compared to their cleanup standards established in the OU 4 Record of Decision, provided in Table 4-3.

Table 4-3 SS10 Soil Cleanup Standard and Detected Levels for COCs

Contaminant of Concern	Established Cleanup Standard (mg/Kg)	Highest Detected Level (mg/Kg)
Diesel Range Organics	2,000	350
Gasoline Range Organics	1,000	240
Xylene	100	0.075
Jet Fuel	2,000	498

The soil sampling results at SS10 show the contaminants of concern are all below the soil Cleanup Standard for this site in the OU 4 Record of Decision.

4.3 RECOMMENDATIONS

4.3.1 SS43 Recommendations

SS43 does not present a risk to the environment by vapor or direct contact because the remaining contamination is located over 10 feet bgs nor does it present a risk to the environment by groundwater because the contaminant plume is not leaving the site and the plume is receding. However, the smear zone under this site is still contaminated. Bioventing introduces oxygen into the vadose zone to promote aerobic biodegradation of contaminants. Because the soil in the smear zone is saturated with water, the oxygen injected by bioventing cannot penetrate between the soil particles to promote biodegradation. Bioventing is not effective at treating contamination within the smear zone. Therefore, the operation of the bioventing systems at this site should be halted. Natural attenuation of the contaminants should be allowed to continue and this natural attenuation should be monitored by the Basewide Groundwater Monitoring Program. Only after meeting groundwater cleanup levels in 18 AAC 75, would soil borings be advanced and soil samples collected.

In the event that the remaining contaminated soil becomes accessible or is removed from the site, or other information becomes available which indicates that the site may pose an unacceptable risk to human health, safety, welfare or the environment, the Air Force will notify ADEC as required under 18 AAC 75.300. Also, any transport or disposal of contaminated soil excavated from the site requires approval from ADEC in accordance with 18 AAC 75.325(i). This approach to cleanup will be included in a future decision document for SS43. Until this decision document is completed, the bioventing systems would remain operational.

4.3.2 SS10 Recommendations

The soil sampling results at SS10 show the contaminants of concern are all below the soil Cleanup Standard for this site in the OU 4 Record of Decision (Table 4-3). Based on these findings, the USAF is requesting from the Agencies a “Site Closure” decision letter for the bioventing site SS10.

5.0 REFERENCES

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APPENDIX A
SURVEY POINTS, BORING LOGS, AND FIELD NOTES

APPENDIX B
CDs AND CHAINS OF CUSTODY

APPENDIX C
DATA DELIVERABLE

APPENDIX D
METHOD 3 CALCULATION

APPENDIX E
RESPONSE TO COMMENTS