3R - 194

REPORTS

DATE:

10/1999

JAQUEZ COM. C #1 AND JAQUEZ COM. E #1

SOIL AND GROUNDWATER REMEDIATION PILOT TEST

October 1999

Prepared For

EL PASO FIELD SERVICES
FARMINGTON, NEW MEXICO

Project 62800019

PHILIP ENVIRONMENTAL

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APPENDICES

1 EXECUTIVE SUMMARY

Philip Environmental Services Corporation (Philip) performed a soil venting/sparging Pilot Test at the El Paso Field Services (EPFS) Jaquez Com. C #1 and Jaquez Com. E #1 meter sites. The test was performed in accordance with the June 1999 Work Plan that EPFS submitted to the New Mexico Oil Conservation Division entitled *Jaquez Com. C #1 and Jaquez Com. E #1 Soil and Groundwater Remediation Work Plan.*

The original model for the continuing hydrocarbon constituents observed in ground water, is that light non-aqueous phase liquid (LNAPL) hydrocarbons in the up-gradient portion of the aquifer and the smear zone just above the water table continue to act as a source of dissolved phase hydrocarbons in down-gradient wells.

The proposed model for remediation of the site includes air sparging into the aquifer to volatilize components of the LNAPL into the vadose zone where they can be biodegraded by microbial activity or driven out of the ground in a gaseous phase. The Pilot Test was designed to observe the affect that pressure differentials in the vadose zone have on air circulation, vapor phase hydrocarbon migration and natural bioremediation processes.

The Pilot Test consisted of a total of four tests, conducted to test the effectiveness of the proposed technology at the site. Three tests were conducted to estimate the soil gas permeability of the vadose zone and one in-situ respiration test was conducted to measure the oxygen utilization rate. Of the three soil permeability tests, one test involved utilizing vapor extraction technology (air extraction), and two tests were conducted utilizing air sparging (air injection) into the aquifer.

Results of the soil gas permeability tests which included both soil venting the vadose zone and air sparging into the aquifer indicate that the site is a candidate for the treatment methods proposed.

Results of the in-situ respiration test indicate that the LNAPL phase can be volatilized into a gas phase and subsequently biodegraded. The test also indicated that, although bioremediation is naturally occurring at the site, the proposed technology will enhance the speed of the remediation process.

2 INTRODUCTION

At the request of El Paso Field Services Company (EPFS), Philip Environmental Services Corporation (Philip) has prepared the following report. This report is intended to show the effectiveness of soil and groundwater remediation proposed in the Work Plan that was submitted to the New Mexico Oil Conservation Division (NMOCD) by EPFS entitled *Jaquez Com. C #1 and Jaquez Com. E #1 Soil and Groundwater Remediation Work Plan*, dated June 1999.

The Jaquez Com. C #1 and Jaquez Com. E #1 meter sites are currently operated by EPFS. The meter sites are located in Section 6, Township 29N, Range 9W, in San Juan County, New Mexico, four miles north of the town of Blanco, New Mexico on San Juan County Rd. 4599.

Citizens Ditch separates the gas wells from the meter locations (Figure 1). Hydrocarbons were initially found in soil and groundwater on both sides of Citizens Ditch. The two meter stations are located within 40 feet of one another and for remediation purposes are treated as one site. Past practices include discharge of pipeline liquids into earthen pit(s) at the site.

Extensive excavation has been conducted in the area and hydrocarbon containing soils have been removed to the extent practical. As stated above, the site is transected by Citizens Ditch, which acts as a water supply conduit for the City of Bloomfield. Surface water in Citizens Ditch has not been affected by the site, although soils underlying Citizens Ditch continue to source groundwater with hydrocarbon constituents.

The June 1999 Work Plan proposed air sparging the groundwater to facilitate volatilization of hydrocarbons into the vadose zone. Soil venting technology was proposed to contain vapor flow, if necessary, and to help supply additional oxygen if low oxygen levels become a limiting factor to efficient biodegradation. If the proposed treatment proves to remediate this area effectively, the area below Citizens Ditch will be a candidate for similar technology. This report documents the results of Pilot Tests performed in accordance with the Work Plan in order to demonstrate the effectiveness of the proposed remediation technology.

3 SITE CHRONOLOGY

Listed below is a brief description of past activities at the site. Figure 1 shows the locations of existing monitor wells.

- Late 1992 - Landowner expressed concern regarding potential hydrocarbon constituents in a garden area near the meter site location.
- March 1993 - Comprehensive soil and groundwater investigation was performed on meter site location and nearby garden area.
- June 1993 - EPFS submitted a remedial plan to NMOCD.
- July 1993 - NMOCD approved the remedial plan.
- August 1993 - Remediation activities initiated. Remediation activities resulted in the excavation of 5,222 yards^3 of hydrocarbon-impacted soils. A total of 1,766 yards^3 of soil were excavated from the impacted area north of the ditch and 3,456 yards^3 of soil were excavated from south of the ditch.
- September 1993 - Monitor wells R-1 through R-5 and M-1 through M-5 were installed north and south of Citizens Ditch. Initial sampling for benzene, toluene, ethylbenzene, and total xylene (BTEX) indicated monitor wells R-1, R-2, R-4, M-3, and M-4 were above New Mexico Water Quality Control Commission (NMWQCC) standards. Monitoring wells at the site were initially sampled monthly and are currently sampled quarterly. A passive venting interceptor trench was installed.
- September 1993 - Remediation activities were completed.
- October 1993 to October 1996 – Free phase hydrocarbons were observed in monitor wells R-1 and R-2 during the months of seasonally low groundwater levels (i.e., January through May). Passive skimmer systems were installed to remove the free phase hydrocarbons during periods of free phase hydrocarbon accumulation.
- November 1996 - A pumping test was performed to determine if light non-aqueous phase liquids (LNAPL) could be removed during high seasonal groundwater by depressing the water table in and around R-1 and R-2.
- December 1996 - Philip injected approximately 500 gallons of urea nitrate in water into the passive vent system and installed magnesium peroxide socks in monitoring wells M-3 and M-4 to supply oxygen to enhance natural biodegradation of hydrocarbons in groundwater.
- January 1997 - Philip installed a belt skimmer in R-2 to remove free phase hydrocarbons.
- February 1997 - Philip installed a belt skimmer in R-1 to remove free phase hydrocarbons.

- June 1997 - Belt skimmer free phase hydrocarbon recovery system was shut down due to seasonal reduction of free phase hydrocarbon thickness related to local irrigation.
- November 1997 - Philip installed two temporary monitor wells inside the formerly excavated area north of R-1 to determine if free phase hydrocarbons could be recovered during the high groundwater season.
- January 1998 - Philip restarted the belt skimmer in R-1 and R-2.
- April 1998 - Belt skimmer free phase hydrocarbon recovery system was shut down due to seasonal reduction of free phase hydrocarbon thickness related to local irrigation.
- July 1998 - Philip injected approximately 500 gallons of urea nitrate in water into the passive vent system and installed magnesium peroxide socks in monitor wells M-3, M-4, R-3 and R-4 to supply oxygen to enhance natural biodegradation of hydrocarbons in groundwater.
- November 1998 - EPFS conducted an investigation of possible hydrocarbon seep of groundwater into the surface water of an arroyo to the south of the property. No hydrocarbons are found during this investigation.
- 1998 - Quarterly groundwater sampling of the following monitor wells was conducted during the first two quarters of 1998: R-3; R-4; R-5; M-1; M-2; M-3; M-4; and, M-5.
- 1998 - Quarterly groundwater samples were collected for four quarters from monitor wells M-3 and M-4.
- May 1999 – Recoverable free phase hydrocarbons (free product in excess of 0.2 feet thick) have not been observed in any of the monitor wells this year. No free phase hydrocarbons have been recovered from the site in 1999.
- August 1999 – Soil Vapor Extraction and aquifer sparge Pilot Tests were performed at the site on the section above Citizens Ditch.

4 METHODOLOGY

The Pilot Test included extracting air from the vadose zone (vapor extraction) and injecting air into the aquifer (air sparging). Prior to the Pilot Test, two test points and five monitoring points were installed (Figure 1 – Location of Existing Wells). The Pilot Test consisted of the following tests.

One soil gas permeability tests was conducted utilizing vapor extraction technology, and two soil gas permeability tests were performed using air sparging technology. Various monitoring points were utilized to monitor pressure during the soil gas permeability test.

An in-situ respiration test was also performed. Oxygen (O_2), carbon dioxide (CO_2) and volatile organic compounds (VOC's) in the vadose zone soil gas were measured and the

oxygen utilization rate subsequently calculated from test results. Gas samples were also collected from the vapor extraction system to measure the organic content of vapor extraction system exhaust.

4.1 Pilot Test- Test Point Installations

On August 11 and 12, one sparge well (SP-01), one vent well (VE-01), and three nested monitoring points (MP-01, MP-02 and MP-03) were installed at the locations shown on Figure 1. SP-01 was completed below the water table, VE-01 was completed above the water table and the monitoring points (MP-01, MP-02 and MP–03) were completed above the water table. Monitoring points MP-02 and MP-03 consist of two points nested in one boring apiece at 5-6 foot and 9-10 foot depths below ground surface and 20 and 30 feet away from SP-01 respectively. One monitoring point (MP-01) was set at a single depth of 5-8 feet below ground surface and 10 feet away from sparge well SP-01. A monitoring point was set at only one depth at MP-01 because of the extremely shallow level of groundwater. Boring and completion logs for all wells and monitoring points can be found in Appendix A.

The wells were installed using hollow stem auger technology. An eight-inch outside diameter, hollow stem auger was used to install the sparge well, the soil vapor extraction well and the nested monitor points. The annular space around the screened interval in all of the test wells and monitoring points was filled with 10-20 Colorado Silica Sand. A two foot seal of bentonite pellets was installed on top of the silica sand and a bentonite/cement grout was installed on top of the bentonite seal to the well surface. The nested monitor points include two sand packed screened intervals, a deep and a shallow interval separated by a seal consisting of hydrated bentonite pellets.

4.2 Soil Gas Permeability Test

The soil gas permeability test was performed using air extraction (SVE) of the vadose zone during the first test and air injection (air sparging) of the aquifer during the second and third soil gas permeability tests. Both tests were conducted on August 19, 1999. During the SVE soil gas permeability test, air was extracted from test point SVE-1 and pressure was monitored in monitoring points MP-01, MP-02 and MP-03. On August 23rd, a shortened soil gas permeability test, using air sparging, was performed on well SP-1 using monitor well R-03 as the only monitoring point. The following steps were taken to perform the soil gas permeability tests:

1. Dissolved oxygen was measured in monitor wells R-01 through R-05.
2. Magnehelic ™ gauges were connected to the top of each monitoring point with the stopcock opened; the gauges were set to zero.
3. The blower unit was turned on, recording the starting time to the nearest second. Initial blower flow rates were controlled by the amount of vacuum/pressure measured at the blower.

4. At 1-minute intervals, vacuum/pressure was recorded at each monitoring point beginning at t = 60 s.
5. After 10 minutes, the vacuum/pressure recording interval was extended to 2 minutes. Pressure readings and the flow rate from the vent well/sparge well were recorded from readings taken at the blower manifold.
6. After 20 minutes, pressure was measured at each monitoring point in 3-minute intervals.
7. Monitoring point pressure data was recorded at 3-minute intervals for the first hour of the test. After one hour a 30-minute interval was used.
8. Once the data collection interval increased to 30 minute increments (or at the end of the test for the shortened soil gas permeability test), soil gas samples were collected from monitoring points, and analyzed for O_2, CO_2, and voc's. Vacuum/pressure data was collected for a total of approximately 2 hours for each of the SVE and Air Sparge portions of the soil gas permeability test.
9. Monitor wells R-01 through R-05 were again measured for dissolved oxygen.

4.3 In-situ Respiration Test

The in-situ respiration test was performed over a two day period on August 23rd and 24th. The in-situ respiration test was conducted 48 hours after the soil gas permeability test was completed to allow sub-surface conditions to stabilize. The following procedures were used to perform the sampling for the in-situ respiration test.

1. The O_2 and CO_2 meter sampling pump was connected to the stopcock at the top of individual monitoring points. The sample pump was calibrated to pump a known volume of air over time.
2. O_2 and CO_2 sampling was performed prior to turning the sparge system on and then again when the sparge unit was turned off. Samples were also collected 2, 4, 11, and 18 hours after the sparge system was turned off. Sample collection times included in the Work Plan were changed due to slow changes observed in the sample results.
3. O_2 and CO_2 values (in %) were then recorded using a multi gas meter, which records O_2, CO_2 ,and CH_4 equivalent volatile organic compounds (VOC) in parts per million, simultaneously.

4.4 Exhaust Gas Testing

After the in-situ respiration test was completed, the air sparging system and the soil vapor extraction system were both turned on for a period of 12 hours in order to best simulate what exhaust gases might be produced. Air samples were collected from the soil vapor extraction system exhaust port into Tedlar bags and analyzed by EPA methods for total petroleum hydrocarbons (TPH) and benzene, toluene, ethyl benzene and total xylenes (BTEX). Air sample results were non-detect for TPH and BTEX constituents. Laboratory analytical data of the air samples can be found in Appendix B.

5 PILOT TEST RESULTS

Field data sheets for all soil gas permeability tests are included in Appendix C. Pressure vs. (ln) time slopes are presented in graphic form in Appendix D (Charts 1 through 3). Calculated Radius of Influence (R_i) using measured pressure data are presented in graphic form in Appendix D (Charts 4 and 5) and VOC in parts per million vs. time and oxygen % vs time are presented in graphic form in Appendix D (Charts 6 and 7).

5.1 Soil Gas Permeability Test

Data for the soil gas permeability test was collected on August 19, 1999. Field data is presented in Appendix C, on Field Data Sheets (FDS) #1, FDS #2, and FDS #3. Monitoring points, MP-01, MP-02 and MP-03 are located 30 feet, 20 feet and 10 feet respectively from the soil vapor extraction well (VE-01). The vacuum differentials between the wells were qualitatively correct since, vacuum measured at MP-03> vacuum measured at MP-02> vacuum measured at MP-01. Soil gas permeability calculations are included as Calculation Sheets 1 through 4 in Appendix E.

The R_i was calculated by plotting the pressure at each monitoring point vs. the log of its radial distance from the vent well and extrapolating the straight line to zero vacuum. Plots of R_i for both the SVE and the Air Sparging test are shown graphically in Appendix D as Charts 4 and 5. Calculated R_i for vapor extraction from test well VE-1 was 35 feet and the calculated R_i of the vadose zone for the air sparging test was 70 feet.

Soil gas permeability in the vadose zone at the site is higher than expected and monitoring points MP-01 and MP-03 quickly reached equilibrium during the venting test. Because static levels of pressure were achieved so quickly in MP-01 and MP-03, data from those monitoring points are used to calculate the soil gas permeability. The static equation for soil gas permeability was used to calculate K. The static test calculation is defined in, *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing,* Air Force Center for Environmental Excellence May 1992. The static equation is included in Appendix E, Calculation Sheet #1. The results of the test indicate a soil gas permeability of 11.6 darcys. This indicates a reasonable permeability for the sandy soil noted on boring logs generated during installation of the monitoring points, sparge well and vapor extraction well.

A slower buildup of vacuum was observed in MP-02 and so the dynamic test method described in the June 1999 Work Plan, was used to calculate the soil gas permeability at MP-02. The dynamic equation is included in Appendix E as Calculation Sheet #2. The results indicated that soil gas permeability around monitor point MP-02 was 765 darcys. This calculation should be ignored for the following reasons: MP-02 audibly "breathed" or released pressure when monitoring devices were unhooked from that point, indicating the monitoring point was probably partially plugged; The results are out of range by an order of magnitude from results calculated from the static test described above; and, The results are out of range for reasonably expected results. It should be noted however, that

the final vacuum attained by MP-02 was in the middle vacuum range between the final vacuums observed at MP-01 and MP-03, which shows that in some qualitative way MP-02 was behaving as expected.

A soil gas permeability test was also performed using air injection (air sparging) of the aquifer. Air pressures built up erratically over time (Chart 2) and so the static method was used to calculate the soil gas permeability (Calculation Sheet #4). The soil gas permeability observed during this test was 19.2 darcys.

A soil gas permeability test was also conducted on August 23, 1999, using monitor well R-03 as a monitoring point. This test was performed during sparging operations, and field results of this test can be found in FDS #4 in Appendix C, and graphic results of the test are included in Appendix D (Chart 3). This test indicated 36.9 darcys for soil gas permeability in the zone just above the water table. Since this is a very permeable clean sand, the results are within the expected range and indicate that soil gas can be forced to flow through the uppermost part of the lithologic unit that contains the aquifer.

5.2 In-situ Respiration Test

The in-situ respiration test was performed over a period of 24 hours. Oxygen, carbon dioxide and VOC readings were collected prior to beginning the respiration test. The sparge system was then allowed to run for 12 hours prior to the beginning of data collection. The sparge system was turned off 12 hours into the test and data was collected at 13, 15, 17, 24 and 36 hours into the test. FDS #6 contains the data for the in-situ respiration test and the results are shown in graphic form in Appendix D as (Charts 5 and 6).

Oxygen utilization rates (K_o) varied from 0.7 % O_2/ hour to 0.25 % O_2/ hour. Again, monitor point MP-02 deep showed signs of being plugged during this test and so the anomalous readings observed from MP-02 during the in-situ respiration test can be ignored. Using the K_o described above, the biodegradation rates of the hydrocarbons can be approximated using K_B in mg of hexane-equivalent per kilogram of soil per day = 0.8 K_o (from *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing,* Air Force Center for Environmental Excellence, May 1992). Therefore the biodegradation rate at the site ranges from 0.56 to 0.20 mg of hexane-equivalent per kilogram of soil per day.

A rise in methane equivalent VOC's was also observed at about 11 hours after the air sparge system was turned off (Chart 6).

6 CONCLUSIONS

The results for the soil gas permeability test indicate that this site is a good candidate for the proposed treatment model. A layer of very permeable sand just above the water table is indicated by the sparge test conducted using MW-03 as a monitoring point. Monitor well MW-03 is completed as a groundwater monitor well with a screen that extends to just above the water table. Therefore, the higher permeability calculated from pressure readings observed from this well would be the result of pressurization of the aquifer sand unit just above the water table. Test results indicate a high soil gas permeability in this zone at 36.9 darcys which correlates well with the lithology. Soil boring logs indicate a clean flowing sand (i.e., a sand that flows when the water bearing portion of the zone is penetrated/excavated).

Soil gas permeability as calculated from pressure/vacuum measurements at the monitoring points indicate soil gas results of 11.6 and 19.2 darcys. These results are very similar considering that the tests were conducted by sparging air into the aquifer in one case and by soil vapor extraction methodology in the other.

Air sparging into the aquifer resulted in slow erratic gains in pressure as measured in the monitoring points. This is probably the result of the differential permeability between the lithologic unit where air was being injected and the lesser permeability of the overlying lithology.

Volatile organics were observed migrating into the upper portion of the vadose zone within 16 hours of initiating air sparging operations. Twenty seven hours after sparging operations were initiated (and 11 hours after the sparge system was turned off), monitoring points showed VOC levels >150 ppm (the instrument limit) and oxygen levels began to increase. These observations can be seen graphically on the overlay Charts 6 and 7.

The increase in oxygen and VOC levels are related, and may be interpreted as the reflection of the time it takes for air to be forced from the more highly permeable lithologic unit that contains the aquifer to the less permeable overlying units. Another explanation might be that VOC concentrations increased to toxic levels for bacteria that are acting as receptors of the volatiles and therefore, the bacteria are no longer consuming oxygen.

More will be known about biodegradation rates and other bioremediation properties after a system is operated for a period of time at the site. If the toxicity scenario proves to be the cause of excess oxygen, then extra vapor extraction points can be installed to reduce the VOC levels and make the atmosphere more hospitable to the microorganisms.

In conclusion, volatilizing hydrocarbon constituents off the groundwater and moving them through the vadose zone for release into the atmosphere or their biodegradation in the vadose zone appears to be a valid remedial model.

7 RECOMMENDATIONS

Philip recommends installing an air sparging system for in-situ remediation of soils at the site utilizing air sparging technology to volatilize and mobilize hydrocarbon constituents. The soil vapor extraction system will be available if non-point source vapor emissions become problematic or if oxygen utilization rates in the subsurface require additional oxygen for more efficient bioremediation of hydrocarbon vapors.

Philip proposes utilizing a total of three sparge points (Figure 2): The sparge point installed for the pilot test (SP-01); a sparge point about 40 feet east of SP-01; and, A sparge point in the area that was previously excavated. The system will be closely monitored the first month of operation. The reaction and processes occurring in the vadose zone with the influx of hydrocarbon constituents will be monitored. If future investigations of the site indicate more widespread hydrocarbon impact, the geometry of the sparge points may be rearranged or more sparge points may be added to the system.

The sparge system will be operated 12 hours per day and then turned off for 12 hours per day. This "pulsing" of the system will allow the formation to heal for 12 hours a day to help prevent short-circuiting of the sparge wells or the formation of preferential pathways in the formation.

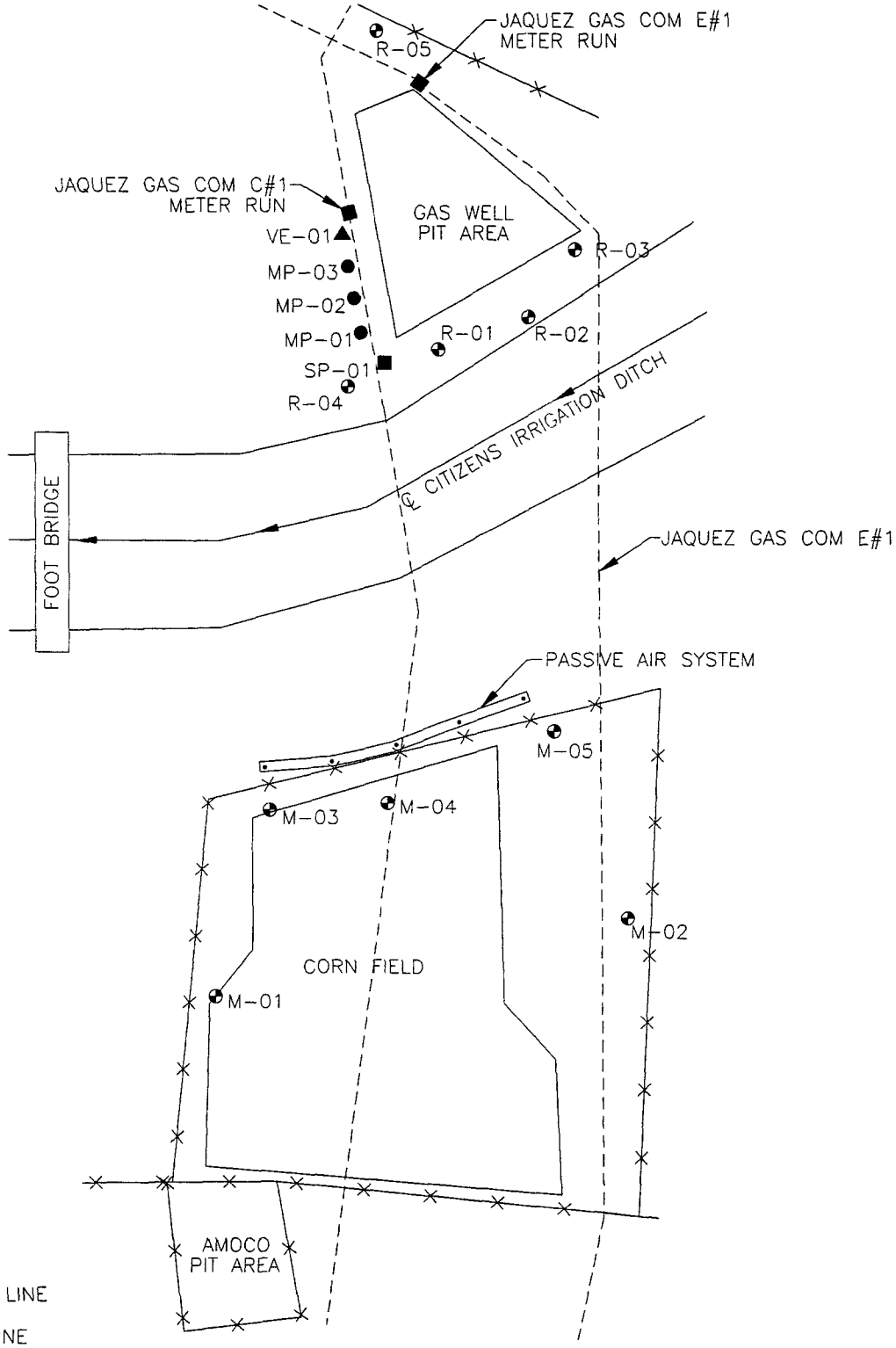
The vapor extraction system will only be used if biological activity in the vadose zone depletes oxygen levels to less than 5% on a consistent basis, or if vapor migration becomes problematic and needs to be controlled. The Pilot Test indicates that a Notice of Intent (NOI) is not required for the exhaust system at this time. However, since the waiting time for an NOI is 30 days, the paperwork can be submitted to NMED on a contingency basis in case one is needed in the future.

During the initial system startup period of the air sparging system, O_2 and VOC measurements of soil gases will be recorded every other day to monitor ongoing biodegradation processes and breathing zone conditions. Subsurface pressures will be recorded once a week at the beginning and end of one twelve hour operational period during the startup period. Also, the system will be shut down on the weekends during this initial startup period. After the initial startup period, monitoring will be performed once a week.

A report will be generated bi-annually for the purpose of summarizing the progress of the remedial system. The report will include historical and current groundwater and vadose zone monitoring results, as well as pertinent data of the sparge and/or vent system such as

the total hours the system has been operational, estimates of gross hydrocarbons removed from the groundwater to date, and vadose zone information.

FIGURES



LEGEND

- FENCE LINE
- PIPE LINE
- M-01 MONITORING WELL LOCATION AND NUMBER
- SP-01 GROUNDWATER SPARGE POINT
- VE-01 VAPOR EXTRACTION POINT
- MP-01 MONITORING POINT

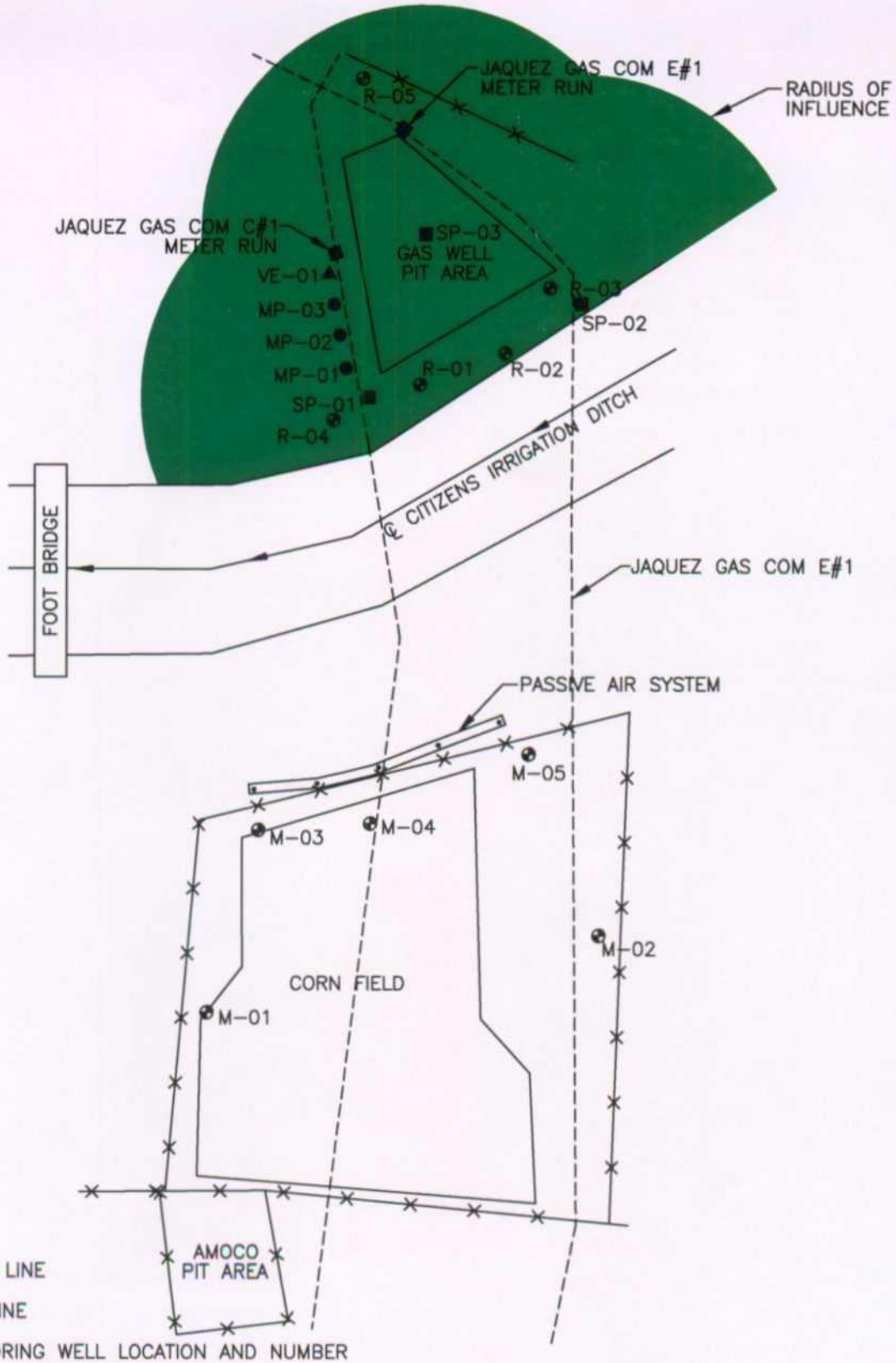
0 50
FEET

PHILIP SERVICES CORP.

TITLE:
LOCATIONS OF VAPOR EXTRACTION, GROUNDWATER SPARGE POINT AND MONITORING POINTS

DWN:	DES.:	PROJECT NO.: 17444
TMM	CI	EL PASO FIELD SERVICE COMPANY
CHKD: CI	APPD:	
DATE: 10/8/9	REV.: 0	FIGURE 1

COL. 17444B-002



LEGEND

- FENCE LINE
- PIPE LINE
- M-01 MONITORING WELL LOCATION AND NUMBER
- SP-01 GROUNDWATER SPARGE POINT
- VE-01 VAPOR EXTRACTION POINT
- MP-01 MONITORING POINT

0 50
FEET

PSC PHILIP SERVICES CORP

TITLE:
PROPOSED LOCATION OF GROUNDWATER SPARGE POINTS SHOWING ESTIMATED RADIUS OF INFLUENCE FOR SPARGE POINTS

DWN:	DES.:	PROJECT NO.: 17444
TMM	CI	EL PASO FIELD SERVICE COMPANY
CHKD: CI	APPD:	
DATE: 10/8/9	REV.: 0	FIGURE 2

COL 174448-005

APPENDIX A

Soil Boring & Well Completion Logs

RECORD OF SUBSURFACE EXPLORATI

Borehole # 1
Well # MP-7
Page 1 of 2

Philip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

Project Name EPFS JAQUEZ SVE
Project Number 62800019 Phase 1
Project Location JAQUEZ GAS COM E #1

Elevation
Borehole Location
GWL Depth
Logged By C. CULLICOTT
Drilled By K. PADILLA & D. PADILLA
Date/Time Started 8/12/99 8:30am
Date/Time Completed 8/12/99 9:45am

Well Logged By C. CULLICOTT
Personnel On-Site K. PADILLA & D. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Drilling Method AUGER
Air Monitoring Method PID

Depth (Feet)		Sample Interval	Sample Type & Recovery (inches)	Sample Description Classification System: USCS	USCS Symbol	Depth Lithology Change (feet)	Air Monitoring Units: NDU BZ	BH	S	Drilling Conditions & Blow Counts
0	1	0-18"		SURFACE DAMP SAND, POORLY SORTED. INCREASING %O CLAY WITH DEPTH TO 1'. LOOSE SAND @ 1', for 1", then tight, CLAY for 2". THEN FINE SAND W/CLAY TO 18"	Hy				0.0	① 9 blows
	2	1½-3½'								
	3	3½-5'							0.0	② 19 blows
5	~~4~~	~~4½-5½~~								
	4	5-7'		③ POOR RECOVERY. 1" thick stiff clay @ ~2', BELOW THAT LOOSE DRY POORLY SORTED SAND					0.0	③ 10 blows
	5	7-8½'							0.0	④ 9 blows
TD 10				⑤ GOOD RECOVERY. MOIST, POORLY SORTED SAND ~~3½~~ 3½" 4', 4 then 1" STIFF CLAYEY SAND, THEN LOOSE, POORLY SORTED SAND, 8", then SAME W/MORE CLAY TO 5'						
15				④ AS ABOVE TO 7', @ 7' SEDIMENT IS NEARLY SATURATED						
20				⑤ POOR RECOVERY. BOTTOM OF SPLIT SPOON IS SATURATED, STIFF SANDY CLAY, GRAY. NO VISIBLE HC STAIN IN THIS HOLE.						
25				TD 9'						
30										
35										
40										

Comments: SUNNY W/A FEW CLOUDS. SITE IS ADJACENT TO IRRIGATION DITCH.

Geologist Signature Cathy Cullicott

MONITORING WELL INSTALLATION RECORD

Philip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

Borehole # 1
Well # MP-1
Page 2 of 2

Project Name EPFS JAQUEZ SVE
Project Number 628000.19 Phase 1
Project Location JAQUEZ

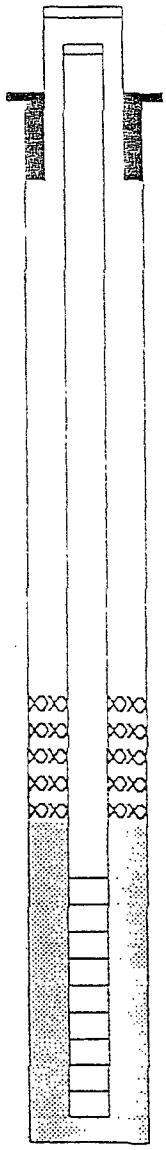
Elevation
Well Location
GWL Depth
Installed By K. PADILLA & A. PADILLA

Date/Time Started 8/12/99 8:30am
Date/Time Completed 8/12/99 9:45am

On-Site Geologist C. CULLICOTT
Personnel On-Site K. PADILLA, A. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Depths in Reference to Ground Surface

Item	Material	Depth
Top of Protective Casing		
Bottom of Protective Casing		
Top of Permanent Borehole Casing		
Bottom of Permanent Borehole Casing		
Top of Concrete		
Bottom of Concrete		
Top of Grout		
Bottom of Grout		
Top of Well Riser	1"	~+2'
Bottom of Well Riser	1"	5'
Top of Well Screen	1"	5'
Bottom of Well Screen	1"	8'
Top of Peltonite Seal	Pellets	2'
Bottom of Peltonite Seal	Pellets	4'
Top of Gravel Pack	COLORADO	4'
Bottom of Gravel Pack	SILICA SAND	9'
Top of Natural Cave-In		
Bottom of Natural Cave-In		
Top of Groundwater		
Total Depth of Borehole		9'



Top of Protective Casing
Top of Riser ~+2'
Ground Surface

BENTONITE CHIPS TO GS

Top of Seal 2'
BENTONITE Pellets

Top of Gravel Pack 4'

Top of Screen 5'

Bottom of Screen 8'
Bottom of Borehole 9'

Comments:

Geologist Signature Cathy Cullicott

RECORD OF SUBSURFACE EXPLORAT...

Borehole # 1
Well # MP 3
Page 1 of 2

Philip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

Project Name EPFS JAQUEZ
Project Number Phase 1
Project Location JAQUEZ GAS COM E #1

Elevation
Borehole Location JAQUEZ
GWL Depth
Logged By C. CULLICOTT
Drilled By K. PADILLA, D. PADILLA
Date/Time Started 8/11/99 9:10am
Date/Time Completed 8/11/99 10:30 am

Well Logged By C. CULLICOTT
Personnel On-Site K. PADILLA, D. PADILLA, C. IRE
Contractors On-Site Ø
Client Personnel On-Site Ø

Drilling Method AUGER
Air Monitoring Method PID

Depth (Feet)		Sample Interval	Sample Type & Recovery (inches)	Sample Description Classification System: USCS	USCS Symbol	Depth Lithology Change (feet)	Air Monitoring Units: NDU BZ	BH	S	Drilling Conditions & Blow Counts
0	1	Grab		SURFACE: SAND						
				0-18" CLEAN SAND, DAMP,						
	2	18"-2½'		TAN, ANGULAR			①		1.2ppm	
				@18" a 1" thick clay seam,						
5	3	2½-4½		Gray, w/ fine roots			②		0.8ppm	
	4	4½-6'		Then sand → loose, medium						
				SAND → 2'.			③		0.8ppm	
	5	6-8'		@ 2½' 3" of GRAY SILTY CLAY.						
10	6	8-10'		then LOOSE, MEDIUM SAND.			④		NS	
TD				CLEAN, to 2½'						
				2½-4½ CLEAN SAND,			⑤		1.0ppm	
				MEDIUM, w/ minor silt/clay						
15				4½-6' INCREASING %			⑥		135ppm	
				CLAY, GRAY, STILL CLEAN,						
				FINER SAND, MORE						
				COHERENT TO 6½'						
20				@6½' MOIST SANDY						
				CLAY, GRAY TO 7'.						
				7-8' BACK INTO SAND,						
25				GRAY TO BROWN CLAYEY						
				SAND, COHERENT, DAMP						
				TO 9½' then INTO HC						
				STAINED SAND. GRAY						
				STAIN INTO BLACK @ 10'.						
30				FINE SAND, SMALLER %						
				CLAY THAN ABOVE,						
				WET, BUT NOT SATURATED-						
				TOP OF "SMEAR ZONE"						
35				TD 11'						
40										

Comments:

Geologist Signature Cathy Cullicott

MONITORING WELL INSTALLATION RECORD

Phillip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

Borehole # 1
Well # MP-3
Page 2 of 2

Project Name EPFS JAQUEZ SVE
Project Number 62800019 Phase 1
Project Location JAQUEZ GAS COM E #1

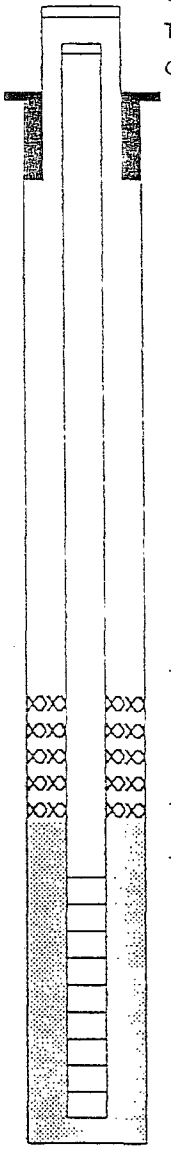
Elevation
Well Location JAQUEZ
GWL Depth
Installed By K. PADILLA + D. PADILLA

Date/Time Started 8/11/99 9:10 am
Date/Time Completed 8/11/99 10:20 am

On-Site Geologist C. IRBY & C. CULLICOTT
Personnel On-Site K. PADILLA + D. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Depths in Reference to Ground Surface

Item	Material		Depth	
Top of Protective Casing				
Bottom of Protective Casing				
Top of Permanent Borehole Casing				
Bottom of Permanent Borehole Casing				
Top of Concrete				
Bottom of Concrete				
Top of Grout				
Bottom of Grout				
Top of Well Riser	1"	D	+2	S 3'
Bottom of Well Riser	1"	D	9'	S 5'
Top of Well Screen	1"	D	9'	S 5'
Bottom of Well Screen	1"	D	10'	S 6'
Top of Peltonite Seal		D	6'	S 6S
Bottom of Peltonite Seal		D	8'	S 4'
Top of Gravel Pack		D	8'	S 4'
Bottom of Gravel Pack		D	11'	S 6'
Top of Natural Cave-In				
Bottom of Natural Cave-In				
Top of Groundwater				
Total Depth of Borehole				



Top of Protective Casing
Top of Riser
Ground Surface

Top of Seal D 6' S 2'
Top of Gravel Pack D 8' S - 4'
Top of Screen D - 9' S - 5'
Bottom of Screen D - 10' BGS S - 6'
Bottom of Borehole 11' BGS

Comments:

Geologist Signature Cathy Cullicott

RECORD OF SUBSURFACE EXPLORATION

Borehole # 2
Well # [redacted] SP-1
Page 1 of 2

Philip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

Project Name EPFS JAQUEZ SVE
Project Number 62800019 Phase 2
Project Location JAQUEZ GAS COM E #1

Elevation
Borehole Location
GWL Depth
Logged By C. CULLICOTT
Drilled By K. PADILLA & D. PADILLA
Date/Time Started 8/12/99 9:45 am
Date/Time Completed 8/12/99 & 12:45pm

Well Logged By C. CULLICOTT
Personnel On-Site K. PADILLA & D. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Drilling Method AUGER
Air Monitoring Method P.I.D

Depth (Feet)		Sample Interval	Sample Type & Recovery (inches)	Sample Description Classification System: USCS	USCS Symbol	Depth Lithology Change (feet)	Air Monitoring Units: NDU BZ	BH	S	Drilling Conditions & Blow Counts
0										
5	(1)	5-6½		(1) DAMP SAND, CLEAN, TAN, POORLY SORTED WITH OVERALL COARSENING WITH DEPTH IN SPLIT SPOON					32.0	(1) 5 BLOWS
10	(2)	10-12		(2) HYDRO CARBON STAINED CLAY W/ VARYING AMOUNTS OF SAND & SILT. DARKER STAIN WITH DEPTH— ~~SOLID~~ BLACK @ BOTTOM OF SPLIT SPOON. STIFF, MOIST					98.0	
15	(3)	15-16½								
20	(4)	20-22		(3) SATURATED POORLY SORTED SAND WITH STRONG HC ODOR					150	
25	(5)	25-26½		(4) SATURATED COARSE SAND W/ PERVASIVE BLACK HC STAIN.					96	
	(6)	26-27½		(5) NO RECOVERY						
30				(6) ~~SAND~~ SATURATED COARSE SAND. GRAY HC STAIN & ODOR @ TOP OF SPLIT SPOON, CLEAN SAND @ BOTTOM						
35						~~Ø~~	Ø	245		
40										

Comments: INFLUX OF SATURATED SAND INTO AUGER. KELLY SPENT A WHILE TRYING TO FLUSH IT OUT WITH NO LUCK SO WILL REDRILL. BOREHOLE PID READING TAKEN DURING AUGER PULL. SUNNY, WARM.

Geologist Signature Cathy Cullicott

MONITORING WELL INSTALLATION RECORD

Phillip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

Borehole # 2
Well # SP-1
Page 2 of 2

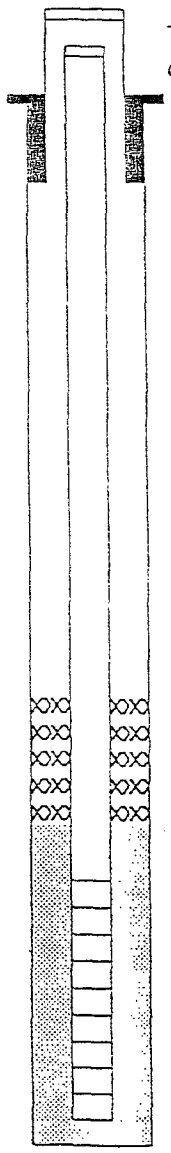
Project Name EPFS JAQUEZ SUE
Project Number 62800019 Phase 2
Project Location JAQUEZ GAS COM E #1

Elevation
Well Location
GWL Depth
Installed By K. PADILLA & D. PADILLA
Date/Time Started 8/12/99 9:45am
Date/Time Completed 8/12/99 12:45pm

On-Site Geologist C. CULLICOTT
Personnel On-Site E. PADILLA & D. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Depths in Reference to Ground Surface

Item	Material	Depth
Top of Protective Casing		
Bottom of Protective Casing		
Top of Permanent Borehole Casing		
Bottom of Permanent Borehole Casing		
Top of Concrete		
Bottom of Concrete		
Top of Grout		GS
Bottom of Grout	Cement	9½'
Top of Well Riser	2"	+5'
Bottom of Well Riser	2"	21'
Top of Well Screen	2"	21'
Bottom of Well Screen	2"	26'
Top of Peltonite Seal	chip + pellet	9½'
Bottom of Peltonite Seal	pellets ~~chips~~	17'
Top of Gravel Pack	clean sand	17'
Bottom of Gravel Pack	natural sed.	26'
Top of Natural Cave-In		
Bottom of Natural Cave-In		
Top of Groundwater		
Total Depth of Borehole		~26'



Top of Protective Casing
Top of Riser
Ground Surface
GROUT
Top of Seal 9½'
Top of Gravel Pack 17'
Top of Screen 21'
Bottom of Screen 26'
Bottom of Borehole 26'

Comments: INFLOW OF SEDIMENT INTO AUGER STEM OCCURRED TWICE, DEPTH OF SEDIMENT ~16'. KELLY & DANNY PUT 30' OF PIPE INTO AUGER & SHOVED IT DOWN TO APPROXIMATELY 26'. ONCE AUGER WAS LIFTED THE SEDIMENT SETTLED TO ~19'. PUT IN 2' OF CLEAN SAND. THEN HOLEPLUG. THERE WAS STANDING WATER IN THE WELL SO THEY POURED IN CEMENT POWDER TO ~1'

Geologist Signature Catherine Cullicott

RECORD OF SUBSURFACE EXPLORATION

Borehole # 3
Well # MP 2
Page 1 of 2

Philip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

EPFS
Project Name JAQUEZ SVE
Project Number 62800019 Phase 1
Project Location JAQUEZ GAS COM E #1

Elevation
Borehole Location
GWL Depth
Logged By C. CULLICOTT
Drilled By K. PADILLA & D. PADILLA
Date/Time Started 8/12/99 1:05 pm
Date/Time Completed 8/12/99 2:25 pm

Well Logged By C. CULLICOTT
Personnel On-Site K. PADILLA & D. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Drilling Method AUGER
Air Monitoring Method PID

Depth (Feet)		Sample Interval	Sample Type & Recovery (inches)	Sample Description Classification System: USCS	USCS Symbol	Depth Lithology Change (feet)	Air Monitoring Units: NDU BZ	BH	S	Drilling Conditions & Blow Counts
0				POORLY SORTED SAND, DAMP, BROWN, @4' - cobble?						
5				5-7' SAND w/higher % fines						
10				@7 & to gray stained clayey sand, cohesive, damp SAME TO 11' HC ODOR & STAIN						
15				TD 11'						
20										
25										
30										
35										
40										

TD

Comments:

Geologist Signature Cathy Cullicott

MONITORING WELL INSTALLATION RECORD

Philip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(606) 326-2262 FAX (606) 326-2388

Borehole # 3
Well # MP-2
Page 2 of 2

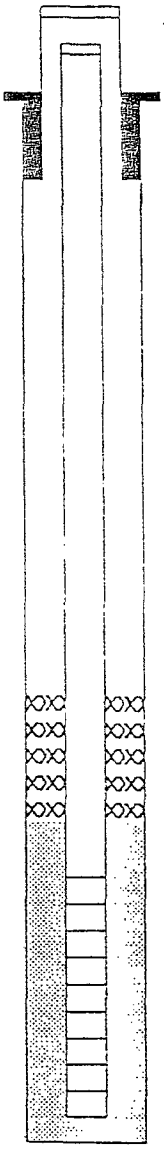
Project Name EPFS JAQUES SVE
Project Number 62800019 Phase 1
Project Location ~~EPFS~~ GAS COM F #1 JAQUEZ
On-Site Geologist C. CULLICOTT
Personnel On-Site K. PADILLA & D. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Elevation
Well Location JAQUEZ
GWL Depth
Installed By K. PADILLA & D. PADILLA

Date/Time Started 8/12/99 1:05pm
Date/Time Completed 8/12/99 2:25pm

Depths in Reference to Ground Surface

Item	Material		Depth	
Top of Protective Casing				
Bottom of Protective Casing				
Top of Permanent Borehole Casing				
Bottom of Permanent Borehole Casing				
Top of Concrete				
Bottom of Concrete				
Top of Grout				
Bottom of Grout				
Top of Well Riser	1"	D	+2	S +3
Bottom of Well Riser	1"	D	9'	S 5'
Top of Well Screen	1"	D	9'	S 5'
Bottom of Well Screen	1"	D	10'	S 6'
Top of Peltonite Seal		D	6'	S GS
Bottom of Peltonite Seal		D	8'	S 4'
Top of Gravel Pack		D	8'	S 4'
Bottom of Gravel Pack		D	11'	S 6'
Top of Natural Cave-In				
Bottom of Natural Cave-In				
Top of Groundwater				
Total Depth of Borehole				



Top of Protective Casing
Top of Riser
Ground Surface

Top of Seal D 6' S 2'
Top of Gravel Pack D 8' S 4'
Top of Screen D 9' S 5'
Bottom of Screen D 10' BGS S - 6'
Bottom of Borehole D 11' BGS

Comments:

Geologist Signature Cathy Cullicott

RECORD OF SUBSURFACE EXPLORATION

Borehole # 4
Well # VE-1
Page 1 of 2

Philip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

Project Name EPFS JAQUEZ SVE
Project Number 628000.19 Phase 2
Project Location JAQUEZ GAS COM E #1

Elevation
Borehole Location
GWL Depth
Logged By C. CULLICOTT
Drilled By R. Padilla; D. PADILLA
Date/Time Started 8/12/99 2:25pm
Date/Time Completed 8/12/99 3:45pm

Well Logged By C. CULLICOTT
Personnel On-Site R. PADILLA; D. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Drilling Method AUGER
Air Monitoring Method PID

Depth (Feet)		Sample Interval	Sample Type & Recovery (inches)	Sample Description Classification System: USCS	USCS Symbol	Depth Lithology Change (feet)	Air Monitoring Units: NDU BZ	BH	S	Drilling Conditions & Blow Counts
0	1	0-18"		POORLY SORTED SAND W/ 1" CLAY SEAM @ ~9". FROM THERE, LOOSE, COARSER, POORLY SORTED SAND TO 18"						① 11 BLOWS
	②	18"-3½'		② LOOSE SAND TO 24", then 5" thick clay seam, STIFF, W/ SAND & SILT. BELOW, LOOSE, POORLY SORTED MEDIUM SAND TO 3½'. TAN						② 20 BLOWS
		3½'-5'								
5	③									③
	④	5-6½'								④ 5 BLOWS
	⑤	6½'-8'								⑤ 8 BLOWS
	⑥	8'-10'								
10				③ AS ABOVE TO 5'						
TD				④ AS ABOVE TO 6', then coarser & better sorted. TO 6½'						
15				⑤ 6½'-7', STIFF CLAYEY SAND, DAMP. 7-8½' POORLY SORTED SAND, DAMP.						
20				⑥ POORLY SORTED SAND, COARSENS WITH DEPTH. WETTER WITH DEPTH						
25				TD 11'						
30				NO CONTAMINATION DETECTED VISUALLY						
35										
40										

Comments:

Geologist Signature Cathy Cullicott

MONITORING WELL INSTALLATION RECORD

Philip Environmental Services Corp.
4000 Monroe Road
Farmington, New Mexico 87401
(505) 326-2262 FAX (505) 326-2388

Borehole # 4
Well # VE-1
Page 2 of 2

Project Name EPFS JAQUEZ SWD
Project Number 62800019 Phase 2
Project Location JAQUEZ GAS COM E #1

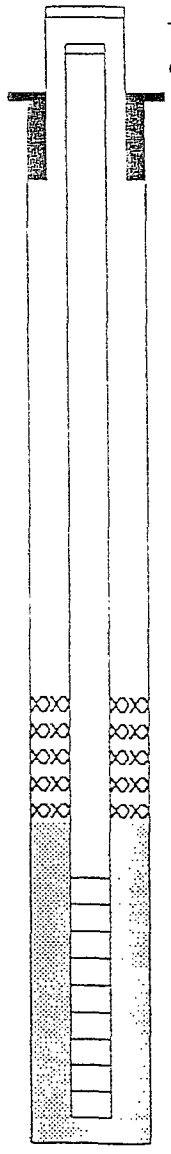
Elevation
Well Location
GWL Depth
Installed By K. PADILLA, D. PADILLA

Date/Time Started 8/12/99 2:25pm
Date/Time Completed 8/12/99 3:45 pm

On-Site Geologist C. CULLICOTT
Personnel On-Site K. PADILLA, D. PADILLA
Contractors On-Site Ø
Client Personnel On-Site Ø

Depths in Reference to Ground Surface

Item	Material	Depth
Top of Protective Casing		
Bottom of Protective Casing		
Top of Permanent Borehole Casing		
Bottom of Permanent Borehole Casing		
Top of Concrete		
Bottom of Concrete		
Top of Grout		GS
Bottom of Grout		3'
Top of Well Riser	2"	+
Bottom of Well Riser	2"	6'
Top of Well Screen	2"	6'
Bottom of Well Screen	2"	11'
Top of Peltonite Seal	BENTONITE	3'
Bottom of Peltonite Seal	CHIPS	5'
Top of Gravel Pack	CO SAND	5'
Bottom of Gravel Pack	"	11'
Top of Natural Cave-In		
Bottom of Natural Cave-In		
Top of Groundwater		
Total Depth of Borehole		11'



Top of Protective Casing
Top of Riser
Ground Surface

HOLE PLUG LAST 1 1/2' TO GS

Top of Seal 3'
Top of Gravel Pack 5'
Top of Screen 6'
Bottom of Screen 11'
Bottom of Borehole 11'

Comments:

Geologist Signature Cathy Cullicott

APPENDIX B

Exhaust Analytical

PINNACLE LABORATORIES

2709-D Pan American Freeway NE
Albuquerque, New Mexico 87107
Phone (505) 344-3777
Fax (505) 344-4413

Pinnacle Lab ID number **908090**
August 26, 1999

PHILIP ENVIRONMENTAL
4000 MONROE ROAD
FARMINGTON, NM 87401

Project Name Jaquez SVE
Project Number 62800019

Attention: A WENITO

On 8/25/99 Pinnacle Laboratories, Inc. Inc., (ADHS License No. AZ0592), received a request to analyze **air** samples. The samples were analyzed with EPA methodology or equivalent methods. The results of these analyses and the quality control data, which follow each set of analyses, are enclosed.

If you have any questions or comments, please do not hesitate to contact us at (505)344-3777.

Kimberly D. McNeill
Project Manager

H. Mitchell Rubenstein, Ph. D.
General Manager

MR: mt

Enclosure

PINNACLE LABORATORIES

2709-D Pan American Freeway NE
Albuquerque, New Mexico 87107
Phone (505) 344-3777
Fax (505) 344-4413

CLIENT	: PHILIP ENVIRONMENTAL	PINNACLE ID	: 908090
PROJECT #	: 62800019	DATE RECEIVED	: 8/25/99
PROJECT NAME	: Jaquez SVE	REPORT DATE	: 8/26/99

PIN I.D. #	CLIENT DESCRIPTION	MATRIX	DATE COLLECTED
1	62800019-8-24-99	AIR	8/24/99

PINNACLE LABORATORIES

2709-D Pan American Freeway NE
Albuquerque, New Mexico 87107
Phone (505) 344-3777
Fax (505) 344-4413

GAS CHROMATOGRAPHY RESULTS

TEST : EPA 8021 MODIFIED / 8015 GRO
CLIENT : PHILIP ENVIRONMENTAL PINNACLE I.D.: 908090
PROJECT # : 62800019
PROJECT NAME : Jaquez SVE

SAMPLE ID. #	CLIENT I.D.	MATRIX	DATE SAMPLED	DATE EXTRACTED	DATE ANALYZED	DIL. FACTOR
01	62800019-8-24-99	AIR	8/24/99	NA	8/25/99	1

PARAMETER	DET. LIMIT	UNITS	62800019-8-24-99
FUEL HYDROCARBONS	5.0	**MG/M ^{3}**	**150**
HYDROCARBON RANGE			**C6-C14**
HYDROCARBONS QUANTITATED USING			**GASOLINE**
BENZENE	0.05	MG/M ^{3}	< 0.05
TOLUENE	0.05	MG/M ^{3}	< 0.05
ETHYLBENZENE	0.05	MG/M ^{3}	< 0.05
TOTAL XYLENES	0.05	MG/M ^{3}	< 0.05
SURROGATE:			
BROMOFLUOROBENZENE (%)			103
SURROGATE LIMITS	(74 - 120)		

CHEMIST NOTES:
N/A

PINNACLE LABORATORIES

2709-D Pan American Freeway NE
Albuquerque, New Mexico 87107
Phone (505) 344-3777
Fax (505) 344-4413

GAS CHROMATOGRAPHY RESULTS
REAGENT BLANK

TEST	: EPA 8021 MODIFIED / 8015 GRO		
BLANK I.D.	: 082599	PINNACLE I.D.	: 908090
CLIENT	: PHILIP ENVIRONMENTAL	DATE EXTRACTED	: NA
PROJECT #	: 62800019	DATE ANALYZED	: 8/25/99
PROJECT NAME	: Jaquez SVE	SAMPLE MATRIX	: AIR

PARAMETER	UNITS	
FUEL HYDROCARBONS	MG/M ^{3}	<5.0
HYDROCARBON RANGE	C6-C14	-
HYDROCARBONS QUANTITATED USING	GASOLINE	-
BENZENE	MG/M ^{3}	<0.05
TOLUENE	MG/M ^{3}	<0.05
ETHYLBENZENE	MG/M ^{3}	<0.05
TOTAL XYLENES	MG/M ^{3}	<0.05
SURROGATE:		
BROMOFLUOROBENZENE (%)		103
SURROGATE LIMITS (80 - 120)		

CHEMIST NOTES:
N/A

PINNACLE LABORATORIES

2709-D Pan American Freeway NE
Albuquerque, New Mexico 87107
Phone (505) 344-3777
Fax (505) 344-4413

GAS CHROMATOGRAPHY QUALITY CONTROL
MSMSD

TEST	: EPA 8021 MODIFIED / 8015 GRO		
MSMSD #	: 082599	PINNACLE I.D.	: 908090
CLIENT	: PHILIP ENVIRONMENTAL	DATE EXTRACTED	: NA
PROJECT #	: 62800019	DATE ANALYZED	: 8/25/99
PROJECT NAME	: Jaquez SVE	SAMPLE MATRIX	: AIR
		UNITS	: MG/M

PARAMETER	SAMPLE RESULT	CONC SPIKE	SPIKED SAMPLE	% REC	DUP SPIKE	DUP % REC	RPD	REC LIMITS	RPD LIMITS
BENZENE	<0.05	2.00	2.25	113	2.06	103	9	(80 - 120)	20
TOLUENE	<0.05	2.00	2.39	120	2.09	105	13	(80 - 120)	20
ETHYLBENZENE	<0.05	2.00	2.27	114	2.05	103	10	(80 - 120)	20
TOTAL XYLENES	<0.05	6.00	6.92	115	6.12	102	12	(80 - 120)	20

CHEMIST NOTES:
N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative Percent Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

PHILIP ENVIRONMENTAL

Chain of Custody Record

908090

4000 Monroe Road
Farmington, NM 87401
(505) 326-2262 Phone
(505) 326-2388 FAX

COC Serial No. C 2434

Project Name Jaquez SVE

Project Number 62800019 Phase . Task

Samplers A Werito

Laboratory Name Pinnacle Labs

Location Albuquerque, NM

Sample Number (and depth)	Date	Time	Matrix	Total Number of Bottles	Type of Analysis and Bottle: TPH	BTEX	Lab ID	Comments
62800019-8-24-99	8-24-99	9:59	Air	2	✓	✓	01	

Relinquished by:

Signature	Date	Time
A Werito	8-24-99	

Received By:

Signature	Date	Time
Francine Smiw	8/25/99	1420

Samples Iced: ☐ Yes ☐ No

Carrier:

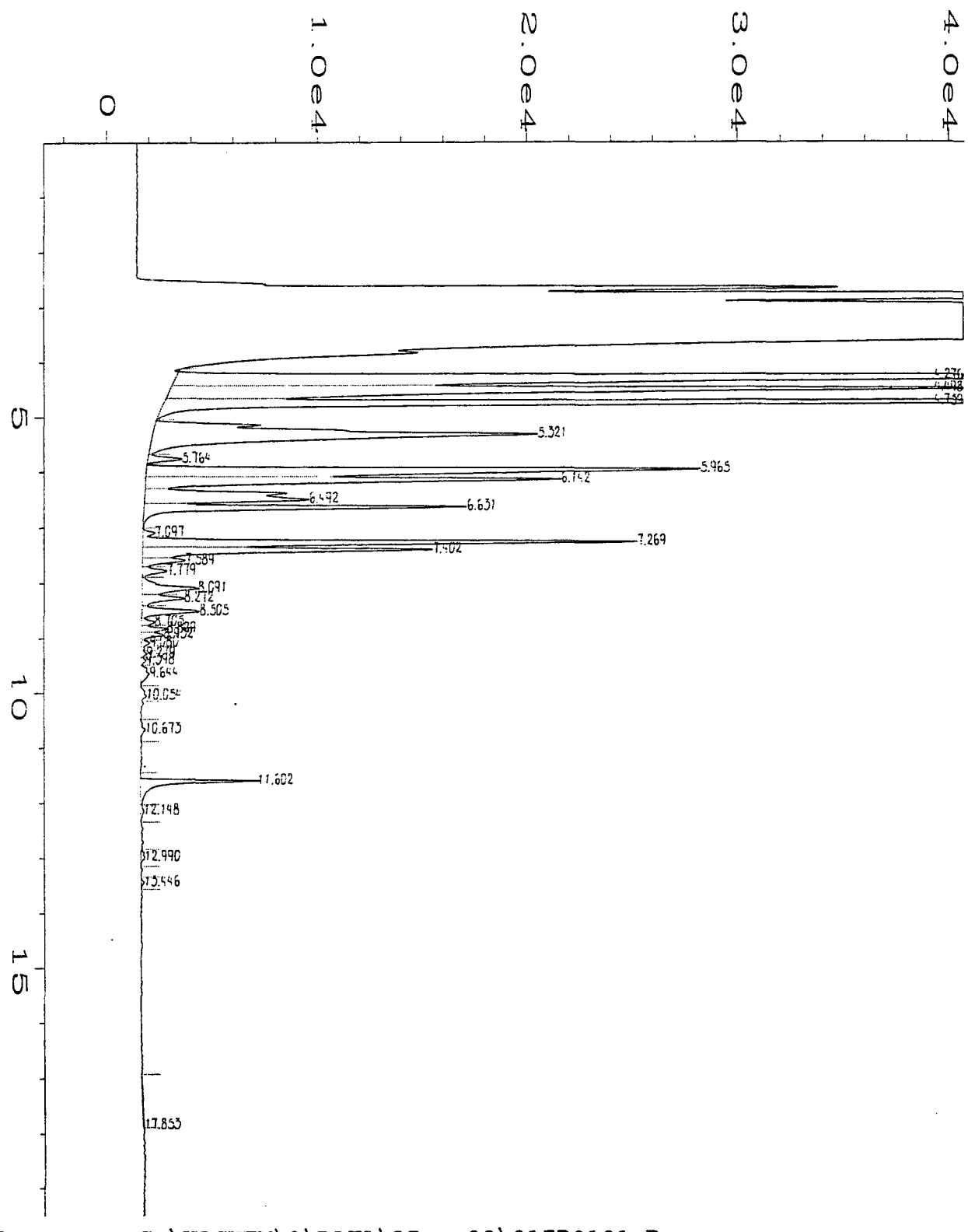
Airbill No.

Preservatives (ONLY for Water Samples)

- ☐ Cyanide ..... Sodium hyroxide (NaOH)
- ☐ Volatile Organic Analysis ..... Hydrochloric acid (HCl)
- ☐ Metals ..... Nitric acid (HNO_3)
- ☐ TPH (418.1) ..... Sulfuric acid (H_2SO_4)
- ☐ Other (Specify) _____
- ☐ Other (Specify) _____

Shipping and Lab Notes:

PE-176 4/95



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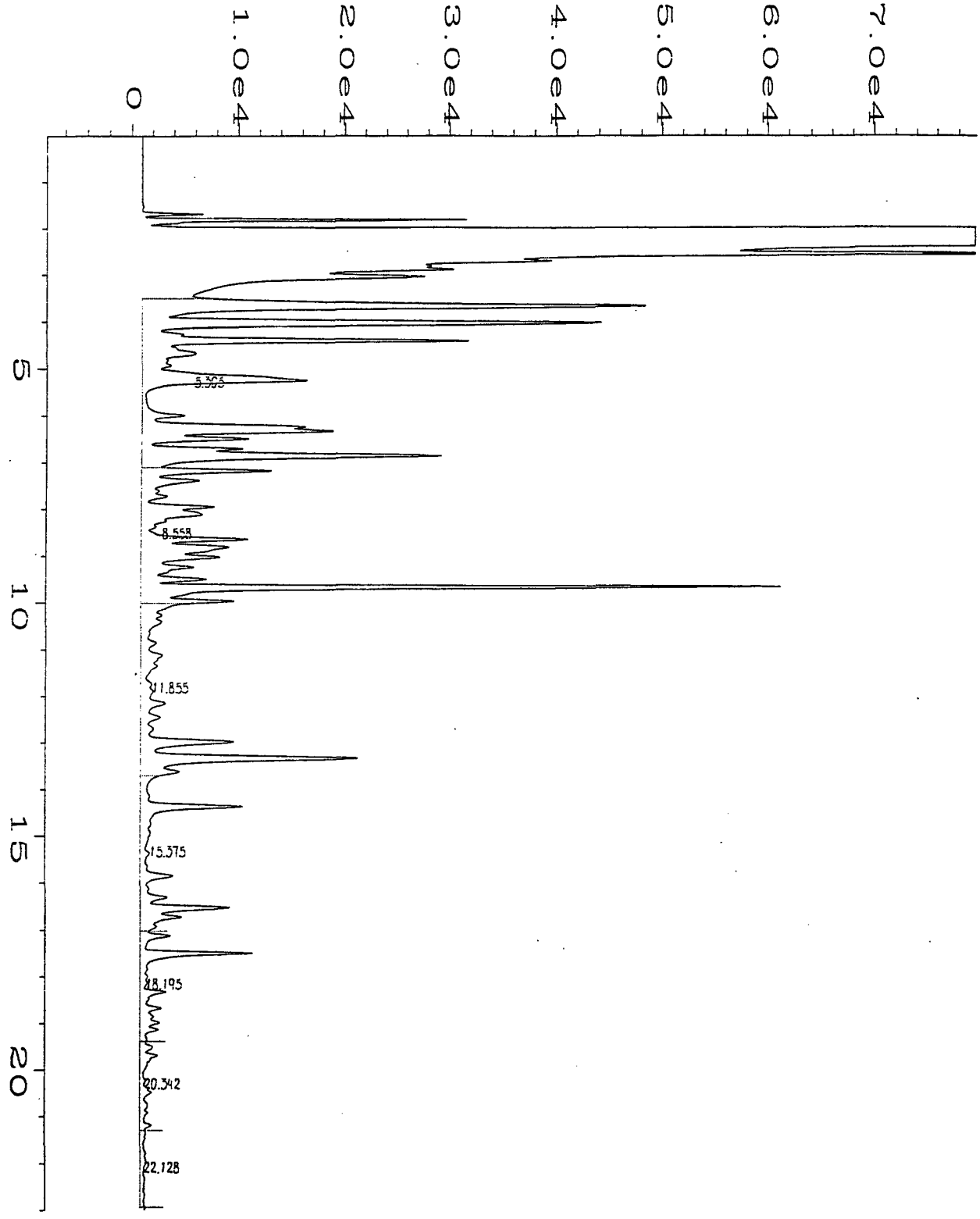
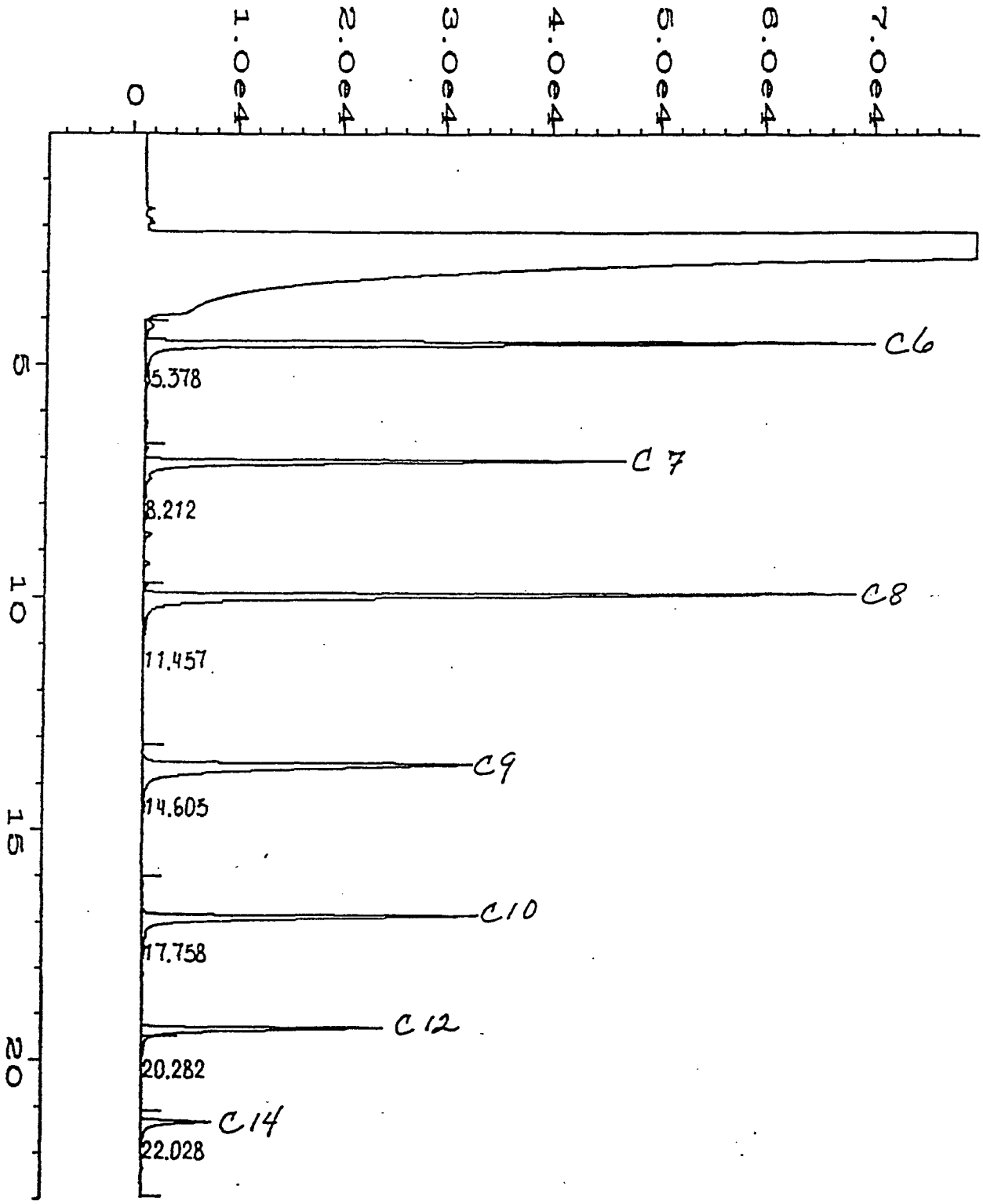
Operator : Pinnacle Labs : MBT
Instrument : PID-FID1
Sample Name : 908090-01 air
Run Time Bar Code:
Acquired on : 25 Aug 99 05:24 PM
Report Created on: 25 Aug 99 05:44 PM

Page Number : 1
Vial Number : 17
Injection Number : 1
Sequence Line : 1
Instrument Method: BTX0727.MTH
Analysis Method : GAS0727x.MTH



Data File Name : C:\HPCHEM\2\DATA\12MAY99\001R0101.D
Operator : Pinnacle Labs : MB
Instrument : PID-FID1
Sample Name : GC2-77-03 gas
Run Time Bar Code:
Acquired on : 12 May 99 07:15 AM
Report Created on: 12 May 99 07:40 AM

Page Number : 1
Vial Number : 1
Injection Number : 1
Sequence Line : 1
Instrument Method: BTX0324.MTH
Analysis Method : GAS0125A.MTH



a File Name : C:\HPCHEM\2\DATA\25JAN99\025R0101.D
rator : Pinnacle Labs : MB
strument : PID-FID1
ple Name : RETENTION STD
Time Bar Code:
quired on : 26 Jan 99 01:20 AM
port Created on: 04 Feb 99 03:57 PM

Page Number : 1
Vial Number : 25
Injection Number : 1
Sequence Line : 1
Instrument Method: BTX0125.MTH
Analysis Method : GAS0125.MTH

APPENDIX C

Field Data Sheets

Job #62800019

Date 8-19-99

SVE Pilot Test
Soil Gas Permeability by Soil Venting
EPFS Jaquez
FDS #1

Monitoring Point=MP1			**Test Point= SVE**		
Time test started=10:10PM			Time test completed=12:10		
Elapsed Time (minutes)	Pressure/Vacuum Readings " H2O		Comments		
0	0.000		O2	CO2	CH4
1	0.080		10.2	6.7	0
2	0.135				
3	0.150				
4	0.155				
5	0.155				
6	0.160				
7	0.145				
8	0.150				
9	0.155				
10	0.150				
12	0.140				
14	0.140				
16	0.130				
18	0.130				
20	0.135				
23	0.140				
26	0.130				
29	0.140				
32	0.140				
35	0.140				
38	0.140				
41	0.135				
44	0.140				
47	0.140				
50	0.140				
53	0.140				
56	0.140				
59	0.135				
90	0.140				
120	0.145		O2	CO2	CH4
			10.5	6.2	0.2
			Page 1 of 1		

J:\62800019\SVEfrm-MP1

Job #62800019

Date 8-19-99

SVE Pilot Test
Soil Gas Permeability by Soil Venting
EPFS Jaquez
FDS #2

Monitoring Point=MP2	Shallow	Deep	**Test Point= SVE**		
Time test started=10:10PM			Time test completed=12:10		
Elapsed Time (minutes)	Pressure/Vacuum Readings " H2O		Comments		
0		0.000	Prior to test		
1		0.500	Shallow		
2		0.110	O2	CO2	CH4
3		0.145	19.3	0.7	4.3
4		0.140			
5		0.125	Deep		
6		0.115	O2	CO2	CH4
7		0.115	20.2	0	0
8		0.150			
9	0.100	0.100			
10	0.150	0.100			
12		0.020			
14		0.100			
16		0.260			
18	0.180	0.360			
20	0.240	0.435			
23		NS			
26		0.250			
29		0.340			
32		0.420			
35		0.465			
38		0.500			
41		NS			
44		0.250			
47		NS			
50		0.355			
53		0.400			
56		0.450			
59		0.455			
90		0.450			
120		0.500	Shallow		
			O2	CO2	CH4
			7.9	7	0.4
			Deep		
			O2	CO2	CH4
			19.9	0	0.3
			Page 1 of 1		

J:\62800019\SVEfrm-MP2

Job #62800019

Date 8-19-99

SVE Pilot Test
Soil Gas Permeability by Soil Venting
EPFS Jaquez
FDS #3

Monitoring Point=MP3	Shallow	Deep	**Test Point= SVE**
Time test started=10:10PM			Time test completed=12:10
Elapsed Time (minutes)	Pressure/Vacuum Readings " H2O		Comments
0	0.000	0.000	Prior to test
1		0.500	Shallow
2		0.550	O2 CO2 CH4
3		0.500	8.7 8 0.2
4		0.400	
5		0.350	Deep
6		0.300	O2 CO2 CH4
7		0.300	0.6 8.5 18.8
8		0.250	
9		0.250	
10	1.000	0.250	
12	1.000	1.050	
14		1.050	
16		1.050	
18		1.050	
20		1.050	
23		1.050	
26		1.050	
29		1.050	
32		1.050	
35		1.050	
38		1.050	
41		1.100	
44		1.100	
47		1.100	
50		1.100	
53		1.100	
56		1.100	
59		1.100	
90		1.100	
120		1.100	After Test
			Shallow
			O2 CO2 CH4
			9.8 6.1 0.2
			Deep
			O2 CO2 CH4
			5.3 6.7 10.3
			Page 1 of 1

J:\62800019\SVEfrm-MP3

Job #62800019

Date 8-19-99

SVE Pilot Test
Soil Gas Permeability Injecting Air
EPFS Jaquez
FDS #4

Monitoring Point=MP1			**Test Point= Sparge**
Time test started=2:00PM			Time test completed=4:30 PM
Elapsed Time	Pressure/Vacuum Readings " H2O		Comments
2:05	0.005		Pump 15psi @ 3-7 CFM
2:10	0.005		
2:15	0.01		
2:20	0.015		
2:25	0.015		
2:30	0.02		
2:40	0.015		
2:50	0.03		
3:00	0.03		
3:10	0.03		
3:20	0.035		
3:45	0.038		
4:00	0.04		
4:15	0.04		4:40 PM
4:30	0.04		MP1
			O2 10.6
			CO2 6.4
			CH4 0.6
			Page 1 of 1

J:\62800019\SpargFRM-MP1

Job #62800019

Date 8-19-99

SVE Pilot Test
Soil Gas Permeability Injecting Air
EPFS Jaquez
FDS #5

Monitoring Point=MP3	Shallow	Deep	**Test Point= Sparge**
Time test started=2:00PM			Time test completed=
Elapsed Time	Pressure/Vacuum Readings " H2O		Comments
2:05	0.015	0.01	
2:10	0.015	0.01	
2:15	0.015	0.01	
2:20	0.015	0.01	
2:25	0.015	0.015	
2:30	0.015	0.015	
2:40	0.02	0.025	
2:50	0.02	0.025	
3:00	0.02	0.03	
3:15	0.04	0.03	
3:30	0.03	0.03	
3:45	0.03	0.03	
4:00	0.03	0.03	
4:15	0.03	0.02	4:55 PM
4:30	0.03	0.03	MP3 Shallow Deep
			O2 7.3 7.3
			CO2 8.3 6.1
			CH4 0.4 9.1
			5:00 PM
			MP2 Shallow Deep
			O2 19.6 13.8
			CO2 0.2 5.2
			CH4 1.1 0.3
			5:05 PM
			O2 18.8
			CO2 1.3
			CH4 0.2
			Page 1 of 1

J:\62800019\SpargFRM-MP3

Job 62800019

Date: 8-24 25-29

O2 Utilization Test
for
In Situ Respiration
FDS #6

Monitoring Point=				**Test Point=**		
Time test started=8:30 am				Time test completed=		
Elapsed Time		Shallow	Deep	02	CO2	CH4
Turn sparge system off 8-23-99 @ 6pm.						
Begin collecting data 8-24-99.						
13 hrs	MP1			10.7	3.6	0
13 hrs	MP2	Shallow		3.7	12.5	106.9
13 hrs			Deep	0.4	6.6	104
13 hrs	MP3	Shallow		5.7	9.5	1
13 hrs			Deep	9.7	0.6	0
13 hrs	SP-01			5.7	9.5	6
13 hrs	R-04			19.8	0	0.5
13 hrs	R-01			18.4	0	0
13 hrs	R-03			15.6	0.5	97.8
15 hrs	MP1			10	3.8	6
15 hrs	MP2	Shallow		3.5	13	104.6
15 hrs			Deep	1	9.2	110
15 hrs	MP3	Shallow		5.5	9.8	13
15 hrs			Deep	8.5	3	20
17 hrs	MP1			9.2	3.6	4
17 hrs	MP2	Shallow		3.1	8.8	20
17 hrs			Deep	2.8	3.6	18
17 hrs	MP3	Shallow		5.3	9	12
17 hrs			Deep	8.2	3.1	6
8/25/99						
24 hrs	MP1			7.7	4.8	>150
24 hrs	MP2	Shallow		1.3	8.6	>150
24 hrs			Deep	5.9	6.5	>150
24 hrs	MP3	Shallow		2.9	10.8	8.1
24 hrs			Deep	0.1	9.4	>150
31 hrs	MP1			12.2	2.6	>150
31 hrs	MP2	Shallow		9.9	4.5	0
31 hrs			Deep	7	5.9	>150
31 hrs	MP3	Shallow		3.4	10.7	1.4
31 hrs			Deep	3.7	7.8	>150
	R-01	DO-.25				
	R-02	DO-.31				
	R-03	DO-.27				
	R-04	DO-.27				

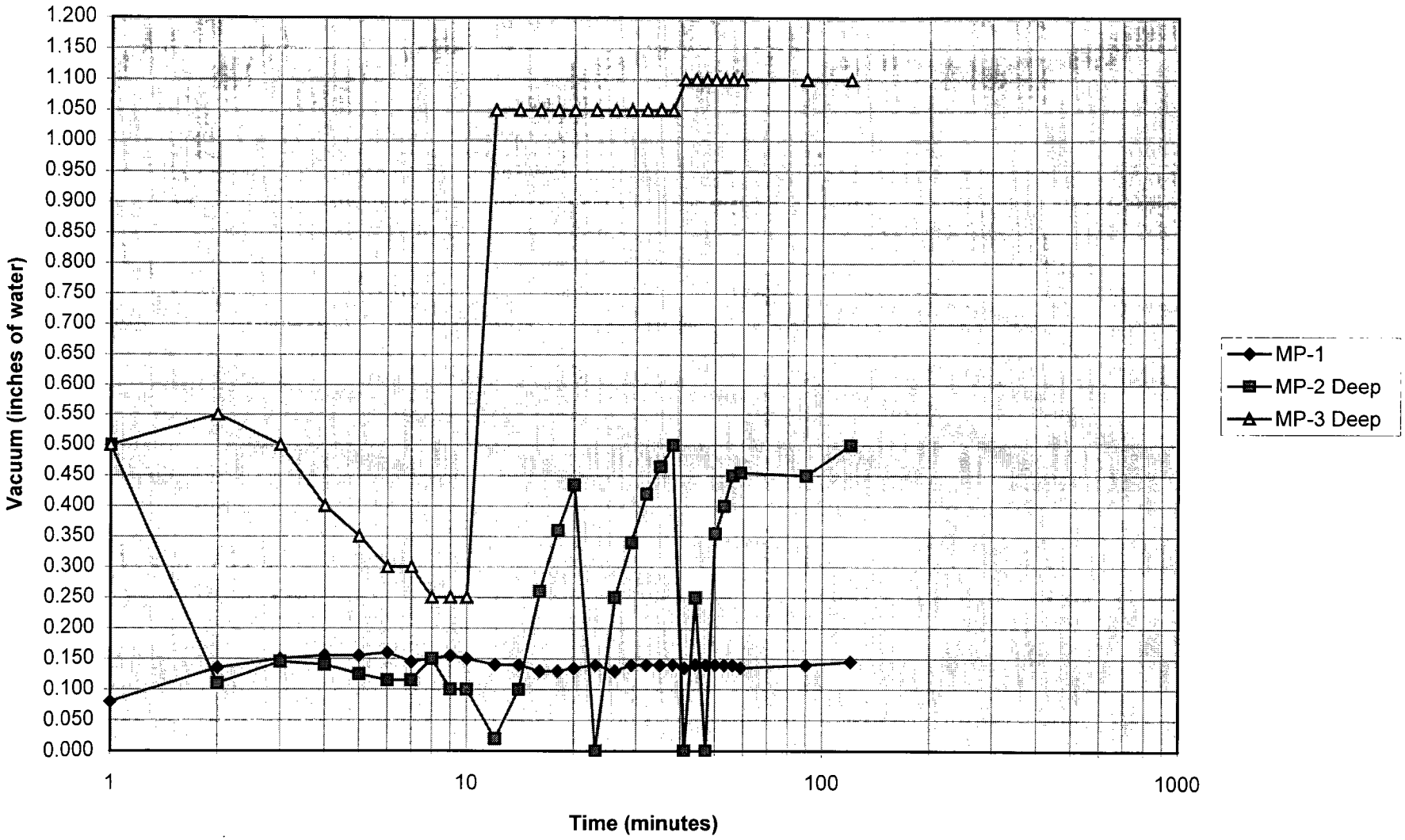
DO=Dissolved Oxygen

J:\62800019\O2FRM1

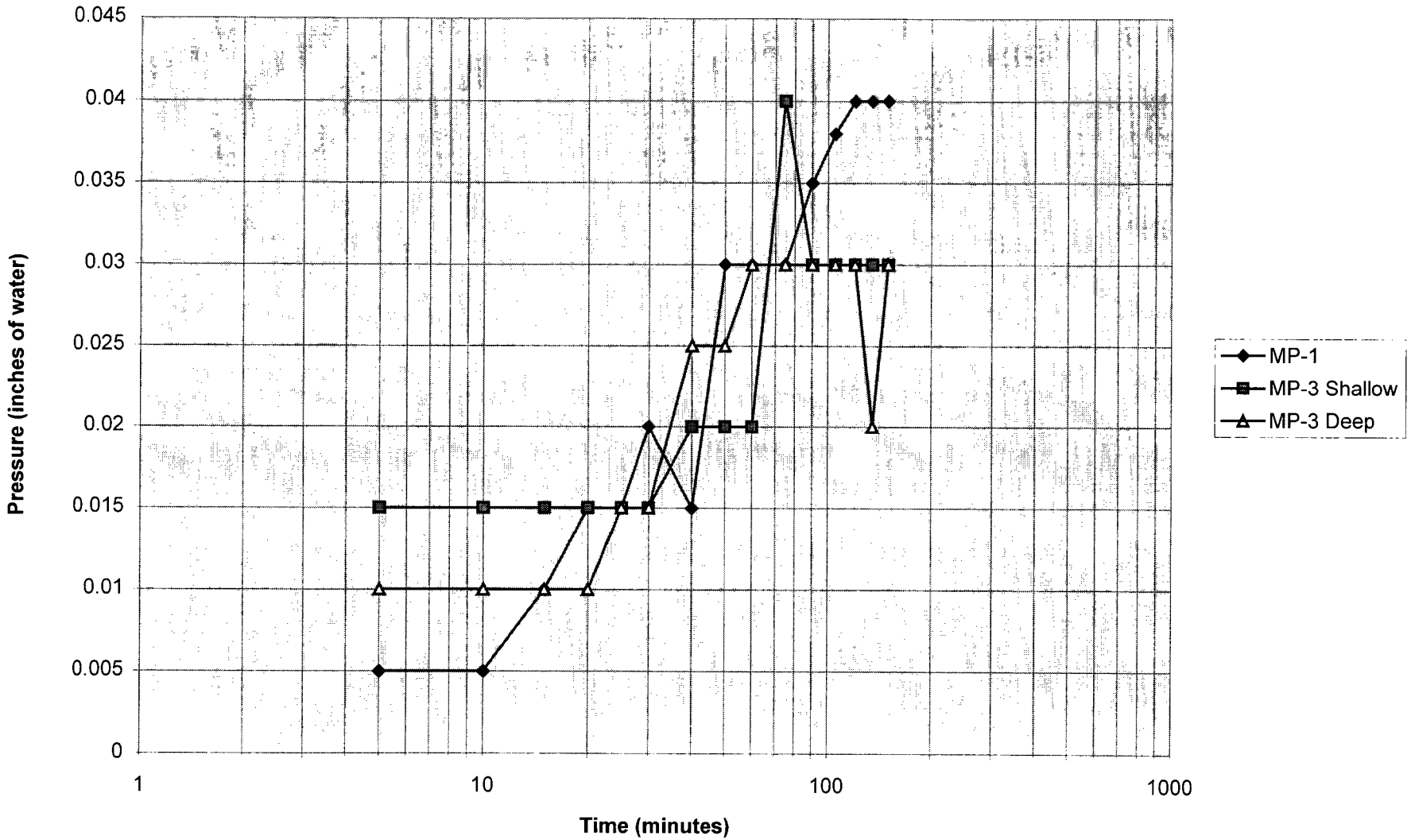
APPENDIX D

Charts

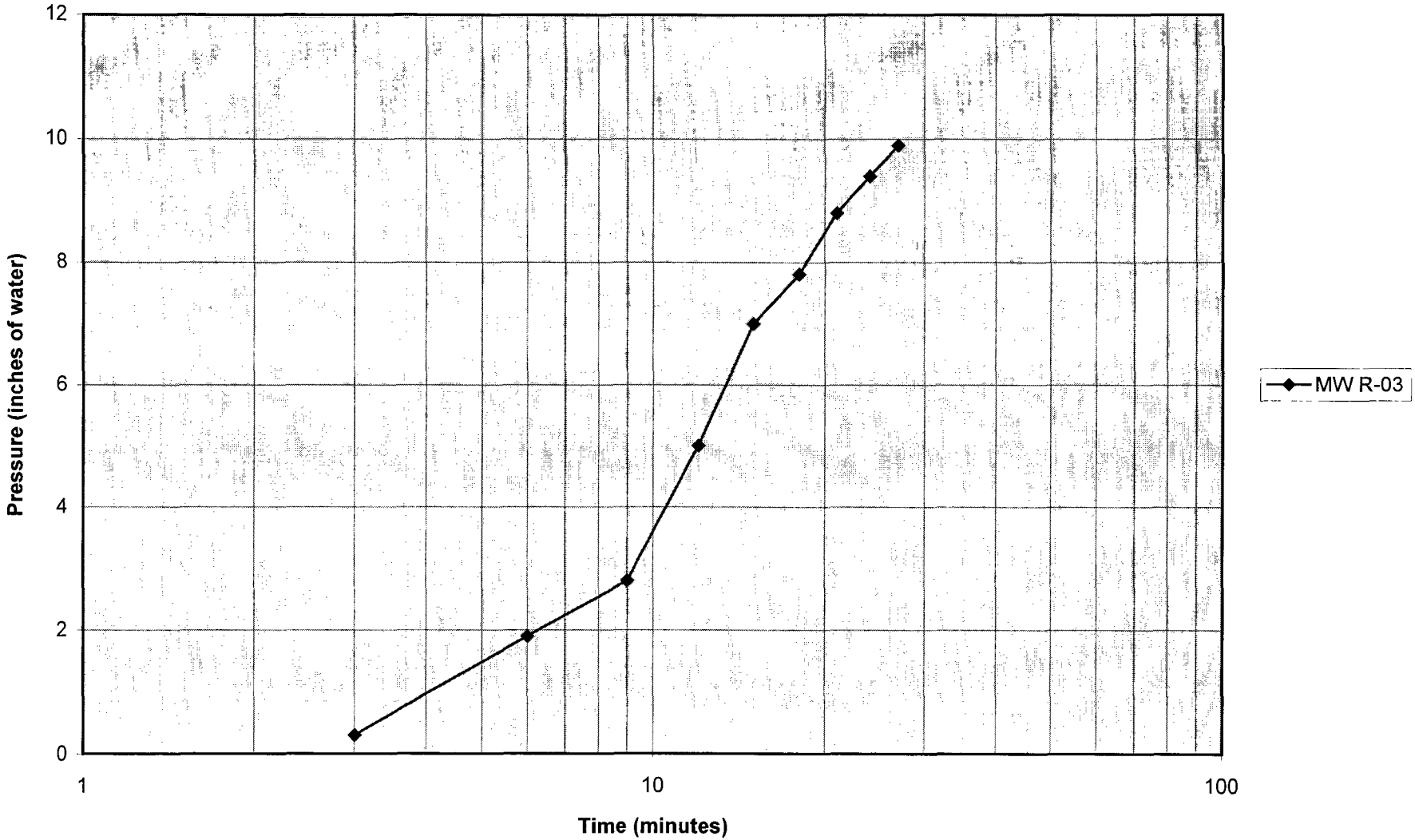
Soil Gas Permeability (SVE) - Chart 1



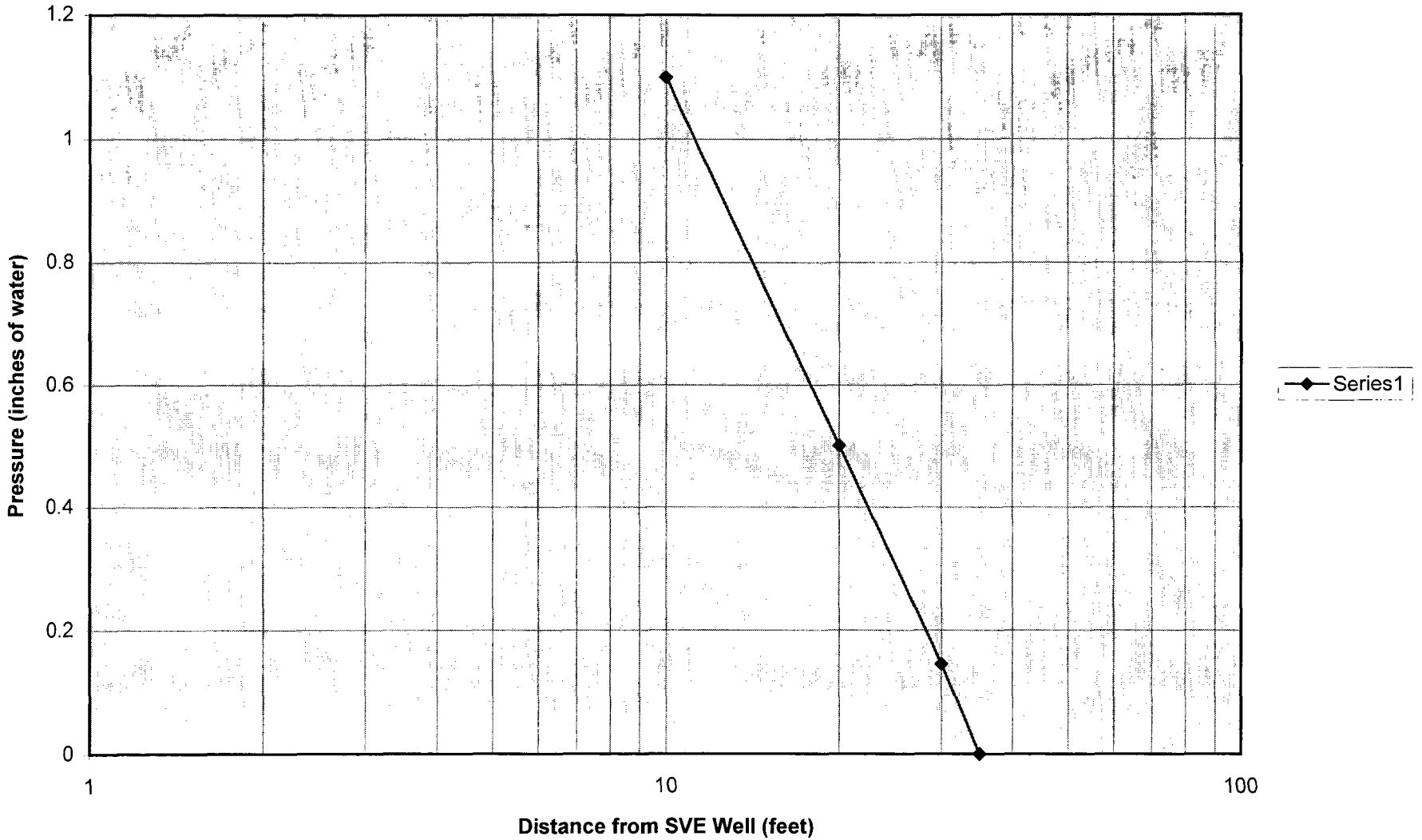
Soil Gas Permeability (Sparging) - Chart 2



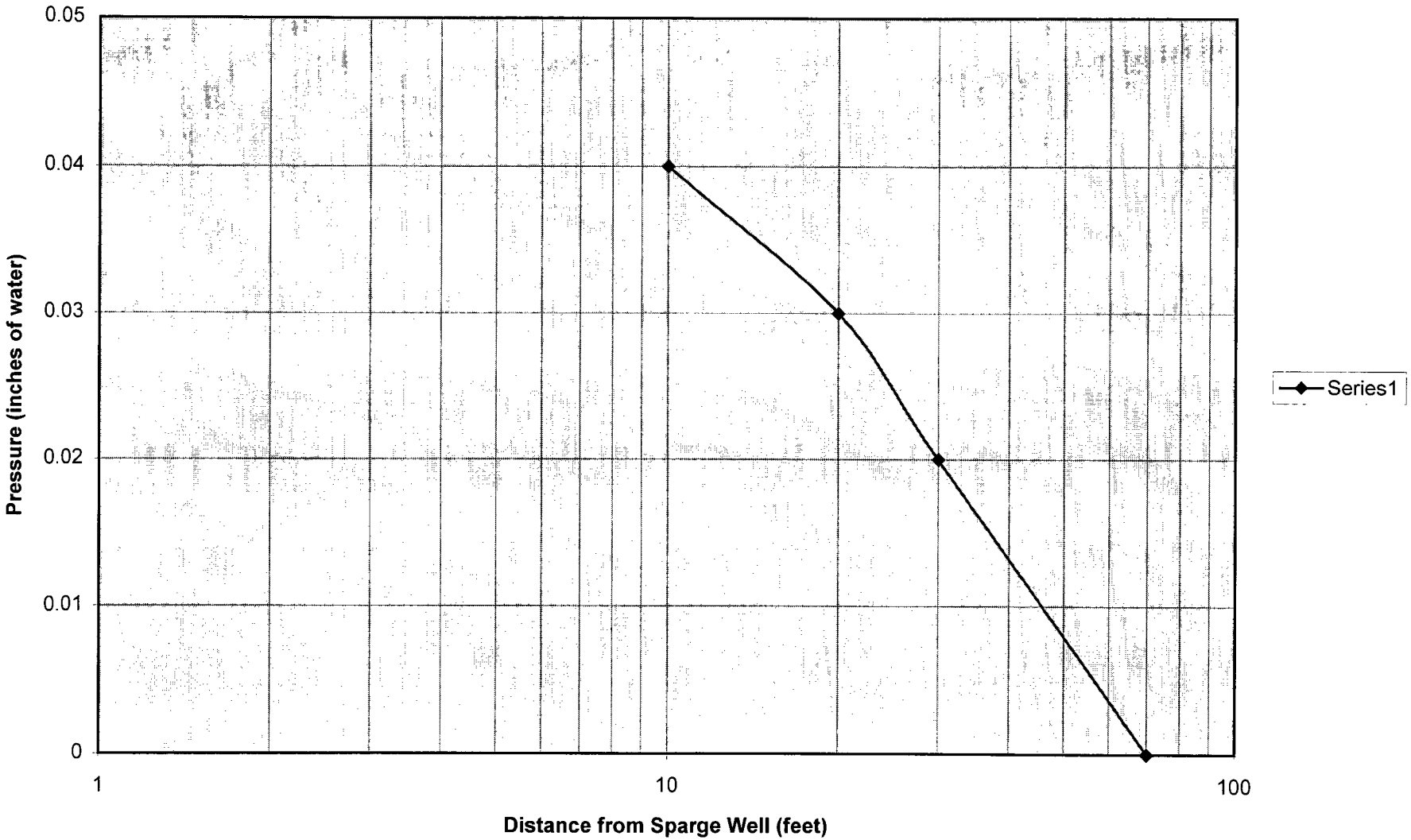
Sparge Effects on MW R-03 - Chart 3

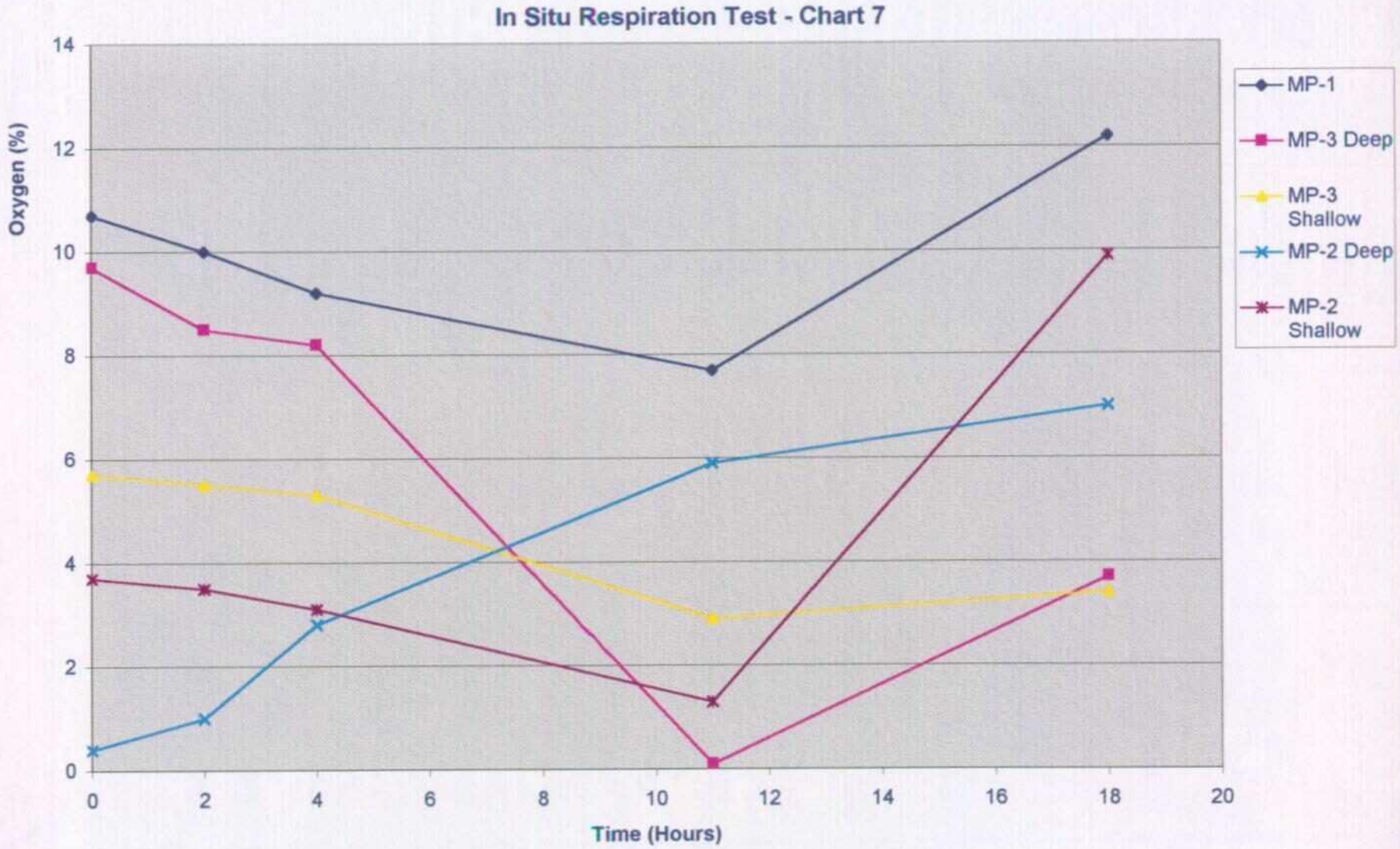


Calculated Radius of Influence (SVE) - Chart 4



Calculated Radius of Influence (Sparge) - Chart 5




In Situ Respiration Test - Chart 7
Oxygen (%)
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Time (Hours)
MP-1
MP-3 Deep
MP-3 Shallow
MP-2 Deep
MP-2 Shallow

APPENDIX E

Calculation Sheets

Calculation Sheet #1
Static Test - Soil Vapor Extraction Data
for monitoring points MP-1 and MP-3

$$K = \frac{Q^* u^* \mathrm{Ln}(Rw/Ri)}{H^* Pi^* P_w(1-(P_{atm}/P_w)^2)}$$

where

Q=	volumetric flow rate for the vent well (cm^3/s)
u=	viscocity of air ($1.8 * 10^{-4}$ g/cm-s @18° C)
R_w=	radius of venting well (cm)
R_i=	radius of venting influence at steady state (cm)
H=	depth of screen (cm)
Pi=	3.14
P_w=	absolute pressure at the venting well (g/cm-s2)
P_{atm}=	ambient pressure ($g/cm\text{-}s^2$)

Conversion Steps

Q=	30 cfm=	.5cfs=	.001416m^3/s=	**1416 cm3/s**
u=	**1.8 * 10-4**	**g/cm-s**		
R_w=	1"=	**2.54 cm**		
R_i=	35'=	10.668 meters=		**1066.8 cm**
H=	5'=	1.524 meters=		**152.4 cm**
Pi=				**3.14**
P_w=	50" water=	.1265 Kg/cm^2=		126.5g/cm^2
to figure absolute (not measured)			=820-126.5=	**= 693.5 g/cm2**

P_{atm}= $P_{surf}*e^{-h/H}$= 1bar*$e^{-1.52/7}$ =.8bars = .82 Kg/cm^2

= 820 g/cm2

-1.53954 / -132082 = 1.166E-05 cm^2= **11.6darcy**

Calculation Sheet #2
Dynamic Test - Soil Vapor Extraction Data
for monitoring points MP-2

$$K = \frac{Q*u}{4*A*Pi*m}$$

where

Q=	volumetric flow rate for the vent well (cm^3/s)		
u=	viscocity of air ($1.8 * 10^{-4}$ g/cm-s @18^{o} C)		
m=	length of screen (cm)	**182.88**	**cm**
Pi=	3.14		
A=	slope of Pressure vs Ln (time)	**0.145**	unitless
u=		**1.8 * 10-4**	**g/cm-s**

Conversion Steps

Q=	30 cfm=	.5cfs=	.001416m^3/s=	**1416**	**cm3/s**

$$\frac{0.25488}{333.0611} = 0.0007653\ cm^2 =$$ **765** darcy

Results are meaningless and make no sense, monitoring point MP-2 was partially plugged.

Calculation Sheet #3
Dynamic Test - Aquifer Sparging Data
Slope (A) is from P vs Ln(T) from Monitor Well R-03

$$K = \frac{Q*u}{4*A*Pi*m}$$

where

Q=	volumetric flow rate for the vent well (cm^3/s)		
u=	viscocity of air (1.8 * 10-4 g/cm-s)	**0.00018**	g/cm-s
m=	length of screen (cm)	**182.88**	**cm**
Pi=	**3.14**		
A=	slope of Pressure vs Ln (time)	**3**	unitless

Conversion Steps

Q=	30 cfm=	.5cfs=	.001416m^3/s=	**1416**	**cm3/s**

$$\frac{0.25488}{6890.918} = 3.699E\text{-}05\ cm^2 =$$ **36.9** darcy

This test is restricted to the flowing sand aquifer within which the monitor wll and the sparge well are completed.

Calculation Sheet #4
Static Test - Air Sparging Data
for monitoring points MP-1. MP-2 and MP-3

$$K = \frac{Q^{*}u^{*}\ Ln(Rw/Ri)}{H^{*}Pi^{*}P_{w}(1-(P_{atm}/P_{w})^{2})}$$

where

Q=	volumetric flow rate for the vent well (cm^3/s)
u=	viscocity of air ($1.8 * 10^{-4}$ g/cm-s @18° C)
R_w=	radius of venting well (cm)
R_i=	radius of venting influence at steady state (cm)
H=	depth of screen (cm)
Pi=	3.14
P_w=	absolute pressure at the venting well (g/cm-s2)
P_{atm}=	ambient pressure ($g/cm-s^2$)

Conversion Steps

Q=	30 cfm=	.5cfs=	.001416m^3/s=	**1416 cm3/s**
u=	**1.8 * 10-4**	**g/cm-s**		
R_w=	1"=	**2.54 cm**		
R_i=	70'=	21.336 meters=		**2133.6 cm**
H=	5'=	1.524 meters=		**152.4 cm**
Pi=				**3.14**
P_w=	14 psi =	.098434Kg/cm^2=		98.434g/cm^2
to figure absolute (not measured)			=820+98.43=	**918.4 g/cm2**

P_{atm}= $P_{surf}*e^{-h/H}$= 1bar*$e^{-1.52/7}$ =.8bars = .82 Kg/cm^2

820 g/cm2

$$\frac{-1.716209}{89130.75} = -1.925E\text{-}05\ cm^2 =$$ **19.2 darcy**