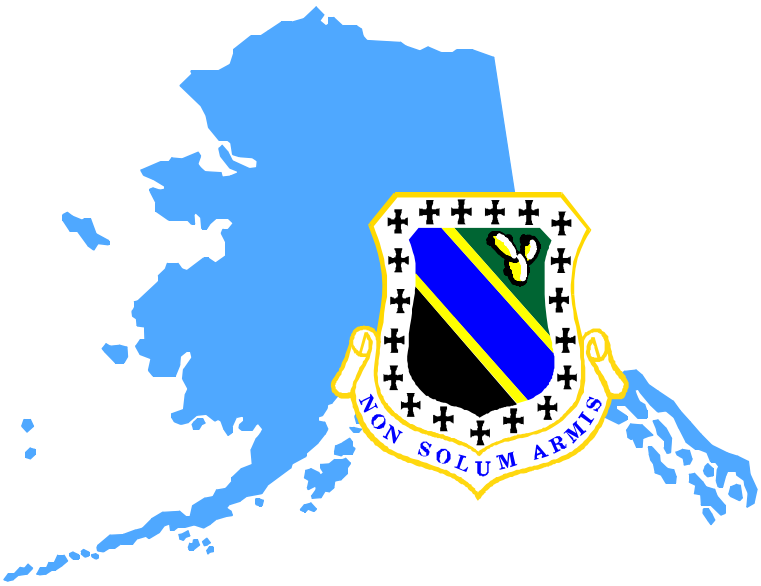

UNITED STATES AIR FORCE
ELMENDORF AIR FORCE BASE, ALASKA

ENVIRONMENTAL RESTORATION PROGRAM

2003 ANNUAL TECHNICAL REPORT ENVIRONMENTAL MONITORING AND SYSTEM OPTIMIZATION OF BASEWIDE BIOVENTING SYSTEMS ELMENDORF AFB, ALASKA

FINAL

JULY 2004

FINAL

2003 ANNUAL TECHNICAL REPORT

Environmental Monitoring and System Optimization of Basewide Bioventing Systems

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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LIST OF ACRONYMS

ADEC	Alaska Department of Environmental Conservation
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liabilities Act
CES/CEVR	Civil Engineer Squadron/Environmental Restoration
CO_2	Carbon Dioxide
DRO	Diesel Range Organics
FSP	Field Sampling Plan
GRO	Gasoline Range Organics
LTO/LTM	Long-Term Operations/Long-Term Maintenance
NPL	National Priority List
O_2	Oxygen
O&M	Operation and Maintenance
OU	Operable Unit
PHSC	Program Health and Safety Coordinator
POL	Petroleum, Oil, and Lubricant
ROD	Record of Decision
RRO	Residual Range Organics
SERA	State-Elmendorf Environmental Restoration Agreement
SOW	Statement of Work
TVH	Total Volatile Hydrocarbons

LIST OF ACRONYMS *(Continued)*

USAF	United States Air Force
USEPA	United States Environmental Protection Agency
WESTON	Weston Solutions, Inc.
WP	Work Plan

1.0 INTRODUCTION

This report has been prepared for the United States Air Force (USAF) under Air Force Center for Environmental Excellence (AFCEE) Contract No. F41624-03-D-8622, Task Order 0002, to document the results of biweekly operation and maintenance (O&M) activities, annual monitoring to include soil gas tests and in-situ respiration testing, and soil sampling at selected bioventing sites. This work was performed as part of the Long-term Operations/Long-term Maintenance (LTO/LTM) of the Basewide Bioventing Systems program at Elmendorf Air Force Base (AFB), Alaska. The report is organized as follows:

- **Section 1** presents a general background of the Basewide Bioventing Systems program and states the current year project objectives;
- **Section 2** details a list of the project activities performed on the Basewide Bioventing Systems program under this contract. It also provides a describes the methodologies followed for in-situ respiration testing, soil sampling at select sites, and bioventing system removal at another site;
- **Section 3** provides a summary of activities conducted at each site to date as well as recommendations and conclusions for current and future actions at each site including a recommendation for continued operation or additional testing to support site closure.
- **Section 4** lists references cited in this report;
- **Appendix A** contains the field notes from in-situ respiration testing;
- **Appendix B** presents biovent system balancing data;
- **Appendix C** contains the certificates of destruction for soil cuttings; and
- **Appendix D** presents comments and responses to the comments received from the USAF.

1.1 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 site subject to the remedial response requirements of the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act. The USAF, USEPA, 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 operable units (OUs), each to be managed as a separate area and investigated according to a sequenced schedule.

In October 1992, the USAF 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 the State-Elmendorf Environmental Restoration Agreement (SERA). The nature and extent of contamination and the potential risks to human health and the environment at SERA sites were evaluated by site assessments and the

OU 4 RI/FS (USAF, 1994). Conclusions were that fuel and fuel constituents were present at a number of source areas. The treatment method selected for remediation of soil contamination within these source areas was bioventing. On October 21, 2002, the SERA was dissolved by the ADEC and the USAF. From this date forward, any contaminated sites formerly covered under SERA that were not formally closed are subject to the current contaminated sites and underground storage tank regulations (18 AAC 75 and 18 AAC 78, respectively).

More recently, the LTO/LTM of all bioventing systems on Elmendorf AFB was incorporated into the Basewide Bioventing Systems program (see Figure 1-1). This program includes bioventing systems at the following SERA and OU locations:

SERA Phase I: Site ST36, Site SS43/55, Site ST61, Site ST71

SERA Phase II: Site ST32 (Tanks 2, 4, 5, 6, 7, and 8), Site ST66, Site ST68, Site ST74

OU 4: Site FT23, Site SD25, Site SS10

Source Areas ST36 and ST66 are in close proximity; therefore, bioventing systems at these two locations have been integrated and are treated as a single remedial effort referred to as ST36/66. The same rationale has been applied to Source Areas SS43 and ST55, which are treated as a single remedial effort and referred to as SS43/55. Table 1-1 summarizes the cleanup standards for each site.

Table 1-1 Bioventing System Cleanup Standards

Site Location	DRO	GRO	Benzene	Toluene	Ethylbenzene	Total Xylenes	Jet Fuel
ST36/66	250	300	0.02	5.4	5.5	78	NA
SS43/55	200	100	0.02	5.4	5.5	78	NA
ST61	250	300	0.02	5.4	5.5	78	NA
ST32 (all sites)	2000	1000	0.02	5.4	5.5	78	NA
ST68	2,000	1,000	0.02	5.4	5.5	78	NA
ST74	Remediation is complete						
FT23	2,000	1,000	NA	NA	NA	NA	NA
SD25	Remediation is complete						
SS10	2,000	1,000	NA	NA	NA	100	2,000
ST71	Remediation is complete						

1.2 Project Objectives and Purpose

A workplan (USAF, 2003b) was prepared to detail procedures that would meet project objectives stated in the project scope of work. This workplan addressed the following field and data quality objectives:

- Obtain information necessary to monitor the progress of remediation at each site;

- Optimize system performance by ensuring operating parameters are within design ranges;
- Obtain information that can be used to optimize the performance of each remedial system; and
- Make recommendations for progress towards closure on a site-by-site basis.

Operation and Maintenance, including biweekly system checks, adjustment, cleaning/replacing filters as needed, and repairs as required were performed, as indicated in Table 2-1, on one bioventing system at ST32 (Tank 7), and five systems at FT23. Operation checks, including checking to ensure the systems are operating, cleaning/replacing filters as needed, and repairs as required were performed on five bioventing systems at SS43, two systems at ST36, one system at ST66, one system at ST32 (Tank 8), one system at SS10, and three systems at ST68. In addition, annual respiration tests were completed to evaluate remediation progress and to collect data used to estimate hydrocarbon degradation rates. This information is then used to predict when final site closure requirements may be met so that closure sampling can be scheduled. Operation, maintenance, monitoring, and testing completed under the current Task Order are presented and discussed in this report.

Figure 1-1 Basewide Bioventing Sytem Locations

2.0 PROJECT ACTIVITIES

The following subsections describe the tasks and methodologies executed to complete the project objectives. The tasks performed at each bioventing site are shown in Table 2-1.

Table 2-1 Summary of Year 2003 Maintenance and Monitoring

Site	System	Operation & Maintenance	Annual Monitoring	Operation Checks	Site Soil Sampling	System Removal
SS43/55	BV-1		4	4	4	
	BV-2		4	4	4	
	BV-3		4	4	4	
	Valve Pit		4	4	4	
	Pump House 3		4	4	4	
ST36	BV-36-1			4		
	BV-36-2			4		
ST66	BV-66-1			4		
ST32	Tank 2				X[1]	
	Tank 7	4	4			
	Tank 8			4		
FT23	BV-2	4	4			
	BV-3	4	4			
	BV-4	4	4			
	BV-5 Upper	4	4			
	BV-5 Lower	4	4			
ST68	BV-68-1			4		
	BV-68-2			4		
	BV-68-3			4		
SS10	BV-6			4	4	
SD25	BV-5					4[2]

X[1] = Not able to accomplish soil boring with vertical drilling due to unanticipated site configuration.
4[2] = Two monitoring points could not be accessed due to presence of spoil pile.

2.1 Biweekly Process Monitoring and system checks

Biweekly process monitoring and general system checks occurred as indicated in Table 2-1 and included a general blower module check and collection of temperature, pressure, and flow rate measurements.

Biweekly Process Monitoring and general system checks occurred as indicated in Table 2-1 and included a general blower module check, as well as checking temperature, pressure, and flow rate measurements. The injection air temperature (T) was kept between 32 degrees Fahrenheit

(°F) and 120 °F. Static gauge pressure (Ps), and differential pressure (ΔP) were checked on a biweekly basis from gauges located inside the blower module.

Operation and maintenance activities, or operation checks, were performed using guidelines from the following manuals:

1. For Site SS43/55: *SERA I Source SS43/55-Pump House 3 Bioventing Treatability Study Operations and Maintenance Manual, Final*. March 1998.
2. For Sites ST 32, ST 36, ST 66, and ST 68*: SERA II Bioventing Treatability Study Operation and Maintenance Manual, Final*. May 1997.
3. For Sites FT 23, SD 25, and SS 10: *OU-4 Bioventing Treatability Study and Maintenance Manual, Final*. May 1996

Table 2-2 summarizes the configuration of bioventing systems included in the 2003 maintenance schedule:

Table 2-2 Configuration of Bioventing Systems Included in 2003 Environmental Monitoring and Optimization Program

Description	ST33/66	SS43/55	ST32	ST68	FT23	SD25	SS10
Modules (Blowers)	2	3	6	2	1	1	1
Injection Wells	3	5	6	3	5	1	1
Implants (1-level)		9				3	3
Implants (2-level)	7		3	7	11		
Implants (3-level)			16				

2.2 Injection Air Flow Rates

Air flow rates are calculated based on the static gauge pressure (Ps), the differential pressure (ΔP), and the injected air temperature (T) measured during the biweekly process monitoring events. The formula used to calculate the air flow rate is:

$$Q\ (scfm) = 128.8 * K * D^2 * [(P_A * \Delta P)/((T+460) * S_s)]^{0.5}$$

where,
- Q = injection air flow rate in standard cubic feet per minute (scfm);
- K = flow coefficient = 0.586 for 2-inch pipes;
- D = inside diameter = 1.939 inches for 2-inch pipes;
- P_A = actual static line pressure (psia) = 14.643 + 0.361 * Ps;
- P_S = static pressure (inches of water column);
- ΔP = differential pressure (inches of water column);
- T = temperature (°F); and
- S_S = specific gravity at 60°F = 1.0 for air.

Airflow rates have historically varied from 5 to 48 standard cubic feet per minute (scfm). The goal of bioventing is to provide oxygen (O2) to the soil vapor implants while minimizing the

flow rate of injected air. Excessive air injection can lead to drying of the soil, which may limit microbial growth and reduce the rate of biodegradation. If data indicated that O2 and total volatile hydrocarbon (TVH) levels in soil gas remained high at some implants, air flow rates were decreased to minimize soil drying and contaminant migration.

2.3 In-situ Respiration Tests

In-situ respiration tests were conducted to evaluate remediation progress and to calculate hydrocarbon degradation rates. Prior to shutdown, the levels of TVH, carbon dioxide (CO2), and O2 concentrations, as well as soil temperature, were measured at the available monitoring points in accordance to the procedures outlined in Section 2.3 of the Field Sampling Plan. The bioventing system blowers are then shut off to limit the supply of O2 to the subsurface, and the same parameters are measured at set time intervals over a 120-hour period. Time intervals are shown in Table 2-3.

Table 2-3 Respiration Testing Summary

Elapsed Time	Activity
Just before blower shutdown	Measure TVH, CO_2, O_2, and soil temperature.
Immediately after blower shutdown (T_0)	
T_0 plus 6 hours	
T_0 plus 24 hours	
T_0 plus 72 hours	
T_0 plus 96 hours	
T_0 plus 120 hours	

CO_2 – carbon dioxide
O_2 - oxygen
TVH – total volatile hydrocarbon

Data gathered from in-situ respiration testing is used to:

- Identify the presence or absence of volatile contaminants in soil gas;
- Calculate the biodegradation rate of hydrocarbons at each soil vapor implant or injection well location; and
- Predict the timeframe in which the remediation is complete.

In-situ respiration testing was performed at the locations listed in Table 2-4. The corresponding site plans are shown as Figures 2-1, 2-2, and 2-3. Sample collection procedures are documented in the project Work Plan (United States Air Force, 2003b). Field data from the respiration testing conducted under this Task Order is presented in Appendix A. Test data is summarized in Table 3-2 and a discussion of the results is presented for the applicable sites in Section 3.0.

Table 2-4 Locations of 2003 Respiration Testing

Site	SERA I	SERA II	OU 4
	SS43/55[1]	ST32[2]	FT23[3]
No. of Injection Wells	3	1	5
No. of Implants (1-level)	6		
No. of Implants (2-level)		3	11
No. of Implants (3-level)			
Total Number of Samples 2003[4]	5	4	19

[1] BV-1, 2, and 3 locations only
[2] Tank 7 location only
[3] BV-2, 3, 4, 5 upper and lower
[4] Difference between number of sample ports and samples taken due to clogged vapor tubes.

Figure 2-1 Site Plan SS43/55

Figure 2-2 Site Plan FT23

Figure 2-3 Site Plan ST32, Tank 7

2.4 Calculation of Hydrocarbon Biodegradation Rates

Oxygen (O_2) utilization rates from in-situ respiration test results can be used to calculate hydrocarbon degradation rates. A stoichiometric relationship for the oxidation of a representative hydrocarbon can be used to estimate biodegradation rates of hydrocarbons in local soils. For calculation of hydrocarbon degradation rates in this report, hexane was used as the representative hydrocarbon, and the stoichiometric relation used to determine degradation rates is:

$$C_6H_{14} + 9.5O_2 \rightarrow 6CO_2 + 7H_2O$$

Based on the utilization rates (i.e., change of O_2 in percentage per day), the biodegradation rate was estimated using the following equation (USAF, 1992):

$$K_B = -K_O A D_O C/100$$

where: K_B = biodegradation rate in milligrams per kilogram per day (mg/Kg/day);
K_O = O_2 utilization rate (percent/day);
A = volume of air/Kg of soil in liters per kilogram (L/Kg);
D_O = density of O_2 gas in milligrams per liter (mg/L); and
C = mass ratio of hydrocarbon to O_2 required for mineralization.

The following assumptions were used to calculate values for A, D_O, and C:

- Soil porosity of 0.3;
- Soil bulk density of 1,440 kilograms per cubic meter;
- O2 density (Do) of 1,330 mg/L; and
- Hydrocarbon to O2 ratio of 1:3.5 for C from the above equation for hexane.

Based upon the assumptions, the volume of air per kilogram of soil (i.e., A) is 0.21, and the resulting equation for the biodegradation rates is:

$$K_B = -(K_O)(0.21)(1,330)(1/3.5)/100 = 0.8K_O$$

This conversion factor, 0.8, was used to calculate the biodegradation rates. A linear regression was performed on the O_2 concentration measurements to calculate the slope (the O_2 utilization rate) and correlation (a numeric value to assess the variability in the data).

2.5 Soil Sampling

In August 2003 soil sampling was performed at sites SS43/55 and SS10. The soil remediation goals are given below in Tables 2-5 and 2-6. A complete discussion of the 2003 soil sampling results is presented in the 2003 Soil Sampling Report (Draft), February 2004. Results from previous soil sampling events are presented in separate reports (USAF 2003a, 2002b, and 2001b).

Table 2-5 SS10 Soil Remediation Goals

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

mg/Kg – milligram per kilogram

Table 2-6 SS43/55 Soil Remediation Goals

Contaminant of Concern	Established Cleanup Level (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

A boring was originally scheduled to be accomplished at site ST32, Tank 2 but new construction on top of the former Four-Million Gallon Hill precluded the use of vertical drilling to obtain samples. Directional drilling will be utilized in 2004 to collect soil samples at this site.

2.6 Semiannual Changeover and Annual Maintenance

A semiannual changeover occurs in the spring and fall of each year to prepare the bioventing systems for the change from summer to winter weather and vice versa. The 2003 changeover, performed November 3-14, 2003, consisted of installation of the winter panels. The air filters were cleaned or replaced on all blower units at the same time the winter panels were installed. Annual maintenance, consisting of lubricating grease fittings and changing o-ring seals, was performed on an as-needed basis, rather than all at once. All tasks were performed according to the applicable O&M manuals.

2.7 Non-routine Maintenance

Non-routine maintenance during 2003 resulted primarily from system shutdown due to loss of power at several systems. Table 2-7 summarizes the isolated maintenance incidents that occurred over the year:

Table 2-7 Non-Routine Maintenance

System	Date Non-operational	Date Operational	Reason
ST 68	Prior to start of TO	14 July one system, 16 July second system	Power disconnected to allow contractor to work in area.
SS 43/55	16 June	10 July	Contractor installing new electrical lines by C5 Ramp
FT 23	21 July	30 July	Army Corps of Engineers advancing soil borings in area disconnected power for safety reason
ST32 Tanks 7 & 8	21 July	22 August	EAFB personnel working on utilities in this area disconnected power
FT 23	3 November	6 November	Army Corps of Engineers advancing soil borings in area disconnected power for safety reason
FT 23	22 December	21 January	Power to the control box disconnected by others

2.8 SD25 SYSTEM REMOVAL

In October 2003, the bioventing system injection well and monitoring points at SD25 were dismantled. However, two of the monitoring points (BV 5B and BV 5C) could not be abandoned because a spoil pile from a large pipe excavation located immediately west of the injection well covered them. The spoil pile was not removed until after the drill rig had demobilized from the site. The monitoring points will be removed during the summer of 2004 when a drill rig is mobilized for work on base. The electrical power to the bioventing blower was disconnected in February 2004 and the blower will be removed later in 2004 after snow melt.

2.9 Other

Following a post award walk though of the project sites, it was discovered that most of the systems were not being operated within the ranges specified in the O&M manual. This was discussed with the previous O&M contractor but the rationale for omitting system balancing procedures during routine system maintenance could not determined. It was also discovered that the fittings to connect the equipment (pitot tubes) to balance the airflows had not been installed in two recently installed air injection wells at FT23. A technical memorandum was prepared for the Elmendorf project manager and AFCEE COR to explain the situation. A subsequent contract modification was issued on 29 September that directed balancing and optimization of the airflow on the FT23 and ST32, Tank 7 systems. One of the bioventing injection ports (BV 5) at the Fire Training Area (FT 23) was modified by adding ports to measure the airflows and subsequently balance the system. The required parts were ordered in early October and received in mid-October. BV 5 was modified so that it could be balanced the week of 27 October. The following week the power was disconnected to this system so that it could not be balanced. Initial oxygen readings were taken at the sampling points at FT 23 and ST 32 Tank 7 the week of

24 November. At FT 23 it was noted that the upper injection port BV 3 was conducting 70.4 cubic feet of air per minute (cfm) while BV 5 upper and lower were conducting 4.8 and 6.7 cfm respectively. The week of 1 December the airflows at ST 32 Tank 7 were adjusted to increase the oxygen content at the 50 ft probe. However, the airflow in BV 3 upper could not be adjusted because the threads in the gate valve that control the airflow were stripped. A new gate valve was ordered. New gate valve and bushings were received and installed on 29 December, however, the electric power to the Fire Training Area had been disconnected again during the week of 22 December so the system could not be balanced. Power was restored on 21 January and the airflow to BV 3 upper was reduced prior to annual respiration testing in February 2004. Balancing data is included in Appendix B.

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3.0 SITE SUMMARIES, CONCLUSIONS, AND RECOMMENDATIONS

A summary of historical activities at each bioventing location as well as conclusions and recommendations based on the current status of each system are presented in this section. Table 3-1 identifies the status of all the sites within the OU4 bioventing program.

Table 3-1 Operational status of Elmendorf AFB Basewide Bioventing Systems

Site Location	Blower/Injection Well	Maintain Bioventing System Operation	Perform In-situ Respiration Testing	Comments	Sites Not Under Current Delivery Order
ST36/66	ST36/56WLA, 56WLB	4		4[1]	
	ST66/BV-66-1, 56WL03	4		4[1]	
SS43/55	ST 43 Center/BV-1, BV-2, BV-3	4	4	4	
	ST 43 East	4	4	4	
	ST 43 West	4	4	4	
ST61	ST 61	4			4[2]
ST32	Tank 2/59BH05	4		4[3]	
	Tank 4/BV-04-1A				4[4]
	Tank 5/59WL30				4[4]
	Tank 6/59WL17				4[4]
	Tank 7/59WL29		4		
	Tank 8/59WL20	4		4	
ST68	ST 68-1/BV-68-1	4			
	ST 68-2/BV-68-2, BV-68-3	4			
ST74	ST 74/65WL03	Remediation Complete[5]			
FT23	FTA-1/BV-2, BV-3, BV-4, BV-5	4	4	4[6]	
	FTA-2/BV-1	Remediation Complete[6]			
SD25	SD 25BV-5	Remediation Complete[7]			
SS10	SS 10/BV-6	4		4[8]	
ST71	ST71	Remediation Complete[9]			

[1] Soil sampling was performed at ST33/66 in 2001.
[2] Soil sampling was performed at ST61 in 2000. No activities were performed at this site under the current task order.
[3] Soil vapor implants at this location were destroyed during 1999 construction activities. Biweekly process monitoring continued. Soil borings scheduled for this task order could not be completed due to unanticipated site configuration. Directional drilling will be used in 2004 to accomplish sampling.
[4] Soil sampling was performed at ST32, Tank 4, Tank 5, and Tank 6 in 2000.
[5] The bioventing system at ST74 was removed during 2000, and soils suspected to be contaminated were excavated and disposed of.
[6] Expansion of the bioventing system at FT23 (FTA-1) was completed in 2002 to address contamination found outside the radius of influence of the original system configuration. Injection port (BV 5) was modified to measure the air flows and balance the system as part of this task order. Remediation at the area associated with FTA-2 is complete.
[7] Soil sampling was performed at SD25 in 2002. The results of the sampling are presented in the Final *SD25 Closure Report* (USAF, 2003). System was dismantled as part of this task order.
[8] Soil sampling was performed in 2003.
[9] Removal and decommissioning of the system at ST71 completed in January 2003.

3.1 ST36/66

Current Task Order: Biweekly system checks were performed on the bioventing systems at ST33/66 during 2003.

Historical: Since no measurable respiration rates were documented at ST36/66 during in-situ respiration testing in 1999, no respiration tests were scheduled or performed in 2000, 2001, or 2002, or 2003. Closure sampling was conducted at ST36/66 in June 2001. Results of this closure sampling, including analytical data and soil boring locations, can be found in the *ST36/66 and ST32, Tank 8 Closure Report* (USAF, 2002b).

Subsurface soil data gained from closure drilling at this site in 2001 show that hydrocarbon contamination exists at levels slightly above ADEC Method 2 cleanup levels for the under 40-inch, migration to groundwater category. Most of the contamination found during sampling exists in the smear zone just above the groundwater surface. Since these soils are constantly being saturated with impacted groundwater and are below the vadose zone, bioventing is not an effective remediation technique for this soil horizon. This contamination should be considered as part of the groundwater medium for the purposes of evaluating site closure (USAF, 2002c).

Recommendations: In the ST33/66 and ST32, Tank 8 Closure Report, a recommendation was made that the bioventing blower units be shut down because data indicated that continued operation would not increase the degradation rate (USAF, 2002b). Draft Decision documents were developed for Sites ST 36/66 and ST68 to record the U.S. Air Force (USAF) decision to shut down the respective bioventing systems and allow contaminants at this location to naturally attenuate. The decision documents will be coordinated through ADEC.

3.2 SS 43/55

Current Task Order: Biweekly system checks were performed on the bioventing systems at SS43/55 during 2003. The asphalt apron immediately south of SS43/55 was expanded this year. Drilling permits were obtained for soil borings at SS43/55. The borings were advanced and analytical samples taken in late August. The soil sampling results show that contamination is still present at this location with GRO up to 1,120 mg/kg, DRO up to 3,240 mg/kg, benzene up to 2.08 mg/kg, toluene up to 24.9 mg/kg, and ethylbenzene up to 13.4 mg/kg. However, all contaminated intervals are located in the groundwater smear zone at this location. The PID results indicate that there is no contamination in the vadose zone that overlies the contaminated smear zone. A more complete discussion of results is contained in the 2003 Soil Sampling Report. Respiration test data continue to indicate low to moderate biological activity at the SS43/55 sampling points, with the highest level of activity at implants 43-1A (.352 mg/kg/day) and 43-2C (.464 mg/kg/day) respectively.

Historical: 2002 respiration testing indicated that TVH concentrations were decreasing at all the sampling points except MPA-12. TVH concentrations ranged from 0 to 84 parts per million (ppm); TVH concentrations during the 2001 and 2000 in-situ respiration test ranged from 0 to 798 ppm, and 1 to 1,450 ppm, respectively. In addition, oxygen concentrations (O_2%) decreased

at all monitoring points except 43-1C. The data suggested that hydrocarbon degradation was still occurring at most of the soil vapor implant locations with the exceptions of 43-1C and MPA-12.

Recommendations: Active bioventing is only minimally effective at SS43/55 because the contamination in the vadose zone has already been cleaned up, and bioventing is not effective in the smear zone which remains contaminated. The smear zone is directly affecting the groundwater which is being monitored at this site by wells 43-WL-07, and SP7/10-04. Therefore, active bioventing should be halted at SS43/55 and the remaining contamination in the smear zone allowed to naturally attenuate. This natural attenuation of the remaining contaminants should be monitored under the Basewide Groundwater Monitoring Program. Well SP7/10-04 should continue to be monitored annually. After groundwater has attained cleanup levels in 18 AAC 75, the soil at SS43/55 should be sampled to confirm that it meets soil cleanup levels in 18 AAC 75.

Blower enclosures at 43/55 (East and West) were damaged during the winter of 2002. Temporary repairs were made in 2003; however, more permanent repairs are needed to ensure optimum performance. The repairs or replacement with a metal box should be made in 2004. Additional wiring and/or rewiring of the metal box will be necessary to complete repairs.

3.3 ST61

Current Task Order: This site was not included in the 2003 monitoring and optimization effort.

Historical: Routine operation, maintenance and monitoring activities were performed on the bioventing systems at ST61 during 2002, as summarized in Table 3-1. Closure sampling was conducted at ST61 during 2000. The results of this closure sampling can be found in the Year 2000 Bioventing Closure Effort Report (USAF, 2001b). Data in this report suggest that contaminated groundwater is creating a "smear zone" with overlying soils and that this contamination just above the water table will not be remediated by the bioventing system currently in place.

Recommendations: Previous recommendations for this site include the decommissioning of the bioventing system since remaining contamination exists only in the smear zone where bioventing is not effective; and continued groundwater monitoring as part of the Basewide Monitoring program (USAF, 2002c). ADEC concurred with the shutdown of the bioventing system, and that further remediation for soils in the smear zone is not required provided that ongoing monitoring of groundwater for DRO and BTEX is performed as part of the Basewide Monitoring program.

3.4 ST32, Tank 2

Current Task Order: This site was not included in the 2003 monitoring and optimization effort. It was noted, however, that this system became non-operational in September of 2003. This location was scheduled to have a soil boring accomplished to help determine the clean-up status of the site. When reviewing the Draft Project Plan, EAFB noted that the contractor seemed to be unaware that the surface at ST 32, Tank 2 had been raised with fill approximately

40 feet during the construction of two new above-ground storage tanks. EAFB thought that the bioventing injection well and sampling points had been raised directly vertically from their initial locations. The surveyed coordinates for the well were converted to global positioning system (GPS) coordinates and these confirmed that the injection well had been raised vertically. The area of highest contamination historically is approximately 30 feet horizontally from the area constructed for the new tanks. A conventional drill rig cannot traverse the slope and drill vertically to sample the point of highest contamination. Drilling from the base of the fill to sample the historically highest contaminated area could only be accomplished with a directional drilling rig. Sampling at this location was removed from the 2003 program.

In February 2004, a release of JP-8 at the fueling station above the ST32 site prompted the investigation of two monitoring wells associated with ST32. A sample collected from monitoring well 59-WL-02 located directly in the center of the former Tank 2 location showed no evidence of free product.

Historical: A summary of seven in-situ respiration tests conducted in 1996 and 1997 indicated that biodegradation rates during that time consistently decreased at both implants (all depths), indicating that hydrocarbon levels in the soil were decreasing (USAF, 1998b).

Recommendations: This site is in close proximity to ST41, where groundwater modeling has demonstrated that BTEX contamination will be treated though natural attenuation. Prior recommendations for this site include closure sampling and the decommissioning of the bioventing system with continued groundwater monitoring as part of the Basewide Monitoring program. The bioventing system is no longer contributing to the remediation effort at this site since remaining contamination exists only in the smear zone where bioventing is not effective (USAF, 2002c). ADEC concurred with the shutdown of the bioventing system, and that further remediation for soils in the smear zone is not required at this time provided that ongoing monitoring of soil and groundwater is performed. Soil sampling will be conducted in 2004 (utilizing directional drilling) to support this decision.

3.5 ST32, Tank 4

Current Task Order: This site was not included in the 2003 monitoring and optimization effort.

Historical: Closure soil sampling was conducted at ST32 Tank 4 during 2000; therefore, in-situ respiration tests have not been conducted at the site since that time. The results of the closure sampling are reported in the *Year 2000 Bioventing Closure Effort Report* (USAF, 2001b). The data suggest that contamination is present only in isolated areas within the non-homogeneous subsurface and quickly dissipates outside the localized area. Continued operation of the bioventing system is unlikely to result in the reduction of hydrocarbons below the soil cleanup criteria (USAF, 2002c). ADEC concurred with shutdown of the bioventing system, provided that ongoing monitoring of soil and groundwater is performed (USAF, 2002c). An excavation is programmed for 2004 to cleanup this site.

3.6 ST32, Tank 5

Current Task Order: This site was not included in the 2003 monitoring and optimization effort.

Historical: Closure soil sampling was conducted at ST32 Tank 5 during 2000. The results of this closure sampling are presented in the *Year 2000 Bioventing Closure Effort Report* (USAF, 2001b). The data suggest that contamination is present only in isolated areas within the non-homogeneous subsurface and quickly dissipates outside the localized area. Continued operation of the bioventing system is unlikely to result in the reduction of hydrocarbons below the soil cleanup criteria (USAF, 2002c). ADEC concurred with shutdown of the bioventing system, provided that ongoing monitoring of soil and groundwater is performed (USAF, 2002c). An excavation is programmed for 2004 to cleanup this site.

3.7 ST32 Tank 6

Current Task Order: This site was not included in the 2003 monitoring and optimization effort.

Historical: Closure soil sampling was conducted at ST32 Tank 6 during 2000. The results of this closure sampling are presented in the *Year 2000 Bioventing Closure Effort Report* (USAF, 2001b). The data suggest that contamination is present only in isolated areas within the non-homogeneous subsurface and quickly dissipates outside the localized area. Continued operation of the bioventing system is unlikely to result in the reduction of hydrocarbons below the soil cleanup criteria (USAF, 2002c). In-situ respiration tests were not conducted at ST32, Tank 6 during 2000 or 2001.

ADEC concurred with shutdown of the bioventing system, provided that ongoing monitoring of soil and groundwater is performed (USAF, 2002c). An excavation is programmed for 2004 to cleanup this site.

3.8 ST32, Tank 7

Current Task Order: Routine operation, maintenance and monitoring activities were performed on the bioventing systems at ST32, Tank 7 during 2003, as summarized in Table 3-1. Respiration testing showed low TVH concentrations at all implants and little to no oxygen uptake even though adequate O_2 appeared to be supplied to all implant points (Table 3-2). The data suggest negligible biodegradation rates and that the bioventing system is no longer contributing to remediation at this site.

Historical: The *Monitoring and Optimization Workplan Basewide Bioventing Systems* recommended that the bioventing system be decommissioned (USAF, 2002a).

Recommendation: Closure sampling and decommissioning should be performed since the bioventing system is no longer contributing to the remediation effort at this site.

3.9 ST32 Tank 8

Current Task Order: Biweekly system checks were performed on the bioventing systems at ST32, Tank 8 during 2003 as summarized in Table 3-1.

Historical: Closure sampling was conducted at the site in June 2001. Results of this closure sampling, including analytical data and soil boring locations, are presented in the *ST36/66 and ST32, Tank 8 Closure Report* (USAF, 2002b).

Reported sample data from two of the three soil borings drilled in 2001 exceeded Method 2, migration to groundwater pathway, cleanup levels for the site. Reported data from closure Soil Boring 3 (near 59BH69) analytical data met the current cleanup levels for soil.

Closure Soil Boring 1, near 59BH68, had concentrations of benzene from the middle vapor implant interval and the lower vapor implant interval that exceeded Method 2 cleanup levels. Both concentrations were just slightly above cleanup levels, indicating that remediation may be near completion at this location. All other analytes were below cleanup levels.

Closure Soil Boring 2 had analytical results exceeding regulatory levels at the upper and middle vapor implant locations. Ethylbenzene, GRO, and DRO from the upper implant and benzene from the middle implant currently exceed cleanup levels. Since 1994, ethylbenzene concentrations near soil vapor implant 59BH58 decreased from 42 to 9.1 milligram per kilogram (mg/Kg), benzene decreased from 12 to 0.037 mg/Kg, and GRO decreased from 5,300 to 710 mg/Kg. DRO showed an increase from 240 to 800 mg/Kg, although the exact interval sampled in 2001 (19-21 feet) was not the same as that sampled in 1994. The contaminant concentrations at this site are generally decreasing, indicating that the bioventing system has been effective at reducing soil contaminant levels. In-situ respiration test data from 2000 indicate that bioventing continues to help degrade contaminants in the soils at the upper and middle soil vapor implant locations near 59BH68.

A remediation effort of approximately three years was estimated to reduce contaminant concentrations in the interval from 19-21 feet bgs near vapor implant 59BH58 to concentrations below cleanup levels (USAF, 2001c). Remediation of remaining contamination from middle and lower depths at 59BH67 and the lower depth near 59BH68 is estimated to take less than one year of additional remediation (USAF, 2001c). Closure sampling will be required in 2004 prior to decommissioning the bioventing system. This sampling event should consist of sampling for benzene at the 2001 Soil Boring 1 location and BTEX, GRO, and DRO sampling at the 2001 Soil Boring 2 location.

Recommendations: Proceed with soil sampling in 2004, and if clean up levels are met, a closure document will be submitted which will allow for the decommission this system.

3.10 ST68

Current Task Order: Biweekly system checks were performed on the bioventing systems at ST68, during 2003.

Historical: Closure sampling was conducted at ST68 during 2000. The data suggest that contamination is present only in isolated areas and quickly dissipates outside of the localized area. Conclusions in the *Year 2000 Bioventing Closure Effort Report* suggest continued bioventing is unlikely to result in the reduction of hydrocarbons below the soil cleanup levels (USAF, 2001b). ADEC concurred with shutdown of the bioventing system, provided that ongoing monitoring of soil and groundwater is performed (USAF, 2002c).

Recommendations: A Decision Document was developed for ST68 to record the USAF decision to shut down the bioventing system and allow contaminants at this location to naturally attenuate. The Decision Document is being finalized at this time.

3.11 ST74

Current Task Order: This site was not included in the 2003 monitoring and optimization effort.

Historical: The bioventing system at ST74 was removed in 2000, and soils suspected to be contaminated were excavated, treated, and disposed. The USAF had the United States Army Corps of Engineers incorporate the requirements of an ADEC letter dated January 18, 2000 into their contract to allow removal of the bioventing system at this site. Remediation of subsurface soils is complete at this site.

Recommendation: A no further action report is being prepared for this site.

3.12 FT23

Current Task Order: Operation, maintenance and monitoring activities were performed on the bioventing system at FT23 during 2003, see Table 3-1. The contract was modified on 29 September to balance the bioventing system at FT23 per the O&M manual.

In-situ respiration tests were performed in February 2004 at this site. This data is presented on Table 3-2. TVH concentrations in soil gas at the BV-2 locations were very low (only 0.1 ppm). TVH max concentrations in soil gas at the BV-3 locations were recorded at 0.7 ppm. TVH concentrations in soil gas at the BV-4 locations range from non-detectable to 0.3 ppm (BV-4A upper). Maximum TVH concentrations in soil gas at BV-5 locations were as high as 821 ppm (BV-5C upper). The data suggests that low levels of hydrocarbon contamination remain in the subsurface near the BV-2, 3 and 4 locations and moderate levels of hydrocarbon contamination are present at the BV-5 location.

Oxygen concentrations (O_2%) were measured prior to shutdown. All monitoring points for BV-2, BV-3, and BV-4 locations had O_2 concentrations greater than 20%. Monitoring points for the BV-5 locations had O_2% concentrations ranging from 5.6% to 20.9% indicating that adequate oxygen was being delivered to all monitoring points.

After shutdown, O_2% concentrations remained relatively constant at the BV-2, BV-3, and BV-4 locations again indicating that bacterial activity is low in these areas. At the BV-5 implants,

however, oxygen utilization rates were relatively high following system shut down with O_2% changes ranging from 1.1% at BV-5D upper to 13.1% at BV-5B upper.

In general, the data suggests that little hydrocarbon degradation is still occurring at the BV-2, BV-3, and BV-4 soil implants. However at the BV-5 locations active biodegradation appears to be occurring at nearly all soil implants.

Historical: In 2002, the bioventing system at FT23 was expanded to address contamination surrounding SB62. Two injection wells were installed near SB62, and drilled to depths of 23 and 40 feet bgs. Four additional soil borings were advanced to install soil vapor implants in order to monitor vapors from the system. The upper soil implants were screened at approximately 11-12 feet bgs and the lower implants were installed at approximately 32-33 feet bgs.

Only blower FTA-1 is operating at FT23. Blower FTA-2 was shut down in 2000 because remediation at the injection well and soil vapor implant locations associated with this blower was complete (USAF, 2000). Blower FTA-1 was connected to three injection wells until the 2002 expansion. One of the bioventing injection ports (BV 5) at the Fire Training Area (FT 23) was modified and fitted with a pitot tube in 2003 as described in Section 2.9. Currently the blower is connected to five injection wells.

Recommendations: It is recommended that the bioventing system be left in operation, with continued biweekly monitoring and maintenance activities. During 2003 respiration tests, the BV-5C upper implant had an oxygen concentration of 5.6% prior to system shutdown. It is recommended that the oxygen concentrations be monitored at all BV-5 upper locations to ensure adequate O_2 is available for biodegradation to occur. If O_2 concentrations drop below 5%, the blower pressure should be increased. Once in-situ respiration test data indicate that bioventing is not contributing to remediation at the site, closure soil sampling should be performed.

3.13 SD25

Current Task Order: In October 2003, the bioventing system at SD25 was dismantled. However, two of the monitoring points at SD 25 (BV 5B and BV 5C) could not be abandoned during the construction season because a spoil pile from a large pipe excavation located immediately west of the injection well covered them. The spoil pile was not removed until after the drill rig had demobilized from the site.

Table 3-2 Summary of 2003 In-situ Respiration Test Data

Site	Implant Identification or Wellhead	Screened Interval [1] (feet bgs)	February 2003 In-situ Respiration Test Data and Comparison with Previous Data								
			Oxygen Prior to Shutdown (%)	Oxygen Concentration at Test Completion (%)	Change in Oxygen (%)	CO_2 at Test Completion (%)	TVH (ppm)	Estimated Degradation Rate Based on Oxygen Utilization (mg/Kg/day)			Comments
								2003	2002	2001	
ST43/55	43-1A	18 – 19	19.2	17.0	-2.2	0.7	1.3	0.352	0.0	0.238	TVH max 6 ppm (2003), 12 ppm (2002), 114 ppm (2001) , 84 ppm (2000)
	43-1B	18 – 19	18.2	18.1	-0.1	0.8	1.0	0.016	0.150	0.267	TVH max 4.1 ppm (2003), 36 ppm (2002), 168 ppm (2001) , 78 ppm (2000)
	43-1C	18 - 19	4.2	4.1	-0.1	3.4	664	0.016	0.0	0.0	TVH max 1142 (2003), 168 ppm (2002), 330 ppm (2001), 111 ppm (2000)
	43-3A	15 - 16	20.7	20.2	-0.5	0.3	73.44	0.08	0.730	0.337	TVH max 95 ppm (2003), 36 ppm (2002), 366 ppm (2001), 110 ppm (2000)
	43-3B	15 - 16							1.138	1.26	Not sampled due to probe blockage. TVH max 96 ppm (2002), 798 ppm (2001) & 190 ppm (2000)
	43-2C	16-17	15.9	13.0	-2.9	1.8	4.7	.464	0.300	0.250	TVH max 7 ppm (2003), 270 ppm (2001), 97 ppm (2000)
FT 23	BV-2A upper	14.5 – 15.5								0.002	Not sampled due to probe blockage. TVH max 90 ppm (2001) & 17 ppm (2000)
	BV-2A lower	34.0 – 35.0	20.9	19.9	-1.0	.2	0.1	0.16		0.018	TVH max .1 ppm (2003) , 60 ppm (2002) & 18 ppm (2000)
	BV-3A upper	11.8 – 12.8	20.9	20.4	-0.5	0.0	0.3	0.08			TVH max 0.5 ppm (2003), 138 ppm (2001), 4,000 ppm (2000)
	BV-3A lower	34.0 – 35.0	20.9	20.5	-0.4	0.0	0.4	0.064		0.186	TVH max 0.7 ppm (2003), 180 ppm (2001), 2,000 ppm (2000)
	BV-3B upper	14.5 – 15.5	20.9	20.6	-0.3	0.0	0.1	0.048		0.004	TVH max 0.2 ppm (2003), 108 ppm (2001), 22 ppm (2000)

Table 3-2 Summary of 2003 In-situ Respiration Test Data *(continued)*

Site	Implant Identification or Wellhead	Screened Interval [1] (feet bgs)	February 2003 In-situ Respiration Test Data and Comparison with Previous Data								
			Oxygen Prior to Shutdown (%)	Oxygen Concentration at Test Completion (%)	Change in Oxygen (%)	CO_2 at Test Completion (%)	TVH (ppm)	Estimated Degradation Rate Based on Oxygen Utilization (mg/Kg/day			Comments
								2003	2002	2001	
FT 23 cont	BV-3B lower	34.5 – 35.5	20.9	19.3	-1.6	0.0	0.2	0.256		0.004	TVH max 0.2 (2003), 48 ppm (2001), 23 ppm (2000)
	BV-4A upper	11.0 - 12.0	20.5	19.2	-1.3	0.0	0.2	0.21	0.021		TVH max 0.3 ppm (2003), 24 ppm (2002), 90 ppm (2001) , 17 ppm (2000)
	BV-4A lower	32.0 - 33.0	20.9	20.4	-0.5	0.0	0.2	0.08			TVH max 0.2 ppm (2003), 54 ppm (2001), 20 ppm (2000)
	BV-4B upper	13.5 - 14.5	20.9	20.5	-0.4	0.0	0.1	0.064		0.20	TVH max 0.2 ppm (2003), 126 ppm (2001), 54 ppm (2000)
	BV-4B lower	32.0 - 33.0	20.9	20.0	-0.9	0	0.2	0.14	0.0	0.073	TVH max 0.2 ppm (2003), 138 ppm (2001), 48 ppm (2000).
	BV-5A upper		19.6	11.1	-8.5	1.8	3.5	1.36	2.752		TVH max 4.8 ppm (2003), 156 ppm (2002)
	BV5A lower		20.7	17.5	-3.2	0.6	2.6	0.512	1.112		TVH max 2.6 ppm (2003), 90 ppm (2002)
	BV-5B upper		15.6	2.5	-13.1	3.4	83.5	2.096	1.344		TVH max 107 ppm (2003), 438 ppm (2002)
	BV-5B lower		20.1	17.2	-2.9	0.8	4.6	0.464	0.590		TVH max 7.4 ppm (2003), 90 ppm (2002)
	BV-5C upper		5.6	1.1	-4.5	4.3	488	0.72	0.0		TVH max 821 ppm (2003
	BV-5C(lower		20.4	13.0	-7.4	1.8	13.2	1.184	0.989		TVH max 24.5 ppm (2003), 156 ppm (2002)
	BV-5D upper		18.5	17.4	-1.1	0.8	1.7	0.176	0.169		2003 TVH max 3.1 ppm (2003), 150 ppm (2002)
	BV-5D lower		20.8	18.7	-2.1	0.3	1.0	0.336	0.974		2003 TVH max 2 ppm, 60 ppm (2002)

Table 3-2 Summary of 2003 In-situ Respiration Test Data *(continued)*

Site	Implant Identification or Wellhead	Screened Interval [1] (feet bgs)	February 2003 In-situ Respiration Test Data and Comparison with Previous Data								
			Oxygen Prior to Shutdown (%)	Oxygen Concentration at Test Completion (%)	Change in Oxygen (%)	CO_2 at Test Completion (%)	TVH (ppm)	Estimated Degradation Rate Based on Oxygen Utilization (mg/Kg/day			Comments
								2003	2002	2001	
ST32, Tank 7	59BH92-15		20.9	20.9	0.0	0.0	1.1	0.0			TVH max 3.3 ppm (2003)
	59BH92-20										Not sampled due to probe blockage
	59BH84-15.9		20.9	20.9	0.0	0.0	1.8	0.0			TVH max 2.4 ppm (2003)
	59BH84-25		20.9	20.9	0.0	0.0	0.7	0.0			TVH max 1.1 ppm (2003)
	59BH91-22		20.9	20.9	0.0	0.0	1.4	0.0			TVH max 2.5 ppm (2003)

Shaded areas indicate no data available.
bgs – below ground surface
CO_2 - carbon dioxide
mg/Kg/day – milligram per kilogram per day
ppm - parts per million
TVH - total volatile hydrocarbons

Historical: Closure sampling at SD25 was performed in 1999. Data gathered during the 1999 closure soil sampling event at SD25 indicated cleanup levels for soils had been achieved for DRO, GRO, and BTEX; however, benzene slightly exceeded the 0.5 mg/Kg closure criterion at the 14-16 feet bgs at SB-57. Based upon the estimated degradation rates calculated from the O_2 utilization measured during the respiration testing in 1999, it was estimated that remediation should be complete in one year (USAF, 2000). In July of 2002, follow-on closure soil sampling was conducted to document that remediation was complete at former boring location SB-57. One sample was collected at the interval of 14-16 feet bgs from boring SB-57c, installed adjacent to former boring location SB-57. Analytical results showed that benzene levels were significantly less than levels in 1999, indicating that degradation of benzene had occurred to levels below remediation goals outlined in the OU 4 ROD. In addition, the GRO concentration had decreased from the remediation goal concentration of 1,000 mg/kg to 120 mg/kg. Based upon these findings the USAF requested and received a "Site Closure" decision letter for bioventing site SD25 (USAF, 2002c) from ADEC.

Recommendations: Two monitoring points that were not removed in 2003 should be removed by drill rig during the summer of 2004.

3.14 SS10

Current Task Order: Biweekly system checks were performed on the bioventing systems at SS10 during 2003, see Table 3-1. Soil sampling was performed in August 2003. The soil sampling at SS10 shows that the contaminants of concern are all below the soil remediation goals set for this site in the OU 4 Record of Decision. A discussion of the results can be found in the 2003 Soil Sampling Report.

Historical: An in-situ respiration test was performed in September 2002. TVH concentrations ranged from 0-66 ppm. Percent O_2 concentrations were all above 20% prior to the start of the test, only soil implant BV-6C showed an O_2 concentration decrease after system shutdown. The hydrocarbon degradation rate at BV-6C was estimated at 0.625 mg/Kg/day. The 2002 respiration tests indicated that biodegradation of hydrocarbons was occurring in the vicinity of BV-6C only, while 2001 data indicated active biodegradation at soil implant BV-6B as well.

Recommendations: Since the sampling results indicated that SS10 meets closure criteria, coordination with EPA and ADEC will take place on decommissioning the bioventing system and closure of the site.

3.15 ST71

Current Task Order: This site was not included in the 2003 monitoring and optimization effort.

Historical: The ST71 site was decommissioned in 2002.

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