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SITE-SPECIFIC TECHNICAL REPORT FOR FREE PRODUCT RECOVERY TESTING AT THE BASE HOUSING AREA, HAVRE AFS, MONTANA

FINAL

PREPARED FOR:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
(AFCEE/ERT)
8001 ARNOLD DRIVE
BROOKS AFS, TEXAS 78235-5357

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SITE-SPECIFIC TECHNICAL REPORT (A003)

for

FREE PRODUCT RECOVERY TESTING AT THE BASE HOUSING AREA, HAVRE AFS, MONTANA

by

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20 February 1997

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EXECUTIVE SUMMARY

This report summarizes the field activities conducted at Havre AFS, for a short-term field pilot test to compare vacuum-enhanced free-product recovery (bioslurping) to traditional free-product recovery techniques to remove light, nonaqueous-phase liquid (LNAPL) from subsurface soils and aquifers. The field testing at Havre AFS is part of the Bioslurper Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division. The AFCEE Bioslurper Initiative is a multisite program designed to evaluate the efficacy of the bioslurping technology for (1) recovery of LNAPL from groundwater and the capillary fringe, and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

The main objective of the Bioslurper Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and identify site parameters that are reliable predictors of bioslurping performance. To measure LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The tests at Havre AFS are two of over 40 similar field tests to be conducted at various locations throughout the United States and its possessions.

The intent of field testing is to collect data to support determination of the predictability of LNAPL recovery and to evaluate the applicability, cost, and performance of the bioslurping technology for removal of free product and remediation of the contaminated area. The on-site testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the performance of more conventional LNAPL recovery technologies. The test method included an initial site characterization followed by LNAPL recovery testing. The three LNAPL recovery technologies tested at Havre AFS were skimmer pumping, bioslurping, and drawdown pumping.

Bioslurper pilot test activities were conducted at two spill sites located within the same general area of the Base Housing Area. Minimal site characterization activities were carried out at Site 1 (monitoring well MW-F), since little free product was recovered at this site. The full scope of Bioslurper Initiative testing was conducted at Site 2 (monitoring well MW-7).

Site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. Testing included baildown testing to evaluate the mobility of LNAPL, soil sampling to determine physical/chemical site characteristics, soil gas permeability testing to determine the radius of influence, and in situ respiration testing to evaluate site microbial activity.

Following the site characterization activities, the pump tests were conducted. At Site 1, a 45-hour bioslurper pump test was conducted at monitoring well MW-F. At Site 2, pilot tests for skimmer pumping, bioslurping, and drawdown pumping were conducted at monitoring well MW-7. The LNAPL recovery testing was conducted in the following sequence at monitoring well MW-7: 39 hours in the skimmer configuration, approximately 98 hours in the bioslurper configuration, 47 hours in the drawdown configuration, and an additional 27 hours in the skimmer configuration. Measurements of extracted soil gas composition, LNAPL thickness, and groundwater level were taken throughout the testing. The volume of LNAPL recovered and groundwater extracted were quantified over time.

None of the LNAPL recovery techniques were successful at recovering free product. These results indicate that there is little free product present at the two sites or that it is relatively immobile. As a result, it was decided to install a bioventing system at both sites to remediate the vadose zone. Bioventing systems were configured to inject air into monitoring well MW-F at Site 1 and monitoring well MW-7 at Site 2.

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. At Site 1, oxygen concentrations increased only at the closest monitoring point; however, based on radius of influence testing, it is likely that soil gas at greater distances will become oxygenated over time. At Site 2, all monitoring points exhibited increased oxygen concentrations. These results correlated with results from the soil gas permeability test where a radius of influence of approximately 12 ft was determined. The radius of influence of the bioventing system potentially may be greater than 12 ft, since the system is configured for air injection. With the radius of influence from these systems, bioventing is treating the entire contaminant plume at both sites.

Implementation of bioslurping or any free-product recovery technique at the Havre AFS test site does not appear likely to facilitate enhanced recovery of LNAPL from the water table and simultaneous in situ biodegradation of hydrocarbons in the vadose zone via bioventing. A large volume of free product does not appear to be present; therefore, bioventing is recommended to remediate vadose zone contamination.

FINAL SITE-SPECIFIC TECHNICAL REPORT (A003)

for

FREE PRODUCT RECOVERY TESTING AT THE BASE HOUSING AREA, HAVRE AFS, MONTANA

20 February 1997

1.0 INTRODUCTION

This report describes activities performed and data collected during field tests at Havre Air Force Station (AFS), Montana, to compare vacuum-enhanced free-product recovery (bioslurping) to traditional free-product recovery technologies for removal of light, nonaqueous-phase liquid (LNAPL) from subsurface soils and aquifers. The field testing at Havre AFS is part of the Bioslurper Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division. The AFCEE Bioslurper Initiative is a multisite program designed to evaluate the efficacy of the bioslurping technology for (1) recovery of LNAPL from groundwater and the capillary fringe and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

1.1 Objectives

The main objective of the Bioslurper Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and identify site parameters that are reliable predictors of bioslurping performance. To measure LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The tests at Havre AFS are two of over 40 similar field tests to be conducted at various locations throughout the United States and its possessions. Aspects of the testing program that apply to all sites are described in the *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). Test provisions specific to activities at Havre AFS were described in the Site-Specific Test Plan provided in Appendix A.

The intent of field testing is to collect data to support determination of the predictability of LNAPL recovery and to evaluate the applicability, cost, and performance of the bioslurping

technology for removal of free product and remediation of the contaminated area. The on-site testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the performance of more conventional LNAPL recovery technologies. The test method included an initial site characterization followed by LNAPL recovery testing. The three LNAPL recovery technologies tested at Havre AFS were skimmer pumping, bioslurping, and drawdown pumping. The specific test objectives, methods, and results for the Havre AFS test program are discussed in the following sections.

1.2 Testing Approach

Bioslurper pilot test activities were conducted at two spill sites located within the same general area of the Base Housing Area. Minimal site characterization activities were carried out at Site 1 (monitoring well MW-F), since little free product was recovered at this site. The full scope of Bioslurper Initiative testing was conducted at Site 2 (monitoring well MW-7). Results from the two test sites are presented separately in the following sections.

Site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. Testing included baildown testing to evaluate the mobility of LNAPL, soil sampling to determine physical/chemical site characteristics, soil gas permeability testing to determine the radius of influence, and in situ respiration testing to evaluate site microbial activity.

Following the site characterization activities, the pump tests were conducted. At Site 1, a 45-hour bioslurper pump test was conducted at monitoring well MW-F. At Site 2, pilot tests for skimmer pumping, bioslurping, and drawdown pumping were conducted at monitoring well MW-7. The LNAPL recovery testing was conducted in the following sequence at monitoring well MW-7: 39 hours in the skimmer configuration, approximately 98 hours in the bioslurper configuration, 47 hours in the drawdown configuration, and an additional 27 hours in the skimmer configuration. Measurements of extracted soil gas composition, LNAPL thickness, and groundwater level were taken throughout the testing. The volume of LNAPL recovered and groundwater extracted were quantified over time.

2.0 SITE DESCRIPTION

The Base Housing Area contains many underground storage tanks (USTs) that were installed in the 1950's. The USTs were used to store heating oil and diesel fuel. In 1984, the Investigative Restoration Program was employed at Havre AFS to determine releases of heating oil and diesel fuel that may pose a threat to human health and the environment in the area. It was found that 19 out of 26 USTs in the Base Housing Area had leaked fuel oil into the surrounding soils. The USTs were removed in September 1992.

Havre AFS geologic conditions are characterized by approximately 15 ft of soil and unconsolidated material which is underlain by the Upper Cretaceous Bearpaw Shale. The unconsolidated materials are mostly comprised of fine sandy loam and clay loam. These loams are generally derived from parent materials of glacial till and tend to form deep soil horizons. Depth to groundwater varies from 10 to 17 ft below ground surface. Groundwater generally occurs in sand lenses lying atop the sandy and clay loams.

Soil samples collected during the UST removal indicated levels of TPH (as diesel) to be 35,200 mg/kg at a depth of 1 ft in the vicinity of monitoring well MW-F. Monitoring wells MW-7 and MW-F have shown measurable free product thickness. Figure 1 is a schematic diagram of the housing facilities and monitoring wells located in the Base Housing Area.

3.0 BIOSLURPER SHORT-TERM PILOT TEST METHODS

This section documents the initial conditions at the test site and describes the test equipment and methods used for the short-term pilot test at Havre AFS.

3.1 Site 1: Activities at Monitoring Well MW-F

3.1.1 Initial LNAPL/Groundwater Measurements and Baildown Testing

Monitoring well MW-F was evaluated for use in the bioslurper pilot testing. Initial depths to LNAPL and to groundwater were measured using an oil/water interface probe (ORS Model #1068013). LNAPL was removed from the well with a Teflon™ bailer until the LNAPL thickness

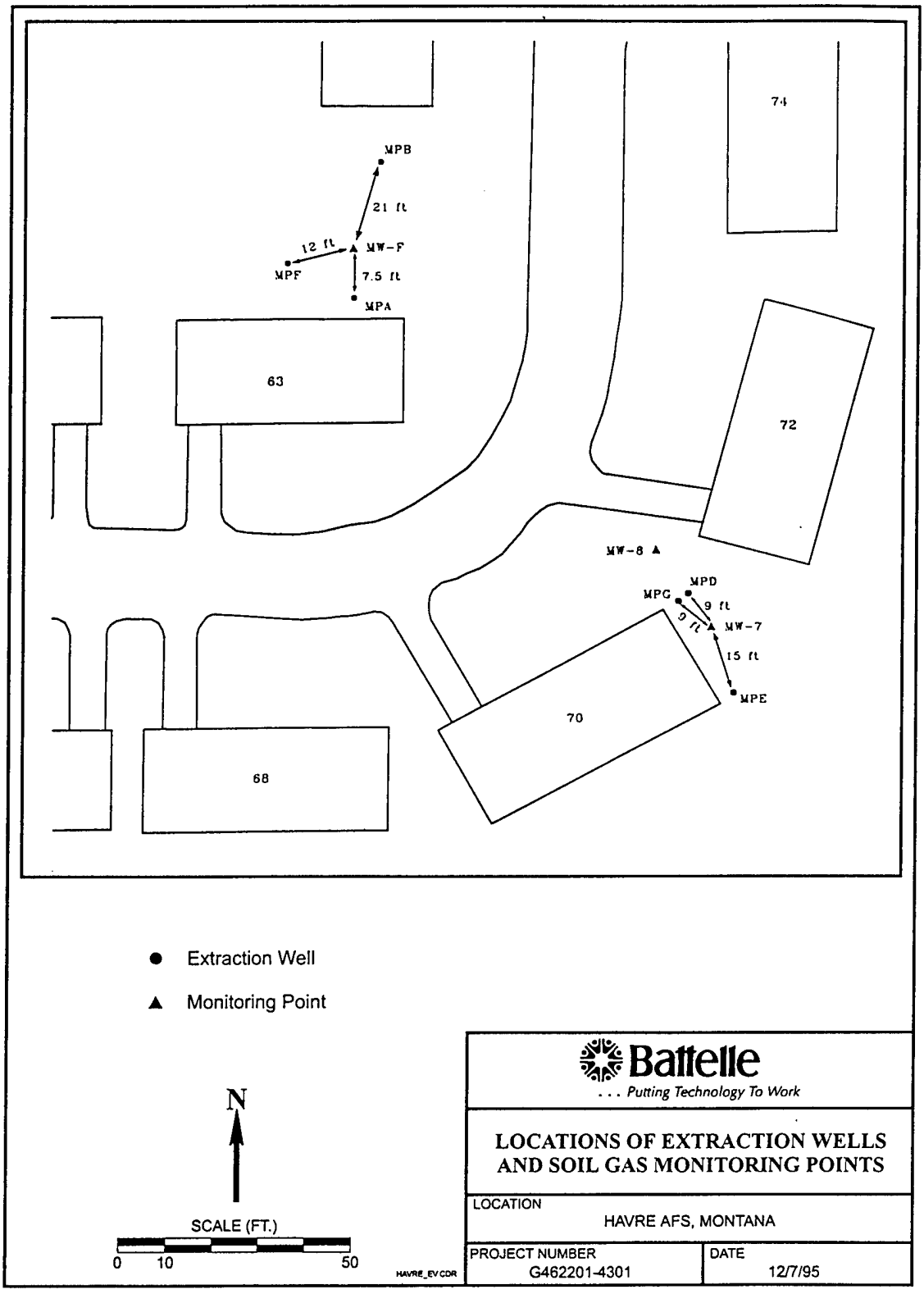

Figure 1. **Schematic Diagram Showing Locations of Monitoring Wells and Monitoring Points at the Base Housing Area, Havre AFS, MT**

could no longer be reduced. The rate of increase in the thickness of the floating LNAPL layer was monitored using the oil/water interface probe for approximately 32 hours.

3.1.2 Well Construction Details

A short-term bioslurper pump test was conducted at existing monitoring well MW-F. The well is constructed of 4-inch-diameter, schedule 40 polyvinyl chloride (PVC). The monitoring well was constructed with a total depth of 19 ft and 15 ft of screen.

3.1.3 Soil Gas Monitoring Point Installation

Four monitoring points were installed in the area of monitoring well MW-F and were labeled MPA, MPB, MPC, and MPF. The locations of the monitoring points are illustrated in Figures 1 and 2.

The monitoring points consisted of sets of ¼-inch tubing, with 1-inch-diameter, 6-inch-long screened areas. The screened lengths were positioned at the appropriate depths, and the annular space corresponding to the screened length was filled with silica sand. The interval between the screened lengths was filled with bentonite clay chips, as was the space from the top of the shallowest screened length to the ground surface. After placement, the bentonite clay was hydrated with water to expand the chips and provide a seal. The monitoring points were installed at depths as follows:

- Monitoring point MPA was installed at a depth of 11.5 ft into a 6-inch diameter borehole. The monitoring point was screened to two depths: 8.0 to 8.5 and 10.0 to 10.5 ft.
- Monitoring point MPB was installed at a depth of 17.5 ft into a 6-inch diameter borehole. The monitoring point was screened to two depths: 10.5 to 11.0 and 15.0 to 15.5 ft.
- Monitoring point MPF was installed at a depth of 14.0 ft into a 6-inch diameter borehole. The monitoring point was screened to two depths: 13.5 to 14.0 and 8.5 to 9.0 ft.

Monitoring point MPC was abandoned because no contamination was evident in the boring. After installation of the monitoring points, initial soil gas measurements were taken with a GasTechtor

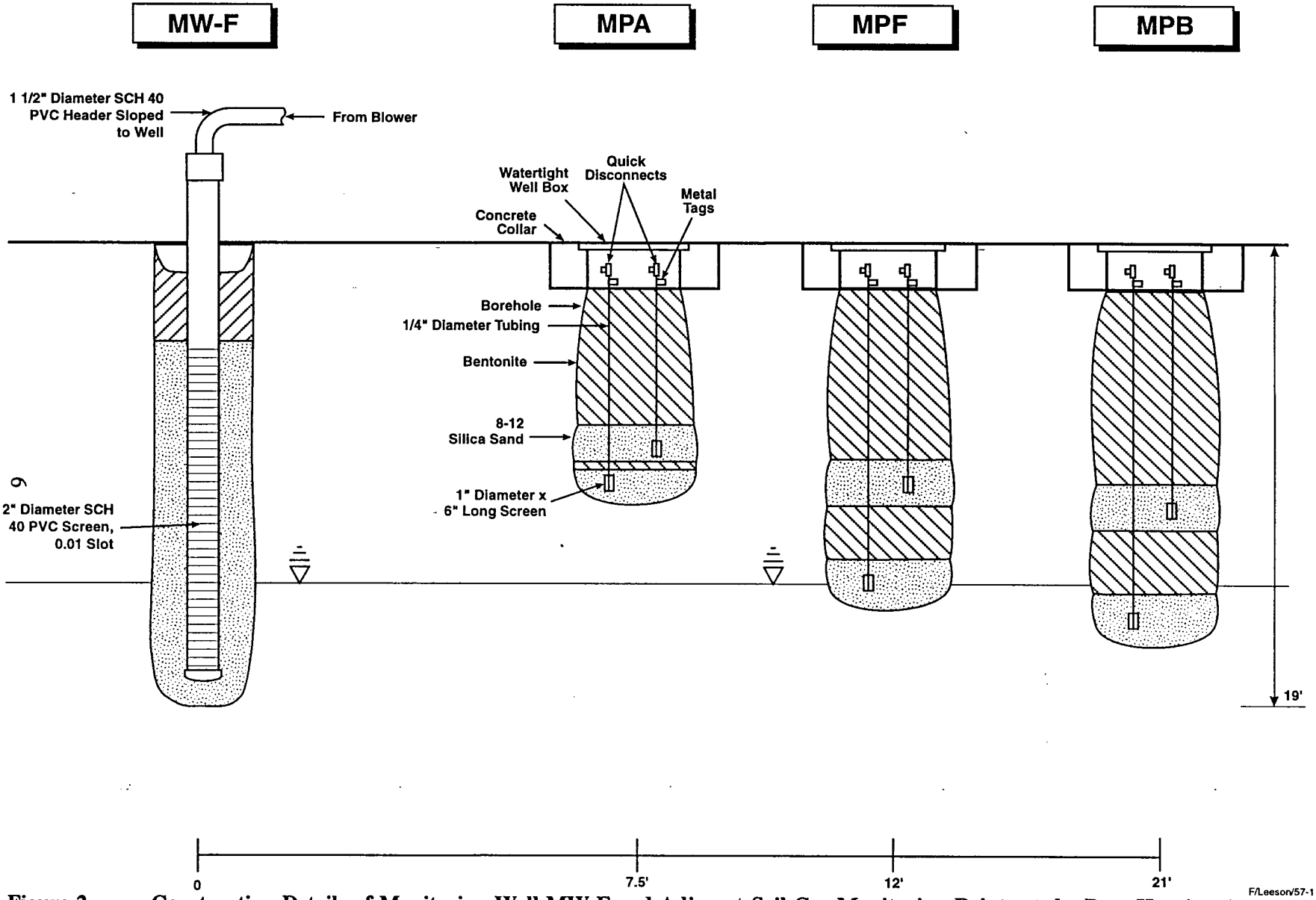

Figure 2. **Construction Details of Monitoring Well MW-F and Adjacent Soil Gas Monitoring Points at the Base Housing Area, Havre AFS, MT**

portable O_2/CO_2 meter and a GasTech Trace-Techtor portable hydrocarbon meter. In general, oxygen limitation was observed at the deeper depths of monitoring points, except at monitoring point MPB. Oxygen concentrations ranging from 0% to 1.0% were found in MPA and MPF at depths of 10.0 ft and greater (Table 1).

Table 1. Initial Soil Gas Compositions at Site 1, the Base Housing Area, Havre AFS, MT

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppmv)
MPA	8.0-8.5	10.0	2.5	600
	10.0-10.5	0.0	14.0	300
MPB	10.5-11.0	19.0	0.50	40
	15.0-15.5	16.5	3.0	195
MPF	8.5-9.0	20.0	0.80	72
	13.5-14.0	1.0	16.0	>10,000

3.1.4 Soil Sampling and Analysis

One soil sample was collected during the installation of monitoring point MPA and was labeled HAV-MPA-10.0'-10.5'. The soil sample was collected in a brass sleeve using a split-spoon sampler. The sample was placed in an insulated cooler, chain-of-custody records and shipping papers were completed, and the sample was sent to Alpha Analytical, Inc., in Sparks, Nevada. The sample was analyzed for BTEX, bulk density, moisture content, particle size, porosity, and TPH. The laboratory analytical report is provided in Appendix B.

3.1.5 LNAPL Recovery Testing

3.1.5.1 System Setup

The bioslurping pilot test system is a trailer-mounted mobile unit. The vacuum pump (Atlantic Fluidics Model A100, 7.5-hp liquid ring pump), oil/water separator, and required support

equipment are carried to the test location on a trailer. The trailer was located near monitoring well MW-F, the well cap was removed, a coupling and tee were attached to the top of the well, and the slurper tube was lowered into the well. The slurper tube was attached to the vacuum pump. Different configurations of the tee and the placement depth of the slurper tube allow for simulation of skimmer pumping, operation in the bioslurping configuration, or simulation of drawdown pumping. Extracted groundwater was treated by passing the effluent through an oil/water separator and allowed to settle in a 500 gallon tank. The groundwater was then discharged to the sanitary sewer.

A brief system startup test was performed prior to LNAPL recovery testing to ensure that all system components were working properly. The system checklist is provided in Appendix C. All site data and field testing information were recorded in a field notebook and then transcribed onto pilot test data sheets provided in Appendix D.

3.1.5.2 Bioslurper Pump Test

Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set at the LNAPL/groundwater interface. The PVC connecting tee was removed, sealing the wellhead and allowing the pump to establish a vacuum in the well (Figure 3). A pressure gauge was installed at the wellhead to measure the vacuum inside the extraction well. The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on October 11, 1995, to begin the bioslurper pump test. The test was operated continuously for approximately 45 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. Test data sheets are provided in Appendix D.

3.1.6 Soil Gas Permeability Testing

Soil gas permeability test data were collected during the bioslurper pump test in monitoring well MW-F. Before a vacuum was established in the extraction well, the initial soil gas pressures at the monitoring points were recorded. The start of the bioslurper pump test created a steep pressure drop in the extraction well which was the starting point for the soil gas permeability testing. Soil gas pressures were measured at each of the three monitoring points at all depths to track the rate of

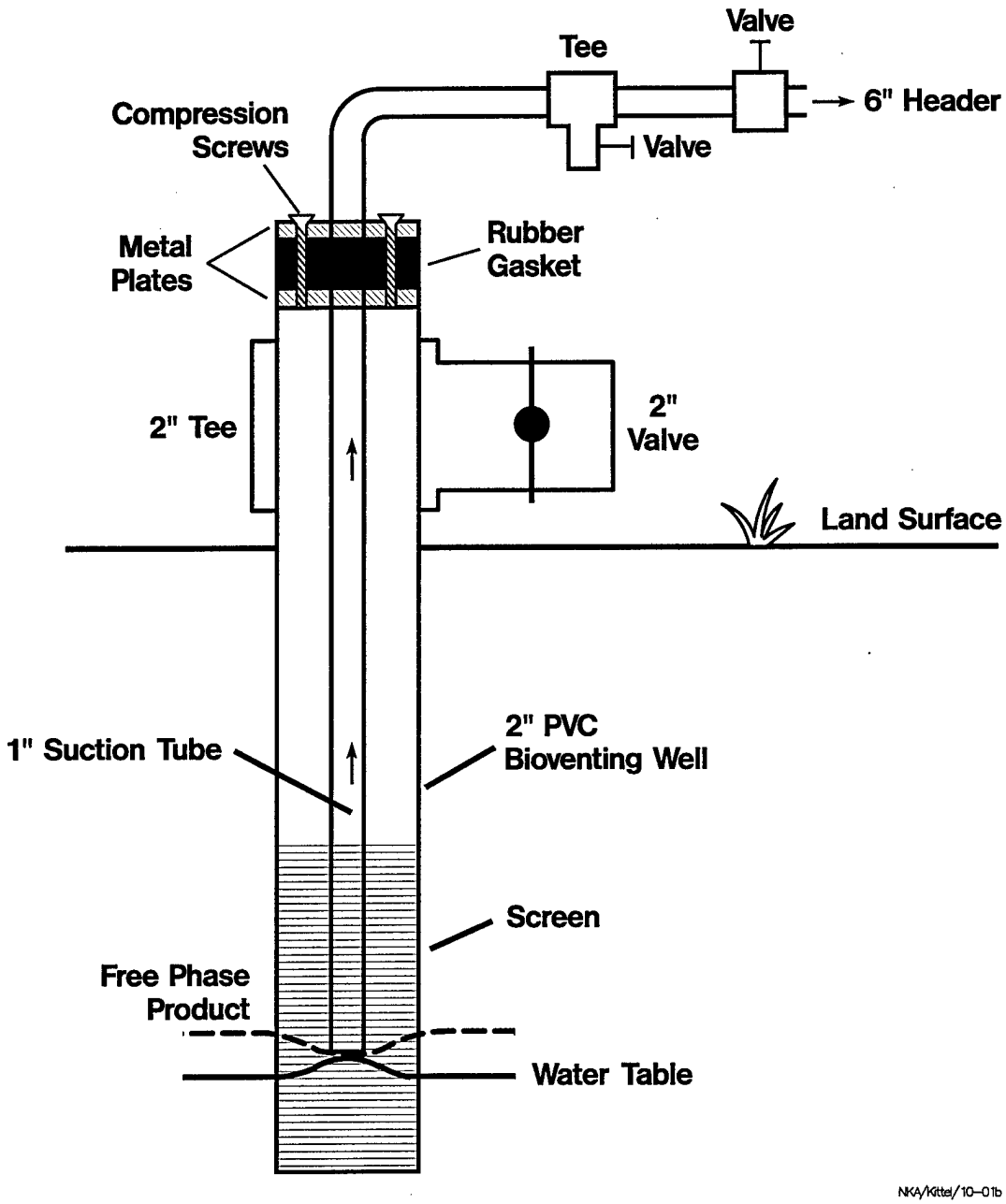

Figure 3. Slurper Tube Placement and Valve Position for the Bioslurper Pump Test

outward propagation of the pressure drop in the extraction well. Soil gas pressure data were collected frequently during the first 20 minutes of the test. The soil gas pressures were recorded throughout the bioslurper pump test to determine the bioventing radius of influence. Test data are provided in Appendix E.

3.2 Site 2: Activities at Monitoring Well MW-7

3.2.1 Initial LNAPL/Groundwater Measurements and Baildown Testing

Monitoring well MW-7 was evaluated for use in the bioslurper pilot testing. Initial depths to LNAPL and to groundwater were measured using an oil/water interface probe (ORS Model #1068013). LNAPL was removed from the well with a peristaltic pump until the LNAPL thickness could no longer be reduced. The rate of increase in the thickness of the floating LNAPL layer was monitored using the oil/water interface probe for approximately 25 hours.

3.2.2 Well Construction Details

Existing monitoring well MW-7 was selected for use in the bioslurper pilot testing. The well is constructed of 4-inch-diameter, schedule 40 PVC. Screened length of the well is unknown, but is likely similar to other wells in the area, with a total depth of approximately 19 ft and 10 to 15 ft of screen.

3.2.3 Soil Gas Monitoring Point, Thermocouple, and DataWrite Oxygen Sensor Installation

Three monitoring points were installed in the area of monitoring well MW-7 and were labeled MPD, MPE, and MPG. The locations of the monitoring points are illustrated in Figures 1 and 4.

The monitoring points consisted of sets of ¼-inch tubing, with 1-inch-diameter, 6-inch-long screened areas. The screened lengths were positioned at the appropriate depths, and the annular space corresponding to the screened length was filled with silica sand. The interval between the screened lengths was filled with bentonite clay chips, as was the space from the top of the shallowest screened length to the ground surface. After placement, the bentonite clay was hydrated with water to expand the chips and provide a seal. The monitoring points were installed at depths as follows:

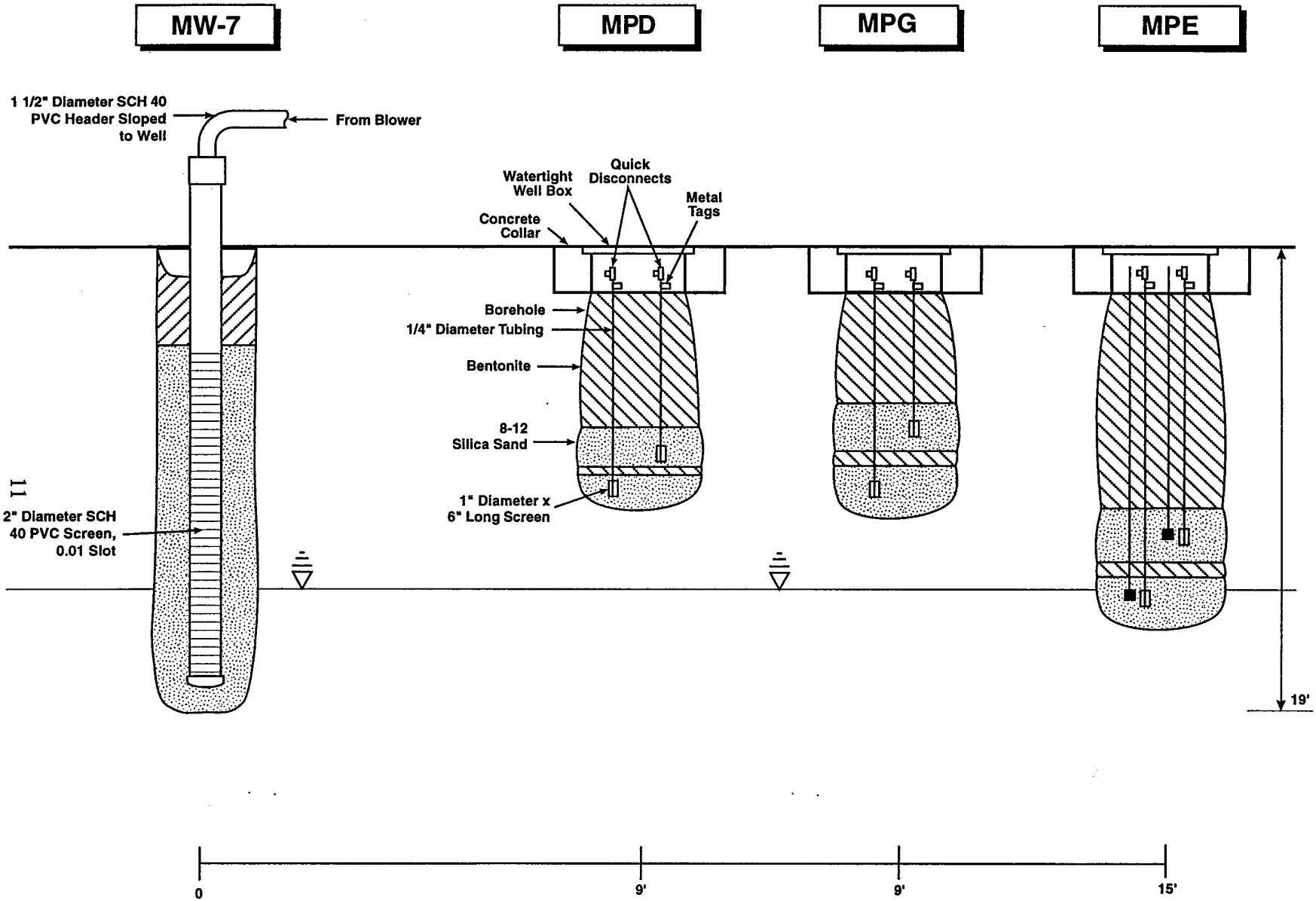

Figure 4. **Construction Details of Monitoring Well MW-7 and Adjacent Soil Gas Monitoring Points at the Base Housing Area, Havre AFS, MT**

F/Leeson/57-2

- Monitoring point MPD was installed at a depth of 11.0 ft into a 6-inch diameter borehole. The monitoring point was screened to two depths: 8.0 to 8.5 and 10.0 to 10.5 ft.

- Monitoring point MPE was installed at a depth of 16.5 ft into a 6-inch diameter borehole. The monitoring point was screened to two depths: 11.5 to 12.0 and 14.0 to 14.5 ft.

- Monitoring point MPG was installed at a depth of 11.0 ft into a 6-inch diameter borehole. The monitoring point was screened to two depths: 7.0 to 7.5 and 10.0 to 10.5 ft.

Type J thermocouples were installed in monitoring point MPE at depths of 12 and 14 ft. DataWrite Research oxygen sensors were installed in monitoring point MPG at depths of 7.5 and 10.5 ft. The oxygen sensors were on-line from October 13 through 23, 1995 and from December 4 through 7, 1995.

The DataWrite oxygen sensors consist of an in situ oxygen probe, signal transfer line, and an aboveground data logger. DataWrite software was installed to a personal computer to calibrate, program, and initiate operation of the sensors. The in situ sensors respond to oxygen concentrations in the soil gas and generate a millivolt signal reflecting that concentration. Each sensor was calibrated before being installed in the vadose zone by producing a response to the atmospheric oxygen level of 21%. The calibration factor (sensor voltage divided by 21) was then retained by the sensor's data logger. Future oxygen concentrations were calculated by applying that calibration factor to the millivolt signal from the sensor.

The DataWrite oxygen sensor was programmed through the data logger to generate oxygen measurements on a temporal basis. The millivolt signal from the two sensors installed at monitoring point MPG was recorded every 30 minutes. The data logger stored these millivolt signals and their resulting oxygen concentrations. The data were downloaded daily to a Hewlett Packard 200LX Palmtop personal computer. Two files were established during this downloading process: (1) a raw data file with recording number, date, time, elapsed time, percent oxygen concentrations, and millivolt signal, and (2) a chart that graphically presented the percent oxygen concentrations over time.

After installation of the monitoring points, initial soil gas measurements were taken with a GasTechtor portable O_2/CO_2 meter and a GasTech Trace-Techtor portable hydrocarbon meter. In general, oxygen limitation was observed at the deeper depths of monitoring points, except at

monitoring point MPE. Oxygen concentrations ranging from 0.5% to 4.0% were found in MPD and MPG at depths of 10.0 ft (Table 2).

Table 2. Initial Soil Gas Compositions at Site 2, the Base Housing Area, Havre AFS, MT

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppmv)
MPD	8-8.5	12.5	7.5	320
	10-10.5	0.50	17.5	840
MPE	11.5-12.0	17.0	4.0	275
	14-14.5	15.5	4.5	350
MPG	7.0-7.5	17.0	3.0	240
	10.0-10.5	4.0	12.0	720

3.2.4 Soil Sampling and Analysis

One soil sample was collected during the installation of monitoring point MPD and was labeled HAV-MPD-10.0'-10.5'. The soil sample was collected in a brass sleeve using a split-spoon sampler. The sample was placed in an insulated cooler, chain-of-custody records and shipping papers were completed, and the sample was sent to Alpha Analytical, Inc., in Sparks, Nevada. The sample was analyzed for BTEX, bulk density, moisture content, particle size, porosity, and TPH. The laboratory analytical report is provided in Appendix B.

3.2.5 LNAPL Recovery Testing

3.2.5.1 System Setup

The bioslurping pilot test system is the same as described in Section 3.1.5.1. A brief system startup test was performed prior to LNAPL recovery testing to ensure that all system components were working properly. The system checklist is provided in Appendix C. All site data and field

testing information were recorded in a field notebook and then transcribed onto pilot test data sheets provided in Appendix D.

3.2.5.2 Initial Skimmer Pump Test

Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set at the LNAPL/groundwater interface with the wellhead open to the atmosphere via a PVC connecting tee (Figure 5). The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on October 11, 1995, to begin the skimmer pump test. The test was operated continuously for approximately 39 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the skimmer pump test. Test data sheets are provided in Appendix D.

An LNAPL sample was collected during the initial skimmer test and was labeled HAV-FUEL-MW7. The sample was sent to Alpha Analytical, Inc., Sparks, Nevada for analysis of BTEX and boiling point fractionation.

3.2.5.3 Bioslurper Pump Test

Upon completion of the skimmer pump test, preparations were made to begin the bioslurper pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set at the LNAPL/groundwater interface, as in the skimmer pump test. However, in contrast to the skimmer pump test, the PVC connecting tee was removed, sealing the wellhead and allowing the pump to establish a vacuum in the well (Figure 3). A pressure gauge was installed at the wellhead to measure the vacuum inside the extraction well. The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on October 14, 1995, to begin the bioslurper pump test. The test was initiated approximately 15 hours after the skimmer pump test and was operated continuously for approximately 98 hours. The LNAPL and groundwater extraction

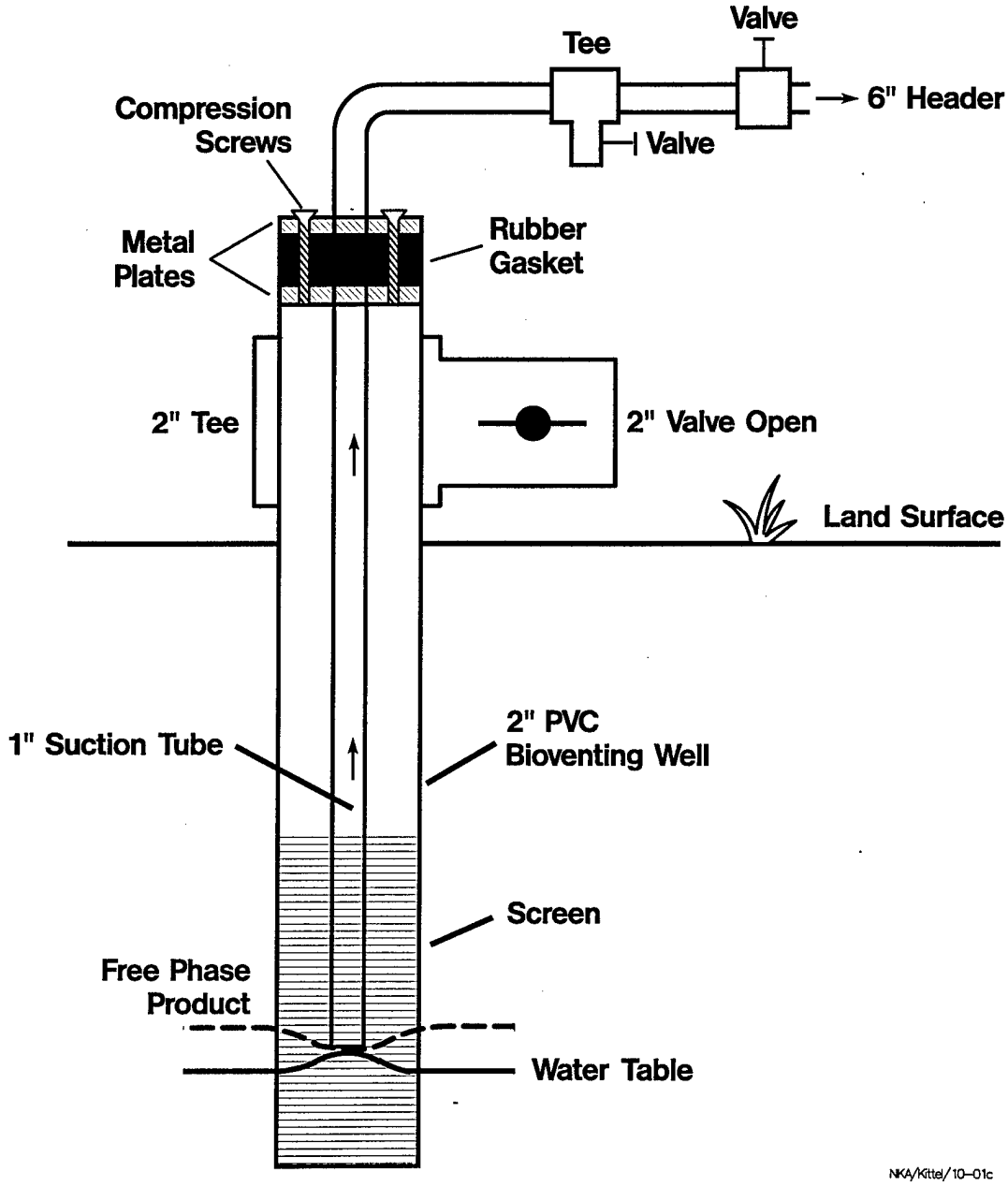

Figure 5. Slurper Tube Placement and Valve Position for the Skimmer Pump Test

rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. Test data sheets are provided in Appendix D.

3.2.5.4 Drawdown Pump Test

Upon completion of the bioslurper pump test, preparations were made to begin the drawdown pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set so that the tip was 17 inches below the oil/water interface with the PVC connecting tee open to the atmosphere (Figure 6). The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on October 18, 1995, to begin the drawdown pump test. The test was initiated approximately 1 hour after the bioslurper pump test and was operated continuously for 47 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the drawdown pump test. Test data sheets are provided in Appendix D.

3.2.5.5 Second Skimmer Pump Test

Upon completion of the drawdown pump test, preparations were made to begin the second skimmer pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The valve and slurper tube configuration were identical to that used for the initial skimmer pump test. The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on October 20, 1995, to begin the second skimmer pump test. The test was initiated approximately 7 hours after the drawdown pump test and was operated continuously for 27 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. Test data sheets are provided in Appendix D.

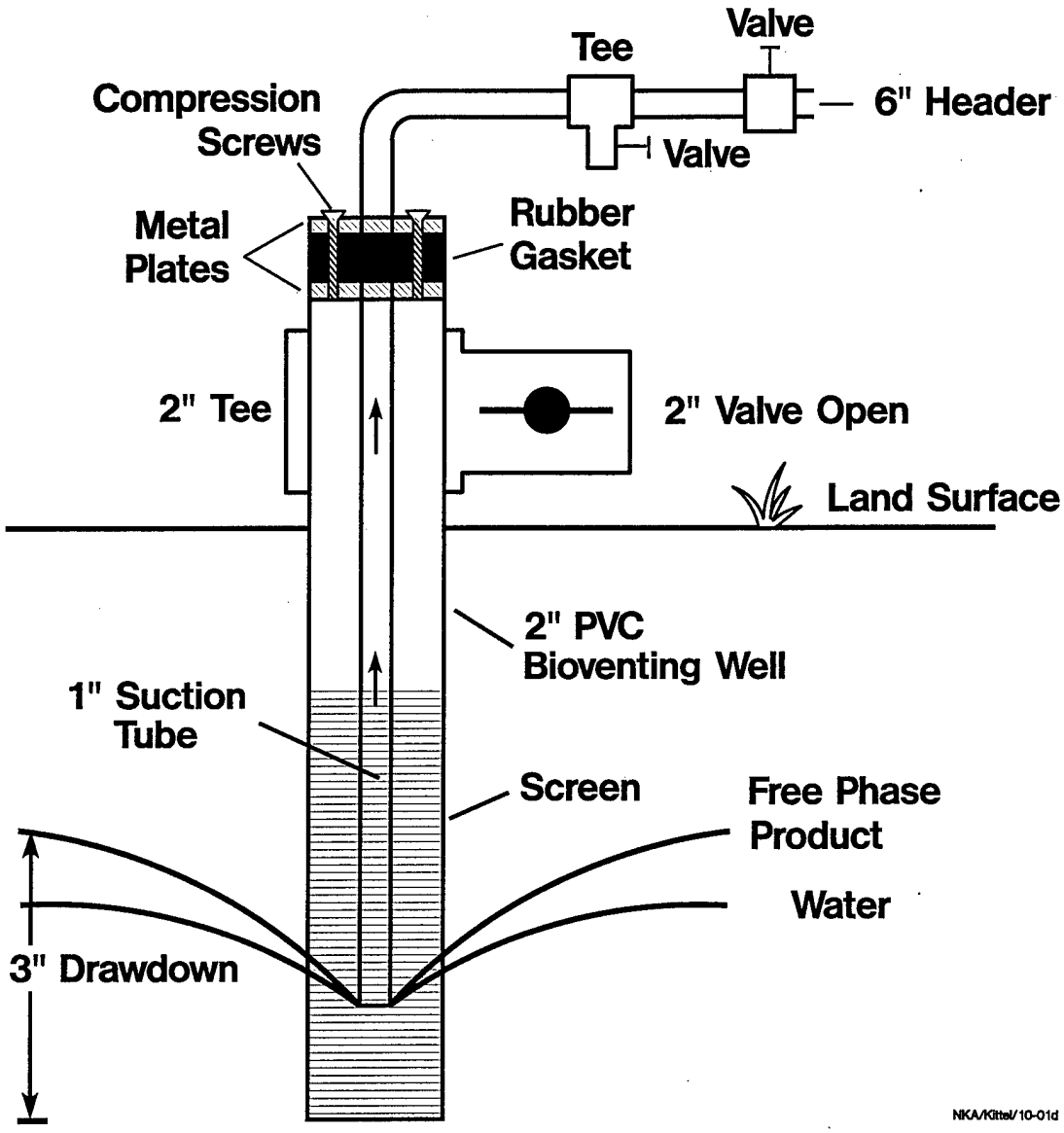

Figure 6. Slurper Tube Placement and Valve Position for the Drawdown Pump Test

3.2.5.6 Off-Gas Sampling and Analysis

A soil gas sample was collected from the bioslurper off-gas during the bioslurper pump test. The sample was collected in a Tedlar™ bag and transferred to a Summa™ canister. The sample was labeled HAV-Stack Gas and sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

3.2.5.7 Groundwater Sampling and Analysis

Two groundwater samples were collected during the bioslurper pump test. Samples were collected from the oil/water separator and were labeled HAV-OWS-Water-Samp1 and HAV-OWS-Water-Samp2. Samples were collected in 40-mL VOA vials containing HCl preservative. Samples were checked to ensure no headspace was present and were then shipped on ice and sent under chain of custody to Alpha Analytical, Inc., in Sparks, Nevada for analyses of BTEX and TPH.

3.2.6 Soil Gas Permeability Testing

Soil gas permeability test data were collected during the bioslurper pump test in monitoring well MW-7. Before a vacuum was established in the extraction well, the initial soil gas pressures at the monitoring points were recorded. The start of the bioslurper pump test created a steep pressure drop in the extraction well which was the starting point for the soil gas permeability testing. Soil gas pressures were measured at each of the three monitoring points at all depths to track the rate of outward propagation of the pressure drop in the extraction well. Soil gas pressure data were collected frequently during the first 20 minutes of the test. The soil gas pressures were recorded throughout the bioslurper pump test to determine the bioventing radius of influence. Test data are provided in Appendix E.

3.2.7 In Situ Respiration Testing

Air containing approximately 3.7% helium was injected into four monitoring points for approximately 23 hours beginning on October 19, 1995. The setup for the in situ respiration test is described in the *Test Plan and Technical Protocol a Field Treatability Test for Bioventing* (Hinchee et al., 1992). A ½-hp diaphragm pump was used for air and helium injection. Air and helium were injected through the following monitoring points at the depths indicated: MPD-8.0′, MPD-10.0′, MPE-11.5′, and MPG-10.0′. After the air/helium injection was terminated, soil gas concentrations of oxygen, carbon dioxide, TPH, and helium were monitored periodically. The respiration test was terminated on October 22, 1995. Oxygen utilization and biodegradation rates were calculated as described in Hinchee et al. (1992). Raw data for these tests are presented in Appendix F.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributable to either diffusion through the soil or leakage. A rapid drop in helium concentration usually indicates leakage. A gradual loss of helium along with a first-order curve generally indicates diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium diffuses approximately 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations at test completion are at least 50 to 60% of the initial levels, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

4.0 RESULTS

This section documents the results of the site characterization, the comparative LNAPL recovery pump test, and other supporting tests conducted at Havre AFS.

4.1 Site 1: Results at Monitoring Well MW-F

4.1.1 Baildown Test Results

Results from the baildown test in monitoring well MW-F is presented in Table 3. A total volume of 9.5 L (2.5 gallons) was removed by hand bailing from monitoring well MW-F. The LNAPL thickness did not recover to initial levels by the end of the 32-hour test period, which indicated that the well may not be suitable for bioslurping. Therefore, only a short-term bioslurper pump test was conducted.

4.1.2 Soil Sample Analyses

Table 4 shows the BTEX and TPH concentrations measured in the soil sample collected from Site 1 at the Base Housing Area. BTEX and TPH concentrations were relatively high at a total BTEX concentration of 2.9 mg/kg and a TPH concentration of 6,700 mg/kg. Benzene and toluene were below detection limits. The results of the physical characterization of the soil is presented in Table 5.

4.1.3 Bioslurper Pump Test Results

LNAPL recovery rates were relatively low during the bioslurper pump test. A total of 2.4 gallons of LNAPL and 400 gallons of groundwater were extracted during the bioslurper pump test, with daily average recovery rates of 1.3 gallons/day for LNAPL and 210 gallons/day for groundwater (Table 6).

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. Oxygen concentrations increased significantly only at monitoring point MPA (Table 7).

4.1.4 Bioventing Analyses: Soil Gas Permeability and Radius of Influence Testing

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the extraction well. The radius of influence is then defined

Table 3. Results of Baildown Testing in Monitoring Well MW-F

Sample Collection Time (Date-Time)	Depth to LNAPL (ft)	Depth to Groundwater (ft)	LNAPL Thickness (ft)
Initial Reading 10/9/95-845	13.55	15.05	1.50
10/10/95-1041	14.70	14.79	0.09
10/10/95-1047	14.62	14.72	0.10
10/10/95-1054	14.56	14.61	0.05
10/10/95-1109	14.36	14.47	0.11
10/10/95-1143	14.12	14.26	0.14
10/10/95-1254	13.92	14.08	0.16
10/10/95-1332	13.88	14.02	0.14
10/10/95-1443	13.83	13.99	0.16
10/10/95-1547	13.78	13.96	0.18
10/10/95-1702	13.76	13.96	0.20
10/11/95-0840	13.79	14.04	0.25
10/11/95-1803	13.76	13.98	0.22

Table 4. BTEX and TPH Concentrations in a Soil Sample from Site 1, the Base Housing Area, Havre AFS, MT

Parameter	Concentration (mg/kg)
	HAV-MPA-10.0'-10.5'
TPH as diesel	6,700
Benzene	<0.50
Toluene	<0.50
Ethylbenzene	1.3
Xylenes	1.1

Table 5. **Physical Characterization of Soil from Site 1, the Base Housing Area, Havre AFS, MT**

Parameter	Sample
	HAV-MPA-Comp
Moisture Content (%)	13.9
Porosity (%)	71.7
Specific Gravity (g/cm^3)	0.75
Particle Size	
Sieve Size	Percent
½-inch	16
4.75 mm	53
2.36 mm	25
2.0 mm	5.2
1.18 mm	0.89
600 μm	<0.10
425 μm	<0.10
300 μm	<0.10
150 μm	<0.10
75 μm	<0.10

Table 6. Bioslurper Pump Test Results at MW-F, the Base Housing Area, Havre AFS, MT

Time (days)	Recovery Rate (gal/day)	
	LNAPL	Groundwater
1	1.9	440
2	0.75	29
Average	1.3	210
Total Recovered (gal)	2.4	400

NA = Not applicable.

Table 7. Oxygen Concentrations During the Bioslurper Pump Test at MW-F

Monitoring Point	Oxygen Concentrations (%) Versus Time (minutes)			
	0	21.5	44.5	50.5
MPA-8-8.5′	10.0	21.0	21.0	21.0
MPA-10-10.5′	0.0	0.0	0.0	2.5
MPB-10.5-11′	19.0	14.0	21.0	20.5
MPB-15-15.5′	16.5	17.0	17.0	17.0
MPF-8.5-9′	20.0	20.0	21.0	20.5
MPF-13.5-14′	1.0	1.0	1.5	1.0

[1] One hour after bioslurper pump shut off.

as the distance from the extraction well where 0.1 inch of H_2O can be measured. Based on this definition, the radius of influence during the bioslurper pump test at monitoring well MW-F was approximately 18 ft (Figure 7).

4.2 Site 2: Results at Monitoring Well MW-7

4.2.1 Baildown Test Results

Results from the baildown test in monitoring well MW-7 is presented in Table 8. A total volume of 1.1 L (0.29 gallons) was removed by hand bailing from monitoring well MW-7. The LNAPL thickness recovered rapidly to approximately initial levels by the end of the 25-hour test period. These results indicated that monitoring well MW-7 was suitable for bioslurper field testing.

4.2.2 Soil Sample Analyses

Table 9 shows the BTEX and TPH concentrations measured in soil samples collected from the Base Housing Area. BTEX and TPH concentrations were relatively high with a total BTEX concentration of 35.3 mg/kg and a TPH concentration of 13,000 mg/kg. The results of the physical characterization of the soils are presented in Table 10.

4.2.3 LNAPL Pump Test Results

Results from the LNAPL pump tests are presented in the following sections. Due to the very low LNAPL recovery, a graph illustrating LNAPL recovery during each pump test was not prepared.

4.2.3.1 Initial Skimmer Pump Test Results

A total of 0.73 gallons of LNAPL was recovered during this test, with an average recovery rate of 0.45 gallons/day (Table 11). A total of 1.6 gallons of groundwater was extracted with an average extraction rate of 0.99 gallons/day (Table 11).

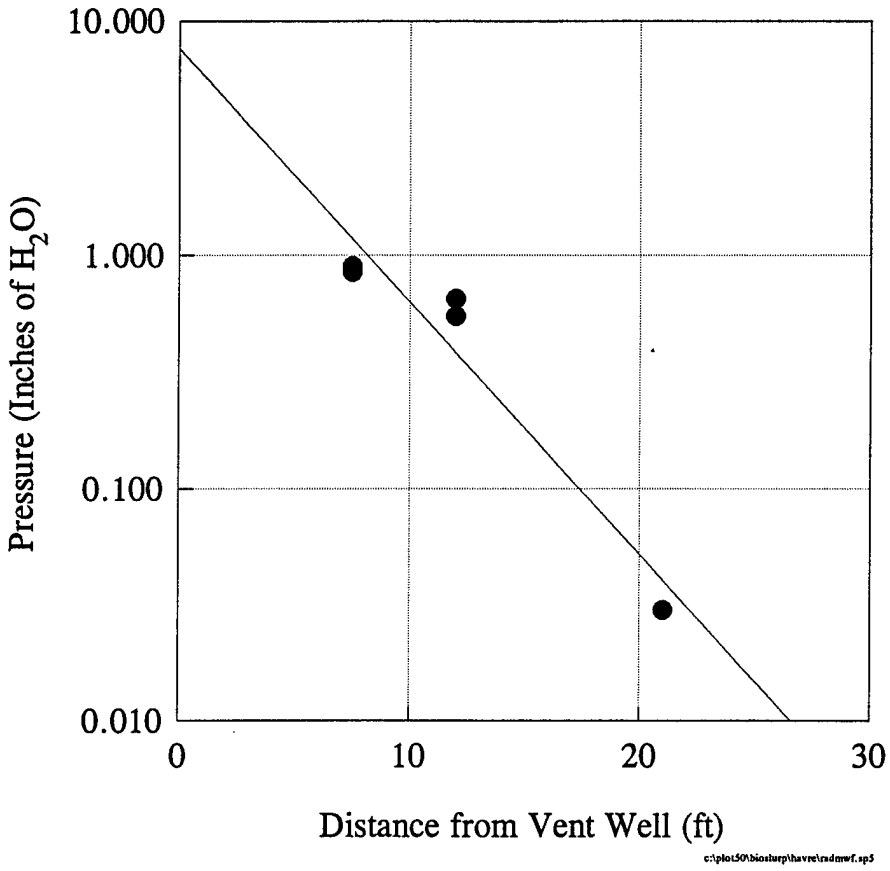

Figure 7. **Soil Gas Pressure Change as a Function of Distance During the Soil Gas Permeability Test at Monitoring Well MW-F**

Table 8. Results of Baildown Testing in Monitoring Well MW-7

Sample Collection Time (Date-Time)	Depth to LNAPL (ft)	Depth to Groundwater (ft)	LNAPL Thickness (ft)
Initial Reading 10/9/95-845	14.72	15.08	0.36
10/10/95-1013	14.90	14.95	0.05
10/10/95-1016	14.88	14.97	0.09
10/10/95-1023	14.86	14.99	0.13
10/10/95-1040	14.84	15.02	0.18
10/10/95-1111	14.82	15.05	0.23
10/10/95-1143	14.80	15.06	0.26
10/10/95-1257	14.78	15.04	0.26
10/10/95-1330	14.76	15.04	0.28
10/10/95-1445	14.74	15.01	0.27
10/10/95-1550	14.74	15.01	0.27
10/10/95-1700	14.74	15.02	0.28
10/11/95-0840	14.76	15.04	0.28
10/11/95-1130	14.76	15.04	0.28

Table 9. BTEX and TPH Concentrations in a Soil Sample from Site 2, the Base Housing Area, Havre AFS, MT

Parameter	Concentration (mg/kg)
	HAV-MPD-10.0'-10.5'
TPH as diesel	13,000
Benzene	< 1.0
Toluene	1.2
Ethylbenzene	1.6
Xylenes	32

Table 10. Physical Characterization of Soil from Site 2, the Base Housing Area, Havre AFS, MT

Parameter	Sample Results
	HAV-MPD-Comp
Moisture Content (%)	16.4
Porosity (%)	73.2
Specific Gravity (g/cm^3)	0.71
Particle Size	
Sieve Size	Percent
½-inch	10
4.75 mm	48
2.36 mm	30
2.0 mm	8.9
1.18 mm	2.4
600 μm	0.46
425 μm	<0.10
300 μm	<0.10
150 μm	<0.10
75 μm	<0.10

Table 11. Pump Test Results at MW-7, the Base Housing Area, Havre AFS, MT

Time (days)	Recovery Rate (gal/day)							
	Initial Skimmer Pump Test		Bioslurper Pump Test		Drawdown Pump Test		Second Skimmer Pump Test	
	LNAPL	Groundwater	LNAPL	Groundwater	LNAPL	Groundwater	LNAPL	Groundwater
1	1.2[1]	1.5[1]	0.27	147	0.15	59	0.018	1.5
2	0.039	0.71	0.11	30	0.010	15	NA	NA
3	NA	NA	0.088	80	NA	NA	NA	NA
4	NA	NA	0.061	47	NA	NA	NA	NA
Average	0.45	0.99	0.14	76	0.078	37	0.018	1.5
Total Recovered (gal)	0.73	1.6	0.55	304	0.15	70	0.020	1.7

1 Represents data collected during the initial 14 hours of operation.
NA Not applicable.

4.2.3.2 Bioslurper Pump Test Results

The LNAPL thickness prior to the bioslurper pump test was 0.060 ft (Table 12). LNAPL recovery rates was relatively low during the bioslurper pump test. A total of 0.55 gallons of LNAPL and 304 gallons of groundwater were extracted during the bioslurper pump test, with daily average recovery rates of 0.14 gallons/day for LNAPL and 76 gallons/day for groundwater (Table 11). The vacuum-exerted wellhead pressure on monitoring well MW-7 ranged from 5 to 9 inches of mercury throughout the bioslurper pump test.

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. Oxygen concentrations increased significantly at all monitoring points in the vicinity of MW-7 (Table 13). These results correlate with radius of influence results from the soil gas permeability test.

Table 12. Depths to Groundwater and LNAPL Prior to Each Pump Test

Test	Test Start Date	Depth to LNAPL (ft)	Depth to Groundwater (ft)	LNAPL Thickness (ft)
Initial Skimmer Pump Test	10/13/95	NM	NM	NM
Bioslurper Pump Test	10/14/95	14.98	15.04	0.060
Drawdown Pump Test	10/18/95	16.34	16.35	0.010
Second Skimmer Pump Test	10/20/95	15.55	15.65	0.10

Table 13. Oxygen Concentrations During the Bioslurper Pump Test at MW-7, Havre AFS, MT

Monitoring Point	Oxygen Concentrations (%) Versus Time (minutes)							
	0	9	26	34.5	54	73	81.5	96.5
MPD-8-8.5′	12.5	17.00	18.00	19.00	19.00	19.25	19.00	19.00
MPD-10-10.5′	0.50	0.50	6.50	8.00	8.50	10.00	18.50	10.80
MPE-11.5-12′	17.00	20.00	19.50	20.00	20.00	20.50	20.20	20.00
MPE-14-14.5′	15.50	16.50	18.00	18.50	19.00	21.00	20.50	18.50
MPG-7.5′	17.00	20.50	20.00	21.00	21.00	20.50	21.00	21.00
MPG-10.5′	4.00	17.50	18.00	19.25	19.50	18.90	18.50	21.00

[1] One hour after bioslurper pump shut off.

4.2.3.3 Drawdown Pump Test

LNAPL recovery was very low during the drawdown pump test. Very little LNAPL or groundwater was extracted, with totals of 0.15 gallons of LNAPL and 70 gallons of groundwater extracted (Table 11). These results demonstrate that operation of the bioslurper system in the drawdown mode was not an effective means of free-product recovery.

4.2.3.4 Second Skimmer Pump Test

Totals of 0.020 gallons of LNAPL and 1.7 gallons of groundwater were recovered during the second skimmer pump test, with daily average recovery rates of 0.018 gallons/day for LNAPL and 1.5 gallons/day for groundwater (Table 11). These results demonstrate that operation of the bioslurper system in the skimmer mode was not an effective means of free-product recovery.

4.2.4 Extracted Groundwater, LNAPL, and Off-Gas Analyses

Groundwater samples were collected during the bioslurper pump test. TPH concentrations were low, with average concentrations of 22 mg/L (Table 14). Benzene and toluene were present below detection limits. Ethylbenzene and xylenes were below 0.10 mg/L.

Off-gas samples from the bioslurper system also were collected during the bioslurper pump test. The results from the off-gas analyses are presented in Table 15. Given a vapor discharge rate of 23 scfm and using an concentration of 66 ppmv TPH and 0.021 ppmv benzene, approximately 0.89 lb/day of TPH and 0.00014 lb/day benzene was emitted to the air during the bioslurper pump test.

The composition of LNAPL is shown in Tables 16 and 17 in terms of BTEX concentrations and distribution of C-range compounds, respectively. The distribution of C-range compounds is shown graphically in Figure 8.

Table 14. **BTEX and TPH Concentrations in Extracted Groundwater During the Bioslurper Pump Test at Havre AFS, MT**

Parameter	Concentration (mg/L)	
	HAV-OWS-Water-Samp1	HAV-OWS-Water-Samp2
TPH (as diesel)	19	25
Benzene	<0.0010	<0.0010
Toluene	<0.0010	<0.0010
Ethylbenzene	0.0011	<0.0010
Total Xylenes	0.014	0.0096

Table 15. **BTEX and TPH Concentrations in Off-Gas During the Bioslurper Pump Test at Havre AFS, MT**

Parameter	Concentration (ppmv)
	HAV-Stack Gas
TPH as jet fuel	66
Benzene	0.021
Toluene	0.030
Ethylbenzene	0.038
Xylenes	0.42M

M = Reported value may be biased due to apparent matrix interferences

Table 16. BTEX Concentrations in LNAPL from Havre AFS, MT

Compound	Concentrations (mg/kg)
Benzene	<30
Toluene	<30
Ethylbenzene	31
Total Xylenes	81

Table 17. C-Range Compounds in LNAPL from Havre AFS, MT

C-Range Compounds	Percentage of Total
<C11	9.6
C12	7.1
C13	9.1
C14	10.0
C15	10.4
C16	11.1
C17	10.0
C18	8.9
C19	7.6
C20	5.7
C21	3.9
C22	2.3
C23	1.4
>C24	2.9

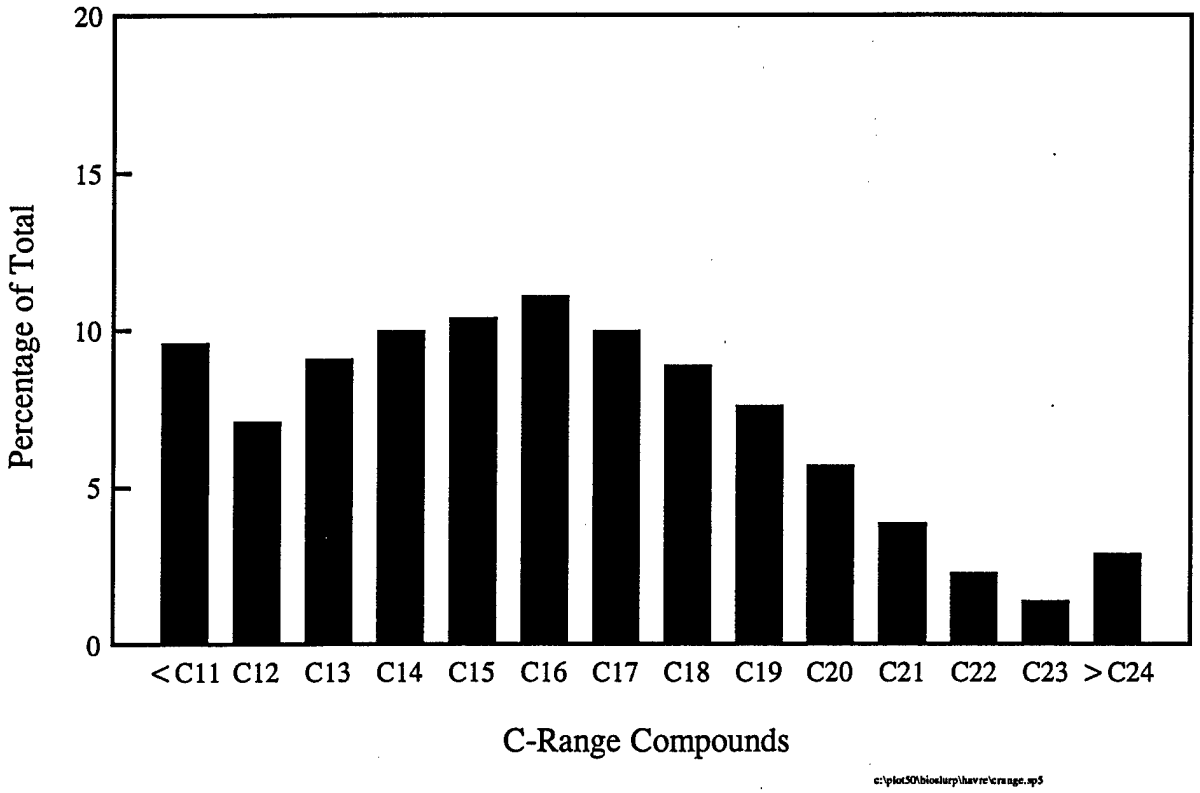

Figure 8. **Distribution of C-Range Compounds in Extracted LNAPL at the Base Housing Area, Havre AFS, MT**

4.2.5 Bioventing Analyses

4.2.5.1 Soil Gas Permeability and Radius of Influence

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the extraction well. The radius of influence is then defined as the distance from the extraction well where 0.1 inch of H_2O can be measured. Based on this definition, the radius of influence during the bioslurper pump test at monitoring well MW-7 was approximately 12 ft (Figure 9).

4.2.5.2 In Situ Respiration Test Results

Results from the in situ respiration test are presented in Table 18. Oxygen depletion was relatively fast, with oxygen utilization rates ranging from 0.083 to 0.45 $\%O_2$/hr. Biodegradation rates ranged from 1.3 to 7.2 mg/kg-day. No oxygen utilization was observed at monitoring point MPE-11.5′; however, soil gas at this monitoring point was not oxygen-depleted prior to the test. The helium concentration was relatively steady at monitoring points MPD; however, helium dropped below 50% of initial levels at monitoring point MPG before the end of the test, indicating that leakage and diffusion may have contributed to oxygen depletion at this monitoring point.

4.2.6 DataWrite Oxygen Sensor Evaluation

The two in situ oxygen sensors generated data over a period of 10 days in October and 3 days in December. Data from these tests is provided in Appendix G. During October, the sensor located 7.5 ft below ground surface operated as programmed and collected a full compliment of data points. Because of the close proximity of the sensor to the surface and low hydrocarbon concentrations, the values reported were generally close to atmospheric concentrations of oxygen. Slight decreases in oxygen levels were observed during the in situ respiration test, which correlated with measurements using field instruments. The sensor located 10.5 ft below ground surface performed properly for the first 7 days, except for abnormally high oxygen readings during the first 16 hours; however, during data transfer to the computer, a malfunction occurred, resulting in the loss of the data for the first week of operation. After this malfunction, data collected corresponded to data from field instruments.

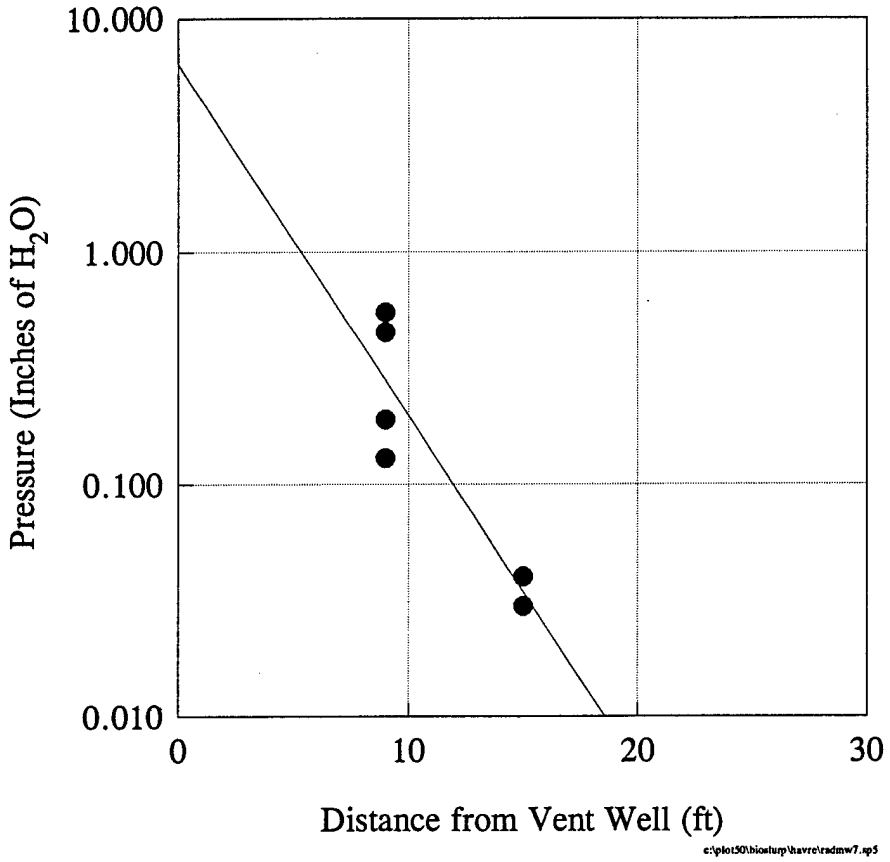

Figure 9. **Soil Gas Pressure Change as a Function of Distance During the Soil Gas Permeability Test at Monitoring Well MW-7**

Table 18. In Situ Respiration Test Results at the Base Housing Area, Havre AFS, MT

Monitoring Point	Oxygen Utilization Rate (%/hr)	Biodegradation Rate (mg/kg-day)
MPD-8.0′	0.083	1.3
MPD-10.0′	0.41	6.6
MPE-11.5′	0.0	0.0
MPG-10.0′	0.45	7.2

Correlation of all data collected with the oxygen sensors versus data collected with the GasTEch O_2/CO_2 meter generates a correlation coefficient of 0.9593. This data indicates that data collected with the oxygen sensors are very comparable to data collected with the field instruments.

A second test was conducted in December by turning off the blower and conducting a short in situ respiration test. Abnormally high oxygen readings again were obtained during initial operation. The data logger was reprogrammed and operated properly until the end of the test. Oxygen concentrations dropped slightly during the test and rose to near initial levels once the aeration was reinitiated. These results indicated that the oxygen sensors were generating useful data, but may require careful attention to ensure data loggers are functioning properly.

5.0 DISCUSSION

None of the LNAPL recovery techniques were successful at recovering free product. These results indicate that there is little free product present at the two sites or that it is relatively immobile. As a result, it was decided to install a bioventing system at both sites to remediate the vadose zone. Bioventing systems were configured to inject air into monitoring well MW-F at Site 1 and monitoring well MW-7 at Site 2.

Soil gas concentrations were measured at monitoring points during the bioslurper pump test to determine whether the vadose zone was being oxygenated. At Site 1, oxygen concentrations increased only at the closest monitoring point; however, based on radius of influence testing, it is likely that soil gas at greater distances will become oxygenated over time. At Site 2, all monitoring

points exhibited increased oxygen concentrations. These results correlated with results from the soil gas permeability test where a radius of influence of approximately 12 ft was determined. The radius of influence of the bioventing system potentially may be greater than 12 ft, since the system is configured for air injection. With the radius of influence from these systems, bioventing is treating the entire contaminant plume at both sites.

Implementation of bioslurping or any free-product recovery technique at the Havre AFS test site does not appear likely to facilitate enhanced recovery of LNAPL from the water table and simultaneous in situ biodegradation of hydrocarbons in the vadose zone via bioventing. A large volume of free product does not appear to be present; therefore, bioventing is recommended to remediate vadose zone contamination.

6.0 REFERENCES

Battelle. 1995. *Test Plan and Technical Protocol for Bioslurping*, Report prepared by Battelle Columbus Operations for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Rev. 2), Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering Sciences, Inc. for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

APPENDIX A

SITE-SPECIFIC TEST PLAN FOR BIOSLURPER FIELD ACTIVITIES AT HAVRE AFS, MONTANA

SITE-SPECIFIC TEST PLAN FOR BIOSLURPER TESTING AT HAVRE AIR FORCE STATION, MONTANA (A002) CONTRACT NO. F41624-94-C-8012

DRAFT

to

U.S. Air Force Center for Environmental Excellence
Technology Transfer Division
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8001 Arnold Drive
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for

Havre AFS, MT

September 27, 1995

by

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SITE-SPECIFIC TEST PLAN FOR BIOSLURPER FIELD ACTIVITIES AT HAVRE AIR FORCE STATION, MONTANA

DRAFT

U.S. Air Force Center for Environmental Excellence
Technology Transfer Division
(AFCEE/ERT)
Brooks AFB, TX

September 27, 1995

1.0 INTRODUCTION

The Air Force Center for Environmental Excellence is conducting a nationwide application of an innovative technology for free-product recovery and soil bioremediation. The technology tested in the Bioslurper Initiative is vacuum-enhanced free-product recovery/bioremediation (bioslurping). The field test and evaluation are intended to demonstrate the initial feasibility of bioslurping by measuring system performance in the field. System performance parameters, mainly free-product recovery, will be determined at numerous sites. Field testing will be performed at many sites to determine the effects of different organic contaminant types and concentrations and different geological conditions on bioslurping effectiveness.

Plans for the field test activities are presented in two documents. The first is the overall test plan and technical protocol for the entire program, titled *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). The overall plan is supplemented by plans specific to each test site. The concise site-specific plans effectively communicate regulatory background to base personnel.

The overall test plan and protocol was developed as a generic plan for the Bioslurper Initiative to improve the accuracy and efficiency of test plan preparation. The field program requires installation and operation of the bioslurping system supported by a wide variety of site characterization, performance monitoring, and chemical analysis activities. The basic methods to be applied from site to site do not change. Preparation and review of the overall plan allows efficient documentation and review of the basic approach to the test program. Peer and regulatory review were performed for the overall plan to ensure the credibility of the overall program.

This letter report is the site-specific plan for application of bioslurping at Havre Air Force Station, Montana. It was prepared based on site-specific information received by Battelle from Havre AFS and other pertinent site-specific information to support the generic test plan.

Site-specific information for Havre AFS included data for three potential test locations. Each location is within the same base residential area. Several housing units in this area were subject to Underground Storage Tank (UST) leakage of heating oil. An initial review of the data indicates that Well MW-F is the most likely candidate for the bioslurper pilot test. If MW-F is found unsuitable for testing, Well MW-7 or MW-G may be viable alternatives.

2.0 SITE DESCRIPTION

The information presented in this section was summarized from the document titled "IRP Preliminary Remedial Design at Havre AFS" prepared byMatney-Frantz Engineering, P.C. (December 1994). A diagram of the remedial investigation area is shown as Figure 1. Monitoring wells MW-7 and MW-F are located within the proposed testing area and have shown measurable free product thickness. Figure 2 is a schematic diagram of the housing facilities and monitoring wells located in the remedial investigation area. Monitoring well construction diagrams are provided in Appendix A.

Site history indicates that many underground storage tanks were installed around the site in the 1950's. The USTs were used to store heating oil and diesel fuel. In 1984, the Investigative Restoration Program was employed at Havre AFS to determine releases of heating oil and diesel fuel that may pose a threat to human health and the environment in the area. It was found that 19 out of 26 USTs in the Havre housing area had leaked fuel oil into the surrounding soils. The USTs were removed in September 1992.

2.1 Site Geology

Havre AFS geologic conditions are characterized by approximately 15 feet of soil and unconsoildated material which is underlain by the Upper Cretaceous Bearpaw Shale. The unconsolidated materials are mostly comprised of fine sandy loam and clay loam. These loams are generally derived from parent materials of glacial till and tend to form deep soil horizons.

2.2 Aquifer Characteristics

At Havre AFS depth to groundwater varies from 10 to 17 feet below ground surface. Groundwater generally occurs in sand lenses lying atop the sandy and clay loams. Measurements in wells at the housing facility at Havre AFS indicated a hydraulic conductivity of 0.69 ft/day. Subsequent measurements gave a hydraulic conductivity of 0.0071 to 0.31 ft/day.

2.3 Site Contamination

Data indicates that the well that is most likely to yield significant amounts of free product is MW-F. Well #MW-F had the largest fuel thickness during the June 27, 1994, measurement (2.21'of free floating product) and has shown the greatest amount of free-product recovery throughout the measurement period (data presented in Appendix A). The type of free product in this well is heating oil. Soil samples collected during the UST removal indicated levels of TPH (as diesel) to be 35,200 mg/kg at a depth of 1 foot in the well #MW-F vicinity. A table which contains TPH concentrations in soil from soil collected during the UST removal is presented in Appendix A. Figure 2 is a site map which displays the arrangement of monitoring wells in the area of interest. Well MW-7, which may serve as an alternative well for the bioslurper pilot test, had a fuel thickness value of 0.32' during the June measurement. MW-G was installed as a free product recovery well after free product was discovered in the soil boring. No specific data has been generated for this well. Site characterization will begin with Well MW-F. If preliminary site characterization indicates that this well is unsuitable, or if site logistics prevent the use this well, Well MW-7 and Well MW-G will be evalutated as the potential bioslurper test site.

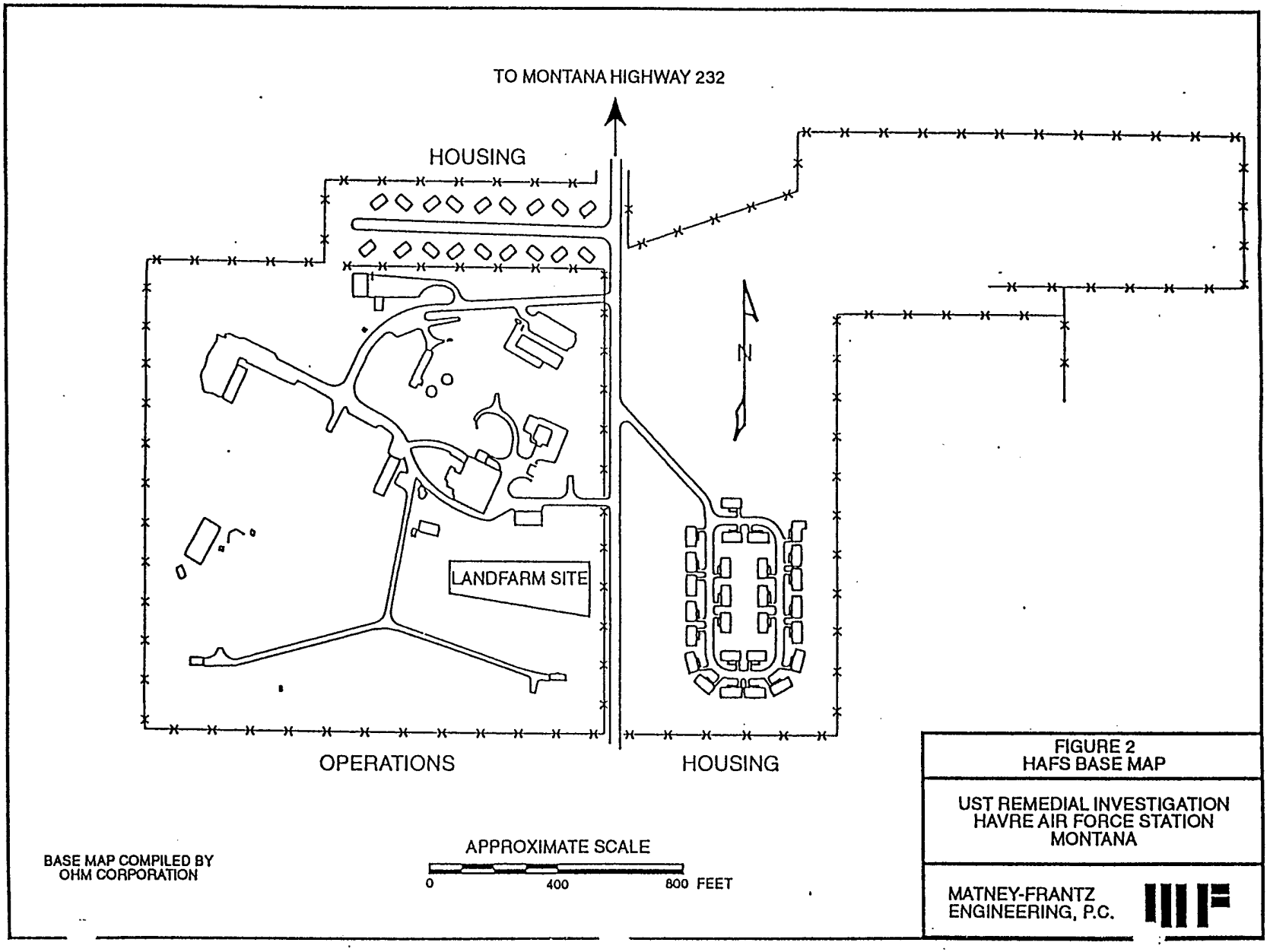
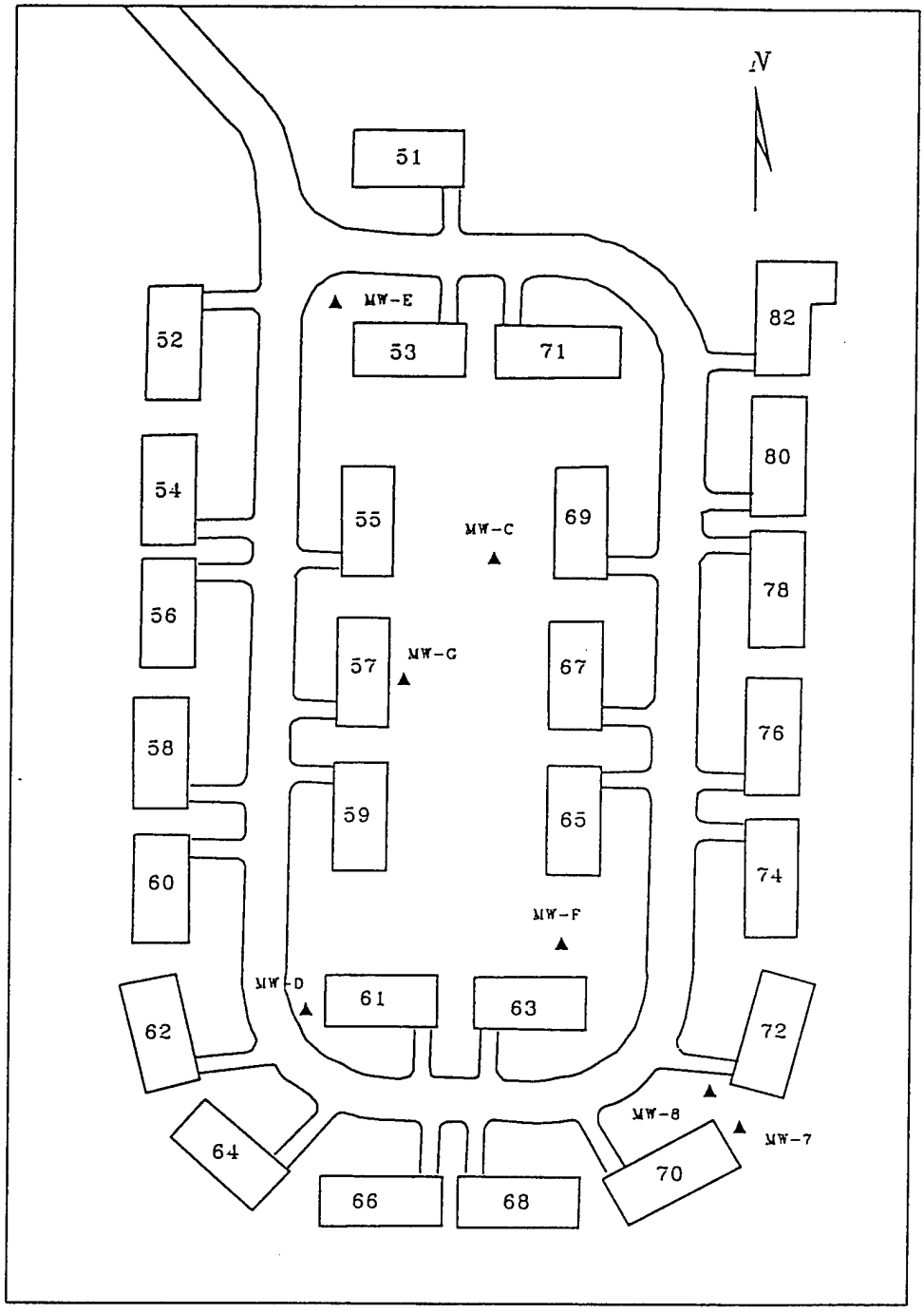


Figure 1. Base map Including the Area of Interest Testing at Havre AFS



Legend

▲ Monitoring Well

Scale

0 50 100 150

FEET

Figure 2. Location of Monitoring Wells in the Housing Area at Havre AFS

3.0 PROJECT ACTIVITIES

The following field activities are planned for the bioslurper pilot test at Havre AFS. Additional details about the activities are presented in the *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). As appropriate, specific sections in the generic Bioslurping Protocol assessment are referenced. Table 1 shows the schedule of activities for the Bioslurper Initiative at Havre AFS.

3.1 Mobilization to the Site

After the site-specific test plan is approved, Battelle staff will mobilize equipment. The 20' by 10' flatbed trailer will be shipped in advance of staff arrival. In case any other equipment used during the pilot test is sent in advance of Battelle staff arrival, the Base Point of Contact (POC) will be asked to find a suitable holding facility to receive the bioslurper pilot test equipment so that it will be easily accessible to the Battelle staff when they arrive with the remainder of the equipment. The exact mobilization date will be confirmed with the Base POC as far in advance of fieldwork as is possible. The Battelle POC will provide the Air Force POC with information on each Battelle employee who will be on site. Battelle personnel will be mobilized to the site after it has been confirmed that the shipped equipment has been received by Havre AFS.

Table 1. Schedule of Bioslurper Test Activities

Pilot Test Activity	Schedule
Mobilization	Day 1-2
Site Characterization	Day 2-3
Baildown Tests and Product/Groundwater Interface Monitoring	
Soil-Gas Survey (limited)	
Slug Tests	
Monitoring Point Installation (3 MPs)	
Soil Sampling (TPH, BTEX[1], physical characteristics)	
System Installation	Day 2-3
Test Startup	Day 3
Skimmer Test (2 days)	Day 3-4
Bioslurper Vacuum Extraction (4 days)	Day 6-9
Soil-Gas Permeability Testing	Day 6
Skimmer Test (continued) (1 day)	Day 10
In Situ Respiration Test — air/helium injection	Day 10
In Situ Respiration Test — monitoring	Day 11-16
Drawdown Pump Test (2 days)	Day 11-12
Demobilization/Mobilization	Day 13-14

[1] BTEX = benzene, toluene, ethylbenzene, and total xylenes

3.2 Site Characterization Tests

3.2.1 Baildown Tests

The baildown test is the primary test for selection of the bioslurper test well. Baildown tests will be performed at wells that contain measurable thicknesses of light, nonaqueous-phase liquid (LNAPL) to estimate the LNAPL recovery potential at those particular wells. Monitoring wells MW-7 and MW-F at the Havre Housing Facility will be tested because they have shown measurable free product thickness in recent surveys. The well exhibiting the highest rate of LNAPL recovery during the baildown tests will be selected for the bioslurper extraction well. Table 2 presents the volume of fuel

that would be present in a 1-ft cross section of various well diameters. Detailed procedures for the baildown tests are provided in Section 5.6 of the generic Bioslurping Protocol.

Table 2. Free Recovery Volumes per Unit Length for Common Well Casing Diameters

Nominal Pipe Size	Schedule 40 Pipe (gallons/ft)	Schedule 80 Pipe (gallons/ft)
2.0	0.174	0.153
3.0	0.384	0.343
4.0	0.661	0.597
6.0	1.50	1.35

3.2.2 Soil-Gas Survey (Limited)

A small-scale soil-gas survey will be conducted to identify the best location for installation of the bioslurping system. The soil-gas survey will be conducted in areas where historical site data indicate the highest contamination levels, namely the areas around MW-F and MW-7. These areas will be surveyed to select the locations for installation of soil-gas monitoring points. Soil-gas monitoring points will be located in areas that exhibit the following characteristics.

1. Relatively high TPH concentrations (10,000 ppm or greater).

2. Relatively low oxygen concentrations (between 0% and 2%).

3. Relatively high carbon dioxide concentrations (depending on soil type, between 2% and 10% or greater).

To obtain further information about the soil-gas survey, consult Section 5.2 of the generic Bioslurping Protocol.

3.2.3 Monitoring Point Installation

Upon conclusion of the initial soil-gas survey and baildown tests, at least three soil-gas monitoring points will be installed. Monitoring points will be used to determine the radius of influence in the vadose zone of the free-product recovery system. In addition, the monitoring points will be located in highly contaminated soils within the free-phase plume and will be positioned to allow detailed monitoring of the in situ changes in soil-gas composition caused by the bioslurper system. The components of soil-gas monitoring points are shown in Figure 3. A general arrangement for soil-gas monitoring points at MW-F in the Housing Area is presented in Figure 4. A shematic diagram of MW-F, and MW-G is presented in Appendix B. Information on monitoring point installation can be found in Section 4.2.1 of the generic Bioslurping Protocol.

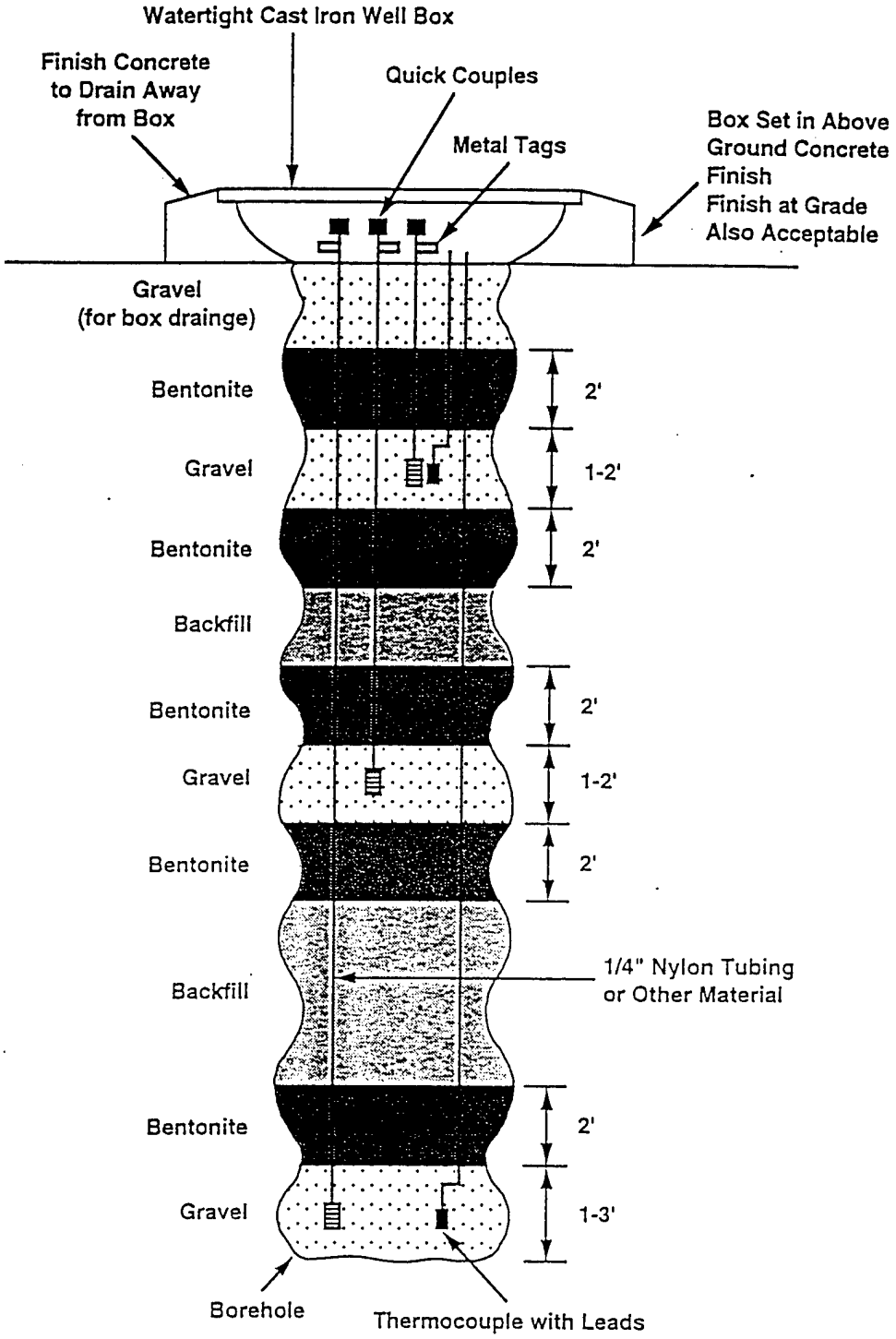


Figure 3. Schematic Diagram of a Typical Soil-Gas Monitoring Point

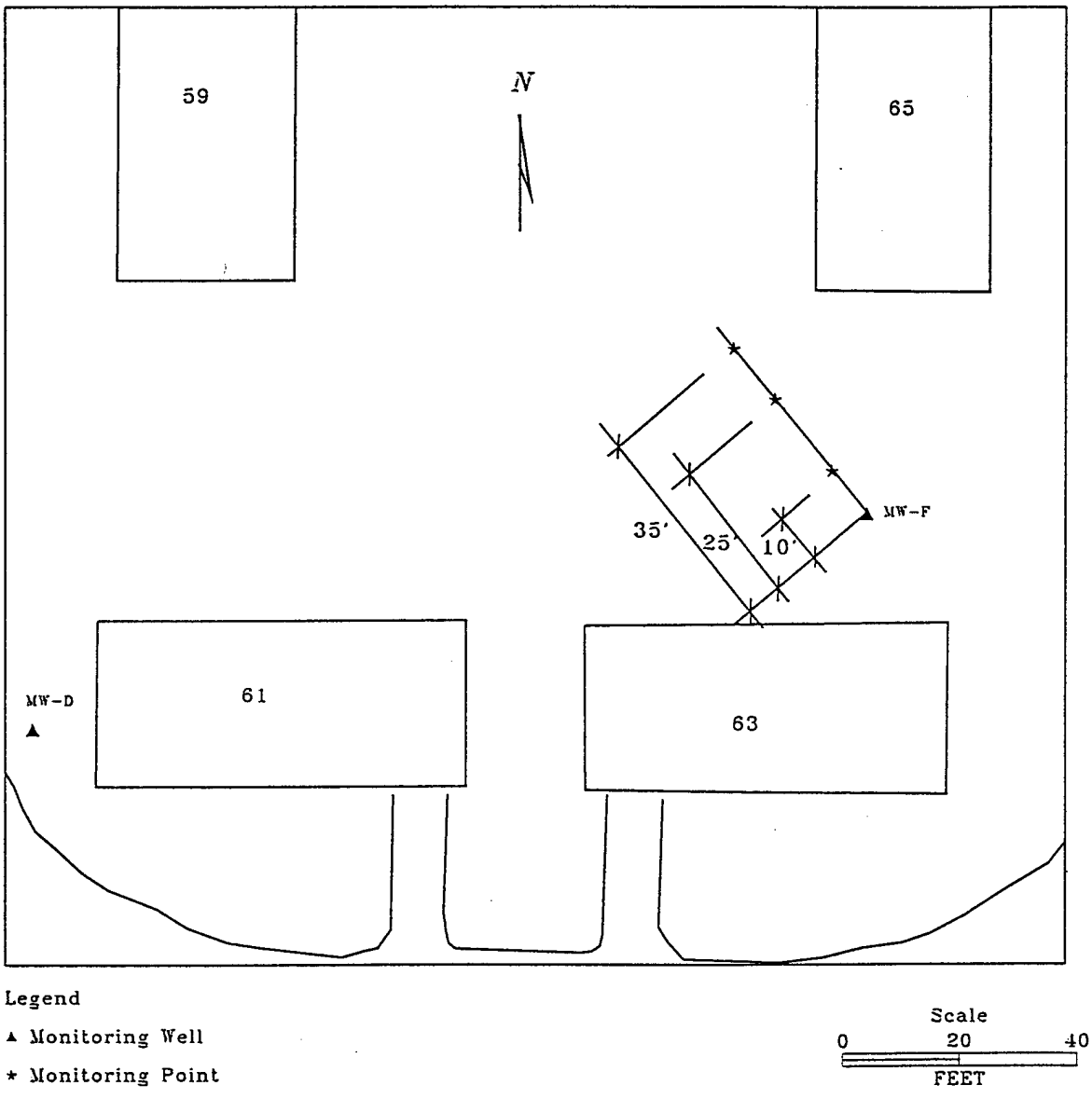


Figure 4. Conceptual Arrangement for Soil-Gas Monitoring Points at MW-F in the Housing Area

3.2.5 Soil Sampling

Soil samples will be collected to determine the physical and chemical composition of the soil near the bioslurper test site. Soil samples will be collected from the boreholes advanced for monitoring point installation at two or three locations at the site chosen for the bioslurper test. Generally, samples will be collected from the capillary fringe over the free product.

Soil samples will be analyzed for particle-size distribution, bulk density, porosity, moisture content, benzene, toluene, ethylbenzene, and xylenes (BTEX), and TPH. Section 5.5.1 of the generic Bioslurping Protocol will be consulted for information on the field measurements and sample collection procedures for soil sampling.

3.3 Bioslurper System Installation and Operation

Once the well to be used for the pilot tests has been identified, the bioslurper pump and support equipment will be installed and the pilot tests will be initiated.

3.3.1 System Setup

Figure 5 shows a flow diagram of the bioslurper process. Figure 6 is a schematic diagram of a typical bioslurper well and slurper tube that will be installed on an existing groundwater well (i.e., monitoring wells MW-F or MW-7). Before the LNAPL recovery tests are initiated, all relevant baseline field data will be collected and recorded. These data will include soil-gas concentrations, initial soil-gas pressures, depth to groundwater, and LNAPL thickness. Ambient soil and all atmospheric conditions (e.g., temperature, humidity, barometric pressure) also will be recorded. All emergency equipment (i.e., emergency shutoff switches and fire extinguishers) will be installed and checked for proper operation at this time.

A clear, level 20- by 10-ft area near the well selected for the bioslurper test installation will be identified to station the equipment required for bioslurper system operation. For more information on bioslurper system installation, consult Section 6.0 of the generic Test Plan and Technical Protocol.

3.3.2 System Shakedown

A brief startup test will be conducted to ensure that the system is constructed properly and operates safely. All system components will be checked for problems and/or malfunctions. A checklist will be provided to document the system shakedown.

3.3.3 System Startup and Test Operations

After installation is complete and the bioslurper system is confirmed to be operating properly, the LNAPL recovery tests will be started. The Bioslurper Initiative has been designed to evaluate the effectiveness of bioslurping as an LNAPL recovery technology relative to conventional gravity-driven LNAPL recovery technologies. The Bioslurper Initiative Test Plan and Technical Protocol includes three separate LNAPL recovery tests: (1) a skimmer pump test, (2) a bioslurper pump test, and (3) a drawdown pump test. The three recovery tests are described in detail in Section 7.3 of the generic Test Plan and Technical Protocol.

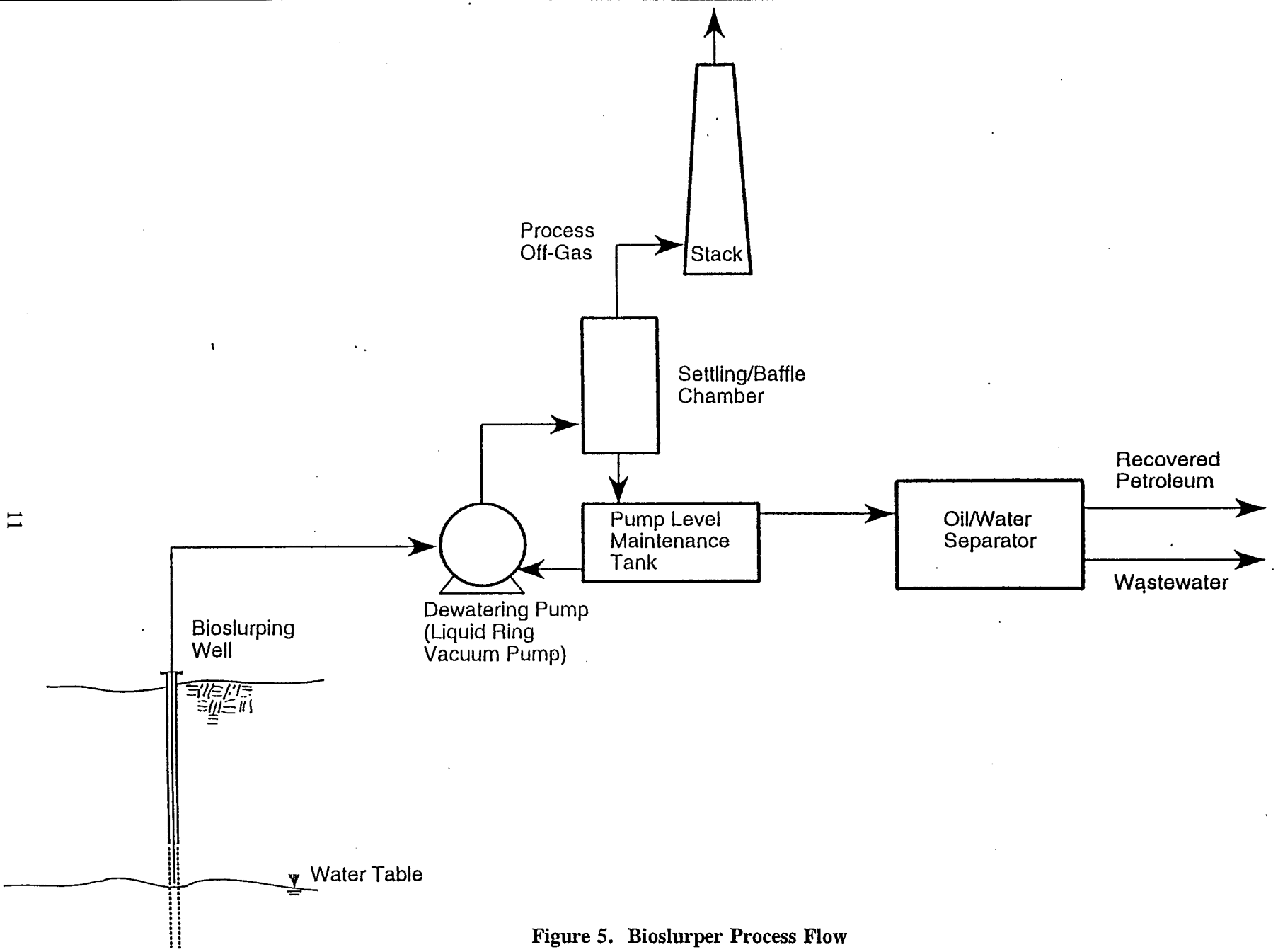


Figure 5. Bioslurper Process Flow

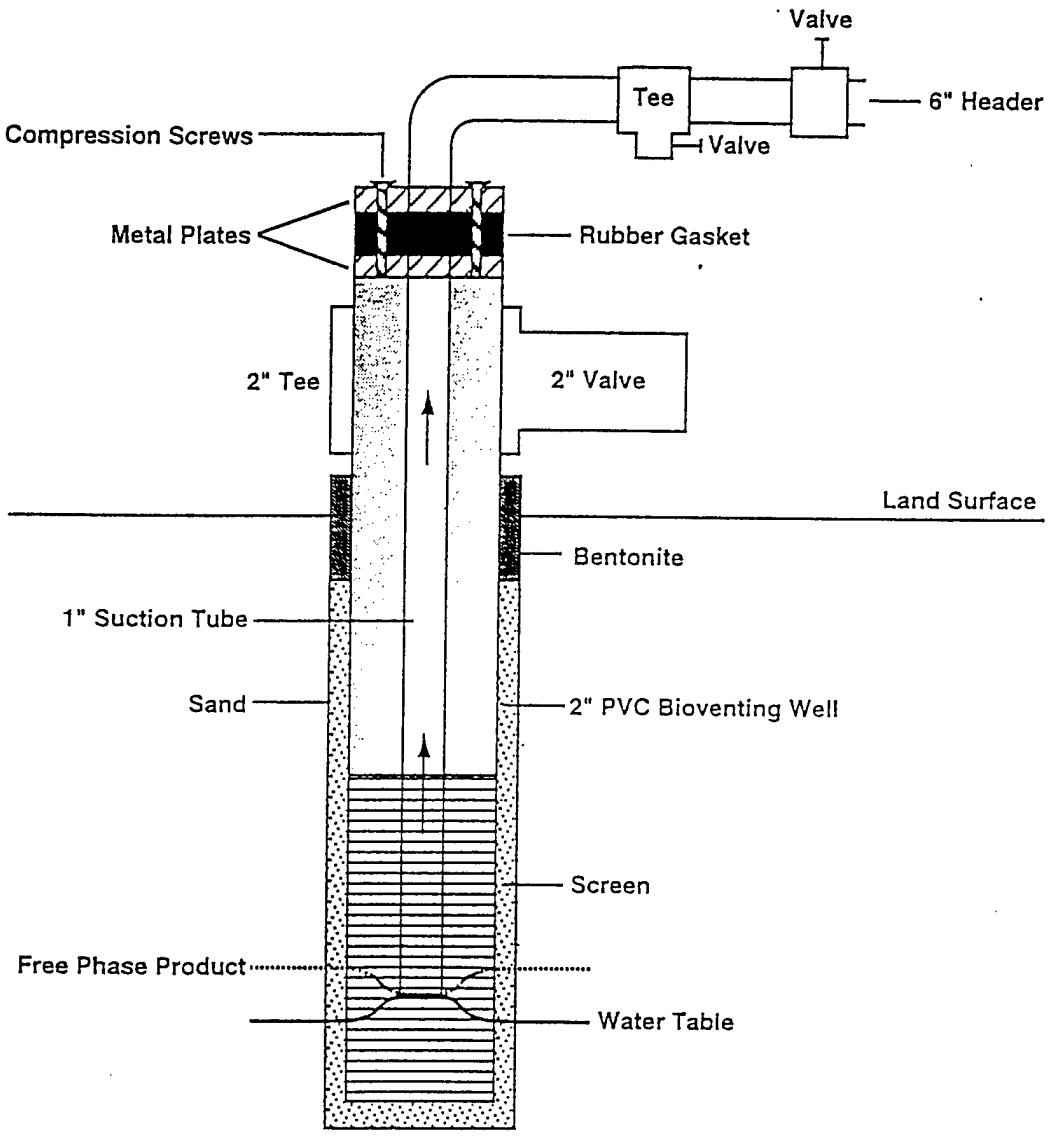


Figure 6. Schematic Digram of a Typical Bioslurper Well

The bioslurper system operating parameters that will be measured during operation are vapor discharge, aqueous effluent, LNAPL recovery volume rates, vapor discharge volume rates, and groundwater discharge volume rates. Vapor monitoring will consist of periodic monitoring of TPH using hand-held instruments supplemented by two samples collected for detailed laboratory analysis. A total of two samples of aqueous effluent will be collected for analysis of BTEX and TPH. Recovered LNAPL volume will recorded using an in-line flow-totalizing meter. The off-gas discharge volume will be measured using a calibrated pilot tube, and the groundwater discharge volume will be recorded using an in-line flow-totalizing meter. Section 8.0 of the generic Test Plan and Technical Protocol describes process monitoring of the bioslurper system.

3.3.4 Soil-Gas Permeability Test

A soil-gas permeability test will be conducted concurrently with startup of the bioslurper pump test. Soil-gas permeability data will support the process of estimating the vadose zone radius of influence of the bioslurper system. Soil-gas permeability results also will aid in determining the number of wells required if it is decided to treat the site with a large-scale bioslurper system. The soil-gas permeability test method is described in Section 5.7 of the generic Test Plan and Technical Protocol.

3.3.5 LNAPL and Water-Level Monitoring

During the bioslurper pump test, the LNAPL and groundwater levels will be monitored in a well adjacent to the extraction well. The top of the monitoring well will be sealed from the atmosphere so the subsurface vacuum will be contained. Additional information for the monitoring of fluid levels during the bioslurper pilot test is located in Section 4.3.4 of the generic Test Plan and Technical Protocol.

3.3.6 In Situ Respiration Test

An in situ respiration test will be conducted after completion of the LNAPL recovery tests. The in situ respiration test will involve injection of air and helium into selected soil-gas monitoring points, followed by monitoring changes in concentration of oxygen, carbon dioxide, TPH, and helium in soil gas. Measurement of the soil-gas composition typically will be conducted at 2, 4, 6, and 8 hours and then every 4 to 12 hours for about 2 days. Timing of the tests will be adjusted based on oxygen-use rate. If oxygen depletion occurs rapidly, more frequent monitoring will be conducted. If oxygen depletion is slow, less frequent readings will be acceptable. The oxygen utilization rate will be used to estimate the biodegradation rate at the site. Further information on the procedures and data collection for in situ respiration testing is given in Section 5.8 of the generic Bioslurping Protocol.

3.3.7 Extended Testing

The AFCEE/ERT has the option of extending the operation of the bioslurper system for up to 6 months if LNAPL recovery rates are promising and viable long-term vapor and aqueous discharge requirements have been identified. If extended testing is to be performed, Havre AFS will need to provide electrical power for long-term operation of the bioslurper pump. Disposition of all generated wastes and routine operation and maintenance of the system will be the Air Force's responsibility. Battelle will provide technical support during the extended testing operation.

3.4 Demobilization

Once all necessary tests have been completed at Havre AFS, the equipment will be disassembled and moved back to the holding facility by Battelle staff; it will remain there until its next destination is determined. Battelle staff will receive this information and will be responsible for shipping of the equipment to the next site before leaving Havre AFS.

4.0 BIOSLURPER SYSTEM DISCHARGE

4.1 Vapor Discharge Disposition

Battelle expects that the operation of the bioslurper test system at the Havre AFS site will not require a waiver or a point source air release registration. Based on a review of data from Havre AFS Housing Area, it is estimated that the mass of TPH released to the atmosphere at Havre AFS will be less than 5 lb TPH/day. The discharge of benzene is estimated to be less than 1 lb/day. These values are based on average discharge levels at two bioslurper test sites (Andrews AFB and Bolling AFB - Site #1) contaminated with the same type of heating oil as that found at Sites 3 and 4. These values may vary depending on soil gas concentrations and soil gas permeability.

The data for TPH and benzene discharge levels at four previous bioslurper sites are presented in Table 3. The relatively high TPH discharge level at Travis AFB is partially due to the extraction rate of the vapors. This estimated extraction rate is the maximum rate a 3-hp pump will achieve and should be much lower at Havre AFS. The vapor stream generated by the bioslurper system can be discharged directly to the atmosphere because of the short duration of the test and the low concentration levels of TPH and benzene in the stream.

To ensure the safety and regulatory compliance of the bioslurper system, vapor discharge samples (TPH, O_2, and CO_2) will be collected periodically throughout the bioslurper pilot test, and field soil-gas screening instruments will be used to monitor vapor discharge concentration. The volume of vapor discharge will be monitored daily using airflow instruments. If state regulatory requirements will not permit the expected amount of organic vapor discharge to the atmosphere, the Base POC should inform AFCEE and Battelle so that alternative plans can be made prior to mobilization to the site. Table 4 presents information typically required to complete an air release registration form.

Table 3. Benzene and TPH Discharge Levels at Previous Bioslurper Test Sites

Site Location	Fuel Type	Extraction Rate (scfm)	Benzene (ppmv)	TPH (ppmv)	Benzene Discharge (lb/day)	TPH Discharge (lb/day)
Wright-Patterson AFB	JP-4 Jet Fuel	3	ND	595	0.0	1.0
Bolling AFB (Site #1)	No. 2 Fuel Oil	4	0.2	153	0.0003	0.009
Bolling AFB (Site #2)	Gasoline	21	370	70,000	2.3	470.1
Andrews	No. 2 Fuel Oil	8	16	2,000	0.001	0.2
Travis AFB	JP-4 Jet Fuel	20	100	10,800	0.58	126.4

ND = not detected.

Table 4. Air Release Summary Information

Data Item	Air Release Information
Contractor Point of Contact	Jeff Kittel, (614) 424-6122
Contractor address	Battelle, 505 King Avenue, Columbus, OH 43201
Estimated total quantity of petroleum product to be recovered	TBD
Description of petroleum product to be recovered	No. 2 Fuel Oil
Planned date of test start	TBD
Test duration	9 days (active pumping)
Maximum total quantity of VOC release	~5.0 lb/day (4 lb TPH, <1.0 lb benzene)
Stack height above ground level	10 ft

4.2 Aqueous Influent/Effluent Disposition

The flowrate of groundwater pumped by the bioslurper will be less than 5 gpm. However, it may be necessary to obtain a groundwater pumping waiver or registration permit in Illinois. If one is required, the base POC will inform Battelle of the necessary steps in obtaining the waiver or permit. Operation of the bioslurper system will generate an aqueous waste discharge that will be passed through an oil/water separator. The intention of Battelle staff will be to dispose of the wastewater by discharging it directly to the Base sanitary sewer system. If existing Base wastewater channels can be used, no water discharge permits will be required.

4.3 Free-Product Recovery Disposition

The bioslurper system will recover free-phase product from the pilot tests performed at Havre AFS. Free product recovered by the bioslurping tests will be turned over to the Base for disposal and/or recycling. The volume of free product recovered from the Base will not be known until the tests have been performed. The maximum recovery rate for this system is 5 gpm, but the actual rate of LNAPL recovery likely will be much lower.

5.0 SCHEDULE

The schedule for the bioslurper fieldwork at Havre AFS will depend on approval of the project Test Plans. Battelle will determine a definitive schedule as soon as possible after approval is received. Battelle will have two to three staff members on site for approximately 2 weeks to conduct all necessary pilot testing. At the conclusion of the field testing at Havre AFS, all staff will return their Base passes and remove all bioslurper field testing equipment from the Base before leaving the site.

6.0 PROJECT SUPPORT ROLES

This section outlines some of the major functions of personnel from Battelle, Havre AFS, and AFCEE during the bioslurper field test.

6.1 Battelle Activities

Battelle's responsibility in the Bioslurper Initiative at Havre AFS will be to supply the staff and equipment necessary to perform all the tests on the bioslurper system. Battelle also will provide technical support in the areas of water and vapor discharge permitting, digging permits, staff support during the extended testing period, and any other technical areas that need to be addressed.

6.2 Havre AFS Support Activities

To support the necessary field tests at Havre AFS, the Base must be able to provide the following:

1. Any digging permits and utility clearances that need to be obtained prior to the initiation of the fieldwork. Any underground utilities should be clearly marked to reduce the chance of utility damage and/or personal injury during soil-gas probe and possible well installation. Battelle will not begin field operations without these clearances and permits.

2. The Air Force will be responsible for obtaining Base and site clearance for the Battelle staff that will be working at the Base. The Base POC will be furnished with all necessary information on each staff member at least 1 week prior to field startup.

3. Access to the local sanitary sewer must be furnished so that Battelle staff can discharge the bioslurper aqueous effluent directly to the Base treatment facility.

4. Regulatory approval, if required, must be obtained by the Base POC prior to startup of the bioslurper pilot test. As stated previously, it is likely that a waiver to allow air releases or a point source air release registration will be required for emissions of approximately <5.0 lb/day of TPH and <1.0 lb/day of benzene. It may be necessary to obtain a waiver for pumping and discharging groundwater at a rate of 5 gpm. The Base POC will obtain all necessary Base permits prior to mobilization to the site. Battelle will provide technical assistance in preparing regulatory approval documents.

5. The Base also will be responsible for the disposition of all waste generated from the pilot testing. Such waste includes any soil cuttings generated from drilling, and all aqueous wastestreams produced from the bioslurper tests. All free product recovered from the bioslurper operation will be disposed of or recycled by the Base. Battelle will provide technical assistance in disposing of the waste generated from the bioslurper pilot test.

6. Before field activities begin, the Health and Safety Plan will be finalized with information provided by the Base POC. Table 5 is a checklist for the information required to complete the Health and Safety Plan. All emergency information will be obtained by the Site Health and Safety Office before operations begin.

6.3 AFCEE Activities

The AFCEE POC will act as a liaison between Battelle and Base staff. The AFCEE POC will ensure that all necessary permits are obtained and the space required to house the bioslurper field equipment is found. The following is a listing of Battelle, AFCEE, and Havre AFS staff who can be contacted in cases of emergency and/or for required technical support during the bioslurper field initiative tests at Havre AFS.

Battelle POCs	Jeff Kittel	(614) 424-6122
	Eric Drescher	(614) 424-3088
AFCEE POC	Patrick Haas	(210) 536-4314
Havre AFS POC	Lt. Chad Mathis	(406) 731-7125
Regulator POCs		
Air:	_____	_____
Water:	_____	_____

Table 5. Health and Safety Information Checklist

Emergency Contacts	Name	Telephone Number
Hospital Emergency Room:		
Point of Contact:		
Fire Department:		
Emergency Unit (Ambulance):		
Security:		
Explosives Unit:		
Community Emergency Response Coordinator:		
Other:		
Program Contacts		
AFCEE:	Patrick Haas	(210) 536-4314
Battelle:	Jeff Kittel	(614) 424-6122
	Eric Drescher	(614) 424-3088
Other:		
Emergency Routes		
Hospital (maps attached)		
Other:		

APPENDIX A

TPH Concentrations in Soil from Housing Area Site

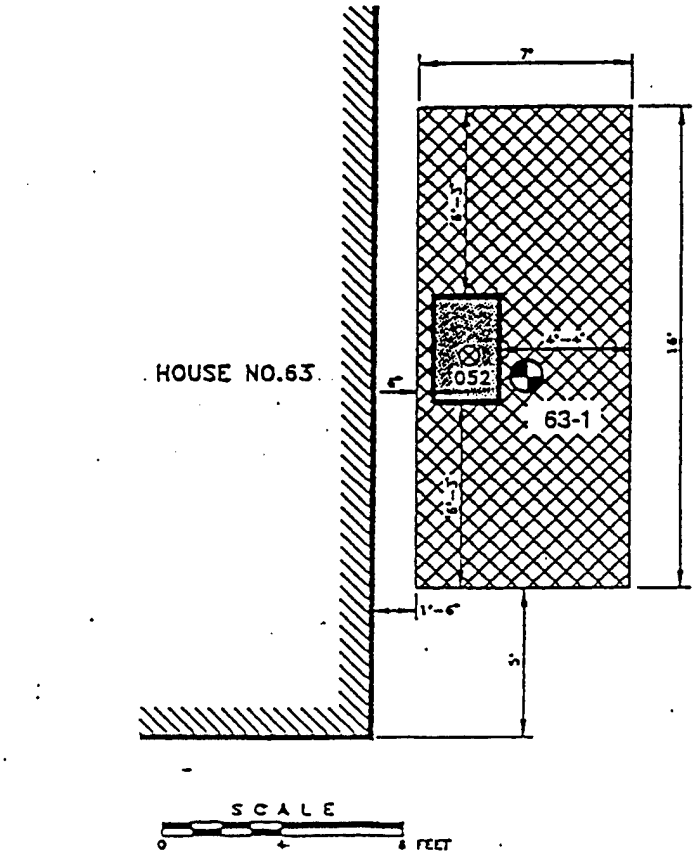
Table 1. Summary of UST Closure Soil Sampling Performed by OHM

TANK ID NO.	REMOVAL DATE	SAMPLE ID NO.	SAMPLE MATRIX	SAMPLE DEPTH	TPH AS DIESEL
Building #40	9/26/92	005	soil	12'	1480 mg/kg
		006	soil	12'	14,060 mg/kg
Building #42	9/26/92	002 (west)	soil	8.5'	226 mg/kg
		003 (east)	soil	8.5'	153 mg/kg
		004 (east)	soil	8.5'	250 mg/kg
Building #44 Piping Trench	9/28/92	007 (east)	soil	?	1870 mg/kg
		008 (west)	soil	?	21.6 mg/kg
Building #44 (#1) (North Tank)	10/5/92	021 (west)	soil	26'	564 mg/kg
		022 (west)	soil	26'	168 mg/kg
		023 (center)	soil	23'	ND
		024 (east)	soil	23'	ND
Building #44 (#2) (Center Tank)	10/5/92	025 (west)	soil	23'	84.1 mg/kg
		026 (center)	soil	21'	24 mg/kg
		027 (east)	soil	?	ND
Building #44 (#3) (South Tank)	10/1/92	028 (west)	soil	20'	ND
		029 (center)	soil	?	13.4 mg/kg
		030 (east)	soil	19'	ND
HU #53	10/15/92	048	soil	12'	9720 mg/kg
HU #54	9/24/92	001	soil	12'	1860 mg/kg
		006 (dup)	soil	12'	9240 mg/kg
HU #55	10/14/92	047	soil	?	19.6 mg/kg
HU #57	10/7/92	018	soil	11.5'	10,310 mg/kg
		018 (dup)	soil	11.5'	13,400 mg/kg
HU #61	10/16/92	051	soil	12'	1940 mg/kg
HU #63	10/19/92	052	soil	12'	35,200 mg/kg
HU #64	9/30/92	010	soil	12'	196 mg/kg
HU #65	10/8/92	019	soil	12'	1910 mg/kg
		020	soil	12'	1890 mg/kg
HU #66	10/1/92	012	soil	?	7130 mg/kg
		012 (dup)	soil	7'	4200 mg/kg
HU #67	10/9/92	031	soil	12'	4890 mg/kg
HU #68	10/5/92	017	soil	11.5'	3013 mg/kg
		017 (dup)	soil	11.5'	3280 mg/kg
HU #69	10/13/92	038	soil	12'	3990 mg/kg
HU #76	10/2/92	013	soil	?	64 mg/kg
		014	soil	?	75.5 mg/kg
HU #82	10/12/92	037	soil	12'	12 mg/kg

"?" Sample Depth designation indicates samples retrieved from bottom of excavation

APPENDIX B

Schematic Diagram of MW-F and MW-G



BOREHOLE SOIL DESCRIPTION

GS — brown clay loam

5 — brown, fine-grained silty sand, slight moist
heated headspace - 28.1 ppm

10 — gray-brown, silty clay, petro odor & stain, moist, blocky structure
heated headspace - 645 ppm

15 — tan, fine-grained sand, moist to wet, petro odor

increase in clay content, grades to clayey sand
core sample retained 17'
heated headspace - 513 ppm

20 — tan, fine-grained sand, wet
heated headspace - 123 ppm

SOIL SAMPLING RESULTS

TANK REMOVAL

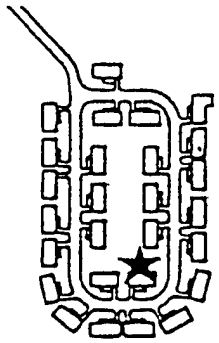
DATE	DEPTH	TPH CONCENTRATION
10/19/92	12' bgs	35200 mg/kg

SOIL BORING

DATE	DEPTH	TPH CONCENTRATION
11/19/93	17' bgs	ND
11/19/93 (dup)	17' bgs	18 mg/kg (field headspace - 513 ppm)

Free phase petroleum product was noted in the borehole within 24 hoursof drilling. Shallow pentration into the water table precluded further development of the borehole.

SITE LOCATION



TANK LOCATION

EXCAVATED AREA TO 11' DEPTH

SAMPLE POINT USED DURING TANK REMOVAL

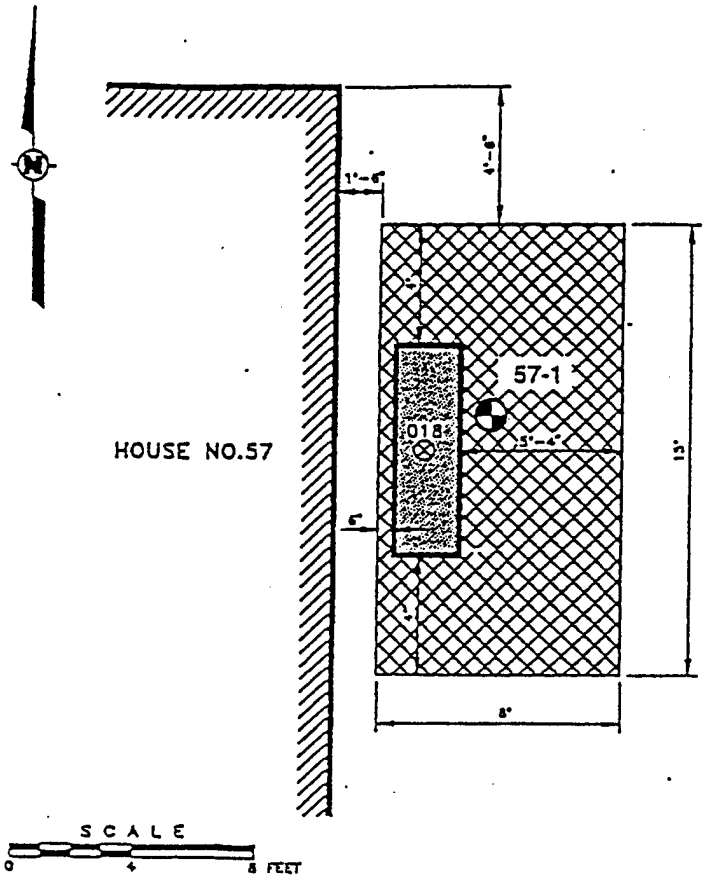
BOREHOLE LOCATION

BASE MAPS COMPILED BY OHM CORPORATION

HOUSING UNIT 63

UST REMEDIAL INVESTIGATION
HAVRE AIR FORCE STATION
MONTANA

MATNEY-FRANTZ ENGINEERING, P.C.



BOREHOLE SOIL DESCRIPTION

GS — brown, fine, sandy loam

5 — light brown, fine-grained sand, slightly moist
heated headspace - ND

10 — brown & gray sandy clay & silty clay with sand stringers, moist, petro odor & black discoloration
heated headspace - 367 ppm

15 — brown, very fine-grained clayey sand, strong petro odork, heavy black discoloration, moist
heated headspace - 772 ppm
core retained 17'
sample submitted #93-192-57-1-17

20 — brown, fine-grained sand, heavy black discoloration & strong petro odor, mica, moist

gray-brown, sandy clay to clayey sand, less petro odor & no discoloration, dry to slightly moist
heated headspace - 550 ppm

25 — orange-brown, fine-grained sand, wet
heated headspace - 361 ppm

SOIL SAMPLING RESULTS

TANK REMOVAL

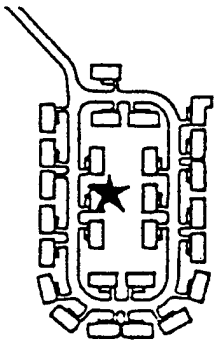
DATE	DEPTH	TPH CONCENTRATION
10/7/92	11.5' bgs	10310 mg/kg
10/7/92 (dup)	11.5' bgs	13400 mg/kg

SOIL BORING

DATE	DEPTH	TPH CONCENTRATION
11/20/93	17' bgs	25000 mg/kg (field headspace - 722 ppm)

Free phase petroleum product was noted in the borehole within 24 hours of drilling. The borehole was completed as an observation/recovery well and designated MW-G. Well completion details are included in Appendix D of the Remedial Investigation Report.

SITE LOCATION



TANK LOCATION

EXCAVATED AREA TO 11' DEPTH

SAMPLE POINT USED DURING TANK REMOVAL

BOREHOLE LOCATION

BASE MAPS COMPILED BY OHM CORPORATION

HOUSING UNIT 57

UST REMEDIAL INVESTIGATION
HAVRE AIR FORCE STATION
MONTANA

MATNEY-FRANTZ ENGINEERING, P.C.

APPENDIX C

Monitoring Well Construction for MW-F and MW-G

FACILITY/PROJECT NAME: USAF/HAFS 93-192

WELL IDENTIFICATION: MW-F

TYPE OF WELL: ☒ MONITOR WELL ☐ OBSERVATION WELL ☐ PIEZOMETER

DRILLING METHOD: hollow-stem auger

DATE INSTALLED: 12/2/93

DRILLER: O'Keefe Drlg., Butte, MT

GEOLOGIST: B.L. Waller

PROTECTIVE COVER:

CAP AND LOCK? ☒ YES ☐ NO

BLANK CASING SIZE AND TYPE: 4 inch Sch. 40 PVC flush threaded

BLANK CASING INTERVAL: 4-0 ft.

WELL SCREEN SIZE AND TYPE: 4 inch Sch. 40 0.020 inch slotted, flush threaded

WELL SCREEN INTERVAL: 19-4 ft.

BOTTOM PLUG? ☒ YES ☐ NO

COMMENTS:

LEGAL DESCRIPTION OF WELL:

DEPTH OF BOREHOLE: 20 ft

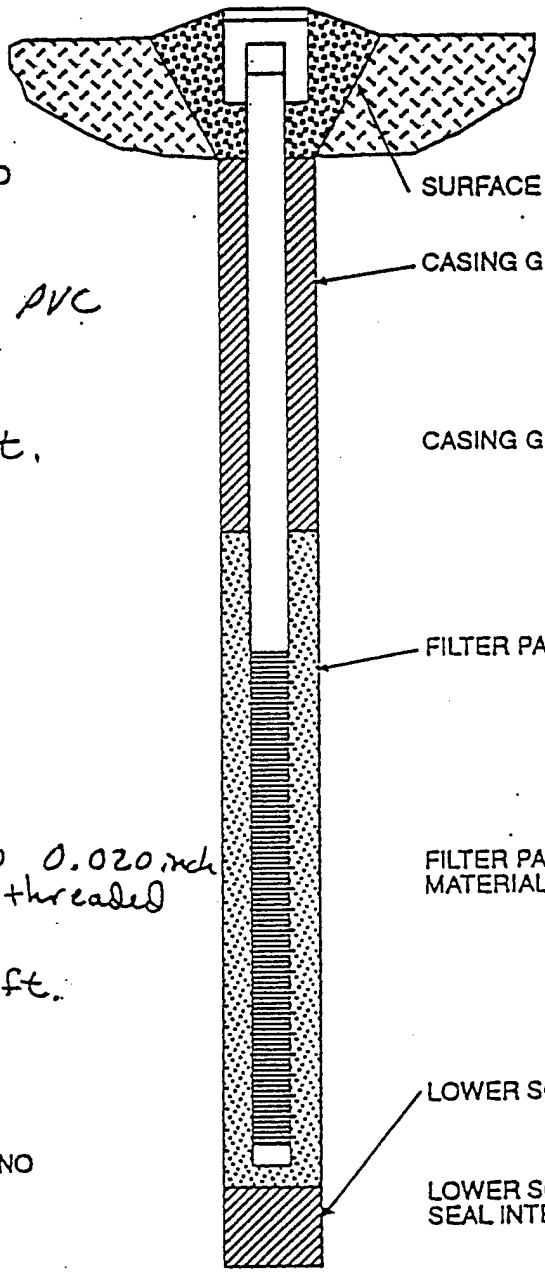
DIAMETER OF BOREHOLE: 10 inch

DEPTH OF WELL: 19 ft

DIAMETER OF WELL: 4 inch

LOCATION OF WELL RELATIVE TO WASTE SOURCE:

DISPOSITION OF DRILL CUTTINGS: landfarm



SURFACE SEAL:

CASING GROUT: 3/8 inch bentonite chips

CASING GROUT INTERVAL: 3-0 ft.

FILTER PACK MATERIAL: 10-20 mesh Colorado Silica

FILTER PACK MATERIAL INTERVAL: 20-3 ft.

LOWER SCREEN SEAL: NA

LOWER SCREEN SEAL INTERVAL: NA

MW-F
WELL COMPLETION DIAGRAM

MATNEY-FRANTZ ENGINEERING, P.C.

FACILITY/PROJECT NAME: USAF - HAFS

WELL IDENTIFICATION:

TYPE OF WELL: ☒ MONITOR WELL
☐ OBSERVATION WELL
☐ PIEZOMETER

DRILLING METHOD: hollowstem auger

DATE INSTALLED: 12/9/93

DRILLER: O'Keefe Drlg., Butte, MT

GEOLOGIST: Bob Waller

PROTECTIVE COVER:

CAP AND LOCK? ☒ YES ☐ NO

BLANK CASING SIZE AND TYPE: 4 inch Sch. 40 PVC flush threaded

BLANK CASING INTERVAL: 7-0 ft.

WELL SCREEN SIZE AND TYPE: 4 inch Sch. 40 PVC 0.020 inch slotted, flush-threaded

WELL SCREEN INTERVAL: 17-7 ft.

BOTTOM PLUG? ☒ YES ☐ NO

LEGAL DESCRIPTION OF WELL:

DEPTH OF BOREHOLE: 20 ft

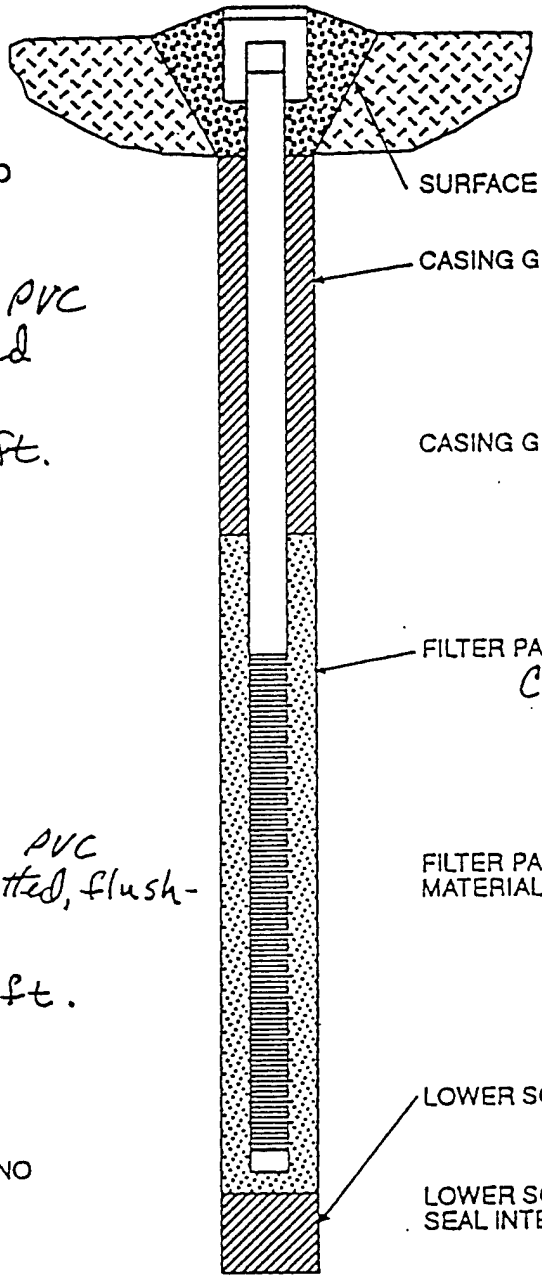
DIAMETER OF BOREHOLE: 8 inch

DEPTH OF WELL: 17 ft.

DIAMETER OF WELL: 4 inch

LOCATION OF WELL RELATIVE TO WASTE SOURCE:

DISPOSITION OF DRILL CUTTINGS: landfarm



SURFACE SEAL:

CASING GROUT: 3/8 inch bentonite chips

CASING GROUT INTERVAL: 9-0 ft

FILTER PACK MATERIAL: 10-20 mesh Colorado Silica

FILTER PACK MATERIAL INTERVAL: 17-9 ft.

LOWER SCREEN SEAL: NA

LOWER SCREEN SEAL INTERVAL: NA

COMMENTS:

MW-G
WELL COMPLETION DIAGRAM

MATNEY-FRANTZ ENGINEERING, P.C.

APPENDIX B

LABORATORY ANALYTICAL REPORTS

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: G462201-30C0601
Phone: (614) 424-3753
Attn: Al Pollack

Sampled: 10/10/95 Received: 10/17/95 Analyzed: 10/20/95

Matrix: [X] Soil [ ] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Extractable Quantitated As Diesel
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - EPA Method 624/8240

TPH/BTXE Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit	
HAV-MPA-10.0'-10.5' /BMI101795-04	TPH *	6,700	100	mg/Kg
	Benzene	ND	500	ug/Kg
	Toluene	ND	500	ug/Kg
	Total Xylenes	1,100	500	ug/Kg
	Ethylbenzene	1,300	500	ug/Kg
HAV-MPD-10.0'-10.5' /BMI101795-06	TPH *	13,000	100	mg/Kg
	Benzene	ND	1,000	ug/Kg
	Toluene	1,200	1,000	ug/Kg
	Total Xylenes	32,000	1,000	ug/Kg
	Ethylbenzene	1,600	1,000	ug/Kg

* - Components are in the range of diesel.

ND - Not Detected

Approved By: Roger E. Scholl Date: 10/27/95
Roger E. Scholl, Ph.D.
Laboratory Director

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date : 11/16/95
Client : ALP-855
Taken by: CLIENT
Report : 14683
PO# :

Sample	Collected Date	Time	MOISTURE CONTENT %	SIEVE ANALYSIS	DENSITY G/CM3	POROSITY %		
BMI101795-03 - HAV-MPA - COMP	10/10/95	:	13.9	YES	0.75	71.7		
BMI101795-05 - HAV-MPD - COMP	10/10/95	:	16.4	YES	0.71	73.2		

Approved By:

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount pai for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

William F. Pillsbury
President

John C. Seher
Manager

Sierra
Environmental
Monitoring, Inc.

Sierra Environmental Monitoring, Inc.
1135 Financial Bloulevard
Reno, NV 89502
702-857-2400 FAX 702-857-2404

SIEVE ANALYSIS REPORT

Client	Alpha Analytical, Inc.	Analytical Method	ASTM
Sample Name	BMI101795-03 HAV-MPA Comp	Sample Date	10/17/95
SEM Lab Number	9510-0484	Analysis Date	11/13/95

U. S. Standard Sieve Size	Percent Passing
1/2 inch	84.0%
No. 4	37.0%
No. 8	20.0%
No. 10	16.0%
No. 16	11.0%
No. 30	<1.0 %
No. 40	<1.0 %
No. 50	<1.0 %
No. 100	<1.0 %
No. 200	<1.0 %

Approved by: _____

John Seher, Laboratory Manager

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Sierra
Environmental
Monitoring, Inc.

Sierra Environmental Monitoring, Inc.
1135 Financial Bloulevard
Reno, NV 89502
702-857-2400 FAX 702-857-2404

SIEVE ANALYSIS REPORT

Client	Alpha Analytical, Inc.	Analytical Method	ASTM
Sample Name	BMI101795-05 HAV-MPD Comp	Sample Date	09/05/95
SEM Lab Number	9510-0485	Analysis Date	09/19/95

U. S. Standard Sieve Size	Percent Passing
1/2 inch	90.0%
No. 4	47.0%
No. 8	28.0%
No. 10	25.0%
No. 16	18.0%
No. 30	13.0%
No. 40	11.0%
No. 50	<1.0 %
No. 100	<1.0 %
No. 200	<1.0 %

Approved by: _____

John Seher, Laboratory Manager

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

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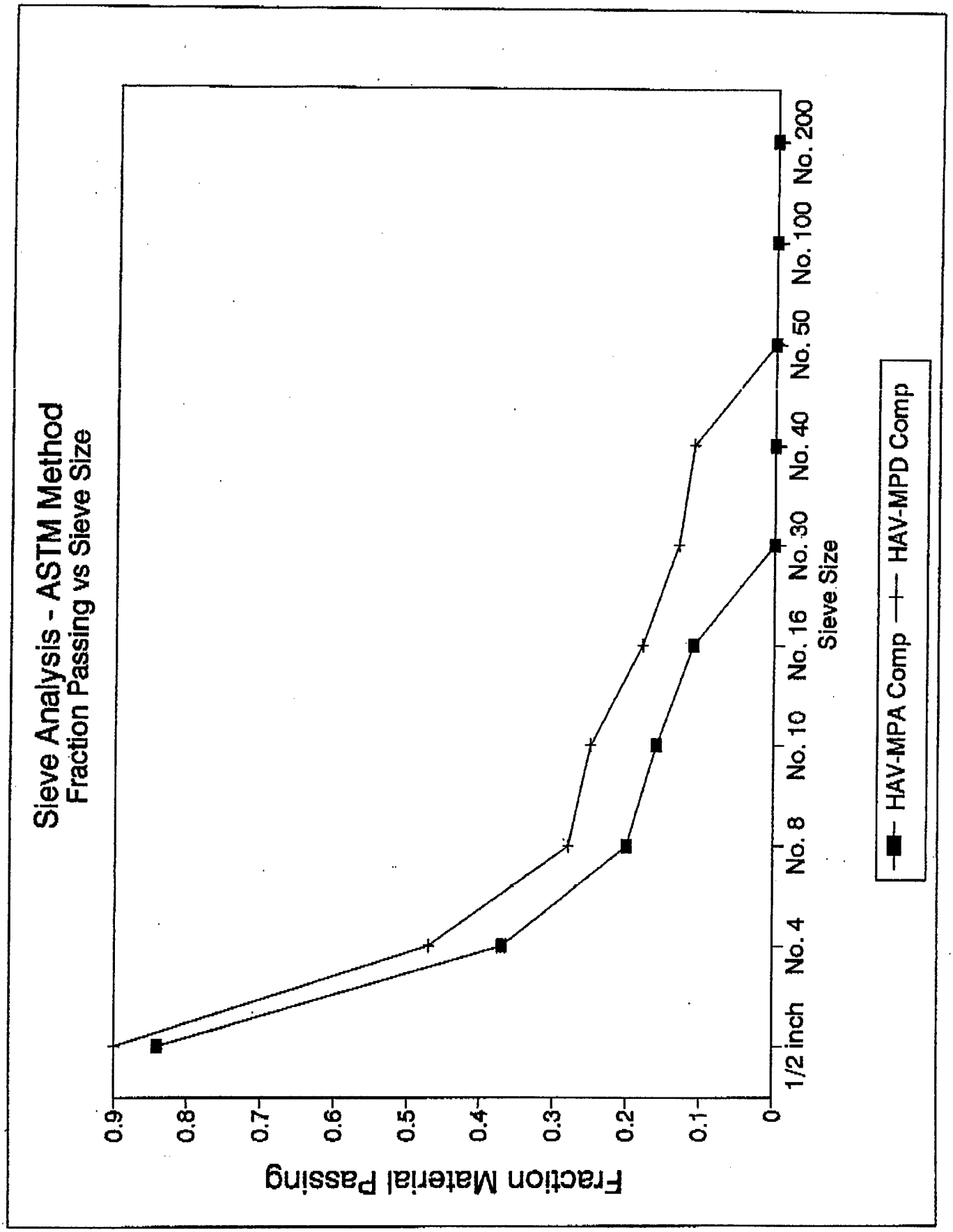
Sieve Analysis - ASTM Method
Fraction Passing vs Sieve Size
Fraction Material Passing
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/2 inch
No. 4
No. 8
No. 10
No. 16
No. 30
No. 40
No. 50
No. 100
No. 200
Sieve Size
HAV-MPA Comp
HAV-MPD Comp

Billing Information:

Name _____
Address _____
City, State, Zip _____
Phone Number _____

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

Page # 1 of 1

Client Name: Battelle
Address:
City, State, Zip:
P.O.# G462201-30C0601
Phone # (614) 424-3753
Report Attention: Al Pollack
Sampled by: Client

Analyses Required

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers	11 Sieve Analysis	Bulk Density	Porosity	Moisture Content		TPH	BTXE			Remarks
	10/10	SO	BM-101775-03	HAV-MPA-7.5-10.0' HAV-MPA-10.5'-11.0'	2	X	X	X	X						Composite
	✓	✓	04	HAV-MPA-10.0-10.5'	3						X	X			
	✓	✓	05	HAV-MPD-7.5-10.0' HAV-MPD-10.5-11.0'	2	X	X	X	X						Composite
	✓	✓	06	HAV-MPD-10.0'-10.5'	1						X	X			

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	[signature]	Linda LERNER	AAI	10/17/95	1030
Relinquished by	[signature]	Robison	AAI	10/17/95	1555
Received by	[signature]	[signature]	SEM	10/17/95	1555
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. _____

Proj. No.	Project Title
G46220I - 30C0601	BIOSLURPER DEMO. HAVRE AFS, MONTANA

SAMPLERS: (Signature)
Al Pollack

DATE	TIME	SAMPLE I.D.	SAMPLE TYPE (√)								Container No.	Number of Containers	Remarks
			11 Sieve Analysis	Bulk Density	Porosity	Moisture Content	BTEX	TPH (Extractable Diesel Fuel)					
Oct 10, 1995	1130h	HAV - MPA - 9.5' → 10.0'	✓	✓	✓	✓					1		Combine these 2 for Physical Parameters.
		HAV - MPA - 10.5' → 11.0'											
		HAV - MPA - 10.0' → 10.5'					✓	✓					
Oct 10, 1995	1400h	HAV - MPD - 9.5' → 10.0'	✓	✓	✓	✓					1		Combine these two for Physical Parameters
		HAV - MPD - 10.5' → 11.0'											
		HAV - MPD - 10.0' → 10.5'					✓	✓					
Please send data to		Battelle, Columbus Labs											
		ATTN: AL POLLACK											

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Al Pollack	10/16/95 0800h				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
			10/17/95 10:20		

Page _____ of _____

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Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: G462201-30C0601
Phone: (614) 424-3753
Attn: Al Pollack

Sampled: 10/15/95 Received: 10/17/95 Analyzed: 10/21-27/95

Matrix: [ ] Soil [X] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Extractable Quantitated As Diesel
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - EPA Method 624/8240

TPH/BTXE Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit	
HAV-OWS-Water-Samp 1 /BMI101795-01	TPH *	19	5.0	mg/L
	Benzene	ND	1.0	ug/L
	Toluene	ND	1.0	ug/L
	Total Xylenes	14	1.0	ug/L
	Ethylbenzene	1.1	1.0	ug/L

* - Components are in the range of diesel.

ND - Not Detected

Approved By: Roger L. Scholl Date: 10/30/95
Roger L. Scholl, Ph.D.
Laboratory Director

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. _____

Proj. No.	Project Title
G-462201-30C0601	BIOSCURPER DEMO, HAVRE AFS MONTANA

SAMPLERS: (Signature)
Al Pollack

DATE	TIME	SAMPLE I.D.	BTEX	TPH (EXTRACTABLE)	Container No.	Number of Containers	Remarks
10-15-95	1830h	HAV-OWS-WATER-SAMP1	✓	✓		3	3x40 ml VOA VIALS CAN BE COMPOSITED FOR THE 2 ANALYSES

PLEASE SEND DATA TO BATTELLE, COLUMBUS LABS
ATTN: AL POLLACK

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Al Pollack	10/16/95 0800h				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
			10/17/95 1030		

Page _____ of _____

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Billing Information:
Name
Address
City, State, Zip
Phone Number

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

Page # 1 of 1

Client Name: Battelle
Address:
City, State, Zip:
P.O. # G462201-30C0601
Phone #:
Report Attention: Al Pollock
Sampled by: Client

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers	TPH	BTXE								Remarks
	10/15	AQ	BM-101775-01	HAV-OWS-Water-Sampl	3	X	X								3 VOAS

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	[signature]	Linda Lerner	AA1	10/17/95	1030
Relinquished by				[illegible]	1330
Received by					
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: G462201-30C0601
Phone: (614) 424-3753
Attn: Al Pollack

Sampled: 10/18/95 Received: 10/20/95 Analyzed: 10/26-27/95

Matrix: [ ] Soil [X] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Extractable Quantitated As Diesel
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - EPA Method 624/8240

TPH/BTXE Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
HAV-OWS-Water-Samp 2 /BMI102095-01	TPH *	25	5.0 mg/L
	Benzene	ND	1.0 ug/L
	Toluene	ND	1.0 ug/L
	Total Xylenes	9.6	1.0 ug/L
	Ethylbenzene	ND	1.0 ug/L

* - Components are in the range of diesel.

ND - Not Detected

Approved By: Roger L. Scholl Date: 10/31/95
Roger L. Scholl, Ph.D.
Laboratory Director

Name
Address
City, State, Zip
Phone Number

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

Page # 1 of 1

Client Name: Battelle
Address:
City, State, Zip:
P.O.# G462201-30C0601
Phone #:
Report Attention: Al Pollock
Sampled by: Client

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers	TPH	BTXE								Remarks
	10/18	AQ	BMI102095-01	HAV-OWS-Water-Samp2	3	X	X								3 VOAs only

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	[signature]	Linda LERNER	AAI	10/20/95	1003
Relinquished by					
Received by					
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other

Battelle Columbus Laboratories

505 KING AVE COLUMBUS OHIO 43201

CHAIN OF CUSTODY RECORD

Form No. _____

Proj. No.	Project Title	SAMPLERS: (Signature)
G-462201-1 30C0601	BATTELLE BIOSLURPER DEMO. HAVRE AFS, MONTANA	Al Pollack

DATE	TIME	SAMPLE I.D.	SAMPLE TYPE (√) BTEX	SAMPLE TYPE (√) TPH (EXTRACTABLES)	Container No.	Number of Containers	Remarks
10-18-95	0840h	HAV-OWS-WATER-SAMP 2	✓	✓		3	3 x 40 ml VOA VIALS, CAN BE COMPOSITED FOR THE 2 ANALYSES

PLEASE SEND DATA TO: BATTELLE COLUMBUS LABS
ATTN: AL POLLACK
(614)424-3753

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Al Pollack	10/19/95 0800h				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
		[illegible]	10/20/95 1103		

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Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: G462201-300601
Phone: (614) 424-6122
Attn: Al Pollack

Alpha Analytical Number: BMI101795-02

Client I.D. Number: HAV-FUEL-MW7

Date Sampled: 10/11/95

Date Received: 10/17/95

Compound	Method	Concentration ug/Kg	Detection Limit ug/Kg	Date Analyzed
Benzene	8240	ND	30,000	10/24/95
Toluene	8240	ND	30,000	10/24/95
Total Xylenes	8240	81,000	30,000	10/24/95
Ethylbenene	8240	31,000	30,000	10/24/95
C-range Compounds	Method	Percentage of Total	Detection Limit (Not Applicable)	Date Analyzed
C11<	GC/FID	9.6	NA	10/24/95
C12	GC/FID	7.1	NA	10/24/95
C13	GC/FID	9.1	NA	10/24/95
C14	GC/FID	10.0	NA	10/24/95
C15	GC/FID	10.4	NA	10/24/95
C16	GC/FID	11.1	NA	10/24/95
C17	GC/FID	10.0	NA	10/24/95
C18	GC/FID	8.9	NA	10/24/95
C19	GC/FID	7.6	NA	10/24/95
C20	GC/FID	5.7	NA	10/24/95
C21	GC/FID	3.9	NA	10/24/95
C22	GC/FID	2.3	NA	10/24/95
C23	GC/FID	1.4	NA	10/24/95
C24>	GC/FID	2.9	NA	10/24/95

Approved by: Roger L. Scholl Date: 10/31/95

Roger L. Scholl, Ph.D.
Laboratory Director

Name
Address
City, State, Zip
Phone Number

255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

Page # 1 of 1

Client Name: Battelle
P.O. # G462201-3060601
Address
Phone #
City, State, Zip
Report Attention: AL Pollock
Sampled by: Client

Analyses Required: BTXE, Boiling PT. Range

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers		BTXE	Boiling PT. Range								Remarks
	10/11	OT	BMI101795-02	HAV-FUEL-MW7	1		X	X								Small Tin Can.

Signature	Print Name	Company	Date	Time
Relinquished by				
Received by [signature]	Linda LERNER	AAI	10/17/95	1030
Relinquished by				
Received by				
Relinquished by				
Received by				

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other

AIR TOXICS LTD.

SAMPLE NAME: HAV-Stack Gas
ID#: 9510248-01A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 9102410 Date of Collection: 10/18/95
Dil. Factor: 2.2 Date of Analysis: 10/24/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.007	0.021	0.068
Toluene	0.002	0.008	0.030	0.11
Ethyl Benzene	0.002	0.010	0.038	0.017
Total Xylenes	0.002	0.010	0.42 M	1.8 M

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 9102410 Date of Collection: 10/18/95
Dil. Factor: 2.2 Date of Analysis: 10/24/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.022	0.14	66	430
C2 - C4** Hydrocarbons	0.022	0.040	Not Detected	Not Detected

*TPH referenced to Jet Fuel (MW=156)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

M = Reported value may be biased due to apparent matrix interferences.

Container Type: 1 Liter Summa Canister

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AIR TOXICS LTD.

SAMPLE NAME: Lab Blank
ID#: 9510248-02A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name:	6102409		Date of Collection: NA	
Dil. Factor:	1.0		Date of Analysis: 10/24/95	
Compound	**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6102409		Date of Collection: NA	
Dil. Factor:	1.0		Date of Analysis: 10/24/95	
Compound	**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
TPH* (C5+ Hydrocarbons)	0.010	0.065	Not Detected	Not Detected
C2 - C4** Hydrocarbons	0.010	0.018	Not Detected	Not Detected

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA

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AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

No 006265

Page 1 of 1

Contact Person: AL POLLACK
Company: BATTELLE
Address: 505 KING AVE City: COLUMBUS State: OH Zip: 43201
Phone: (614) 424-3753 FAX: (614) 424-3637
Collected By: Signature: Al Pollack

Project Info:
P.O. #:
Project #: G462201-30C0601
Project Name: BIOSLURPER DEMO, HAVRE AFS MONTANA

Turn Around Time:
[X] Normal
[ ] Rush ____ Specify

Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt
01	HAV- STACK GAS	10/18/95 @ 0920h	BTEX and TPH as Jet Fuel (MODIFIED TO-14)	27.5"Hg	0psig	20"Hg 10/20/95

Relinquished By: (Signature) Date/Time: Al Pollack 10/19/95 @ 0800h
Print Name: AL POLLACK
Relinquished By: (Signature) Date/Time:
Received By: (Signature) Date/Time:
Relinquished By: (Signature) Date/Time:
Received By: (Signature) Date/Time: 0950 10/20/95

Notes: Because of the late arrival of the sample canister, this will be the only sample from this site.
A.P.

Lab Use Only

Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact?	Work Order #
FEDEX	537 3836 731	TRG.	10/20/95 0950	AMBIENT	GOOD	Yes No (None) N/A	9510248

Form 1293 rev. 06

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APPENDIX C

SYSTEM CHECKLIST

Checklist for System Shakedown

Site: Hanscom AFB

Date: 10/10/95

Operator's Initials: MP + AT

Equipment	Check if Okay	Comments
Liquid Ring Pump	✓	
Aqueous Effluent Transfer Pump	✓	
Oil/Water Separator	✓	
Vapor Flow Meter	✓	
Fuel Flow Meter	✓	GRADUATED CYLINDER USED TO MEASURE FUEL
Water Flow Meter	✓	
Emergency Shut off Float Switch -Effluent Transfer Tank	✓	
Analytical Field Instrumentation -GasTechtor O_2/CO_2 Analyzer -TraceTechtor Hydrocarbon Analyzer -Oil/Water Interface Probe -Magnehelic Boards -Thermocouple Thermometer	✓	

APPENDIX D

DATA SHEETS FROM THE SHORT-TERM PILOT TEST

Baildown Test Record Sheet

Site: Havre AFS

Well Identification: MW-F

Well Diameter (OD/ID): 4"

Date at Start of Test: 10/10/95 Sampler's Initials: MP, AP

Time at Start of Test: 1041

Initial Readings

Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)	Total Volume Bailed (L)
15.05	13.55	1.5	9.5 L

Test Data

Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
10/10/95-1041	14.79	14.70	0.09
1047	14.72	14.62	0.10
1054	14.61	14.56	0.05
1109	14.47	14.36	0.11
1143	14.26	14.12	0.14
1254	14.08	13.92	0.16
1332	14.02	13.88	0.14
1443	13.99	13.83	0.16
1547	13.96	13.78	0.18
1702	13.96	13.76	0.20
10/11/95-0840	14.04	13.79	0.25
-1803	13.98	13.76	0.22

Figure 9. Typical Baildown Test Record Sheet

Baildown Test Record Sheet

Site: Havre AFS

Well Identification: MW-7

Well Diameter (OD/ID): _____

Date at Start of Test: 10/10/95 Sampler's Initials: MP, AP

Time at Start of Test: 1013

Initial Readings

Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)	Total Volume Bailed (L)
15.08	14.72	0.36	1.1 L

Test Data

Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
10/10/95 - 1013	14.95	14.90	0.05
1016	14.97	14.88	0.09
1023	14.99	14.86	0.13
1040	15.02	14.84	0.18
1111	15.05	14.82	0.23
1143	15.06	14.80	0.26
1257	15.04	14.78	0.26
1330	15.04	14.76	0.28
1445	15.01	14.74	0.27
1550	15.01	14.74	0.27
1700	15.02	14.74	0.28
10/11/95 - 1130	15.04	14.76	0.28

Figure 9. Typical Baildown Test Record Sheet

BATTELLE		SOIL GAS SURVEY INFORMATION			DATE: 10/11/95	
METERS (SERIAL NUMBERS): O_2 _____ CO_2 _____ TPH _____					SITE: Havre AFS	
POINT #	DEPTH (ft. & tenths) (e.g., 10.2')	READINGS			PUMP PRESS (in Hg. Vac.)	Recorded by: MP, AP
		O_2 (%)	CO_2 (%)	TPH (ppm)		Comments
MPA - Red	10.5	0	14	300		Initial Soi Gas (10/11/95)
MPA - Blue	8.5	10	2.5	600		Recorded on 10/11/95
MPB - Blue	11.0	19.0	0.5	40		Recorded on 10/11/95
MPB - Red	15.5	16.5	3.0	195		" " "
MPD	8.5	12.5	7.5	320		Recorded on 10/14/95
MPD	10.5	0.5	17.5	840		" " "
MPE	12.0	17.0	4.0	275		Recorded on 10/14/95
MPE	14.5	15.5	4.5	350		" " "
MPF	9.0	20.0	0.8	72		Recorded on 10/12/95
MPF	14.0	1.0	16.0	>10,000		" " "
MPG - Blue	7.5	17.0	3.0	240		Recorded on 10/14/95
MPG - Red	10.5	4.0	12.0	720		" " "

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page ___ of ___

Site: Havre AFS, MWF

Start Date: 10/11/95

Operators: _____

Start Time: 1930

Test Type: Bioslurper

Well ID: MW-F

Depth to Groundwater: 15.05 Depth to Fuel: 13.55

Depth of Tube: MP, AP

Date/Time	Run Time	Vapor Extraction			Pump Stack Temp (°C)	Pump Head Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)
		Stack Pressure (in. H_2O)	Carbon Drums (in. H_2O)	Flowrate (scfm)			
10/12/95-840		0.08"		2.15		7"	6.2"
1530		ND				6"	5"
10/13/95-0908		0.20"		2.1		5.5"	>10"
1630		10"				5"	9.2"

Figure 14. Typical Record Sheets for Bioslurper Pilot Testing (continued)

Bioslurping Pilot Test
(Data Sheet 1)
Well Characteristics

Page ___ of ___

Site: Havre AFS, MW-7

Test Type (skimmer, bioslurper vacuum extraction, drawdown): Bioslurper

Depth to Groundwater: 15.04 Depth to Fuel: 14.98 Depth of Slurper Tube: 15'1"

Date at Start of Test: 10/14/95

Time at Start of Test: 0816 Operator's Initials: MP, AP

Date/Time	Well ID: MW-8			Well ID:			Well ID:		
	LNAPL Level	Water Level	Pressure (in H_2O)	LNAPL Level	Water Level	Pressure (in H_2O)	LNAPL Level	Water Level	Pressure (in H_2O)
10/14 - 1635	—	15.58							
10/15 - 0930	—	15.74							
10/16 - 0940	sheen	15.56							
10/18 - 0804	sheen	15.75							

Figure 14. Typical Record Sheets for Bioslurper Pilot Testing

Bioslurping Pilot Test
(Data Sheet 1)
Well Characteristics

Page ___ of ___

Site: Havre AFS

Test Type (skimmer, bioslurper vacuum extraction, drawdown): Drawdown

Depth to Groundwater: 16.35 Depth to Fuel: 16.34 Depth of Slurper Tube: 17.0

Date at Start of Test: 10/18/95

Time at Start of Test: 1005

Operator's Initials: MP, AP

Date/Time	Well ID: MW-8			Well ID:			Well ID:		
	LNAPL Level	Water Level	Pressure (in H_2O)	LNAPL Level	Water Level	Pressure (in H_2O)	LNAPL Level	Water Level	Pressure (in H_2O)
10/19 -0830	Sheen	16.68							

Figure 14. Typical Record Sheets for Bioslurper Pilot Testing

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page 1 of 4

Site: Havre AFS

Start Date: 10/11/95

Operators: MP, AP

Start Time: 1145

Test Type: 1st Skimmer

Well ID: MW-7

Depth to Groundwater: 15.08 Depth to Fuel: 14.72

Depth of Tube: _____

Date/Time	Run Time	Vapor Extraction			Pump Stack Temp (°C)	Pump Head Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)
		Stack Pressure (in. H_2O)	Carbon Drums (in. H_2O)	Flowrate (scfm)			
	* Peristaltic pump was used for the skimmer pump test, therefore data is not applicable.						

Figure 14. Typical Record Sheets for Bioslurper Pilot Testing (continued)

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page 2 of 4

Site: Havre AFS
Operators: MP, AP
Test Type: Bioslurper
Depth to Groundwater: 15.04 Depth to Fuel: 14.98

Start Date: 10/14/95
Start Time: 0810
Well ID: MW-7
Depth of Tube: 15' 1"

Date/Time	Run Time	Vapor Extraction			Pump Stack Temp (°C)	Pump Head Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)
		Stack Pressure (in. H_2O)	Carbon Drums (in. H_2O)	Flowrate (scfm)			
10/14-1635		0.1"		~~23~~ 17		12"	8"
10/15-930		10"			34.3°	10"	6.5"
1810		— NT				10"	6"
10/16-1330		0.18"		23	32.2	8"	5"
10/17-0829		0.18"		23	29.6	7.5"	5.0"
1700		0.09"		16.5	33.9	7.0"	4.25"
10/18-0804		0.10"		17	31.1	7.0"	4.2"

Figure 14. Typical Record Sheets for Bioslurper Pilot Testing (continued)

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page 3 of 4

Site: Havre AFS
Start Date: 10/18/95
Operators: MP, AP
Start Time: _____
Test Type: Drawdown
Well ID: MW-7
Depth to Groundwater: 16.35 Depth to Fuel: 16.34
Depth of Tube: 17.0

Date/Time	Run Time	Vapor Extraction			Pump Stack Temp (°C)	Pump Head Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)
		Stack Pressure (in. H_2O)	Carbon Drums (in. H_2O)	Flowrate (scfm)			
10/18/95							
1545		0.72"			30.4	0	VD
10/19/95							
0830		0.50"				7"	
0945		12"				0"	
		0.60"				0"	

Figure 14. Typical Record Sheets for Bioslurper Pilot Testing (continued)

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page 4 of 4

Site: Havre AFS
Operators: MP, AP
Test Type: 2nd Skimmer
Depth to Groundwater: 15.65 Depth to Fuel: 15.55

Start Date: 10/20/95
Start Time: 1545
Well ID: MW-7
Depth of Tube: 15.65' BTC

Date/Time	Run Time	Vapor Extraction			Pump Stack Temp (°C)	Pump Head Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)
		Stack Pressure (in. H_2O)	Carbon Drums (in. H_2O)	Flowrate (scfm)			
	*	Peristaltic pump was used for the skimmer pump test, therefore data is not applicable.					

Figure 14. Typical Record Sheets for Bioslurper Pilot Testing (continued)

Fuel and Water Recovery Data

Site: Havre AFS
Well ID: MW-7
Test Type: 1st Skimmer

Start Date: 2/14/95
Start Date: 2/16/95
Operaters: J. Kittel, M. Place, A. Pollack

Date/Time (mm/dd/yr hr:min)	Elapsed Time (hours)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gph)	Avg. Rate (gph)	Collected (gal)	Total (gal)	Rate (gph)	Avg. Rate (gph)
10/11/95 11:45	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
10/11/95 11:48	0.0	0.26	0.3	5.3	5.3	0.00	0.0	0.0	0.0
10/11/95 12:00	0.2	0.01	0.3	0.1	1.1	0.00	0.0	0.0	0.0
10/11/95 12:05	0.3	0.01	0.3	0.2	0.9	0.00	0.0	0.0	0.0
10/11/95 12:19	0.6	0.03	0.3	0.1	0.6	0.00	0.0	0.0	0.0
10/11/95 12:48	1.0	0.05	0.4	0.1	0.4	0.00	0.0	0.0	0.0
10/11/95 13:10	1.4	0.01	0.4	0.0	0.3	0.00	0.0	0.0	0.0
10/11/95 18:35	6.8	0.08	0.5	0.0	0.1	0.48	0.5	0.1	0.1
10/11/95 19:45	8.0	0.03	0.5	0.0	0.1	0.08	0.6	0.1	0.1
10/12/95 9:55	8.7	0.00	0.5	0.0	0.1	0.00	0.6	0.0	0.1
10/12/95 15:30	14.3	0.21	0.7	0.0	0.0	0.32	0.9	0.1	0.1
10/13/95 9:08	31.9	0.03	0.7	0.0	0.0	0.11	1.0	0.0	0.0
10/13/95 16:30	39.2	0.01	0.7	0.0	0.0	0.63	1.6	0.1	0.0
Total Time (hours)	39.20	Rate (gph)	0.02	Rate (gpd)	0.45	Rate (gph)	0.04	Rate (gpd)	0.99

Fuel and Water Recovery Data

Site: Havre AFS
Well ID: MW-7
Test Type: Vacuum Enhancement

Start Date: 10/14/95
End Date: 10/18/95
Operaters: J. Kittel, M. Place, A. Pollack

Date/Time (mm/dd/yr hr:min)	Elapsed Time (hours)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gph)	Avg. Rate (gph)	Collected (gal)	Total (gal)	Rate (gph)	Avg. Rate (gph)
10/14/95 7:30	0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
10/14/95 16:35	9.1	0.21	0.2	0.0	0.0	135.00	135.0	14.9	14.9
10/15/95 9:35	26.1	0.08	0.3	0.0	0.0	25.00	160.0	1.5	6.1
10/15/95 18:10	34.7	0.08	0.4	0.0	0.0	5.00	165.0	0.6	4.8
10/16/95 13:30	54.0	0.05	0.4	0.0	0.0	30.00	195.0	1.6	3.6
10/17/95 8:29	73.0	0.07	0.5	0.0	0.0	63.00	258.0	3.3	3.5
10/17/95 17:00	81.5	0.04	0.5	0.0	0.0	36.00	294.0	4.2	3.6
10/18/95 8:04	96.6	0.02	0.5	0.0	0.0	10.00	304.0	0.7	3.1
Total Time (hours)	96.57	Rate (gph)	0.01	Rate (gpd)	0.14	Rate (gph)	3.15	Rate (gpd)	75.55

Fuel and Water Recovery Data

Site: Havre AFS
Well ID: MW-7
Test Type: Drawdown
Start Date: 10/18/95
End Date: 10/20/95
Operaters: J. Kittel, M. Place, A. Pollack

Date/Time (mm/dd/yr hr:min)	Elapsed Time (hours)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gph)	Avg. Rate (gph)	Collected (gal)	Total (gal)	Rate (gph)	Avg. Rate (gph)
10/18/95 10:05	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
10/18/95 15:45	5.7	0.11	0.1	0.0	0.0	27	27.0	4.8	4.8
10/19/95 8:30	22.4	0.03	0.1	0.0	0.0	28	55.0	1.7	2.5
10/19/95 16:50	30.8	0.01	0.1	0.0	0.0	5	60.0	0.6	2.0
10/20/95 8:05	46.0	0.00	0.1	0.0	0.0	10	70.0	0.7	1.5
Total Time (hours)	46.00	Rate (gph)	0.00	Rate (gpd)	0.07	Rate (gph)	1.52	Rate (gpd)	36.52

Fuel and Water Recovery Data

Site: Havre AFS
Well ID: MW-7
Test Type: 2nd Skimmer

Start Date: 2/14/95
Start Date: 2/16/95
Operaters: J. Kittel, M. Place, A. Pollack

Date/Time (mm/dd/yr hr:min)	Elapsed Time (hours)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gph)	Avg. Rate (gph)	Collected (gal)	Total (gal)	Rate (gph)	Avg. Rate (gph)
10/20/95 15:45	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0
10/21/95 9:15	17.5	0.01	0.0	0.0	0.0	0.90	0.9	0.1	0.1
10/21/95 18:35	26.8	0.01	0.0	0.0	0.0	0.79	1.7	0.1	0.1

Record Sheet for In Situ Respiration Test

Site Havre AFS	Monitoring Point MPE-12.0	
Shutdown Date 10/20/95 ~~9/15~~	O_2/CO_2 Meter No.	TPH Meter No.
Shutdown Time 0900	Recorded by MP, AP	

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
10/20/95	0910	20	0	2	4.2		
	1130	20	0.1	38	3.6		
	1705	20	0	45	2.8	10.3	
10/21/95	0955	20	0.1	42	1.4		
	1315	20	0.1	44	1.3		
	1835	20	0.1	38	1.0		
10/22/95	0900	20.5	0.2	32	0.72	10.9	

Record Sheet for In Situ Respiration Test

Site Havre AFS	Monitoring Point MPE - 14.5
Shutdown Date 10/20/95	O_2/CO_2 Meter No. / TPH Meter No.
Shutdown Time 0900	Recorded by MP, AP

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
10/20/95	0910	20	0	0	3.7		
	1130	20	0.1	28	3.2		
	1705	20	0.1	42	3.1	10.0	
10/21/95	0955	20	0.1	45	1.7		
	1315	20.5	0.1	50	1.5		
	1835	20	0.1	52	1.2		
10/22/95	0900	20.5	0.25	46	0.93	10.6	

Record Sheet for In Situ Respiration Test

Site Havre AFS		Monitoring Point MP0-8.5	
Shutdown Date 10/20/95		O_2/CO_2 Meter No.	TPH Meter No.
Shutdown Time 0900		Recorded by MP, AP	

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
10/20/95	0910	20	0	0	4.4		
	1130	20	0	30	4.6		
	1705	19.25	0.1	48	4.2		
10/21/95	0955	18	0.15	38	2.9		
	1315	18	0.2	42	2.5		
	1835	18	0.15	36	2.1		
10/22/95	0900	17.5	0.3	38	1.6		

Record Sheet for In Situ Respiration Test

Site Havre AFS		Monitoring Point MPD - 10.5	
Shutdown Date 10/20/95		O_2/CO_2 Meter No.	TPH Meter No.
Shutdown Time 0900		Recorded by MP, AP	

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
10/20/95	0910	20	0.1	5	4.5		
	1130	18	0	40	4.5		
	1705	15	0.2	77	4.5		
10/21/95	0955	9	0.5	110	4.0		
	1315	8	0.6	150	3.8		
	1835	7	0.8	160	3.7		
10/22/95	0900	4.5	1.4	200	3.2		

Record Sheet for In Situ Respiration Test

Site Havre AFS		Monitoring Point MPC-7.5	
Shutdown Date 10/20/95		O_2/CO_2 Meter No.	TPH Meter No.
Shutdown Time 0900		Recorded by MP, AP	

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
10/20/95	0910	20	0.1	6	3.8		
	1130	20	0.1	40	3.6		
	1705	20	0.1	50	2.6		
10/21/95	0955	19.5	0.2	52	1.5		
	1315	19.75	0.2	70	1.2		
	1835	19.5	0.15	67	1.1		
10/22/95	0900	19.5	0.25	52	0.8		

Record Sheet for In Situ Respiration Test

Site Havre AFS		Monitoring Point MPG-10.5	
Shutdown Date 10/20/95		O_2/CO_2 Meter No.	TPH Meter No.
Shutdown Time 0900		Recorded by MP, AP	

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
10/20/95	0910	20	0.1	4	4.5		
	1130	18.5	0.1	30	4.4		
	1705	15	0.2	48	4.5		
10/21/95	0955	8.5	0.5	68	4.1		
	1315	9.75	0.5	94	3.5		
	1835	6.75	0.75	100	3.7		
10/22/95	0900	3.75	1.1	185	3.3		

APPENDIX E

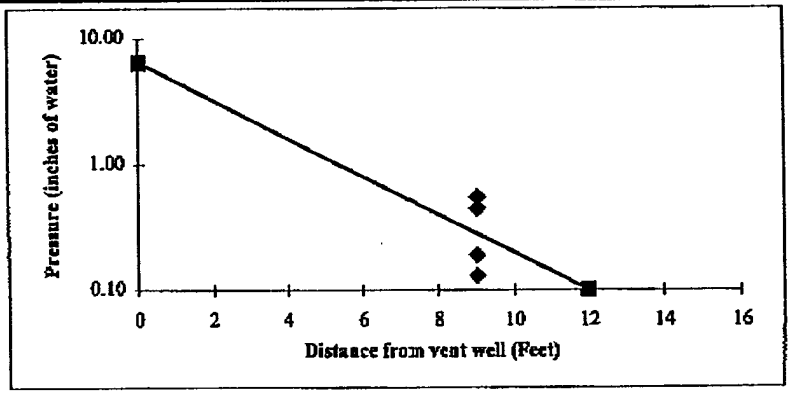
SOIL GAS PERMEABILITY TEST RESULTS

Radius of Influence

Site Name Havre AFS MW-7 **Operator(s)** J. Kittel, M. Place, A. Pollack **Date:** 10/22/95

Time (min.)	Air Flow (cfm)	Vacuum (inches of water)													
		MPD-b	MPD-r	MPE-b	MPE-r	MPG-b	MPG-r								
0.00		0.00	0.00	0.00	0.00	0.00	0.00								
5.00		0.20	0.45	0.03	0.28	0.14	0.55								
10.00		0.30	0.45	0.03	0.03	0.13	0.55								
15.00		0.30	0.45	0.03	0.03	0.13	0.55								
20.00		0.25	0.45	0.03	0.03	0.13	0.55								
45.00		0.15	0.45	0.03	0.03	0.13	0.55								
120.00		0.19	0.45	0.04	0.03	0.13	0.55								
Distance (ft)		9	9	15	15	9	9								

R_i: 11.95 ft

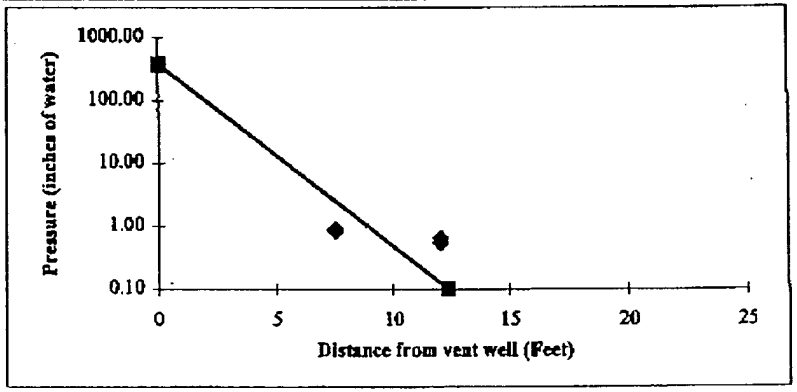


Radius of Influence

Site Name Havre AFS MW-F **Operator(s)** J. Kittel, M. Place, A. Pollack **Date:** 10/22/95

Time (min.)	Air Flow (cfm)	Vacuum (inches of water)													
		MPA-b	MPA-r	MPB-b	MPB-r	MPF-b	MPF-r								
0.00		0.00	0.00	0.00	0.00	0.00	0.00								
6.00		0.90	0.80	0.00	0.01	0.50	0.80								
15.00		1.00	0.90	0.00	0.02	0.50	0.65								
30.00		1.00	0.90	0.00	0.02	0.50	0.65								
45.00		1.00	0.80	0.00	0.03	0.50	0.55								
60.00		1.00	0.85	0.00	0.03	0.50	0.50								
90.00		0.90	0.85	0.00	0.03	0.55	0.65								
Distance (ft)		7.5	7.5	21	21	12	12								

R_1: 12.32 ft



APPENDIX F

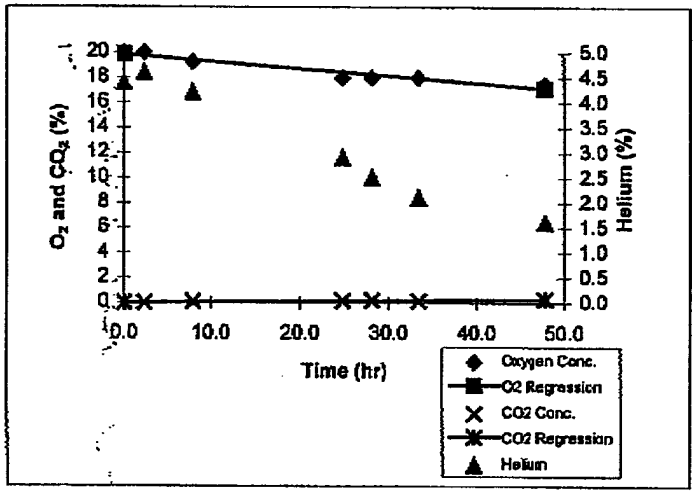
IN SITU RESPIRATION TEST RESULTS

Oxygen Utilization Rate (1)

Date: 10/22/95 **Site Name:** Havre AFS

Monitoring Point: MPD-8 **Depth of M.P. (ft):** 8-8.5

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
10/20/95 9:10	0.0	20.00	0.00	4.40
10/20/95 11:30	2.3	20.00	0.00	4.60
10/20/95 17:05	7.9	19.25	0.10	4.20
10/21/95 9:55	24.8	18.00	0.15	2.90
10/21/95 13:15	28.1	18.00	0.20	2.50
10/21/95 18:35	33.4	18.00	0.15	2.10
10/22/95 9:00	47.8	17.50	0.30	1.60



O_2 Utilization Rate

Ko	0.001	%/min
	0.057	%/hr
	1.357	%/day

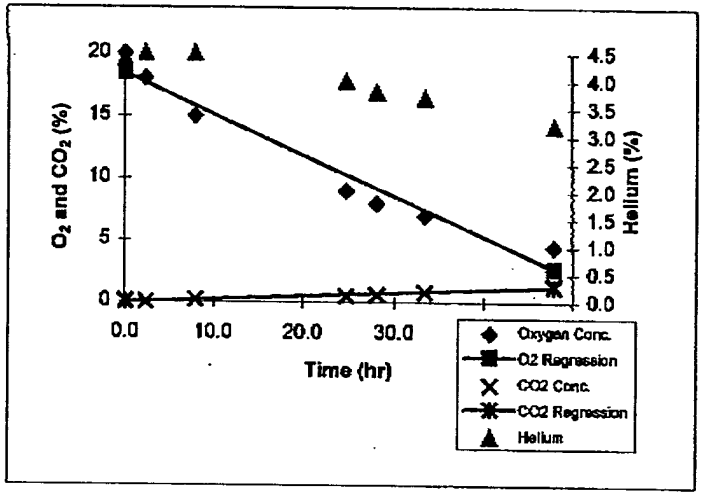
Regression Lines	O_2	CO_2
Slope	-0.0565	0.0058
Intercept	19.8441	0.0099
Determination Coef.	0.9205	0.9078
No. of Data Points.	7	7

Oxygen Utilization Rate (2)

Date: 10/22/95 **Site Name:** Havre AFS

Monitoring Point: MPD-10 **Depth of M.P. (ft):** 10-10.5

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
10/20/95 9:10	0.0	20.00	0.10	4.40
10/20/95 11:30	2.3	18.00	0.00	4.50
10/20/95 17:05	7.9	15.00	0.20	4.50
10/21/95 9:55	24.8	9.00	0.50	4.00
10/21/95 13:15	28.1	8.00	0.60	3.80
10/21/95 18:35	33.4	7.00	0.80	3.70
10/22/95 9:00	47.8	4.50	1.40	3.20



O_2 Utilization Rate

Ko	0.005 %/min
	0.328 %/hr
	7.879 %/day

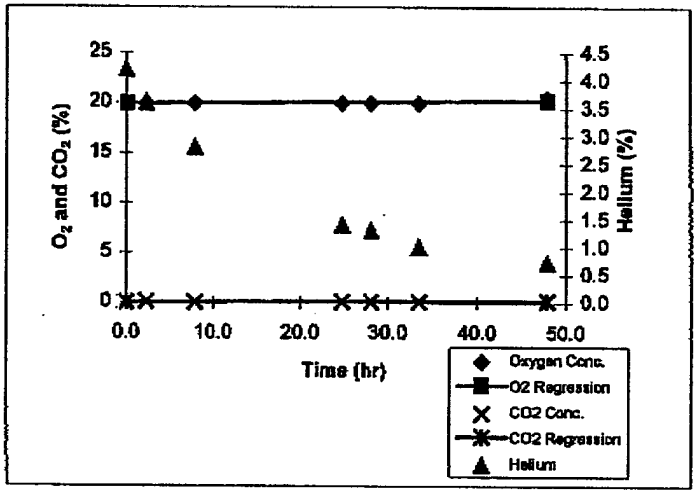
Regression Lines	O_2	CO_2
Slope	-0.3283	0.0265
Intercept	18.4120	-0.0319
Determination Coef.	0.9543	0.9456
No. of Data Points.	7	7

Oxygen Utilization Rate (3)

Date: 10/22/95 **Site Name:** Havre AFS

Monitoring Point: MPE-11.5 **Depth of M.P. (ft):** 11.5-12

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
10/20/95 9:10	0.0	20.00	0.00	4.20
10/20/95 11:30	2.3	20.00	0.10	3.60
10/20/95 17:05	7.9	20.00	0.00	2.80
10/21/95 9:55	24.8	20.00	0.10	1.40
10/21/95 13:15	28.1	20.00	0.10	1.30
10/21/95 18:35	33.4	20.00	0.10	1.00
10/22/95 9:00	47.8	20.50	0.20	0.72



O_2 Utilization Rate

Ko 0.000 %/min
-0.007 %/hr
-0.172 %/day

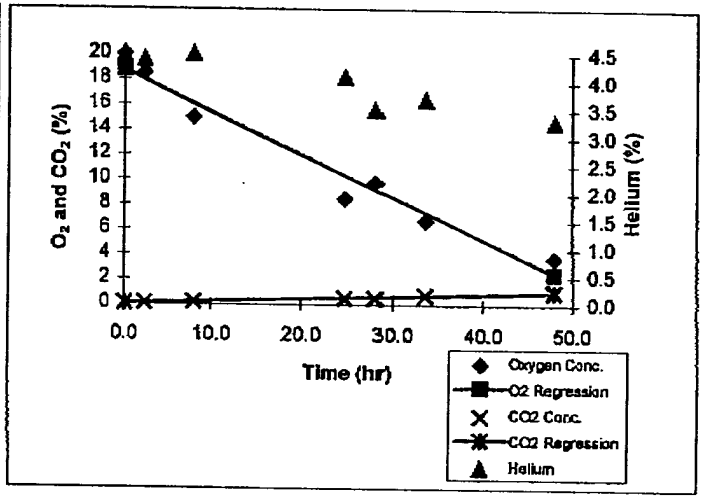
Regression Lines	O_2	CO_2
Slope	0.0072	0.0032
Intercept	19.9236	0.0200
Determination Coef.	0.4552	0.6758
No. of Data Points.	7	7

Oxygen Utilization Rate (1)

Date: 10/22/95 **Site Name:** Havre AFS

Monitoring Point: MPG-10 **Depth of M.P. (ft):** 10-10.5

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
10/20/95 9:10	0.0	20.00	0.10	4.50
10/20/95 11:30	2.3	18.50	0.10	4.40
10/20/95 17:05	7.9	15.00	0.20	4.50
10/21/95 9:55	24.8	8.50	0.50	4.10
10/21/95 13:15	28.1	9.75	0.50	3.50
10/21/95 18:35	33.4	6.75	0.75	3.70
10/22/95 9:00	47.8	3.75	1.10	3.30



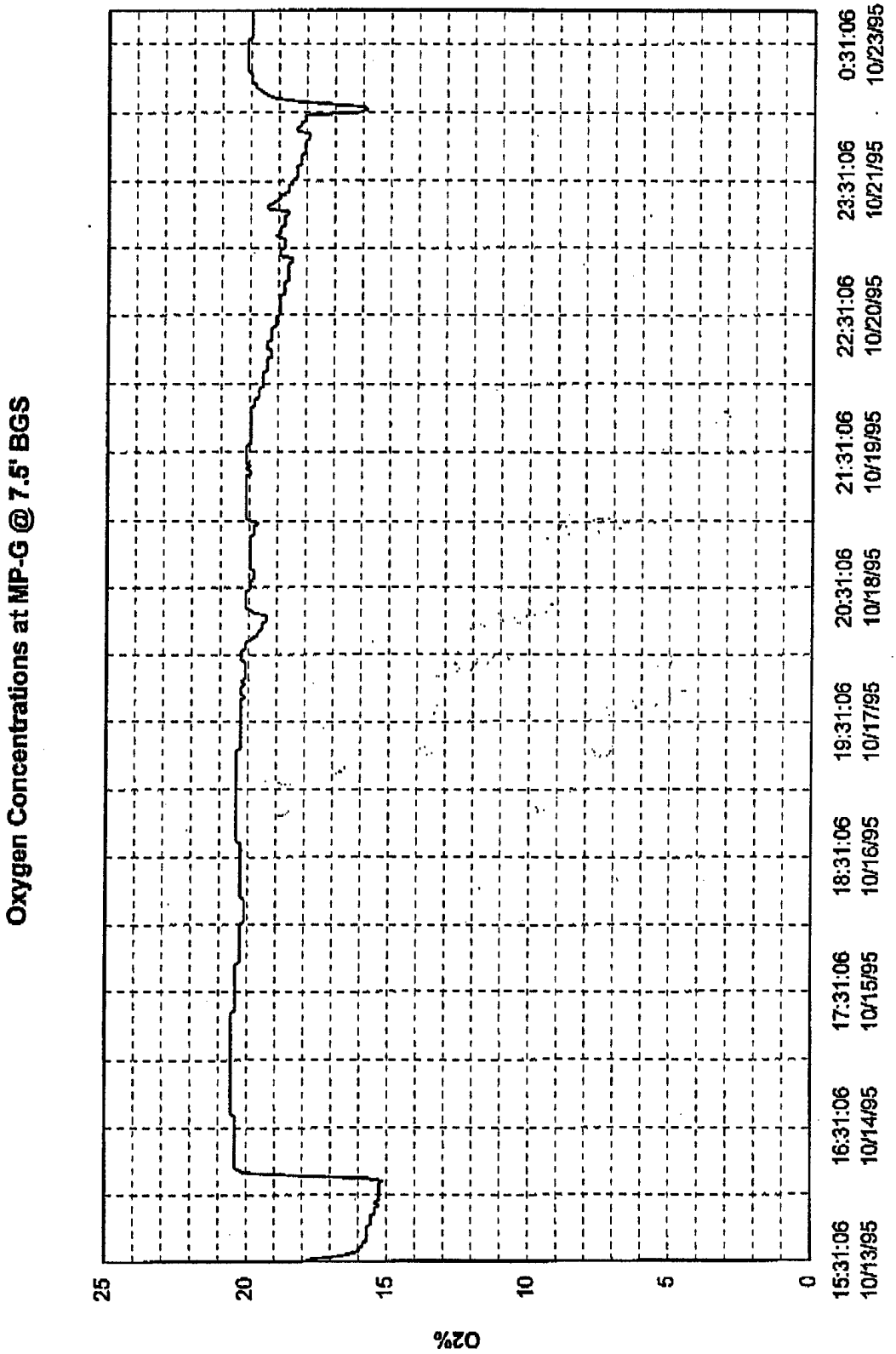
O_2 Utilization Rate

Ko 0.006 %/min
0.340 %/hr
8.154 %/day

Regression Lines	O_2	CO_2
Slope	-0.3398	0.0205
Intercept	18.7555	0.0417
Determination Coef.	0.9620	0.9681
No. of Data Points.	7	7

APPENDIX G

DATAWRITE OXYGEN SENSOR DATA


Oxygen Concentrations at MP-G @ 7.5' BGS
O2%
25
20
15
10
5
0
15:31:06 10/13/95
16:31:06 10/14/95
17:31:06 10/15/95
18:31:06 10/16/95
19:31:06 10/17/95
20:31:06 10/18/95
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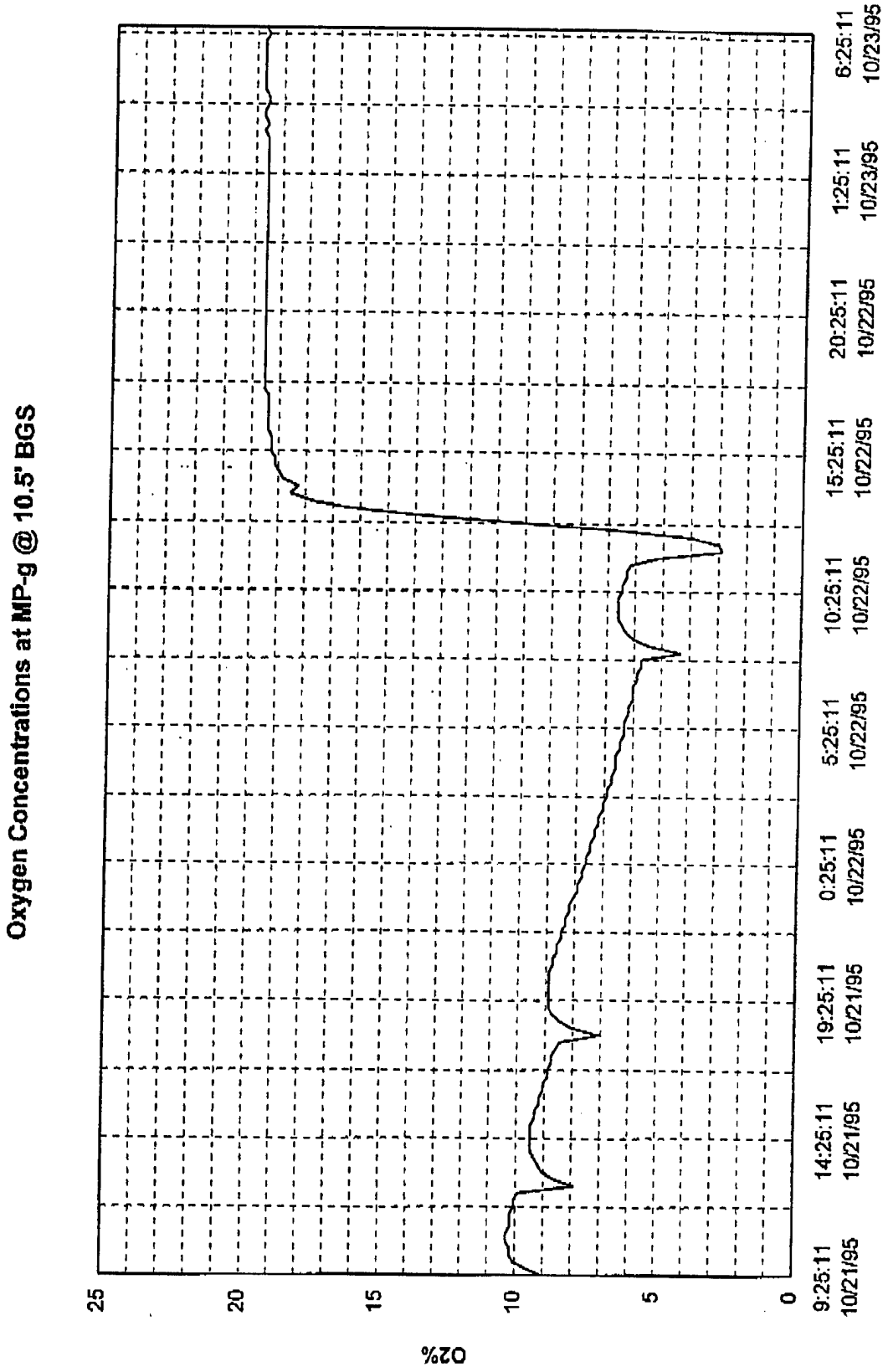
0:31:06 10/23/95
Time/Date


Oxygen Concentrations at MP-g @ 10.5' BGS
O2%
25
20
15
10
5
0
9:25:11 10/21/95
14:25:11 10/21/95
19:25:11 10/21/95
0:25:11 10/22/95
5:25:11 10/22/95
10:25:11 10/22/95
15:25:11 10/22/95
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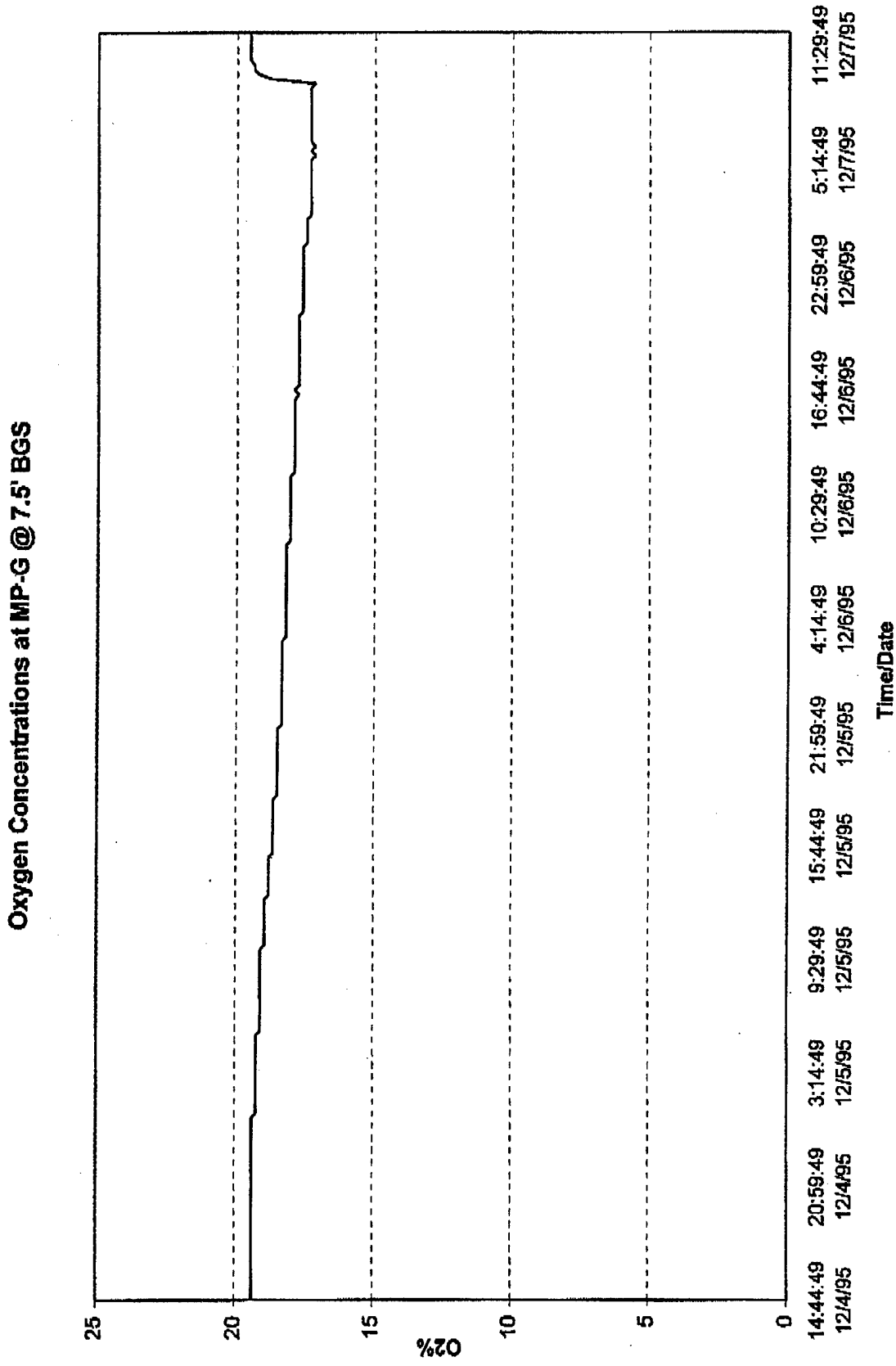
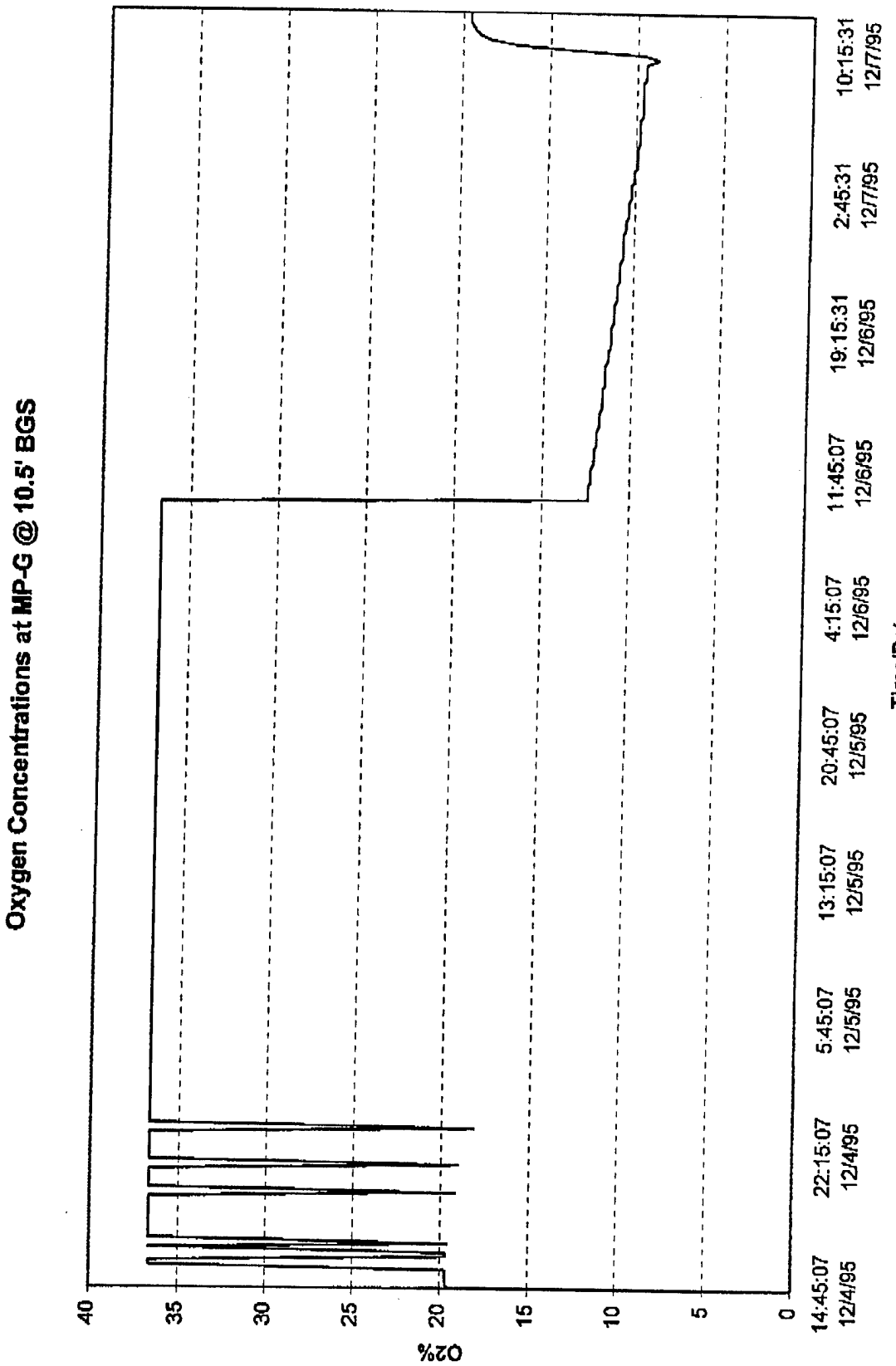
6:25:11 10/23/95
Time/Date


Oxygen Concentrations at MP-G @ 7.5' BGS
25
20
15
10
5
0
O2%
14:44:49 12/4/95
20:59:49 12/4/95
3:14:49 12/5/95
9:29:49 12/5/95
15:44:49 12/5/95
21:59:49 12/5/95
4:14:49 12/6/95
10:29:49 12/6/95
16:44:49 12/6/95
22:59:49 12/6/95
5:14:49 12/7/95
11:29:49 12/7/95
Time/Date


Oxygen Concentrations at MP-G @ 10.5' BGS
O2%
40
35
30
25
20
15
10
5
0
14:45:07 12/4/95
22:15:07 12/4/95
5:45:07 12/5/95
13:15:07 12/5/95
20:45:07 12/5/95
4:15:07 12/6/95
11:45:07 12/6/95
19:15:31 12/6/95
2:45:31 12/7/95
10:15:31 12/7/95
Time/Date

554834
REPORT DATE / TIME... 10-25-1995 / 14:11:14

Unit Serial Number > 554834
Total # Recordings > 182
Recording Intervals > 00:15:00
Elapsed Log Time > 1Days,21:15:00
Time Of Retrieval > 10-23-95 , 6:42:16
Started Recordings > 10-21-95 , 9:25:11
Ending Recording > 10-23-95 , 6:40:11
Battery Condition > Battery is ok

Min/Max <> Average > 2.8767 / 19.705 <> 12.226 %o2

COUNT	DATE	TIME	ELTIME	%o2	Mv
1	10-21-95	09:25:11	00:00:00	9.0616	15.75
2	10-21-95	09:40:11	00:15:00	9.6369	16.75
3	10-21-95	09:55:11	00:30:00	10.068	17.50
4	10-21-95	10:10:11	00:45:00	10.212	17.75
5	10-21-95	10:25:11	01:00:00	10.212	17.75
6	10-21-95	10:40:11	01:15:00	10.356	18.0
7	10-21-95	10:55:11	01:30:00	10.356	18.0
8	10-21-95	11:10:11	01:45:00	10.212	17.75
9	10-21-95	11:25:11	02:00:00	10.212	17.75
10	10-21-95	11:40:11	02:15:00	10.212	17.75
11	10-21-95	11:55:11	02:30:00	10.068	17.50
12	10-21-95	12:10:11	02:45:00	10.068	17.50
13	10-21-95	12:25:11	03:00:00	9.9246	17.25
14	10-21-95	12:40:11	03:15:00	7.9109	13.75
15	10-21-95	12:55:11	03:30:00	8.6301	15.0
16	10-21-95	13:10:11	03:45:00	9.0616	15.75
17	10-21-95	13:25:11	04:00:00	9.2054	16.0
18	10-21-95	13:40:11	04:15:00	9.3493	16.25
19	10-21-95	13:55:11	04:30:00	9.4931	16.50
20	10-21-95	14:10:11	04:45:00	9.4931	16.50
21	10-21-95	14:25:11	05:00:00	9.4931	16.50
22	10-21-95	14:40:11	05:15:00	9.4931	16.50
23	10-21-95	14:55:11	05:30:00	9.4931	16.50
24	10-21-95	15:10:11	05:45:00	9.3493	16.25
25	10-21-95	15:25:11	06:00:00	9.3493	16.25
26	10-21-95	15:40:11	06:15:00	9.2054	16.0
27	10-21-95	15:55:11	06:30:00	9.2054	16.0
28	10-21-95	16:10:11	06:45:00	9.0616	15.75
29	10-21-95	16:25:11	07:00:00	9.0616	15.75
30	10-21-95	16:40:11	07:15:00	8.9178	15.50
31	10-21-95	16:55:11	07:30:00	8.9178	15.50
32	10-21-95	17:10:11	07:45:00	8.7739	15.25
33	10-21-95	17:25:11	08:00:00	8.7739	15.25
34	10-21-95	17:40:11	08:15:00	8.6301	15.0

35	10-21-95	17:55:11	08:30:00	8.4863	14.75
36	10-21-95	18:10:11	08:45:00	7.0479	12.25
37	10-21-95	18:25:11	09:00:00	8.0547	14.0
38	10-21-95	18:40:11	09:15:00	8.4863	14.75
39	10-21-95	18:55:11	09:30:00	8.7739	15.25
40	10-21-95	19:10:11	09:45:00	8.9178	15.50
41	10-21-95	19:25:11	10:00:00	8.9178	15.50
42	10-21-95	19:40:11	10:15:00	8.9178	15.50
43	10-21-95	19:55:11	10:30:00	8.9178	15.50
44	10-21-95	20:10:11	10:45:00	8.9178	15.50
45	10-21-95	20:25:11	11:00:00	8.9178	15.50
46	10-21-95	20:40:11	11:15:00	8.7739	15.25
47	10-21-95	20:55:11	11:30:00	8.7739	15.25
48	10-21-95	21:10:11	11:45:00	8.6301	15.0
49	10-21-95	21:25:11	12:00:00	8.6301	15.0
50	10-21-95	21:40:11	12:15:00	8.4863	14.75
51	10-21-95	21:55:11	12:30:00	8.4863	14.75
52	10-21-95	22:10:11	12:45:00	8.3424	14.50
53	10-21-95	22:25:11	13:00:00	8.3424	14.50
54	10-21-95	22:40:11	13:15:00	8.1986	14.25
55	10-21-95	22:55:11	13:30:00	8.1986	14.25
56	10-21-95	23:10:11	13:45:00	8.0547	14.0
57	10-21-95	23:25:11	14:00:00	7.9109	13.75
58	10-21-95	23:40:11	14:15:00	7.9109	13.75
59	10-21-95	23:55:11	14:30:00	7.7671	13.50
60	10-22-95	00:10:11	14:45:00	7.7671	13.50
61	10-22-95	00:25:11	15:00:00	7.6232	13.25
62	10-22-95	00:40:11	15:15:00	7.6232	13.25
63	10-22-95	00:55:11	15:30:00	7.4794	13.0
64	10-22-95	01:10:11	15:45:00	7.4794	13.0
65	10-22-95	01:25:11	16:00:00	7.3356	12.75
66	10-22-95	01:40:11	16:15:00	7.3356	12.75
67	10-22-95	01:55:11	16:30:00	7.1917	12.50
68	10-22-95	02:10:11	16:45:00	7.1917	12.50
69	10-22-95	02:25:11	17:00:00	7.0479	12.25
70	10-22-95	02:40:11	17:15:00	7.0479	12.25
71	10-22-95	02:55:11	17:30:00	6.9041	12.0
72	10-22-95	03:10:11	17:45:00	6.9041	12.0
73	10-22-95	03:25:11	18:00:00	6.7602	11.75
74	10-22-95	03:40:11	18:15:00	6.7602	11.75
75	10-22-95	03:55:11	18:30:00	6.6164	11.50
76	10-22-95	04:10:11	18:45:00	6.6164	11.50
77	10-22-95	04:25:11	19:00:00	6.6164	11.50
78	10-22-95	04:40:11	19:15:00	6.4726	11.25
79	10-22-95	04:55:11	19:30:00	6.4726	11.25
80	10-22-95	05:10:11	19:45:00	6.3287	11.0
81	10-22-95	05:25:11	20:00:00	6.3287	11.0
82	10-22-95	05:40:11	20:15:00	6.3287	11.0
83	10-22-95	05:55:11	20:30:00	6.1849	10.75
84	10-22-95	06:10:11	20:45:00	6.1849	10.75
85	10-22-95	06:25:11	21:00:00	6.0410	10.50

86	10-22-95	06:40:11	21:15:00	6.0410	10.50
87	10-22-95	06:55:11	21:30:00	6.0410	10.50
88	10-22-95	07:10:11	21:45:00	5.8972	10.25
89	10-22-95	07:25:11	22:00:00	5.8972	10.25
90	10-22-95	07:40:11	22:15:00	5.7534	10.0
91	10-22-95	07:55:11	22:30:00	5.7534	10.0
92	10-22-95	08:10:11	22:45:00	4.3150	7.50
93	10-22-95	08:25:11	23:00:00	5.4657	9.50
94	10-22-95	08:40:11	23:15:00	6.0410	10.50
95	10-22-95	08:55:11	23:30:00	6.3287	11.0
96	10-22-95	09:10:11	23:45:00	6.4726	11.25
97	10-22-95	09:25:11	1Days,00:00:00	6.6164	11.50
98	10-22-95	09:40:11	1Days,00:15:00	6.6164	11.50
99	10-22-95	09:55:11	1Days,00:30:00	6.6164	11.50
100	10-22-95	10:10:11	1Days,00:45:00	6.6164	11.50
101	10-22-95	10:25:11	1Days,01:00:00	6.4726	11.25
102	10-22-95	10:40:11	1Days,01:15:00	6.4726	11.25
103	10-22-95	10:55:11	1Days,01:30:00	6.3287	11.0
104	10-22-95	11:10:11	1Days,01:45:00	6.3287	11.0
105	10-22-95	11:25:11	1Days,02:00:00	6.1849	10.75
106	10-22-95	11:40:11	1Days,02:15:00	5.1780	9.0
107	10-22-95	11:55:11	1Days,02:30:00	2.8767	5.0
108	10-22-95	12:10:11	1Days,02:45:00	3.0205	5.25
109	10-22-95	12:25:11	1Days,03:00:00	4.0273	7.0
110	10-22-95	12:40:11	1Days,03:15:00	6.4726	11.25
111	10-22-95	12:55:11	1Days,03:30:00	10.212	17.75
112	10-22-95	13:10:11	1Days,03:45:00	13.808	24.0
113	10-22-95	13:25:11	1Days,04:00:00	16.397	28.50
114	10-22-95	13:40:11	1Days,04:15:00	17.835	31.0
115	10-22-95	13:55:11	1Days,04:30:00	18.554	32.25
116	10-22-95	14:10:11	1Days,04:45:00	18.267	31.75
117	10-22-95	14:25:11	1Days,05:00:00	18.842	32.75
118	10-22-95	14:40:11	1Days,05:15:00	18.986	33.0
119	10-22-95	14:55:11	1Days,05:30:00	19.130	33.25
120	10-22-95	15:10:11	1Days,05:45:00	19.130	33.25
121	10-22-95	15:25:11	1Days,06:00:00	19.273	33.50
122	10-22-95	15:40:11	1Days,06:15:00	19.273	33.50
123	10-22-95	15:55:11	1Days,06:30:00	19.273	33.50
124	10-22-95	16:10:11	1Days,06:45:00	19.417	33.75
125	10-22-95	16:25:11	1Days,07:00:00	19.417	33.75
126	10-22-95	16:40:11	1Days,07:15:00	19.417	33.75
127	10-22-95	16:55:11	1Days,07:30:00	19.417	33.75
128	10-22-95	17:10:11	1Days,07:45:00	19.417	33.75
129	10-22-95	17:25:11	1Days,08:00:00	19.417	33.75
130	10-22-95	17:40:11	1Days,08:15:00	19.561	34.0
131	10-22-95	17:55:11	1Days,08:30:00	19.561	34.0
132	10-22-95	18:10:11	1Days,08:45:00	19.561	34.0
133	10-22-95	18:25:11	1Days,09:00:00	19.561	34.0
134	10-22-95	18:40:11	1Days,09:15:00	19.561	34.0
135	10-22-95	18:55:11	1Days,09:30:00	19.561	34.0
136	10-22-95	19:10:11	1Days,09:45:00	19.561	34.0

137	10-22-95	19:25:11	1Days,10:00:00	19.561	34.0
138	10-22-95	19:40:11	1Days,10:15:00	19.561	34.0
139	10-22-95	19:55:11	1Days,10:30:00	19.561	34.0
140	10-22-95	20:10:11	1Days,10:45:00	19.561	34.0
141	10-22-95	20:25:11	1Days,11:00:00	19.561	34.0
142	10-22-95	20:40:11	1Days,11:15:00	19.561	34.0
143	10-22-95	20:55:11	1Days,11:30:00	19.561	34.0
144	10-22-95	21:10:11	1Days,11:45:00	19.561	34.0
145	10-22-95	21:25:11	1Days,12:00:00	19.561	34.0
146	10-22-95	21:40:11	1Days,12:15:00	19.561	34.0
147	10-22-95	21:55:11	1Days,12:30:00	19.561	34.0
148	10-22-95	22:10:11	1Days,12:45:00	19.561	34.0
149	10-22-95	22:25:11	1Days,13:00:00	19.561	34.0
150	10-22-95	22:40:11	1Days,13:15:00	19.561	34.0
151	10-22-95	22:55:11	1Days,13:30:00	19.561	34.0
152	10-22-95	23:10:11	1Days,13:45:00	19.561	34.0
153	10-22-95	23:25:11	1Days,14:00:00	19.561	34.0
154	10-22-95	23:40:11	1Days,14:15:00	19.561	34.0
155	10-22-95	23:55:11	1Days,14:30:00	19.561	34.0
156	10-23-95	00:10:11	1Days,14:45:00	19.561	34.0
157	10-23-95	00:25:11	1Days,15:00:00	19.561	34.0
158	10-23-95	00:40:11	1Days,15:15:00	19.561	34.0
159	10-23-95	00:55:11	1Days,15:30:00	19.561	34.0
160	10-23-95	01:10:11	1Days,15:45:00	19.561	34.0
161	10-23-95	01:25:11	1Days,16:00:00	19.561	34.0
162	10-23-95	01:40:11	1Days,16:15:00	19.561	34.0
163	10-23-95	01:55:11	1Days,16:30:00	19.561	34.0
164	10-23-95	02:10:11	1Days,16:45:00	19.561	34.0
165	10-23-95	02:25:11	1Days,17:00:00	19.561	34.0
166	10-23-95	02:40:11	1Days,17:15:00	19.561	34.0
167	10-23-95	02:55:11	1Days,17:30:00	19.705	34.25
168	10-23-95	03:10:11	1Days,17:45:00	19.561	34.0
169	10-23-95	03:25:11	1Days,18:00:00	19.705	34.25
170	10-23-95	03:40:11	1Days,18:15:00	19.705	34.25
171	10-23-95	03:55:11	1Days,18:30:00	19.561	34.0
172	10-23-95	04:10:11	1Days,18:45:00	19.561	34.0
173	10-23-95	04:25:11	1Days,19:00:00	19.705	34.25
174	10-23-95	04:40:11	1Days,19:15:00	19.705	34.25
175	10-23-95	04:55:11	1Days,19:30:00	19.705	34.25
176	10-23-95	05:10:11	1Days,19:45:00	19.705	34.25
177	10-23-95	05:25:11	1Days,20:00:00	19.705	34.25
178	10-23-95	05:40:11	1Days,20:15:00	19.705	34.25
179	10-23-95	05:55:11	1Days,20:30:00	19.705	34.25
180	10-23-95	06:10:11	1Days,20:45:00	19.705	34.25
181	10-23-95	06:25:11	1Days,21:00:00	19.561	34.0
182	10-23-95	06:40:11	1Days,21:15:00	19.705	34.25

END OF RECORDINGS

554993
REPORT DATE / TIME... 10-25-1995 / 14:10:48

Unit Serial Number > 554993
Total # Recordings > 463
Recording Intervals > 00:30:00
Elapsed Log Time > 9Days,15:00:00
Time Of Retrieval > 10-23-95 , 6:42:27
Started Recordings > 10-13-95 , 15:31:6
Ending Recording > 10-23-95 , 6:31:6
Battery Condition > Battery is ok

Min/Max <> Average > 15.125 / 20.559 <> 19.531 %o2

COUNT	DATE	TIME	ELTIME	%o2	Mv
1	10-13-95	15:31:06	00:00:00	17.916	30.50
2	10-13-95	16:01:06	00:30:00	17.622	30.0
3	10-13-95	16:31:06	01:00:00	16.741	28.50
4	10-13-95	17:01:06	01:30:00	16.300	27.75
5	10-13-95	17:31:06	02:00:00	16.006	27.25
6	10-13-95	18:01:06	02:30:00	16.006	27.25
7	10-13-95	18:31:06	03:00:00	15.860	27.0
8	10-13-95	19:01:06	03:30:00	15.860	27.0
9	10-13-95	19:31:06	04:00:00	15.713	26.75
10	10-13-95	20:01:06	04:30:00	15.713	26.75
11	10-13-95	20:31:06	05:00:00	15.713	26.75
12	10-13-95	21:01:06	05:30:00	15.713	26.75
13	10-13-95	21:31:06	06:00:00	15.713	26.75
14	10-13-95	22:01:06	06:30:00	15.713	26.75
15	10-13-95	22:31:06	07:00:00	15.566	26.50
16	10-13-95	23:01:06	07:30:00	15.566	26.50
17	10-13-95	23:31:06	08:00:00	15.566	26.50
18	10-14-95	00:01:06	08:30:00	15.566	26.50
19	10-14-95	00:31:06	09:00:00	15.419	26.25
20	10-14-95	01:01:06	09:30:00	15.419	26.25
21	10-14-95	01:31:06	10:00:00	15.419	26.25
22	10-14-95	02:01:06	10:30:00	15.272	26.0
23	10-14-95	02:31:06	11:00:00	15.419	26.25
24	10-14-95	03:01:06	11:30:00	15.272	26.0
25	10-14-95	03:31:06	12:00:00	15.272	26.0
26	10-14-95	04:01:06	12:30:00	15.272	26.0
27	10-14-95	04:31:06	13:00:00	15.272	26.0
28	10-14-95	05:01:06	13:30:00	15.272	26.0
29	10-14-95	05:31:06	14:00:00	15.272	26.0
30	10-14-95	06:01:06	14:30:00	15.272	26.0
31	10-14-95	06:31:06	15:00:00	15.125	25.75
32	10-14-95	07:01:06	15:30:00	15.713	26.75
33	10-14-95	07:31:06	16:00:00	18.209	31.0
34	10-14-95	08:01:06	16:30:00	20.118	34.25

35	10-14-95	08:31:06	17:00:00	20.265	34.50
36	10-14-95	09:01:06	17:30:00	20.412	34.75
37	10-14-95	09:31:06	18:00:00	20.412	34.75
38	10-14-95	10:01:06	18:30:00	20.412	34.75
39	10-14-95	10:31:06	19:00:00	20.412	34.75
40	10-14-95	11:01:06	19:30:00	20.412	34.75
41	10-14-95	11:31:06	20:00:00	20.412	34.75
42	10-14-95	12:01:06	20:30:00	20.412	34.75
43	10-14-95	12:31:06	21:00:00	20.412	34.75
44	10-14-95	13:01:06	21:30:00	20.412	34.75
45	10-14-95	13:31:06	22:00:00	20.412	34.75
46	10-14-95	14:01:06	22:30:00	20.412	34.75
47	10-14-95	14:31:06	23:00:00	20.412	34.75
48	10-14-95	15:01:06	23:30:00	20.412	34.75
49	10-14-95	15:31:06	1Days,00:00:00	20.412	34.75
50	10-14-95	16:01:06	1Days,00:30:00	20.412	34.75
51	10-14-95	16:31:06	1Days,01:00:00	20.412	34.75
52	10-14-95	17:01:06	1Days,01:30:00	20.412	34.75
53	10-14-95	17:31:06	1Days,02:00:00	20.412	34.75
54	10-14-95	18:01:06	1Days,02:30:00	20.412	34.75
55	10-14-95	18:31:06	1Days,03:00:00	20.412	34.75
56	10-14-95	19:01:06	1Days,03:30:00	20.559	35.0
57	10-14-95	19:31:06	1Days,04:00:00	20.559	35.0
58	10-14-95	20:01:06	1Days,04:30:00	20.559	35.0
59	10-14-95	20:31:06	1Days,05:00:00	20.559	35.0
60	10-14-95	21:01:06	1Days,05:30:00	20.559	35.0
61	10-14-95	21:31:06	1Days,06:00:00	20.559	35.0
62	10-14-95	22:01:06	1Days,06:30:00	20.559	35.0
63	10-14-95	22:31:06	1Days,07:00:00	20.559	35.0
64	10-14-95	23:01:06	1Days,07:30:00	20.559	35.0
65	10-14-95	23:31:06	1Days,08:00:00	20.559	35.0
66	10-15-95	00:01:06	1Days,08:30:00	20.559	35.0
67	10-15-95	00:31:06	1Days,09:00:00	20.559	35.0
68	10-15-95	01:01:06	1Days,09:30:00	20.559	35.0
69	10-15-95	01:31:06	1Days,10:00:00	20.559	35.0
70	10-15-95	02:01:06	1Days,10:30:00	20.559	35.0
71	10-15-95	02:31:06	1Days,11:00:00	20.559	35.0
72	10-15-95	03:01:06	1Days,11:30:00	20.559	35.0
73	10-15-95	03:31:06	1Days,12:00:00	20.559	35.0
74	10-15-95	04:01:06	1Days,12:30:00	20.559	35.0
75	10-15-95	04:31:06	1Days,13:00:00	20.559	35.0
76	10-15-95	05:01:06	1Days,13:30:00	20.559	35.0
77	10-15-95	05:31:06	1Days,14:00:00	20.559	35.0
78	10-15-95	06:01:06	1Days,14:30:00	20.559	35.0
79	10-15-95	06:31:06	1Days,15:00:00	20.559	35.0
80	10-15-95	07:01:06	1Days,15:30:00	20.559	35.0
81	10-15-95	07:31:06	1Days,16:00:00	20.559	35.0
82	10-15-95	08:01:06	1Days,16:30:00	20.559	35.0
83	10-15-95	08:31:06	1Days,17:00:00	20.559	35.0
84	10-15-95	09:01:06	1Days,17:30:00	20.559	35.0
85	10-15-95	09:31:06	1Days,18:00:00	20.559	35.0

86	10-15-95	10:01:06	1Days,18:30:00	20.559	35.0
87	10-15-95	10:31:06	1Days,19:00:00	20.559	35.0
88	10-15-95	11:01:06	1Days,19:30:00	20.559	35.0
89	10-15-95	11:31:06	1Days,20:00:00	20.559	35.0
90	10-15-95	12:01:06	1Days,20:30:00	20.559	35.0
91	10-15-95	12:31:06	1Days,21:00:00	20.559	35.0
92	10-15-95	13:01:06	1Days,21:30:00	20.559	35.0
93	10-15-95	13:31:06	1Days,22:00:00	20.559	35.0
94	10-15-95	14:01:06	1Days,22:30:00	20.412	34.75
95	10-15-95	14:31:06	1Days,23:00:00	20.412	34.75
96	10-15-95	15:01:06	1Days,23:30:00	20.412	34.75
97	10-15-95	15:31:06	2Days,00:00:00	20.412	34.75
98	10-15-95	16:01:06	2Days,00:30:00	20.412	34.75
99	10-15-95	16:31:06	2Days,01:00:00	20.412	34.75
100	10-15-95	17:01:06	2Days,01:30:00	20.412	34.75
101	10-15-95	17:31:06	2Days,02:00:00	20.412	34.75
102	10-15-95	18:01:06	2Days,02:30:00	20.412	34.75
103	10-15-95	18:31:06	2Days,03:00:00	20.412	34.75
104	10-15-95	19:01:06	2Days,03:30:00	20.412	34.75
105	10-15-95	19:31:06	2Days,04:00:00	20.412	34.75
106	10-15-95	20:01:06	2Days,04:30:00	20.412	34.75
107	10-15-95	20:31:06	2Days,05:00:00	20.412	34.75
108	10-15-95	21:01:06	2Days,05:30:00	20.412	34.75
109	10-15-95	21:31:06	2Days,06:00:00	20.412	34.75
110	10-15-95	22:01:06	2Days,06:30:00	20.412	34.75
111	10-15-95	22:31:06	2Days,07:00:00	20.412	34.75
112	10-15-95	23:01:06	2Days,07:30:00	20.265	34.50
113	10-15-95	23:31:06	2Days,08:00:00	20.265	34.50
114	10-16-95	00:01:06	2Days,08:30:00	20.265	34.50
115	10-16-95	00:31:06	2Days,09:00:00	20.265	34.50
116	10-16-95	01:01:06	2Days,09:30:00	20.265	34.50
117	10-16-95	01:31:06	2Days,10:00:00	20.265	34.50
118	10-16-95	02:01:06	2Days,10:30:00	20.265	34.50
119	10-16-95	02:31:06	2Days,11:00:00	20.265	34.50
120	10-16-95	03:01:06	2Days,11:30:00	20.265	34.50
121	10-16-95	03:31:06	2Days,12:00:00	20.265	34.50
122	10-16-95	04:01:06	2Days,12:30:00	20.265	34.50
123	10-16-95	04:31:06	2Days,13:00:00	20.265	34.50
124	10-16-95	05:01:06	2Days,13:30:00	20.265	34.50
125	10-16-95	05:31:06	2Days,14:00:00	20.265	34.50
126	10-16-95	06:01:06	2Days,14:30:00	20.265	34.50
127	10-16-95	06:31:06	2Days,15:00:00	20.118	34.25
128	10-16-95	07:01:06	2Days,15:30:00	20.118	34.25
129	10-16-95	07:31:06	2Days,16:00:00	20.118	34.25
130	10-16-95	08:01:06	2Days,16:30:00	20.118	34.25
131	10-16-95	08:31:06	2Days,17:00:00	20.118	34.25
132	10-16-95	09:01:06	2Days,17:30:00	20.118	34.25
133	10-16-95	09:31:06	2Days,18:00:00	20.118	34.25
134	10-16-95	10:01:06	2Days,18:30:00	20.118	34.25
135	10-16-95	10:31:06	2Days,19:00:00	20.118	34.25
136	10-16-95	11:01:06	2Days,19:30:00	20.265	34.50

137	10-16-95	11:31:06	2Days,20:00:00	20.265	34.50
138	10-16-95	12:01:06	2Days,20:30:00	20.265	34.50
139	10-16-95	12:31:06	2Days,21:00:00	20.265	34.50
140	10-16-95	13:01:06	2Days,21:30:00	20.265	34.50
141	10-16-95	13:31:06	2Days,22:00:00	20.265	34.50
142	10-16-95	14:01:06	2Days,22:30:00	20.265	34.50
143	10-16-95	14:31:06	2Days,23:00:00	20.265	34.50
144	10-16-95	15:01:06	2Days,23:30:00	20.265	34.50
145	10-16-95	15:31:06	3Days,00:00:00	20.265	34.50
146	10-16-95	16:01:06	3Days,00:30:00	20.265	34.50
147	10-16-95	16:31:06	3Days,01:00:00	20.265	34.50
148	10-16-95	17:01:06	3Days,01:30:00	20.265	34.50
149	10-16-95	17:31:06	3Days,02:00:00	20.265	34.50
150	10-16-95	18:01:06	3Days,02:30:00	20.265	34.50
151	10-16-95	18:31:06	3Days,03:00:00	20.265	34.50
152	10-16-95	19:01:06	3Days,03:30:00	20.265	34.50
153	10-16-95	19:31:06	3Days,04:00:00	20.265	34.50
154	10-16-95	20:01:06	3Days,04:30:00	20.265	34.50
155	10-16-95	20:31:06	3Days,05:00:00	20.265	34.50
156	10-16-95	21:01:06	3Days,05:30:00	20.265	34.50
157	10-16-95	21:31:06	3Days,06:00:00	20.412	34.75
158	10-16-95	22:01:06	3Days,06:30:00	20.412	34.75
159	10-16-95	22:31:06	3Days,07:00:00	20.412	34.75
160	10-16-95	23:01:06	3Days,07:30:00	20.412	34.75
161	10-16-95	23:31:06	3Days,08:00:00	20.412	34.75
162	10-17-95	00:01:06	3Days,08:30:00	20.412	34.75
163	10-17-95	00:31:06	3Days,09:00:00	20.412	34.75
164	10-17-95	01:01:06	3Days,09:30:00	20.412	34.75
165	10-17-95	01:31:06	3Days,10:00:00	20.412	34.75
166	10-17-95	02:01:06	3Days,10:30:00	20.412	34.75
167	10-17-95	02:31:06	3Days,11:00:00	20.412	34.75
168	10-17-95	03:01:06	3Days,11:30:00	20.412	34.75
169	10-17-95	03:31:06	3Days,12:00:00	20.412	34.75
170	10-17-95	04:01:06	3Days,12:30:00	20.412	34.75
171	10-17-95	04:31:06	3Days,13:00:00	20.412	34.75
172	10-17-95	05:01:06	3Days,13:30:00	20.412	34.75
173	10-17-95	05:31:06	3Days,14:00:00	20.412	34.75
174	10-17-95	06:01:06	3Days,14:30:00	20.412	34.75
175	10-17-95	06:31:06	3Days,15:00:00	20.412	34.75
176	10-17-95	07:01:06	3Days,15:30:00	20.412	34.75
177	10-17-95	07:31:06	3Days,16:00:00	20.412	34.75
178	10-17-95	08:01:06	3Days,16:30:00	20.412	34.75
179	10-17-95	08:31:06	3Days,17:00:00	20.412	34.75
180	10-17-95	09:01:06	3Days,17:30:00	20.412	34.75
181	10-17-95	09:31:06	3Days,18:00:00	20.412	34.75
182	10-17-95	10:01:06	3Days,18:30:00	20.412	34.75
183	10-17-95	10:31:06	3Days,19:00:00	20.412	34.75
184	10-17-95	11:01:06	3Days,19:30:00	20.412	34.75
185	10-17-95	11:31:06	3Days,20:00:00	20.412	34.75
186	10-17-95	12:01:06	3Days,20:30:00	20.412	34.75
187	10-17-95	12:31:06	3Days,21:00:00	20.412	34.75

188	10-17-95	13:01:06	3Days,21:30:00	20.412	34.75
189	10-17-95	13:31:06	3Days,22:00:00	20.412	34.75
190	10-17-95	14:01:06	3Days,22:30:00	20.412	34.75
191	10-17-95	14:31:06	3Days,23:00:00	20.265	34.50
192	10-17-95	15:01:06	3Days,23:30:00	20.265	34.50
193	10-17-95	15:31:06	4Days,00:00:00	20.265	34.50
194	10-17-95	16:01:06	4Days,00:30:00	20.265	34.50
195	10-17-95	16:31:06	4Days,01:00:00	20.265	34.50
196	10-17-95	17:01:06	4Days,01:30:00	20.265	34.50
197	10-17-95	17:31:06	4Days,02:00:00	20.265	34.50
198	10-17-95	18:01:06	4Days,02:30:00	20.265	34.50
199	10-17-95	18:31:06	4Days,03:00:00	20.265	34.50
200	10-17-95	19:01:06	4Days,03:30:00	20.265	34.50
201	10-17-95	19:31:06	4Days,04:00:00	20.265	34.50
202	10-17-95	20:01:06	4Days,04:30:00	20.265	34.50
203	10-17-95	20:31:06	4Days,05:00:00	20.265	34.50
204	10-17-95	21:01:06	4Days,05:30:00	20.265	34.50
205	10-17-95	21:31:06	4Days,06:00:00	20.265	34.50
206	10-17-95	22:01:06	4Days,06:30:00	20.265	34.50
207	10-17-95	22:31:06	4Days,07:00:00	20.265	34.50
208	10-17-95	23:01:06	4Days,07:30:00	20.265	34.50
209	10-17-95	23:31:06	4Days,08:00:00	20.265	34.50
210	10-18-95	00:01:06	4Days,08:30:00	20.118	34.25
211	10-18-95	00:31:06	4Days,09:00:00	20.265	34.50
212	10-18-95	01:01:06	4Days,09:30:00	20.265	34.50
213	10-18-95	01:31:06	4Days,10:00:00	20.265	34.50
214	10-18-95	02:01:06	4Days,10:30:00	20.265	34.50
215	10-18-95	02:31:06	4Days,11:00:00	20.118	34.25
216	10-18-95	03:01:06	4Days,11:30:00	20.265	34.50
217	10-18-95	03:31:06	4Days,12:00:00	20.118	34.25
218	10-18-95	04:01:06	4Days,12:30:00	20.118	34.25
219	10-18-95	04:31:06	4Days,13:00:00	20.118	34.25
220	10-18-95	05:01:06	4Days,13:30:00	20.118	34.25
221	10-18-95	05:31:06	4Days,14:00:00	20.118	34.25
222	10-18-95	06:01:06	4Days,14:30:00	20.118	34.25
223	10-18-95	06:31:06	4Days,15:00:00	20.118	34.25
224	10-18-95	07:01:06	4Days,15:30:00	20.265	34.50
225	10-18-95	07:31:06	4Days,16:00:00	20.265	34.50
226	10-18-95	08:01:06	4Days,16:30:00	20.265	34.50
227	10-18-95	08:31:06	4Days,17:00:00	20.265	34.50
228	10-18-95	09:01:06	4Days,17:30:00	20.118	34.25
229	10-18-95	09:31:06	4Days,18:00:00	20.118	34.25
230	10-18-95	10:01:06	4Days,18:30:00	20.118	34.25
231	10-18-95	10:31:06	4Days,19:00:00	19.972	34.0
232	10-18-95	11:01:06	4Days,19:30:00	19.825	33.75
233	10-18-95	11:31:06	4Days,20:00:00	19.678	33.50
234	10-18-95	12:01:06	4Days,20:30:00	19.678	33.50
235	10-18-95	12:31:06	4Days,21:00:00	19.531	33.25
236	10-18-95	13:01:06	4Days,21:30:00	19.531	33.25
237	10-18-95	13:31:06	4Days,22:00:00	19.531	33.25
238	10-18-95	14:01:06	4Days,22:30:00	19.384	33.0

239	10-18-95	14:31:06	4Days,23:00:00	19.384	33.0
240	10-18-95	15:01:06	4Days,23:30:00	19.384	33.0
241	10-18-95	15:31:06	5Days,00:00:00	19.825	33.75
242	10-18-95	16:01:06	5Days,00:30:00	19.972	34.0
243	10-18-95	16:31:06	5Days,01:00:00	20.118	34.25
244	10-18-95	17:01:06	5Days,01:30:00	20.118	34.25
245	10-18-95	17:31:06	5Days,02:00:00	20.118	34.25
246	10-18-95	18:01:06	5Days,02:30:00	20.118	34.25
247	10-18-95	18:31:06	5Days,03:00:00	20.118	34.25
248	10-18-95	19:01:06	5Days,03:30:00	20.118	34.25
249	10-18-95	19:31:06	5Days,04:00:00	20.118	34.25
250	10-18-95	20:01:06	5Days,04:30:00	19.972	34.0
251	10-18-95	20:31:06	5Days,05:00:00	19.972	34.0
252	10-18-95	21:01:06	5Days,05:30:00	19.972	34.0
253	10-18-95	21:31:06	5Days,06:00:00	19.972	34.0
254	10-18-95	22:01:06	5Days,06:30:00	19.825	33.75
255	10-18-95	22:31:06	5Days,07:00:00	19.825	33.75
256	10-18-95	23:01:06	5Days,07:30:00	19.825	33.75
257	10-18-95	23:31:06	5Days,08:00:00	19.825	33.75
258	10-19-95	00:01:06	5Days,08:30:00	19.972	34.0
259	10-19-95	00:31:06	5Days,09:00:00	19.972	34.0
260	10-19-95	01:01:06	5Days,09:30:00	19.972	34.0
261	10-19-95	01:31:06	5Days,10:00:00	19.972	34.0
262	10-19-95	02:01:06	5Days,10:30:00	19.972	34.0
263	10-19-95	02:31:06	5Days,11:00:00	19.972	34.0
264	10-19-95	03:01:06	5Days,11:30:00	19.972	34.0
265	10-19-95	03:31:06	5Days,12:00:00	19.972	34.0
266	10-19-95	04:01:06	5Days,12:30:00	19.972	34.0
267	10-19-95	04:31:06	5Days,13:00:00	19.972	34.0
268	10-19-95	05:01:06	5Days,13:30:00	19.972	34.0
269	10-19-95	05:31:06	5Days,14:00:00	19.972	34.0
270	10-19-95	06:01:06	5Days,14:30:00	19.972	34.0
271	10-19-95	06:31:06	5Days,15:00:00	19.825	33.75
272	10-19-95	07:01:06	5Days,15:30:00	19.825	33.75
273	10-19-95	07:31:06	5Days,16:00:00	19.825	33.75
274	10-19-95	08:01:06	5Days,16:30:00	19.825	33.75
275	10-19-95	08:31:06	5Days,17:00:00	19.678	33.50
276	10-19-95	09:01:06	5Days,17:30:00	19.972	34.0
277	10-19-95	09:31:06	5Days,18:00:00	20.118	34.25
278	10-19-95	10:01:06	5Days,18:30:00	20.118	34.25
279	10-19-95	10:31:06	5Days,19:00:00	20.118	34.25
280	10-19-95	11:01:06	5Days,19:30:00	20.118	34.25
281	10-19-95	11:31:06	5Days,20:00:00	20.118	34.25
282	10-19-95	12:01:06	5Days,20:30:00	20.118	34.25
283	10-19-95	12:31:06	5Days,21:00:00	20.118	34.25
284	10-19-95	13:01:06	5Days,21:30:00	20.118	34.25
285	10-19-95	13:31:06	5Days,22:00:00	20.118	34.25
286	10-19-95	14:01:06	5Days,22:30:00	20.118	34.25
287	10-19-95	14:31:06	5Days,23:00:00	20.118	34.25
288	10-19-95	15:01:06	5Days,23:30:00	20.118	34.25
289	10-19-95	15:31:06	6Days,00:00:00	20.118	34.25

290	10-19-95	16:01:06	6Days,00:30:00	20.118	34.25
291	10-19-95	16:31:06	6Days,01:00:00	20.118	34.25
292	10-19-95	17:01:06	6Days,01:30:00	20.118	34.25
293	10-19-95	17:31:06	6Days,02:00:00	19.972	34.0
294	10-19-95	18:01:06	6Days,02:30:00	19.972	34.0
295	10-19-95	18:31:06	6Days,03:00:00	20.118	34.25
296	10-19-95	19:01:06	6Days,03:30:00	19.972	34.0
297	10-19-95	19:31:06	6Days,04:00:00	20.118	34.25
298	10-19-95	20:01:06	6Days,04:30:00	20.118	34.25
299	10-19-95	20:31:06	6Days,05:00:00	20.118	34.25
300	10-19-95	21:01:06	6Days,05:30:00	20.118	34.25
301	10-19-95	21:31:06	6Days,06:00:00	20.118	34.25
302	10-19-95	22:01:06	6Days,06:30:00	20.118	34.25
303	10-19-95	22:31:06	6Days,07:00:00	20.118	34.25
304	10-19-95	23:01:06	6Days,07:30:00	19.972	34.0
305	10-19-95	23:31:06	6Days,08:00:00	19.972	34.0
306	10-20-95	00:01:06	6Days,08:30:00	19.972	34.0
307	10-20-95	00:31:06	6Days,09:00:00	19.972	34.0
308	10-20-95	01:01:06	6Days,09:30:00	19.972	34.0
309	10-20-95	01:31:06	6Days,10:00:00	19.972	34.0
310	10-20-95	02:01:06	6Days,10:30:00	19.972	34.0
311	10-20-95	02:31:06	6Days,11:00:00	19.972	34.0
312	10-20-95	03:01:06	6Days,11:30:00	19.972	34.0
313	10-20-95	03:31:06	6Days,12:00:00	19.972	34.0
314	10-20-95	04:01:06	6Days,12:30:00	19.972	34.0
315	10-20-95	04:31:06	6Days,13:00:00	19.972	34.0
316	10-20-95	05:01:06	6Days,13:30:00	19.972	34.0
317	10-20-95	05:31:06	6Days,14:00:00	19.972	34.0
318	10-20-95	06:01:06	6Days,14:30:00	19.825	33.75
319	10-20-95	06:31:06	6Days,15:00:00	19.825	33.75
320	10-20-95	07:01:06	6Days,15:30:00	19.825	33.75
321	10-20-95	07:31:06	6Days,16:00:00	19.678	33.50
322	10-20-95	08:01:06	6Days,16:30:00	19.678	33.50
323	10-20-95	08:31:06	6Days,17:00:00	19.678	33.50
324	10-20-95	09:01:06	6Days,17:30:00	19.678	33.50
325	10-20-95	09:31:06	6Days,18:00:00	19.531	33.25
326	10-20-95	10:01:06	6Days,18:30:00	19.531	33.25
327	10-20-95	10:31:06	6Days,19:00:00	19.531	33.25
328	10-20-95	11:01:06	6Days,19:30:00	19.531	33.25
329	10-20-95	11:31:06	6Days,20:00:00	19.531	33.25
330	10-20-95	12:01:06	6Days,20:30:00	19.531	33.25
331	10-20-95	12:31:06	6Days,21:00:00	19.384	33.0
332	10-20-95	13:01:06	6Days,21:30:00	19.384	33.0
333	10-20-95	13:31:06	6Days,22:00:00	19.384	33.0
334	10-20-95	14:01:06	6Days,22:30:00	19.384	33.0
335	10-20-95	14:31:06	6Days,23:00:00	19.384	33.0
336	10-20-95	15:01:06	6Days,23:30:00	19.237	32.75
337	10-20-95	15:31:06	7Days,00:00:00	19.237	32.75
338	10-20-95	16:01:06	7Days,00:30:00	19.237	32.75
339	10-20-95	16:31:06	7Days,01:00:00	19.384	33.0
340	10-20-95	17:01:06	7Days,01:30:00	19.384	33.0

341	10-20-95	17:31:06	7Days,02:00:00	19.384	33.0
342	10-20-95	18:01:06	7Days,02:30:00	19.237	32.75
343	10-20-95	18:31:06	7Days,03:00:00	19.237	32.75
344	10-20-95	19:01:06	7Days,03:30:00	19.237	32.75
345	10-20-95	19:31:06	7Days,04:00:00	19.237	32.75
346	10-20-95	20:01:06	7Days,04:30:00	19.237	32.75
347	10-20-95	20:31:06	7Days,05:00:00	19.090	32.50
348	10-20-95	21:01:06	7Days,05:30:00	19.090	32.50
349	10-20-95	21:31:06	7Days,06:00:00	19.090	32.50
350	10-20-95	22:01:06	7Days,06:30:00	19.090	32.50
351	10-20-95	22:31:06	7Days,07:00:00	18.944	32.25
352	10-20-95	23:01:06	7Days,07:30:00	18.944	32.25
353	10-20-95	23:31:06	7Days,08:00:00	18.944	32.25
354	10-21-95	00:01:06	7Days,08:30:00	18.944	32.25
355	10-21-95	00:31:06	7Days,09:00:00	18.944	32.25
356	10-21-95	01:01:06	7Days,09:30:00	18.944	32.25
357	10-21-95	01:31:06	7Days,10:00:00	18.944	32.25
358	10-21-95	02:01:06	7Days,10:30:00	18.944	32.25
359	10-21-95	02:31:06	7Days,11:00:00	18.797	32.0
360	10-21-95	03:01:06	7Days,11:30:00	18.797	32.0
361	10-21-95	03:31:06	7Days,12:00:00	18.797	32.0
362	10-21-95	04:01:06	7Days,12:30:00	18.797	32.0
363	10-21-95	04:31:06	7Days,13:00:00	18.797	32.0
364	10-21-95	05:01:06	7Days,13:30:00	18.650	31.75
365	10-21-95	05:31:06	7Days,14:00:00	18.650	31.75
366	10-21-95	06:01:06	7Days,14:30:00	18.650	31.75
367	10-21-95	06:31:06	7Days,15:00:00	18.650	31.75
368	10-21-95	07:01:06	7Days,15:30:00	18.650	31.75
369	10-21-95	07:31:06	7Days,16:00:00	18.650	31.75
370	10-21-95	08:01:06	7Days,16:30:00	18.650	31.75
371	10-21-95	08:31:06	7Days,17:00:00	18.503	31.50
372	10-21-95	09:01:06	7Days,17:30:00	18.503	31.50
373	10-21-95	09:31:06	7Days,18:00:00	18.944	32.25
374	10-21-95	10:01:06	7Days,18:30:00	18.944	32.25
375	10-21-95	10:31:06	7Days,19:00:00	18.944	32.25
376	10-21-95	11:01:06	7Days,19:30:00	18.797	32.0
377	10-21-95	11:31:06	7Days,20:00:00	18.797	32.0
378	10-21-95	12:01:06	7Days,20:30:00	18.797	32.0
379	10-21-95	12:31:06	7Days,21:00:00	18.797	32.0
380	10-21-95	13:01:06	7Days,21:30:00	19.090	32.50
381	10-21-95	13:31:06	7Days,22:00:00	18.944	32.25
382	10-21-95	14:01:06	7Days,22:30:00	18.944	32.25
383	10-21-95	14:31:06	7Days,23:00:00	18.944	32.25
384	10-21-95	15:01:06	7Days,23:30:00	18.797	32.0
385	10-21-95	15:31:06	8Days,00:00:00	18.797	32.0
386	10-21-95	16:01:06	8Days,00:30:00	18.797	32.0
387	10-21-95	16:31:06	8Days,01:00:00	18.797	32.0
388	10-21-95	17:01:06	8Days,01:30:00	18.650	31.75
389	10-21-95	17:31:06	8Days,02:00:00	18.650	31.75
390	10-21-95	18:01:06	8Days,02:30:00	19.384	33.0
391	10-21-95	18:31:06	8Days,03:00:00	19.384	33.0

392	10-21-95	19:01:06	8Days,03:30:00	19.237	32.75
393	10-21-95	19:31:06	8Days,04:00:00	19.090	32.50
394	10-21-95	20:01:06	8Days,04:30:00	18.944	32.25
395	10-21-95	20:31:06	8Days,05:00:00	18.944	32.25
396	10-21-95	21:01:06	8Days,05:30:00	18.797	32.0
397	10-21-95	21:31:06	8Days,06:00:00	18.650	31.75
398	10-21-95	22:01:06	8Days,06:30:00	18.650	31.75
399	10-21-95	22:31:06	8Days,07:00:00	18.650	31.75
400	10-21-95	23:01:06	8Days,07:30:00	18.503	31.50
401	10-21-95	23:31:06	8Days,08:00:00	18.503	31.50
402	10-22-95	00:01:06	8Days,08:30:00	18.356	31.25
403	10-22-95	00:31:06	8Days,09:00:00	18.356	31.25
404	10-22-95	01:01:06	8Days,09:30:00	18.356	31.25
405	10-22-95	01:31:06	8Days,10:00:00	18.356	31.25
406	10-22-95	02:01:06	8Days,10:30:00	18.356	31.25
407	10-22-95	02:31:06	8Days,11:00:00	18.209	31.0
408	10-22-95	03:01:06	8Days,11:30:00	18.209	31.0
409	10-22-95	03:31:06	8Days,12:00:00	18.209	31.0
410	10-22-95	04:01:06	8Days,12:30:00	18.209	31.0
411	10-22-95	04:31:06	8Days,13:00:00	18.062	30.75
412	10-22-95	05:01:06	8Days,13:30:00	18.062	30.75
413	10-22-95	05:31:06	8Days,14:00:00	18.062	30.75
414	10-22-95	06:01:06	8Days,14:30:00	18.062	30.75
415	10-22-95	06:31:06	8Days,15:00:00	18.062	30.75
416	10-22-95	07:01:06	8Days,15:30:00	17.916	30.50
417	10-22-95	07:31:06	8Days,16:00:00	17.916	30.50
418	10-22-95	08:01:06	8Days,16:30:00	17.916	30.50
419	10-22-95	08:31:06	8Days,17:00:00	18.356	31.25
420	10-22-95	09:01:06	8Days,17:30:00	18.356	31.25
421	10-22-95	09:31:06	8Days,18:00:00	18.209	31.0
422	10-22-95	10:01:06	8Days,18:30:00	18.209	31.0
423	10-22-95	10:31:06	8Days,19:00:00	18.062	30.75
424	10-22-95	11:01:06	8Days,19:30:00	18.062	30.75
425	10-22-95	11:31:06	8Days,20:00:00	18.062	30.75
426	10-22-95	12:01:06	8Days,20:30:00	16.153	27.50
427	10-22-95	12:31:06	8Days,21:00:00	15.860	27.0
428	10-22-95	13:01:06	8Days,21:30:00	16.006	27.25
429	10-22-95	13:31:06	8Days,22:00:00	17.181	29.25
430	10-22-95	14:01:06	8Days,22:30:00	18.356	31.25
431	10-22-95	14:31:06	8Days,23:00:00	19.090	32.50
432	10-22-95	15:01:06	8Days,23:30:00	19.384	33.0
433	10-22-95	15:31:06	9Days,00:00:00	19.531	33.25
434	10-22-95	16:01:06	9Days,00:30:00	19.678	33.50
435	10-22-95	16:31:06	9Days,01:00:00	19.825	33.75
436	10-22-95	17:01:06	9Days,01:30:00	19.825	33.75
437	10-22-95	17:31:06	9Days,02:00:00	19.972	34.0
438	10-22-95	18:01:06	9Days,02:30:00	19.972	34.0
439	10-22-95	18:31:06	9Days,03:00:00	19.972	34.0
440	10-22-95	19:01:06	9Days,03:30:00	19.972	34.0
441	10-22-95	19:31:06	9Days,04:00:00	20.118	34.25
442	10-22-95	20:01:06	9Days,04:30:00	20.118	34.25

443	10-22-95	20:31:06	9Days,05:00:00	20.118	34.25
444	10-22-95	21:01:06	9Days,05:30:00	20.118	34.25
445	10-22-95	21:31:06	9Days,06:00:00	20.118	34.25
446	10-22-95	22:01:06	9Days,06:30:00	20.118	34.25
447	10-22-95	22:31:06	9Days,07:00:00	20.118	34.25
448	10-22-95	23:01:06	9Days,07:30:00	20.118	34.25
449	10-22-95	23:31:06	9Days,08:00:00	20.118	34.25
450	10-23-95	00:01:06	9Days,08:30:00	20.118	34.25
451	10-23-95	00:31:06	9Days,09:00:00	20.118	34.25
452	10-23-95	01:01:06	9Days,09:30:00	20.118	34.25
453	10-23-95	01:31:06	9Days,10:00:00	19.972	34.0
454	10-23-95	02:01:06	9Days,10:30:00	19.972	34.0
455	10-23-95	02:31:06	9Days,11:00:00	19.972	34.0
456	10-23-95	03:01:06	9Days,11:30:00	19.972	34.0
457	10-23-95	03:31:06	9Days,12:00:00	19.972	34.0
458	10-23-95	04:01:06	9Days,12:30:00	19.972	34.0
459	10-23-95	04:31:06	9Days,13:00:00	19.972	34.0
460	10-23-95	05:01:06	9Days,13:30:00	19.972	34.0
461	10-23-95	05:31:06	9Days,14:00:00	19.972	34.0
462	10-23-95	06:01:06	9Days,14:30:00	19.972	34.0
463	10-23-95	06:31:06	9Days,15:00:00	19.972	34.0

END OF RECORDINGS

HAVRE AFS
O_2 Utilization Test
Dec. 4 → 7, 1995
O_2 Sensor @ 10.5' BGS
MPG

A Roberts

554834-2
REPORT DATE / TIME... 12-13-1995 / 15:05:41

Unit Serial Number > 554834
Total # Recordings > 190
Recording Intervals > 00:15:00
Elapsed Log Time > 1Days,23:15:00
Time Of Retrieval > 12-6-95 , 14:2:2
Started Recordings > 12-4-95 , 14:45:7
Ending Recording > 12-6-95 , 14:0:7
Battery Condition > Battery is ok

Min/Max <> Average > 11.794 / 36.678 <> 33.369 %o2

Note - Problems w/ this data logger again. Had to reprogram to get it operating again.

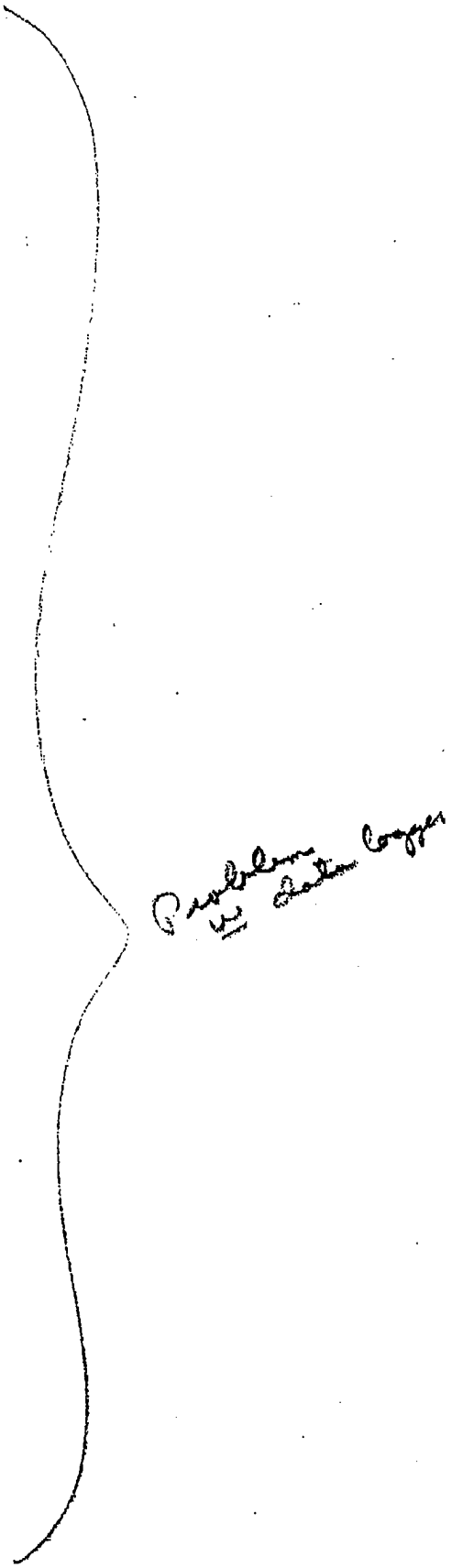
COUNT	DATE	TIME	ELTIME	%o2	Mv	
1	12-04-95	14:45:07	00:00:00	19.561	34.0	Blower operating.
2	12-04-95	15:00:07	00:15:00	19.705	34.25	
3	12-04-95	15:15:07	00:30:00	19.705	34.25	
4	12-04-95	15:30:07	00:45:00	19.705	34.25	
5	12-04-95	15:45:07	01:00:00	19.705	34.25	→ Blower turned off.
6	12-04-95	16:00:07	01:15:00	36.678	63.75	
7	12-04-95	16:15:07	01:30:00	36.678	63.75	
8	12-04-95	16:30:07	01:45:00	19.705	34.25	
9	12-04-95	16:45:07	02:00:00	19.705	34.25	
10	12-04-95	17:00:07	02:15:00	36.678	63.75	
11	12-04-95	17:15:07	02:30:00	19.561	34.0	
12	12-04-95	17:30:07	02:45:00	36.678	63.75	Problem w/ data logger
13	12-04-95	17:45:07	03:00:00	36.678	63.75	
14	12-04-95	18:00:07	03:15:00	36.678	63.75	
15	12-04-95	18:15:07	03:30:00	36.678	63.75	
16	12-04-95	18:30:07	03:45:00	36.678	63.75	
17	12-04-95	18:45:07	04:00:00	36.678	63.75	
18	12-04-95	19:00:07	04:15:00	36.678	63.75	
19	12-04-95	19:15:07	04:30:00	36.678	63.75	
20	12-04-95	19:30:07	04:45:00	36.678	63.75	
21	12-04-95	19:45:07	05:00:00	36.678	63.75	
22	12-04-95	20:00:07	05:15:00	19.130	33.25	
23	12-04-95	20:15:07	05:30:00	36.678	63.75	Problem w/ data logger
24	12-04-95	20:30:07	05:45:00	36.678	63.75	
25	12-04-95	20:45:07	06:00:00	36.678	63.75	
26	12-04-95	21:00:07	06:15:00	36.678	63.75	
27	12-04-95	21:15:07	06:30:00	36.678	63.75	
28	12-04-95	21:30:07	06:45:00	18.986	33.0	
29	12-04-95	21:45:07	07:00:00	36.678	63.75	Problem w/ data logger
30	12-04-95	22:00:07	07:15:00	36.678	63.75	
31	12-04-95	22:15:07	07:30:00	36.678	63.75	
32	12-04-95	22:30:07	07:45:00	36.678	63.75	
33	12-04-95	22:45:07	08:00:00	36.678	63.75	
34	12-04-95	23:00:07	08:15:00	36.678	63.75	

35	12-04-95	23:15:07	08:30:00	36.678	63.75
36	12-04-95	23:30:07	08:45:00	18.123	31.50
37	12-04-95	23:45:07	09:00:00	36.678	63.75
38	12-05-95	00:00:07	09:15:00	36.678	63.75
39	12-05-95	00:15:07	09:30:00	36.678	63.75
40	12-05-95	00:30:07	09:45:00	36.678	63.75
41	12-05-95	00:45:07	10:00:00	36.678	63.75
42	12-05-95	01:00:07	10:15:00	36.678	63.75
43	12-05-95	01:15:07	10:30:00	36.678	63.75
44	12-05-95	01:30:07	10:45:00	36.678	63.75
45	12-05-95	01:45:07	11:00:00	36.678	63.75
46	12-05-95	02:00:07	11:15:00	36.678	63.75
47	12-05-95	02:15:07	11:30:00	36.678	63.75
48	12-05-95	02:30:07	11:45:00	36.678	63.75
49	12-05-95	02:45:07	12:00:00	36.678	63.75
50	12-05-95	03:00:07	12:15:00	36.678	63.75
51	12-05-95	03:15:07	12:30:00	36.678	63.75
52	12-05-95	03:30:07	12:45:00	36.678	63.75
53	12-05-95	03:45:07	13:00:00	36.678	63.75
54	12-05-95	04:00:07	13:15:00	36.678	63.75
55	12-05-95	04:15:07	13:30:00	36.678	63.75
56	12-05-95	04:30:07	13:45:00	36.678	63.75
57	12-05-95	04:45:07	14:00:00	36.678	63.75
58	12-05-95	05:00:07	14:15:00	36.678	63.75
59	12-05-95	05:15:07	14:30:00	36.678	63.75
60	12-05-95	05:30:07	14:45:00	36.678	63.75
61	12-05-95	05:45:07	15:00:00	36.678	63.75
62	12-05-95	06:00:07	15:15:00	36.678	63.75
63	12-05-95	06:15:07	15:30:00	36.678	63.75
64	12-05-95	06:30:07	15:45:00	36.678	63.75
65	12-05-95	06:45:07	16:00:00	36.678	63.75
66	12-05-95	07:00:07	16:15:00	36.678	63.75
67	12-05-95	07:15:07	16:30:00	36.678	63.75
68	12-05-95	07:30:07	16:45:00	36.678	63.75
69	12-05-95	07:45:07	17:00:00	36.678	63.75
70	12-05-95	08:00:07	17:15:00	36.678	63.75
71	12-05-95	08:15:07	17:30:00	36.678	63.75
72	12-05-95	08:30:07	17:45:00	36.678	63.75
73	12-05-95	08:45:07	18:00:00	36.678	63.75
74	12-05-95	09:00:07	18:15:00	36.678	63.75
75	12-05-95	09:15:07	18:30:00	36.678	63.75
76	12-05-95	09:30:07	18:45:00	36.678	63.75
77	12-05-95	09:45:07	19:00:00	36.678	63.75
78	12-05-95	10:00:07	19:15:00	36.678	63.75
79	12-05-95	10:15:07	19:30:00	36.678	63.75
80	12-05-95	10:30:07	19:45:00	36.678	63.75
81	12-05-95	10:45:07	20:00:00	36.678	63.75
82	12-05-95	11:00:07	20:15:00	36.678	63.75
83	12-05-95	11:15:07	20:30:00	36.678	63.75
84	12-05-95	11:30:07	20:45:00	36.678	63.75
85	12-05-95	11:45:07	21:00:00	36.678	63.75

— Problem w/ data logger

Problem w/ data logger

86	12-05-95	12:00:07	21:15:00	36.678	63.75
87	12-05-95	12:15:07	21:30:00	36.678	63.75
88	12-05-95	12:30:07	21:45:00	36.678	63.75
89	12-05-95	12:45:07	22:00:00	36.678	63.75
90	12-05-95	13:00:07	22:15:00	36.678	63.75
91	12-05-95	13:15:07	22:30:00	36.678	63.75
92	12-05-95	13:30:07	22:45:00	36.678	63.75
93	12-05-95	13:45:07	23:00:00	36.678	63.75
94	12-05-95	14:00:07	23:15:00	36.678	63.75
95	12-05-95	14:15:07	23:30:00	36.678	63.75
96	12-05-95	14:30:07	23:45:00	36.678	63.75
97	12-05-95	14:45:07	1Days,00:00:00	36.678	63.75
98	12-05-95	15:00:07	1Days,00:15:00	36.678	63.75
99	12-05-95	15:15:07	1Days,00:30:00	36.678	63.75
100	12-05-95	15:30:07	1Days,00:45:00	36.678	63.75
101	12-05-95	15:45:07	1Days,01:00:00	36.678	63.75
102	12-05-95	16:00:07	1Days,01:15:00	36.678	63.75
103	12-05-95	16:15:07	1Days,01:30:00	36.678	63.75
104	12-05-95	16:30:07	1Days,01:45:00	36.678	63.75
105	12-05-95	16:45:07	1Days,02:00:00	36.678	63.75
106	12-05-95	17:00:07	1Days,02:15:00	36.678	63.75
107	12-05-95	17:15:07	1Days,02:30:00	36.678	63.75
108	12-05-95	17:30:07	1Days,02:45:00	36.678	63.75
109	12-05-95	17:45:07	1Days,03:00:00	36.678	63.75
110	12-05-95	18:00:07	1Days,03:15:00	36.678	63.75
111	12-05-95	18:15:07	1Days,03:30:00	36.678	63.75
112	12-05-95	18:30:07	1Days,03:45:00	36.678	63.75
113	12-05-95	18:45:07	1Days,04:00:00	36.678	63.75
114	12-05-95	19:00:07	1Days,04:15:00	36.678	63.75
115	12-05-95	19:15:07	1Days,04:30:00	36.678	63.75
116	12-05-95	19:30:07	1Days,04:45:00	36.678	63.75
117	12-05-95	19:45:07	1Days,05:00:00	36.678	63.75
118	12-05-95	20:00:07	1Days,05:15:00	36.678	63.75
119	12-05-95	20:15:07	1Days,05:30:00	36.678	63.75
120	12-05-95	20:30:07	1Days,05:45:00	36.678	63.75
121	12-05-95	20:45:07	1Days,06:00:00	36.678	63.75
122	12-05-95	21:00:07	1Days,06:15:00	36.678	63.75
123	12-05-95	21:15:07	1Days,06:30:00	36.678	63.75
124	12-05-95	21:30:07	1Days,06:45:00	36.678	63.75
125	12-05-95	21:45:07	1Days,07:00:00	36.678	63.75
126	12-05-95	22:00:07	1Days,07:15:00	36.678	63.75
127	12-05-95	22:15:07	1Days,07:30:00	36.678	63.75
128	12-05-95	22:30:07	1Days,07:45:00	36.678	63.75
129	12-05-95	22:45:07	1Days,08:00:00	36.678	63.75
130	12-05-95	23:00:07	1Days,08:15:00	36.678	63.75
131	12-05-95	23:15:07	1Days,08:30:00	36.678	63.75
132	12-05-95	23:30:07	1Days,08:45:00	36.678	63.75
133	12-05-95	23:45:07	1Days,09:00:00	36.678	63.75
134	12-06-95	00:00:07	1Days,09:15:00	36.678	63.75
135	12-06-95	00:15:07	1Days,09:30:00	36.678	63.75
136	12-06-95	00:30:07	1Days,09:45:00	36.678	63.75



137	12-06-95	00:45:07	1Days,10:00:00	36.678	63.75
138	12-06-95	01:00:07	1Days,10:15:00	36.678	63.75
139	12-06-95	01:15:07	1Days,10:30:00	36.678	63.75
140	12-06-95	01:30:07	1Days,10:45:00	36.678	63.75
141	12-06-95	01:45:07	1Days,11:00:00	36.678	63.75
142	12-06-95	02:00:07	1Days,11:15:00	36.678	63.75
143	12-06-95	02:15:07	1Days,11:30:00	36.678	63.75
144	12-06-95	02:30:07	1Days,11:45:00	36.678	63.75
145	12-06-95	02:45:07	1Days,12:00:00	36.678	63.75
146	12-06-95	03:00:07	1Days,12:15:00	36.678	63.75
147	12-06-95	03:15:07	1Days,12:30:00	36.678	63.75
148	12-06-95	03:30:07	1Days,12:45:00	36.678	63.75
149	12-06-95	03:45:07	1Days,13:00:00	36.678	63.75
150	12-06-95	04:00:07	1Days,13:15:00	36.678	63.75
151	12-06-95	04:15:07	1Days,13:30:00	36.678	63.75
152	12-06-95	04:30:07	1Days,13:45:00	36.678	63.75
153	12-06-95	04:45:07	1Days,14:00:00	36.678	63.75
154	12-06-95	05:00:07	1Days,14:15:00	36.678	63.75
155	12-06-95	05:15:07	1Days,14:30:00	36.678	63.75
156	12-06-95	05:30:07	1Days,14:45:00	36.678	63.75
157	12-06-95	05:45:07	1Days,15:00:00	36.678	63.75
158	12-06-95	06:00:07	1Days,15:15:00	36.678	63.75
159	12-06-95	06:15:07	1Days,15:30:00	36.678	63.75
160	12-06-95	06:30:07	1Days,15:45:00	36.678	63.75
161	12-06-95	06:45:07	1Days,16:00:00	36.678	63.75
162	12-06-95	07:00:07	1Days,16:15:00	36.678	63.75
163	12-06-95	07:15:07	1Days,16:30:00	36.678	63.75
164	12-06-95	07:30:07	1Days,16:45:00	36.678	63.75
165	12-06-95	07:45:07	1Days,17:00:00	36.678	63.75
166	12-06-95	08:00:07	1Days,17:15:00	36.678	63.75
167	12-06-95	08:15:07	1Days,17:30:00	36.678	63.75
168	12-06-95	08:30:07	1Days,17:45:00	36.678	63.75
169	12-06-95	08:45:07	1Days,18:00:00	36.678	63.75
170	12-06-95	09:00:07	1Days,18:15:00	36.678	63.75
171	12-06-95	09:15:07	1Days,18:30:00	36.678	63.75
172	12-06-95	09:30:07	1Days,18:45:00	36.678	63.75
173	12-06-95	09:45:07	1Days,19:00:00	36.678	63.75
174	12-06-95	10:00:07	1Days,19:15:00	12.369	21.50
175	12-06-95	10:15:07	1Days,19:30:00	12.369	21.50
176	12-06-95	10:30:07	1Days,19:45:00	12.369	21.50
177	12-06-95	10:45:07	1Days,20:00:00	12.369	21.50
178	12-06-95	11:00:07	1Days,20:15:00	12.226	21.25
179	12-06-95	11:15:07	1Days,20:30:00	12.226	21.25
180	12-06-95	11:30:07	1Days,20:45:00	12.226	21.25
181	12-06-95	11:45:07	1Days,21:00:00	12.226	21.25
182	12-06-95	12:00:07	1Days,21:15:00	12.082	21.0
183	12-06-95	12:15:07	1Days,21:30:00	12.082	21.0
184	12-06-95	12:30:07	1Days,21:45:00	12.082	21.0
185	12-06-95	12:45:07	1Days,22:00:00	12.082	21.0
186	12-06-95	13:00:07	1Days,22:15:00	11.938	20.75
187	12-06-95	13:15:07	1Days,22:30:00	11.938	20.75

Problem = Data logger

Reprogrammed the data log

188	12-06-95	13:30:07	1Days,22:45:00	11.938	20.75
189	12-06-95	13:45:07	1Days,23:00:00	11.938	20.75
190	12-06-95	14:00:07	1Days,23:15:00	11.794	20.50

END OF RECORDINGS

Data continues on next file 554834-4

See next Page.

Hanna AFS
O_2 Utilization Test
Dec 4 → 7, 1995
O_2 Sensor @ 7.5' BGS
MPG

554993-2
REPORT DATE / TIME... 12-14-1995 / 14:02:28

Unit Serial Number > 554993
Total # Recordings > 279
Recording Intervals > 00:15:00
Elapsed Log Time > 2Days,21:30:00
Time Of Retrieval > 12-7-95 , 12:27:10
Started Recordings > 12-4-95 , 14:44:49
Ending Recording > 12-7-95 , 12:14:49
Battery Condition > Battery is ok

Min/Max <> Average > 17.181 / 19.531 <> 18.356 %o2

COUNT	DATE	TIME	ELTIME	%o2	Mv
1	12-04-95	14:44:49	00:00:00	19.384	33.0
2	12-04-95	14:59:49	00:15:00	19.384	33.0
3	12-04-95	15:14:49	00:30:00	19.384	33.0
4	12-04-95	15:29:49	00:45:00	19.384	33.0
5	12-04-95	15:44:49	01:00:00	19.384	33.0
6	12-04-95	15:59:49	01:15:00	19.384	33.0
7	12-04-95	16:14:49	01:30:00	19.384	33.0
8	12-04-95	16:29:49	01:45:00	19.384	33.0
9	12-04-95	16:44:49	02:00:00	19.384	33.0
10	12-04-95	16:59:49	02:15:00	19.384	33.0
11	12-04-95	17:14:49	02:30:00	19.384	33.0
12	12-04-95	17:29:49	02:45:00	19.384	33.0
13	12-04-95	17:44:49	03:00:00	19.384	33.0
14	12-04-95	17:59:49	03:15:00	19.384	33.0
15	12-04-95	18:14:49	03:30:00	19.384	33.0
16	12-04-95	18:29:49	03:45:00	19.384	33.0
17	12-04-95	18:44:49	04:00:00	19.384	33.0
18	12-04-95	18:59:49	04:15:00	19.384	33.0
19	12-04-95	19:14:49	04:30:00	19.384	33.0
20	12-04-95	19:29:49	04:45:00	19.384	33.0
21	12-04-95	19:44:49	05:00:00	19.384	33.0
22	12-04-95	19:59:49	05:15:00	19.384	33.0
23	12-04-95	20:14:49	05:30:00	19.384	33.0
24	12-04-95	20:29:49	05:45:00	19.384	33.0
25	12-04-95	20:44:49	06:00:00	19.384	33.0
26	12-04-95	20:59:49	06:15:00	19.384	33.0
27	12-04-95	21:14:49	06:30:00	19.384	33.0
28	12-04-95	21:29:49	06:45:00	19.384	33.0
29	12-04-95	21:44:49	07:00:00	19.384	33.0
30	12-04-95	21:59:49	07:15:00	19.384	33.0
31	12-04-95	22:14:49	07:30:00	19.384	33.0
32	12-04-95	22:29:49	07:45:00	19.384	33.0
33	12-04-95	22:44:49	08:00:00	19.384	33.0
34	12-04-95	22:59:49	08:15:00	19.384	33.0

Blower operating
Blower Turned Off

35	12-04-95	23:14:49	08:30:00	19.384	33.0
36	12-04-95	23:29:49	08:45:00	19.384	33.0
37	12-04-95	23:44:49	09:00:00	19.384	33.0
38	12-04-95	23:59:49	09:15:00	19.384	33.0
39	12-05-95	00:14:49	09:30:00	19.384	33.0
40	12-05-95	00:29:49	09:45:00	19.384	33.0
41	12-05-95	00:44:49	10:00:00	19.384	33.0
42	12-05-95	00:59:49	10:15:00	19.237	32.75
43	12-05-95	01:14:49	10:30:00	19.237	32.75
44	12-05-95	01:29:49	10:45:00	19.237	32.75
45	12-05-95	01:44:49	11:00:00	19.237	32.75
46	12-05-95	01:59:49	11:15:00	19.237	32.75
47	12-05-95	02:14:49	11:30:00	19.237	32.75
48	12-05-95	02:29:49	11:45:00	19.237	32.75
49	12-05-95	02:44:49	12:00:00	19.237	32.75
50	12-05-95	02:59:49	12:15:00	19.237	32.75
51	12-05-95	03:14:49	12:30:00	19.237	32.75
52	12-05-95	03:29:49	12:45:00	19.237	32.75
53	12-05-95	03:44:49	13:00:00	19.237	32.75
54	12-05-95	03:59:49	13:15:00	19.237	32.75
55	12-05-95	04:14:49	13:30:00	19.237	32.75
56	12-05-95	04:29:49	13:45:00	19.237	32.75
57	12-05-95	04:44:49	14:00:00	19.237	32.75
58	12-05-95	04:59:49	14:15:00	19.237	32.75
59	12-05-95	05:14:49	14:30:00	19.237	32.75
60	12-05-95	05:29:49	14:45:00	19.090	32.50
61	12-05-95	05:44:49	15:00:00	19.090	32.50
62	12-05-95	05:59:49	15:15:00	19.090	32.50
63	12-05-95	06:14:49	15:30:00	19.090	32.50
64	12-05-95	06:29:49	15:45:00	19.090	32.50
65	12-05-95	06:44:49	16:00:00	19.090	32.50
66	12-05-95	06:59:49	16:15:00	19.090	32.50
67	12-05-95	07:14:49	16:30:00	19.090	32.50
68	12-05-95	07:29:49	16:45:00	19.090	32.50
69	12-05-95	07:44:49	17:00:00	19.090	32.50
70	12-05-95	07:59:49	17:15:00	19.090	32.50
71	12-05-95	08:14:49	17:30:00	19.090	32.50
72	12-05-95	08:29:49	17:45:00	19.090	32.50
73	12-05-95	08:44:49	18:00:00	19.090	32.50
74	12-05-95	08:59:49	18:15:00	19.090	32.50
75	12-05-95	09:14:49	18:30:00	19.090	32.50
76	12-05-95	09:29:49	18:45:00	19.090	32.50
77	12-05-95	09:44:49	19:00:00	19.090	32.50
78	12-05-95	09:59:49	19:15:00	19.090	32.50
79	12-05-95	10:14:49	19:30:00	18.944	32.25
80	12-05-95	10:29:49	19:45:00	18.944	32.25
81	12-05-95	10:44:49	20:00:00	18.944	32.25
82	12-05-95	10:59:49	20:15:00	18.944	32.25
83	12-05-95	11:14:49	20:30:00	18.944	32.25
84	12-05-95	11:29:49	20:45:00	18.944	32.25
85	12-05-95	11:44:49	21:00:00	18.944	32.25

86	12-05-95	11:59:49	21:15:00	18.944	32.25
87	12-05-95	12:14:49	21:30:00	18.944	32.25
88	12-05-95	12:29:49	21:45:00	18.944	32.25
89	12-05-95	12:44:49	22:00:00	18.944	32.25
90	12-05-95	12:59:49	22:15:00	18.797	32.0
91	12-05-95	13:14:49	22:30:00	18.797	32.0
92	12-05-95	13:29:49	22:45:00	18.797	32.0
93	12-05-95	13:44:49	23:00:00	18.797	32.0
94	12-05-95	13:59:49	23:15:00	18.797	32.0
95	12-05-95	14:14:49	23:30:00	18.797	32.0
96	12-05-95	14:29:49	23:45:00	18.797	32.0
97	12-05-95	14:44:49	1Days,00:00:00	18.797	32.0
98	12-05-95	14:59:49	1Days,00:15:00	18.797	32.0
99	12-05-95	15:14:49	1Days,00:30:00	18.650	31.75
100	12-05-95	15:29:49	1Days,00:45:00	18.650	31.75
101	12-05-95	15:44:49	1Days,01:00:00	18.650	31.75
102	12-05-95	15:59:49	1Days,01:15:00	18.650	31.75
103	12-05-95	16:14:49	1Days,01:30:00	18.650	31.75
104	12-05-95	16:29:49	1Days,01:45:00	18.650	31.75
105	12-05-95	16:44:49	1Days,02:00:00	18.650	31.75
106	12-05-95	16:59:49	1Days,02:15:00	18.650	31.75
107	12-05-95	17:14:49	1Days,02:30:00	18.650	31.75
108	12-05-95	17:29:49	1Days,02:45:00	18.650	31.75
109	12-05-95	17:44:49	1Days,03:00:00	18.650	31.75
110	12-05-95	17:59:49	1Days,03:15:00	18.650	31.75
111	12-05-95	18:14:49	1Days,03:30:00	18.650	31.75
112	12-05-95	18:29:49	1Days,03:45:00	18.503	31.50
113	12-05-95	18:44:49	1Days,04:00:00	18.503	31.50
114	12-05-95	18:59:49	1Days,04:15:00	18.503	31.50
115	12-05-95	19:14:49	1Days,04:30:00	18.503	31.50
116	12-05-95	19:29:49	1Days,04:45:00	18.503	31.50
117	12-05-95	19:44:49	1Days,05:00:00	18.503	31.50
118	12-05-95	19:59:49	1Days,05:15:00	18.503	31.50
119	12-05-95	20:14:49	1Days,05:30:00	18.503	31.50
120	12-05-95	20:29:49	1Days,05:45:00	18.503	31.50
121	12-05-95	20:44:49	1Days,06:00:00	18.503	31.50
122	12-05-95	20:59:49	1Days,06:15:00	18.503	31.50
123	12-05-95	21:14:49	1Days,06:30:00	18.503	31.50
124	12-05-95	21:29:49	1Days,06:45:00	18.503	31.50
125	12-05-95	21:44:49	1Days,07:00:00	18.503	31.50
126	12-05-95	21:59:49	1Days,07:15:00	18.503	31.50
127	12-05-95	22:14:49	1Days,07:30:00	18.503	31.50
128	12-05-95	22:29:49	1Days,07:45:00	18.356	31.25
129	12-05-95	22:44:49	1Days,08:00:00	18.356	31.25
130	12-05-95	22:59:49	1Days,08:15:00	18.356	31.25
131	12-05-95	23:14:49	1Days,08:30:00	18.356	31.25
132	12-05-95	23:29:49	1Days,08:45:00	18.356	31.25
133	12-05-95	23:44:49	1Days,09:00:00	18.356	31.25
134	12-05-95	23:59:49	1Days,09:15:00	18.356	31.25
135	12-06-95	00:14:49	1Days,09:30:00	18.356	31.25
136	12-06-95	00:29:49	1Days,09:45:00	18.356	31.25

137	12-06-95	00:44:49	1Days,10:00:00	18.356	31.25
138	12-06-95	00:59:49	1Days,10:15:00	18.356	31.25
139	12-06-95	01:14:49	1Days,10:30:00	18.356	31.25
140	12-06-95	01:29:49	1Days,10:45:00	18.356	31.25
141	12-06-95	01:44:49	1Days,11:00:00	18.356	31.25
142	12-06-95	01:59:49	1Days,11:15:00	18.356	31.25
143	12-06-95	02:14:49	1Days,11:30:00	18.356	31.25
144	12-06-95	02:29:49	1Days,11:45:00	18.356	31.25
145	12-06-95	02:44:49	1Days,12:00:00	18.356	31.25
146	12-06-95	02:59:49	1Days,12:15:00	18.356	31.25
147	12-06-95	03:14:49	1Days,12:30:00	18.209	31.0
148	12-06-95	03:29:49	1Days,12:45:00	18.209	31.0
149	12-06-95	03:44:49	1Days,13:00:00	18.209	31.0
150	12-06-95	03:59:49	1Days,13:15:00	18.209	31.0
151	12-06-95	04:14:49	1Days,13:30:00	18.209	31.0
152	12-06-95	04:29:49	1Days,13:45:00	18.209	31.0
153	12-06-95	04:44:49	1Days,14:00:00	18.209	31.0
154	12-06-95	04:59:49	1Days,14:15:00	18.209	31.0
155	12-06-95	05:14:49	1Days,14:30:00	18.209	31.0
156	12-06-95	05:29:49	1Days,14:45:00	18.209	31.0
157	12-06-95	05:44:49	1Days,15:00:00	18.209	31.0
158	12-06-95	05:59:49	1Days,15:15:00	18.209	31.0
159	12-06-95	06:14:49	1Days,15:30:00	18.209	31.0
160	12-06-95	06:29:49	1Days,15:45:00	18.209	31.0
161	12-06-95	06:44:49	1Days,16:00:00	18.209	31.0
162	12-06-95	06:59:49	1Days,16:15:00	18.209	31.0
163	12-06-95	07:14:49	1Days,16:30:00	18.209	31.0
164	12-06-95	07:29:49	1Days,16:45:00	18.209	31.0
165	12-06-95	07:44:49	1Days,17:00:00	18.209	31.0
166	12-06-95	07:59:49	1Days,17:15:00	18.209	31.0
167	12-06-95	08:14:49	1Days,17:30:00	18.209	31.0
168	12-06-95	08:29:49	1Days,17:45:00	18.062	30.75
169	12-06-95	08:44:49	1Days,18:00:00	18.062	30.75
170	12-06-95	08:59:49	1Days,18:15:00	18.062	30.75
171	12-06-95	09:14:49	1Days,18:30:00	18.062	30.75
172	12-06-95	09:29:49	1Days,18:45:00	18.062	30.75
173	12-06-95	09:44:49	1Days,19:00:00	18.062	30.75
174	12-06-95	09:59:49	1Days,19:15:00	18.062	30.75
175	12-06-95	10:14:49	1Days,19:30:00	18.062	30.75
176	12-06-95	10:29:49	1Days,19:45:00	18.062	30.75
177	12-06-95	10:44:49	1Days,20:00:00	18.062	30.75
178	12-06-95	10:59:49	1Days,20:15:00	18.062	30.75
179	12-06-95	11:14:49	1Days,20:30:00	18.062	30.75
180	12-06-95	11:29:49	1Days,20:45:00	18.062	30.75
181	12-06-95	11:44:49	1Days,21:00:00	18.062	30.75
182	12-06-95	11:59:49	1Days,21:15:00	18.062	30.75
183	12-06-95	12:14:49	1Days,21:30:00	17.916	30.50
184	12-06-95	12:29:49	1Days,21:45:00	17.916	30.50
185	12-06-95	12:44:49	1Days,22:00:00	17.916	30.50
186	12-06-95	12:59:49	1Days,22:15:00	17.916	30.50
187	12-06-95	13:14:49	1Days,22:30:00	17.916	30.50

188	12-06-95	13:29:49	1Days,22:45:00	17.916	30.50
189	12-06-95	13:44:49	1Days,23:00:00	17.916	30.50
190	12-06-95	13:59:49	1Days,23:15:00	17.916	30.50
191	12-06-95	14:14:49	1Days,23:30:00	17.916	30.50
192	12-06-95	14:29:49	1Days,23:45:00	17.916	30.50
193	12-06-95	14:44:49	2Days,00:00:00	17.916	30.50
194	12-06-95	14:59:49	2Days,00:15:00	17.916	30.50
195	12-06-95	15:14:49	2Days,00:30:00	17.916	30.50
196	12-06-95	15:29:49	2Days,00:45:00	17.916	30.50
197	12-06-95	15:44:49	2Days,01:00:00	17.916	30.50
198	12-06-95	15:59:49	2Days,01:15:00	17.916	30.50
199	12-06-95	16:14:49	2Days,01:30:00	17.916	30.50
200	12-06-95	16:29:49	2Days,01:45:00	17.769	30.25
201	12-06-95	16:44:49	2Days,02:00:00	17.916	30.50
202	12-06-95	16:59:49	2Days,02:15:00	17.769	30.25
203	12-06-95	17:14:49	2Days,02:30:00	17.769	30.25
204	12-06-95	17:29:49	2Days,02:45:00	17.769	30.25
205	12-06-95	17:44:49	2Days,03:00:00	17.769	30.25
206	12-06-95	17:59:49	2Days,03:15:00	17.769	30.25
207	12-06-95	18:14:49	2Days,03:30:00	17.769	30.25
208	12-06-95	18:29:49	2Days,03:45:00	17.769	30.25
209	12-06-95	18:44:49	2Days,04:00:00	17.769	30.25
210	12-06-95	18:59:49	2Days,04:15:00	17.769	30.25
211	12-06-95	19:14:49	2Days,04:30:00	17.769	30.25
212	12-06-95	19:29:49	2Days,04:45:00	17.769	30.25
213	12-06-95	19:44:49	2Days,05:00:00	17.769	30.25
214	12-06-95	19:59:49	2Days,05:15:00	17.769	30.25
215	12-06-95	20:14:49	2Days,05:30:00	17.769	30.25
216	12-06-95	20:29:49	2Days,05:45:00	17.769	30.25
217	12-06-95	20:44:49	2Days,06:00:00	17.769	30.25
218	12-06-95	20:59:49	2Days,06:15:00	17.622	30.0
219	12-06-95	21:14:49	2Days,06:30:00	17.622	30.0
220	12-06-95	21:29:49	2Days,06:45:00	17.622	30.0
221	12-06-95	21:44:49	2Days,07:00:00	17.622	30.0
222	12-06-95	21:59:49	2Days,07:15:00	17.622	30.0
223	12-06-95	22:14:49	2Days,07:30:00	17.622	30.0
224	12-06-95	22:29:49	2Days,07:45:00	17.622	30.0
225	12-06-95	22:44:49	2Days,08:00:00	17.622	30.0
226	12-06-95	22:59:49	2Days,08:15:00	17.622	30.0
227	12-06-95	23:14:49	2Days,08:30:00	17.622	30.0
228	12-06-95	23:29:49	2Days,08:45:00	17.622	30.0
229	12-06-95	23:44:49	2Days,09:00:00	17.622	30.0
230	12-06-95	23:59:49	2Days,09:15:00	17.622	30.0
231	12-07-95	00:14:49	2Days,09:30:00	17.622	30.0
232	12-07-95	00:29:49	2Days,09:45:00	17.622	30.0
233	12-07-95	00:44:49	2Days,10:00:00	17.475	29.75
234	12-07-95	00:59:49	2Days,10:15:00	17.475	29.75
235	12-07-95	01:14:49	2Days,10:30:00	17.475	29.75
236	12-07-95	01:29:49	2Days,10:45:00	17.475	29.75
237	12-07-95	01:44:49	2Days,11:00:00	17.475	29.75
238	12-07-95	01:59:49	2Days,11:15:00	17.475	29.75

239	12-07-95	02:14:49	2Days,11:30:00	17.328	29.50
240	12-07-95	02:29:49	2Days,11:45:00	17.328	29.50
241	12-07-95	02:44:49	2Days,12:00:00	17.328	29.50
242	12-07-95	02:59:49	2Days,12:15:00	17.328	29.50
243	12-07-95	03:14:49	2Days,12:30:00	17.328	29.50
244	12-07-95	03:29:49	2Days,12:45:00	17.328	29.50
245	12-07-95	03:44:49	2Days,13:00:00	17.328	29.50
246	12-07-95	03:59:49	2Days,13:15:00	17.328	29.50
247	12-07-95	04:14:49	2Days,13:30:00	17.328	29.50
248	12-07-95	04:29:49	2Days,13:45:00	17.328	29.50
249	12-07-95	04:44:49	2Days,14:00:00	17.328	29.50
250	12-07-95	04:59:49	2Days,14:15:00	17.328	29.50
251	12-07-95	05:14:49	2Days,14:30:00	17.328	29.50
252	12-07-95	05:29:49	2Days,14:45:00	17.181	29.25
253	12-07-95	05:44:49	2Days,15:00:00	17.328	29.50
254	12-07-95	05:59:49	2Days,15:15:00	17.181	29.25
255	12-07-95	06:14:49	2Days,15:30:00	17.328	29.50
256	12-07-95	06:29:49	2Days,15:45:00	17.328	29.50
257	12-07-95	06:44:49	2Days,16:00:00	17.328	29.50
258	12-07-95	06:59:49	2Days,16:15:00	17.328	29.50
259	12-07-95	07:14:49	2Days,16:30:00	17.328	29.50
260	12-07-95	07:29:49	2Days,16:45:00	17.328	29.50
261	12-07-95	07:44:49	2Days,17:00:00	17.328	29.50
262	12-07-95	07:59:49	2Days,17:15:00	17.328	29.50
263	12-07-95	08:14:49	2Days,17:30:00	17.328	29.50
264	12-07-95	08:29:49	2Days,17:45:00	17.328	29.50
265	12-07-95	08:44:49	2Days,18:00:00	17.328	29.50
266	12-07-95	08:59:49	2Days,18:15:00	17.328	29.50
267	12-07-95	09:14:49	2Days,18:30:00	17.328	29.50
268	12-07-95	09:29:49	2Days,18:45:00	17.181	29.25 → Blower Turned back on
269	12-07-95	09:44:49	2Days,19:00:00	18.797	32.0
270	12-07-95	09:59:49	2Days,19:15:00	19.237	32.75
271	12-07-95	10:14:49	2Days,19:30:00	19.384	33.0
272	12-07-95	10:29:49	2Days,19:45:00	19.384	33.0
273	12-07-95	10:44:49	2Days,20:00:00	19.531	33.25
274	12-07-95	10:59:49	2Days,20:15:00	19.531	33.25
275	12-07-95	11:14:49	2Days,20:30:00	19.531	33.25
276	12-07-95	11:29:49	2Days,20:45:00	19.531	33.25
277	12-07-95	11:44:49	2Days,21:00:00	19.531	33.25
278	12-07-95	11:59:49	2Days,21:15:00	19.531	33.25
279	12-07-95	12:14:49	2Days,21:30:00	19.531	33.25

END OF RECORDINGS

554834-4
REPORT DATE / TIME... 12-13-1995 / 15:05:47

Unit Serial Number > 554834
Total # Recordings > 89
Recording Intervals > 00:15:00
Elapsed Log Time > 22:00:00
Time Of Retrieval > 12-7-95 , 12:27:47
Started Recordings > 12-6-95 , 14:15:31
Ending Recording > 12-7-95 , 12:15:31
Battery Condition > << BATTERY IS LOW >>

Min/Max <> Average > 8.7739 / 19.561 <> 11.219 %o2

COUNT	DATE	TIME	ELTIME	%o2	Mv
1	12-06-95	14:15:31	00:00:00	11.794	20.50
2	12-06-95	14:30:31	00:15:00	11.794	20.50
3	12-06-95	14:45:31	00:30:00	11.794	20.50
4	12-06-95	15:00:31	00:45:00	11.650	20.25
5	12-06-95	15:15:31	01:00:00	11.650	20.25
6	12-06-95	15:30:31	01:15:00	11.650	20.25
7	12-06-95	15:45:31	01:30:00	11.650	20.25
8	12-06-95	16:00:31	01:45:00	11.650	20.25
9	12-06-95	16:15:31	02:00:00	11.506	20.0
10	12-06-95	16:30:31	02:15:00	11.506	20.0
11	12-06-95	16:45:31	02:30:00	11.506	20.0
12	12-06-95	17:00:31	02:45:00	11.506	20.0
13	12-06-95	17:15:31	03:00:00	11.506	20.0
14	12-06-95	17:30:31	03:15:00	11.363	19.75
15	12-06-95	17:45:31	03:30:00	11.363	19.75
16	12-06-95	18:00:31	03:45:00	11.363	19.75
17	12-06-95	18:15:31	04:00:00	11.219	19.50
18	12-06-95	18:30:31	04:15:00	11.219	19.50
19	12-06-95	18:45:31	04:30:00	11.219	19.50
20	12-06-95	19:00:31	04:45:00	11.219	19.50
21	12-06-95	19:15:31	05:00:00	11.219	19.50
22	12-06-95	19:30:31	05:15:00	11.075	19.25
23	12-06-95	19:45:31	05:30:00	11.075	19.25
24	12-06-95	20:00:31	05:45:00	11.075	19.25
25	12-06-95	20:15:31	06:00:00	11.075	19.25
26	12-06-95	20:30:31	06:15:00	11.075	19.25
27	12-06-95	20:45:31	06:30:00	10.931	19.0
28	12-06-95	21:00:31	06:45:00	10.931	19.0
29	12-06-95	21:15:31	07:00:00	10.931	19.0
30	12-06-95	21:30:31	07:15:00	10.931	19.0
31	12-06-95	21:45:31	07:30:00	10.787	18.75
32	12-06-95	22:00:31	07:45:00	10.787	18.75
33	12-06-95	22:15:31	08:00:00	10.787	18.75
34	12-06-95	22:30:31	08:15:00	10.787	18.75

35	12-06-95	22:45:31	08:30:00	10.787	18.75
36	12-06-95	23:00:31	08:45:00	10.643	18.50
37	12-06-95	23:15:31	09:00:00	10.643	18.50
38	12-06-95	23:30:31	09:15:00	10.643	18.50
39	12-06-95	23:45:31	09:30:00	10.643	18.50
40	12-07-95	00:00:31	09:45:00	10.643	18.50
41	12-07-95	00:15:31	10:00:00	10.643	18.50
42	12-07-95	00:30:31	10:15:00	10.5	18.25
43	12-07-95	00:45:31	10:30:00	10.5	18.25
44	12-07-95	01:00:31	10:45:00	10.5	18.25
45	12-07-95	01:15:31	11:00:00	10.356	18.0
46	12-07-95	01:30:31	11:15:00	10.356	18.0
47	12-07-95	01:45:31	11:30:00	10.356	18.0
48	12-07-95	02:00:31	11:45:00	10.356	18.0
49	12-07-95	02:15:31	12:00:00	10.212	17.75
50	12-07-95	02:30:31	12:15:00	10.212	17.75
51	12-07-95	02:45:31	12:30:00	10.212	17.75
52	12-07-95	03:00:31	12:45:00	10.212	17.75
53	12-07-95	03:15:31	13:00:00	10.068	17.50
54	12-07-95	03:30:31	13:15:00	10.068	17.50
55	12-07-95	03:45:31	13:30:00	10.068	17.50
56	12-07-95	04:00:31	13:45:00	9.9246	17.25
57	12-07-95	04:15:31	14:00:00	9.9246	17.25
58	12-07-95	04:30:31	14:15:00	9.9246	17.25
59	12-07-95	04:45:31	14:30:00	9.9246	17.25
60	12-07-95	05:00:31	14:45:00	9.9246	17.25
61	12-07-95	05:15:31	15:00:00	9.7808	17.0
62	12-07-95	05:30:31	15:15:00	9.7808	17.0
63	12-07-95	05:45:31	15:30:00	9.7808	17.0
64	12-07-95	06:00:31	15:45:00	9.7808	17.0
65	12-07-95	06:15:31	16:00:00	9.7808	17.0
66	12-07-95	06:30:31	16:15:00	9.7808	17.0
67	12-07-95	06:45:31	16:30:00	9.6369	16.75
68	12-07-95	07:00:31	16:45:00	9.6369	16.75
69	12-07-95	07:15:31	17:00:00	9.6369	16.75
70	12-07-95	07:30:31	17:15:00	9.6369	16.75
71	12-07-95	07:45:31	17:30:00	9.6369	16.75
72	12-07-95	08:00:31	17:45:00	9.6369	16.75
73	12-07-95	08:15:31	18:00:00	9.6369	16.75
74	12-07-95	08:30:31	18:15:00	9.6369	16.75
75	12-07-95	08:45:31	18:30:00	9.4931	16.50
76	12-07-95	09:00:31	18:45:00	9.4931	16.50
77	12-07-95	09:15:31	19:00:00	9.4931	16.50
78	12-07-95	09:30:31	19:15:00	9.4931	16.50
79	12-07-95	09:45:31	19:30:00	8.7739	15.25
80	12-07-95	10:00:31	19:45:00	9.6369	16.75
81	12-07-95	10:15:31	20:00:00	13.664	23.75
82	12-07-95	10:30:31	20:15:00	16.972	29.50
83	12-07-95	10:45:31	20:30:00	18.410	32.0
84	12-07-95	11:00:31	20:45:00	18.986	33.0
85	12-07-95	11:15:31	21:00:00	19.273	33.50

→ Blower Turned back on

86	12-07-95	11:30:31	21:15:00	19.417	33.75
87	12-07-95	11:45:31	21:30:00	19.561	34.0
88	12-07-95	12:00:31	21:45:00	19.561	34.0
89	12-07-95	12:15:31	22:00:00	19.561	34.0

END OF RECORDINGS