OUB 0028962

FINAL

TREATABILITY STUDY REPORT

OPERABLE UNIT B, POLELINE ROAD DISPOSAL AREA FORT RICHARDSON, ALASKA

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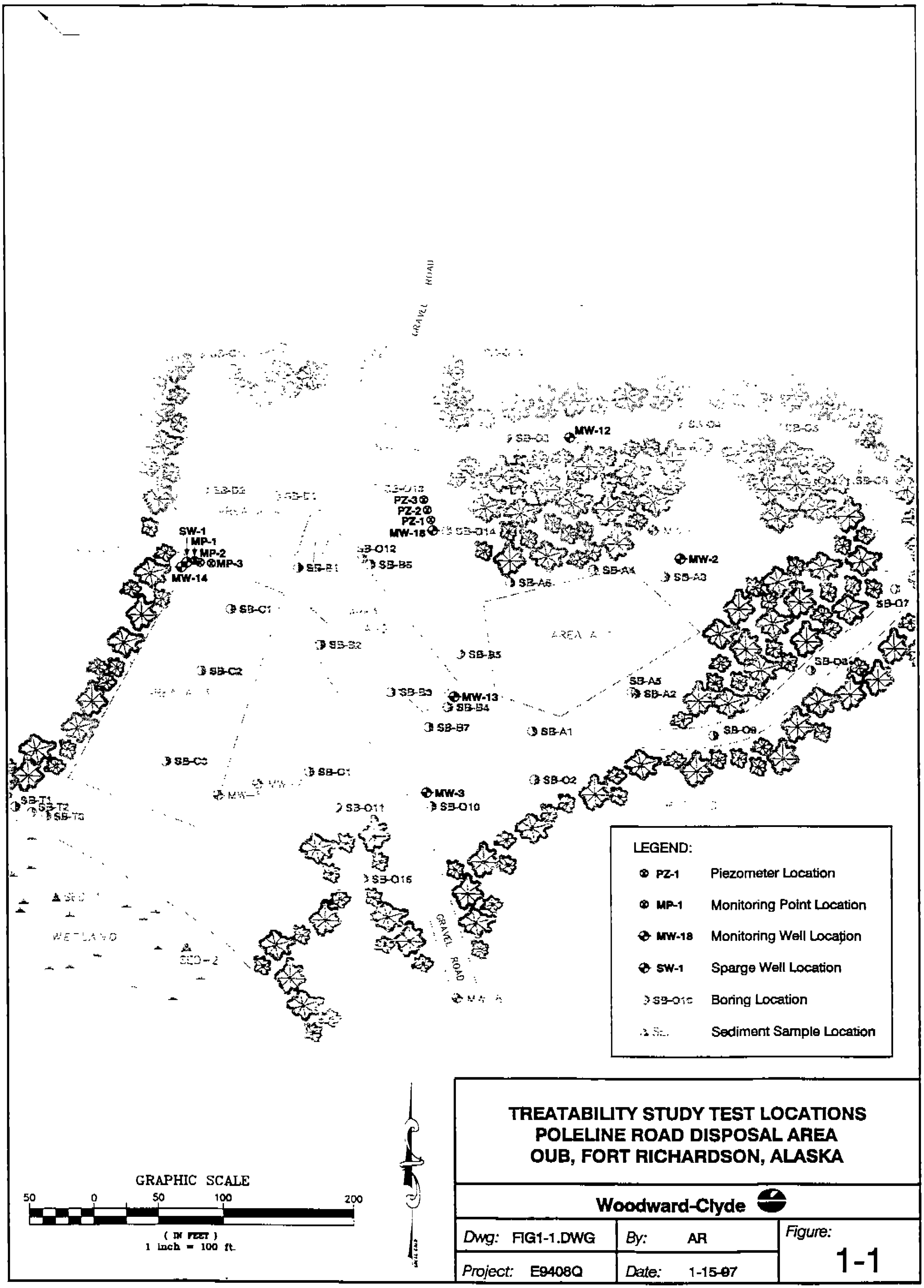
SECTIONONE Introduction

A Remedial Investigation (RI) was conducted at Operable Unit B (OUB) during August and September 1995 (Woodward-Clyde 1996a). Soil and groundwater samples collected from the main disposal area had high levels of chlorinated solvents. 1,1,2,2-tetrachloroethane was detected at 2,030 mg/kg in the soil and 1,900 mg/L in the groundwater. TCE was detected at 384 mg/kg in the soil and 220 mg/L in the groundwater. Several other chlorinated solvents were detected at significantly lower levels in both the soil and the groundwater.

Based on the results of the RI, a Feasibility Study (FS) was prepared (Woodward-Clyde 1996b). The FS identifies a number of remedial alternatives for OUB, including soil vapor extraction (SVE), air sparging (AS), natural attenuation, and groundwater pump and treat. There is a relatively high level of uncertainty in the effectiveness of some of the treatment methods proposed for the site. This Treatability Study report presents the results of several tests conducted at OUB to help reduce the uncertainty in the alternatives presented in the FS. Treatability studies were conducted to gather data concerning SVE, AS, and hydraulic conductivity of on-site soils. Groundwater samples were collected and analyzed to help evaluate which types of natural attenuation processes may be degrading contaminants in groundwater at the site. Figure 1-1 shows the locations where the treatability study was conducted.



TREATABILITY STUDY TEST LOCATIONS
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: FIG1-1.DWG	By: AR	Figure:
Project: E9408Q	Date: 1-15-97	1-1

Alternatives 4, 5 and 6 in the FS included SVE. The objective for using SVE in these alternatives is to remove the greatest amount of solvents in a timely and cost effective manner. This treatability study was done to increase our understanding of how effective an SVE system might be for remediating contaminated soil at OUB.

SVE relies on the vapor pressure characteristics of the target compounds. When a vacuum is applied to the soil gas, the target compounds will change from a liquid state to a vapor state (volatilize) more readily in response to the lowered pressure of the surrounding gas. The volatile compounds will travel in the direction of the lower pressure gradients, eventually reaching the vapor extraction well. The vapor pressures for 1,1,2,2-tetrachloroethane and trichloroethene, the target compounds, are 6 and 57.8 mm mercury (Hg) at 25°C, respectively. Chemicals with a vapor pressure greater than 0.5 mm Hg have vapor pressures high enough for soil vapor extraction to be effective.

2.1 SYSTEM SETUP

Soil gas vapors were extracted through monitoring well MW-14 (Figure 1-1). MW-14 is a 4-inch stainless-steel monitoring well screened in the perched groundwater interval. The screen extends from 9 to 19 feet (ft) below ground surface (bgs). A groundwater sampling pump was left in the well during the SVE test so that water mounding could be minimized. Figure 2-1 is a schematic of the SVE and air sparging pilot tests. A 4-inch PVC "tee" was placed at the top of the SVE well and a 10-ft. long section of 4-inch PVC pipe was connected to the side of the "tee." A pitot tube was installed into the middle of the 10-ft. long PVC pipe to measure the flow of soil gas from the well. Pitot tube measurements are only applicable when the flow has minimal turbulence. The 10-ft. section of pipe allows the turbulence to decrease to an acceptable level for pitot tube use.

A 4-inch section of flexible tubing connected the end of the 4-inch PVC pipe to the knockout tank. A second section of flexible tubing connected the knockout tank to the inlet pipe on the blower. The outlet pipe from the blower was connected to a small section of high temperature flexible tubing and then to a 10-ft. long section of PVC pipe. The last section of pipe served as the exhaust stack.

The blower for the system was a Sutorbuilt 5LL with a 20 horsepower (hp) 230/460 three-phase motor. The blower was capable of pulling nearly 190 inches of water vacuum. This blower was larger than most blowers used for SVE pilot tests, but previous information concerning soils at the site indicated that relatively small amounts of soil gas would be removed under greater than normal vacuum. The blower did not have an adjustment to vary the amount of vacuum it pulled once it was turned on. A dilution valve on the knockout tank is used to adjust the vacuum applied to the wellhead. The dilution valve was left open at the beginning of the test and then slowly closed, pulling less air from the atmosphere and more air from the well.

Temperature, vacuum, and flame ionization detector (FID) readings were collected at the wellhead. A thermometer probe mounted in the wellhead measured the temperature of the extracted soil gas. A fitting drilled into the wellhead allowed vacuum readings to be collected using a digital manometer, and also allowed air samples to be collected. A vacuum pump was connected to the fitting to pull soil gas from the wellhead. Air samples collected at the wellhead were analyzed on site with an FID or were collected into a summa canister for analysis at an analytical laboratory. Flow rate measurements were collected from the pitot tube described above.

Three monitoring points were installed adjacent to the SVE well. Each monitoring point has two soil gas sampling points and a 2-inch PVC well for water level measurements. The shallow soil gas sampling points are 10 feet bgs and the deep soil gas sampling points are 23 feet bgs. The PVC wells are screened in the shallow groundwater interval at the site. The three monitoring points are located at 10, 15 and 25 feet from the SVE well. The wells were developed and allowed to sit for several days. A bailer placed into MP-2 several days after it was developed had approximately three inches of a dark liquid in the bottom of the bailer. The dark liquid had a very strong solvent odor. This is the first nonaqueous phase liquid (NAPL) observed at the site. Since the liquid was found at the bottom of the well, it can be more accurately described as a dense nonaqueous phase liquid (DNAPL).

2.2 DATA

Data were recorded during the SVE test at least once every four hours and more frequently at the beginning of the test. Generally, the readings were recorded just before the high water level in the knockout tank caused the pressure relief valve to trip. When this occurred, the test was interrupted until the water was pumped or drained from the knockout tank. The test was restarted within one hour of shut-down, with the exception of two extended intervals to remove ice build-up in the system. Data recorded during the SVE test are shown in Table 2.1.

Wellhead vacuum versus time is displayed in Figure 2-2. A step test was performed during the first day of the SVE test (Figure 2-3). The vacuum started at 33.7 inches of water even with the dilution valve fully opened. The vacuum was stepped at increments of approximately 10 to 12 inches of water, and the digital manometers were zeroed before each pressure reading. Measurable flow rates were not observed until the vacuum was increased to 45 inches of water. The step test continued until the vacuum reached 120 inches of water. Once the step test was finished, the vacuum was set at 100 inches of water. The vacuum decreased significantly the last day of the test. This change may have been a result of the air sparge test which was conducted during this same time period or it may have been from ice build-up in the piping. When the system was shut down, the pipe leading from the wellhead to the knockout tank was almost completely blocked with ice.

The extracted soil gas flow rate versus time is displayed in Figure 2-4. The very high and very low anomalies in the graphs are probably attributable to ice build-up on the pitot tube. The average flow rate appears to be approximately 183 cubic feet per minute (CFM).

FID readings versus time are displayed in Figure 2-5. The lack of data during the middle of the test is due to ice build-up in the air sampling port. The sampling procedure was altered once the ice build-up was detected. The average FID readings appear to be between 40 and 60 ppm, and generally decrease throughout the test. The average FID reading is 45 ppm.

2.2.1 Radius of Influence

Soil gas sampling points were installed at two depths in each of the three monitoring points, for a total of six soil gas monitoring points. Vacuum readings were measured in the soil gas monitoring points during the SVE test. Table 2.2 presents the vacuum measurements recorded at the monitoring points. Only the shallow soil gas points at MP-2 and MP-3 had measurable vacuum readings. The shallow point at MP-1 may have been installed in a clay layer or sealed with bentonite during installation. The shallow points are located about 10 feet bgs. The deep sampling points are located at approximately 23 feet bgs. These data are presented in Figures 2-6 and 2-7.

2.2.2 Air Sparging

Air was injected into the shallow groundwater using a five horsepower blower. The blower was connected to a 4-inch carbon steel well with a screened section from 30.5 to 34 feet below ground surface. Dissolved oxygen, water levels, and soil gas pressure changes were observed in the nearby monitoring points (MP-1, MP-2, MP-3). Each of the monitoring points has a 2-inch PVC well that is screened in the same groundwater unit that the sparge well is screened. Each monitoring point has a soil gas monitoring point located just above the groundwater. The monitoring points are located 5 (MP-1), 10 (MP-2), and 20 feet (MP-3) from the sparge well. The sparge well is located 5 feet from the SVE well.

Table 2.3 displays the dissolved oxygen and water level data recorded during the air sparging portion of the SVE test. The air sparge test was performed on the last day of the 5-day SVE test. The initial dissolved oxygen levels in the groundwater ranged from 4 to 7 percent. Maximum oxygen levels achieved during the air sparging test ranged from 100 to 155 percent; the oxygen concentrations increased in all three monitoring points.

Figure 2-8 depicts the change in water levels in MP-1, -2, and -3 during the air sparge test. The water levels were elevated in MP-1 and MP-2, by up to 2 feet.

Soil gas pressure readings were collected from the soil gas monitoring points and from the SVE wellhead while the air sparge blower was operating. These readings were collected before and after the air sparge blower was turned on, to see the effect air sparging would have on the SVE system. Two of the deep soil gas monitoring points (MP-2 and -3) had pressure increases after turning on the air sparge blower. The shallow soil gas points at MP-2 and -3 had slight decreases in the vacuum after air sparging started. Vacuum readings at the SVE wellhead also fell during the air sparge test. The vacuum decreases in the shallow soil gas points and the wellhead could be the result of pressure from the air sparge blower, or a decrease in the amount of flow through the SVE well. Large amounts of ice were found in the airline leading from the wellhead to the knockout tank when the system was shut down and disassembled. This ice buildup could have restricted air flow and reduced the amount of vacuum applied to the wellhead.

2.2.3 Laboratory Analysis of Soil Gas

Extracted soil gas samples were collected during the SVE test with tedlar bags and with summa canisters. The samples collected with tedlar bags were analyzed on site with an FID. The samples collected with summa canisters were sent to an analytical laboratory for analysis on a wet basis. The results of the FID field screening are presented in Table 2.4. The laboratory analyses are presented in Table 2.5 and Figure 2.9.

TCE and 1,1,2,2-tetrachloroethane were detected at the highest concentrations. The highest concentration of TCE was detected in the first summa canister sample collected (46,000 ppbv). The highest concentration of 1,1,2,2-tetrachloroethane was detected in the fifth summa canister sample collected (28,000 ppbv). The first summa canister was collected about five hours after the SVE test began, and the fifth summa canister was collected about 29 hours after the SVE test began. It is not clear why the 1,1,2,2-tetrachloroethane concentration peaked at a later time than the TCE.

The ratio of TCE to 1,1,2,2-tetrachloroethane in the soil gas samples was different than the soil samples collected at MW-14. TCE was generally found at either higher or the same concentrations as 1,1,2,2-tetrachloroethane in the extracted soil gas. TCE was found at considerably lower concentrations than 1,1,2,2-tetrachloroethane in the soil samples collected at MW-14. This difference is a result of the different vapor pressures for TCE (57.8 mm Hg) and 1,1,2,2-tetrachloroethane (6 mm Hg). Although the TCE is found at lower concentrations in the soil, it is found at higher concentrations in the soil gas because it volatilizes more readily.

2.3 ANALYSIS

Using data collected during the SVE test, the following parameters were calculated:

- Intrinsic Permeability = 1.6 E-07 cm^2
- SVE Radius of Influence is between 25 and 35 feet
- The amount of solvents removed from the soil during the 5 day test is about 11.6 lbs

Intrinsic Permeability

The calculated intrinsic permeability (K), also known as soil gas permeability, corresponds with a silty sand (10^{-6} - 10^{-11}). SVE is generally considered effective in soils with K values greater than 10^{-8} cm^2 (USEPA, 1995). The permeability calculation is shown in Appendix A.

Radius of Influence

There is more than one radius of influence to estimate for the pilot study. The radius of influence of the SVE system is the first to consider. The SVE radius of influence was at least 25 feet since the outermost soil gas sampling point had an observable vacuum. Figure 2.7 is a plot of the vacuum readings at MP-2 and -3. A line drawn through the two points intercepts the x-axis (distance) at 35 feet; this point represents an estimate of the maximum radius of influence. A radius of influence of 25 feet was calculated using an equation from the Corps' Engineering Manual on Soil Vapor Extraction and Bioventing (EM 1110-1-4001). The 25-foot estimate would be the most reasonable number to assume for design purposes.

The next radius of influence to consider is for air sparging. The water level and dissolved oxygen measurements from the monitoring points give an indication of how air sparging is affecting the groundwater. Groundwater mounding was noted in the three monitoring points while the air sparge blower was on. The two closest points, MP-1 and MP-2, had almost the same increase in the measured groundwater elevations. The groundwater elevation increase at MP-3 was less than half the amount measured in the other points. Dissolved oxygen in groundwater readings from the three monitoring points increased once the air sparge blower was turned on. Dissolved oxygen readings in the groundwater started at less than 10 % and increased to 100% and greater. Based on these two measurements, the radius of influence for the air sparging is at least 10 feet and possibly 20 feet.

Amount of Solvent Removed

An estimated 11.6 lbs. of solvents were removed by the SVE system during the pilot test. This estimate is based on the average concentration of solvent in the extracted air, the volume of air removed and the amount of time that the system was running during the 5 day test. The average concentration of total VOCs in the extracted soil gas was 40 ppm. The total volume of air extracted was 986, 580 ft^3. The extracted soil gas was assumed to contain only 1,1,2,2-tetrachloroethane, to simplify the calculations. An estimated 200 gallons of groundwater were removed from the knockout tank during the test.

2.4 CONCLUSIONS

Based on the data collected during the treatability study and previous investigations completed at the site, the following conclusions can be made:

- SVE is capable of removing the target analytes. TCE and 1,1,2,2-tetrachloroethane are found at high levels in the soil and in the extracted soil gas.
- Air sparging did increase the amount of TCE extracted from the SVE well, but made little impact on the 1,1,2,2-tetrachloroethane.
- Operating the SVE system under high vacuum caused a significant amount of water to be extracted with the soil gas.
- The intrinsic soil gas permeability is within the range considered acceptable for SVE.

Typically, SVE systems are not capable of remediating groundwater. An unexpected result of operating the SVE pilot study system at OUB, was that a fairly large amount of water was extracted with the soil gas. Roughly 20 gallons of water had to be removed from the knock-out tank every three to four hours. A full scale SVE system could enhance the amount of extracted groundwater by adding a bubble tube. A bubble tube could be placed into the SVE well so that air is blown into the bottom of the well. The bubbles would help to increase the amount of water extracted from the well and also volatilize DNAPLs, if present in the well.

The efficiency of SVE may be enhanced by introducing heat to the subsurface. Technologies available for heating include steam, electricity, or radio frequency. Additional treatability studies are recommended to evaluate the effectiveness of heat-enhanced SVE at OUB.

TABLE 2.1
SVE DATA AT WELLHEAD

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

DATE	TIME	Elapsed Time days	FLOWRATE ft^3/min	VACUUM* inches water	COMMENTS
11/14/96	13:40	0.00	0	33.7	
11/14/96	13:42	0.00	0	33.6	
11/14/96	13:44	0.00	0	33.5	
11/14/96	13:46	0.00	0	33.5	
11/14/96	13:48	0.01	0	33.4	
11/14/96	13:50	0.01	0	33.2	
11/14/96	13:52	0.01	0	32.9	
11/14/96	13:54	0.01	0	32.7	
11/14/96	13:56	0.01	0	32.5	
11/14/96	13:58	0.01	0	33.2	Tightened wellhead. Increase in pressure.
11/14/96	14:02	0.02	0	33.2	
11/14/96	14:05	0.02	0	33.3	
11/14/96	14:09	0.02	0	33.4	
11/14/96	14:12	0.02	0	33.5	
11/14/96	14:16	0.03	109	45.6	Increase vacuum.
11/14/96	14:19	0.03	109	46.6	
11/14/96	14:21	0.03	109	46.6	
11/14/96	14:25	0.03	-	-	Pump 5 gal. water from MW-14.
11/14/96	14:27	0.03	109	47.0	
11/14/96	14:30	0.03	0	47.2	
11/14/96	14:35	0.04	0	47.2	
11/14/96	14:39	0.04	0	47.5	
11/14/96	14:41	0.04	-	-	Start pumping water from well (appox. 0.5 gal./min.)
11/14/96	14:45	0.05	0	47.7	
11/14/96	14:45	0.05	-	-	Stop pumping - have 5 gal.
11/14/96	14:50	0.05,	-	47.2	
11/14/96	14:55	0.05	-	-	Start pumping at .5 gal./min.
11/14/96	14:55	0.05	0	47.2	
11/14/96	15:00	0.06	0	47.2	
11/14/96	15:05	0.06	0	45.3	
11/14/96	15:12	0.06	109	45.6	
11/14/96	15:17	0.07	109	57.1	Increase vacuum.
11/14/96	15:22	0.07	0	57.0	
11/14/96	15:27	0.07	0	57.4	
11/14/96	15:35	0.08	0	56.4	
11/14/96	15:49	0.09	0	56.2	
11/14/96	15:50	0.09	0	68.0	Increase vacuum.
11/14/96	15:58	0.10	0	68.0	
11/14/96	16:02	0.10	0	68.8	
11/14/96	16:05	0.10	0	68.8	
11/14/96	16:08	0.10	109	78 (eratic)	Increase vacuum to 78.
11/14/96	16:15	0.11	148	77 (eratic)	
11/14/96	16:34	0.12	109	77 (eratic)	FID - 70 ppm Tedlar bag; 50 ppm Exhaust stack.

TABLE 2.1
SVE DATA AT WELLHEAD

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

DATE	TIME	Elapsed Time days	FLOWRATE ft^3/min	VACUUM* inches water	COMMENTS
11/14/96	16:42	0.13	109	78.0	
11/14/96	16:47	0.13	109	78.0	
11/14/96	17:00	0.14	183	94.0	Increase vacuum.
11/14/96	17:08	0.14	183	94.0	
11/14/96	17:14	0.15	148	94.0	
11/14/96	17:24	0.16	148	93.5	
11/14/96	17:29	0.16	148	94.0	
11/14/96	17:35	0.16	148	94.5	
11/14/96	17:41	0.17	148	93.8	
11/14/96	17:44	0.17	183	106.0	
11/14/96	17:48	0.17	183	106.0	
11/14/96	17:58	0.18	183	105.7	
11/14/96	18:03	0.18	183	120.0	
11/14/96	18:10	0.19	214	119.5	
11/14/96	18:45	0.21	-	120.4	
11/14/96	21:30	0.33	-	-	Knockout tank full - emptied tank.
11/14/96	21:50	0.34	-	-	Restarted blower.
11/14/96	23:00	0.39	183	97.0	
11/14/96	23:05	0.39	-	-	
11/14/96	23:40	0.42	-	-	Emptied knockout tank.
11/14/96	00:05	0.43	-	-	Restart blower.
11/15/96	01:15	0.48	-	-	Knockout pot full again. Slow flow rate when draining. Pot seems to be filling with ice.
11/15/96	03:00	0.56	214	93.6	
11/15/96	06:30	0.70	0	-	Bag filter in knockout tank covered with ice.
11/15/96	12:15	0.94	-	-	Restart blower with some of the outlet gas being redirected to the dilution valve.
11/15/96	13:15	0.98	-	-	Blower stopped - vacuum release valve on knockout tank tripped, drain knockout tank.
11/15/96	14:20	1.03	0	77.0	restart blower.
11/15/96	14:25	1.03	183	100.0	
11/15/96	19:00	1.22	183	97.8	
11/15/96	23:10	1.40	214	96.8	
11/16/96	03:00	1.56	183	89.5	
11/16/96	07:00	1.72	214	96.0	
11/16/96	08:00	1.76	-	-	Shut off blower since there is not enough room in the drums to store water from the knockout tank.
11/16/96	11:07	1.89	-	-	Restart blower.
11/16/96	11:10	1.90	109	100.0	
11/16/96	16:10	2.10	305	95.0	
11/16/96	16:40	2.13	340	99.0	
11/16/96	17:15	2.15	-	-	
11/16/96	19:15	2.23	0	90.0	

TABLE 2.1
SVE DATA AT WELLHEAD

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

DATE	TIME	Elapsed Time days	FLOWRATE ft^3/min	VACUUM* inches water	COMMENTS
11/16/96	22:50	2.38	340	83.0	
11/17/96	02:00	2.51	0	83.0	Shut down due to ice in knockout tank.
11/17/96	06:45	2.71	-	-	Restart after thawing out knockout tank
11/17/96	07:00	2.72	183	102.0	
11/17/96	07:15	2.73	0	-	Shut down to thaw out wellhead.
11/17/96	11:15	2.90	-	-	Restart.
11/17/96	11:20	2.90	214	100.0	
11/17/96	15:20	3.07	148	95.0	
11/17/96	19:00	3.22	148	95.0	
11/17/96	22:45	3.38	214	95.0	
11/18/96	02:40	3.54	183	96.0	
11/18/96	06:30	3.70	148	95.0	
11/18/96	14:40	4.04	214	96.5	
11/18/96	14:50	4.05	-	-	Start sparge blower.
11/18/96	14:55	4.05	214	87.5	
11/18/96	15:10	4.06	214	93.0	
11/18/96	15:25	4.07	183	92.0	
11/18/96	15:40	4.08	183	93.0	
11/18/96	16:10	4.10	214	93.0	
11/18/96	16:30	4.12	183	88.0	
11/18/96	17:50	4.17	183	87.0	
11/18/96	19:00	4.22	-	48.8	
11/18/96	19:30	4.24	-	61.8	
11/18/96	23:00	4.39	-	73.3	
11/19/96	03:00	4.56	-	57.9	
11/19/96	07:00	4.72	109	48.0	
11/19/96	13:20	4.99	0	26.0	
11/19/96	13:30	4.99	-	-	Shut down sparge & SVE.

*Vacuum measurements were collected at the wellhead.

TABLE ..2
PRESSURES AT MONITORING POINTS

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Date	Time	Elapsed Time (days)	MP-1 (r = 10 ft) S (In. H_2O)	MP-1 (r = 10 ft) D (In. H_2O)	MP-2 (r = 15 ft) S (In. H_2O)	MP-2 (r = 15 ft) D (In. H_2O)	MP-3 (r = 25 ft) S (In. H_2O)	MP-3 (r = 25 ft) D (In. H_2O)	Comments
11/14/96	13:41	0.00	0.0	0.0	-	-	-	-	Start at 13:40.
11/14/96	13:42	0.00	-	-	-0.7	0.0	-	-	Vacuum at 33.7 in. water at start.
11/14/96	13:43	0.00	-	-	-	-	-0.2	0.0	
11/14/96	13:45	0.00	-0.1	0.0	-	-	-	-	
11/14/96	13:46	0.00	-	-	-0.7	0.0	-	-	
11/14/96	13:46	0.00	-	-	-	-	-0.3	0.0	
11/14/96	13:48	0.01	-0.1	0.0	-	-	-	-	
11/14/96	13:49	0.01	-	-	-0.7	0.0	-0.3	0.0	
11/14/96	13:50	0.01	-0.1	0.0	-	-	-	-	
11/14/96	13:52	0.01	-	-	-0.6	0.0	-	-	
11/14/96	13:53	0.01	-	-	-	-	-0.2	0.0	
11/14/96	13:56	0.01	0.0	0.0	-0.6	0.0	-0.2	0.0	
11/14/96	14:00	0.01	0.0	0.0	-0.7	0.0	-0.3	0.0	
11/14/96	14:04	0.02	0.0	0.0	-0.5	0.0	-0.1	-0.1	
11/14/96	14:07	0.02	0.0	0.0	-0.5	0.0	-0.1	-0.1	
11/14/96	14:10	0.02	0.0	0.0	-0.6	0.0	-0.2	0.0	
11/14/96	14:13	0.02	-0.1	0.0	-	-	-	-	
11/14/96	14:14	0.02	0.0	0.0	-0.7	0.0	-0.3	0.0	
11/14/96	14:17	0.03	0.0	0.0	-0.7	0.0	-0.2	0.0	Increased Vacuum to 45.6 in. water.
11/14/96	14:19	0.03	0.0	0.0	-0.8	0.0	-0.3	0.0	
11/14/96	14:21	0.03	0.0	0.0	-0.7	0.0	-0.2	0.0	
11/14/96	14:23	0.03	0.0	0.0	-0.7	0.0	-0.2	0.0	
11/14/96	14:28	0.03	0.0	0.0	-0.8	0.0	-0.2	0.0	
11/14/96	14:34	0.04	0.0	0.0	-0.8	0.0	-0.2	0.0	
11/14/96	14:40	0.03	0.0	0.0	-0.8	0.0	-0.2	0.0	
11/14/96	14:43	0.04	0.0	0.0	-0.8	0.0	-0.3	0.0	
11/14/96	14:46	0.05	0.0	0.0	-0.8	0.0	-0.2	0.0	

TABLE 2.2
PRESSURES AT MONITORING POINTS

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Date	Time	Elapsed Time (days)	MP-1 (r = 10 ft) S ($In. H_2O$)	MP-1 (r = 10 ft) D ($In. H_2O$)	MP-2 (r = 15 ft) S ($In. H_2O$)	MP-2 (r = 15 ft) D ($In. H_2O$)	MP-3 (r = 25 ft) S ($In. H_2O$)	MP-3 (r = 25 ft) D ($In. H_2O$)	Comments
11/14/96	14:50	0.05	0.0	0.0	-0.8	0.0	-0.2	0.0	
11/14/96	14:58	0.05	0.0	0.0	-1.0	0.0	0.4	0.0	
11/14/96	15:05	0.06	0.0	0.0	-0.8	0.0	-0.2	-0.1	
11/14/96	15:14	0.07	0.0	0.0	-0.8	0.0	-0.2	0.0	
11/14/96	15:19	0.07	0.0	0.0	-0.8	0.0	-0.2	0.0	Increased Vacuum to 57.1 in. water.
11/14/96	15:23	0.07	0.0	0.0	-0.8	0.0	-0.2	0.0	
11/14/96	15:30	0.08	0.0	0.0	-0.9	0.0	-0.2	0.0	
11/14/96	15:34	0.08	0.0	0.0	-0.9	0.0	-0.3	0.0	
11/14/96	15:40	0.08	0.0	0.0	-0.9	0.0	-0.3	0.0	
11/14/96	15:49	0.09	0.0	0.0	-1.0	0.0	-0.4	0.0	
11/14/96	15:50	0.09	0.0	0.0	-1.1	0.0	-0.4	0.0	Increased Vacuum to 68.0 in. water.
11/14/96	15:54	0.09	0.0	0.0	-1.0	0.0	-0.3	0.0	
11/14/96	15:58	0.10	0.0	0.0	-1.0	0.0	-0.4	0.0	
11/14/96	16:02	0.10	0.0	0.0	-1.0	0.0	-0.3	0.0	
11/14/96	16:05	0.10	0.0	0.0	-1.1	0.0	-0.4	0.0	
11/14/96	16:09	0.10	0.0	0.0	-1.1	0.0	-0.4	0.0	Increased Vacuum to 78.0 in. water.
11/14/96	16:15	0.11	0.0	0.0	-1.2	0.0	-0.5	0.0	
11/14/96	16:25	0.11	0.0	0.0	-1.1	0.0	-0.4	0.0	
11/14/96	16:37	0.12	0.0	0.0	-1.2	0.0	-0.5	0.0	
11/14/96	16:44	0.13	0.0	0.0	-1.3	0.0	-0.5	0.0	
11/14/96	16:49	0.13	0.0	0.0	-1.3	0.0	-0.5	0.0	
11/14/96	16:52	0.13	0.0	0.0	-1.2	0.0	-0.5	0.0	
11/14/96	17:00	0.14	0.0	0.0	-1.4	0.0	-0.6	0.0	Increased Vacuum to 94.0 in. water.
11/14/96	17:03	0.14	0.0	0.0	-1.5	0.0	-0.6	0.0	
11/14/96	17:08	0.14	0.0	0.0	-1.5	0.0	-0.6	0.0	
11/14/96	17:13	0.15	0.0	0.0	-1.5	0.0	-0.6	0.0	
11/14/96	17:23	0.15	0.0	0.0	-1.5	0.0	-0.6	0.0	

TABLE _.2
PRESSURES AT MONITORING POINTS

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Date	Time	Elapsed Time (days)	MP-1 (r = 10 ft) S (In. H_2O)	MP-1 (r = 10 ft) D (In. H_2O)	MP-2 (r = 15 ft) S (In. H_2O)	MP-2 (r = 15 ft) D (In. H_2O)	MP-3 (r = 25 ft) S (In. H_2O)	MP-3 (r = 25 ft) D (In. H_2O)	Comments
11/14/96	17:29	0.16	0.0	0.0	-1.5	0.0	-0.6	0.0	
11/14/96	17:34	0.16	0.0	0.0	-1.5	0.0	-0.5	0.0	
11/14/96	17:43	0.17	0.0	0.0	-1.5	0.0	-0.5	0.0	
11/14/96	17:45	0.17	0.0	0.0	-1.6	0.0	-0.6	0.0	Increased Vacuum to 106.0 in. water.
11/14/96	17:51	0.17	0.0	0.0	-1.6	0.0	-0.6	0.0	
11/14/96	17:59	0.18	0.0	0.0	-1.6	0.0	-0.6	0.0	
11/14/96	18:08	0.19	0.0	0.0	-1.7	0.0	-0.6	0.0	
11/14/96	23:00	0.39	0.0	0.0	-1.5	0.0	-0.6	0.0	
11/15/96	3:00	0.56	-0.1	0.0	-1.3	-0.2	-0.5	-0.1	
11/15/96	14:44	1.04	-0.1	0.0	-1.6	0.0	-0.6	0.0	
11/15/96	19:00	1.22	-0.1	-0.1	-1.3	-0.1	-0.3	-0.1	Increased Vacuum to 106.0 in. water at 1803.
11/15/96	23:10	1.40	-0.1	-0.1	-1.2	-0.2	-0.2	-0.1	Reduced Vacuum to 97.0 in. water.
11/16/96	3:00	1.56	-0.1	-0.1	-1.3	-0.1	-0.3	-0.1	
11/16/96	7:00	1.72	-0.1	0.0	-1.6	0.0	-0.6	0.0	
11/16/96	11:10	1.90	0.0	0.0	-1.6	0.0	-0.6	0.0	
11/16/96	16:10	2.10	0.0	0.0	-1.9	0.0	-0.9	0.0	
11/16/96	16:45	2.13	0.0	0.0	-1.8	0.0	0.8	0.0	
11/16/96	19:15	2.23	0.0	0.0	-1.7	0.0	0.8	0.0	
11/16/96	22:50	2.38	0.0	0.0	-1.8	0.0	-0.7	0.0	
11/17/96	2:00	2.51	0.0	0.0	-1.8	0.0	-0.7	0.0	
11/17/96	7:00	2.72	0.0	0.0	-0.2	0.0	0.0	0.0	
11/17/96	11:20	2.90	0.0	0.0	-1.4	0.0	-0.6	0.0	
11/17/96	15:20	3.07	0.0	0.0	-1.6	0.0	-0.9	0.0	
11/17/96	19:00	3.22	0.0	0.0	-1.7	0.0	-0.7	0.0	
11/17/96	22:50	3.38	0.0	0.0	-1.7	0.0	-0.7	0.0	
11/18/96	2:40	3.54	0.0	0.0	-1.7	0.0	-0.7	0.0	
11/18/96	6:30	3.70	0.0	0.0	-1.8	0.0	-0.8	0.0	

TABLE 2.2
PRESSURES AT MONITORING POINTS

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Date	Time	Elapsed Time (days)	MP-1 (r = 10 ft) S (In. H_2O)	MP-1 (r = 10 ft) D (In. H_2O)	MP-2 (r = 15 ft) S (In. H_2O)	MP-2 (r = 15 ft) D (In. H_2O)	MP-3 (r = 25 ft) S (In. H_2O)	MP-3 (r = 25 ft) D (In. H_2O)	Comments
11/18/96	14:40	4.04	0.0	0.0	-1.8	0.0	-0.8	0.0	
11/18/96	14:51	4.05	0.0	0.0	-1.7	0.0	-0.7	0.0	Start sparge test.
11/18/96	14:56	4.05	0.0	0.0	-1.6	0.0	-0.6	0.0	
11/18/96	15:01	4.06	0.0	0.0	-1.6	0.0	-0.7	0.0	
11/18/96	15:05	4.06	0.0	0.0	-1.7	0.0	-0.7	0.0	
11/18/96	15:10	4.06	0.0	0.0	-1.7	0.0	-0.8	0.0	
11/18/96	15:15	4.07	0.0	0.0	-1.7	0.0	-0.7	0.0	
11/18/96	15:20	4.07	0.0	0.0	-1.8	0.0	-0.7	0.0	
11/18/96	15:25	4.07	0.0	0.0	-1.9	0.0	-0.8	0.0	
11/18/96	15:30	4.08	0.0	0.0	-1.9	+0.1	-0.8	0.0	
11/18/96	15:35	4.08	0.0	0.0	-1.7	+0.1	-0.6	0.0	
11/18/96	15:45	4.09	0.0	0.0	-1.7	+0.1	-0.6	0.0	
11/18/96	16:10	4.10	0.0	0.0	-1.7	+0.1	-0.7	0.0	
11/18/96	16:30	4.12	0.0	0.0	-1.7	0.0	-0.8	0.0	
11/18/96	17:50	4.17	0.0	0.0	-1.7	+0.1	-0.7	0.0	
11/18/96	19:00	4.22	0.0	0.0	-1.6	0.0	-0.6	0.0	
11/18/96	23:00	4.39	0.0	0.0	-1.1	+0.1	-0.7	+0.1	
11/19/96	3:00	4.56	0.0	0.0	-1.1	0.0	-0.2	0.0	
11/19/96	7:00	4.72	0.0	0.0	-0.1	+0.5	-0.5	0.0	
11/19/96	13:20	4.99	0.0	0.0	-0.6	+0.1	-0.4	0.0	Shut down sparge & SVE

MP = Monitoring Point
S = Shallow
D = Deep
r = Distance from SVE well

TABLE .3
AIR SPARGING DATA

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

			MP-1 (r = 5 ft)			MP-2 (r = 10 ft)			MP-3 (r = 20 ft)		
DATE	TIME	Elapsed Time days	D.O. percent	Elevation feet	Δ depth feet	D.O. percent	Elevation feet	Δ depth feet	D.O. percent	Elevation feet	Δ depth feet
11/18/96	13:15	0.00	4.2	274.90	0	3.5	274.88	0.00	7.2	274.65	0.00
11/18/96	14:51	0.07	14.5	274.72	-0.18	10.0	271.91	-2.97	11.0	274.54	-0.11
11/18/96	15:05	0.08	15.0	276.01	1.11	12.0	276.77	1.89	13.0	274.25	-0.40
11/18/96	15:17	0.08	12.5	276.51	1.61	13.0	277.36	2.48	14.0	275.25	0.60
11/18/96	15:30	0.09	5.1	276.48	1.58	5.2	276.94	2.06	4.4	273.96	-0.69
11/18/96	15:40	0.10	22.0	276.40	1.50	30.0	276.70	1.82	20.0	274.11	-0.54
11/18/96	16:10	0.12	19.0	276.48	1.58	17.0	276.80	1.92	15.0	274.32	-0.33
11/18/96	16:40	0.14	13.0	276.68	1.78	20.0	276.87	1.99	25.0	274.40	-0.25
11/18/96	17:50	0.19	155.0	276.84	1.94	105.0	276.90	2.02	100.0	275.74	1.09
11/18/96	19:00	0.24	104.2	276.60	1.70	95.0	276.90	2.02	88.6	274.82	0.17
11/18/96	23:00	0.41	62.0	276.44	1.54	101.9	276.53	1.65	69.4	275.05	0.40
11/19/96	03:00	0.57	88.2	276.37	1.47	94.7	276.44	1.56	44.0	275.04	0.39
11/19/96	07:00	0.74	76.1	276.41	1.51	83.2	276.60	1.72	59.9	275.15	0.50
11/19/96	12:45	0.98	82.0	276.28	1.38	100.0	276.55	1.67	68.0	275.17	0.52

MP = Monitoring Point
r = distance from SVE well
D.O. = dissolved oxygen

TABLE 2.4
FID FIELD SCREENING DATA

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

DATE	TIME	FID ppm
11/14/96	14:27	200
11/14/96	16:34	70
11/14/96	18:45	55
11/14/96	23:05	60
11/15/96	03:00	15
11/15/96	19:00	9
11/15/96	23:10	75
11/16/96	03:00	4
11/16/96	07:00	0
11/16/96	11:10	7
11/16/96	16:10	1
11/16/96	16:40	1
11/16/96	19:15	1
11/16/96	22:50	1
11/17/96	02:00	1
11/17/96	11:20	60
11/17/96	15:20	25
11/17/96	19:00	40
11/17/96	22:45	8
11/18/96	02:40	35
11/18/96	06:30	35
11/18/96	14:40	40
11/18/96	14:55	30
11/18/96	15:10	20
11/18/96	15:25	20
11/18/96	15:40	25
11/18/96	16:10	60
11/18/96	16:30	60
11/18/96	17:50	25
11/18/96	19:00	25
11/18/96	23:00	28
11/19/96	03:00	22

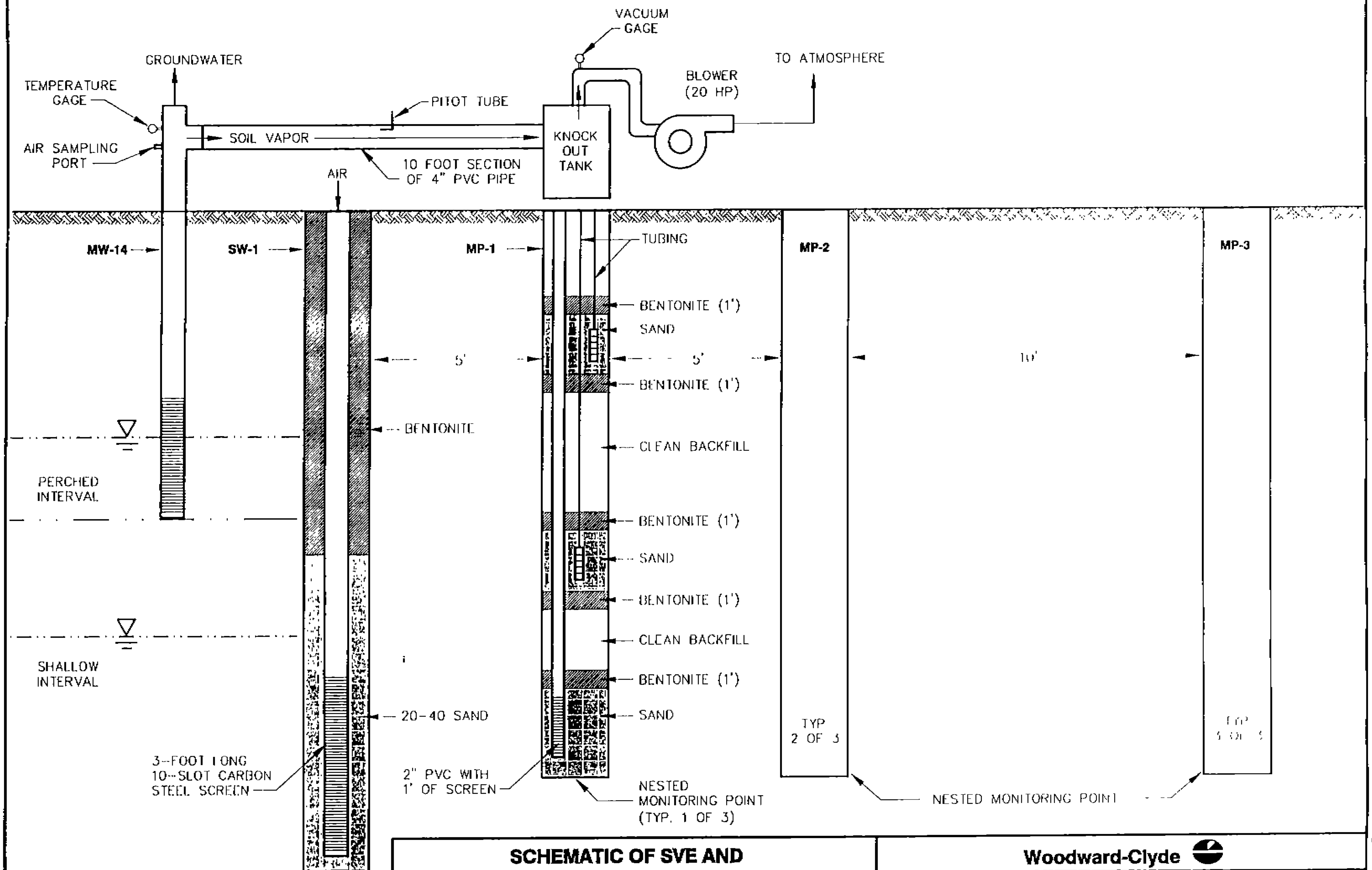
TABL.. .5
EXTRACTED SOIL GAS ANALYTICAL RESULTS

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Sample ID	Date Collected	Time Collected	Methylene Chloride (ppbv)	cis-1,2 Dichloroethene (ppbv)	Chloroform (ppbv)	Carbon Tetrachloride (ppbv)	Benzene (ppbv)	Trichloroethene (ppbv)	Toluene (ppbv)	Tetrachloroethene (ppbv)
AS1	11/14/96	1845	ND (180)	1,500 (180)	520 (180)	ND (180)	340 (180)	46,000 (180)	ND (180)	1,700 (180)
AS2	11/14/96	1930	ND (130)	1,100 (130)	320 (130)	ND (130)	140 (130)	31,000 (130)	ND (130)	1,200 (130)
AS3	11/14/96	2030	ND (110)	1,100 (110)	350 (110)	ND (110)	140 (110)	30,000 (110)	ND (110)	1,200 (110)
AS4	11/14/96	2300	ND (110)	1,100 (110)	300 (110)	ND (110)	160 (110)	29,000 (110)	ND (110)	1,200 (110)
AS5	11/15/96	1900	ND (68)	700 (68)	200 (68)	ND (68)	140 (68)	19,000 (68)	ND (68)	820 (68)
AS6	11/16/96	0630	ND (3.3)	ND (3.3)	ND (3.3)	ND (3.3)	5.2 (3.3)	67 (3.3)	17 (3.3)	6.2 (3.3)
AS7	11/16/96	1927	3.5 (3.2)	ND (3.2)	ND (3.2)	ND (3.2)	ND (3.2)	33 (3.2)	ND (3.2)	ND (3.2)
AS8	11/18/96	1440	ND (34)	53 (34)	ND (34)	ND (34)	ND (34)	1,400 (34)	ND (34)	66 (34)
AS9	11/18/96	1525	ND (11)	ND (11)	ND (11)	ND (11)	ND (11)	230 (11)	ND (11)	20 (11)
AS10	11/18/96	1550	ND (52)	340 (52)	73 (52)	52 (83)	120 (52)	8,600 (52)	ND (52)	350 (52)
AS11	11/18/96	1805	ND (2.9)	ND (2.9)	ND (2.9)	ND (2.9)	ND (2.9)	25 (2.9)	ND (2.9)	ND (2.9)
AS12	11/18/96	2000	53 (33)	450 (33)	90 (33)	36 (33)	80 (33)	9,100 (33)	ND (33)	360 (33)
AS13	11/19/96	0400	ND (28)	380 (28)	75 (28)	ND (28)	76 (28)	6,400 (28)	ND (28)	270 (28)

Sample ID	Date Collected	Time Collected	Ethyl Benzene (ppbv)	m,p-Xylene (ppbv)	o-Xylene (ppbv)	1,1,2,2-Tetrachloroethane (ppbv)	1,3,5-Trimethylbenzene (ppbv)	1,2,4-Trimethylbenzene (ppbv)	trans-1,2-Dichloroethene (ppbv)
AS1	11/14/96	1845	ND (180)	ND (180)	ND (180)	19,000 (180)	ND (180)	ND (180)	1,200 (720)
AS2	11/14/96	1930	ND (130)	ND (130)	ND (130)	23,000 (130)	ND (130)	ND (130)	860 (520)
AS3	11/14/96	2030	ND (110)	ND (110)	ND (110)	23,000 (110)	ND (110)	ND (110)	870 (450)
AS4	11/14/96	2300	ND (110)	ND (110)	ND (110)	25,000 (110)	ND (110)	ND (110)	860 (450)
AS5	11/15/96	1900	ND (68)	ND (68)	ND (68)	28,000 (68)	ND (68)	ND (68)	650 (270)
AS6	11/16/96	0630	3.5 (3.3)	12 (3.3)	4.9 (3.3)	1,200 (3.3)	3.6 (3.3)	15 (3.3)	ND (13)
AS7	11/16/96	1927	ND (3.2)	ND (3.2)	ND (3.2)	480 (3.2)	ND (3.2)	ND (3.2)	ND (13)
AS8	11/18/96	1440	ND (34)	ND (34)	ND (34)	7,900 (34)	ND (34)	ND (34)	ND (140)
AS9	11/18/96	1525	ND (11)	ND (11)	ND (11)	4,400 (11)	ND (11)	ND (11)	ND (46)
AS10	11/18/96	1550	ND (52)	ND (52)	ND (52)	13,000 (52)	ND (52)	ND (52)	320 (210)
AS11	11/18/96	1805	ND (2.9)	ND (2.9)	ND (2.9)	850 (2.9)	ND (2.9)	ND (2.9)	ND (12)
AS12	11/18/96	2000	ND (33)	ND (33)	ND (33)	8,100 (33)	ND (33)	ND (33)	450 (130)
AS13	11/19/96	0400	ND (28)	ND (28)	ND (28)	7,100 (28)	ND (28)	ND (28)	320 (110)

ppbv = parts per billion volume



SCHEMATIC OF SVE AND AIR SPARGING PILOT TEST, POLELINE ROAD DISPOSAL AREA OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: FIG2-1.DWG	By: AR	Figure: 2-1
Project: E9408Q	Date: 1-15-97	

Figure 2-2
SVE TEST - Wellhead Vacuum vs Time
Poleline Road Disposal Area
OUB, Fort Richardson, Alaska

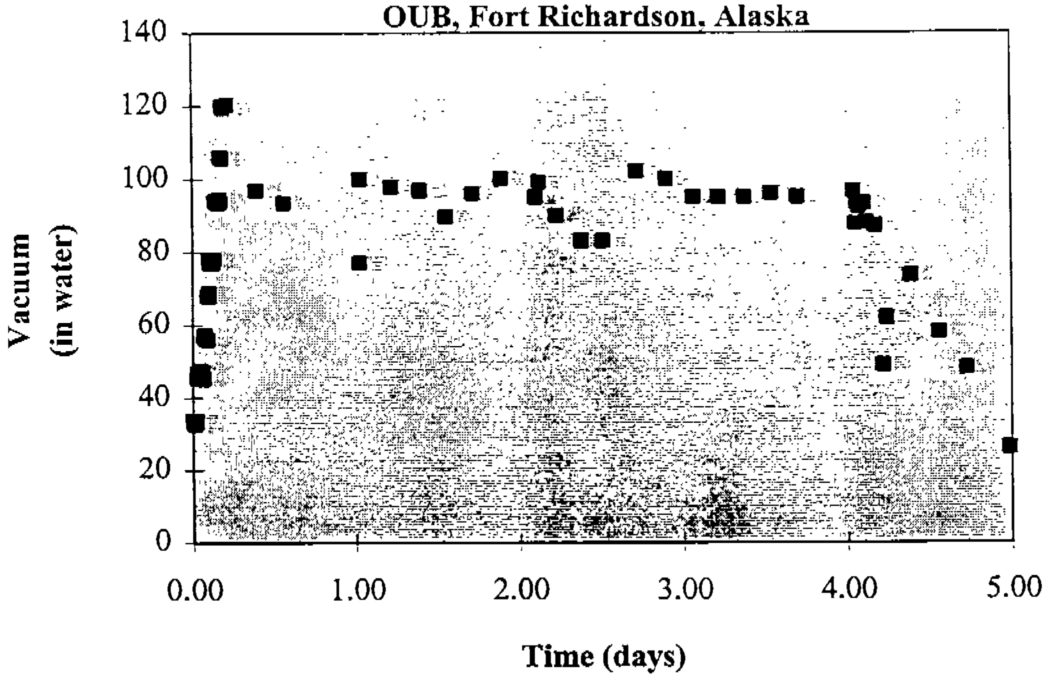


Figure 2-3
SVE TEST - Wellhead Vacuum & Flow vs Time
Poleline Road Disposal Area
OUB, Fort Richardson, Alaska

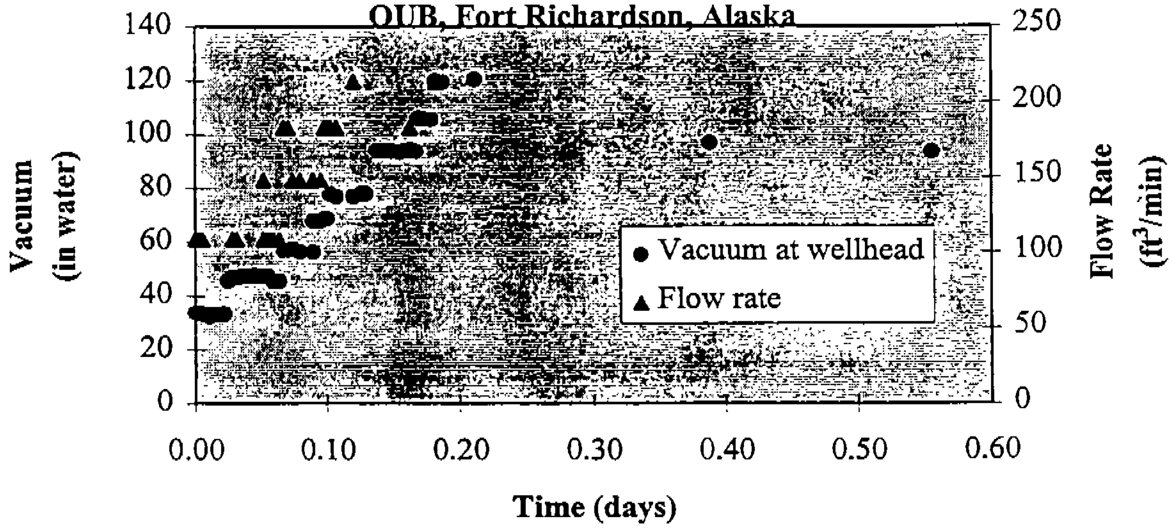


Figure 2-4: SVE TEST - Flow vs Time

Poleline Road Disposal Area
OUB, Fort Richardson, Alaska

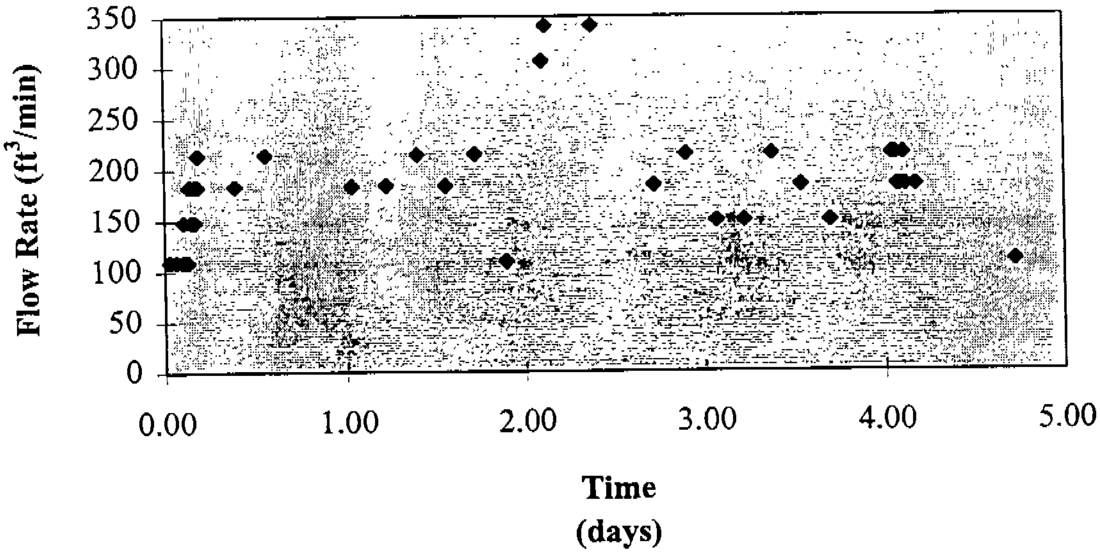


Figure 2-5: SVE TEST - FID Readings vs Time

Poleline Road Disposal Area
OUB, Fort Richardson, Alaska

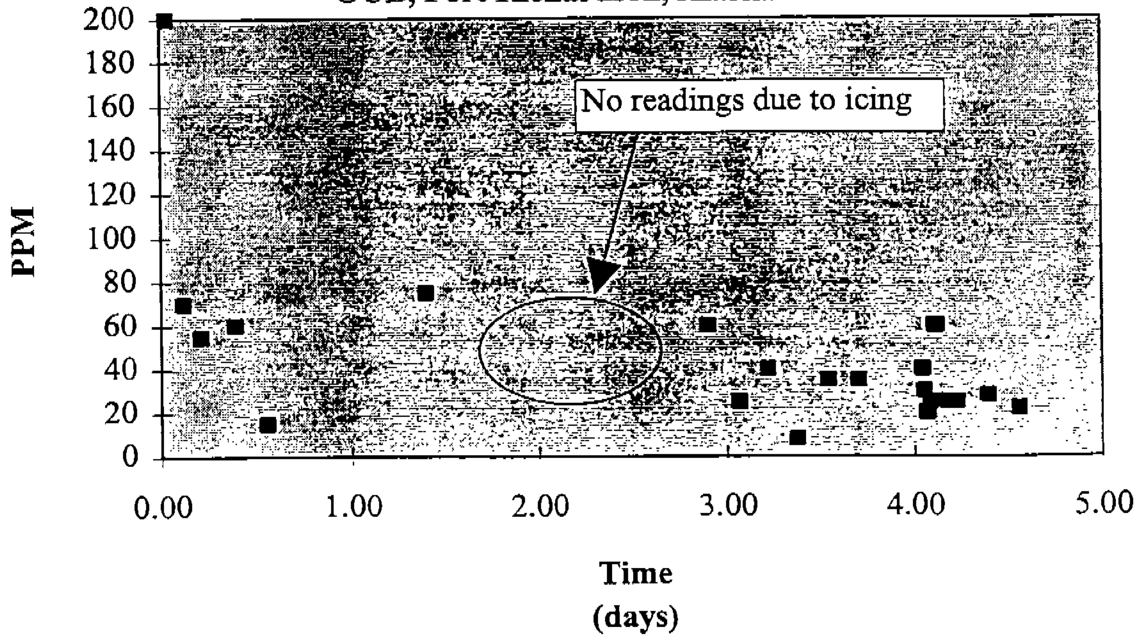


Figure 2-6
SVE TEST - MP2 & MP3, Shallow, vs Time
Poleline Road Disposal Area
OUB, Fort Richardson, Alaska

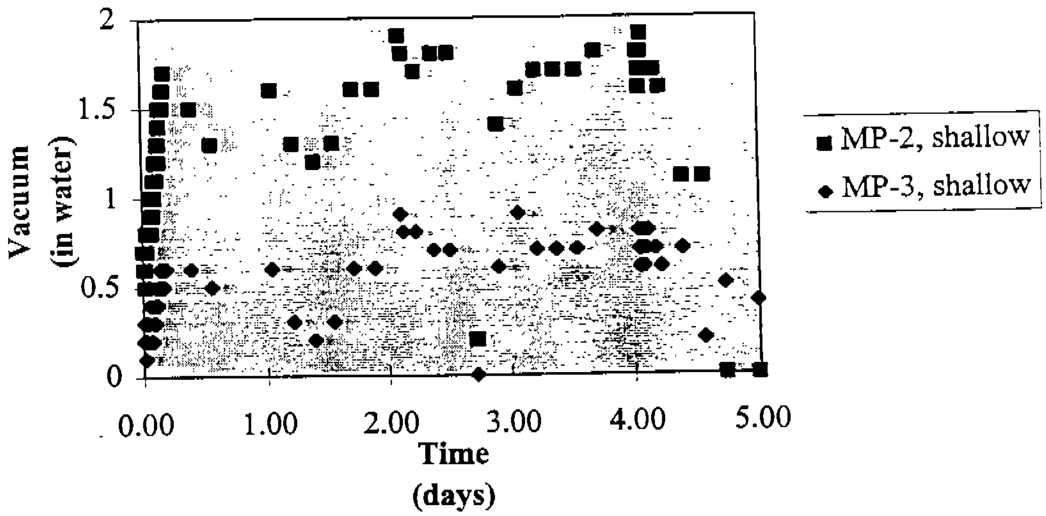
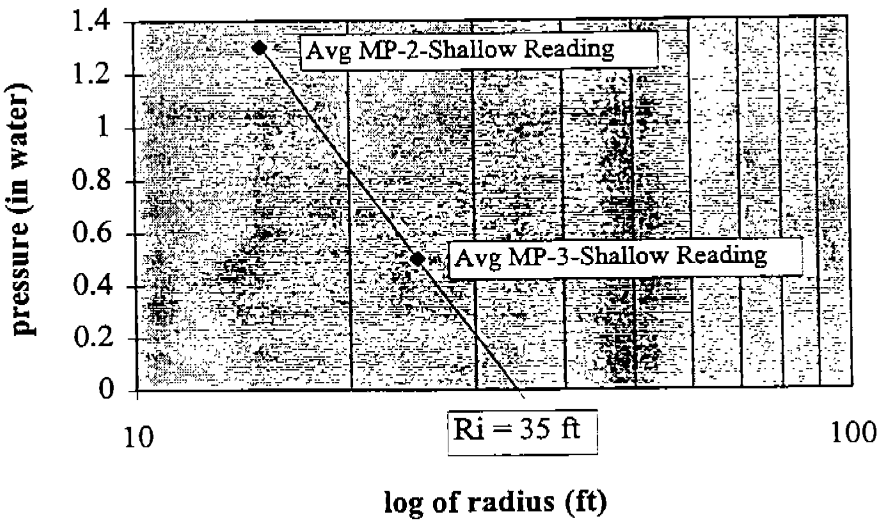


Figure 2-7: Log of Radius vs Pressure
Poleline Road Disposal Area
OUB, Fort Richardson, Alaska



Ri = Maximum Radius of Influence

Figure 2-8
Water Elevation During Air Sparge Test
Poleline Road Disposal Area
OUB, Fort Richardson, Alaska

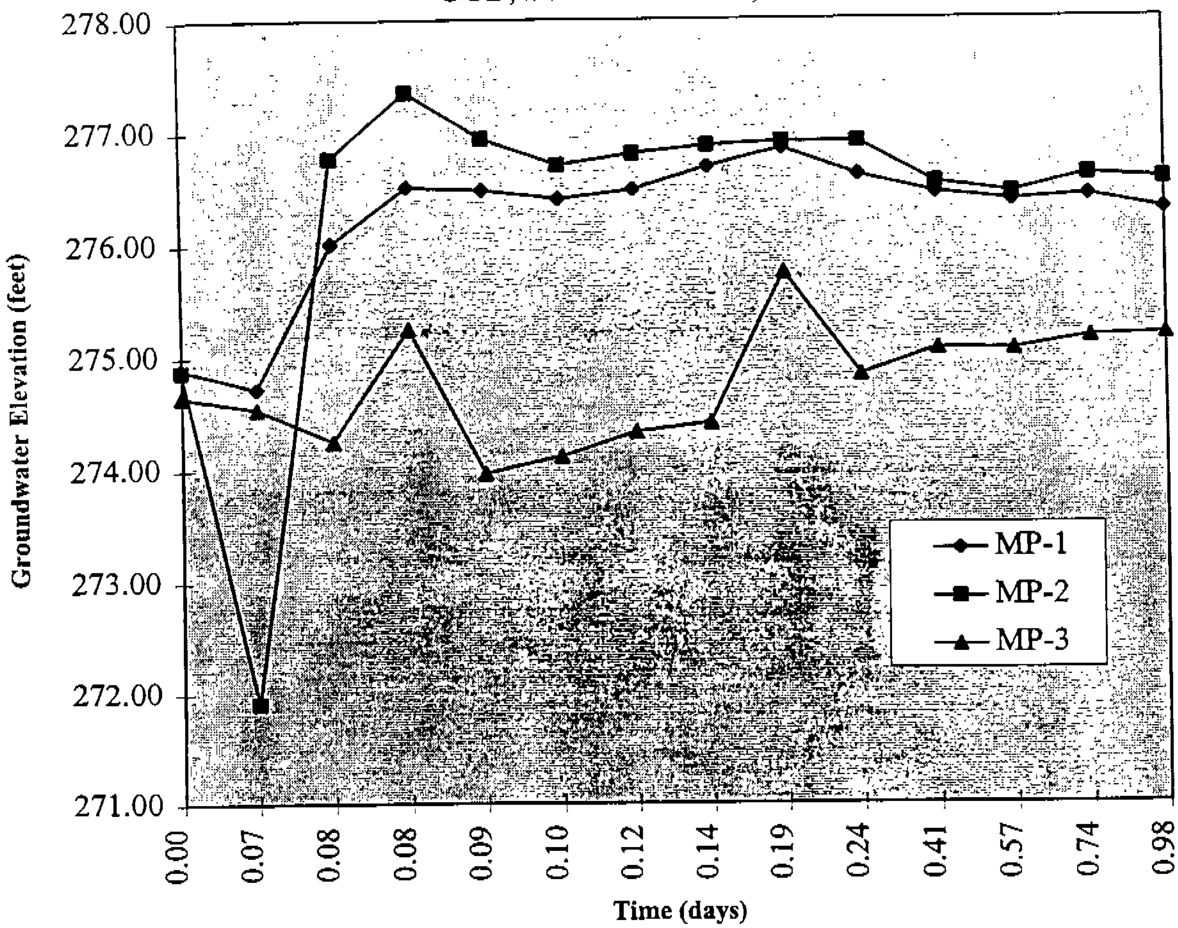
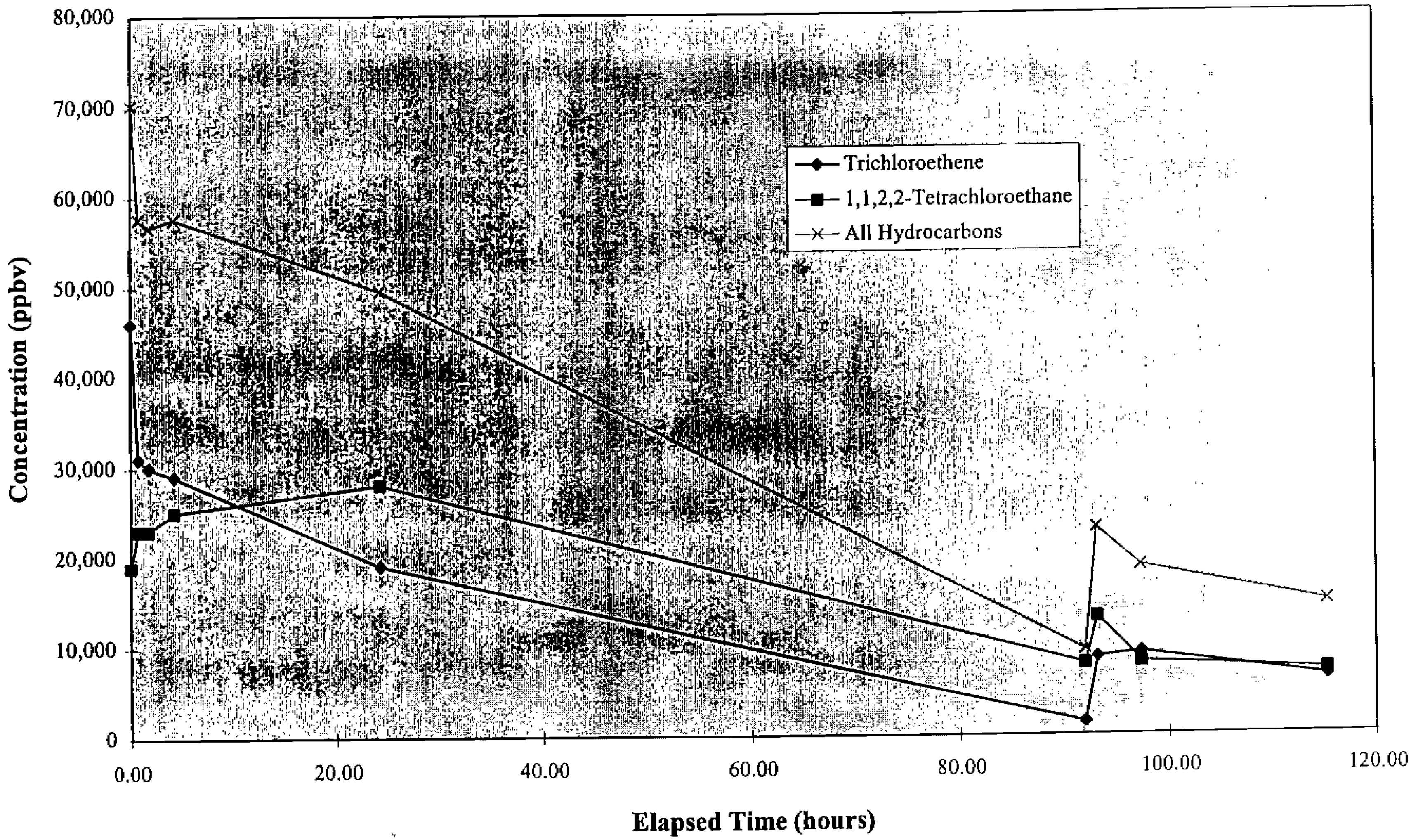


Figure 2-9: Solvent Concentration in Extracted Soil Gas

Poleline Road Disposal Area

OUB, Fort Richardson, Alaska



OUB 0028986

The FS identified a number of remedial alternatives for OUB. There is a relatively high level of uncertainty in some of the parameters of those alternatives, particularly the hydraulic conductivity. This report discusses the results of tests completed at OUB to estimate the hydraulic conductivity of the on-site soils.

Four water bearing intervals have been identified at the PRDA (Figure 3-1). The four water bearing intervals are a perched interval, a shallow interval, an intermediate interval, and a deep aquifer. The detection of contaminants in all four intervals suggests that they are interconnected to some degree.

The perched interval was observed in borings drilled between Area A-2 and the wetlands, and in Area A-3 (Figure 3-2). The top of the perched interval was encountered at 4 to 10 feet below ground surface (bgs), and the bottom was found at 6 to 12 feet bgs. The average thickness of the perched interval is approximately 5 feet. The perched interval is recharged mainly by surface water from the wetlands, although some recharge also occurs from precipitation. The only well installed in the perched interval is MW-14.

The shallow saturated interval is an average of 10 feet thick; the top was encountered at 20 to 25 feet bgs, and the bottom was found at 28 to 36 feet bgs. Groundwater elevations indicate that shallow groundwater is flowing in a north-northeast direction. There are 11 monitoring wells screened in the shallow interval, including the background well. The shallow interval is recharged by water from the perched interval and by infiltration of precipitation.

The intermediate interval was observed while drilling deep monitoring well MW-16. The saturated portion of the intermediate interval was encountered at approximately 65 to 95 feet bgs in MW-16. The intermediate saturated interval does not correlate with the other deep wells on site, suggesting that it is an isolated lens with limited continuity. There may be several isolated lenses of saturated material within the intermediate interval.

The five deep monitoring wells at the PRDA penetrate the deep aquifer, the top of which was encountered from approximately 80 to 125 feet bgs. The deep aquifer is an advance moraine/till complex with a thickness of between 3 and 40 feet. Groundwater elevations indicate that the flow direction in the deep aquifer is locally to the northeast and regionally to the northwest.

Hydraulic conductivities, used in the model for the RI, were estimated from existing site data (slug tests performed by Environmental Science and Engineering, Inc. [ESE], and grain size analyses conducted during the RI) and from literature values documenting hydraulic conductivities in similar hydrogeologic intervals in the Eagle River area (Munter and Allely, 1992):

Saturated Interval	Estimated Hydraulic Conductivity
Perched	0.5 feet per day (ft/day)
Shallow	0.5 ft/day
Intermediate	0.05 ft/day
Deep	0.3 ft/day

The ultimate discharge of the water-bearing intervals at the PRDA is probably the Eagle River, approximately 1 mile north of the PRDA. The Eagle River flows into the Knik Arm of Cook Inlet approximately 5 miles northwest of the PRDA.

3.1 SYSTEM

A 5-day pump test was planned to estimate aquifer characteristics of the shallow groundwater interval. Three piezometers and a well were installed at about 200 feet downgradient of MW-14 (Figure 3-1). It was observed that PZ-1 recovered faster and produced more water than PZ-3 and PZ-2, during development. Therefore, the pumping well, MW-18, was installed 10 feet from PZ-1. Approximately 6 feet of water were present in PZ-1, PZ-2, and PZ-3. MW-18 had less than one foot of water after installation. The three piezometers and one well were installed at nearly the same depth, except that MW-18 was installed slightly deeper. MW-18 was intended to be the pumping well for the pump test, but the lack of water prevented conducting a pump test.

Several one-hour, single well pump tests were performed to estimate the hydraulic conductivity. Only wells located in the shallow interval were tested (Figure 3.1). A pumping rate of greater than 1 gallon per minute is needed during a pump test or the data collected are not reliable. It is generally difficult to keep the pump rate from fluctuating less than 10 percent when the pump rate falls below 1 gpm. Some of the wells tested produced little amounts of water and were pumped dry in less than one hour at pumping rates less than 1 gallon per minute. Figure 3.1 shows the locations of the wells that were tested.

3.2 DATA

Data collected during the five single well pump tests are presented in the table below. The Jacobs straight-line time-drawdown method was utilized to estimate the hydraulic conductivities. The underlying assumptions for the Jacobs method are:

- The aquifer is confined;
- The aquifer has seemingly infinite areal extent;
- The aquifer is homogeneous, isotropic, and of uniform thickness over the area influenced by the test;
- Prior to pumping, the piezometric surface is horizontal (or nearly so) over the area that will be influenced by the test;
- The aquifer is pumped at a constant discharge rate;
- The well penetrates the entire thickness of the aquifer and thus receives water by horizontal flow;
- The diameter of the well is small, i.e. the storage in the well can be neglected; and
- The flow to the well is in unsteady state.

The following assumptions did not apply at OUB. The tested aquifer is not confined, the aquifer is not homogenous, and the well may not have penetrated the full thickness of the aquifer. Applying Jacobs method to an unconfined aquifer will bias the results toward a lower calculated hydraulic conductivity due to the non-horizontal flow toward the well. Not penetrating the full thickness of the aquifer also causes non-horizontal flow toward the well. The tested aquifer is also non-homogenous. All of these conditions cause head loss not related to the conductivity of the formation and result in larger drawdown in the well. The aquifer thickness was estimated from soil descriptions recorded during the well installation and water levels measured after well development. The Jacobs method was selected because the fewest assumptions were violated and the data collected in the field matched the inputs required for the method. See Appendix B for the raw data, graphs of the data, and the calculations for the transmissivity and hydraulic conductivity.

Monitoring Well Number	Avg pump rate (GPM)	Duration of test (hr:min)	DTW (ft. TOC)	DTB (ft. TOC)	Est. thickness of unit (b) (feet)	Calculated Transmissivity (ft^2/day)	Calculated Hydraulic Conductivity (ft/day)
MW-2	0.67	0:59 (dry)	23.0	34.0	3**	10.3	3.4
MW-3	1.53	0:32*	31.0	60.0	28.6	29.9	1.0
MW-12	0.57	0:59	31.0	40.0	9.2	10.8	1.2
MW-13	0.60	0:37	24.0	31.0	7.3	1.6	2.0
PZ-1	0.74	0:17 (dry)	30.0	36.0	6.5	4.3	0.7

DTW = depth to water;
* = out of storage capacity, DTW stable
PM = gallons per minute

DTB = depth to bottom of well
** = based on drawdown plot
TOC = from top of casing

Six soil samples (two per boring) were collected from saturated zones in soil borings PZ-1, PZ-2, and PZ-3, two per boring. The samples were analyzed for permeability at a geotechnical laboratory. The results of the analyses are reported in Table 3.1. The results vary from 0.0018 to 1.5 feet per day, with an average value of 0.44 ft/day.

3.3 ANALYSIS

The hydraulic conductivities calculated from the five pump tests fell within a fairly narrow range (0.7 - 3.4 ft/day). The range of hydraulic conductivities expected for till is 0.3 - 0.003 ft/day (Kruseman & de Ridder, 1991). Our calculated conductivities are about one order of magnitude higher than the expected upper limit for tills.

The average K values from the six laboratory soil samples is 0.44 ft/day; the average K value from the five single-well pump tests is 1.7 ft/day.

The difference between the geotechnical analyses and the pump test hydraulic conductivity estimates can be attributed to variances in hydraulic conductivity across the site. The hydraulic conductivity estimated (0.7 ft/day) from a pump test conducted on one of the three new piezometers (PZ-1) was very close to the average hydraulic conductivity (0.44 ft/day) calculated by the geotechnical analyses. This indicates that there is some agreement between the pump test results and the geotechnical data. The rest of the pump tests were conducted at other locations around the site where the hydraulic conductivities could be different.

The difference between the expected hydraulic conductivity range of tills and the hydraulic conductivity estimated from the pump test data may result from the wide variety of soils that can be described as till. The range of hydraulic conductivities typical for tills, as mentioned above, covers three orders of magnitude. Having the pump test data fall within an order of magnitude of the upper range of expected hydraulic conductivities for tills is reasonable given the wide range of soils that can be described as tills. The range provided by Kruseman and de Ridder may be a conservative estimate of the expected range of hydraulic conductivities for tills.

3.4 CONCLUSIONS

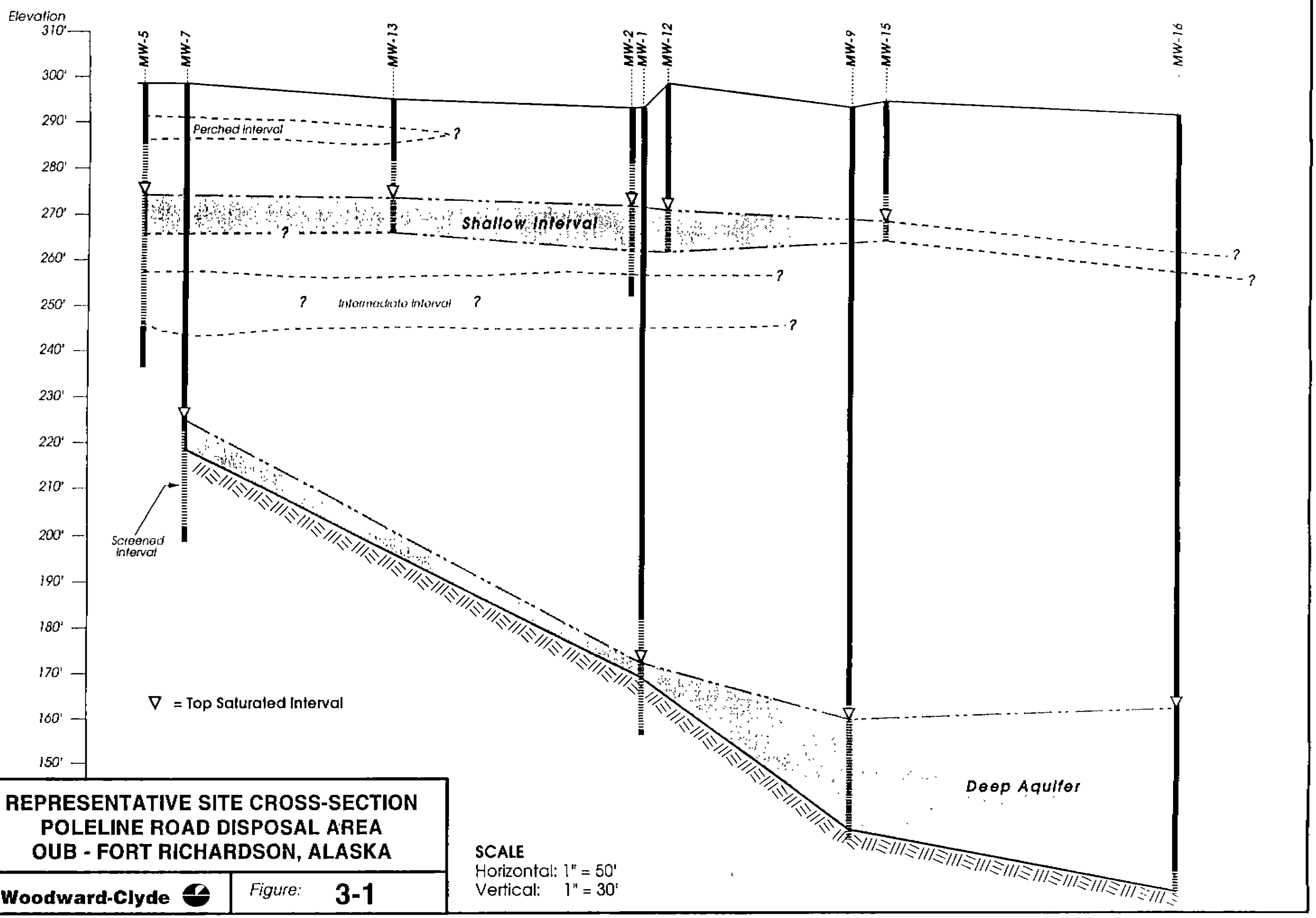
The hydraulic conductivity estimate presented in the RI was very close to the K values calculated from the single well pump tests and from the soil samples collected from PZ-1, -2, and -3. Hydraulic conductivity values are not likely to restrict or prevent certain remedial technologies from being considered. The K values that have been estimated for the site indicate that the formation has an adequate ability to transmit fluids. It is the location and amount of water that will restrict certain remedial technologies. Experience at the site indicates that the water bearing zones are not very continuous. For example, MW-14 is installed in a perched groundwater interval; but, when the air sparge well was installed 5 feet from MW-14, no perched groundwater interval was observed in the soil samples. Groundwater appears, in some cases, to occur in limited zones, and the K values we calculated represent these zones. There may be lower conductivity zones between the pockets of groundwater that are not reflected in the K values.

TABL. .1

LABORATORY SOIL-PERMEABILITY DATA

POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

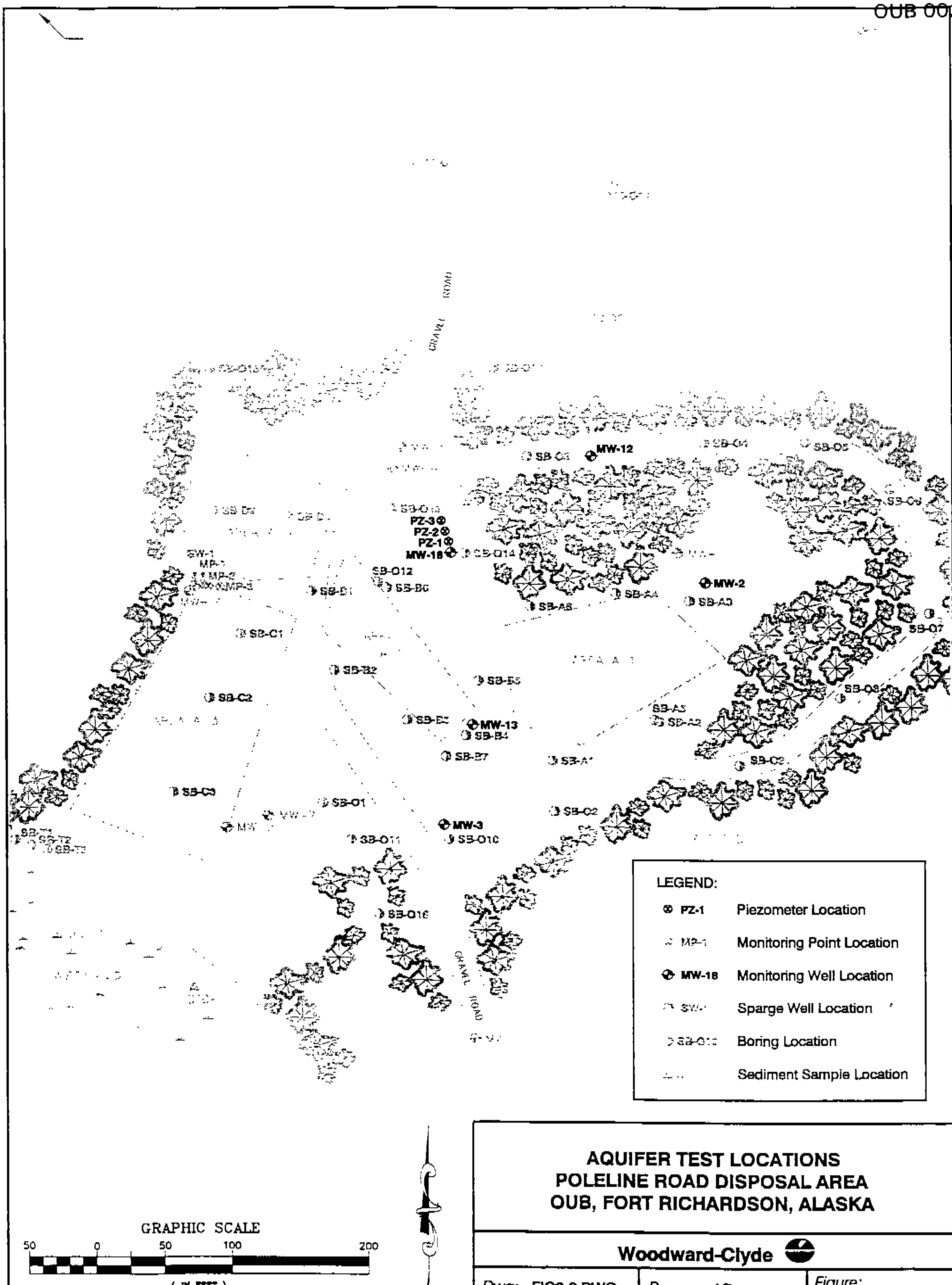
Location	Depth feet	Hydraulic Conductivity cm/second	Hydraulic Conductivity feet/day	Dry Density lbs/ft^3	Moisture Content percent
PZ-1	34.0-34.5	3.2 E-05	1.3 E-01	140	6.1
PZ-1	29.0-29.5	9.9 E-06	4.0 E-02	140.5	5.7
PZ-2	34.5-36.0	3.8 E-04	1.5 E+00	131.5	6.9
PZ-2	30.5-31.5	4.5 E-07	1.8 E-03	151	6.3
PZ-3	29.5-31.0	8.1 E-07	3.3 E-03	135	6.8
PZ-3	34.0-34.5	2.4 E-04	9.6 E-01	140	5.8
average		1.1 E-04	4.4 E-01		



REPRESENTATIVE SITE CROSS-SECTION
POLELINE ROAD DISPOSAL AREA
OUB - FORT RICHARDSON, ALASKA

Woodward-Clyde | *Figure:* **3-1**

SCALE
Horizontal: 1" = 50'
Vertical: 1" = 30'



LEGEND:

PZ-1	Piezometer Location
MP-1	Monitoring Point Location
MW-18	Monitoring Well Location
SW-1	Sparge Well Location
SB-O11	Boring Location
	Sediment Sample Location

AQUIFER TEST LOCATIONS
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: FIG3-2.DWG	By: AR	Figure: 3-2
Project: E9408Q	Date: 1-15-97	

Seven groundwater samples were collected from monitoring wells at OUB and analyzed for geochemical parameters. These parameters were selected to help identify what types of natural processes may be degrading contaminants at the site. The parameters that were measured, the wells sampled and the results are presented in Table 4.1.

The sampling results indicate that there is little to no natural attenuation of contaminants at the site. The strongest indication that natural attenuation is not occurring, is that none of the end products were detected. Methane, ethane, ethene, and sulfide are produced by the degradation of chlorinated solvent. None of these compounds were detected above the detection limit.

A paper titled "Intrinsic In Situ Anaerobic Biodegradation of Chlorinated Solvents at an Industrial Landfill" presents a method to identify natural attenuation processes at the site (Lee et al., 1995). A site is under methanogenic reducing conditions if methane is detected above 1.0 mg/L. Methane was not detected above the detection limit (0.02 mg/L) at OUB. A site is under sulfate reducing conditions if the sulfide concentration is greater than 0.2 mg/L. Sulfide was not detected above the detection limit (0.05 mg/L) at OUB. A site is under iron reducing conditions if the concentration of iron is greater than 1.5 mg/L. Iron was detected at concentrations ranging from ND (0.05 mg/L) to 0.8 mg/L, less than the 1.5 mg/L needed for iron reducing conditions. A site is under manganese reducing conditions if the concentration of manganese is greater than 0.2 mg/L. Four of the seven samples collected (MW-12, MW-5, MW-14, and PZ-1) had concentrations of manganese detected above 0.2 mg/L. A site is under nitrate reducing conditions if nitrate and nitrite are present, and none of the previously mentioned parameters are present above critical levels. Groundwater at OUB is not under nitrate reducing conditions since only nitrate was detected in the samples, except MW-14. Only nitrite was detected in MW-14. According to Lee et al., the site may be under manganese reducing conditions. Since manganese was found in only four of the seven wells, manganese reducing conditions do not appear to be widespread.

The U.S. Air Force Center for Environmental Excellence developed a technical protocol for evaluating the natural attenuation of chlorinated aliphatic hydrocarbons in groundwater (USAF 1996). The Air Force protocol uses a scoring system to rate the potential for natural attenuation at a site. The score is based on the concentration at which various analytes and parameters were detected. The higher the score, the higher the likelihood that natural attenuation is occurring at the site. A score of 0 to 5 indicates inadequate evidence for biodegradation of chlorinated organics, 6 to 14 indicates limited evidence, 15 to 20 indicates adequate evidence, and a score of greater than 20 indicates strong evidence of biodegradation. A score was developed for OUB using results from the seven groundwater samples collected in November. The score fell into the 0 to 5 range, indicating inadequate evidence for biodegradation.

Table 4.1: Natural Att ation Parameters

Parameter	Units	MW-16 96PRDA-O-001GW	MW-12 96PRDA-O-001GW	MW-13 96PRDA-O-007GW	MW-5 96PRDA-O-008GW	MW-2 96PRDA-O-009GW	PZ-1 96PRDA-O-010GW	MW-14 96PRDA-O-011GW
Nutrients/Electron Acceptors								
Ammonia-N	mg/L	0.129	0.157	0.37	0.633	0.144	0.232	0.122
Total Phosphorous	mg/L	0.028	0.421	0.047	0.029	0.749	0.059	0.342
Nitrite-N	mg/L	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	0.71
Nitrate-N	mg/L	0.57	0.24	0.32	2.1	0.53	ND (0.1)	ND (2.0)
Chloride	mg/L	23.2	1.67	1.74	7.33	1.6	2.13	127
Iron	mg/L	0.0761	0.246	0.218	0.595	0.864	0.0937	ND (0.05)
Manganese	mg/L	ND (0.02)	1.84	0.0304	0.537	0.111	0.815	0.511
Sulfate	mg/L	16.8	17	17	82.3	17.3	26.9	44
Total Residue	mg/L	576	1030	186	294	2400	237	996
Total kjedahl	mg/L	ND (0.2)	0.452	0.242	0.82	0.271	0.76	0.365
Substrates								
Total Organic Carbon	mg/L	ND (0.5)	1.4	1.2	4.4	1.3	2.6	5.2
Other								
Oil Degrading Bacteria	col/L	ND (20)	ND (20)	ND (20)	ND (20)	ND (20)	ND (20)	ND (20)
Sulfate Reducing Bacteria	col/L	Negative	Negative	Negative	Negative	Negative	Negative	Negative
Hetrotrophic Plate Count	col/L	204	72	200	201	1300	490	2
Metabolic End Products								
Methane	mg/L	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)
Ethane	mg/L	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)
Ethene	mg/L	ND (0.06)	ND (0.06)	ND (0.06)	ND (0.06)	ND (0.06)	ND (0.06)	ND (0.06)
Sulfide	mg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Field Parameters								
Temperature	°F	41.1	40.3	43.5	42.6	41.1	41	44.9
pH		7.22	7.48	7.5	6.67	7.49	7.04	7.22
Conductivity	uS/cm	225	194	228	233	163	229	638
Dissolved Oxygen	ppm	8.77	3.9	8.3	4.33	9.63	3.65	4.38
Redox Potential	mV	-10.2	94.2	81.9	5.4	63.3	-75.5	112.8
VOCs								
1,1,2,2-Tetrachloroethane	mg/L	ND (0.001)	0.07	0.0041	3.1	ND (0.001)	0.94	186
Trichloroethane	mg/L	ND (0.001)	0.024	0.0011	9.1	ND (0.001)	1.4	1000

NAT-ATTN.XLS

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APPENDIX A

SOIL GAS PERMEABILITY CALCULATIONS

Appendix A
Soil Gas Permeability

Permeability is defined as the ability of atmospheric air to travel through the soil matrix. Since pressure at the monitoring points rapidly reached a near steady-state, permeability (k) of the soil was calculated using the steady-state method. The method is based on the solution to the following equation:

$$k = \frac{Q\,\mu\,\ln(Rw/R_I)}{H\,\pi\,Patm\,[(1-Pw/Patm)^2]}$$

Definitions:

- k = Permeability
- Q = Flow of air
- μ = Viscosity of air
- R_w = Radius of injection well
- R_I = Distance to monitoring point to the injection well
- H = Height of vent well screen
- P_w = Absolute pressure at injection well
- P_{atm} = Ambient pressure

Using the parameters recorded during the SVE test at or near the extraction well and data from the system installation, the solution to the equation can be determined. The recorded units and data are converted from English units to the International System of Units (SI). The conversions are:

- Q: 183 cubic feet per minute = 86,500 cubic centimeters per second
- μ: An assumed value of 0.00018 grams per centimeter-second
- Rw: 2 inch = 5.08 centimeters
- R_I: 25 feet = 762 centimeters
- H: 10 feet = 305 centimeters
- P_w: 90 inches of water = 792,000 grams per centimeter, second squared
- P_{atm}: An assumed value of 1,013,000 grams per centimeter, second squared

Inserting the values obtained into the equation:

$$k = \frac{86{,}500*0.00018*\ln(5.08/762)}{305*\pi*792{,}000*[1-(1{,}013{,}000/792{,}000)^2]}$$

$$k = 1.6 * 10^{-7}\ \text{cm}^2 \text{ or } 0.16 \text{ Darcy}$$

The calculated permeability value of 0.16 Darcy is a typical value for silty soils and glacial till (USEPA, 1995).

APPENDIX B

HYDRAULIC CONDUCTIVITY CALCULATIONS

PZ-1

Gal pumpe	PZ-1 Water Depth (ft - TOC)	Elapsed time (min)	PZ-1 Drawdown (feet)	ump Freq (Hz)	Pump Rate (GPM)
0	29.59	0.00		134	
1	31.79	0.83	2.20	131	1.20
2	31.81	2.67	2.22	131	0.54
3	32.05	4.50	2.46	131	0.55
4	32.35	6.50	2.76	131	0.50
5	32.55	8.00	2.96	131	0.67
6	32.66	9.83	3.07	131	0.55
7	32.74	12.00	3.15	131	0.46
8	34.56	13.67	4.97	135	0.60
9	NR	15.50	-	135	1.09
10	NR	17.17	-	135	1.20
12					
				Avg pump rate =	0.74

NR = no reading (water level below top of pump)

A. $(2.3\ Q) / (4\Pi * \Delta(H_o - H)) = T$

$(2.3 * 0.74\ \text{gal/min} * 60\text{min/hr} * 24\ \text{hr/day} * \text{ft}^3/7.48\text{gal}) / (4*\Pi*6.1\ \text{ft})$

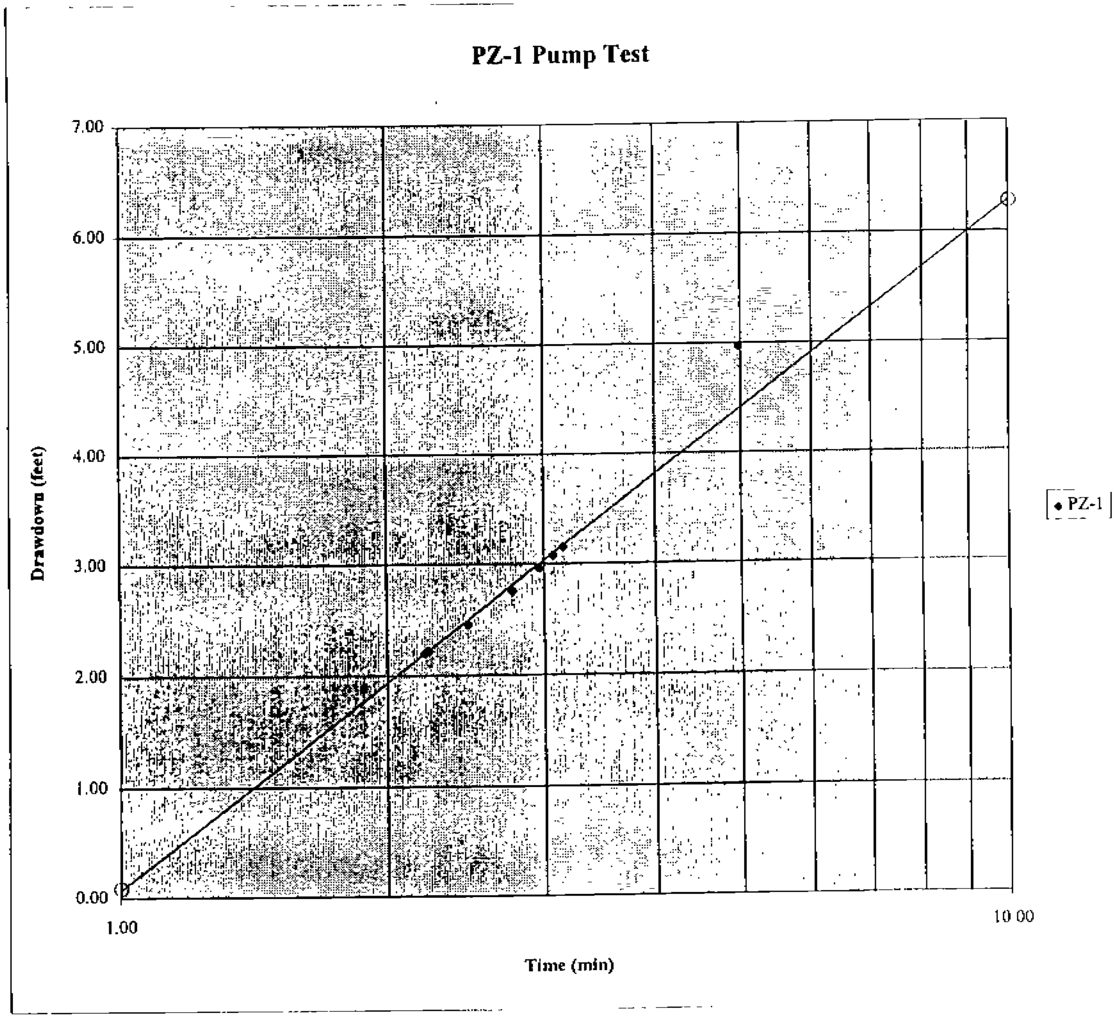
T = 4.25 ft^2/day

T = bK b = 36.05'-29.5 6.55 ft

K = 4.25 / 6.6

$\boxed{K = 0.6\ \text{ft/day}}$

T = Transmissivity (ft^2/day)
b = thickness of aquifer (ft)
Q = flowrate during test (GPM - ft^3/day)
Δ(Ho-H) = the drawdown per log cycle of time (ft)
K = Hydraulic conductivity (ft/day)



$\Delta(H_o\text{-}H) = 6.2 - 0.1 = 6.1$ ft

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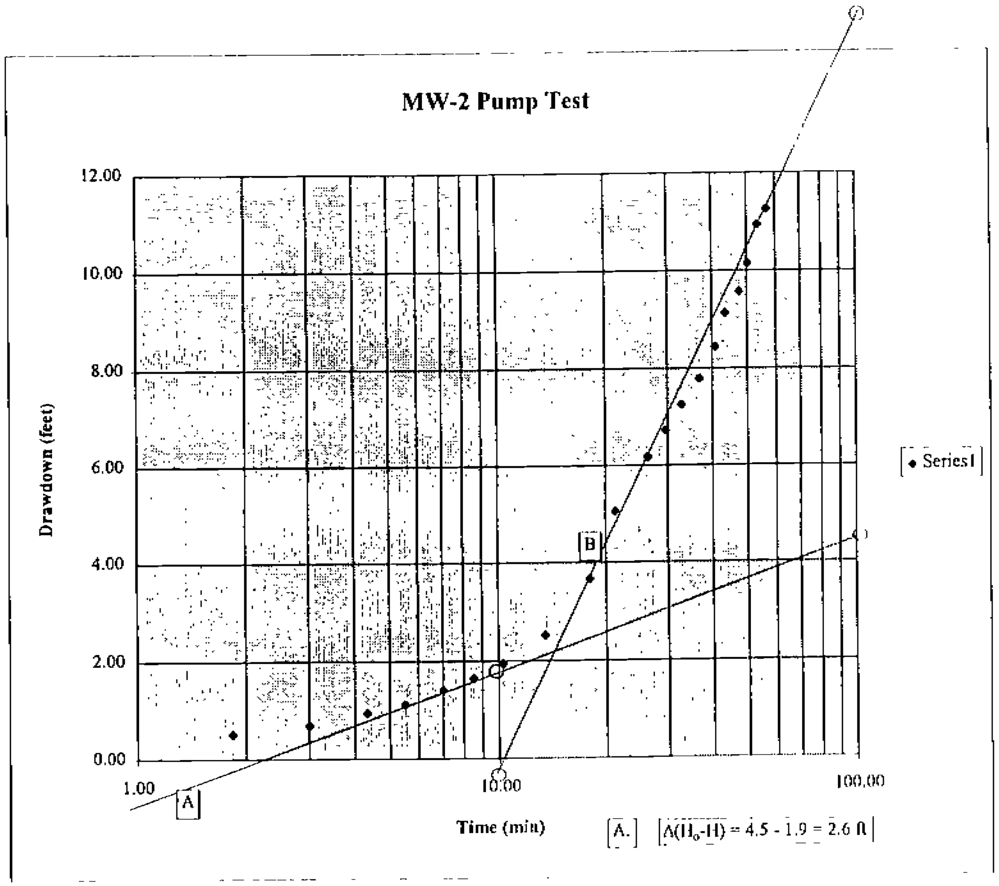
MW-2

Gal pumped	Water Dept (ft - TOC)	Elapsed time (min)	Drawdow (feet)	Pump Freq. (Hz)	Pump Rate (GPM)
0	22.99	0.00	0.00	120	
1	23.27	0.75	0.28	120	1.33
2	23.50	1.83	0.51	120	0.93
3	23.67	3.00	0.68	120	0.85
4	23.92	4.33	0.93	120	0.75
5	24.09	5.50	1.10	120	0.85
6	24.39	7.00	1.40	120	0.67
7	24.63	8.50	1.64	120	0.67
8	24.92	10.25	1.93	120	0.57
10	25.51	13.50	2.52	120	0.62
12	26.64	18.00	3.65	120	0.44
14	28.04	21.25	5.05	124	0.62
16	29.15	26.25	6.16	124	0.40
18	29.71	29.50	6.72	129	0.62
20	30.24	32.75	7.25	129	0.62
22	30.77	36.75	7.78	129	0.50
24	31.42	40.75	8.43	129	0.50
26	32.11	43.50	9.12	129	0.73
28	32.55	47.50	9.56	129	0.50
30	33.13	50.25	10.14	129	0.73
32	33.91	53.50	10.92	129	0.62
34	34.23	56.75	11.24	129	0.62
well dry (<36)		58.83			
				Avg pump rate =	0.67



B. [$\Delta(H_o\text{-}H)$ = 14.8 - 0 = 14.8 ft]

Jacob's Method:

A. (2.3 Q) / (4Π*$\Delta(H_o\text{-}H)$) = T

(2.3 * 0.67 gal/min * 60min/hr * 24 hr/day * ft^3/7.48gal) / (4*Π*2.6 ft)

T = 9.11 ft^2/day

T = bK   b = 2.5' ** =   2.5 ft

K = 9.11 ft2/day / 2.5 ft

K =	3.6 ft/day

B. (2.3 Q) / (4Π*$\Delta(H_o\text{-}H)$) = T

(2.3 * 0.67 gal/min * 60min/hr * 24 hr/day * ft^3/7.48gal) / (4*Π*14.8 ft)

T = 1.60 ft^2/day

T = bK   b = 34.3' - 23' - 2.5' =   8.8 ft

K = 1.60 ft2/day / 8.8 ft

K =	0.2 ft/day

T = Transmissivity (ft^2/day)
b = thickness of aquifer (ft)
Q = flowrate during test (GPM - ft^3/day)
Δ(Ho-H) = the drawdown per log cycle of time (ft)
K = Hydraulic conductivity (ft/day)
** = determined the top three feet of aquifer (A) has a different K value than rest (B)

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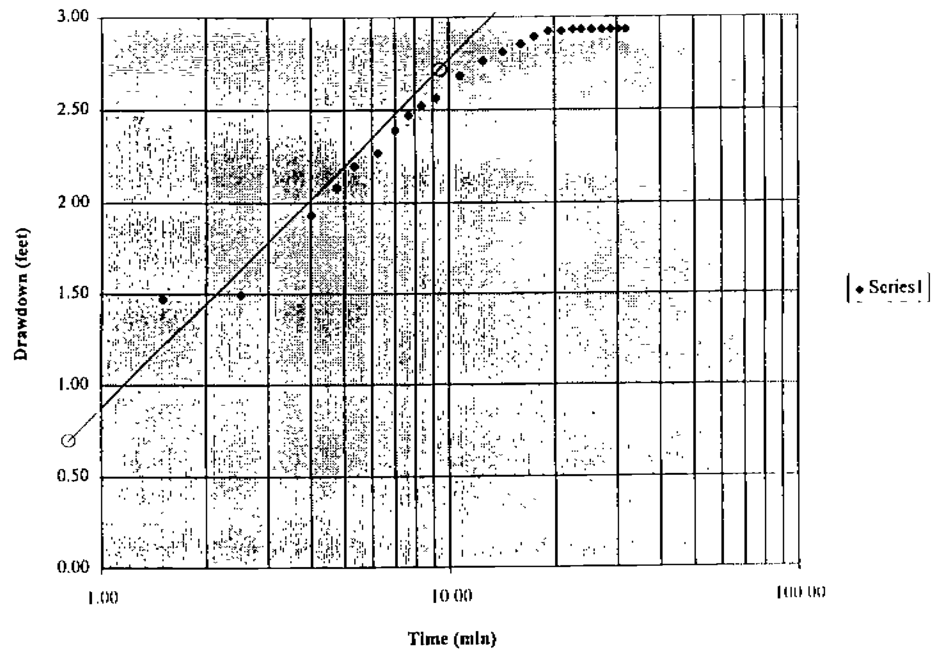
MW-3

Gal pumpe	Water Depth (ft - TOC)	Elapsed time (min)	Drawdow (feet)	Pump Fre (Hz)	Pump Rate (GPM)
0	30.98	0.00			
2	32.45	1.50	1.47	141	1.33
4	32.47	2.50	1.49	141	2.00
5	32.91	4.00	1.93	141	0.67
6	33.06	4.75	2.08	141	1.33
7	33.18	5.33	2.20	141	1.72
8	33.25	6.25	2.27	141	1.09
10	33.37	7.00	2.39	141	2.67
12	33.45	7.66	2.47	141	3.03
14	33.50	8.33	2.52	141	2.99
16	33.54	9.17	2.56	141	2.38
18	33.66	10.75	2.68	141	1.27
20	33.74	12.50	2.76	141	1.14
22	33.79	14.25	2.81	141	1.14
24	33.83	16.00	2.85	141	1.14
26	33.87	17.50	2.89	141	1.33
28	33.90	19.17	2.92	141	1.20
30	33.90	20.83	2.92	141	1.20
32	33.91	22.50	2.93	141	1.20
34	33.91	23.83	2.93	141	1.50
36	33.91	25.50	2.93	141	1.20
38	33.91	27.25	2.93	141	1.14
40	33.91	28.83	2.93	141	1.27
42	33.91	30.33	2.93	141	1.33
44	33.91	31.83	2.93	141	1.33

Avg pump rate = 1.53

MW-3 Pump Test



$\Delta(H_o\text{-}H) = 2.6 - 0.8 = 1.8$ ft

Jacob's Method:

A. $(2.3\ Q) / (4\Pi * \Delta(H_o\text{-}H)) = T$

(2.3 * 1.53 gal/min * 60min/hr * 24 hr/day * ft³/7.48gal) / (4*Π*1.8 ft)

T = 29.86 ft²/day

T = bK b = 59.6' - 31.0' = 28.6 ft

K = 29.86 / 28.6

K =	1.0	ft/day

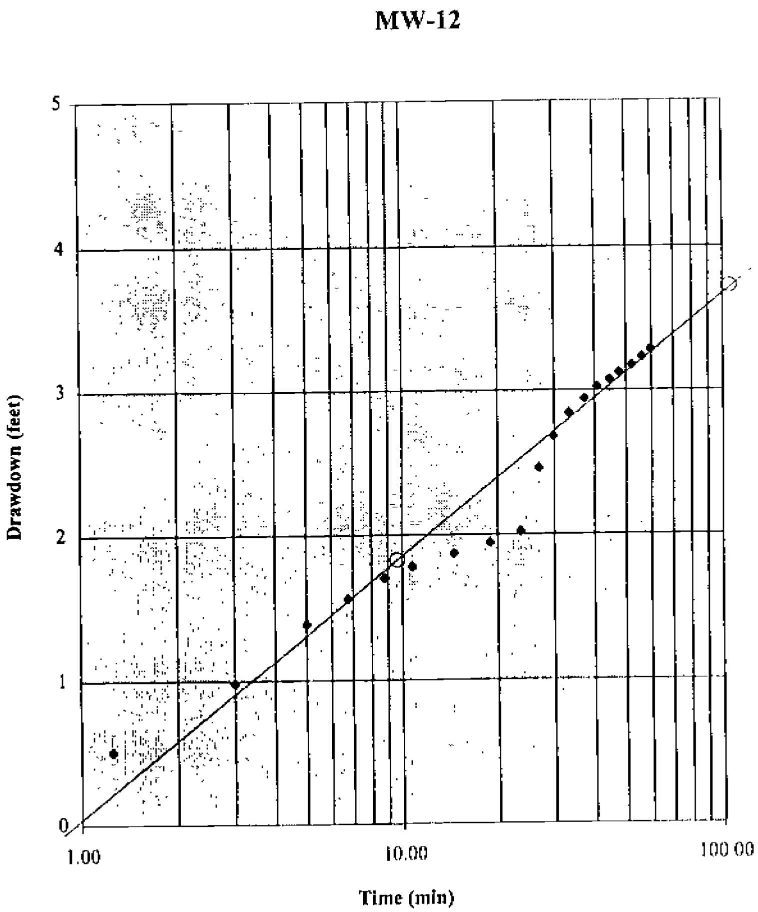
T = Transmissivity (ft²/day)
b = thickness of aquifer (ft)
Q = flowrate during test (GPM - ft³/day)
Δ(Ho-H) = the drawdown per log cycle of time (ft)
K = Hydraulic conductivity (ft/day)

OUB 0029002

MW-12

Water Dept (feet)	Gal Pumpe	Time (hr:min:sec)	Elapsed time (hr:min:sec)	min	Drawdow (feet)	Pump freq (Hz)	Pump Rate (GPM)
30.84	0	11:38:00	0:00:00		0	125	
31.35	1	11:39:15	0:01:15	1.25	0.51	125	0.80
31.82	2	11:41:00	0:03:00	3.00	0.98	125	0.57
32.23	3	11:43:00	0:05:00	5.00	1.39	125	0.50
32.4	4	11:44:45	0:06:45	6.75	1.56	125	0.57
32.54	5	11:46:45	0:08:45	8.75	1.7	125	0.50
32.62	6	11:48:45	0:10:45	10.75	1.78	125	0.50
32.71	8	11:52:30	0:14:30	14.50	1.87	125	0.53
32.78	10	11:56:50	0:18:50	18.83	1.94	125	0.46
32.86	12	12:01:30	0:23:30	23.50	2.02	125	0.43
33.3	14	12:04:45	0:26:45	26.75	2.46	128	0.62
33.52	16	12:07:50	0:29:50	29.83	2.68	128	0.65
33.68	18	12:11:15	0:33:15	33.25	2.84	128	0.58
33.78	20	12:15:10	0:37:10	37.17	2.94	128	0.51
33.86	22	12:18:45	0:40:45	40.75	3.02	128	0.56
33.91	24	12:22:30	0:44:30	44.50	3.07	128	0.53
33.96	26	12:25:45	0:47:45	47.75	3.12	128	0.62
34.01	28	12:30:00	0:52:00	52.00	3.17	128	0.47
34.07	30	12:34:00	0:56:00	56.00	3.23	128	0.50
34.12	32	12:37:30	0:59:30	59.50	3.28	128	0.57

Avg pump rate = 0.55



$\Delta(H_o\text{-}H) = 3.7 - 1.9 = 1.8$ ft

A. $(2.3\ Q) / (4\Pi * \Delta(H_o\text{-}H)) = T$

(2.3 * 0.55 gal/min * 60min/hr * 24 hr/day * ft^3/7.48gal) / (4*Π*1.8 ft)

T = 10.79 ft^2/day

T = bK b = 40' - 30.8' = 9.2 ft

K = 10.79 / 9.2

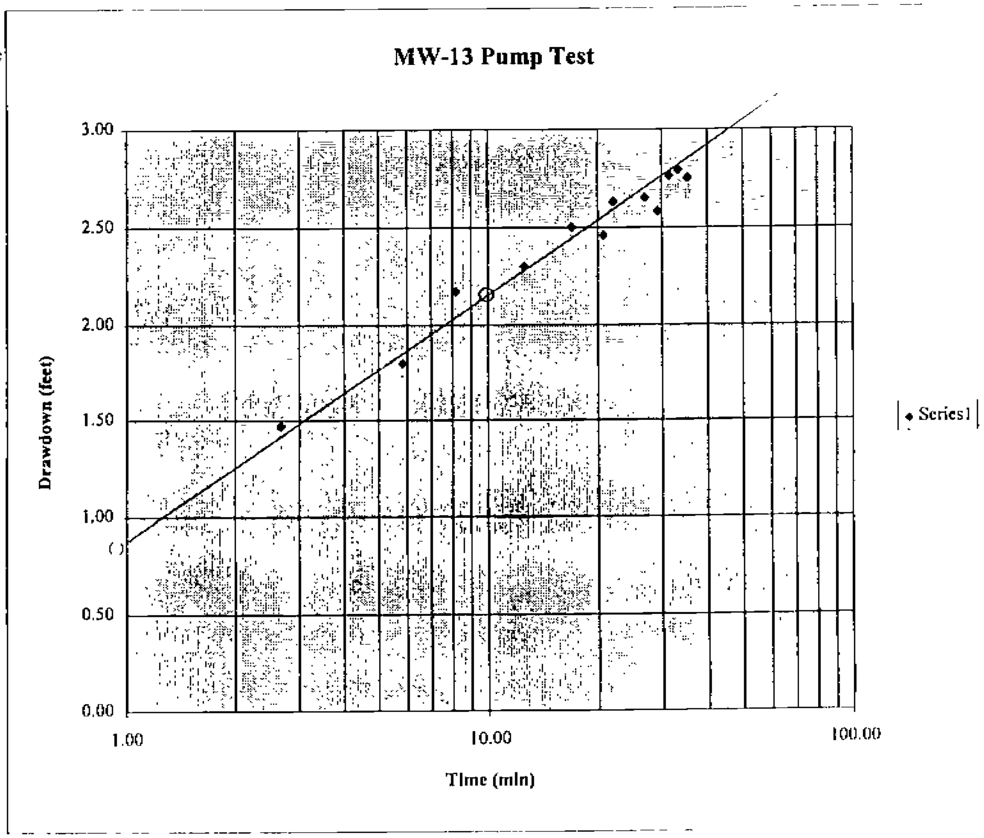
K =	1.2	ft/day

T = Transmissivity (ft^2/day)
b = thickness of aquifer (ft)
Q = flowrate during test (GPM - ft^3/day)
Δ(Ho-H) = the drawdown per log cycle of time (ft)
K = Hydraulic conductivity (ft/day)

MW-13

Gal pump	Water De (ft - TOC)	Elapsed time (min)	Drawdow (feet)	Pump Fre (Hz)	Pump Rate (GPM)
0	24.18	0.00			
1		0.50		110	2.00
2		2.13		110	0.61
	25.65	2.67	1.47	110	
3		3.67		110	0.65
4		5.47		110	0.56
	25.98	5.83	1.80	110	
5		7.22		110	0.57
6		8.83		110	0.62
	26.35	8.17	2.17	110	
7		10.55		110	0.58
8	26.48	12.58	2.30	110	0.49
9		14.83		110	0.44
10		16.67		110	0.54
	26.68	16.95	2.50	110	
11		18.50		110	0.55
12	26.64	20.73	2.46	110	0.45
13	26.81	22.05	2.63	110	0.76
14		24.92		110	0.35
15	26.83	26.97	2.65	110	0.49
16	26.76	29.20	2.58	110	0.45
17	26.94	31.38	2.76	110	0.46
18	26.97	33.20	2.79	110	0.55
19	26.93	35.28	2.75	110	0.48
20		37.48		110	0.45

Avg pump rate = 0.60



$\Delta(H_o\text{-}H) = 2.2 - 0.9 = 1.3$ ft

A. $(2.3\ Q) / (4\Pi * \Delta(H_o\text{-}H)) = T$

(2.3 * 0.60 gal/min * 60min/hr * 24 hr/day * ft^3/7.48gal) / (4*Π*1.3 ft)

T = 16.33 ft^2/day

T = bK b = 31.5' - 24.2 = 7.3 ft

K = 16.33 / 7.3

K = 2.2 ft/day

T = Transmissivity (ft^2/day)
b = thickness of aquifer (ft)
Q = flowrate during test (GPM - ft^3/day)
Δ(Ho-H) = the drawdown per log cycle of time (ft)
K = Hydraulic conductivity (ft/day)

APPENDIX C

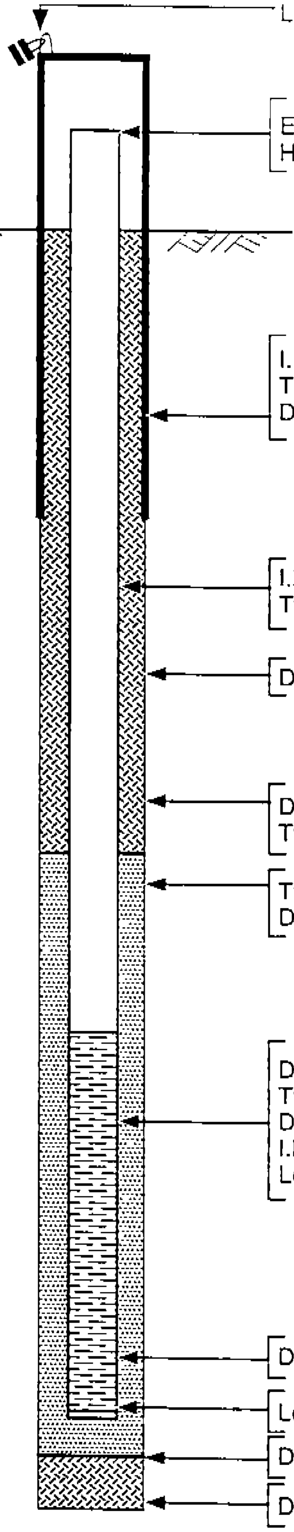
BORING AND WELL COMPLETION LOGS

MONITORING WELL INSTALLATION DETAILS

PROJECT: FT. RICHARDSON OUB Feasibility Study	WELL NO: SW-1
	WELL LOCATION: AREA C
DATE COMPLETED: 10/23/96 TOTAL DEPTH: 39.0'	DRAWING NOT TO SCALE

NOTE:
DEPTHS *listed are from ground level.*
ELEVATIONS *listed are from mean sea level.*

Ground Elevation = 303.60



Locking Cap

Elevation of top of riser pipe: 305.17 ft
Height of top of riser pipe above ground surface: 1.57 ft

I.D. of surface casing.
Type of surface casing: 6"-steel
Depth of surface casing below ground: 6.43 ft

I.D. of riser pipe: 4"
Type of riser pipe: carbon steel

Diameter of borehole: 8"

Depth to bottom of seal: 28.0 ft
Type of seal: Bentonite

Type of sand pack: #20/40 screened
Depth of top of sand pack 28.0 ft

Depth to top of screened section: 30.5 ft
Type of screened section: carbon steel-10 slot
Describe openings: 0.010"
I.D. of screened section: 4"
Length of screen: 3.5 ft

Depth to bottom of screened section: 34.0 ft

Length of blank section: 2 in

Depth to top of seal: 36.0 ft

Depth of hole below ground surface: 39.0 ft

Woodward-Clyde	PROJECT NO: E9408Q/7200	PAGE 1 OF 1

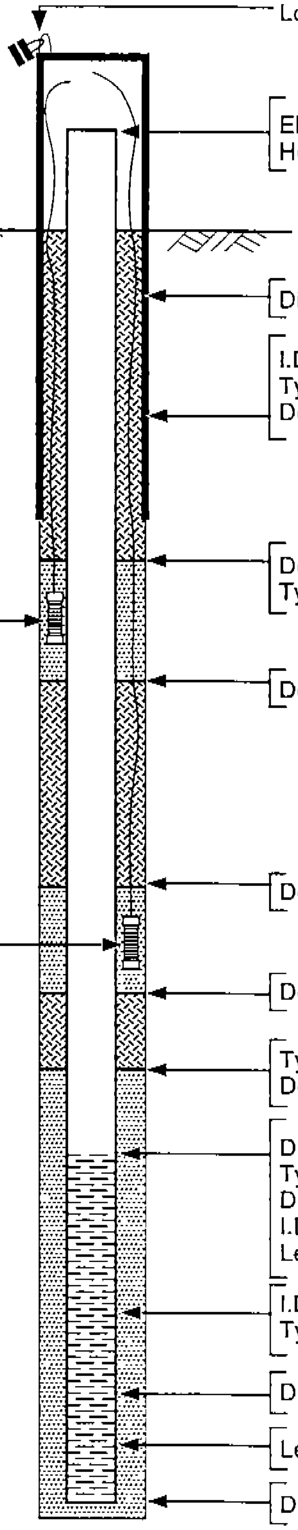
Well Completion Form and General Diagram

MONITORING WELL INSTALLATION DETAILS

PROJECT: FT. RICHARDSON OUB Feasibility Study	WELL NO: MP-1
	WELL LOCATION: AREA-C
DATE COMPLETED: 10/24/96 TOTAL DEPTH: 33.0'	DRAWING NOT TO SCALE

NOTE:
***DEPTHS** listed are from ground level.*
***ELEVATIONS** listed are from state plane.*

Ground Elevation = 303.03



Locking Cap

Elevation of top of riser pipe: 305.49 ft
Height of top of riser pipe above ground surface: 2.46 ft

Diameter of borehole: 6"

I.D. of surface casing.
Type of surface casing: 4"-steel
Depth of surface casing below ground: 5.54 ft

Depth to bottom of seal: 9.0 ft
Type of seal: Bentonite

Vapor probe depth (shallow) 9.5 ft

Depth to bottom of sand: 10.0 ft

Depth to bottom of seal: 20.0 ft

Vapor probe depth (deep) 23.5 ft

Depth to bottom of sand: 24.0 ft

Type of sand pack: #20/40 screened
Depth of top of sand pack 26.0 ft

Depth to top of screened section: 28.0 ft
Type of screened section: PVC-10 slot
Describe openings: 0.010"
I.D. of screened section: 2"
Length of screen: 5.0 ft

I.D. of riser pipe: 2"
Type of riser pipe: PVC

Depth to bottom of screened section: 33.0 ft

Length of blank section: 2 in

Depth of hole below ground surface: 33.0 ft

Woodward-Clyde	PROJECT NO: E9408Q/7200	PAGE 1 OF 1

Well Completion Form and General Diagram

MONITORING WELL INSTALLATION DETAILS

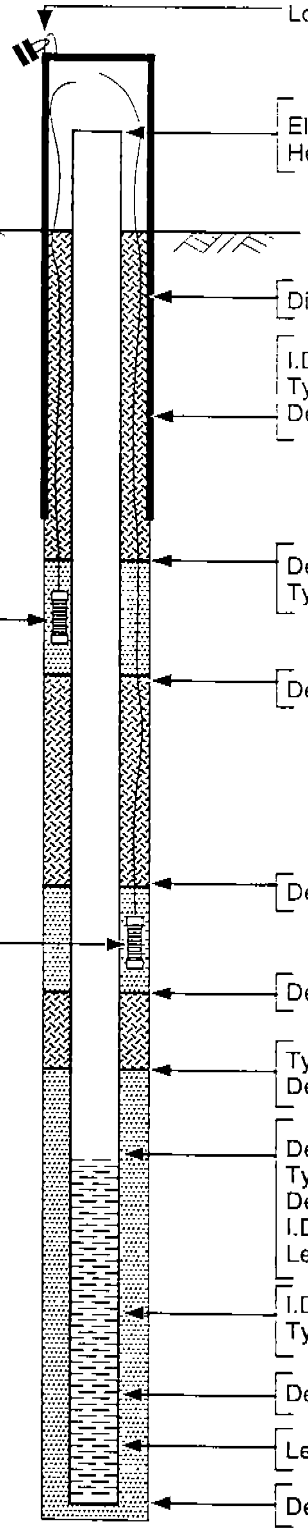
PROJECT: FT. RICHARDSON OUB Feasibility Study	WELL NO: MP-2
	WELL LOCATION: AREA-C
DATE COMPLETED: 10/24/96 TOTAL DEPTH: 33.0'	DRAWING NOT TO SCALE

NOTE:
***DEPTHS** listed are from ground level.*
***ELEVATIONS** listed are from state plane.*

Ground Elevation = 302.43

Vapor probe depth (shallow) 9.5 ft

Vapor probe depth (deep) 19.0 ft



Locking Cap

Elevation of top of riser pipe: 304.72 ft
Height of top of riser pipe above ground surface: 2.29 ft

Diameter of borehole: 6"

I.D. of surface casing.
Type of surface casing: 4"-steel
Depth of surface casing below ground: 5.71 ft

Depth to bottom of seal: 8.0 ft
Type of seal: Bentonite

Depth to bottom of sand: 10.0 ft

Depth to bottom of seal: 18.0 ft

Depth to bottom of sand: 20.0 ft

Type of sand pack: #20/40 screened
Depth of top of sand pack 26.0 ft

Depth to top of screened section: 28.0 ft
Type of screened section: PVC-10 slot
Describe openings: 0.010"
I.D. of screened section: 2"
Length of screen: 5.0 ft

I.D. of riser pipe: 2"
Type of riser pipe: PVC

Depth to bottom of screened section: 33.0 ft

Length of blank section: 2 in

Depth of hole below ground surface: 33.0 ft

Woodward-Clyde	PROJECT NO: E9408Q/7200	PAGE 1 OF 1

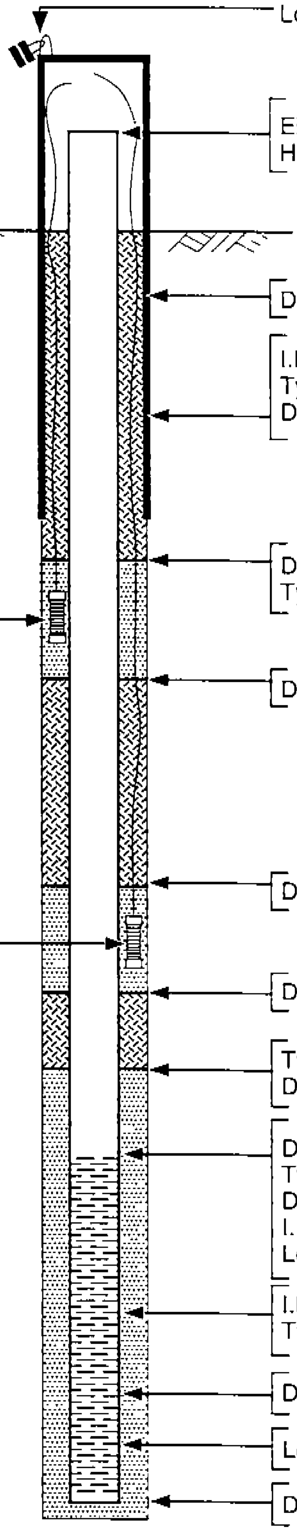
Well Completion Form and General Diagram

OUB 0029009

MONITORING WELL INSTALLATION DETAILS

PROJECT: FT. RICHARDSON OUB Feasibility Study	WELL NO: MP-3
	WELL LOCATION: AREA-C
DATE COMPLETED: 10/24/96 TOTAL DEPTH: 34.0'	DRAWING NOT TO SCALE

NOTE:
***DEPTHS** listed are from ground level.*
***ELEVATIONS** listed are from state plane.*



Locking Cap

Elevation of top of riser pipe: 303.66 ft
Height of top of riser pipe above ground surface: 1.69 ft

Ground Elevation = 301.97

Diameter of borehole: 6"

I.D. of surface casing.
Type of surface casing: 4"-steel
Depth of surface casing below ground: 6.31 ft

Depth to bottom of seal: 9.0 ft
Type of seal: Bentonite

Vapor probe depth (shallow) 9.5 ft

Depth to bottom of sand: 10.0 ft

Depth to bottom of seal: 23.0 ft

Vapor probe depth (deep) 23.5 ft

Depth to bottom of sand: 24.0 ft

Type of sand pack: #20/40 screened
Depth of top of sand pack 26.0 ft

Depth to top of screened section: 29.0 ft
Type of screened section: PVC-10 slot
Describe openings: 0.010"
I.D. of screened section: 2"
Length of screen: 5.0 ft

I.D. of riser pipe: 2"
Type of riser pipe: PVC

Depth to bottom of screened section: 33.0 ft

Length of blank section: 2 in

Depth of hole below ground surface: 34.0 ft

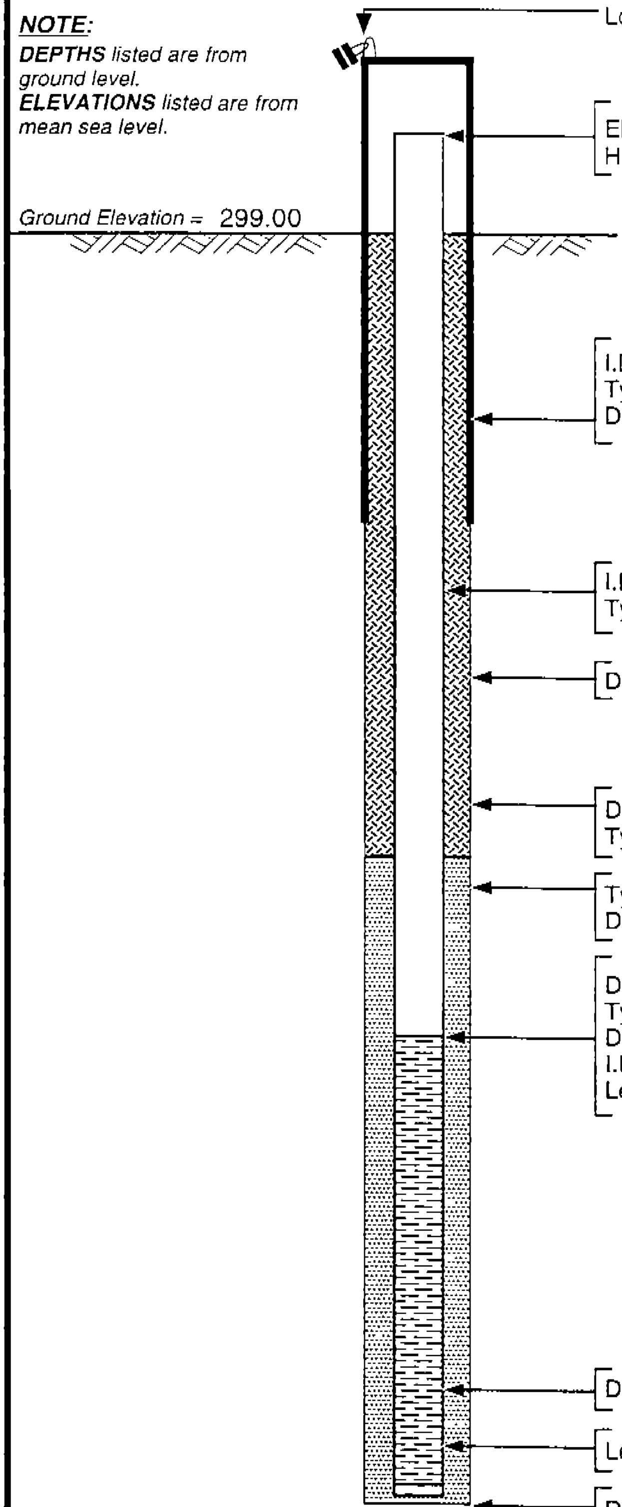
Woodward-Clyde	PROJECT NO: E9408Q/7200	PAGE 1 OF 1

Well Completion Form and General Diagram

MONITORING WELL INSTALLATION DETAILS

PROJECT: FT. RICHARDSON OUB Feasibility Study	WELL NO: PZ-1
	WELL LOCATION: N.E. of area B
DATE COMPLETED: 10/19/96 TOTAL DEPTH: 34.5'	DRAWING NOT TO SCALE

NOTE:
DEPTHS *listed are from ground level.*
ELEVATIONS *listed are from mean sea level.*



Elevation of top of riser pipe: 301.44 ft
Height of top of riser pipe above ground surface: 2.44 ft

I.D. of surface casing.
Type of surface casing: 4"-steel
Depth of surface casing below ground: 5.56 ft

I.D. of riser pipe: 2"
Type of riser pipe: carbon steel

Diameter of borehole: 6"

Depth to bottom of seal: 22.0 ft
Type of seal: Bentonite

Type of sand pack: #20/40 screened
Depth of top of sand pack 22.0 ft

Depth to top of screened section: 24.0 ft
Type of screened section: PVC-10 slot
Describe openings: 0.010"
I.D. of screened section: 2"
Length of screen: 10.0 ft

Depth to bottom of screened section: 34.0 ft

Length of blank section: 2 in

Depth of hole below ground surface: 34.5 ft

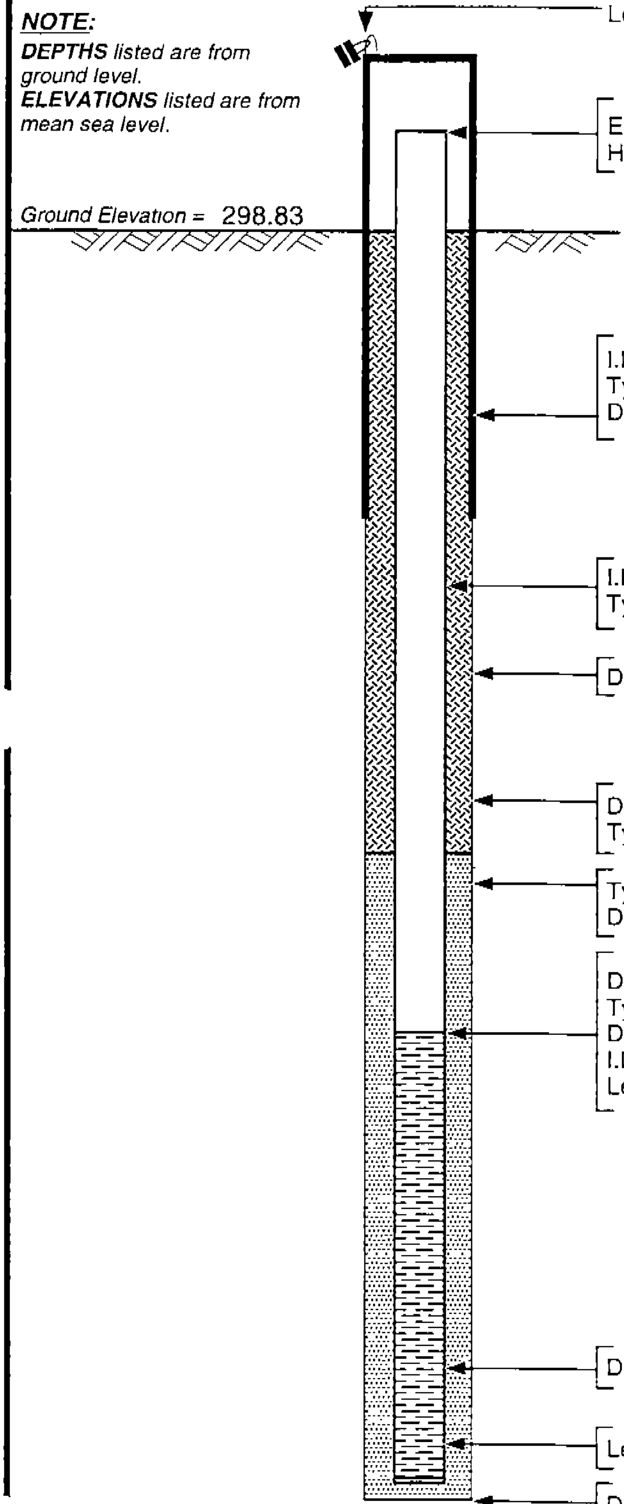
Woodward-Clyde	PROJECT NO: E9408Q/7200	PAGE 1 OF 1

Well Completion Form and General Diagram

MONITORING WELL INSTALLATION DETAILS

PROJECT: FT. RICHARDSON OUB Feasibility Study	WELL NO: PZ-2
	WELL LOCATION: N.E. of area B
DATE COMPLETED: 10/20/96 TOTAL DEPTH: 34.0'	DRAWING NOT TO SCALE

NOTE:
DEPTHS *listed are from ground level.*
ELEVATIONS *listed are from mean sea level.*



Elevation of top of riser pipe: 301.0 ft
Height of top of riser pipe above ground surface: 2.17 ft

I.D. of surface casing.
Type of surface casing: 4"-steel
Depth of surface casing below ground: 6.08 ft

I.D. of riser pipe: 2"
Type of riser pipe: PVC

Diameter of borehole: 6"

Depth to bottom of seal: 23.5 ft
Type of seal: Bentonite

Type of sand pack: #20/40 screened
Depth of top of sand pack 23.5 ft

Depth to top of screened section: 24.0 ft
Type of screened section: stainless-10 slot
Describe openings: 0.010"
I.D. of screened section: 2"
Length of screen: 10.0 ft

Depth to bottom of screened section: 34.0 ft

Length of blank section: 2 in

Depth of hole below ground surface: 34.0 ft

Woodward-Clyde	PROJECT NO: E9408Q/7200	PAGE 1 OF 1

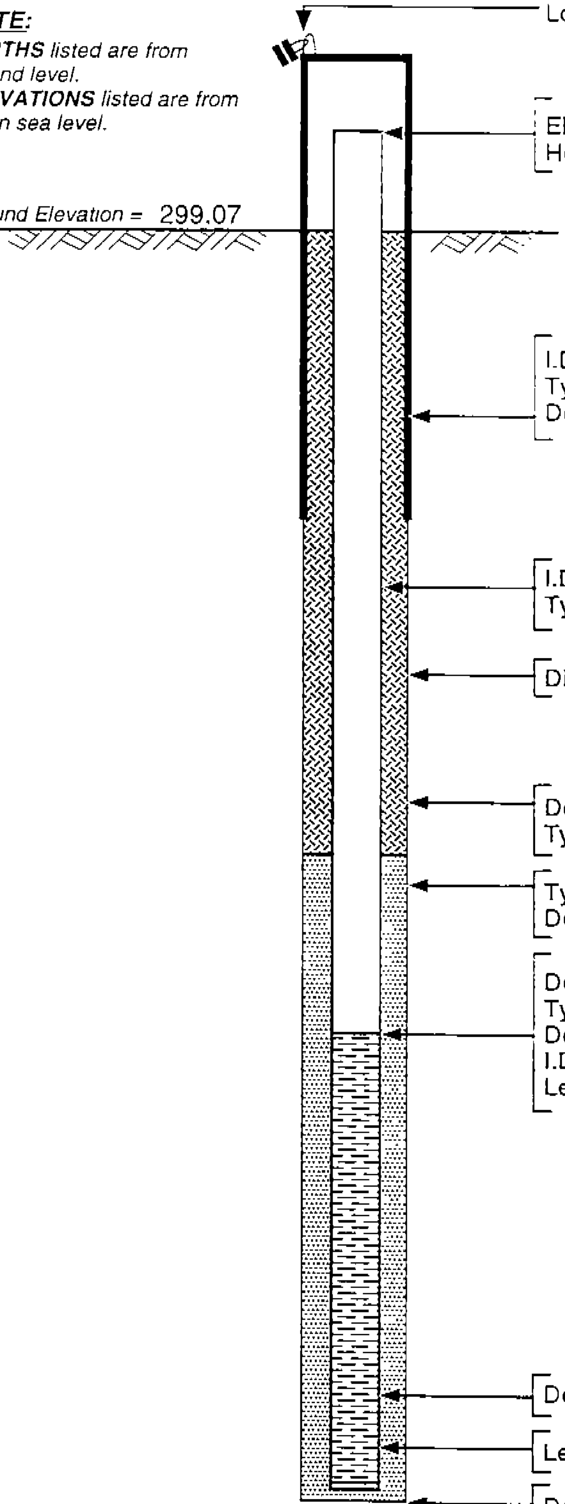
Well Completion Form and General Diagram

MONITORING WELL INSTALLATION DETAILS

PROJECT: FT. RICHARDSON OUB Feasibility Study	WELL NO: PZ-3
	WELL LOCATION: N.E. of area B
DATE COMPLETED: 10/21/96 TOTAL DEPTH: 34.0'	DRAWING NOT TO SCALE

NOTE:
DEPTHS *listed are from ground level.*
ELEVATIONS *listed are from mean sea level.*

Ground Elevation = 299.07



Locking Cap

Elevation of top of riser pipe: 301.09 ft
Height of top of riser pipe above ground surface: 2.02 ft

I.D. of surface casing.
Type of surface casing: 4"-steel
Depth of surface casing below ground: 5.98 ft

I.D. of riser pipe: 2"
Type of riser pipe: PVC

Diameter of borehole: 6"

Depth to bottom of seal: 22.0 ft
Type of seal: Bentonite

Type of sand pack: #20/40 screened
Depth of top of sand pack 22.0 ft

Depth to top of screened section: 24.0 ft
Type of screened section: PVC10 slot
Describe openings: 0.010"
I.D. of screened section: 2"
Length of screen: 10.0 ft

Depth to bottom of screened section: 34.0 ft

Length of blank section: 2 in

Depth of hole below ground surface: 34.0 ft

Woodward-Clyde	PROJECT NO: E9408Q/7200	PAGE 1 OF 1

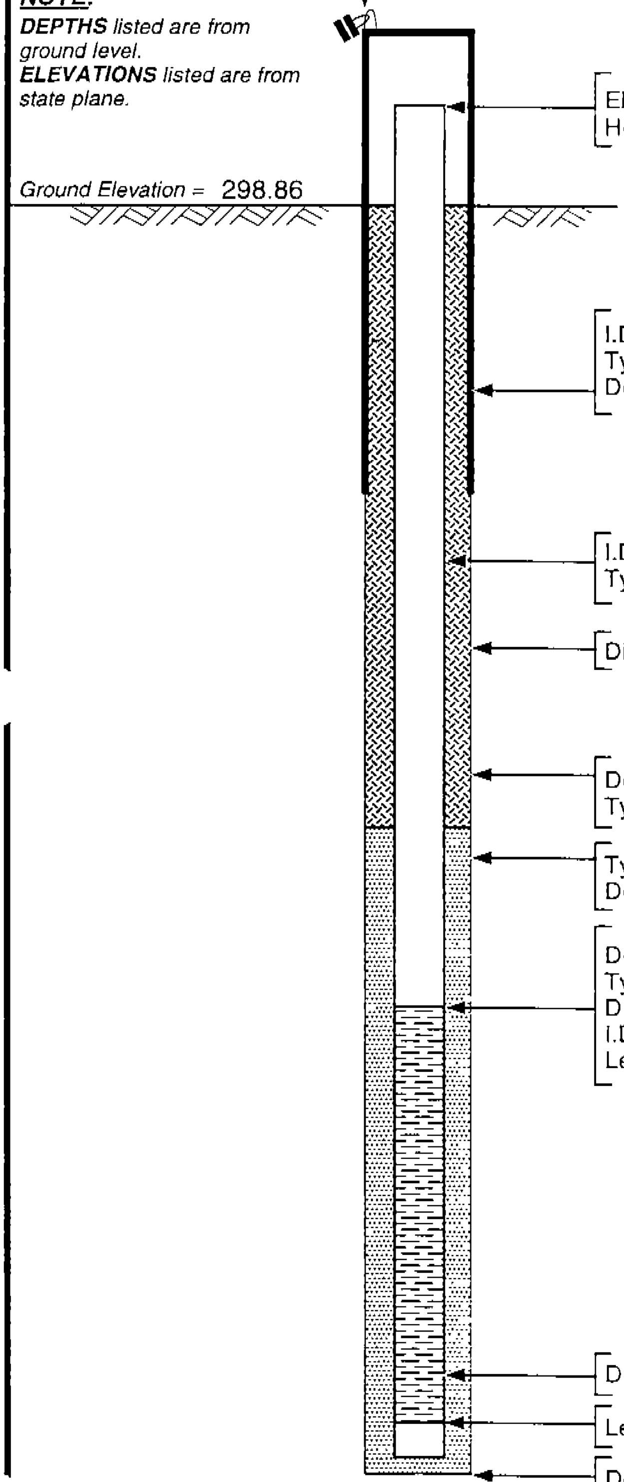
Well Completion Form and General Diagram

MONITORING WELL INSTALLATION DETAILS

PROJECT: FT. RICHARDSON OUB Feasibility Study	WELL NO: MW-18
	WELL LOCATION: N.E. of area B
DATE COMPLETED: 10/23/96 TOTAL DEPTH: 40.0'	DRAWING NOT TO SCALE

NOTE:
DEPTHS *listed are from ground level.*
ELEVATIONS *listed are from state plane.*

Ground Elevation = 298.86



Locking Cap

Elevation of top of riser pipe: 300.41 ft
Height of top of riser pipe above ground surface: 1.55 ft

I.D. of surface casing.
Type of surface casing: 6"-steel
Depth of surface casing below ground: 6.45 ft

I.D. of riser pipe: 4"
Type of riser pipe: carbon steel

Diameter of borehole: 8"

Depth to bottom of seal: 23.0 ft
Type of seal: Bentonite

Type of sand pack: #20/40 screened
Depth of top of sand pack 23.0 ft

Depth to top of screened section: 28.0 ft
Type of screened section: stainless-10 slot
Describe openings: 0.010"
I.D. of screened section: 4"
Length of screen: 10.0 ft

Depth to bottom of screened section: 38.0 ft

Length of blank section: .5 ft

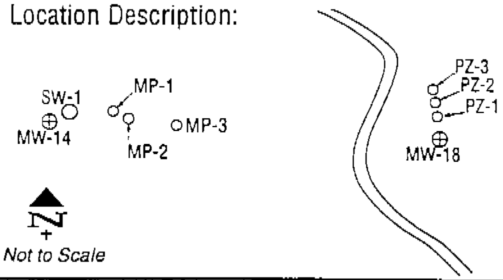
Depth of hole below ground surface: 40.0 ft

Woodward-Clyde	PROJECT NO: E9408Q/7200	PAGE 1 OF 1

Well Completion Form and General Diagram

Project: FT. RICH OUB FS	Field Hole No. PZ-1	Permanent Hole No. PZ-1

Location Description:



☐ Test Boring ☐ Monitoring Point ☒ Monitoring Well

Logged By: S. Kendall

Driller: Tester Drilling Services Rig: Moble B-61

Drill Method: Hollow Stem Auger (6")

Sample Method: Split Spoon Sampler (3" O.D. X 24")

Hammer Wt: 140 lb. Drop: 30"

Start Date: 10/19/96 Time: 0950

Complete Date: 10/19/96 Time: 1500

Weather: NA Instrumentation: Sensidyne FID

Location Coordinate System: State Plane

Northing (ft.) 2668965.38

Easting (ft.) 569130.07

Elevation Datum ☒ MSL ☐ Other

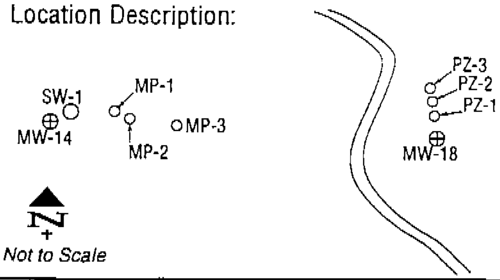
Top of Hole Elevation (ft.)	Depth Drilled (ft.)	Total Depth (ft.)	Depth to Groundwater (ft.)
301.44	34.5	34.5	00.0

Depth (ft.)	Sample I.D.	Sample Interval	USCS Symbol	Classification	Max. Size (in.)	Description and Remarks	Graphic Log	Blows/ 6 Inches	OVA Reading (ppm)	Water/ Screen Interval
30	PERM-1		SM	SAND, fine to coarse and fine gravel with trace silt, grayish green, wet	NA	80% recovery		200	0.0	
	PERM-2		GM	GRAVEL fine with some fine sand and little silt, greenish gray, moist	NA	100% recovery		250	0.0	
35				Boring ended at 34.5' below ground surface.						

Project No: E9408Q	Woodward-Clyde	Page 1 of 1	Hole No. PZ-1

Project: FT. RICH OUB FS	Field Hole No. PZ-2	Permanent Hole No. PZ-2

Location Description:



☐ Test Boring ☐ Monitoring Point ☒ Monitoring Well

Logged By: S. Kendall

Driller: Tester Drilling Services Rig: Moble B-61

Drill Method: Hollow Stem Auger (6")

Sample Method: Split Spoon Sampler (3" O.D. X 24")

Hammer Wt: 140 lb. Drop: 30"

Start Date: 10/20/96 Time: 0900

Complete Date: 10/20/96 Time: 1430

Weather: NA Instrumentation: Sensidyne FID

Location Coordinate System: State Plane

Northing (ft.) 2668957.38

Easting (ft.) 569132.87

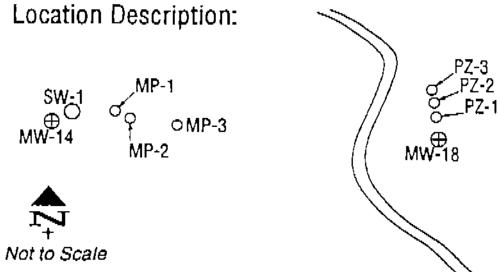
Elevation Datum ☒ MSL ☐ Other

Top of Hole Elevation (ft.)	Depth Drilled (ft.)	Total Depth (ft.)	Depth to Groundwater (ft.)
301.00	36.0	36.0	29.30

Depth (ft.)	Sample I.D.	Sample Interval	USCS Symbol	Classification	Max. Size (in.)	Description and Remarks	Graphic Log	Blows/ 6 Inches	OVA Reading (ppm)	Water/ Screen Interval
5										
10										
15										
20										
25										
30	No Permeability Sample	☒	SM	SAND fine, with fine gravel and silt, green, moist	NA	10% recovery		100/ 0.5"	0.0	
	PERM-3	☒	SM	SAND medium and fine gravel, with little silt, greenish gray, wet	NA	50% recovery		50 110	0.0	
35	PERM-4	☒	SM	SAND medium and fine gravel, with little silt, greenish gray, moist	NA	70% recovery		120 125 140	0.0	
				Boring ended at 36'						

Project: FT. RICH OUB FS	Field Hole No. PZ-3	Permanent Hole No. PZ-3

Location Description:



☐ Test Boring ☐ Monitoring Point ☒ Monitoring Well

Logged By: S. Kendall

Driller: Tester Drilling Services — Rig: Moble B-61

Drill Method: Hollow Stem Auger (6")

Sample Method: Split Spoon Sampler (3" O.D. X 24")

Hammer Wt: 140 lb. — Drop: 30"

Start Date: 10/20/96 — Time: 1545

Complete Date: 10/21/96 — Time: 1325

Weather: Clear, calm — Instrumentation: Sensidyne FID

Location Coordinate System: State Plane

Northing (ft.) 2668949.65

Easting (ft.) 569135.49

Elevation Datum ☒ MSL ☐ Other

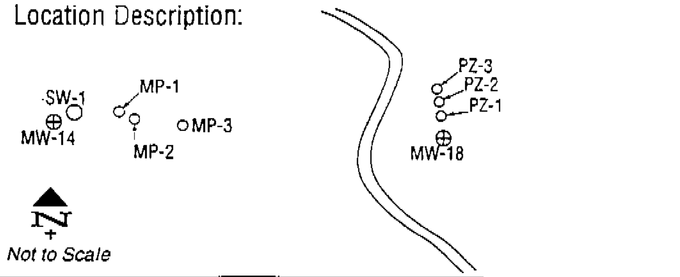
Top of Hole Elevation (ft.)	Depth Drilled (ft.)	Total Depth (ft.)	Depth to Groundwater (ft.)
301.09	34.0	34.0	27.20

Depth (ft.)	Sample I.D.	Sample Interval	USCS Symbol	Classification	Max. Size (in.)	Description and Remarks	Graphic Log	Blows/ 6 Inches	OVA Reading (ppm)	Water/ Screen Interval
5										
10										
15										
20										
25										
30	PERM-5	☒	SW	SAND, fine-medium with some fine gravel, trace silt, greenish gray, moist, wet	NA	80% recovery		100 136 87	20	
	PERM-6	☒	SW	SAND fine and fine GRAVEL, trace silt, greenish gray, wet	NA	60% recovery		88 100/1"	20	
35				Boring ended at 34'						

Project No: E9408Q	Woodward-Clyde	Page 1 of 1	Hole No. PZ-3

Project: FT. RICH OUB FS	Field Hole No. MW-18	Permanent Hole No. MW-18

Location Description:



☐ Test Boring ☐ Monitoring Point ☒ Monitoring Well

Logged By: J. Moncrieff

Driller: Tester Drilling Services Rig: Moble B-61

Drill Method: Hollow Stem Auger (8")

Sample Method: Split Spoon Sampler (3" O.D. X 30")

Hammer Wt: 140 lb. Drop: 30"

Start Date: 10/22/96 Time: 1045

Complete Date: 10/23/96 Time: 0920

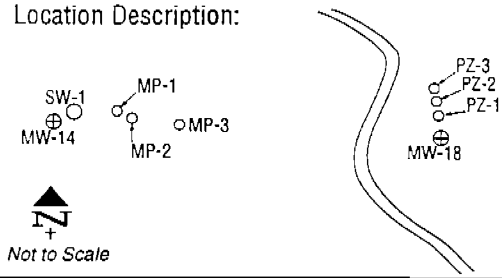
Weather: Clear, calm, cold 1°F Instrumentation: Sensidyne FID

Location Coordinate System: State Plane	Elevation Datum ☒ MSL ☐ Other			
Northing (ft.) 2668941.30	Top of Hole Elevation (ft.)	Depth Drilled (ft.)	Total Depth (ft.)	Depth to Groundwater (ft.)
Easting (ft.) 569136.96	300.41	40.0	40.0	37.25

Depth (ft.)	Sample I.D.	Sample Interval	USCS Symbol	Classification	Max. Size (in.)	Description and Remarks	Graphic Log	Blows/ 6 Inches	OVA Reading (ppm)	Water/ Screen Interval
0						Battery discharged on FID				
25		☒	GP	ROCK fractured, dry, 3" clean	NA	0% recovery		87		
30		☒	GP	GRAVEL, angular with some sand, greenish gray, wet	2.5	30% recovery		36 48 150		
35		☒	GP	ROCK, split-spoon destroyed		0% recovery				
		☒	GP	Slough only recovered		0% recovery		246 4"		
40		☒	GP	SAND medium with some silt, trace fine gravel, moist, brown		20% recovery		13/2' 248/6"		
				Boring ended at 40' below ground surface						

Project: FT. RICH OUB FS	Field Hole No. SW-1	Permanent Hole No. SW-1

Location Description:



☐ Test Boring ☐ Monitoring Point ☒ Monitoring Well

Logged By: J Moncrieff

Driller: Tester Drilling Services Rig: Moble B-61

Drill Method: Hollow Stem Auger (8")

Sample Method: Split Spoon Sampler (3" O.D. X 24")

Hammer Wt: 140 lb. Drop: 30"

Start Date: 10/23/96 Time: 1115

Complete Date: 10/23/96 Time: 1810

Weather: Pty cloudy, calm, 15°F Instrumentation: Sensidyne FID

Location Coordinate System: State Plane

Northing (ft.) 2668915.69

Easting (ft.) 568948.03

Elevation Datum ☒ MSL ☐ Other

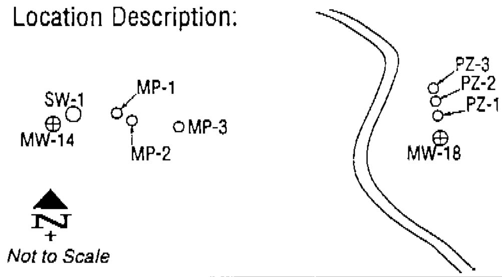
Top of Hole Elevation (ft.)	Depth Drilled (ft.)	Total Depth (ft.)	Depth to Groundwater (ft.)
305.17	39.0	39.0	30.59

Depth (ft.)	Sample I.D.	Sample Interval	USCS Symbol	Classification	Max. Size (in.)	Description and Remarks	Graphic Log	Blows/ 6 Inches	OVA Reading (ppm)	Water/ Screen Interval
15		X	GM	COBBLES and large SAND, with some fine gravel, few silt, gray with a small patch of orange, dry/ moist	2.5"	70% recovery		90 113	2.0	
20		X	GM	One angular rock recovered, dry	3"	0% recovery		46 72	1.0	
25		X	GW	Large SAND and medium sub-anglar gravel, gray with few orange patches, moist	NA	100% recovery		30 40	30	
30		X	GM	COBBLES with fine silt, gray, wet	NA	70% recovery		200	2.0	
35		X	GM	Two COBBLES	NA	0% recovery		200	1.0	
		X	GM	GRAVEL angular with fine gravel and silt, grayish brown, moist	2.5" NA	30% recovery 100% recovery		40 100/2" 43/100	1.0 2.0	
40				Boring ended at 39' below ground surface						

Project No: E9408Q	Woodward-Clyde	Page 1 of 1	Hole No. SW-1

Project: FT. RICH OUB FS	Field Hole No. MP-1	Permanent Hole No. MP-1

Location Description:



☐ Test Boring ☒ Monitoring Point ☐ Monitoring Well

Logged By: J. Moncrieff
Driller: Tester Drilling Services Rig: Moble B-61
Drill Method: Hollow Stem Auger (6")
Sample Method: Split Spoon Sampler (3" O.D. X 24")
Hammer Wt: 140 lb. Drop: 30"
Start Date: 10/24/96 Time: 1000
Complete Date: 10/24/96 Time: 1600
Weather: Clear, calm 5°F Instrumentation: Sensidyne FID

Location Coordinate System: State Plane
Northing (ft.) 2668917.01
Easting (ft.) 568953.70

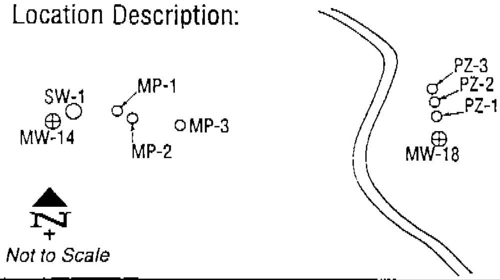
Elevation Datum ☒ MSL ☐ Other

Top of Hole Elevation (ft.)	Depth Drilled (ft.)	Total Depth (ft.)	Depth to Groundwater (ft.)
305.49	33.0	33.0	30.26

Depth (ft.)	Sample I.D.	Sample Interval	USCS Symbol	Classification	Max. Size (in.)	Description and Remarks	Graphic Log	Blows/ 6 Inches	OVA Reading (ppm)	Water/ Screen Interval
10	No subsurface sample taken	☒	GW	GRAVEL with cobbles and large sand, moist, brown, with dry pocket	NA	70% recovery		75 50/3"	1.0	
22	No subsurface sample taken	☒	ML	SILT with few gravel and cobbles, brown, moist	NA	30% recovery		1 20	15.0	
30	No subsurface sample taken	☒	GM	GRAVEL with coarse sand and few silt, brown, moist	NA	70% recovery		150/3"	4.0	
				Boring ended at 33' below ground surface.		Vapor probes placed at 9.5' and 23.5'				

Project: FT. RICH OUB FS	Field Hole No. MP-2	Permanent Hole No. MP-2

Location Description:



☐ Test Boring ☒ Monitoring Point ☐ Monitoring Well

Logged By: J. Moncrieff

Driller: Tester Drilling Services — Rig: Moble B-61

Drill Method: Hollow Stem Auger (6")

Sample Method: Split Spoon Sampler (3" O.D. X 24")

Hammer Wt: 140 lb. — Drop: 30"

Start Date: 10/24/96 — Time: 1900

Complete Date: 10/24/96 — Time: 2130

Weather: Clear, calm 5°F — Instrumentation: Sensidyne FID

Location Coordinate System: State Plane

Northing (ft.) 2668915.47

Easting (ft.) 568957.98

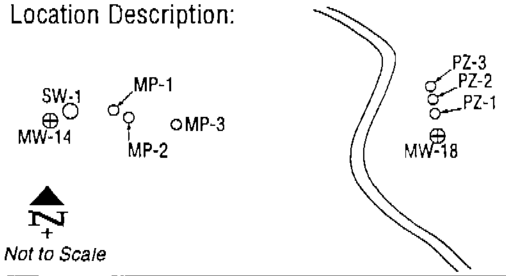
Elevation Datum: ☒ MSL ☐ Other

Top of Hole Elevation (ft.)	Depth Drilled (ft.)	Total Depth (ft.)	Depth to Groundwater (ft.)
304.72	33.0	33.0	29.56

Depth (ft.)	Sample I.D.	Sample Interval	USCS Symbol	Classification	Max. Size (in.)	Description and Remarks	Graphic Log	Blows/ 6 Inches	OVA Reading (ppm)	Water/ Screen Interval
0–33	No subsurface sample taken									
33–35				Boring ended at 33' below ground surface.		Vapor probes placed at 9.5' and 19'				

Project: FT. RICH OUB FS	Field Hole No. MP-3	Permanent Hole No. MP-3

Location Description:



☐ Test Boring ☒ Monitoring Point ☐ Monitoring Well

Logged By: J. Moncrieff

Driller: Tester Drilling Services Rig: Moble B-61

Drill Method: Hollow Stem Auger (6")

Sample Method: Split Spoon Sampler (3" O.D. X 24")

Hammer Wt: 140 lb. Drop: 30"

Start Date: 10/25/96 Time: 1115

Complete Date: 10/25/96 Time: 1515

Weather: Clear, cold, calm 0°F Instrumentation: Sensidyne FID

Location Coordinate System: State Plane

Northing (ft.) 2668914.84

Easting (ft.) 568966.67

Elevation Datum ☒ MSL ☐ Other

Top of Hole Elevation (ft.)	Depth Drilled (ft.)	Total Depth (ft.)	Depth to Groundwater (ft.)
303.66	34.0	33.0	17.0

Depth (ft.)	Sample I.D.	Sample Interval	USCS Symbol	Classification	Max. Size (in.)	Description and Remarks	Graphic Log	Blows/ 6 Inches	OVA Reading (ppm)	Water/ Screen Interval
10	No subsurface sample taken		GM	COBBLES and SAND with fine gravel and some silt, brown, moist	NA	70% recovery		120	1.5	
20	No subsurface sample taken		ML	CLAY with some gravel, brown, moist	NA	70% recovery, rest was slough.		16 25	40	
29.5	No subsurface sample taken		GM	GRAVEL with few silt, brown, moist	NA	30% recovery, rest was slough.		150/3"	10	
33				Boring ended at 33' below ground surface.		Vapor probes placed at 9.5' and 23.5'				