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**INSTALLATION
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PROGRAM**

Eglin Air Force Base, Florida

FINAL

Bioventing Final Letter Report

**First Year of Full Scale
Bioventing Operation**

7th Street BX Service Station

September 1993

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INSTALLATION RESTORATION PROGRAM
FINAL
BIOVENTING FINAL LETTER REPORT
FIRST YEAR OF FULL SCALE BIOVENTING OPERATION

AIR FORCE MATERIEL COMMAND
EGLIN AIR FORCE BASE, FLORIDA

SEPTEMBER 24, 1993

PREPARED BY

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FIRST YEAR OF FULL SCALE BIOVENTING OPERATION THE BIOVENTING SYSTEM AT THE 7TH STREET BX SERVICE STATION, EGLIN AFB

INTRODUCTION

This report presents the results of a full scale bioventing remediation work at the 7th Street BX Service Station in Eglin AFB, Florida. The report includes a summary of initial pilot test results, system start-up and system optimization, and results and analysis of in-situ respiration tests conducted to evaluate the effectiveness of the system during the first year of operation. In addition, a summary of the monthly operation and maintenance effort is also included.

The 7th Street BX Service Station is located near the intersection of 7th Street and Eglin Boulevard on Eglin Main Base (Figure 1). The site description and history were presented in detail in the Engineering Work Plan for installation of this system (ES, 1992). Previous and ongoing investigations at the site revealed presence of volatile and semivolatile organic compounds in the groundwater. Contaminants detected are mostly constituents of gasoline. A single spill discovered in 1983 released an estimated 3,600 gallons of unleaded gasoline (Geraghty and Miller, 1985). This is believed to be the source of present contamination at the site. Free product has been measured at the site at various times over the past 6 years. A significant portion of the soil at the site is suspected to be impacted by the release of gasoline into the subsurface. Currently, a product recovery and groundwater treatment system is being operated at the site to remove floating and dissolved petroleum hydrocarbons from the groundwater. The product recovery and treatment system is incapable of remediating soil contamination, therefore, a bioventing treatability system has been installed to remediate the soil contamination.

ES installed the bioventing system between May 11 and 15, 1992. The objective of the bioventing system at the 7th Street BX Service Station is to aid in expediting remediation efforts. This objective was developed through evaluation of previous investigation results, current remediation efforts, and results of a bioventing pilot test at the site.

The bioventing system consists of two vapor extraction wells (VEWs), two vapor monitoring points (VMPs), and two recirculation/injection trenches (Figure 2). The boring logs for the VEWs and VMPs are included in Attachment A. To obtain baseline soil sampling data, soil samples were collected from the boring for these wells for

analyses of TPH and BTEX compounds. The results of these analyses are included in this report. The as-built flow schematic for the system and other construction information and specifications are included in Figure 3.

INITIAL SITE CONDITIONS (Pre-Venting Conditions)

Operation of the bioventing system at the 7th Street BX Service Station began in May 1992. Prior to initiating venting at the site, initial soil gas concentrations of oxygen and carbon dioxide were measured at the two vapor monitoring points (VMP-1, VMP-2), two existing ground water monitoring wells (MW-1, MW-10), and a background soil gas probe located approximately 500 feet north of the site. The depth of the background soil gas probe was 3 feet and the probe was driven at the edge of a large asphalt area. Soil gas conditions in all monitoring points within the fuel spill area were oxygen depleted with all points reading 0.0 percent oxygen. Carbon dioxide in all points within the spill area exceeded 15 percent. These (anaerobic) soil gas conditions indicate that fuel biodegradation is oxygen limited and will benefit from oxygen addition. In contrast, oxygen and carbon dioxide concentrations in the background soil gas monitoring probe were near atmospheric conditions at 20.4 percent and 0.6 percent respectively. The oxygen and carbon dioxide levels found in background soils indicate that the oxygen deficient vapor found at the 7th street site was not caused by natural carbon biodegradation or abiotic (chemical) oxygen uptake in the soil but are the result of increased biologic activity. Soil sampling was conducted during installation of the wells and construction of the injection trenches to document baseline soil conditions prior to bioventing. Results of baseline soils condition are discussed under "Soil Sampling Results". The analytical data is provided in Appendix B.

Initial Respiration Test

After installation of the system in May 1992, an in-situ respiration test was conducted to confirm the presence of biological activity and to determine the initial oxygen utilization rates for this fuel spill site. The purpose of the respiration test is to ensure that nutrients, moisture are not limiting biodegradation and to confirm the presence of biological activity. The test began by injecting air into VMP-1 (Deep) and VMP-2 (Shallow) for approximately 12 hours to build up the supply of oxygen in the soil. Prior to air injection, a soil oxygen concentration of zero was measured in both VMP-1 and VMP-2 indicating a severe oxygen limitation. Following the 12 hours of air injection, soil oxygen levels were increased to over 20 percent in both VMPs. Rates of oxygen utilization varied from 0.15 to 0.28 percent oxygen per hour which closely compare to a oxygen utilization ratio of 0.12 to 0.36 percent oxygen per hour measured in similar soil and climatic conditions at Tyndall AFB, Florida (Miller, 1990). Biodegradation rate was estimated at 2.9 to 5.3 mg/kg/day or from 1000 to 2000 mg/kg/yr.

ES believed these rates will increase over the first few months of bioventing as the aerobic bacterial population is reestablished in the oxygen enriched environment. A

repeat respiration test discussed later in this report was performed in September 1992 to determine the oxygen enriched, long term respiration rates at the site.

The equipment used during the respiration tests on this project included an oxygen/carbon dioxide (O_2/CO_2) meter, a total hydrocarbon meter and a 1 scfm pump. A Gas Tech Model 3552OX O_2/CO_2 meter was used in measuring concentration of gases at each point of interest (i.e., vapor monitoring points). This equipment measures oxygen levels from 0 to 25% and carbon dioxide levels from 0 to 25%. A GasTech TraceTechor™ hydrocarbon analyzer was used to measure total hydrocarbon concentrations with range settings of 100 ppm, 1,000 ppm, and 10,000 ppm. This equipment was calibrated daily prior to use. The O_2/CO_2 meter was calibrated using a 0% and 5% standard for O_2 and a 5% standard for CO_2 . The hydrocarbon analyzer was calibrated with hexane at 4,400 ppm. The O_2/CO_2 instrument was checked against atmospheric concentration prior to taking field measurements.

System Start-Up

At 0800 on 20 May 1992, bioventing was initiated at the 7th Street Service Station. Vacuum levels at the filter inlet, filter outlet, and blower outlet were also monitored to determine blower performance and flow rate. With the dilution valve closed, vacuum at the air filter inlet was 28" H_2O , head loss through the filter was 18" H_2O , and pressure at the blower exit was +18" H_2O . The total pressure across the blower of 64" H_2O was slightly greater than the manufacturer's recommended operating maximum of 60" H_2O . Based on the manufacturer's blower curve, approximately 35 scfm of soil gas was being removed from the venting wells at a vacuum pressure of 64" H_2O .

After approximately 90 minutes of operating, the oxygen, carbon dioxide and volatile hydrocarbon concentrations were measured in the sampling port located upstream of the dilution valve. An oxygen concentration of 4.5% was measured in the vented soil gas into the contaminated area. Carbon dioxide was reduced from an average pre-venting concentration of >15% to 12%. Initial volatile hydrocarbon concentrations were difficult to measure because of high initial levels. A 1:12 dilution was required to bring the concentrations to within the TraceTechor gas analyzers calibration range of 0 to 10,000 ppmv. Using this dilution, an initial concentration of approximately 90,000 ppmv (as hexane) was measured.

System Optimization

The bioventing system at this site was designed to provide both oxygen to the primary spill area beneath the asphalt and to reinject hydrocarbon vapors into a "biofiltering" trench where biodegradation of vapors will take place. System optimization requires reducing the soil gas extraction rate in the highly contaminated area, while maintaining enough oxygen influx to sustain initial fuel biodegradation rates. The optimization was accomplished by opening the dilution valve in steps and then measuring vacuum response and oxygen influx at vapor monitoring points and the extracted soil gas. An additional goal of the initial optimization was to insure that

adequate oxygen was provided to the "biofilter" trench to biodegrade injected vapors. This objective was also accomplished by adjusting the dilution valve to supply oxygen rich ambient air to the trench. The change in vacuum and soil gas concentrations resulting from each optimization step were presented in the Bioventing System Start-up Report (ES, June 1992).

At 0900 on 21 May the dilution valve was set at the final 1:3 dilution and the dilution valve handle was removed. Final vacuum response readings were taken to insure that soil gas movement (oxygen influx) was occurring at this lower dilution rate. All monitoring points registered vacuum levels of 0.2" H₂O or higher. Final soil gas oxygen concentration ranged from 12.0 to 20.8 percent throughout the contaminated soil volume indicating that a combined flow of 15 cfm through VEW-1 and VEW-2 was sufficient to oxygenate contaminated soils beneath the asphalt and soils at 15 to 20 feet on each side of the air injection trenches. Based on an estimated contaminated soil volume of 26,000 cubic feet, the soil gas extraction rate of 15 scfm represents approximately one pore volume exchange per day. Previous bioventing studies have shown that in-situ biodegradation can be sustained at this level of oxygen influx (Miller, 1990).

RESULTS OF IN-SITU RESPIRATION TEST AFTER 3 MONTHS OF FULL SCALE OPERATION.

After three months of full scale operation an in-situ respiration test was performed to ensure that nutrients and moisture are not limiting biodegradation and to confirm the presence of biological activity. The results of this effort were provided in a letter report (ES, October 1992). Prior to this test, concern for potential off gas emission at the site prompted down-sizing of the 2.5 horse power (hp) blower used since startup of the system to a 1 hp unit. The bioventing system had been operating continuously with a 1 horse power (hp) blower for about one week prior to the date of this test to ensure adequate supply of oxygen into the soil at the site. Vacuum levels at the filter inlet, filter outlet, and blower outlet were also monitored to determine blower performance and flow rate prior to the respiration test. With the dilution valve open, vacuum at the air filter inlet was 4" H₂O, head loss through the filter was 12" H₂O, and pressure at the blower exhaust was 16" H₂O. The total pressure across the blower was 36" H₂O indicating the total flow into the injection trenches was approximately 30 CFM. The temperature at the filter inlet was 100°F and 110°F at the blower discharge.

A leak test was performed at each of the vapor monitoring points (VMPs) to find out if air leakage could occur at the VMPs during the respiration test. A leak was detected at the valve for VMP-1S and could not be corrected prior to the test. Therefore, the data for this well could not be used. Subsequently, a cap was placed on the valve to stop the leak. Initial measurements taken on arrival at the site indicated oxygen levels from 5.4% and 6.5% at the deep vapor monitoring points VMP-1D and VMP-2D, respectively and at 0.5% and 10% at the shallow vapor monitoring points VMP-1S and VMP-2S,

respectively. Notably, up to 20% oxygen had been measured at the deep VMPs during use of the 2.5 hp blower over the first two months of system operation. This apparent decrease in oxygen level at the vapor monitoring points was attributed to the reduced air flow from the new 1 hp blower being used.

The results of this test was presented in a report dated October 2, 1992. Using data obtained from VMP-1D and VMP-2D, rates of oxygen utilization varied from 0.28 to 1.35% oxygen per hour. The rate of fuel biodegradation was estimated at 5.36 to 25.85 mg/kg/day. In May 1992, at startup of operation of the system, the fuel biodegradation rate was estimated at 2.9 to 5.3 mg/kg/day, therefore, these fuel biodegradation rates were interpreted as indicative of significant increase in bioactivity since start up of the bioventing system at the site and suggested that a more active bacterial population has been reestablished. In addition, it was concluded that this increase could also be attributed to increase in soil temperature and biological activity during warm summer months. Final evaluation of the data suggest the 1 hp blower is providing adequate oxygen supply to support operation of the bioventing system. A second respiration test to confirm these results and verify long term respiration rates, scheduled for late November 1992 could not be performed because of high water table conditions.

RESULTS OF IN-SITU RESPIRATION TEST AFTER 1 YEAR OF FULL SCALE OPERATION.

The bioventing system had been operating continuously with a 1 horse power (hp) blower for approximately eight months. Prior to this, the system was operational for four months with a 2.5 hp blower. High water table conditions had prevented efforts to conduct additional in-situ respiration tests since the test in September 1992 (third month of system operation). However, by May 1993, the water table had dropped to a level that provided adequate room in the vadose zone for successful implementation of the test. A summary of the physical parameters measured over the first year of operation is presented in Table 1.

Vacuum levels at the filter inlet, filter outlet, and blower outlet were monitored during the test to determine blower performance and flow rate prior to the respiration test. With the dilution valve 50 percent open, vacuum at the air filter inlet was 5" H₂O, head loss through the filter was 9" H₂O, and pressure at the blower exhaust was 18" H₂O. The total pressure across the blower was 32". The total flow into the injection trenches was approximately 24 CFM. The temperature at the filter inlet was 78°F and 93°F at the blower discharge. Steady state oxygen levels at VMP-2S and VMP-2D were 2.8 and 19.5, respectively. No oxygen was detected in VMP-1S or VMP-1D indicating that insufficient air flow was occurring at the western edge of the spill area.

Because the oxygen level was at 0% in VMP-1S and VMP-1D, air was injected into these wells using a 1 scfm pump for approximately 4 hours to allow adequate supply of oxygen before commencement of the respiration test.

Test Results

At 1725 hours on May 26, 1993 the system was shutdown to begin the respiration test. Readings were taken over a two day period after shutdown. The respiratory test data is presented in Table 2. Data collected are also presented graphically in figures 4 through 7. Total hydrocarbon levels measured during the respiration test are also included in Table 2. Approximately 15% oxygen consumption was recorded in VMP-1S and VMP-2D 15 hours into the test. At approximately 53 hours into the test full oxygen consumption state was reached at VMP-1S and VMP-2D. Oxygen utilization in VMP-1D occurred at a rather slow rate and full oxygen consumption state was not attained at VMP-1D before the test was completed. Carbon dioxide levels increased up to about 13% at VMP-2S and VMP-2D at the end of the respiration test and appeared to have complemented oxygen readings throughout the test. Oxygen and carbon dioxide curves for VMP-1S and VMP-1D also show a rise in carbon dioxide complementing the drop in oxygen.

Oxygen utilization rates were calculated as the percent change in O_2 over time (slope of O_2 vs. time). The slope of the curve was determined from the best fit line drawn through the test data or to a point where O_2 level approached zero. Using test data, rates of oxygen utilization varied from **0.10 to 0.33%** oxygen per hour. The rate of fuel biodegradation was estimated using the equation:

$$K_b = K_o A D_o C/100$$

Where:

K_b = Fuel biodegradation rate (mg/kg/day)

K_o = Oxygen utilization rate (% per day) (2.4 to 7.9)

A = Volume of air/kg of soil (L/kg) (estimated at 0.21 L/kg soil)

D_o = Density of oxygen (mg/L) (1330 mg/L)

C = Mass ratio of hydrocarbon to oxygen for mineralization (1:3.5)

Solving:

K_b = 1.9 to 6.3 mg/kg/day

In May 1992, at startup of operation of the system, the fuel biodegradation rate was estimated at 2.9 to 5.3 mg/kg/day. In September 1992, the fuel biodegradation rate was estimated at 5.36 to 25.86 mg/kg/day. The rates measured in May 1993 were 1.9 to 6.3 mg/kg/day. Based on an estimated contaminated soil volume of 26,000 cubic feet, this equates to approximately 1 to 3 gallons of fuel biodegraded each day. Rates in September 1992 could represent a growth phase where bacteria are growing at a rapid rate under oxygenated and warm temperature conditions.

The results of the first year in-situ respiration test at the 7th Street BX Service Station indicate steady rates of respiration are being achieved with the system. The

relatively close agreement of estimated fuel biodegradation rates at the VMPs suggest steady state has been achieved.

SOIL VAPOR MONITORING RESULTS

Results of biweekly/monthly concentrations of oxygen, carbon dioxide and total hydrocarbons throughout the bioventing system are depicted on Figures 8 through 10 and included in Appendix C. These results support increased biological activity in the subsurface. Results indicate oxygen supply to the subsurface has been adequately sustained except for recent measurements that showed a pronounced decrease in oxygen concentration and slight increase in carbon dioxide concentration at monitoring location VMP-1D. Available data indicate a rapid decline in total hydrocarbon concentration over the first six months of operation (from June 1992 through December 1992). Volatilization and to a greater extent biodegradation are believed to be responsible for the total hydrocarbons removed. A letter report presenting a summary of the operation and maintenance (O&M) effort over the first year is provided in Appendix C.

SOIL SAMPLING RESULTS

A summary of the analytical results for soils in May of 1992 and in May of 1993 is presented in Table 3. Results from soil sampling effort in May 1993 suggest that significant reduction in total recoverable petroleum hydrocarbon has occurred in subsurface soils. Specifically, reduction in TRPH concentrations varied from approximately 54% to 98%. This result is supported by the pronounced decrease in TPH concentration in soil vapor (see Figure 8). However, the effectiveness of the bioventing effort could not be clearly determined when BTEX results were evaluated. Reduction in BTEX concentrations in contaminated soil in VEW1 at depth of 4 to 6 feet was about 71% and about 10% in VMP2. But 74% increase in BTEX concentrations was noted in soil near VEW2. The reason(s) for this increase is not known. Potential conditions that could have caused this are; 1) fluctuation in water table conditions could have caused movement of product into this area and 2) a recent spill or leak (recent measurement in June 1993 indicated presence of product in a well downgradient of VEW2). Results for samples taken from the east air injection trench complemented results of May 1992 and indicated the long-term injection of hydrocarbon into this trench has not impacted the soil in this area. The raw analytical data is included in Appendix B.

RECOMMENDATIONS

ES recommends the Base continue operation of the pump and treat/bioventing system after the gasoline station has been closed. Closure of this station and proper tank and pipeline abandonment will also insure removal of all potential free product sources from the station. Once free product can no longer be detected in recovery wells, ES recommends that this site be included in the AFCEE natural attenuation study to demonstrate the natural biodegradation of remaining dissolved BTEX.

Prior to departing the site on 28 May 1993, ES personnel restarted the bioventing system and increased the extraction rate on VEW 1 to insure adequate air flow at the western edge of the spill zone. Additional adjustments may be required after the station closes if significant disturbance to soils and the asphalt cover occurs.

REFERENCES

- Engineering-Science 1992 (June), Letter Report : Bioventing System Start-up Report, 7th Street BX Service Stations
- Engineering-Science 1992 (October), Bioventing In-situ Respiration Test Report, 7th Street BX Service Station, Eglin AFB.
- Geraghty and Miller 1985, Remedial Action Plan for 7th Street BX Station.
- Miller, R.N. 1990, A Field Scale Investigation of Enhanced Petroleum Hydrocarbon Biodegradation in the Vadose Zone - Tyndall AFB FL Proceedings HWWA/API Petroleum Hydrocarbons and Organic Chemicals in Groundwater. pp 339-351. Houston, TX

IN-SITU RESPIRATION TEST - 1ST YEAR
DETERMINATION OF FUEL BIODEGRADATION RATE - K_b

$$K_b = K_o A D_o R \times 1/100 \times 1440 \text{ min/day} \quad (1)$$

or $K_b = K_o A D_o C/100 \quad (2)$

where:

K_b = Fuel Biodegradation Rate (mg/kg/day)

K_o = (Oxygen Utilization Rate) % per day

A = 0.21 liter/kilograms of soil (L/kg)

D_o = 1330 milligrams/liter (mg/L)

C = 1:3.5

Using Eq. (2)

For VMP-1S $K_o = 7.68\%$ per day

$$K_b = 7.68 \text{ \%/day} \times 0.21 \text{ L/kg} \times 1330 \text{ mg/L} \times 1/3.5 \times 0.01 = 6.13 \text{ (mg/kg/day)}$$

For VMP-1D $K_o = 3.31\%$ per day

$$K_b = 3.31 \text{ \%/day} \times 0.21 \text{ L/kg} \times 1330 \text{ mg/L} \times 1/3.5 \times 0.01 = 2.64 \text{ (mg/kg/day)}$$

For VMP-2S $K_o = 2.4\%$ per day

$$K_b = 2.4 \text{ \%/day} \times 0.21 \text{ L/kg} \times 1330 \text{ mg/L} \times 1/3.5 \times 0.01 = 1.91 \text{ (mg/kg/day)}$$

for VMP-2D $K_o = 7.89\%$ per day

$$K_b = 7.89 \text{ \%/day} \times 0.21 \text{ L/kg} \times 1330 \text{ mg/L} \times 1/3.5 \times 0.01 = 6.3 \text{ (mg/kg/day)}$$

IN-SITU RESPIRATION TEST - 1ST YEAR **DETERMINATION OF FUEL BIODEGRADATION RATE - K_b** ---

CALCULATIONS TO DETERMINE GALLONS OF FUEL PER DAY **BIODEGRADED**

Volume of Soil = 26,000 ft³

Density of Soil (sand), $\rho = 2.65 \text{ g}_{\text{sand}}/\text{cm}^3$

Porosity, $n = 0.3$

Bulk Density of Soil $= \rho(1-n) = (2.65 \text{ g}_{\text{sand}}/\text{cm}^3)(1-0.3) = 1.86 \text{ g}_{\text{soil}}/\text{cm}^3$
 $= (1.86 \text{ g}_{\text{soil}}/\text{cm}^3) (30.48 \text{ cm}/\text{ft})^3 (1 \text{ kg}_{\text{soil}}/1000 \text{ g}_{\text{soil}})$
 $= 52.7 \text{ kg}_{\text{soil}}/\text{ft}^3$

Specific Gravity Fuel (gasoline) = 0.72

Total Mass Of Soil $= (26,000 \text{ ft}^3)(52.7 \text{ kg}_{\text{soil}}/\text{ft}^3) = 1,370,000 \text{ kg}_{\text{soil}}$

Pound/Gallon Of Product $= (62.4 \text{ lb}_{\text{water}}/\text{ft}^3) (0.72 \text{ lb}_{\text{prod}}/\text{lb}_{\text{water}}) (\text{ft}^3/7.48 \text{ gal})$
 $= 6.0 \text{ lb}_{\text{prod}}/\text{gal of Product}$

Fuel Biodegradation Rate

May 1992 - K_b range = 2.9 to 5.3 mg/kg/day

FBR = $(2.9 \text{ mg}_{\text{prod}}/\text{kg}_{\text{soil}}/\text{day}) (1,370,000 \text{ kg}_{\text{soil}})(\text{kg}_{\text{prod}}/1 \times 10^6 \text{ mg}_{\text{prod}})$
 $(2.2 \text{ lb}_{\text{prod}}/\text{kg}_{\text{prod}}) = 8.74 \text{ lb}_{\text{prod}}/\text{day}$

$= (8.74 \text{ lb}_{\text{prod}}/\text{day}) / (6.0 \text{ lb}_{\text{prod}}/\text{gal}) = 1.5 \text{ gal}_{\text{prod}}/\text{day}$

FBR = $1.5 \text{ gal}_{\text{prod}}/\text{day} = 550 \text{ gal}_{\text{prod}}/\text{year}$

FBR = $(5.3 \text{ mg}_{\text{prod}}/\text{kg}_{\text{soil}}/\text{day}) (1,370,000 \text{ kg}_{\text{soil}})(\text{kg}_{\text{prod}}/1 \times 10^6 \text{ mg}_{\text{prod}})$
 $(2.2 \text{ lb}_{\text{prod}}/\text{kg}_{\text{prod}}) = 15.97 \text{ lb}_{\text{prod}}/\text{day}$

$= (15.97 \text{ lb}_{\text{prod}}/\text{day}) / (6.0 \text{ lb}_{\text{prod}}/\text{gal}) = 2.66 \text{ gal}_{\text{prod}}/\text{day}$

FBR = $2.66 \text{ gal}_{\text{prod}}/\text{day} = 972 \text{ gal}_{\text{prod}}/\text{year}$

September 1992 - K_b range = 5.36 to 25.86 mg/kg/day

$$\text{FBR} = \frac{(5.36 \text{ mg}_{\text{prod}}/\text{kg}_{\text{soil}}/\text{day}) (1,370,000 \text{ kg}_{\text{soil}})(\text{kg}_{\text{prod}}/1 \times 10^6 \text{ mg}_{\text{prod}})}{(2.2 \text{ lb}_{\text{prod}}/\text{kg}_{\text{prod}})} = 16.16 \text{ lb}_{\text{prod}}/\text{day}$$

$$= (16.16 \text{ lb}_{\text{prod}}/\text{day}) / (6.0 \text{ lb}_{\text{prod}}/\text{gal}) = 2.69 \text{ gal}_{\text{prod}}/\text{day}$$

$$\text{FBR} = 2.69 \text{ gal}_{\text{prod}}/\text{day} = 982 \text{ gal}_{\text{prod}}/\text{year}$$

$$\text{FBR} = \frac{(25.86 \text{ mg}_{\text{prod}}/\text{kg}_{\text{soil}}/\text{day}) (1,370,000 \text{ kg}_{\text{soil}})(\text{kg}_{\text{prod}}/1 \times 10^6 \text{ mg}_{\text{prod}})}{(2.2 \text{ lb}_{\text{prod}}/\text{kg}_{\text{prod}})} = 77 \text{ lb}_{\text{prod}}/\text{day}$$

$$= (77 \text{ lb}_{\text{prod}}/\text{day}) / (6.0 \text{ lb}_{\text{prod}}/\text{gal}) = 12 \text{ gal}_{\text{prod}}/\text{day}$$

$$\text{FBR} = 12 \text{ gal}_{\text{prod}}/\text{day} = 4,380 \text{ gal}_{\text{prod}}/\text{year}$$

May 1993 - K_b range = 1.9 to 6.3 mg/kg/day

$$\text{FBR} = \frac{(1.9 \text{ mg}_{\text{prod}}/\text{kg}_{\text{soil}}/\text{day}) (1,370,000 \text{ kg}_{\text{soil}})(\text{kg}_{\text{prod}}/1 \times 10^6 \text{ mg}_{\text{prod}})}{(2.2 \text{ lb}_{\text{prod}}/\text{kg}_{\text{prod}})} = 5.73 \text{ lb}_{\text{prod}}/\text{day}$$

$$= (5.73 \text{ lb}_{\text{prod}}/\text{day}) / (6.0 \text{ lb}_{\text{prod}}/\text{gal}) = 0.95 \text{ gal}_{\text{prod}}/\text{day}$$

$$\text{FBR} = 0.95 \text{ gal}_{\text{prod}}/\text{day} = 347 \text{ gal}_{\text{prod}}/\text{year}$$

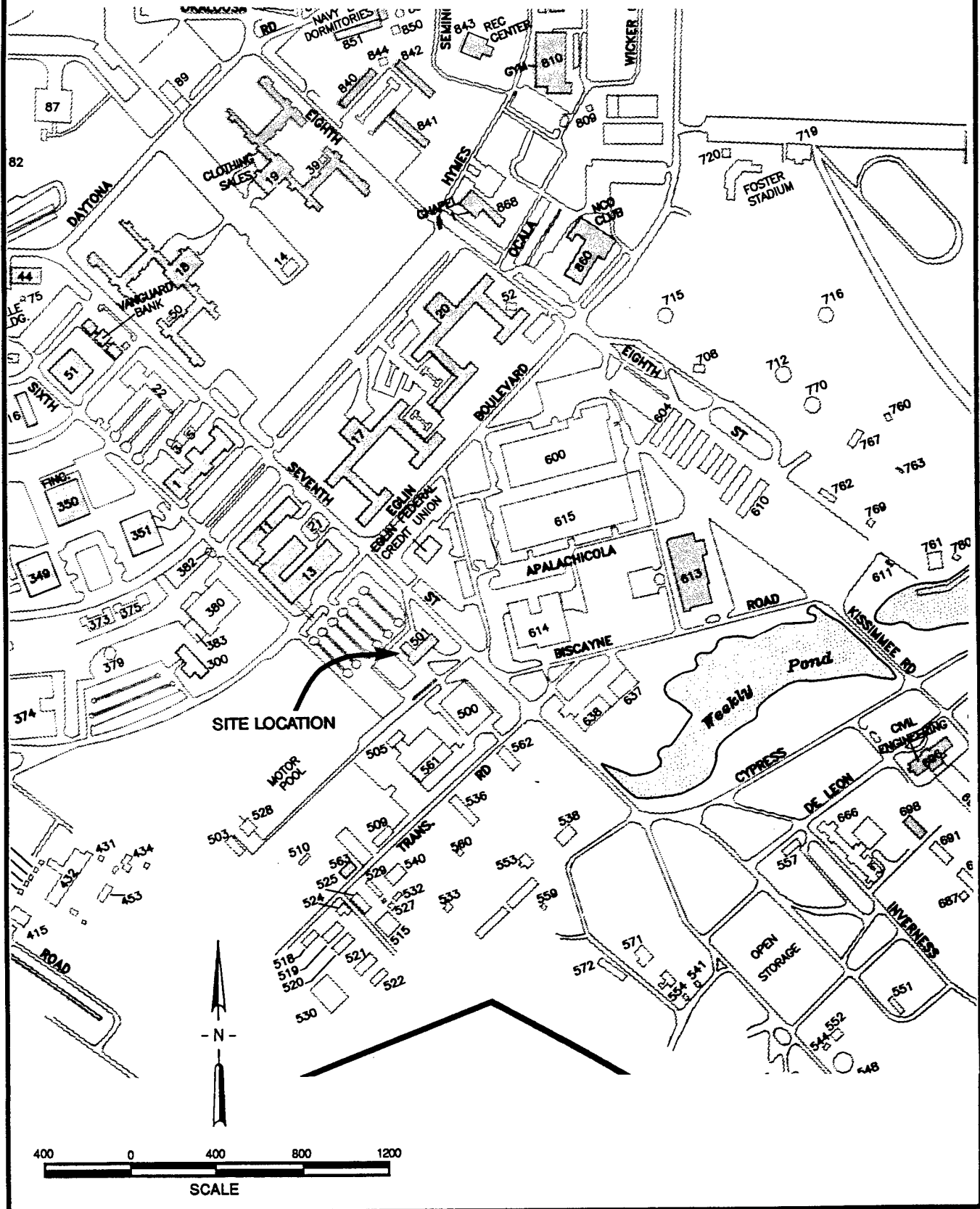
$$\text{FBR} = \frac{(6.3 \text{ mg}_{\text{prod}}/\text{kg}_{\text{soil}}/\text{day}) (1,370,000 \text{ kg}_{\text{soil}})(\text{kg}_{\text{prod}}/1 \times 10^6 \text{ mg}_{\text{prod}})}{(2.2 \text{ lb}_{\text{prod}}/\text{kg}_{\text{prod}})} = 18.99 \text{ lb}_{\text{prod}}/\text{day}$$

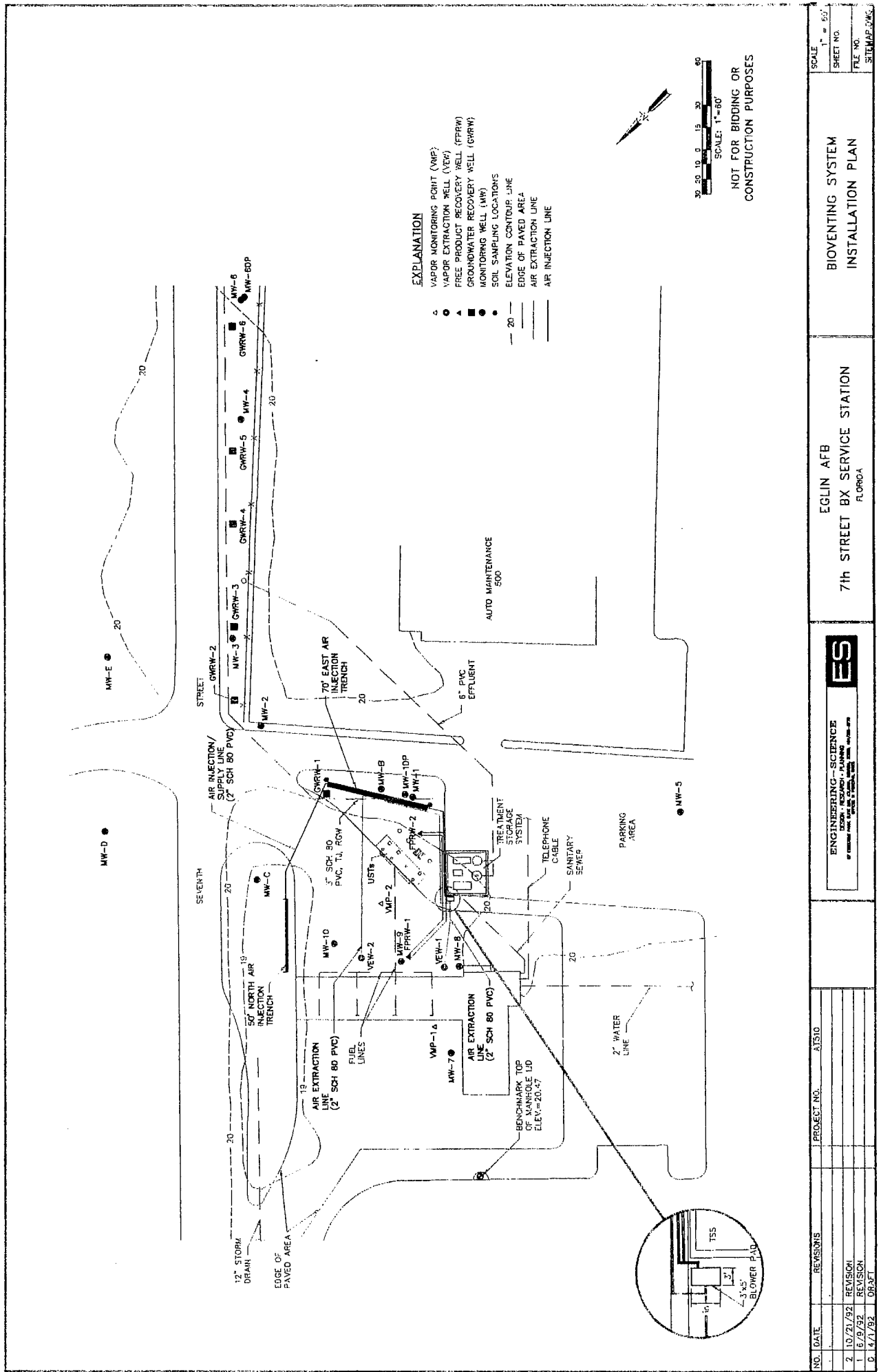
$$= (18.99 \text{ lb}_{\text{prod}}/\text{day}) / (6.0 \text{ lb}_{\text{prod}}/\text{gal}) = 3.16 \text{ gal}_{\text{prod}}/\text{day}$$

$$\text{FBR} = 3.16 \text{ gal}_{\text{prod}}/\text{day} = 1,153 \text{ gal}_{\text{prod}}/\text{year}$$

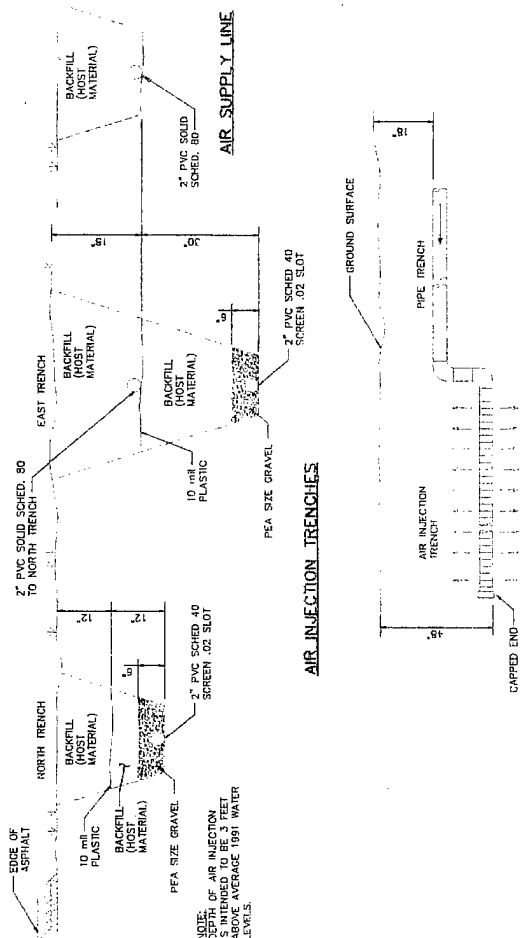
Figure 1

EGLIN AFB LOCATION OF 7th STREET BX SERVICE STATION



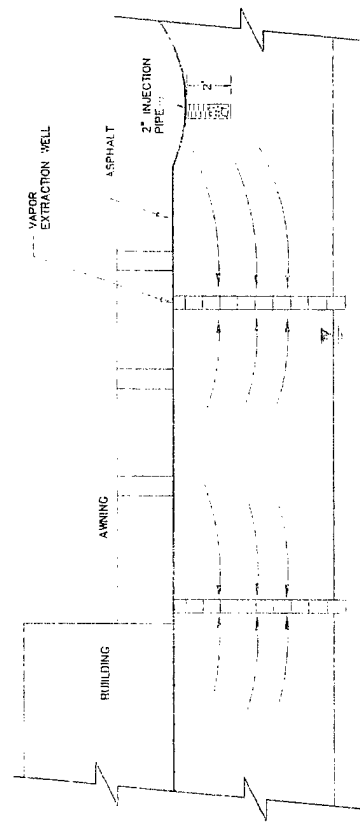


FLOW SCHEMATIC



TYPICAL SECTION

TYPICAL SECTION OF AIR INJECTION TRENCHES AND PIPE TRENCH



CONCEPTUAL CROSS-SECTION DESIGN FOR IN-SITU RECIRCULATION

NOTE:
NOT FOR BIDDING OR
CONSTRUCTION PURPOSES.

[illegible]

Figure 4

RESPIRATION TEST RESULTS AT VMP-IS
7TH STREET BX SERVICE STATION
EGLIN AFB

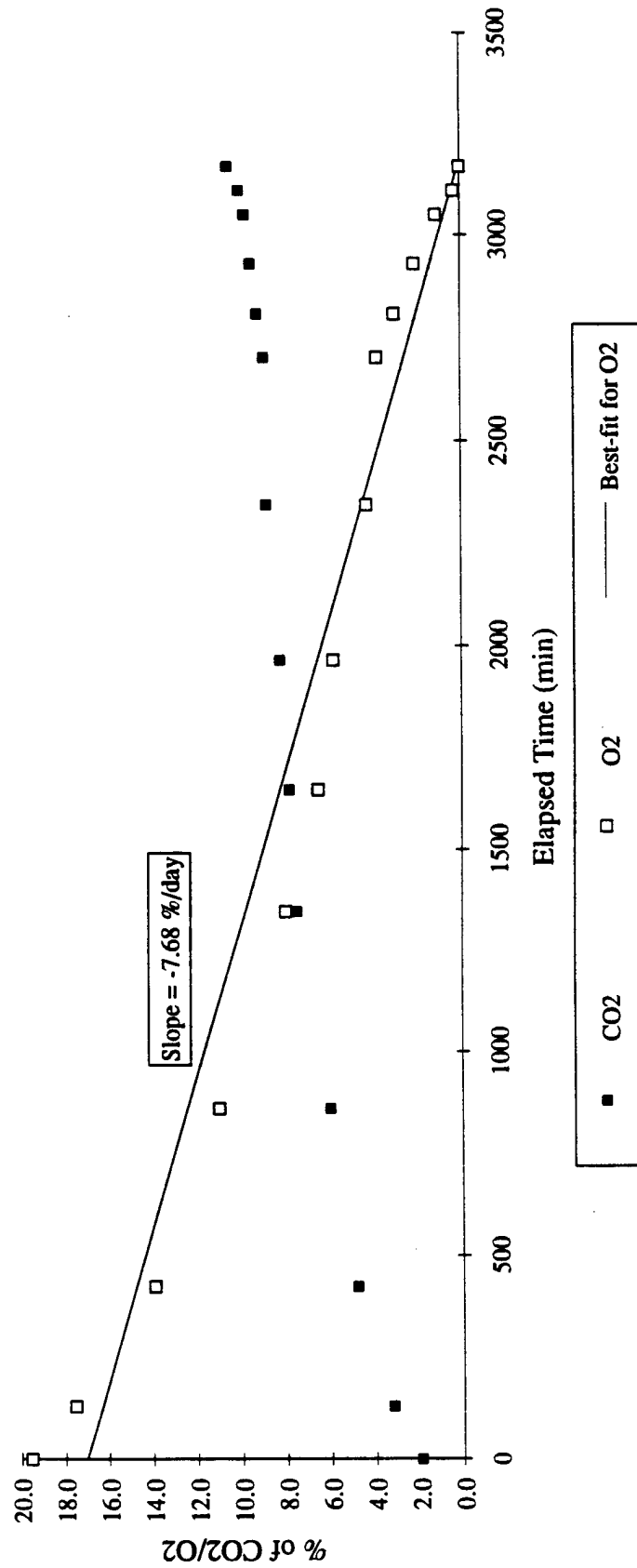
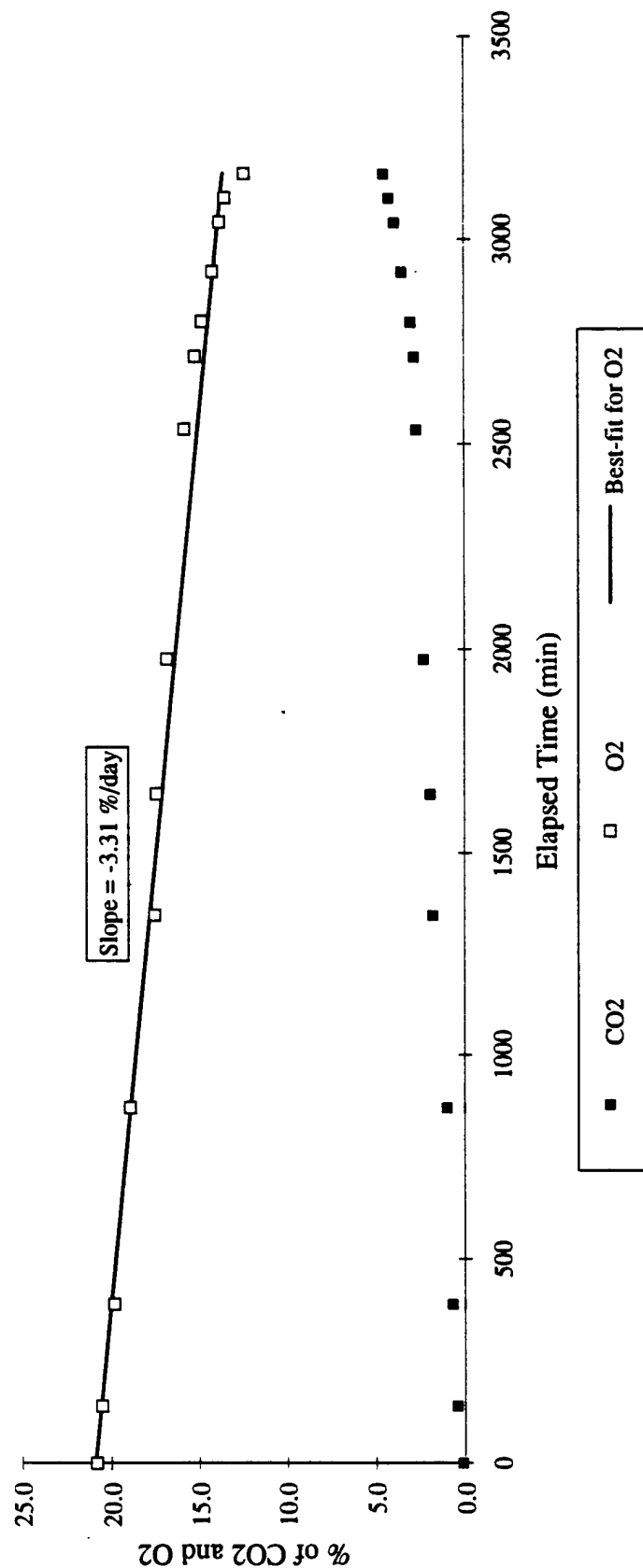


Figure 5

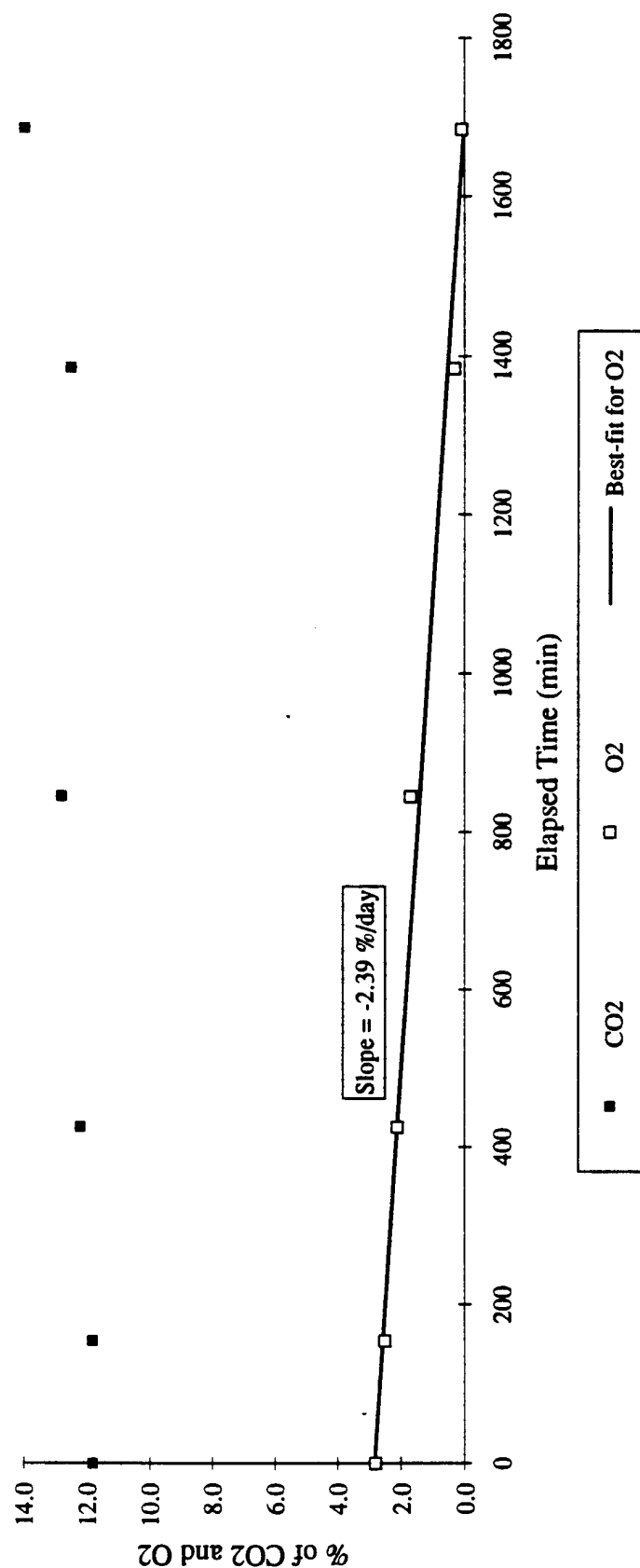
RESPIRATION TEST RESULTS AT VMP-1D
7TH STREET BX SERVICE STATION
EGLIN AFB



H:\AT510936J88T-2.XLS Chart 3

Figure 6

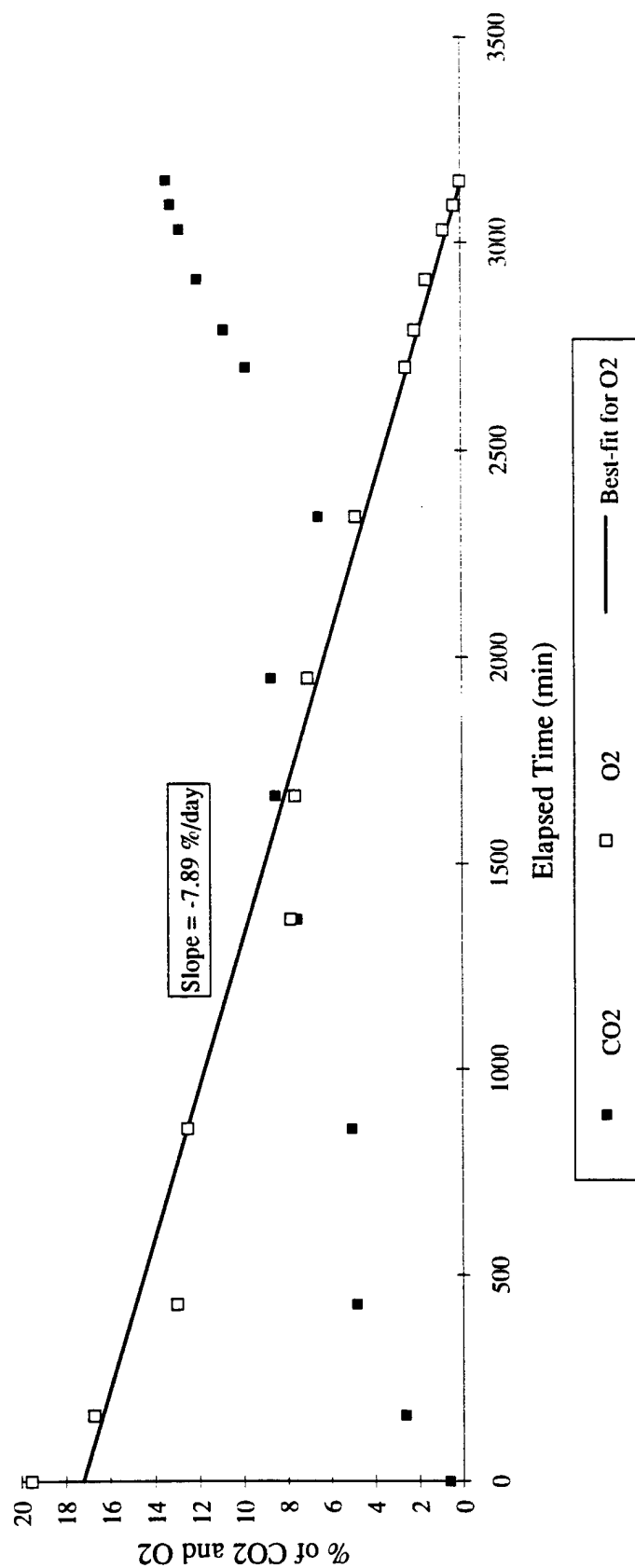
RESPIRATION TEST RESULTS AT VMP-2S
7TH STREET BX SERVICE STATION
EGLIN AFB



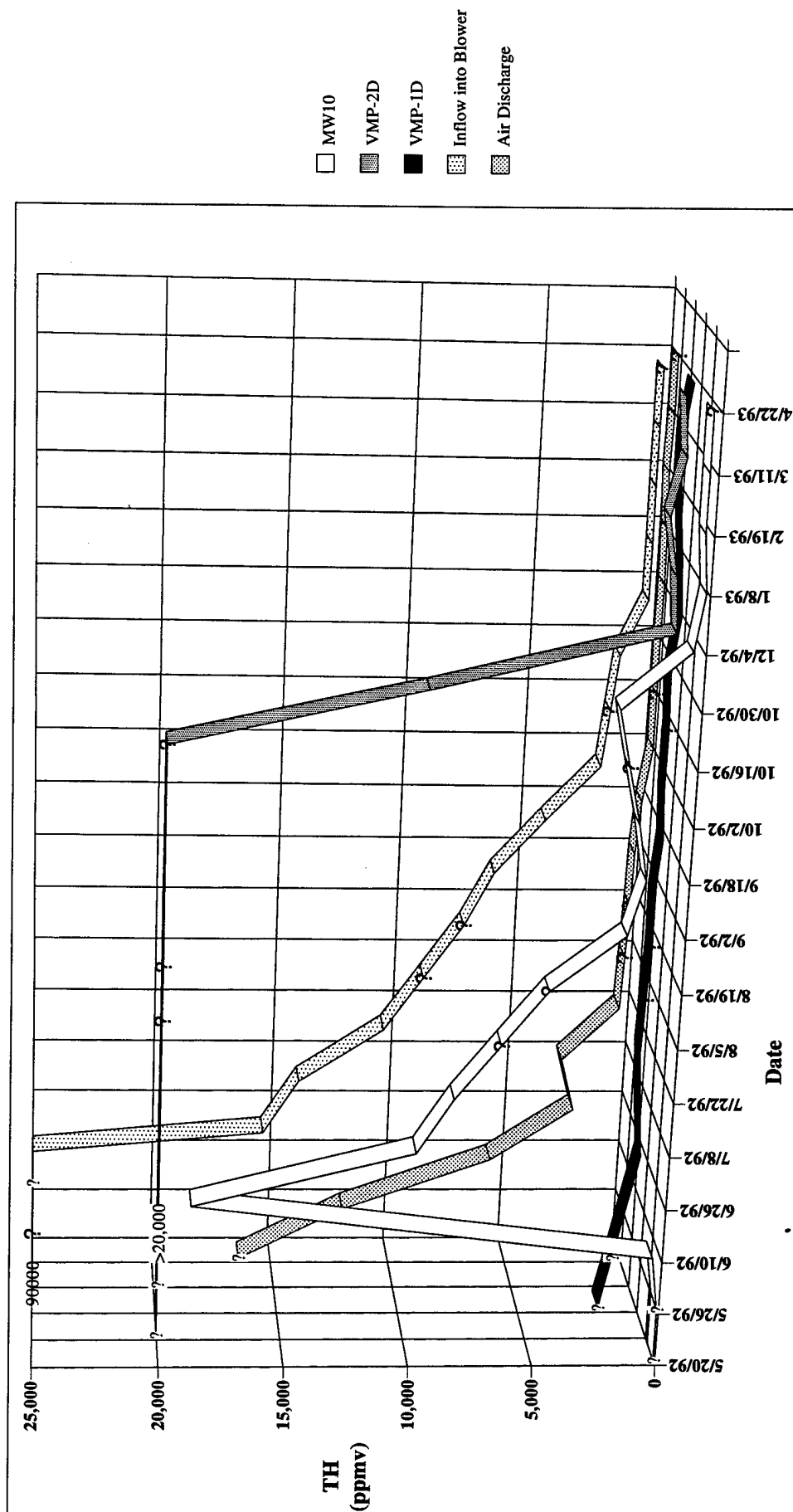
H:\AT510936J88T-2.XLS Chart 4

Figure 7

RESPIRATION TEST RESULTS AT VMP-2D
7TH STREET BX SERVICE STATION
EGLIN AFB



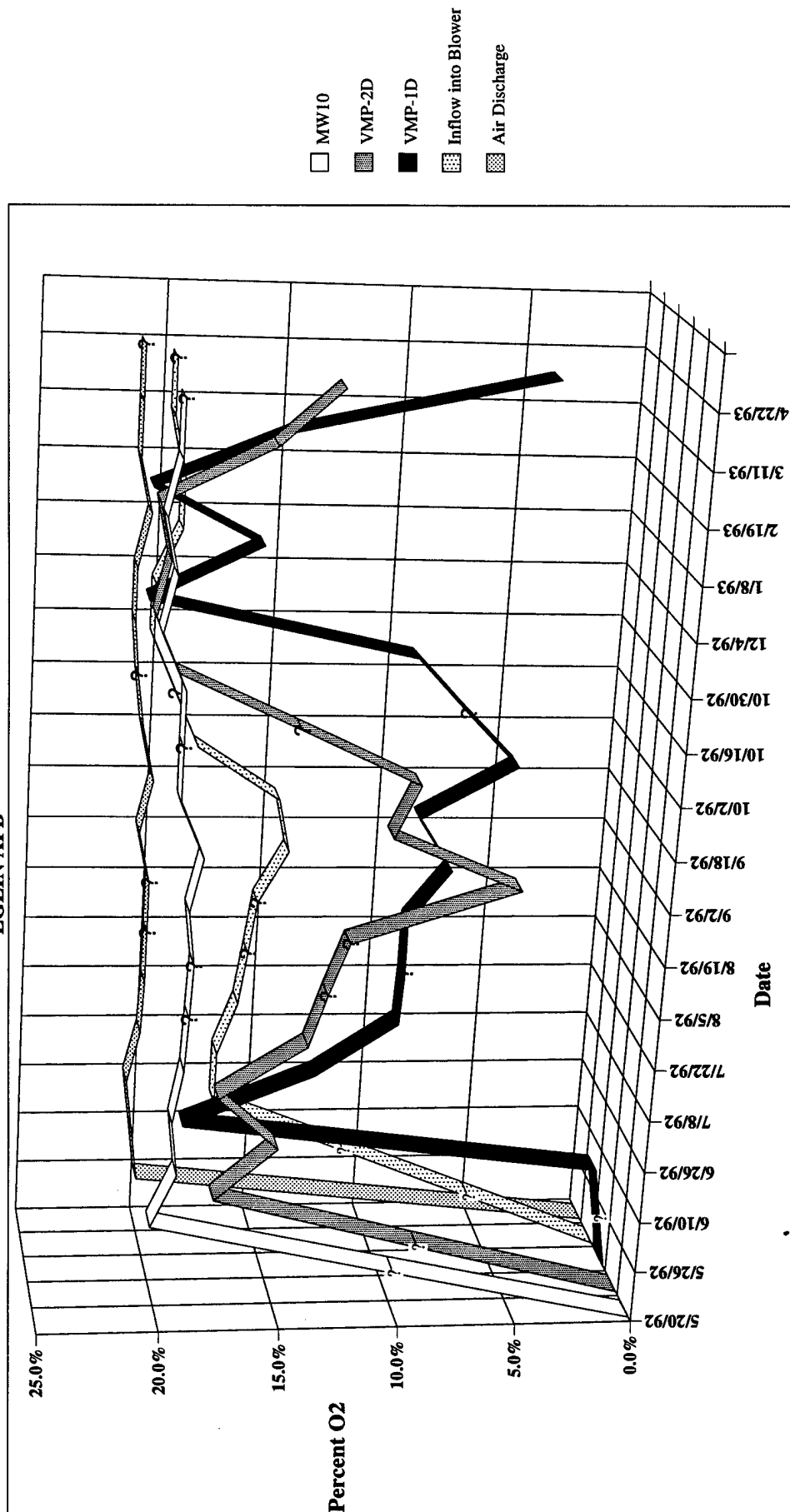
TOTAL HYDROCARBON LEVELS DURING BIOVENTING AT 7TH STREET BX SERVICE STATION (5/20/92 - 4/22/93)



Note: "?" indicates no data was recorded on this date; slopes are assumed to be linear.

Figure 8

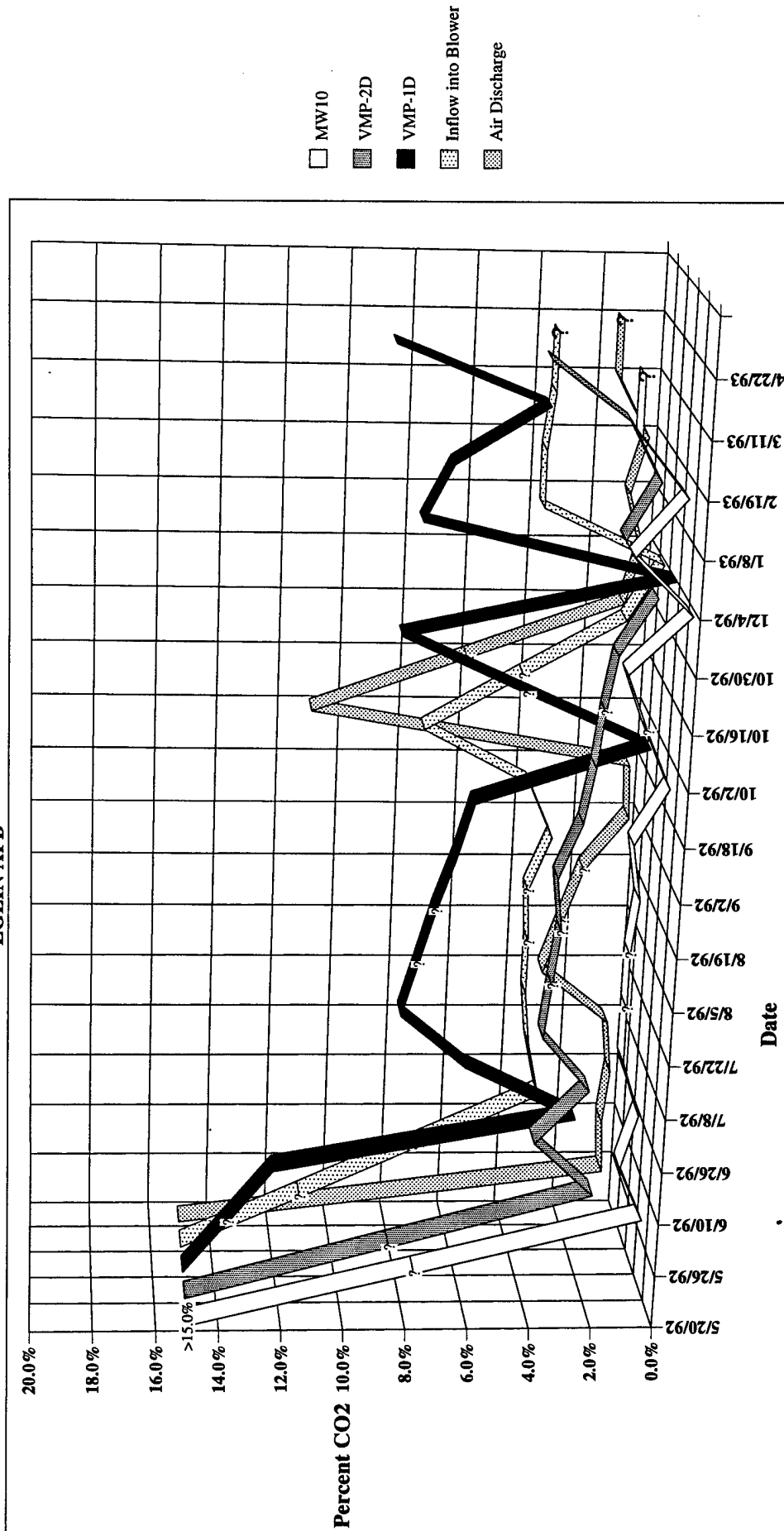
OXYGEN LEVELS DURING BIOVENTING AT 7TH STREET BX SERVICE STATION EGLIN AFB



Note: "?" indicates no data was recorded on this date; slopes are assumed to be linear.

Figure 10

**CARBON DIOXIDE LEVELS DURING BIOVENTING
AT 7TH STREET BX SERVICE STATION (5/20/92 - 4/22/93)
EGLIN AFB**



Note: "?" indicates no data was recorded on this date; slopes are assumed to be linear.

TABLE 1
MEASUREMENTS OF OTHER PHYSICAL PARAMETERS
BIOVENTING SYSTEM AT THE 7TH STREET BX SERVICE STATION
EGLIN AFB, FLORIDA

BLOWER SUCTION				BLOWER EXHAUST	
Date	Temp (Deg. F)	Vacuum Air Filter (ins. of H ₂ O)	Filter Gauge Reading (ins. of H ₂ O)	Temp (Deg. F)	Pressure (ins. of H ₂ O)
08/06/92 *					
09/02/92	100	4	12	110	16
10/15/92	92	2	12	93	20
10/30/92	78	4	12	100	20
12/03/92	60	4	12	83	22
01/08/93	60	4	12	78	14
02/12/93	60	4	12	82	19
03/11/93	69	4	14	89	18
03/25/93	72	4	12	98	17
04/07/93	64	4	12	75	18
04/22/93	54	4	12	71	18
05/06/93	100	4	16	90	16
05/20/93	70	4	12	100	17
05/26/93	78	5	14	93	18
06/03/93	100	30	33	135	8

* New (1 hp) Blower was installed

Note: Air Dilution Value was 50% open during period 8/6/92 through 5/26/93.

TABLE 2
BIOVENTING IN-SITU RESPIRATION TEST RESULTS (MAY 1993 TEST)
7TH STREET BX SERVICE STATION
EGLIN AFB

VMP-1S				VMP-1D				VMP-2S				VMP-2D			
Elapsed Time (min)	CO2 (%)	O2 (%)	Total Hydrocarbons (ppm)	Elapsed Time (min)	CO2 (%)	O2 (%)	Total Hydrocarbons (ppm)	Elapsed Time (min)	CO2 (%)	O2 (%)	Total Hydrocarbons (ppm)	Elapsed Time (min)	CO2 (%)	O2 (%)	Total Hydrocarbons (ppm)
0	1.9	19.5	280	0	0.1	20.8	160	0	11.8	2.8	7500	0	0.6	19.5	9000
130	3.2	17.5	400	140	0.4	20.5	100	155	11.8	2.5	9000	160	2.6	16.7	5000
425	4.8	13.9	340	390	0.7	19.8	260	425	12.2	2.1	8200	430	4.8	13.0	8000
860	6.0	11.0	660	870	1.0	18.9	580	845	12.8	1.7	6800	855	5.0	12.5	8200
1348	7.5	8.0	750	1345	1.8	17.5	670	1385	12.5	0.3	8500	1365	7.5	7.8	9500
1645	7.8	6.5	300	1645	1.9	17.4	400	1685	14.0	0.1	11000	1665	8.5	7.6	8500
1965	8.2	5.8	150	1975	2.3	16.8	200					1950	8.7	7.0	12000
2345	8.8	4.3	100	2535	2.7	15.8	150					2340	6.5	4.8	8500
2705	8.9	3.8	150	2715	2.8	15.2	160					2700	9.8	2.5	12500
2810	9.2	3.0	150	2800	3.0	14.8	100					2790	10.8	2.1	14000
2930	9.5	2.1	200	2920	3.5	14.2	150					2910	12.0	1.6	14500
3050	9.75	1.1	250	3040	3.9	13.8	300					3030	12.8	0.8	13000
3110	10	0.3	380	3100	4.2	13.5	250					3090	13.2	0.3	14000
3170	10.5	0	200	3160	4.5	12.4	200					3150	13.4	0	13500

TABLE 3
SUMMARY OF SOIL SAMPLING RESULTS OVER ONE YEAR OF BIOVENTING
7TH STREET BX SERVICE STATION
EGLIN AFB

Parameter	Units	VIEW1				VIEW2				EAST TRENCH B1				EAST TRENCH B2				VAPOR MONITORING POINTS			
		May -92		May -93		May -92		May -93		May -92		May -93		May -92		May -93		May -92		May -93	
		SS1	SS2	SS1	SS2	SS1	SS2	SS1	SS2	SB1	SB2	SB1	SB2	VMP1	VMP2	VMP1	VMP2	VMP1	VMP2	VMP1	VMP2
Benzene	ug/Kg	NA	ND	ND	ND	NA	1190 J	NA	5500 U	5400 U	NA	NA	ND	ND	1.0 U	26,500	1.5	5400 U			
Toluene	ug/Kg	NA	4,760	8,900	1,100	NA	7,620	NA	1,200	22,000	NA	NA	ND	ND	1.0 U	152,000	5.4 U	73,000			
Ethylbenzene	ug/Kg	NA	23,000	17,000	5,500	NA	6,430	NA	5500 U	8,900	NA	NA	ND	ND	1.0 U	55,300	4.6	38,000			
Xylenes	ug/Kg	NA	56,700	92,000	18,000	NA	32,100	NA	130,000	150,000	NA	NA	ND	ND	1.0 U	274,000	7.6	340,000			
TPH/TRPH	mg/Kg	830	150	53	31	1,000	130	180	55	640	ND	12B	13B	ND	1,200	15.0	190.0				

NOTE: May - 92 Data is for pre-bioventing conditions at the site. May - 93 Data is for site subsurface conditions after one year of bioventing.

NA Not Analyzed

ND - Not Detected

J - Estimated value

TRPH analysis was performed in May 1993.

TPH analysis was performed in May 1992.

U - Not Detected at the detection limit shown.

**APPENDIX A
BORING LOGS**

ENGINEERING - SCIENCE

SOIL BORING LOG AND WELL CONSTRUCTION RECORD

Client <u>Eglin AFB</u> Site <u>7th Street</u> Boring I.D. <u>VMP-1</u> Geologist/Engineer <u>Staas</u> Drilling Method <u>HSA</u> Sampling Method <u>Split Spoon</u> Date Started <u>5/13/92</u> Date Completed <u>5/13/92</u> Driller <u>Griner Drilling Co.</u> Borehole Diameter (in) <u>6 5/8</u> Depth Drilled (ft) <u>6</u> Ground Elevation (ft) _____ Depth to Water (ft) <u>NA</u> Date Measured <u>NA</u>	Page 1 of 1 Project I.D. <u>AT510</u> Well I.D. <u>VMP-1</u> Date Installed <u>5/13/92</u> Date Grouted <u>5/13/92</u> Casing Material <u>.25" Polyethylene</u> Screen Material <u>1" PVC, 0.010 slot</u> Casing Interval (ft) <u>0-2/0-3.25</u> Screened Interval (ft) <u>6"</u> Sump Installed? <u>No</u> Well Depth (ft) <u>5.17</u> TOC Elevation (ft) _____ Water Level (ft) _____ Date Measured _____
---	---

DEPTH (feet)	SAMPLE	BLOWS/6 IN	% REC.	HMU/OVA (ppm)	LITHOLOGIC DESCRIPTION	SOIL CLASS	GRAPHIC LOG	WELL DIAGRAM
0					ASPHALT.	SW		Steel Well Box
12.11, 11.13				25	SAND, light tan to black, medium-grained, slightly moist, uniform.			Valve with Hose Barb
2								Cement
3.4, 6.5				80	As above, light tan to black to red-brown, moderate petroleum odor.			Grout
4								Bentonite Seal
5.5, 5.9				10	As above, light tan to light brown, minor petroleum odor.			Screened Interval
6					Total Depth = 6'			Sand Pack
8								
10								

ENGINEERING - SCIENCE

SOIL BORING LOG AND WELL CONSTRUCTION RECORD

Client <u>Eglin AFB</u> Site <u>7th Street</u> Boring I.D. <u>VMP-2</u> Geologist/Engineer <u>Staas</u> Drilling Method <u>HSA</u> Sampling Method <u>Split Spoon</u> Date Started <u>5/13/92</u> Date Completed <u>5/13/92</u> Driller <u>Griner Drilling Co.</u> Borehole Diameter (in) <u>6 5/8</u> Depth Drilled (ft) <u>5</u> Ground Elevation (ft) _____ Depth to Water (ft) <u>NA</u> Date Measured <u>NA</u>	Page 1 of 1 Project I.D. <u>AT510</u> Well I.D. <u>VMP-2</u> Date Installed <u>5/13/92</u> Date Grouted <u>5/13/92</u> Casing Material <u>.25" Polyethylene</u> Screen Material <u>1" PVC 0.010 slot</u> Casing Interval (ft) <u>0-2.25/0-4.5</u> Screened Interval (ft) <u>6"</u> Sump Installed? <u>No</u> Well Depth (ft) <u>5</u> TOC Elevation (ft) _____ Water Level (ft) _____ Date Measured _____
---	---

DEPTH (feet)	SAMPLE	BLOWS/6 IN	% REC.	HNU/OVA (ppm)	LITHOLOGIC DESCRIPTION	SOIL CLASS	GRAPHIC LOG	WELL DIAGRAM
0					ASPHALT.	SW		
1	5.8, 10.12			85	SAND, light tan to black, medium-grained, fairly uniform, some shells, tree stump at 2.5'.			
2	1.1, -			90	Black petroliferous SAND, spoon dropped two feet.			
4	1.1, 3.3			90	Black SAND with WOOD timber, all wood in spoon.			
					Total Depth = 5'			
6								
8								
10								

ENGINEERING - SCIENCE

SOIL BORING LOG AND WELL CONSTRUCTION RECORD

Client <u>Eglin AFB</u> Site <u>7th Street</u> Boring I.D. <u>VEW-2</u> Geologist/Engineer <u>Staas</u> Drilling Method <u>HSA</u> Sampling Method <u>Split Spoon</u> Date Started <u>5/12/92</u> Date Completed <u>5/12/92</u> Driller <u>Griner Drilling Co.</u> Borehole Diameter (in) <u>6 5/8</u> Depth Drilled (ft) <u>8.58</u> Ground Elevation (ft) _____ Depth to Water (ft) <u>6.08</u> Date Measured <u>5/12/92</u>	Page 1 of 1 Project I.D. <u>AT510</u> Well I.D. <u>VEW-2</u> Date Installed <u>5/12/92</u> Date Grouted <u>5/12/92</u> Casing Material <u>PVC Sch. 40</u> Screen Material <u>same, 0.020 slot</u> Casing Interval (ft) <u>0-2</u> Screened Interval (ft) <u>2-7</u> Sump Installed? <u>No</u> Well Depth (ft) <u>7</u> TOC Elevation (ft) _____ Water Level (ft) _____ Date Measured _____
---	--

DEPTH (feet)	SAMPLE	BLOWS/6 IN	% REC.	HNu/OVA (ppm)	LITHOLOGIC DESCRIPTION	SOIL CLASS	GRAPHIC LOG	WELL DIAGRAM
0					ASPHALT.	SW		Vacuum Line to Blower Steel Well Box
7.6, 6.7				35	SAND, black to light tan, medium-grained, uniform, moderate petroleum odor.			Cement
2								Bentonite Seal
3.3, 3.3				55				
4								
1.1, 2.6				30	As above, strong petroleum odor, moist, light tan.			
6								
1.5, 9.11				45	As above, some black layers, strong petroleum odor, saturated at 6.17'.			
8								
10					Total Depth = 8.58'			

ENGINEERING - SCIENCE

SOIL BORING LOG AND WELL CONSTRUCTION RECORD

Client <u>Eglin AFB</u> Site <u>7th Street</u> Boring I.D. <u>VEW-1</u> Geologist/Engineer <u>Staas</u> Drilling Method <u>HSA</u> Sampling Method <u>Split Spoon</u> Date Started <u>5/12/92</u> Date Completed <u>5/12/92</u> Driller <u>Griner Drilling Co.</u> Borehole Diameter (in) <u>6 5/8</u> Depth Drilled (ft) <u>8</u> Ground Elevation (ft) _____ Depth to Water (ft) <u>6</u> Date Measured <u>5/12/92</u>	Page 1 of 1 Project I.D. <u>AT510</u> Well I.D. <u>VEW-1</u> Date Installed <u>5/12/92</u> Date Grouted <u>5/12/92</u> Casing Material <u>PVC Sch. 40</u> Screen Material <u>same, 0.020 slot</u> Casing Interval (ft) <u>0-3</u> Screened Interval (ft) <u>3-8</u> Sump Installed? <u>No</u> Well Depth (ft) <u>8</u> TOC Elevation (ft) _____ Water Level (ft) _____ Date Measured _____
---	--

DEPTH (feet)	SAMPLE	BLOWS/6 IN	% REC.	HNU/OVA (ppm)	LITHOLOGIC DESCRIPTION	SOIL CLASS	GRAPHIC LOG	WELL DIAGRAM
0					ASPHALT. SAND, black, petroliferous, moderate odor, medium-grained, uniform.	SW		Vacuum Line to Blower Steel Well Box Cement Bentonite Seal Sand Pack Screened Interval
11.11, 5.13		90						
2					As above, black to light tan, alternating layers, dark brown at 4'.			
5.7, 11.12		50						
4					As above, light tan, moderate to strong petroleum odor, moist at 5.8'.			
4.6, 6.13		40						
6					As above, light tan, strong petroleum odor, saturated at 6'.			
5.8, 10.11		70						
8					Total Depth = 8'			
10								

APPENDIX B
ANALYTICAL DATA

CASE NARRATIVE

SDG EGL08
SL PROJECT S343132

Total Petroleum Hydrocarbons Fraction

The following samples were analyzed using Method 418.1 of Methods for Chemical Analysis of Water and Wastes.

SL No.	Client ID	Matrix
S343132-1	AT510-7ST-ETS-SS93	Soil
S343132-2	AT510-7ST-ETN-SS93	Soil
S343132-3	AT510-7ST-VEW1-SS93(4-5')	Soil
S343132-4	AT510-7ST-VEW1-SS93(5-6')	Soil
S343132-5	AT510-7ST-VEW2-SS93(4-5')	Soil
S343132-6	AT510-7ST-VEW2-SS93(5-6')	Soil
S343132-7	AT510-7ST-VMP1-SS93	Soil
S343132-8	AT510-7ST-VMP2-SS93	Soil

Sample S343132-3 (AT510-7ST-VEW1-SS93(4-5')) was the designated matrix spike/matrix spike duplicate.

CASE NARRATIVE

SDG EGL08
SL PROJECT S343132

Volatile Gas Chromatography Fraction

The following samples were analyzed following 40 CFR Method 602.

SL No.	Client ID	Matrix
S343132-1	AT510-7ST-ETS-SS93	Soil
S343132-2	AT510-7ST-ETN-SS93	Soil
S343132-3	AT510-7ST-VEW1-SS93(4-5')	Soil
S343132-4	AT510-7ST-VEW1-SS93(5-6')	Soil
S343132-5	AT510-7ST-VEW2-SS93(4-5')	Soil
S343132-6	AT510-7ST-VEW2-SS93(5-6')	Soil
S343132-7	AT510-7ST-VMP1-SS93	Soil
S343132-8	AT510-7ST-VMP2-SS93	Soil

Sample S343132-3 (AT510-7ST-VEW1-SS93(4-5')) was the designated matrix spike.

Samples S343132-1, -2, and -7 were analyzed within a 24-hour clock that included the initial calibration; therefore, no continuing calibration data are required for these samples.

CASE NARRATIVE

SDG EGL09
SL PROJECT S343131

Volatile Gas Chromatography Fraction

The following samples were analyzed following 40 CFR Methods 601 and 602.

SL No.	Client ID	Matrix
S343131-1	AT510-A20-ASI-18-GWI	Liquid
S343131-2	AT570-A20-ASE-18-GWI	Liquid
S343131-3	AT510-A20-TB18	Liquid

CASE NARRATIVE

SDG EGL09
SL PROJECT S343131

Polynuclear Aromatics Fraction

The following samples were analyzed utilizing CFR-40 method 610.

SL No.	Client ID	Matrix
S343131-1	AT510-A20-ASI-18-GW1	Liquid
S343131-2	AT510-A20-ASE-18-GW1	Liquid

The samples were extracted June 06, 1993. Quality control for this SDG group consisted of a lab blank and lab control standard.

000001

SL SAVANNAH LABORATORIES

& ENVIRONMENTAL SERVICES, INC.

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 900 Lakeside Drive, Mobile, AL 36693
 6712 Benjamin Road, Suite 100, Tampa, FL 33634

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

P.O. NUMBER		PROJECT NUMBER		PROJECT NAME		MATRIX TYPE		REQUIRED ANALYSES		PAGE 1 OF 1	
1001 NUMBER		AT510-03106		ESLIN AFB AS/B10K							
CLIENT NAME		ENGINEERING SPECIAL		TELEPHONE/FAX NO.							
AFCEE		404-325-0770									
CLIENT ADDRESS		CITY, STATE, ZIP CODE									
57 EXECUTIVE PARK SOUTH, NE ATLANTA GA 30329											
SAMPLER(S) NAME(S)		CLIENT PROJECT MANAGER									
OLA AWOSIKA O.A. OLA AWOSIKA											
SAMPLING		SAMPLE IDENTIFICATION		NUMBER OF CONTAINERS SUBMITTED		REPORT DUE DATE		* SUBJECT TO RUSH FEES		STANDARD TAT	
DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME
05/28	0800	AT510-7ST-FIS-SS93		1	00						
05/28	0830	AT510-7ST-FIN-SS93		1	00						
05/28	1000	AT510-7ST-VEN1-SS93		1	00						
05/28	1015	AT510-7ST-VEN1-SS93		1	00						
05/28	1200	AT510-7ST-VEN2-SS93		1	00						
05/28	1230	AT510-7ST-VEN2-SS93		1	00						
05/28	1600	AT510-7ST-VMP1-SS93		1	00						
05/28	1630	AT510-7ST-VMP2-SS93		1	00						
		AT510-									
05/28	1400	AT510-A20-ASI-18-GW1		1	00						
05/28	1415	AT510-A20-ASE-18-GW1		1	00						
		AT510-A20-TB18		1	00						
RELINQUISHED BY: (SIGNATURE)		DATE		TIME		RECEIVED BY: (SIGNATURE)		DATE		TIME	
[Signature]		5/28/03		11:30		[Signature]		5/28/03		11:30	
RECEIVED BY: (SIGNATURE)		DATE		TIME		RELINQUISHED BY: (SIGNATURE)		DATE		TIME	
O.A. AWOSIKA		5/28/03		1200		O.A. AWOSIKA		5/28/03		1700	
FOR SAVANNAH LABORATORY USE ONLY											
RECEIVED FOR LABORATORY BY: (SIGNATURE)				CUSTODY SEAL NO.				S.L. LOG NO.			
[Signature]				YES ☒ NO ☐							
LABORATORY REMARKS											
601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000											

SL SAVANNAH LABORATORIES & ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S3-43132

Received: 29 MAY 93

Mr. Ola Awosika
Engineering Science, Inc.
57 Executive Park South, Suite 500
Atlanta, Georgia 30329

Project: AT510.06/Elglin AFB (SDG EGL08)
Sampled By: Client

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE/ TIME SAMPLED	SDG#
43132-1	AT510-7ST-ETS-SS93	05-28-93/0800	EGL08
43132-2	AT510-7ST-ETN-SS93	05-28-93/0830	EGL08
PARAMETER	43132-1	43132-2	
Petroleum Hydrocarbons			
Total Recoverable	12B	13B	
Petroleum Hydrocarbons (418.1), mg/kg dw			
Date Analyzed	06.16.93	06.16.93	
Initial Volume/Weight	25.00	25.00	
Final Volume (FV1)	100	100	
Batch ID	0616AA	0616AA	
Dilution factor	1.0	1.0	
Purgeable Aromatics (602/8020)			
Benzene, mg/kg dw	0.0053U	0.0052U	
Chlorobenzene, mg/kg dw	0.0053U	0.0052U	
1,2-Dichlorobenzene, mg/kg dw	0.0053U	0.0052U	
1,3-Dichlorobenzene, mg/kg dw	0.0053U	0.0052U	
1,4-Dichlorobenzene, mg/kg dw	0.0053U	0.0052U	
Ethylbenzene, mg/kg dw	0.0053U	0.0052U	
Toluene, mg/kg dw	0.0053U	0.0052U	
Xylenes, mg/kg dw	0.0053U	0.0052U	
Surrogate - a,a,a-Trifluorotoluene	0.156/0.150/104 %	0.177/0.150/118 %	
Dilution factor	1.0	1.0	
Date Analyzed	06.11.93	06.11.93	
Batch ID	0607A	0607A	
Level (High/Low)	LOW	LOW	

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Page 2

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE/ TIME SAMPLED	SDG#
43132-1	AT510-7ST-ETS-SS93	05-28-93/0800	EGL08
43132-2	AT510-7ST-ETN-SS93	05-28-93/0830	EGL08
PARAMETER	43132-1	43132-2	
Percent Solids, %	95	96	

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE/ TIME SAMPLED	SDG#
43132-3	AT510-7ST-VEW1-SS93 (4-5')	05-28-93/1000	EGL08
43132-4	AT510-7ST-VEW1-SS93 (5-6')	05-28-93/1015	EGL08
PARAMETER	43132-3	43132-4	
Petroleum Hydrocarbons			
Total Recoverable	53	31	
Petroleum Hydrocarbons (418.1), mg/kg dw			
Date Analyzed	06.16.93	06.16.93	
Initial Volume/Weight	25.00	25.00	
Final Volume (FV1)	100	100	
Batch ID	0616AA	0616AA	
Dilution factor	1.0	1.0	
Purgeable Aromatics (602/8020)			
Benzene, mg/kg dw	5.4U	1.1U	
Chlorobenzene, mg/kg dw	5.4U	1.1U	
1,2-Dichlorobenzene, mg/kg dw	5.4U	1.1U	
1,3-Dichlorobenzene, mg/kg dw	5.4U	1.1U	
1,4-Dichlorobenzene, mg/kg dw	5.4U	1.1U	
Ethylbenzene, mg/kg dw	17	5.5	
Toluene, mg/kg dw	8.9	1.1	
Xylenes, mg/kg dw	92	18	
Surrogate - a,a,a-Trifluorotoluene	0.135/0.150/90 %	0.139/0.150/93 %	
Dilution factor	5000	1000	
Date Analyzed	06.10.93	06.11.93	
Batch ID	0607B	0607B	
Level (High/Low)	HIGH	HIGH	

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REPORT OF RESULTS

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE/ TIME SAMPLED	SDG#
43132-3	AT510-7ST-VEW1-SS93 (4-5')	05-28-93/1000	EGL08
43132-4	AT510-7ST-VEW1-SS93 (5-6')	05-28-93/1015	EGL08
PARAMETER	43132-3	43132-4	
Percent Solids, %	92	89	

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REPORT OF RESULTS

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE/ TIME SAMPLED	SDG#
43132-5	AT510-7ST-VEW2-SS93 (4-5')	05-28-93/1200	EGL08
43132-6	AT510-7ST-VEW2-SS93 (5-6')	05-28-93/1230	EGL08
PARAMETER	43132-5	43132-6	
Petroleum Hydrocarbons			
Total Recoverable	180		55
Petroleum Hydrocarbons (418.1), mg/kg dw			
Date Analyzed	06.16.93		06.16.93
Initial Volume/Weight	25.00		25.00
Final Volume (FV1)	100		100
Batch ID	0616AA		0616AA
Dilution factor	1.0		1.0
Purgeable Aromatics (602/8020)			
Benzene, mg/kg dw	5.5U		5.4U
Chlorobenzene, mg/kg dw	5.5U		5.4U
1,2-Dichlorobenzene, mg/kg dw	5.5U		5.4U
1,3-Dichlorobenzene, mg/kg dw	5.5U		5.4U
1,4-Dichlorobenzene, mg/kg dw	5.5U		5.4U
Ethylbenzene, mg/kg dw	5.5U		8.9
Toluene, mg/kg dw	1.2		22
Xylenes, mg/kg dw	130		150
Surrogate - a,a,a-Trifluorotoluene	0.129/0.150/86 %		0.133/0.150/89 %
Dilution factor	5000		5000
Date Analyzed	06.10.93		06.10.93
Batch ID	0607B		0607B
Level (High/Low)	HIGH		HIGH

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REPORT OF RESULTS

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE/ TIME SAMPLED	SDG#
43132-5	AT510-7ST-VEW2-SS93 (4-5')	05-28-93/1200	EGL08
43132-6	AT510-7ST-VEW2-SS93 (5-6')	05-28-93/1230	EGL08
PARAMETER	43132-5	43132-6	
Percent Solids, %	91	93	

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REPORT OF RESULTS

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE/ TIME SAMPLED	SDG#
43132-7	AT510-7ST-VMP1-SS93	05-28-93/1600	EGL08
43132-8	AT510-7ST-VMP2-SS93	05-28-93/1630	EGL08
PARAMETER	43132-7	43132-8	
Petroleum Hydrocarbons			
Total Recoverable	15		190
Petroleum Hydrocarbons (418.1), mg/kg dw			
Date Analyzed	06.16.93		06.16.93
Initial Volume/Weight	25.00		25.00
Final Volume (FV1)	100		100
Batch ID	0616AA		0616AA
Dilution factor	1.0		1.0
Purgeable Aromatics (602/8020)			
Benzene, mg/kg dw	0.0015J		5.4U
Chlorobenzene, mg/kg dw	0.0054U		5.4U
1,2-Dichlorobenzene, mg/kg dw	0.0054U		5.4U
1,3-Dichlorobenzene, mg/kg dw	0.0054U		5.4U
1,4-Dichlorobenzene, mg/kg dw	0.0054U		5.4U
Ethylbenzene, mg/kg dw	0.0046		38
Toluene, mg/kg dw	0.0054U		73
Xylenes, mg/kg dw	0.0076		340
Surrogate - a,a,a-Trifluorotoluene	0.178/0.150/119 %	0.120/0.150/80 %	
Dilution factor	1.0		5000
Date Analyzed	06.11.93		06.10.93
Batch ID	0607A		0607B
Level (High/Low)	LOW		HIGH

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REPORT OF RESULTS

Page 8

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	DATE/ TIME SAMPLED	SDG#
43132-7	AT510-7ST-VMP1-SS93	05-28-93/1600	EGL08
43132-8	AT510-7ST-VMP2-SS93	05-28-93/1630	EGL08
PARAMETER	43132-7		43132-8
Percent Solids, %	92		93

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LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SDG#
43132-9	Detection Limits	EGL08
43132-10	Method Blank	EGL08
PARAMETER	43132-9	43132-10
Petroleum Hydrocarbons		
Total Recoverable	10	10U
Petroleum Hydrocarbons (418.1), mg/kg dw		
Date Analyzed	---	06.16.93
Initial Volume/Weight	---	25.00
Final Volume (FV1)	---	100
Batch ID	---	0616AA
Dilution factor	---	1.0
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	0.0050	0.0050
Chlorobenzene, mg/kg dw	0.0050	0.0050
1,2-Dichlorobenzene, mg/kg dw	0.0050	0.0050
1,3-Dichlorobenzene, mg/kg dw	0.0050	0.0050
1,4-Dichlorobenzene, mg/kg dw	0.0050	0.0050
Ethylbenzene, mg/kg dw	0.0050	0.0050
Toluene, mg/kg dw	0.0050	0.0050
Xylenes, mg/kg dw	0.0050	0.0050
Level (High/Low)	LOW	LOW
Surrogate - a,a,a-Trifluorotoluene	---	0.153/0.150/102 %
Dilution factor	---	1.0
Date Analyzed	---	06.11.93
Batch ID	---	0607A

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REPORT OF RESULTS

Page 10

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SDG#
43132-11	MS Result (AT510-7ST-VEW1-SS93 4-5')	EGL08
43132-12	MSD Result (AT510-7ST-VEW1-SS93 4-5')	EGL08
PARAMETER	43132-11	43132-12
Petroleum Hydrocarbons		
Total Recoverable	56	58
Petroleum Hydrocarbons (418.1), mg/kg dw		
Date Analyzed	06.16.93	06.16.93
Initial Volume/Weight	25.00	25.00
Final Volume (FV1)	100	100
Batch ID	0616AA	0616AA
Dilution factor	1.0	1.0
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	0.935	0.880
Chlorobenzene, mg/kg dw	0.793	0.750
Toluene, mg/kg dw	1.09	0.989
Surrogate - a,a,a-Trifluorotoluene	0.162/0.150/108 %	0.156/0.150/104 %
Dilution factor	5000	5000
Date Analyzed	06.11.93	06.11.93
Batch ID	0607B	0607B
Level (High/Low)	HIGH	HIGH

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REPORT OF RESULTS

Page 11

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SDG#
43132-13	MS Expected Value	EGL08
43132-14	MS % Recovery	EGL08
PARAMETER	43132-13	43132-14
Petroleum Hydrocarbons		
Total Recoverable	100	56 %
Petroleum Hydrocarbons (418.1), mg/kg dw		
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	1.09	86 %
Chlorobenzene, mg/kg dw	1.09	73 %
Toluene, mg/kg dw	1.09	100 %
Level (High/Low)	HIGH	---

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LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SDG#
43132-15	MSD % Recovery	EGL08
43132-16	MS % RPD	EGL08
PARAMETER	43132-15	43132-16
Petroleum Hydrocarbons		
Total Recoverable	58 %	3.5 %
Petroleum Hydrocarbons (418.1)		
Purgeable Aromatics (602/8020)		
Benzene	81 %	6.0 %
Chlorobenzene	69 %	5.6 %
Toluene	91 %	9.4 %

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REPORT OF RESULTS

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LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SDG#
43132-17	Blank Spike Result	EGL08
43132-18	Blank Spike Dup Result	EGL08
PARAMETER	43132-17	43132-18
Petroleum Hydrocarbons		
Total Recoverable	73.0	72.0
Petroleum Hydrocarbons (418.1), mg/kg dw		
Dilution factor	1.0	1.0
Date Analyzed	06.16.93	06.16.93
Initial Volume/Weight	25.00	25.00
Final Volume (FV1)	100	100
Batch ID	0616AA	0616AA
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	0.113	0.103
Chlorobenzene, mg/kg dw	0.104	0.096
Toluene, mg/kg dw	0.109	0.10
Surrogate - a,a,a-Trifluorotoluene	0.141/0.150/94 %	0.139/0.150/93 %
Dilution factor	1.0	1.0
Date Analyzed	06.11.93	06.11.93
Batch ID	0607B	0607B
Level (High/Low)	LOW	LOW

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REPORT OF RESULTS

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LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SDG#
43132-19	Blank Spike Expected Value	EGL08
43132-20	Blank Spike % Recovery	EGL08
PARAMETER	43132-19	43132-20
Petroleum Hydrocarbons		
Total Recoverable	95.6	76 %
Petroleum Hydrocarbons (418.1), mg/kg dw		
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	0.10	113 %
Chlorobenzene, mg/kg dw	0.10	104 %
Toluene, mg/kg dw	0.10	109 %
Level (High/Low)	LOW	---

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LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SDG#
43132-21	Blank Spike Dup % Recovery	EGL08
43132-22	Blank Spike % RPD	EGL08
PARAMETER	43132-21	43132-22
Petroleum Hydrocarbons		
Total Recoverable	75 %	1.3 %
Petroleum Hydrocarbons (418.1)		
Purgeable Aromatics (602/8020)		
Benzene	103 %	9.3 %
Chlorobenzene	96 %	8.0 %
Toluene	100 %	8.6 %

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LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SDG#
43132-23	Method Blank (High Level)	EGL08
PARAMETER	43132-23	
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	0.20U	
Chlorobenzene, mg/kg dw	0.20U	
1,2-Dichlorobenzene, mg/kg dw	0.20U	
1,3-Dichlorobenzene, mg/kg dw	0.20U	
1,4-Dichlorobenzene, mg/kg dw	0.20U	
Ethylbenzene, mg/kg dw	0.20U	
Toluene, mg/kg dw	0.20U	
Xylenes, mg/kg dw	0.20U	
Surrogate - a,a,a-Trifluorotoluene	0.138/0.150/92 %	
Dilution factor	200	
Date Analyzed	06.10.93	
Batch ID	0608B	
Level (High/Low)	HIGH	

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SDG#
43132-24	Blank Spike Result (High Level)	EGL08
43132-25	Blank Spike Dup Result (High Level)	EGL08
PARAMETER	43132-24	43132-25
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	1.08	1.22
Chlorobenzene, mg/kg dw	0.99	1.10
Toluene, mg/kg dw	1.07	1.19
Surrogate -	0.155/0.150/103 %	0.152/0.150/101 %
a,a,a-Trifluorotoluene		
Dilution factor	200	200
Date Analyzed	06.11.93	06.11.93
Batch ID	0607A	0607A
Level (High/Low)	HIGH	HIGH

SL SAVANNAH LABORATORIES & ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S3-43132

Received: 29 MAY 93

Mr. Ola Awosika
Engineering Science, Inc.
57 Executive Park South, Suite 500
Atlanta, Georgia 30329

Project: AT510.06/Elglin AFB (SDG EGL08)
Sampled By: Client

REPORT OF RESULTS

Page 18

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SDG#
43132-26	Blank Spike Expected Value (High Level)	EGL08
43132-27	Blank Spike % Recovery (High Level)	EGL08
PARAMETER	43132-26	43132-27
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	1.0	108 %
Chlorobenzene, mg/kg dw	1.0	99 %
Toluene, mg/kg dw	1.0	107 %
Level (High/Low)	HIGH	---

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REPORT OF RESULTS

Page 19

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SDG#
43132-28	Blank Spike Dup % Recovery (High Level)	EGL08
43132-29	Blank Spike % RPD (High Level)	EGL08
PARAMETER	43132-28	43132-29
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	122 %	12 %
Chlorobenzene, mg/kg dw	110 %	11 %
Toluene, mg/kg dw	119 %	11 %

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LOG NO: S3-43132

Received: 29 MAY 93

Mr. Ola Awosika
Engineering Science, Inc.
57 Executive Park South, Suite 500
Atlanta, Georgia 30329

Project: AT510.06/Elglin AFB (SDG EGL08)
Sampled By: Client

REPORT OF RESULTS

Page 20

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	SDG#
43132-30	Detection Limits (High Level)	EGL08
PARAMETER	43132-30	
Purgeable Aromatics (602/8020)		
Benzene, mg/kg dw	0.20U	
Chlorobenzene, mg/kg dw	0.20U	
1,2-Dichlorobenzene, mg/kg dw	0.20U	
1,3-Dichlorobenzene, mg/kg dw	0.20U	
1,4-Dichlorobenzene, mg/kg dw	0.20U	
Ethylbenzene, mg/kg dw	0.20U	
Toluene, mg/kg dw	0.20U	
Xylenes, mg/kg dw	0.20U	
Level (High/Low)	HIGH	

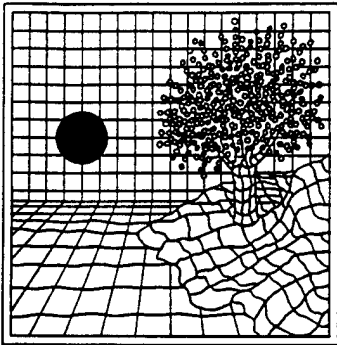
Methods: EPA SW-846

Surrogates are expressed in the following format:
Surrogate Result/Expected Value/% Recovery

Initial weights for soil extractions and
digestions are expressed in grams (g).

Final volumes for extractions and digestions are
expressed in milliliters (mL).


Linda A. Wolfe



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

June 12, 1992

Ola Awosika
ENGINEERING SCIENCE, INC.
57 Executive Park South, Suite 590
Atlanta, GA 30329

REC'D JUN 15 1992

Project: AT510/Eglin AFB
SWLO ID: 9637.01 - 9637.10

Dear Mr. Awosika:

Enclosed we are submitting the analytical results for your samples received in our laboratory on May 15, 1992 for the above-captioned project.

Please note that we revised your original request to include BTEX per our May 21st conversation.

If, in your review, you have any questions or require additional information, please call.

Sincerely,

Daryl Alstatt
Project Officer

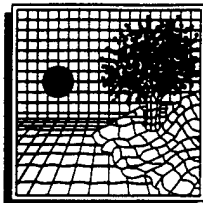
DA/lk

enclosures

CHAIN OF CUSTODY RECORD

[illegible]

Distribution Original Accompanies Shipment. Yellow Copy Returned With Report.
 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 1051 1052 1053 1054 1055 1056 1057 1058 1059 1060 1061 1062 1063 1064 1065 1066 1067 1068 1069 1070 1071 1072 1073 1074 1075 1076 1077 1078 1079 1080 1081 1082 1083 1084 1085 1086 1087 1088 1089 1090 1091 1092 1093 1094 1095 1096 1097 1098 1099 1100 1101 1102 1103 1104 1105 1106 1107 1108 1109 1110 1111 1112 1113 1114 1115 1116 1117 1118 1119 1120 1121 1122 1123 1124 1125 1126 1127 1128 1129 1130 1131 1132 1133 1134 1135 1136 1137 1138 1139 1140 1141 1142 1143 1144 1145 1146 1147 1148 1149 1150 1151 1152 1153 1154 1155 1156 1157 1158 1159 1160 1161 1162 1163 1164 1165 1166 1167 1168 1169 1170 1171 1172 1173 1174 1175 1176 1177 1178 1179 1180 1181 1182 1183 1184 1185 1186 1187 1188 1189 1190 1191 1192 1193 1194 1195 1196 1197 1198 1199 1200 1201 1202 1203 1204 1205 1206 1207 1208 1209 1210 1211 1212 1213 1214 1215 1216 1217 1218 1219 1220 1221 1222 1223 1224 1225 1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239 1240 1241 1242 1243 1244 1245 1246 1247 1248 1249 1250 1251 1252 1253 1254 1255 1256 1257 1258 1259 1260 1261 1262 1263 1264 1265 1266 1267 1268 1269 1270 1271 1272 1273 1274 1275 1276 1277 1278 1279 1280 1281 1282 1283 1284 1285 1286 1287 1288 1289 1290 1291 1292 1293 1294 1295 1296 1297 1298 1299 1300 1301 1302 1303 1304 1305 1306 1307 1308 1309 1310 1311 1312 1313 1314 1315 1316 1317 1318 1319 1320 1321 1322 1323 1324 1325 1326 1327 1328 1329 1330 1331 1332 1333 1334 1335 1336 1337 1338 1339 1340 1341 1342 1343 1344 1345 1346 1347 1348 1349 1350 1351 1352 1353 1354 1355 1356 1357 1358 1359 1360 1361 1362 1363 1364 1365 1366 1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1389 1390 1391 1392 1393 1394 1395 1396 1397 1398 1399 1400 1401 1402 1403 1404 1405 1406 1407 1408 1409 1410 1411 1412 1413 1414 1415 1416 1417 1418 1419 1420 1421 1422 1423 1424 1425 1426 1427 1428 1429 1430 1431 1432 1433 1434 1435 1436 1437 1438 1439 1440 1441 1442 1443 1444 1445 1446 1447 1448 1449 1450 1451 1452 1453 1454 1455 1456 1457 1458 1459 1460 1461 1462 1463 1464 1465 1466 1467 1468 1469 1470 1471 1472 1473 1474 1475 1476 1477 1478 1479 1480 1481 1482 1483 1484 1485 1486 1487 1488 1489 1490 1491 1492 1493 1494 1495 1496 1497 1498 1499 1500 1501 1502 1503 1504 1505 1506 1507 1508 1509 1510 1511 1512 1513 1514 1515 1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535 1536 1537 1538 1539 1540 1541 1542 1543 1544 1545 1546 1547 1548 1549 1550 1551 1552 1553 1554 1555 1556 1557 1558 1559 1560 1561 1562 1563 1564 1565 1566 1567 1568 1569 1570 1571 1572 1573 1574 1575 1576 1577 1578 1579 1580 1581 1582 1583 1584 1585 1586 1587 1588 1589 1590 1591 1592 1593 1594 1595 1596 1597 1598 1599 1600 1601 1602 1603 1604 1605 1606 1607 1608 1609 1610 1611 1612 1613 1614 1615 1616 1617 1618 1619 1620 1621 1622 1623 1624 1625 1626 1627 1628 1629 1630 1631 1632 1633 1634 1635 1636 1637 1638 1639 1640 1641 1642 1643 1644 1645 1646 1647 1648 1649 1650 1651 1652 1653 1654 1655 1656 1657 1658 1659 1660 1661 1662 1663 1664 1665 1666 1667 1668 1669 1670 1671 1672 1673 1674 1675 1676 1677 1678 1679 1680 1681 1682 1683 1684 1685 1686 1687 1688 1689 1690 1691 1692 1693 1694 1695 1696 1697 1698 1699 1700 1701 1702 1703 1704 1705 1706 1707 1708 1709 1710 1711 1712 1713 1714 1715 1716 1717 1718 1719 1720 1721 1722 1723 1724 1725 1726 1727 1728 1729 1730 1731 1732 1733 1734 1735 1736 1737 1738 1739 1740 1741 1742 1743 1744 1745 1746 1747 1748 1749 1750 1751 1752 1753 1754 1755 1756 1757 1758 1759 1760 1761 1762 1763 1764 1765 1766 1767 1768 1769 1770 1771 1772 1773 1774 1775 1776 1777 1778 1779 1780 1781 1782 1783 1784 1785 1786 1787 1788 1789 1790 1791 1792 1793 1794 1795 1796 1797 1798 1799 1800 1801 1802 1803 1804 1805 1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821 1822 1823 1824 1825 1



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637TPH-S

DATE: 06-12-92

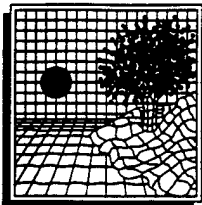
SAMPLE MATRIX: SOIL
SWLO #: 9637.01-9637.08, 9637.10
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-20-92
PROJECT: AT 510/EGLIN AFB

METHOD REFERENCE FOR TOTAL PETROLEUM HYDROCARBON: EPA 418.1

CLIENT ID	DATE SAMPLED	SWLO I.D	DET. LIMIT	UNIT	RESULT
EGHO-S7-VEW2-SS1	05-12-92	9637.01	10.0	mg/Kg	1000
EGHO-S7-VEW2-SS2	05-12-92	9637.02	10.0	mg/Kg	130
EGHO-S7-VEW2-SS3	05-12-92	9637.03	10.0	mg/Kg	34
EGHO-S7-VEW1-SS1	05-12-92	9637.04	10.0	mg/Kg	830
EGHO-S7-VEW1-SS2	05-12-92	9637.05	10.0	mg/Kg	150
EGHO-S7-SR1-SS1	05-12-92	9637.06	10.0	mg/Kg	640
EGHO-S7-SR2-SS1	05-12-92	9637.07	10.0	mg/Kg	ND
EGHO-S7-VMP2-SS1	05-13-92	9637.08	10.0	mg/Kg	1200
EGHO-S7-VMP1-SS1	05-13-92	9637.10	10.0	mg/Kg	ND

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
EPA = #EPA600/4-79-020, MARCH 1985
SM = STANDARD METHOD, 16TH EDITION

REC'D JUN 15 1992



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637TPH-W

DATE: 06-12-92

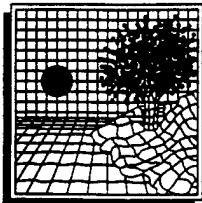
SAMPLE MATRIX: WATER
SWLO #: 9637.09
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-27-92
PROJECT: AT 510/EGLIN AFB

METHOD REFERENCE FOR TOTAL PETROLEUM HYDROCARBON: EPA 418.1

<u>CLIENT ID</u>	<u>DATE SAMPLED</u>	<u>SWLO I.D</u>	<u>DET. LIMIT</u>	<u>UNIT</u>	<u>RESULT</u>
EGHO-S7-RIN	05-13-92	9637.09	4.0	mg/L	ND

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
EPA = #EPA600/4-79-020, MARCH 1985
SM = STANDARD METHOD, 16TH EDITION

REC'D JUN 15 1992



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AMOSIKA

REPORT: 9637.02BX

DATE: 06-12-92

SAMPLE MATRIX: SOIL
SWLO #: 9637.02
METHOD REFERENCE: EPA 602
DATE SAMPLED : 05-12-92
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-21-92
PROJECT: AT 510
SAMPLE ID: EGHO-S7-VEW2-SS2

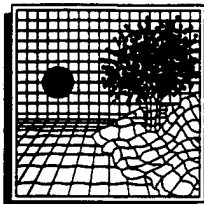
PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1250	ug/Kg	1190 J
TOLUENE	1250	ug/Kg	7620
ETHYLBENZENE	1250	ug/Kg	6430
XYLENES	1250	ug/Kg	32100

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 107%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
B = ANALYTE DETECTED IN BLANK AS WELL AS SAMPLE
J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS ON ORIGINAL RUN AND RERUN.
SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

REC'D JUN 15 1992



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637.02BX-CR

DATE: 06-12-92

SAMPLE MATRIX: SOIL
SWLO #: 9637.02 (CONFIRMATION RUN)
METHOD REFERENCE: EPA 602
DATE SAMPLED : 05-12-92
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-21-92
PROJECT: AT 510
SAMPLE ID: EGH0-S7-VEW2-S62

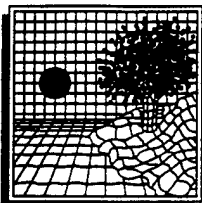
PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1250	ug/Kg	ND
TOLUENE	1250	ug/Kg	10400
ETHYLBENZENE	1250	ug/Kg	ND
XYLENES	1250	ug/Kg	33200

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 98%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
B = ANALYTE DETECTED IN BLANK AS WELL AS SAMPLE
J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
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SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

REC'D JUN 15 1992



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637.05BX

DATE: 06-12-92

SAMPLE MATRIX: SOIL
SWLO #: 9637.05
METHOD REFERENCE: EPA 602
DATE SAMPLED : 05-12-92
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-21-92
PROJECT: AT 510
SAMPLE ID: EGH0-S7-VEW1-S52

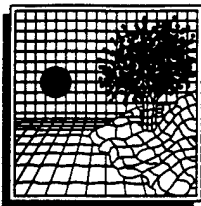
PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1250	ug/Kg	ND
TOLUENE	1250	ug/Kg	4760
ETHYLBENZENE	1250	ug/Kg	23000
XYLENES	1250	ug/Kg	56700

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 98%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
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J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS ON ORIGINAL RUN AND RERUN.
SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

REC'D JUN 15 1992



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637.05BX-CR

DATE: 06-12-92

SAMPLE MATRIX: SOIL
SWLD #: 9637.05 (CONFIRMATION RUN)
METHOD REFERENCE: EPA 602
DATE SAMPLED : 05-12-92
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-21-92
PROJECT: AT 510
SAMPLE ID: EGH0-S7-VEW1-SS2

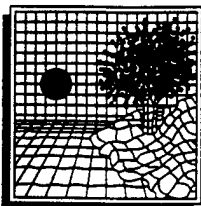
PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1250	ug/Kg	ND
TOLUENE	1250	ug/Kg	5510
ETHYLBENZENE	1250	ug/Kg	23200
XYLENES	1250	ug/Kg	60400

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 93%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
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J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS ON ORIGINAL RUN AND RERUN.
SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

REC'D JUN 16 1992



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637.08BX

DATE: 06-12-92

SAMPLE MATRIX: SOIL
SWLO #: 9637.08
METHOD REFERENCE: EPA 602
DATE SAMPLED : 05-13-92
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-21-92
PROJECT: AT 510
SAMPLE ID: ECHO-S7-VMP2-SS1

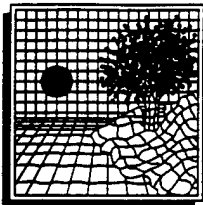
PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1250	ug/Kg	26500
TOLUENE	1250	ug/Kg	152000
ETHYLBENZENE	1250	ug/Kg	55300
XYLENES	1250	ug/Kg	274000

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 125%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
B = ANALYTE DETECTED IN BLANK AS WELL AS SAMPLE
J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS ON ORIGINAL RUN AND RERUN.
SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

REC'D JUN 15 1992



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637.08BX-CR

DATE: 06-12-92

SAMPLE MATRIX: SOIL
SWLO #: 9637.08 (CONFIRMATION RUN)
METHOD REFERENCE: EPA 602
DATE SAMPLED : 05-13-92
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-21-92
PROJECT: AT 510
SAMPLE ID: EGHO-S7-VMP2-SS1

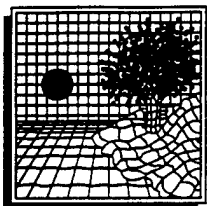
PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1250	ug/Kg	29300
TOLUENE	1250	ug/Kg	284000
ETHYLBENZENE	1250	ug/Kg	71600
XYLENES	1250	ug/Kg	462000

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 108%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
B = ANALYTE DETECTED IN BLANK AS WELL AS SAMPLE
J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS ON ORIGINAL RUN AND RERUN.
SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

REC'D JUN 15 1992



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637.10BX

DATE: 06-12-92

SAMPLE MATRIX: SOIL
SWLO #: 9637.10
METHOD REFERENCE: EPA 602
DATE SAMPLED : 05-13-92
DATE SUBMITTED: 05-15-92
DATE ANALYZED: 05-21-92
PROJECT: AT 510
SAMPLE ID: EGHO-S7-VMP1-SS1

PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1.0	ug/Kg	ND
TOLUENE	1.0	ug/Kg	ND
ETHYLBENZENE	1.0	ug/Kg	ND
XYLENES	1.0	ug/Kg	ND

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 74%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
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SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

REC'D JUN 15 1992

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

1700 W. Albany • Broken Arrow, Oklahoma 74012 • 918-251-2858 • FAX: 918-251-2599

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637a

DATE: 06-12-92

SAMPLE MATRIX: SOIL
SWLO #: METHOD BLANK
DATE ANALYZED : 05-20-92
METHOD REFERENCE: EPA 418.1
SAMPLE ID: SRLK05199201

RESULTS REPORTED IN mg/Kg OR Parts Per Million (PPM)

<u>PARAMETER</u>	<u>DET. LIMIT</u>	<u>RESULTS</u>
TPH	10.0	ND

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
B = ANALYTE DETECTED IN BLANK AS WELL AS SAMPLE
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS

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CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637b

DATE: 06-12-92

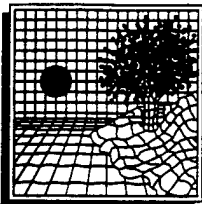
SAMPLE MATRIX: WATER
SWLO #: METHOD BLANK
DATE ANALYZED : 05-27-92
METHOD REFERENCE: EPA 418.1
SAMPLE ID: WRLK05279201

RESULTS REPORTED IN mg/L OR Parts Per Million (PPM)

<u>PARAMETER</u>	<u>DET. LIMIT</u>	<u>RESULTS</u>
TPH	0.5	ND

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
B = ANALYTE DETECTED IN BLANK AS WELL AS SAMPLE
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS

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CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 8819c

DATE: 06-12-92

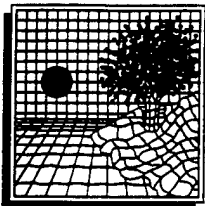
SAMPLE MATRIX: SOIL
DATE ANALYZED: 05-20-92
SWLO #: CONFIDENTIAL SAMPLE ID

TPH MATRIX SPIKE/MATRIX SPIKE DUPLICATE

	SPIKE CONC. (mg/Kg)	SAMPLE CONC. (mg/Kg)	MATRIX SPIKE CONC. (mg/Kg)	PERCENT RECOVERY
TPH	667	0	591	89.0%

	MSD CONC. (mg/Kg)*	MSD PERCENT RECOVERY	RECOVERY PERCENT DIFFERENCE
TPH	566	85%	4%

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CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637d

DATE: 06-12-92

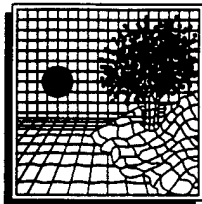
SAMPLE MATRIX: WATER
SWLO # WS05279201
PROJECT: AT510/EGLIN AFB

LABORATORY CONTROL SPIKE

	SPIKE CONC. (mg/L)	CONTROL SAMPLE CONC. (mg/L)*	MS CONC. (mg/L)*	MS PERCENT RECOVERY
TPH	20.0	0	17.1	85.5%

* = DILUTION FACTOR NOT APPLIED TO THESE CONCENTRATIONS

REC'D JUN 15 1992



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CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637e

DATE: 06-12-92

SAMPLE MATRIX: WATER
SWLO #: METHOD BLANK
METHOD REFERENCE: EPA 602
DATE ANALYZED: 05-21-92
SAMPLE ID: BLANK

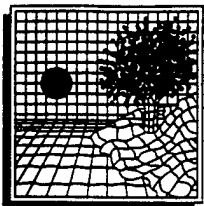
PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1.0	ug/L	ND
TOLUENE	1.0	ug/L	ND
ETHYLBENZENE	1.0	ug/L	ND
XYLENES	1.0	ug/L	ND

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 83%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
B = ANALYTE DETECTED IN BLANK AS WELL AS SAMPLE
J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS ON ORIGINAL RUN AND RERUN.
SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

REC'D JUN 15 1992



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1700 West Albany • Broken Arrow, Oklahoma 74012 • Office (918) 251-2858 • Fax (918) 251-2858

CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AMOSIKA

REPORT: 9637f

DATE: 06-12-92

SAMPLE MATRIX: WATER
SWLO #: METHOD BLANK (CONFIRMATION RUN)
METHOD REFERENCE: EPA 602
DATE ANALYZED: 05-21-92
SAMPLE ID: BLANK

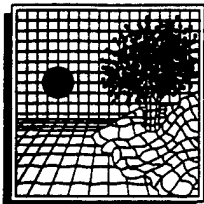
PARAMETER	DET. LIMIT	UNIT	RESULTS
<u>GAS CHROMATOGRAPHY</u>			
BENZENE	1.0	ug/L	ND
TOLUENE	1.0	ug/L	ND
ETHYLBENZENE	1.0	ug/L	ND
XYLENES	1.0	ug/L	ND

QA/QC SURROGATE RECOVERIES

4-BROMOFLUOROBENZENE (65-135%) 96%

ND = NOT DETECTED ABOVE QUANTITATION LIMIT
B = ANALYTE DETECTED IN BLANK AS WELL AS SAMPLE
J = ESTIMATED VALUE: CONCENTRATION BELOW LIMIT OF QUANTITATION
* = SURROGATE RECOVERY OUTSIDE OF QC LIMITS ON ORIGINAL RUN AND RERUN.
SW = TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION #SW846, THIRD EDITION, NOVEMBER 1986

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CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637g

DATE: 06-12-92

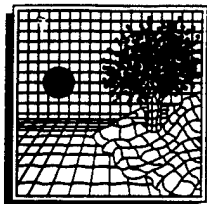
SAMPLE MATRIX: SOIL
DATE ANALYZED: 05-21-92
SWLO #: 9637.10
PROJECT: AT 510
SAMPLE ID: EGHO-S7-VMP1-SS1 (MS/MSD)

BTEX MATRIX SPIKE/MATRIX SPIKE DUPLICATE

	SPIKE CONC. (ug/Kg)	SAMPLE CONC. (ug/Kg)	MATRIX SPIKE CONC. (ug/Kg)	PERCENT RECOVERY
BENZENE	10.0	0	10.5	105.4%
TOLUENE	10.0	0	10.1	100.7%
ETHYLBENZENE	10.0	0	9.7	97.1%
TOTAL XYLENES	30.0	0	25.3	84.2%

	MATRIX SPIKE DUP NSD CONC. (ug/Kg)	PERCENT REC. (ug/Kg)	RECOVERY PERCENT DIFFERENCE
BENZENE	10.3	103.0%	2.30%
TOLUENE	9.9	99.4%	1.30%
ETHYLBENZENE	10.2	102.2%	5.12%
TOTAL XYLENES	27.3	91.0%	7.76%

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CLIENT: ENGINEERING SCIENCE, INC.
57 EXECUTIVE PARK SOUTH, SUITE 590
ATLANTA, GA 30329
ATTN: OLA AWOSIKA

REPORT: 9637h

DATE: 06-12-92

SAMPLE MATRIX: SOIL
DATE ANALYZED: 05-21-92
SWLO #: 9637.10 (CONFIRMATION RUN)
PROJECT: AT 510
SAMPLE ID: EGH0-S7-VMP1-SS1 (MS/MSD)

BTEX MATRIX SPIKE/MATRIX SPIKE DUPLICATE

	SPIKE CONC. (ug/Kg)	SAMPLE CONC. (ug/Kg)	MATRIX SPIKE CONC. (ug/Kg)	PERCENT RECOVERY
BENZENE	10.0	0.1	9.9	97.9%
TOLUENE	10.0	0.3	10.4	101.0%
ETHYLBENZENE	10.0	0.1	10.5	103.8%
TOTAL XYLENES	30.0	0.4	27.0	88.6%

	MATRIX SPIKE DUP NSD CONC. (ug/Kg)	PERCENT REC. (ug/Kg)	RECOVERY PERCENT DIFFERENCE
BENZENE	9.8	97.3%	0.61%
TOLUENE	10.4	100.7%	0.40%
ETHYLBENZENE	10.6	105.0%	1.15%
TOTAL XYLENES	27.1	88.9%	0.26%

REC'D JUN 15 1992

APPENDIX C
OPERATION AND MAINTENANCE REPORT

May 25, 1993

Mr. Jim Williams P.G., C.G.W.P.
Department of the Air Force
Center for Environmental Excellence
DERA Restoration Division (ESR)
8001 Inner Circle Drive Suite 2
Brooks AFB, Texas 78235-5328

Subject: F33615 - 90 - D - 4014, Order 04,
O&M Effort for the Bioventing System at the 7th Street BX Service Station
(May 1992 through 1st Week in May 1993), Eglin, AFB

Dear Mr. Williams:

A copy of the letter report for the monitoring effort for the Bioventing System at the 7th Street BX Service Station, over the referenced period are attached. This report includes a summary of operation and maintenance, and monitoring efforts performed for the subject period. The charts have been revised to reflect percentages as requested.

Copies of this report are being distributed as indicated below. If you have any questions please call me.

Sincerely,

ENGINEERING-SCIENCE, INC.



Ola A. Awosika, P.G.
Project Manager

OAA:bb
Attachment

cc/att: Lt. Col. Miller (AFCEE)
D. Downey, (ES)
J. Krishak (Eglin AFB) (2)

**O&M EFFORT FOR THE BIOVENTING SYSTEM AT THE 7TH STREET BX
SERVICE STATION (MAY 1992 THROUGH 1ST WEEK IN MAY 1993),
EGLIN, AFB**

OPERATION AND MAINTENANCE

Operation and maintenance (O&M) effort since installation of the bioventing system in May 1992 has included a check on each of the bioventing system components (i.e., blower, gauges, air filter, vapor extraction wells, and injection trenches) to evaluate operating status and to make adjustment where appropriate or necessary. The O&M effort also involved measurement of the following physical parameters:

- Temperature at both blower suction and exhaust;
- Vacuum at air filter;
- Head loss through filter; and
- Pressure at Blower exhaust

May-July, 1992

Over the period May 20 through July 22, 1992, no significant adjustment was made to the system other than increasing the air dilution rate at the air dilution valve on the intake to the blower unit. This adjustment was made to reduce off gas concentration at the injection trenches and to minimize emission of gases into the atmosphere. Prior to making this adjustment a pressure relief valve was installed downstream of the blower. The air filter was changed twice to maximize air flow from the air intake line to the blower and to ensure removal of fugitive materials.

August 1992

Because of continued reports of strong gasoline odor at the gasoline station, a decision was made to replace the existing 2.5 horse power (hp) blower unit being used with a 1 hp unit. On August 3, 1992, the 2.5 hp blower was replaced with a 1 hp blower. A visit to the site on August 20 revealed the blower has not been operating continuously because of power failures associated with frequent storms in the area. A decision was made to rewire the starter for the blower to allow continued operation once power is restored after a storm event. Rewiring of the starter was completed the week ending August 28. A summary of the data gathered since the 1 hp blower was installed in August is presented in Table 1.

September 1992

An in-situ respiration test was performed on September 2 and 3. The respiration test was performed to ensure that nutrients, moisture, or oxygen are not limiting biodegradation. The respiration test included oxygen and carbon dioxide monitoring over a 24 to 48 hour period. The results of the respiration test were presented in a letter report dated October 7, 1992. Based on the results of this test, a fuel biodegradation rate of 5.36 to 25.85 mg/kg/day was estimated. This variation in the biodegradation rate is related to the location of the monitoring point where the rate was calculated. When compared to rates estimated at startup of system operation, current fuel biodegradation

rates are indicative of significant increase in bioactivity and suggest that a more active bacterial population has been established. During this period no adjustments were made to the system.

October 1992

O&M effort in October involved replacement of the air filter and measurement of physical parameters. A summary of the data gathered since the 1 hp blower was installed is presented on Table 1.

November-December 1992

Monitoring effort in November was delayed to early December (Dec. 3). An in-situ respiration test was also scheduled for December 3. This test could not be completed as planned because high water table condition prevented collection of representative samples for analysis during the test. Available information indicated that the Eglin area had experienced heavy rainfall during the month of November. Long range weather forecast indicated this high water table condition may continue into the spring. Engineering - Science monitored storm events during December and January to explore possible opportunity to perform the respiration test.

January 1993

An O&M visit was made on January 8, 1993. Water level measurements collected during this visit indicated the high water table condition persisted. However, samples were collected at routine sampling ports (e.g., vapor monitoring points - VMP-1D and VMP-2D, well MW10, and blower suction and discharge). The air filter was replaced with a new part. A repeat of the respiration test may not be possible until the 3rd Quarter O&M effort scheduled for the first week in March. On the basis of the data collected to date, adjustments to system components were not warranted during this O&M visit.

February 1993

Off gas monitoring effort in February reflected a similar trend in attenuation of total hydrocarbons in the soil gas as in previous months. Other physical parameters measured in the field were consistent with previous data and indicated adjustment to the system components was not warranted. A fair amount of rainfall occurred during early to mid February but was not as much as in previous months (November through January). An in-situ respiration test was scheduled for the 2nd week in March. Data gathered during the month of February is included in Tables 1 and 2 and depicted in Figure 2.

March 1993

ES visited the site on March 10. O&M and monitoring efforts were performed on March 11. Water level measurements obtained during this visit indicated high water table conditions persisted. Therefore, the in-situ respiration test was again postponed. From all indications further attempts to perform this test will not be made again until May. It was observed during this visit that only two recovery wells were in operation. Effort was in progress to get two additional recovery wells back in service. If operation of these four wells is maintained, subsequent drawdown may be sufficient to lower the water table below the screened portion of the vapor monitoring points. The data

collected during this visit is provided in Tables 1 and 2 and depicted in Figure 2. The air filter for the blower was in good condition. No adjustments were made to the bioventing system components.

April 1993

ES made two visits to the site during this period; one on April 7 and another on April 22. The lowest temperature readings since startup of system operation were recorded (Table 1). This was attributed to cold weather conditions experienced during this period. Oxygen levels dropped in both VMP-1D and VMP-2D and this was complimented by an increase in carbon dioxide levels. A continued decline in total hydrocarbons' level was evident at VMP-1D. A slight increase (>200 ppmv) in TH level was observed at VMP-2D. Other physical parameters remained virtually the same. The results of the soil gas samples taken from monitoring points at the site are presented in Figures 1 through 2. Water level measurements taken this period indicates a gradual decline in water table conditions (Table 3). It is anticipated that by the end of May the water table would have dropped low enough to allow performance of a respiration test.

May 1993

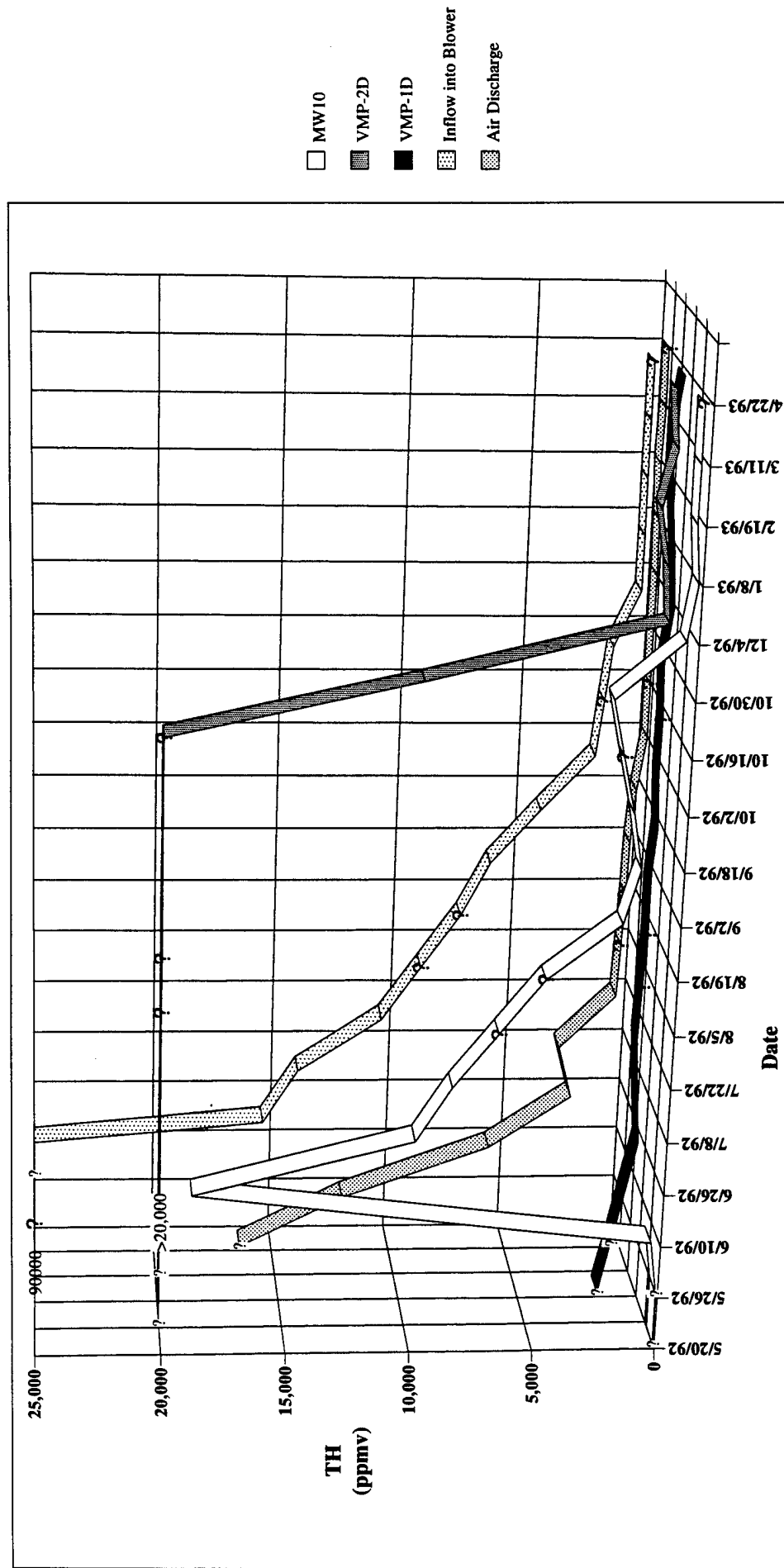
O&M visit was made to the site on May 6. The system components were inspected to ensure continued operation of the system as desired. Data obtained suggest the filter may need to be replaced. This will be accomplished on the next O&M visit. A respiration test is planned for May 26/27. Available water level data suggest subsurface conditions will be appropriate for the test (i.e., lower water table conditions are anticipated).

OVERVIEW OF ANALYTICAL RESULTS (Update)

Results of biweekly/monthly concentrations of oxygen, carbon dioxide and Total Hydrocarbons throughout the bioventing system are presented in Table 2 and depicted in the attached charts (Figures 1 through 3). These results continued to indicate increased biological activity in the subsurface and suggest potential increase in aerobic bacterial population. Results indicate oxygen supply to the subsurface has been adequately sustained except for a recent measurement that showed a pronounced decrease in oxygen concentration and slight increase in Carbon dioxide concentration at monitoring location VMP-1D. This monitoring point will be observed closely to determine if increase in bio-uptake of oxygen is the reason for the decline in oxygen level. Available data indicate a rapid decline in total hydrocarbon concentration over the past five months (December through April). Volatilization and to a greater extent biodegradation are believed to be responsible for the total hydrocarbons removed. The system will be watched closely to observe changes that would likely occur as a result of increasing warm weather conditions.

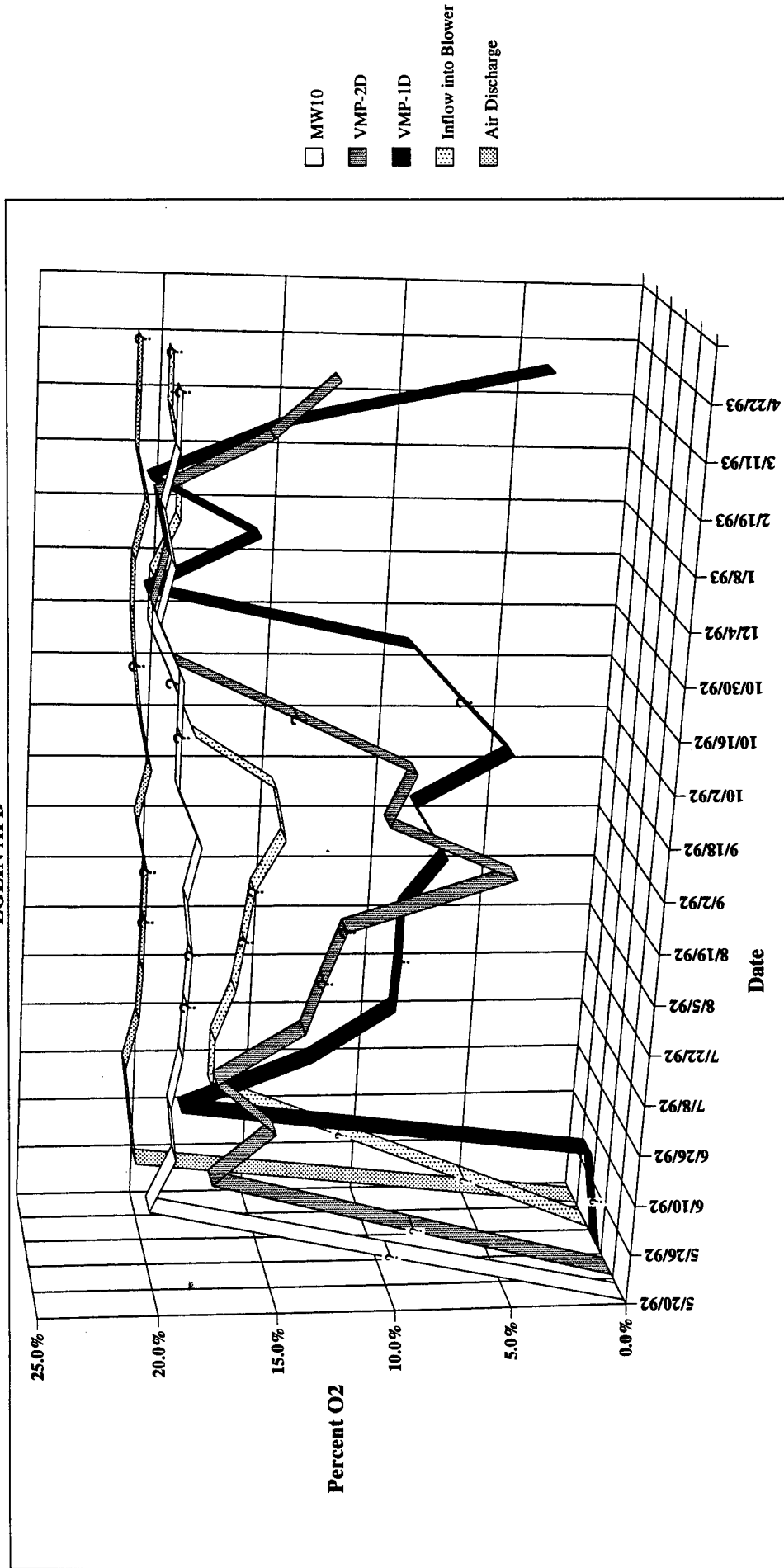
Figure 1

**TOTAL HYDROCARBON LEVELS DURING BIOVENTING
AT 7TH STREET BX SERVICE STATION (5/20/92 - 4/22/93)**



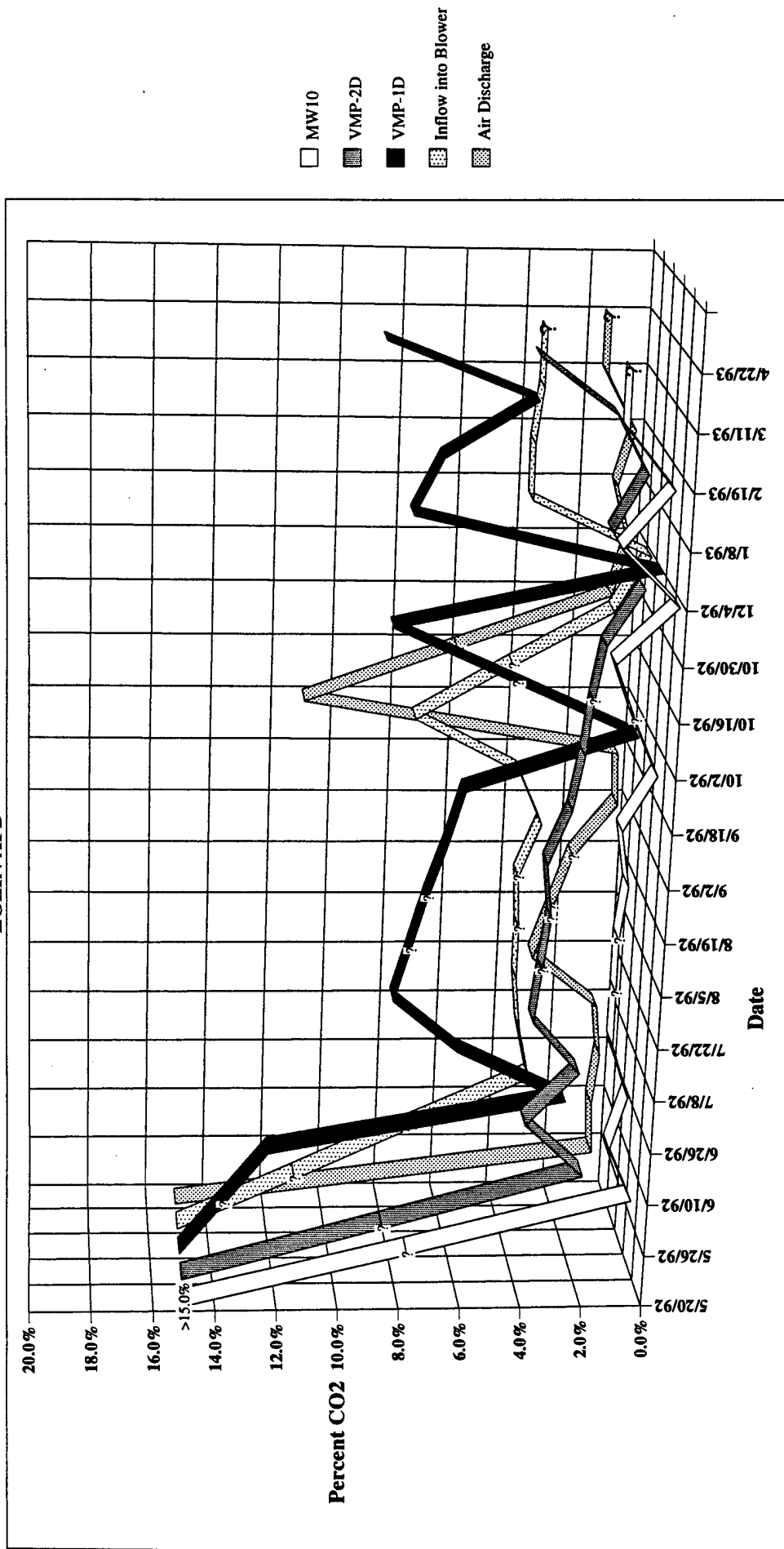
Note: "?" indicates no data was recorded on this date; slopes are assumed to be linear.

OXYGEN LEVELS DURING BIOVENTING AT 7TH STREET EX SERVICE STATION EGLIN AFB



Note: "?" indicates no data was recorded on this date; slopes are assumed to be linear.

CARBON DIOXIDE LEVELS DURING BIOVENTING AT 7TH STREET BX SERVICE STATION (5/20/92 - 4/22/93) EGLIN AFB



Note: "?" indicates no data was recorded on this date; slopes are assumed to be linear.

Figure 3

TABLE 1

**MEASUREMENTS OF OTHER PHYSICAL PARAMETERS
BIOVENTING SYSTEM AT THE 7TH STREET BX SERVICE STATION**

Date	BLOWER SUCTION			BLOWER EXHAUST	
	Temp (Deg. F)	Vacuum Air Filter (ins. of H ₂ O)	Head loss Filter (ins. of H ₂ O)	Temp (Deg. F)	Pressure (ins. of H ₂ O)
8/6/92 *					
9/2/92	100	4	12	110	16
10/15/92	92	2	12	93	20
10/30/92	78	4	12	100	20
12/3/92	60	4	12	83	22
1/8/93	60	4	12	78	14
2/12/93	60	4	12	82	19
3/11/93	69	4	14	89	18
3/25/93	72	4	12	98	17
4/7/93	64	4	12	75	18
4/22/93	54	4	12	71	18
5/6/93	100	4	16	90	16

* New (1 hp) Blower was installed

TABLE 2
RESULTS OF SOIL GAS ANALYSES
DURING BIOVENTING (5/20/92 - 4/22/93)
AT 7TH STREET BX SERVICE STATION
EGLIN AFB

Location	Baseline(1) 5/20/92				1st Week(2) 5/26/92				3rd Week 6/10/92			
	TH ppmv	O2 %	CO2 %		TH ppmv	O2 %	CO2 %		TH ppmv	O2 %	CO2 %	
Air Discharge to Injection Trench	-	0.0%	> 15.0%		12,000	20.0%	0.6%		5,800	20.3%	0.7%	
Inflow into Blower	90,000	0.0%	> 15.0%		-	-	-		-	-	-	
VMP-1D	-	0.0%	> 15.0%		-	-	-		680	0.7%	12.1%	
VMP-2D	-	0.0%	> 15.0%		-	-	-		> 20,000	17.6%	1.8%	
MW10	-	0.0%	> 15.0%		-	-	-		320	20.5%	0.5%	

(1) - Baseline background conditions were: Oxygen - 20.4%, Carbon Dioxide - 0.6%.

(2) - Week since start-up of system operation

TH - Total Hydrocarbons

ppmv - parts per million by volume

TABLE 2 - Continued
RESULTS OF SOIL GAS ANALYSES
DURING BIOVENTING (5/20/92 - 4/22/93)
AT 7TH STREET BX SERVICE STATION
EGLIN AFB

Location	5th Week			7th Week			9th Week		
	TH	O ₂	CO ₂	TH	O ₂	CO ₂	TH	O ₂	CO ₂
	ppmv	%	%	ppmv	%	%	ppmv	%	%
Air Discharge to Injection Trench	2,400	20.6%	0.5%	3,000	20.1%	0.7%	720	20.0%	3.0%
Inflow into Blower	15,600	17.1%	3.2%	14,200	17.1%	3.6%	10,800	16.3%	3.8%
VMP-1D	220	18.7%	2.2%	396	13.2%	5.9%	540	9.8%	8.1%
VMP-2D	> 20,000	15.0%	3.8%	> 20,000	17.6%	2.1%	> 20,000	14.0%	3.7%
MW10	18,800	19.5%	1.3%	10,000	19.8%	0.8%	8,600	19.4%	1.4%

TABLE 2 - Continued
RESULTS OF SOIL GAS ANALYSES
DURING BIOVENTING (5/20/92 - 4/22/93)
AT 7TH STREET BX SERVICE STATION
EGLIN AFB

Location	11th Week			13th Week			15th Week		
	TH	O ₂	CO ₂	TH	O ₂	CO ₂	TH	O ₂	CO ₂
	ppmv	%	%	ppmv	%	%	ppmv	%	%
Air Discharge to Injection Trench	-	-	-	-	-	-	480	20.5%	0.4%
Inflow into Blower	-	-	-	-	-	-	6,550	14.5%	3.2%
VMP-1D	-	-	-	-	-	-	390	8.0%	6.5%
VMP-2D	-	-	-	-	-	-	> 20,000	5.5%	3.5%
MW10	-	-	-	-	-	-	2,200	19.5%	1.2%

TABLE 2 - Continued
RESULTS OF SOIL GAS ANALYSES
DURING BIOVENTING (5/20/92 - 4/22/93)
AT 7TH STREET BX SERVICE STATION
EGLIN AFB

Location	17th Week			19th Week			21st Week		
	TH	O ₂	CO ₂	TH	O ₂	CO ₂	TH	O ₂	CO ₂
	ppmv	%	%	ppmv	%	%	ppmv	%	%
Air Discharge to Injection Trench	340	20.0%	0.5%	20	20.5%	11.0%	-	-	-
Inflow into Blower	4,600	15.0%	4.0%	2,500	18.5%	7.5%	-	-	-
VMP-1D	200	9.5%	6.0%	300	5.5%	0.5%	-	-	-
VMP-2D	> 20,000	11.0%	2.8%	> 20,000	10.0%	2.5%	-	-	-
MW10	1,600	19.0%	1.5%	2,000	20.0%	0.5%	-	-	-

TABLE 2 - Continued
RESULTS OF SOIL GAS ANALYSES
DURING BIOVENTING (5/20/92 - 4/22/93)
AT 7TH STREET BX SERVICE STATION
EGLIN AFB

Location	23rd Week			28th Week			33rd Week		
	TH	O ₂	CO ₂	TH	O ₂	CO ₂	TH	O ₂	CO ₂
	ppmv	%	%	ppmv	%	%	ppmv	%	%
Air Discharge to Injection Trench	35	21.0%	1.0%	10	21.0%	0.5%	34	20.5%	1.0%
Inflow into Blower	2,000	20.5%	1.2%	1,000	20.5%	0.1%	998	19.5%	4.0%
VMP-1D	360	10.0%	8.5%	80	21.0%	0.1%	200	16.5%	8.0%
VMP-2D	> 10,000	20.0%	2.0%	650	21.0%	0.9%	800	20.5%	2.0%
MW10	3,000	20.0%	2.0%	400	21.0%	0.2%	68	20.5%	2.0%

* - High water table conditions observed.

TABLE 2 - Continued
RESULTS OF SOIL GAS ANALYSES
DURING BIOVENTING (5/20/92 - 4/22/93)
AT 7TH STREET BX SERVICE STATION
EGLIN AFB

Location	39th Week			42nd Week			48th Week		
	TH	O ₂	CO ₂	TH	O ₂	CO ₂	TH	O ₂	CO ₂
	ppmv	%	%	ppmv	%	%	ppmv	%	%
Air Discharge to Injection Trench	100	21.0%	0.5%	45	21.0%	1.5%	45	21.0%	1.5%
Inflow into Blower	ND	ND	ND	1,000	2.0%	3.8%	1,000	2.0%	3.8%
VMP-1D	400	21.0%	7.1%	500	15.5%	4.2%	210	5.0%	9.0%
VMP-2D	1,200	21.0%	1.0%	700	16.5%	2.0%	> 900	14.0%	4.5%
MW10	250	21.0%	0.5%	ND	ND	ND	ND	ND	ND

ND - Sample could not be obtained at this sampling location.

* - High water table conditions observed.

TABLE 3

WATER LEVEL DATA (March through 1st Week in May)								
Well ID	Depth To Water						Drop in Water Level since Jan.	Attributes
	9-Jan	10-Mar	25-Mar	7-Apr	22-Apr	6-May		
FP-1	4.37	4.88	5.00	5.00	4.95	5.30	0.93	
FP-2	5.24	4.42	6.05	5.65	5.85	6.20	0.96	near MP-2
GW-1	6.30	4.41	6.60	6.35	7.20	8.10	1.80	
GW-2	5.52	6.10	6.40	6.30	6.70	6.92	1.40	
GW-3	5.36	5.61	5.85	5.85	6.10	6.50	1.14	
MW-1	6.55	6.63	7.30	7.15	7.35	7.70	1.15	near MP-2
MW-8	5.27	5.47	5.82	5.73	5.90	6.20	0.93	near MP-1
MW-9	4.85	5.56	5.40	5.34	5.48	5.78	0.93	near MP-1
MW-10	4.37	4.62	5.80	4.92	5.10	5.42	1.05	