



PUBLIC SERVICE COMPANY OF NEW MEXICO

ALVARADO SQUARE ALBUQUERQUE, NEW MEXICO 87158 _ _ _ _

March 2, 1984

Mr. Anthony Drypolcher
Acting Bureau Chief
Groundwater and Hazardous
Waste Bureau
New Mexico Environmental
Improvement Division
Post Office box 968
Santa Fe, NM 87504-0968

RECEIVED

MAR 02 1984

GROUND WATER/HAZARDOUS WASTE
BUREAU

Dear Mr. Drypolcher:

Subject: Public Service Company of New Mexico (PNM)--
Person Generating Station, EPA ID NMT 360010342

Enclosed is PNM's assessment of the soil contamination resulting from the leakage of material from a subsurface storage tank located at Person Generating Station (Attachment 1). As you can see by the size of the document, a considerable amount of data has been collected and analyzed (some replicate laboratory analysis is still being processed) in an effort to fully characterize the extent of contaminated soil and potential for movement of this contamination through the vadose zone. It is our opinion that the area of contamination is localized near the point of origin as shown in Section 5.0 of Attachment 1.

It is also our opinion that the effects of this spilled material can be mitigated by the remedial action proposed in Attachment 2. PNM is proposing to remove the soil from the ground and treat on site, transport the material to a local landfill approved by NMEID, or transport the material to a treatment, storage, disposal facility capable of receiving such waste, dependent upon the technical merits and cost-effectiveness of each alternative. PNM is requesting NMEID concurrence that this level of mitigation satisfactorily meets NMEID's requirements for removal of contaminated materials as expressed in NMEID's letters of October 20, 1983, November 9, 1983, and February 2, 1984, prior to commencement of this work. Specifically we solicit your concurrence that our proposal for mitigation is responsive under the requirements of Section 74-4-10 New Mexico State Act (NMSA) and that once mitigation is completed, we will not be subject to Sections 206B, 206D, and Part III Hazardous Waste Management Regulations (HWMR). In addition, we ask for your concurrence that once this mitigation is completed, the facility will not be subject to the Part 5 Underground Injection Control (UIC) provisions of the New Mexico Water Quality Control Commission (WQCC) regulations.

Three groundwater monitoring wells have been installed near the spill location. Preliminary evaluation of groundwater obtained from these wells indicates levels of contamination are present which were neither anticipated from, nor supported by the results of PNM's assessment of

Mr. Anthony Drypolcher

-2-

March 2, 1984

soil contamination. No mechanism for the transport of the materials from the origin of the spill to the groundwater is presently identifiable (see Section 6.0 of Attachment 1). PNM intends, therefore, to further evaluate the contamination found in the groundwater.

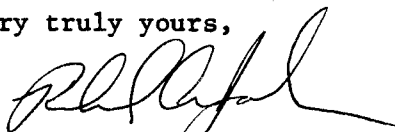
Three additional groundwater monitoring wells are to be installed. Analyses of water obtained from the three new wells, the three existing groundwater monitoring wells, and three production wells will be performed. PNM believes that this program should provide clarification that the extent of groundwater contamination which exists is expansive and that fact contributes to the conclusion that the source of the contamination is not Person Generating Station. PNM will also use the data collected in Phase IV to further support proposed mitigation involving the removal of contaminated soil. A detailed description of the action to be taken in this Phase IV investigation is found in Attachment 3.

PNM understands that NMEID has conducted some investigation of the groundwater within the general area of Person Generating Station. We would appreciate receiving copies of reports resulting from any such investigations which indicate the depth to groundwater, contamination found, groundwater gradients and potential sources of groundwater contamination. The availability of this information could greatly enhance PNM's evaluation, analysis, and understanding of the apparent groundwater contamination in the vicinity of Person Station.

On February 16, 1983, and February 21, 1984, David G. Boyer, NMEID, commented on previous submissions by PNM. Responses to these comments are found in Attachment 4 and 5.

We look forward to discussing this report with you and members of your staff on March 9, 1984. However, should you have any immediate questions, please contact me.

Very truly yours,



Richard A. Jordan, Manager
Regulatory Licensing and Compliance

HLP:wp
Enclosures

xc: Mr. David Boyer, NMEID
Mr. Jack Rex - 0216
Mr. Raymond Sisneros, NMEID

FINAL SOIL CONTAMINATION ASSESSMENT
AND PRELIMINARY GROUND WATER
CONTAMINATION ASSESSMENT
PNM PERSON GENERATING STATION

prepared for:

Public Service Company of New Mexico
Alvarado Square
Albuquerque, New Mexico 87103

February 29, 1984

prepared by:

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1.0 EXECUTIVE SUMMARY

Leakage from a waste storage tank at Person Generating Station has resulted in soil contamination adjacent to and below the tank. Chemical analyses indicate that the waste was mostly water containing some tetrachloroethylene (PCE), trichloroethane (TCA), and oil and grease. PCE concentrations indicative of liquid phase contamination are present in soils up to 60 feet below the surface. The surface expression of this liquid phase contamination encloses an area of approximately 30 square meters. Low-levels of PCE due to vapor phase contamination are also present to depths of 90 feet below the surface. The total mass of PCE in the soil has been determined to be between 100 and 105 kg. Waste storage practices in the tank ceased on October 13, 1983.

Concentrations of PCE (up to a maximum of 2.32 ppm) and TCA (up to a maximum of 10.7 ppm) were also detected in the top 20 feet of the saturated zone from three 130' deep monitoring wells located within 50 feet of the storage tank.

The monitoring data indicate the presence of PCE and TCA in the soil and at the top of the saturated zone below the storage tank. However, a viable mechanism which would account for transport of contaminants through the 110 foot thick vadose zone from the tank into the ground water has not been determined. Continued contaminant transport due to saturated fluid flow or unsaturated fluid flow is not

possible. In addition, the vertical concentration gradient is inconsistent with the only other possible mechanism: molecular diffusion/ vapor phase transport. Since several organic constituents found in the ground water (e.g., methylene chloride, 1-1 dichloroethylene, and dichloroethane) were not found in the storage tank waste, the possibility that the observed ground water quality may be a reflection of a regional ground water quality problem common in the south valley of Albuquerque rather than leakage solely or primarily from the storage tank must be considered.

This document contains a detailed description and analysis of the extent and magnitude of soil contamination. It also includes a preliminary analysis of contaminant transport mechanisms with respect to the soil contamination and ground water quality at the site.

2.0 PROGRAM HISTORY AND METHODOLOGY

The existence of problems with the waste storage tank at Person Station was first noted on October 13, 1983. Since that time PNM has proceeded with an exhaustive program to identify and characterize any environmental impacts that may have arisen due to the use of the storage tank. This program has included comprehensive waste and soil sampling and analysis programs, laboratory determinations of saturated and unsaturated hydraulic conductivities (using material from boreholes on the site), installation of 3 ground water monitoring wells, and precise measurement of water levels in these wells. This work is being performed by PNM, Geoscience Consultants, Ltd., and Metric Corporation. The extent of soil contamination has been defined and characterized in detail. The potential impact to ground water and possible mechanisms for transport of contaminants to the ground water are currently being investigated.

2.1 PROJECT HISTORY

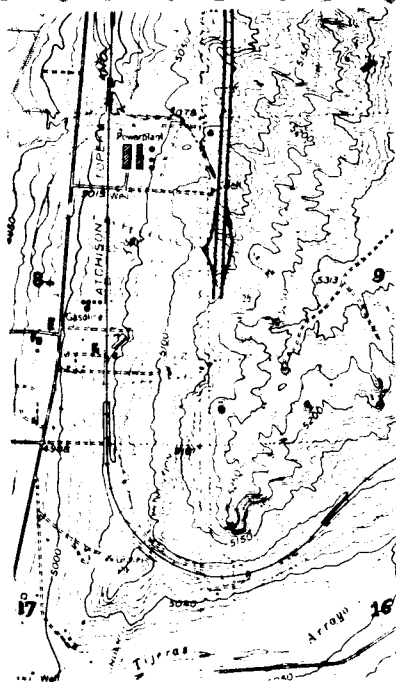
The Hazardous Waste Section of the Environmental Improvement Division was informed of the Phase I sampling program (October 24-27, 1984). In this phase 5 boreholes were drilled and sampled. Phase II field investigations commenced on December 19, 1983. The PS-6 through PS-13 (Phase II) bore hole/soil sampling program was completed on December 27, 1983. Ms. Devon Jercinovic of the EID Ground

Water Section observed drilling and sampling during the last corehole (PS-13) of this phase, and took splits of soil samples. She also took a ground water sample from Person Station water supply well #1. Phase III soil sampling (core holes PS-14 through PS-19) was begun on January 30, 1984 and completed on February 2, 1984. Phase III also included drilling three boreholes for background soil chemistry with completion of these boreholes as monitor wells (Feb.6 - Feb. 20). Ms. Jercinovic also observed the monitor well installation. Figure 2-1 shows the location and total depth of each bore hole and monitor well. A summary of the communications between PNM and the NMEID is provided in Table 2-1.

2.2 SOIL SAMPLING METHODOLOGY

During the period of October 24 - October 27, 1983 an initial drilling and soil sampling program was carried out by PNM and Geoscience Consultants at Person Generating Station. These holes were sampled at 2.5', 5.0', or 10' intervals with a split spoon sampler. Before and after sample removal, the split spoon samplers were entirely disassembled, steam (250° F) cleaned, and allowed to dry prior to taking another sample. The upper and lower 6 cm of the 46 cm long split spoon sample were discarded to avoid sample contamination from material that may have been present in or on the sides of the auger (Figure 2-2).

Immediately after splitting the core barrel, samples were taken throughout the length of the core to minimize the



Sec. 8,
T 9N
R 3E
Person Station

PSMW-3 •

127'

Distance Between Wells

N

62.0'

19
90'

1
50'

16
90'

15
90'

14
90'

17
90'

7
90'

4
90'

8
107'

6
90'

3
60'

5
90'

2
50'

• PSMW-2

131'

98.5'

10

18
90'

114'

13

12
90'

9

107'

PSMW-1

131'

Hydraulic Gradient

10 5 0 5 10 Feet

FIGURE 2-1 Location and Total Depths of Coreholes and Monitoring Wells

TABLE 2-1

SUMMARY OF PNM SUBMISSIONS AND NMEID RESPONSES

Originator	Date	Summary
PNM	10/13/83	Verbal notification of spill of potentially hazardous material had occurred at Person Generating Station. Use of tank ceased on this date.
NMEID	10/18/83	NMEID personnel arrived at Person Generating Station to review the problem.
NMEID	10/19/83	Hazardous waste compliance inspection conducted.
NMEID	10/20/83	Request by NMEID for a plan of cleanup action to occur at Person Generating Station
PNM	11/03/83	Written response by PNM to NMEID letter of 10/20/83. Description of work done on Phase I of investigation to determine extent of soil contamination.
NMEID	11/09/83	Warning letter issued stating Person Generating Station in violation of New Mexico Hazardous Waste Management Regulations - Received November 16, 1983.
PNM	12/09/83	PNM's response to NMEID's letter of 11/09/83 detailing planned investigation and feasibility study and background discussion of Person Generating Station.
PNM	12/12/83	PNM met with NMEID staff in Santa Fe to discuss PNM's letter of 12/09/83. NMEID requested further clarification of response.
PNM	12/16/83	PNM's clarification of response dated 12/09/83 as requested in discussion 12/12/83
PNM	12/16/83	Discussion of initial sampling plan, laboratory results, Phase II and III sampling plans, interlaboratory analytical checks, ground water sampling, use of PCE as most conservative organic tracer.

PNM	12/23/84	Correction of typographical error found in technical data submitted 12/16/83.
NMEID	12/27/83	Collection of split samples with PNM at Person Generating Station.
PNM	12/29/93	Submission of information to NMEID agreed to 12/12/83 as follows: Minutes of Dec. 12, 1983, Meeting of PNM and NMEID; Summary of Phase I Investigation at Public Service Company of New Mexico - Person Generating Station; Geologic Description of Person Well - Field Area; Description of Person Generating Station Production Wells; Waste Oil Recycling at PNM Generating Facilities
PNM	01/20/84	Submission of preliminary analytical results for soil sampling completed 12/23/83. Statement that Phase III sampling would begin and that ground water wells would be installed. PNM requests NMEID comments by 01/29/84.
NMEID	02/02/84	Acceptance of PNM's response of 12/16/83. Acceptance of investigation and feasibility study proposed by PNM 12/09/83.
NMEID	02/08/84	NMEID provided analytical results for one soil sample (EID Sample 1-8312270910). This was hand delivered by Devon Jercinovic.



Figure 2-2 Photo of Split Spoon Sample.
Taken prior to removal of ends to assure no
sample cross contamination. Note uniformity
of particles.



Figure 2-3 Photo of Sample Vials with Soil.
Samples in 40ml vials from entire length
of core to reduce the effect of particle
size on analyses.

effect of any small difference in grain size. Samples were collected in 40 ml VOA vials for chemical analysis (Figure 2-3). The remainder of the core was frozen in plastic bags for any future analysis that may be required. Samples were handled with disposable rubber gloves and discarded after each use to prevent cross-contamination.

At least every 10 feet a representative sample was taken immediately after opening the core barrel for soil moisture analysis. The samples were immediately sealed in two plastic whirlpaks to prevent moisture loss. Samples were kept cool and transported to the laboratory daily for analysis. Samples from depths of 25', 40', and 70' in hole PS-4 were sent to Dr. Daniel B. Stephens at NMIMT for development of soil moisture characteristic curves in order to determine unsaturated hydraulic conductivity (K_u) as a function of volumetric soil moisture (θ) for the material at the site.

The auger holes were backfilled with bentonite pellets and granular bentonite to seal the hole and to insure that fluids could not move down the bore hole.

2.3 GROUND WATER SAMPLING METHODOLOGY

This section describes the design, construction, and initial sampling method of three monitor wells installed at Person Generating Station during the week of February 6, 1984. The three wells are designated PSMW-1, PSMW-2, and PSMW-3.

Construction diagrams for each of the wells are

presented in Figures 2-4, 2-5, and 2-6. Identical procedures were followed for construction of each of the wells. Since one purpose of the wells is to monitor organic solvent levels in the ground-water, special care was taken to insure that no contaminants were introduced by the construction techniques.

At each well location, a 6-5/8 inch nominal diameter hole was advanced with a 3-1/4 inch i.d. hollow stem auger to the approximate water table elevation. The augers were thoroughly steam cleaned before each hole was augered.

Following augering, the bottom interior of the auger was cleaned with a three inch ring sampler, and the string of augers was raised approximately 10 feet above the bottom of the hole. Subsequently, a 20 foot long, 2 inch diameter, pipe-base, wire wound stainless steel screen with 0.010 inch slots was driven approximately 18 feet beneath the water table (see Figures 2-4, 2-5, and 2-6). The blank casing above the screen to the ground surface consists of threaded and coupled schedule 40, stainless steel pipe. The driving hammer, screen, pipe, and couplings were all thoroughly steam cleaned and allowed to dry at the site prior to installation.

After the driving was completed, the hollow-stem auger was removed and the annular space was backfilled with alternating layers of 10-20 quartz sand and 200 mesh bentonite as shown in Figures 2-4, 2-5, and 2-6. The backfill materials were placed dry.

Each well was then completed with a lockable concrete and steel well head and a neoprene cap.

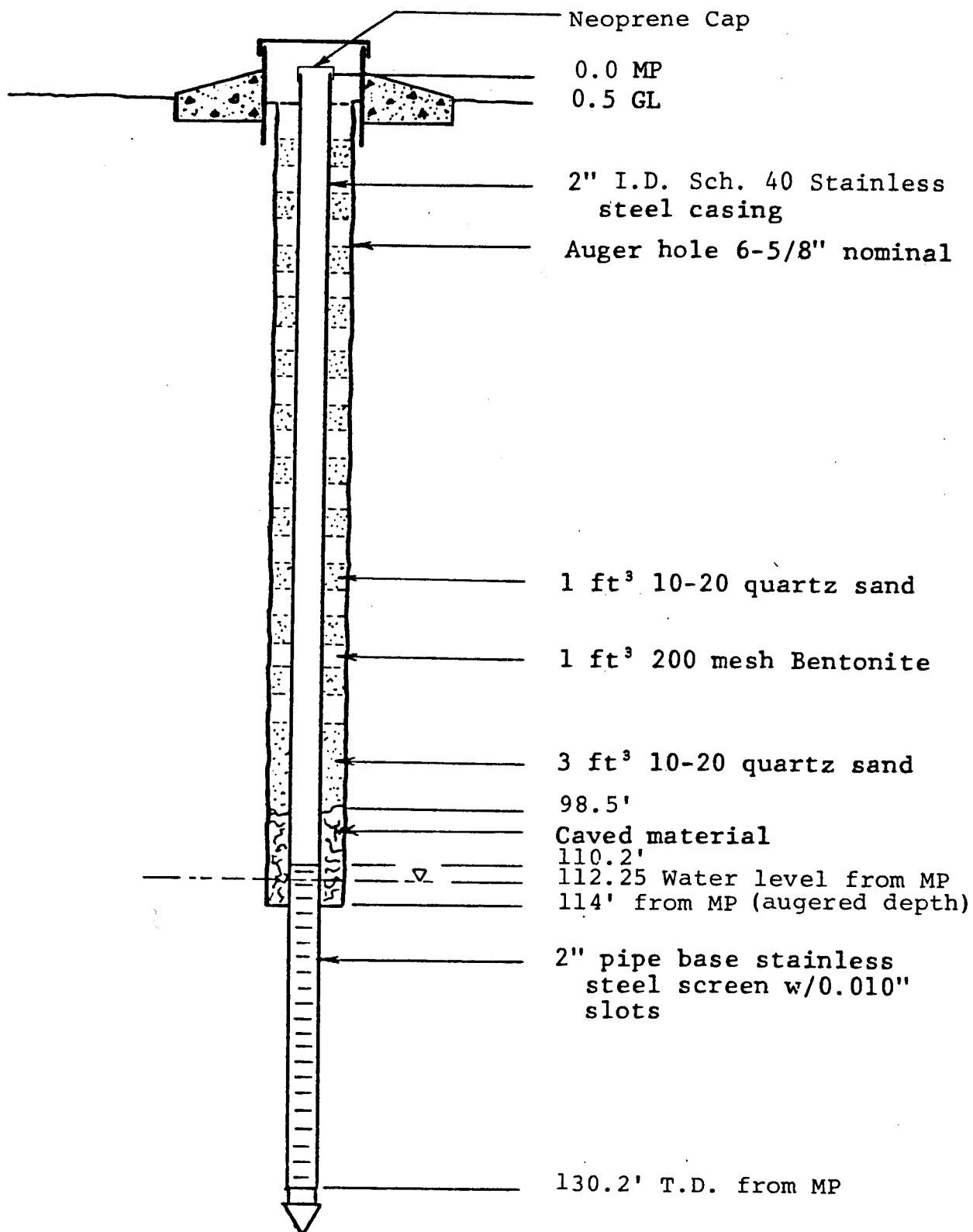


Figure 2-4 Construction Diagram
PSMW-1

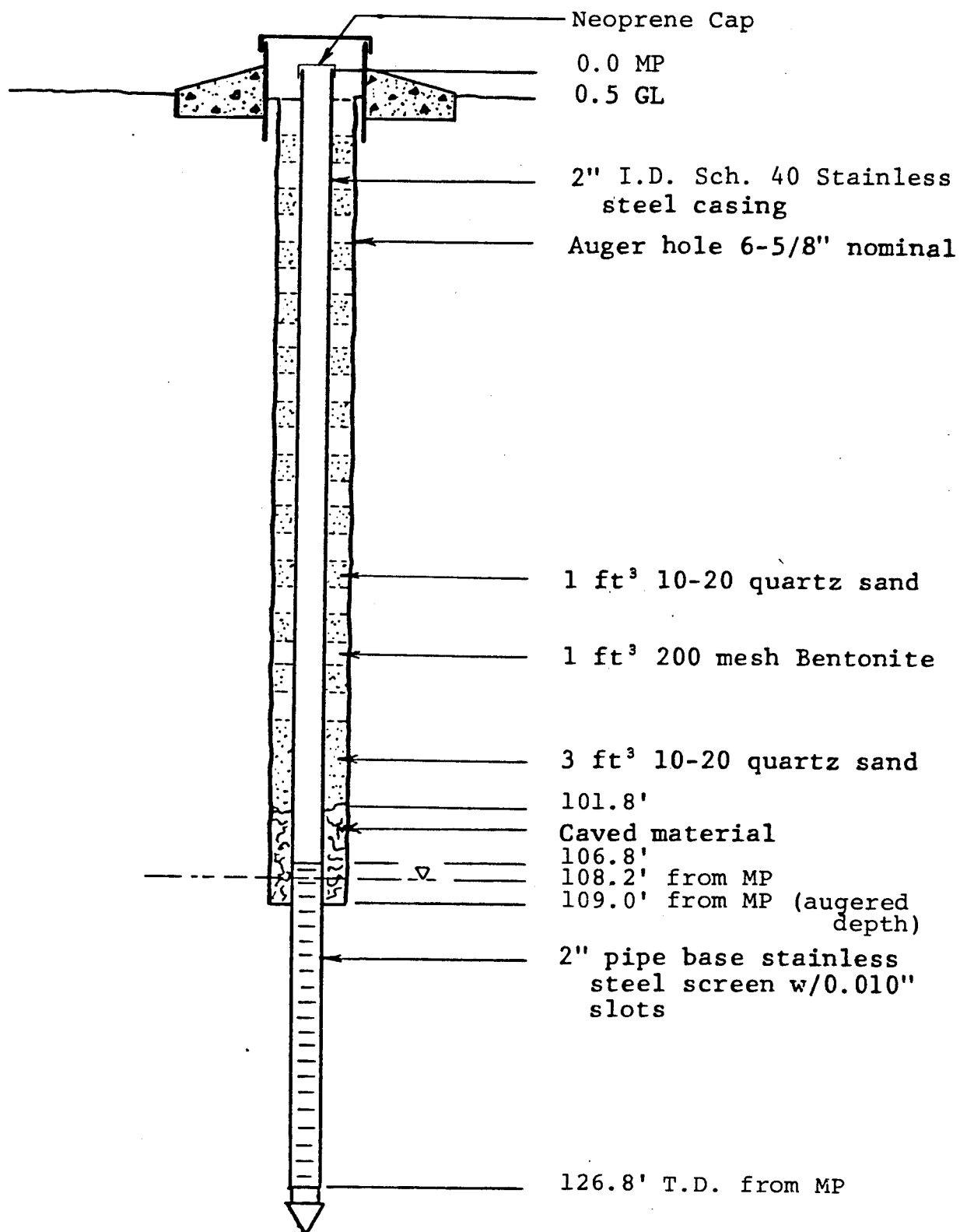


Figure 2-5 - Construction Diagram
PSMW-2

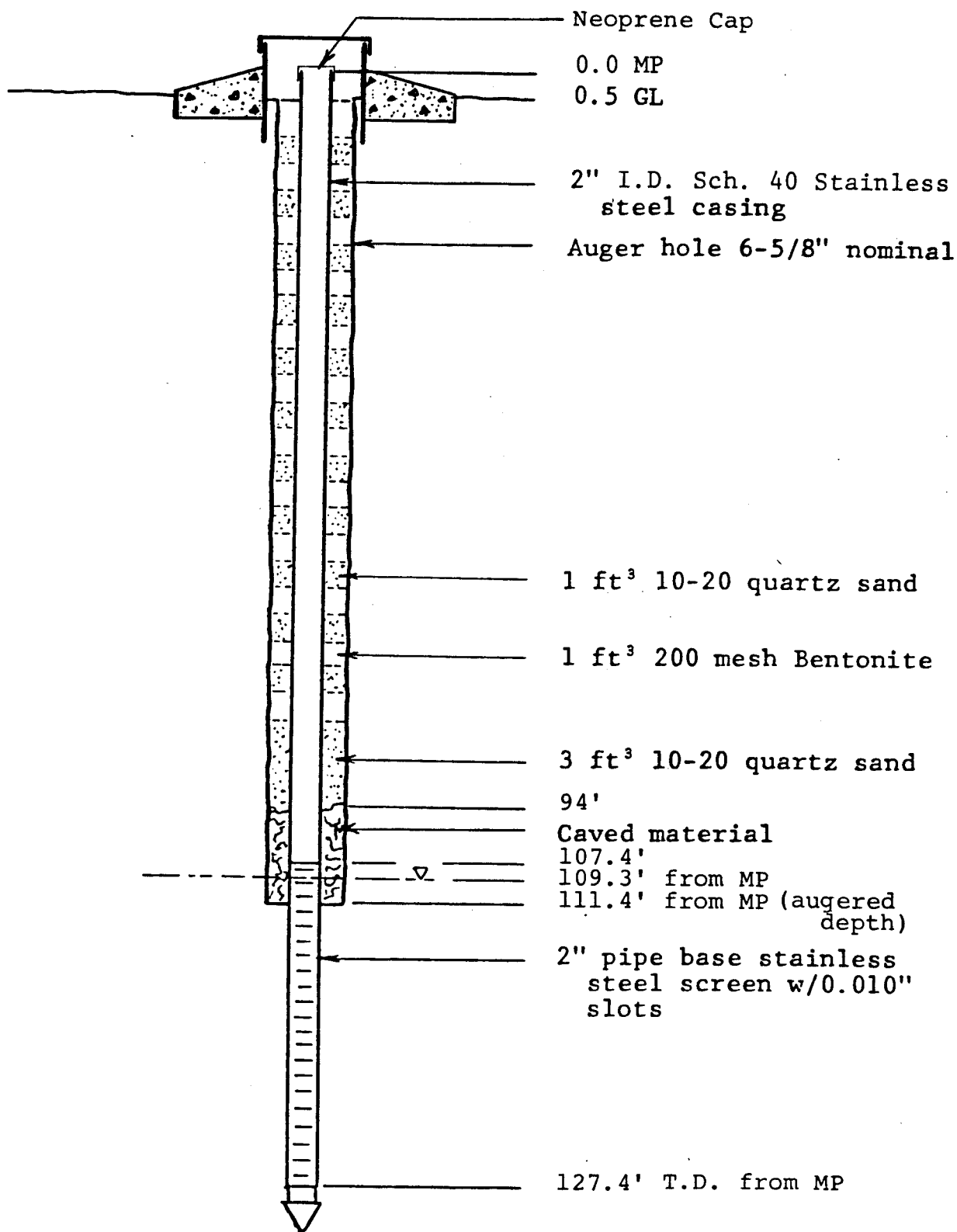


Figure 2-6 Construction Diagram
PMSW-3

For development and sampling purposes, a stainless steel bailer with teflon check valves was dedicated to each well. Each bailer is equipped with a removeable upper check valve to prevent the escape of volatile constituents during sampling (Figure 2-7). The upper valve is removed for development and purging of the wells to ease emptying of the bailer. A polypropylene rope, bailer emptying device (see Figure 2-8), and polyethylene ground cloth are also dedicated to each well to prevent cross contamination.

Each of the wells was bailed on two separate days for the purpose of development prior to sampling. Approximately 15 gallons of water was removed from each well each day.

The bailing was conducted using a small portable rig with a cathead hoist. Prior to bailing, the cathead, mast, and crown block on the rig were steam cleaned as well as the bailer, rope, and ground cloth. During bailing, the rope was laid on the ground cloth to prevent contamination from the soil. Before moving to another well during any bailing operation, the cathead and crown block were re-steam cleaned. Following the use of a particular bailer, it was disassembled and steam cleaned along with its rope and ground cloth. Each bailer along with its rope and ground cloth is stored in an individual tube to keep it clean between uses.

On February 13, 1984, each of the three monitor wells, PSMW-1, PSMW-2, and PSMW-3 was sampled. Using the procedures outlined above for bailing, two casing volumes (approximately 3.25 gallons) were removed from each well.

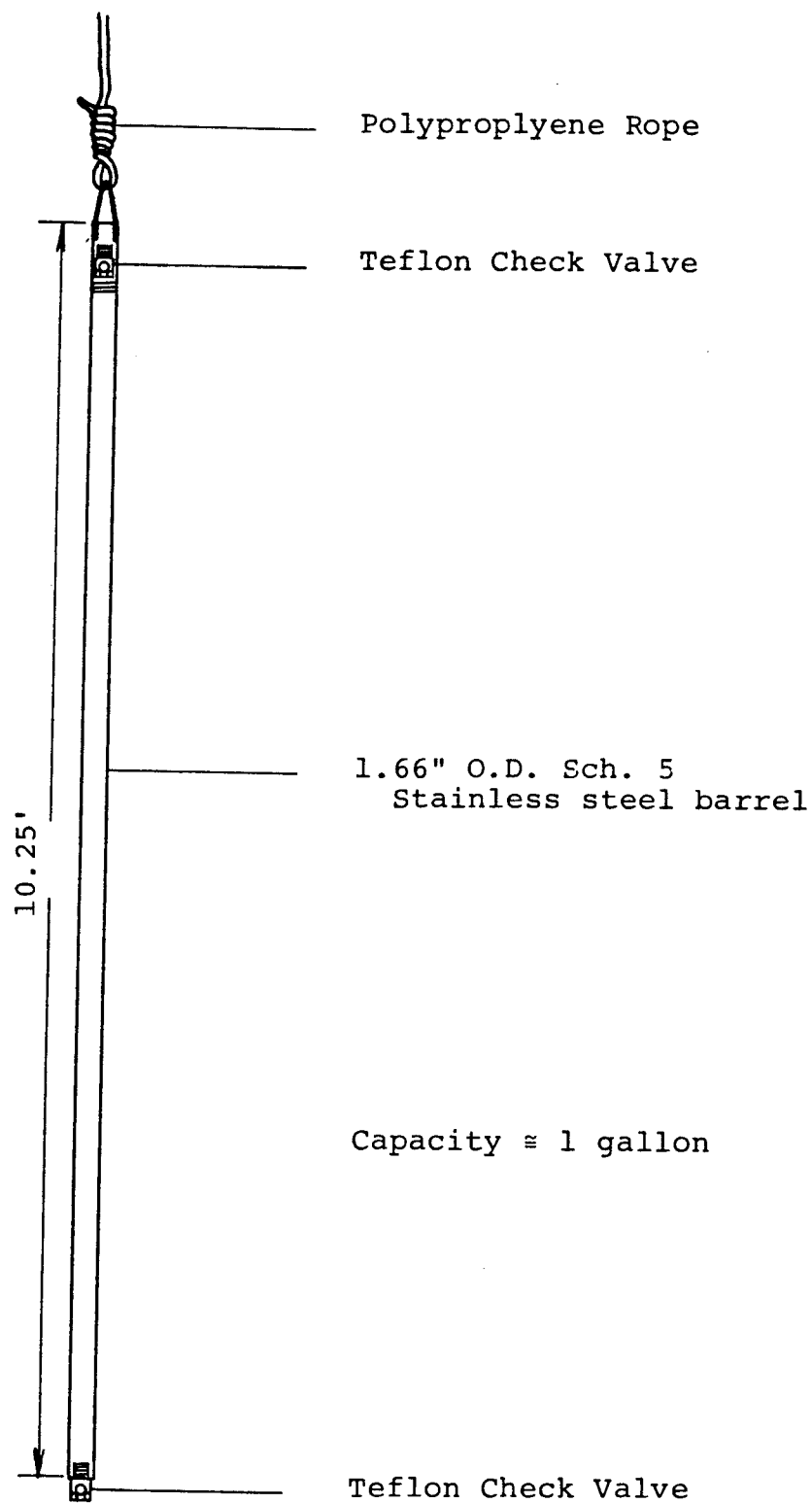


Figure 2-7 Stainless Steel Bailer Details

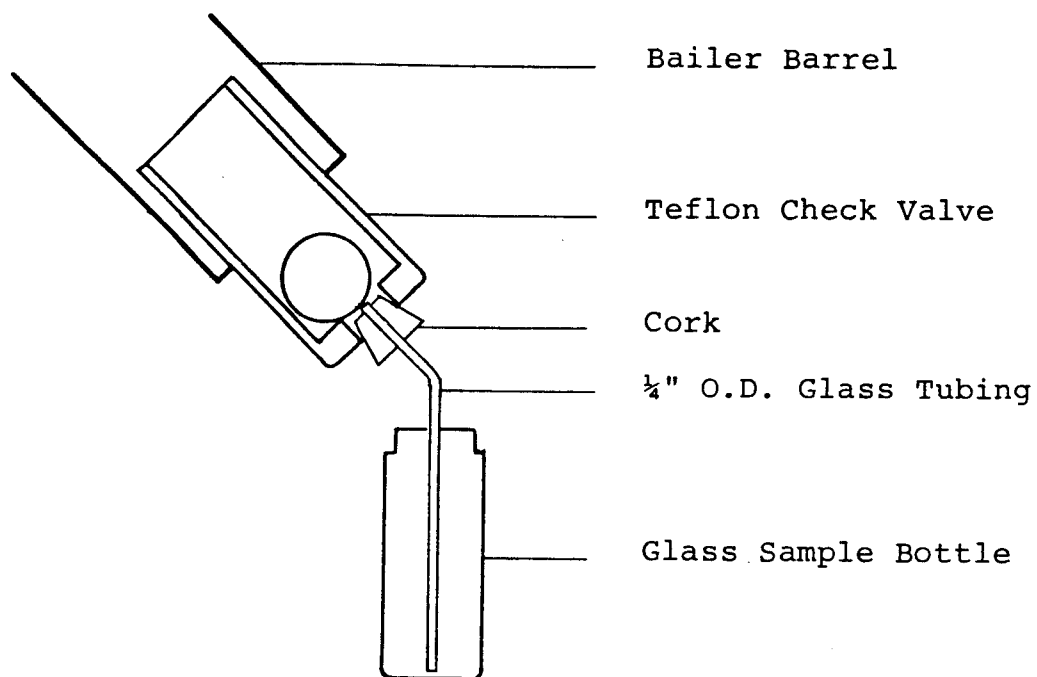


Figure 2-8 Bailer Emptying Device

The upper check valve was then installed in the bailer and samples were collected in glass bottles using a dedicated, steam cleaned bailer sampling device as shown in Figure 2-8.

2.4 CHEMICAL ANALYSIS METHODOLOGY

Soil samples analyzed for tetrachloroethylene (PCE) were stored frozen in VOA vials until analyses were performed. In the laboratory, samples were thawed and a representative portion of the soil in the vial was used for methanol extraction. The extract was analyzed using gas chromatography with electron capture detection. The procedure that was utilized is included in "Test Methods for Evaluating Solid Waste", 2nd edition, USEPA, SWER, SW846, 1982 and "Organic Analysis using Gas Chromatography/Mass Spectrometry", 1979, Budde & Eichelberger, Ann Arbor Science Press.

Replicate samples from some vials were analyzed to evaluate PCE concentration variability due to grain size variation in the vial and differences introduced by subsampling soil from the VOA vial. Since tetrachloroethylene (PCE) is the least volatile of the wastes stored in the tank, it will have a longer residence time in the soil and thus it was chosen as the most conservative organic tracer for studying the soil contamination. A number of soil samples were analyzed for other organic and inorganic species. Selected sample splits were also sent to Radian Corporation for analysis.

Ground water samples were not frozen, but were analyzed within 48 hours of the sampling. The analytical procedures employed for ground water samples was EPA method 601 (EPA-600/4-82-057, July 1982). Radian Corporation performed the analyses with a Tracor Model 560 gas chromatograph equipped with a Hall electrolytic conductivity detector. Sample introduction was effected using the purge-and-trap technique.

Soil moisture tests were done by drying the material at 75°C for 36 hours. This method assured the release of all the moisture in the sample with the exception of molecular (bound water) which does not affect unsaturated hydraulic conductivities (Ku).

2.5 LABORATORY DETERMINATION OF UNSATURATED HYDRAULIC CONDUCTIVITY (KU)

Three soil samples from Phase I sampling (PS-4 25', 40', and 70') sent to Dr. Daniel B. Stephens of NMINT were analyzed in the laboratory to determine Ku values. Since the material was quite uniform throughout, the soil moisture characteristic curves did not vary greatly with depth.

All moisture content data are reported on a volumetric rather than on a mass basis. During analysis for volumetric water content and pressure head, the soil remains in stainless steel rings. Two methods of analysis were employed: the hanging water column and the volumetric pressure plate extractor. Procedures for both methods follow those prescribed in Methods of Soil Analysis, American Society of Agronomy, C.A. Black, et al. (eds), 1965. The results of the analysis are represented graphically in

Section 4.3.

During the final step of determining moisture content versus pressure head, the soil samples are oven dried for 24 hours at 105°C. The oven drying is necessary to calculate water contents and porosity. To determine saturated hydraulic conductivity all samples were placed in a constant head permeameter for about 24 hours. Socorro city tap water was used in the permeameter. There was no evidence of piping through any of the samples. Measurements of hydraulic gradient and flow rate in the permeameter were taken within the subsequent 24 hour period.

A methodology by Mualem (WRR,12(3), 1976) to determine hydraulic conductivity versus pressure head was used in conjunction with a computer program by R. Van Genuchten (Princeton University, Civil Engineering Department, Research Report 78-WR-08, 1978). Data requirements for the computer model include the volumetric water content versus pressure head and saturated hydraulic conductivity. Recently reported studies and previous experience indicate that this approach provides an accurate representation of the unsaturated hydraulic conductivities (Van Genuchten, 1980, Soil Science Soc. Amer. Proc. 44(5)).

3.0 SOIL AND GROUND WATER ANALYSES DATA

This section is a compilation of the results of all the soil and ground water analyses performed to date.

3.1 SOIL MOISTURE ANALYSES

The results of the soil moisture analysis are tabulated in Table 3-1 and copies of the original laboratory reports (Appendix A). Table 3-1 converts weight % moisture content reported by the laboratory to the volumetric moisture content. The volumetric moisture content is necessary to determine Ku values from soil moisture characteristic curves. The results from the moisture content analyses show a uniform gradient with an average value of less than 9%. These volumetric moisture contents yield very low Ku values when using data developed from the three samples taken at various depths (25', 40', and 70') in PS-4. Grain size analyses are presented in Appendix A.

3.2 CHEMICAL ANALYSES OF SOIL

The results of analyses are tabulated by 10' intervals in Table 3-2. In addition, some soil samples were also analyzed for trichloroethane (TCA) and lead (Pb). See Table 3-3 for the results of TCA and PCE concentrations in soil samples where both parameters were analyzed. Note the high ratio of PCE to TCA found in all the samples. Pb was non-detectable in all 38 samples analyzed ($<.002$ ppm) (Appendix A). The results of these analyses are in the lab reports dated January 12, 19, 24, and February 14, 1984 (pages

TABLE 3-1
MOISTURE CONTENT OF UNSATURATED ZONE
PERSON STATION

	<u>depth</u>	<u>wt % fluid</u>	<u>ρ^*</u>	<u>θ^{**}</u>
PS-1	30	3.67	1.6	5.8
	40	4.27	1.6	6.83
	50	2.28	1.65	3.76
				av. θ = 5.4
PS-2	22.5	7.85	1.5	11.8
	32.5	4.95	1.6	7.9
	42.5	3.64	1.65	6.0
	50.00	6.56	1.5	9.8
				av. θ = 8.9
PS-3	30	3.14	1.65	5.2
	40	3.81	1.65	6.3
	50	2.87	1.65	4.7
	60	5.74	1.5	8.61
				av. θ = 6.2
PS-4	5	3.15	1.65	5.2
	10	3.98	1.65	6.6
	15	5.6	1.65	9.2
	20	6.67	1.5	10.00
	25	5.08	1.65	8.4
	30	5.78	1.5	8.7
	35	9.24	1.4	12.9
	40	4.32	1.6	6.48
	50	4.93	1.65	8.1
	60	5.11	1.65	8.4
	70	5.19	1.6	8.3
	80	7.06	1.5	10.6
	90	5.69	1.65	9.4
				av. θ = 9.0
PS-5	15	4.45	1.7	7.6
	20	5.18	1.5	7.7
	25	5.89	1.5	8.8
	30	7.13	1.5	10.7
	35	7.05	1.5	10.6
	40	4.43	1.65	7.3
	45	5.28	1.5	7.9
	50	6.68	1.5	10.2
	60	3.42	1.6	5.6
	70	3.10	1.7	5.3
	80	2.39	1.6	3.8
	90	2.76	1.7	4.7
				av. θ = 7.5

* ρ = Bulk Density (g/cc) (determined from field observations of grain size verified by lab tests)

** θ = Volumetric Moisture Content (%)

TABLE 3-1 continued

	depth	wt % fluid	ρ^*	θ^{**}
PS-6	10-11.5	4.8	1.65	7.9
	20-21.5	4.81	1.5	7.2
	30-31.5	4.25	1.7	7.2
	40-41.5	5.03	1.7	8.6
	50-51.5	3.69	1.7	6.3
	60-61.5	4.77	1.65	7.9
	70-71.5	4.29	1.6	6.9
	80	4.99	1.6	8.0
	90	4.93	1.7	4.9
				av. $\theta = 7.2$
PS-7	10-11.5	5.55	1.5	8.3
	20-21.5	3.85	1.7	6.6
	30-31.5	4.18	1.6	6.7
	40-41.5	4.19	1.65	7.0
	50-51.5	2.88	1.5	4.3
	60	4.75	1.6	7.6
	70	2.81	1.6	4.5
	80	2.89	1.7	5.0
	90	4.93	1.5	7.4
				av. $\theta = 6.4$
PS-8	10	3.37	1.7	5.7
	20	2.89	1.6	4.6
	30	3.82	1.6	6.1
	40	3.24	1.7	5.5
	50	6.02	1.5	9.0
	60-61.5	7.99	1.5	12.0
	70	4.26	1.7	7.2
	80	3.99	1.7	6.8
	90	3.91	1.6	6.3
	100	9.27	1.5	6.8
	105	7.31	1.7	12.4
	110	11.07	1.6	17.7
				av. $\theta = 8.3$

TABLE 3-1 continued

	depth	wt % fluid	ρ^*	θ^{**}
PS-9	10	4.8	1.6	7.7
	30	4.89	1.5	7.3
	40	5.77	1.5	8.7
	50	4.48	1.6	7.2
	60	3.57	1.6	5.7
	70	4.25	1.7	7.2
	80	7.10	1.7	12.1
	90	3.69	1.5	5.5
	95	9.98	1.6	16.0
	100	3.98	1.7	6.8
	102.5	3.23	1.65	5.3
	107.5	8.83	1.65	14.6
	no depth	3.36	1.5	5.0
				av. θ = 8.4
PS-10	10	3.47	1.6	5.6
	20	3.39	1.5	5.1
	30	5.58	1.7	9.5
	40	5.34	1.7	9.1
	50	2.82	1.7	4.8
	60	2.32	1.7	4.0
	70	6.14	1.7	10.4
	80	6.52	1.6	10.4
	90	7.3	1.5	11.0
	95	2.94	1.7	5.0
	100	6.04	1.5	9.1
	110	9.23	1.5	13.9
	112.5	9.8	1.65	16.2
	112.5	11.61	1.65	19.2
				av. θ = 9.5
PS-11	50-51.5	2.99	1.5	4.5
	60-61.5	4.38	1.6	7.0
	70	3.51	1.7	6.0
	80	4.36	1.65	7.2
	90	4.18	1.65	6.9
				av. θ = 6.3
PS-12	10-11.5	3.98	1.6	6.4
	20-21.5	3.26	1.7	5.5
	30-31.5	2.61	1.7	4.4
	40-41.5	5.77	1.7	9.8
	50-51.5	4.10	1.5	6.2
	60-61.5	2.10	1.7	3.6
	70-71.5	3.28	1.7	5.8
	80	3.38	1.5	5.1
	90	9.12	1.5	13.7
				av. θ = 6.7

TABLE 3-1 continued

	depth	wt % fluid	ρ^*	θ^{**}
PS-13	surface	6.61	1.7	11.2
	10	2.65	1.6	4.2
	20	3.94	1.65	6.5
	30	9.29	1.5	14.0
	40	2.67	1.65	4.4
	50	3.72	1.7	6.3
	60	3.59	1.7	6.1
	70	3.64	1.7	6.2
	80	3.47	1.7	5.9
	90	4.34	1.65	7.2
				av. θ = 7.2
PS-14	10	1.09	1.5	1.6
	20	2.73	1.5	4.1
	30	3.11	1.5	4.7
	40	3.86	1.5	5.8
	50	2.32	1.65	3.8
	60	9.42	1.65	15.5
	70	4.87	1.65	8.0
	80	4.51	1.6	7.2
	90	2.67	1.7	4.5
				av. θ = 6.1
PS-15	10	2.57	1.5	3.9
	20	3.44	1.5	5.2
	30	3.02	1.5	4.5
	40	3.74	1.65	6.2
	50	2.66	1.5	4.0
	60	4.56	1.65	7.5
	70	4.14	1.65	6.8
	80	4.15	1.70	7.1
	90	3.83	1.65	6.3
				av. θ = 5.7
PS-16	10	3.19	1.65	5.3
	20	5.24	1.7	9.0
	30	6.16	1.65	10.2
	50	3.40	1.5	5.1
	60	3.40	1.65	5.6
	70	3.55	1.70	6.0
	80	3.05	1.70	5.2
	90	4.45	1.65	7.3
				av. θ = 6.7

TABLE 3-1 continued

	depth	wt % fluid	ρ^*	θ^{**}
PS-17	10	4.20	1.5	6.3
	20	3.56	1.60	5.7
	30	2.27	1.7	3.9
	40	4.88	1.7	8.3
	50	2.94	1.5	4.4
	60	3.22	1.7	5.5
	70	7.44	1.65	12.3
	80	2.26	1.7	3.8
	90	7.05	1.65	11.6
				av. $\theta = 6.9$
PS-18	10	2.84	1.7	4.8
	20	4.49	1.6	7.2
	30	3.55	1.5	5.3
	40	8.32	1.4	11.7
	50	3.96	1.65	6.5
	60	3.55	1.7	6.0
	70	7.80	1.60	12.5
	80	2.39	1.7	4.1
	90	10.26	1.65	17.0
				av. $\theta = 8.3$
PS-19	10	5.64	1.5	8.5
	20	9.14	1.5	13.7
	30	3.97	1.5	6.0
	40	3.63	1.7	6.2
	50	4.08	1.65	6.7
	60	8.70	1.6	14.0
	70	9.70	1.65	16.0
	80	5.49	1.6	8.8
	80	2.75	1.7	4.7
	90	6.42	1.65	10.6
				av. $\theta = 9.5$

TABLE 3-2
RESULTS OF PHASE I, & PHASE II, AND PHASE III PCE ANALYSES

Core Hole #	PCE Concentration (ppm or µg PCE/g soil)	Log ₁₀ PCE Concentration
SURFACE		
PS-1	.062	-1.208
PS-2	.030	-1.242
PS-3	.015	-2.046
PS-4	.017	-1.760
PS-5	----	-----
PS-6	.052	-1.284
PS-7	.156	- .807
PS-8	.575	- .240
PS-9	20.9	1.320
PS-10	.320	-.495
PS-11	----	-----
PS-12	.169	-.772
PS-13	.100	-1.000
PS-14	.032	-1.495
PS-15	.030	-1.523
PS-16	.137	-.863
PS-17	.029	-1.538
PS-18	.126	-.900
PS-19	22.5	1.352
10 FOOT LEVEL		
PS-1	.030	-1.523
PS-2	.006	-2.222
PS-3	.005	-2.301
PS-4	371.5	2.570
PS-5	----	-----
PS-6	.028	-1.553
PS-7	.012	-1.921
PS-8	.011	-1.959
PS-9	.030	-1.523
PS-10	.017	-1.770
PS-11	.121	-.920
PS-12	.004	-2.398
PS-13	23.3	1.367
PS-14	.029	-1.538
PS-15	.447	-.350
PS-16	<.001	-3.000
PS-17	.005	-2.301
PS-18	.007	-2.155
PS-19	.020	-1.699

TABLE 3-2 continued

Core Hole #	PCE Concentration (ppm or μg PCE/g soil)	Log ₁₀ PCE Concentration
20 FOOT LEVEL		
PS-1	.015	-1.824
PS-2	.003	-2.523
PS-3	361.7	2.558
PS-4	230.2	2.362
PS-5	202.7	2.307
PS-6	.018	-1.744
PS-7	15.8	1.199
PS-8	.079	-1.102
PS-9	.021	-1.678
PS-10	59.1	1.772
PS-11	.001	-3.000
PS-12	.005	-2.301
PS-13	21.9	1.340
PS-14	.053	-1.276
PS-15	.017	-1.77
PS-16	<.001	-3.00
PS-17	<.001	-3.00
PS-18	.005	-2.301
PS-19	.015	-1.824
30 FOOT LEVEL		
PS-1	.025	-1.602
PS-2	.004	-2.398
PS-3	405.6	2.608
PS-4	236.8	2.374
PS-5	167.6	2.224
PS-6	.009	-2.046
PS-7	1443.8	3.160
PS-8	.052	-1.284
PS-9	.010	-2.000
PS-10	331.4	2.520
PS-11	.006	-2.222
PS-12	.020	-1.699
PS-13	391.1	2.592
PS-14	231.5	2.365
PS-15	580.00	2.763
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	.005	-2.301
PS-19	.008	-2.097

TABLE 3-2 continued

Core Hole #	PCE Concentration (ppm or μg PCE/g soil)	Log ₁₀ PCE Concentration
40 FOOT LEVEL		
PS-1	.020	-1.699
PS-2	.007	-2.154
PS-3	451.8	2.655
PS-4	263.3	2.420
PS-5	438.5	2.642
PS-6	.011	-1.959
PS-7	593.6	2.773
PS-8	.003	-2.523
PS-9	.002	-2.700
PS-10	.021	-1.678
PS-11	.007	-2.154
PS-12	.012	-1.921
PS-13	.011	-1.960
PS-14	.024	-1.62
PS-15	.018	-1.745
PS-16	<.001	-3.000
PS-17	.002	-2.70
PS-18	.004	-2.40
PS-19	.005	-2.301

50 FOOT LEVEL

PS-1	.015	-1.824
PS-2	.052	-1.284
PS-3	18.000	1.255
PS-4	305.7	2.485
PS-5	295.2	2.470
PS-6	.020	-1.699
PS-7	820.9	2.914
PS-8	.045	-1.347
PS-9	.013	-1.886
PS-10	.009	-2.046
PS-11	.002	-2.699
PS-12	.012	-1.921
PS-13	.001	-3.000
PS-14	.727	-.138
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	.010	-2.000
PS-19	.004	-2.398

TABLE 3-2 continued

Core Hole #	PCE Concentration (ppm or µg PCE/g soil)	Log ₁₀ PCE Concentration
60 FOOT LEVEL		
PS-1	-----	-----
PS-2	-----	-----
PS-3	.032	-1.495
PS-4	156.27	2.194
PS-5	.013	-1.886
PS-6	.001	-3.000
PS-7	240.8	2.382
PS-8	.065	-1.187
PS-9	.001	-3.00
PS-10	.001	-3.00
PS-11	.002	-2.699
PS-12	.001	-3.00
PS-13	.026	-1.585
PS-14	.035	-1.456
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	.039	-1.410
PS-19	<.001	-3.000
70 FOOT LEVEL		
PS-1	-----	-----
PS-2	-----	-----
PS-3	-----	-----
PS-4	.006	-2.222
PS-5	.002	-2.699
PS-6	.042	-1.377
PS-7	.028	-1.553
PS-8	.002	-2.699
PS-9	.001	-3.000
PS-10	.061	-1.215
PS-11	.004	-2.398
PS-12	.084	-1.076
PS-13	.002	-2.699
PS-14	.024	-1.62
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	.027	-1.569
PS-18	<.001	-3.000
PS-19	<.001	-3.000

TABLE 3-2 continued

Core Hole #	PCE Concentration (ppm or μg PCE/g soil)	Log ₁₀ PCE Concentration
80 FOOT LEVEL		
PS-1	----	-----
PS-2	----	-----
PS-3	----	-----
PS-4	.010	-2.0
PS-5	.004	-2.398
PS-6	.001	-3.000
PS-7	.003	-2.523
PS-8	.086	-1.066
PS-9	.001	-3.000
PS-10	.040	-1.397
PS-11	.002	-2.699
PS-12	.064	-1.194
PS-13	.031	-1.509
PS-14	.003	-2.097
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	<.001	-3.000
PS-19	<.001	-3.000

90 FOOT LEVEL

PS-1	----	-----
PS-2	----	-----
PS-3	----	-----
PS-4	.019	-1.721
PS-5	.011	-1.959
PS-6	.009	-2.046
PS-7	.002	-2.699
PS-8	.008	-2.097
PS-9	.001	-3.000
PS-10	.006	-2.222
PS-11	.001	-3.000
PS-12	.009	-2.046
PS-13	.013	-1.886
PS-14	.005	-2.301
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	<.001	-3.000
PS-19	<.001	-3.000

TABLE 3-3
TCA ANALYSES (SOILS)

CORE HOLE #	DEPTH (ft)	PCE (ppm) mg PCE/g Soil	TCA (ppm) mg TCA/g Soil
5	15	2127.0	462.2
7	30	1443.8	168.3
	60	240.8	30.16
8	0	0.575	0.152
	50	0.005	0.002
9	0	20.9	1.388
	40	0.002	<0.001
10	0	0.320	0.28
	20	59.1	0.146
11	60	0.005	0.003
	80	0.002	<0.001
12	10	0.004	0.002
	40	0.001	0.003
13	10	29.3	0.173
	60	0.009	<0.001
14	50	0.103	0.099, 0.051
	90	0.005	<0.001
15	30	580.0	0.252
	80	<0.001	<0.001
16	0	0.30	0.002
	70	<0.001	<0.001
17	20	<0.001	<0.001
	80	<0.001	<0.001
18	0	0.126	0.040
	60	0.039	<0.001
19	0	22.5	1.83
	40	0.005	<0.001
PSMW-1	20	<0.001	<0.001
	60	<0.001	<0.001
PSMW-2	30	<0.001	<0.001
	70	<0.001	<0.001
PSMW-3	10	<0.001	<0.001
	90	<0.001	<0.001

3-21 through 3-30). In addition to the analyses performed by Assagai for PNM, Ms. Devon Jercinovic from NMEID took a composite sample from PS-13 that was analyzed by IT Analytical Services. These results are included in the lab report dated January 19, 1984 (Appendix A).

3.3 CHEMICAL ANALYSES OF LIQUID IN STORAGE TANK

Chemical analyses on the liquid in the storage tank were performed on October 13, 1983 and November 28, 1983. The results of these analyses yielded high levels of:

--Trichloroethane (17,274 ppm, 2,132 ppm)
and --Tetrachlorethylene (3,562.4 ppm)

although the majority of the fluid was water. A variety of other parameters were analyzed and are included in the lab reports (Appendix A).

3.4 CHEMICAL ANALYSIS OF GROUND WATER

The results of the chemical analysis of ground water performed by Radian Laboratories (EPA-certified) of Austin, Texas are presented in Table 3-4 and included in the original lab report (Appendix A).

TABLE 3-4

PNM PERSON STATION
RESULTS OF GROUND WATER ANALYSIS

Sample	Ratio TCA/PCE	Concentration (ppb) 1,1,1-Trichloroethane	Concentration (ppb) tetrachloroethylene (PCE)
PSMW1-A3	3.7	4960	1330
PSMW1-B3	4.9	5900	1190
PSMW1-C3	5.1	5620	1090
MEAN, PSMW1	4.6	5490	1200
PSMW2-A3	4.8	4080	842
PSMW2-B3	5.9	4630	778
PSMW2-C3	4.8	4410	908
Mean, PSMW2	5.2	4370	843
PSMW3-A3	4.3	10700	2460
PSMW3-B3	4.8	11400	2360
PSMW3-C3	4.7	10100	2130
Mean, PSMW3	4.6	10700	2320

4.0 SITE GEOHYDROLOGY

This section presents geologic and hydrologic data of the upper portion of the underlying aquifer and the vadose zone. Lithologic descriptions of the vadose and saturated zones are given in Sections 4.1 and 4.2. Section 4.3 describes the hydrologic characteristics of the vadose zone based upon the results of permeability and moisture analyses from samples. The hydrology of the saturated zone is summarized in Section 4.5.

4.1 LITHOLOGIC DESCRIPTION OF VADOSE ZONE

The coring and logging of the 22 holes drilled in Phase 1, 2, and 3 of the study indicate that the material consists of a fairly uniform, medium-coarse grained, fluvially deposited sand with some minor amounts of clay and gravel to a depth of at least 110' (depth of deepest core hole, see Figures 2-2, 2-3, and 4-1).

No continuous gravel or clay lenses could be correlated between any of the holes. Within an individual core, where gravel or clay was present, the thickness of the lens never exceeded 20 cm. The grain size of sand was fairly uniform throughout the profile. However, finer sediments were generally more common in deeper intervals (Figure 4-1). Sieve analyses of two representative samples are presented in Section 3.0.

In summary, the lithology of the site is characterized by large-scale homogeneity (sands) and small-scale

PNM Person Station

Generalized Lithologic Log

Scale in Feet

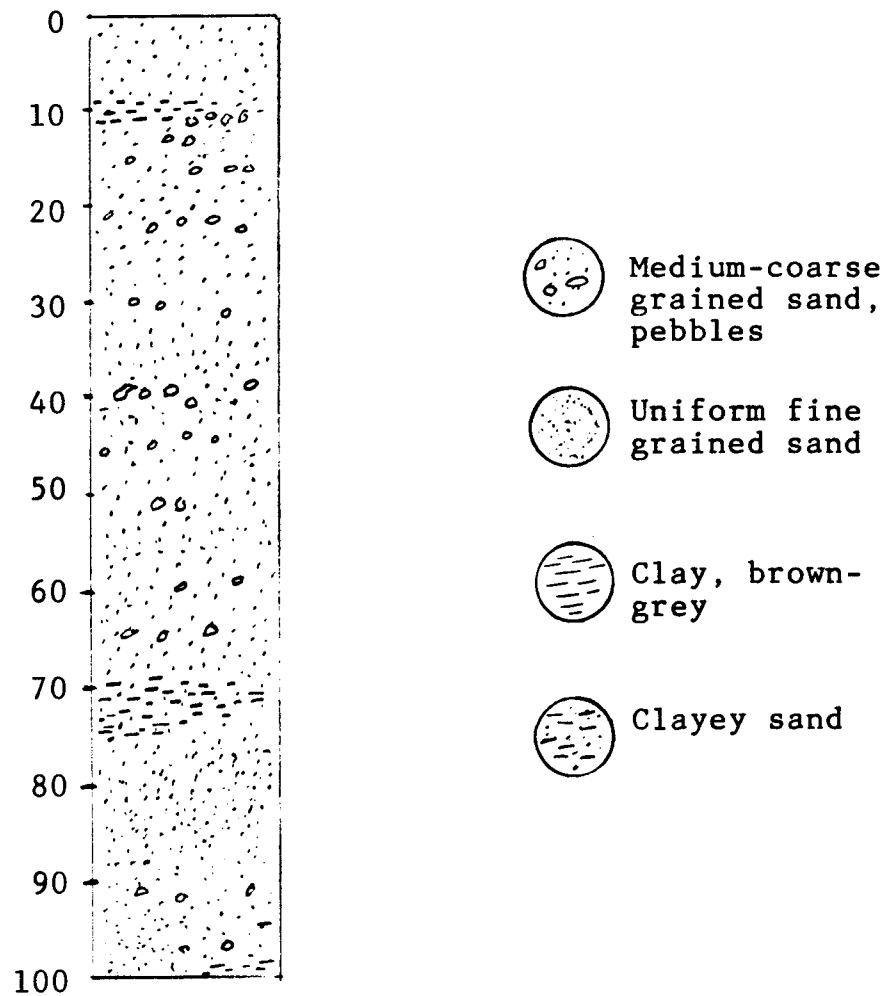


Figure 4-1 Generalized Lithologic Log of Soil Cores (PS-1-PS19) and Monitoring Wells (PSMW-1,2,&3)

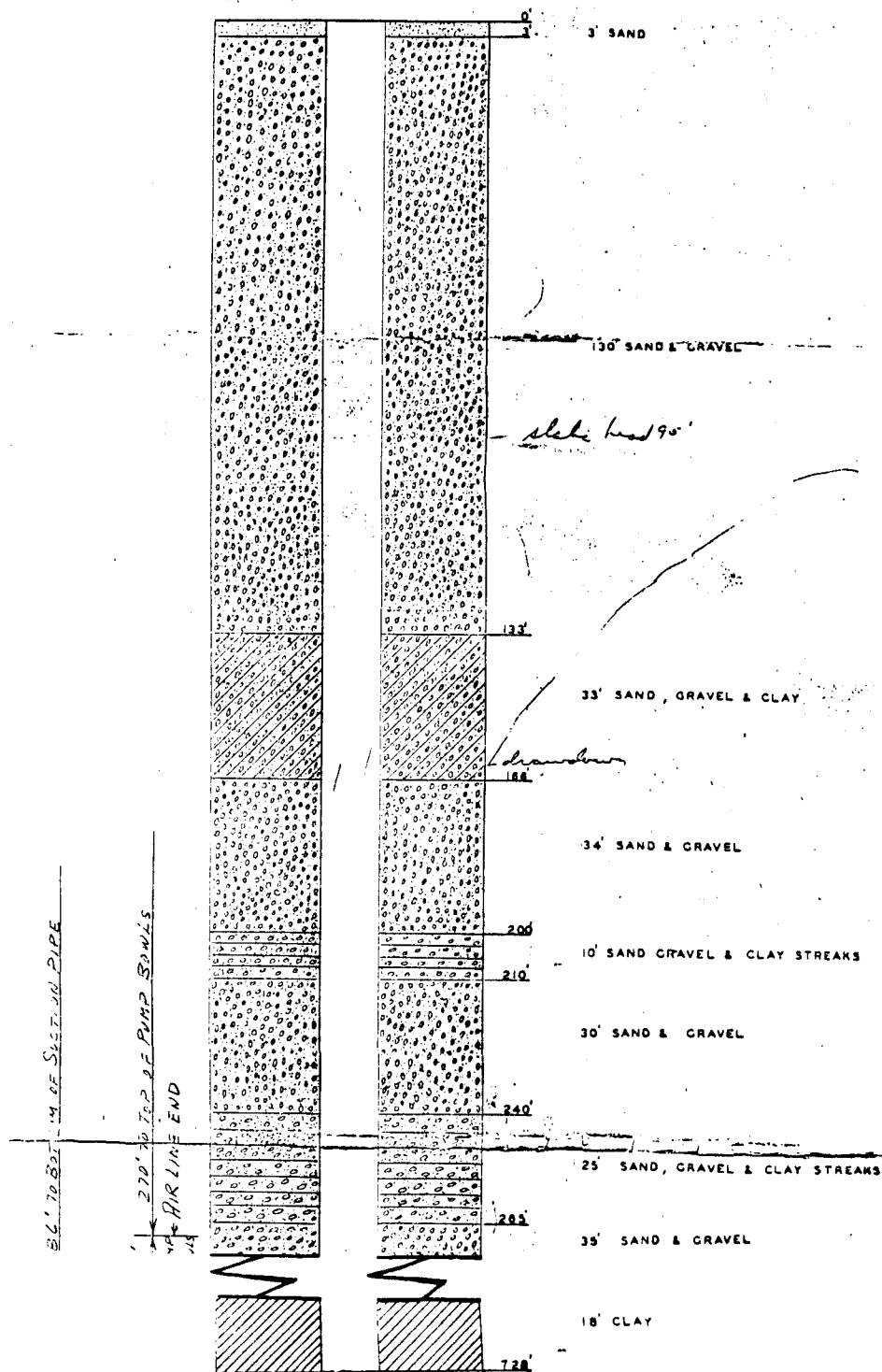
heterogeneity consisting of clay and non-continuous gravels. No cracks or other potential fluid channels were visible in any of the cores, on the ground surface, or on any nearby outcrops of the upper portion of the unit.

4.2 LITHOLOGIC DESCRIPTION OF THE SATURATED ZONE

Neither the soil core holes nor the monitor well bore holes yielded cuttings from the saturated zone. Data on the saturated zone is limited to published reports, driller's logs of nearby production wells and observation of the drilling and production characteristics of the monitor wells. The lithologic logs from the upper 250 feet of the production wells #1 and #4 are displayed in figures 4-2 and 4-3. These data indicate little difference between the lithologies of the vadose zone and the saturated zone. Published information is limited to regional descriptions which generally agree with the characterization shown in the driller's logs of production wells (see Reeder and others, 1967). Observations of installation and development of the three monitor wells on the site suggest that the upper portion of the aquifer is characterized by fine-grained sand with coarse-grained sand, some clay, and gravel also present. The driving of the well points required up to 4 hours for 20 feet of penetration. The drillers indicated that the nature of the driving was typical of clayey sediments rather than coarse grained gravels. Production from the monitor wells (1 liter/min) supports the driller's observations. To summarize, the lithology of the upper portion of the aquifer

LOG OF PERSON STATION WELL NO.1

1952



CASING RECORD:

TOP OF CASING TO 298'
 16" X 12-3/4" SWAGE 298'-300'
 300'-618' 16" O.D. BLANK PIPE
 618'-643' PERFORATED 12-3/4" PIPE
 643'-718' BLANK 12-3/4" PIPE
 718'-728' PERFORATED 12-3/4" PIPE
 728' BLANK PIPE 12-3/4"

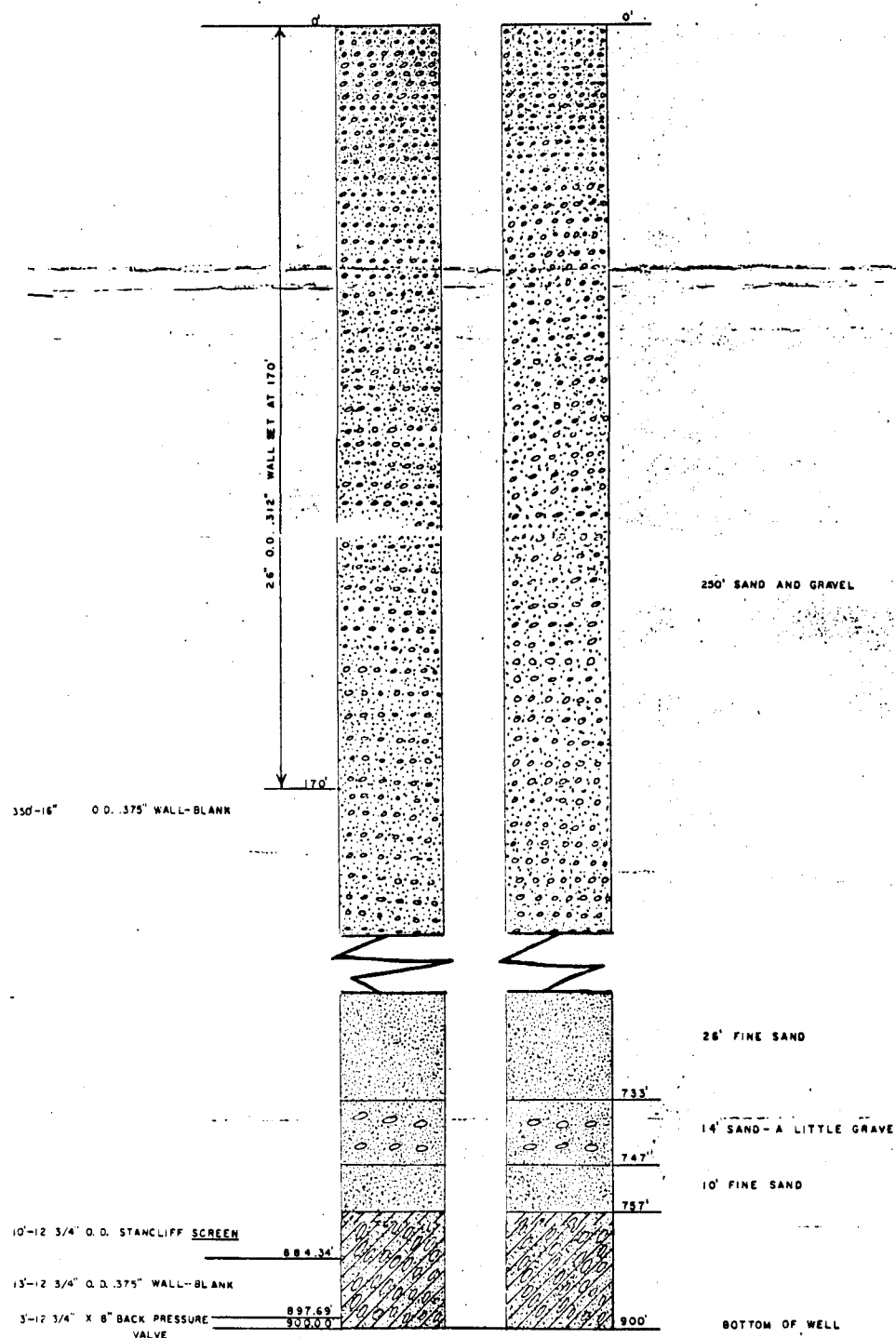
CASING CLAMPED AT SURFACE ON TOP OF CONCRETE PAD - CONCRETE TO 18' AROUND CASING.
 TEN FOOT GRAVEL PLUG IN BOTTOM OF WELL.

CAPACITY TEST:

PUMPED 1030 G.P.M. WITH 104' DRAWDOWN AT END OF EIGHT HOUR TEST.
 PUMPED 860 G.P.M. WITH 96' DRAWDOWN AT END OF TWENTY TWO HOUR TEST.
 PUMPED 760 G.P.M. WITH 76' DRAWDOWN AT END OF TWO HOUR TEST.
 PUMPED 640 G.P.M. WITH 66' DRAWDOWN AT END OF TWO HOUR TEST.
 PUMPED WELL A TOTAL OF 51 HOURS.

Figure 4-2
 Lithologic Log of Production Well #1

LOG OF PERSON STATION WELL NO. 4



TOTAL AMOUNT 12" SCREEN—270'

TOTAL AMOUNT 12" BLANK PIPE—280'

STATIC WATER LEVEL—MARCH 16, 1956—183'

SCREEN WIRE—STAINLESS STEEL, SCREEN GAGE—.050"

9 7/8" PILOT HOLE TO 900'

30" SURFACE HOLE TO 100'

24" HOLE FROM 170' TO 900'

WELL GRAVELED WITH 120 YARD OF 1/8" TO 1/4" GRAVEL

WELL DEVELOPED FOR 100 HOURS WITH 11" BAILER

WELL PRODUCES 2000 G.P.M. AND HAS 128' DRAWDOWN

26" CASING CEMENTED IN 30" HOLE WITH 225 SACKS OF CEMENT BY HALIBURTON OIL WELL CEMENTING CO.

Figure 4-3
Lithologic Log of Production Well #4

in the area of interest appears to consist of fine-grained clayey sands with minor amounts of gravel.

4.3 HYDROLOGY OF THE VADOSE ZONE

Volumetric moisture contents of samples from the drilling program are displayed in Section 3-1. The average of all data is 8.33% with several samples showing considerably lower values (much below the estimated specific retention or field capacity for medium-grained sands (Figure 4-4)).

The relationship of volumetric moisture content (θ) to unsaturated hydraulic conductivity (K_u) was determined for three representative soil samples using the laboratory techniques described in Section 2.5. The soil moisture characteristic curves shown in Figures 4-5, 4-6, and 4-7 can be used to determine K_u values for each of the samples by comparison with the K_u vs. θ curves (Figures 4-8, 4-9, and 4-10). Only the drying curves are used in this report because they represent the actual field conditions. Cessation of disposal practices and the asphalt cover over the contaminated soil will effectively prevent re-wetting of the soil. Wetting curves are included in Appendix A for reference. Comparison of soil moisture data with Figures 4-5 to 4-7 demonstrate that K_u values for much of the soil profile approach zero. In the samples where the K_u values are greater than zero, only two or three samples have a conductivity greater than 6×10^{-6} cm/sec. It should be noted that all of the laboratory determined K_u values tend

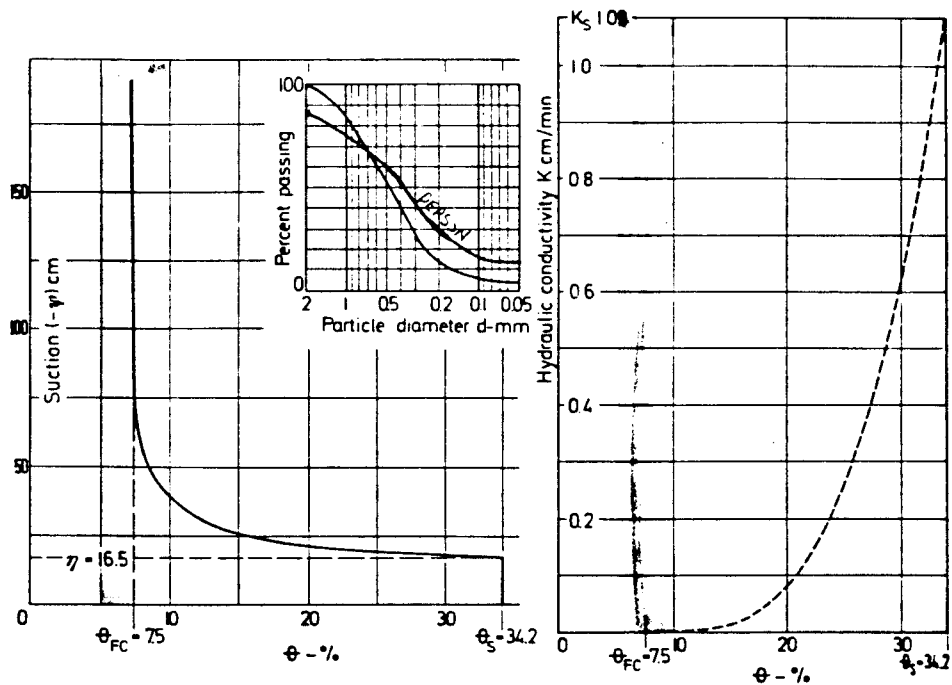
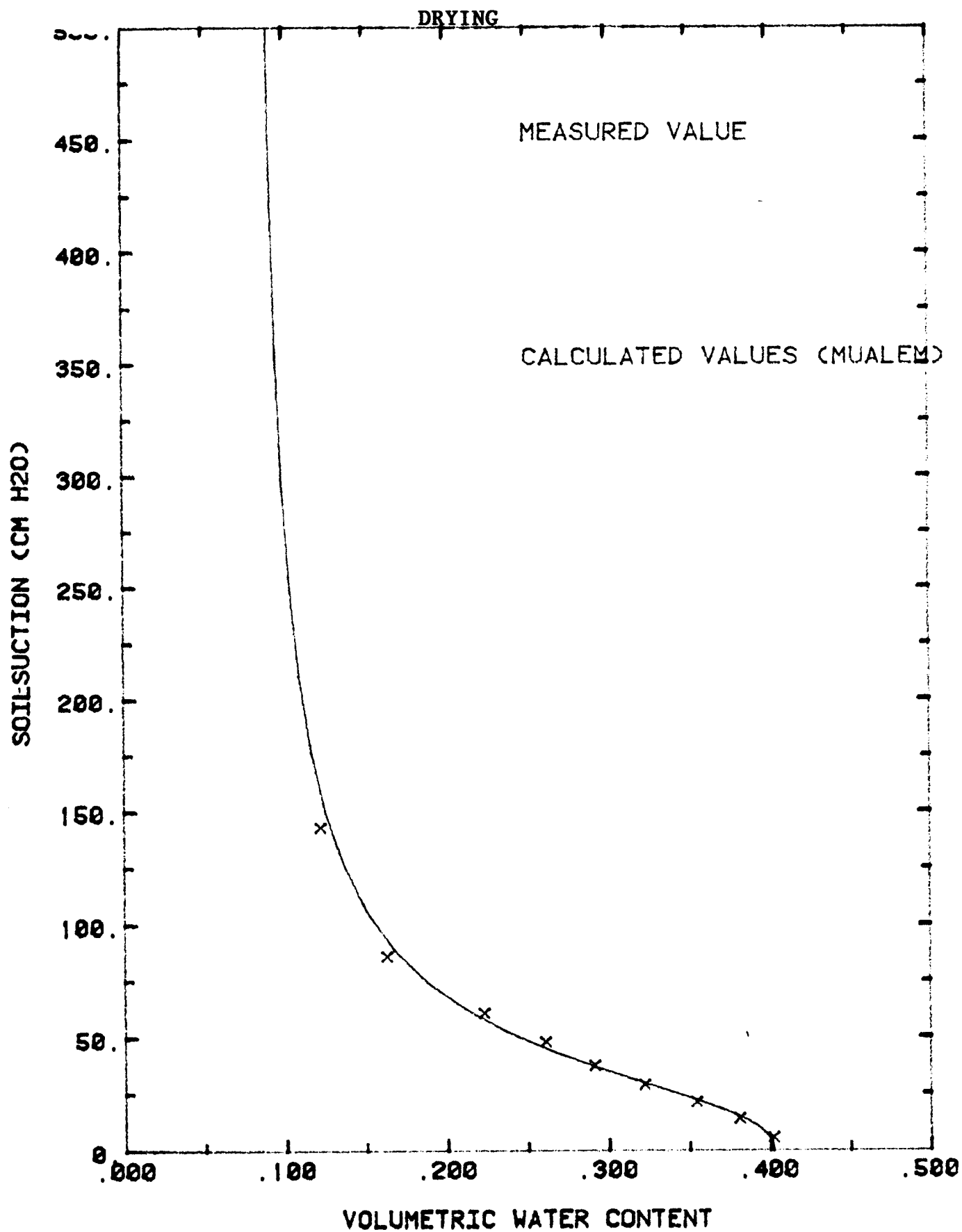
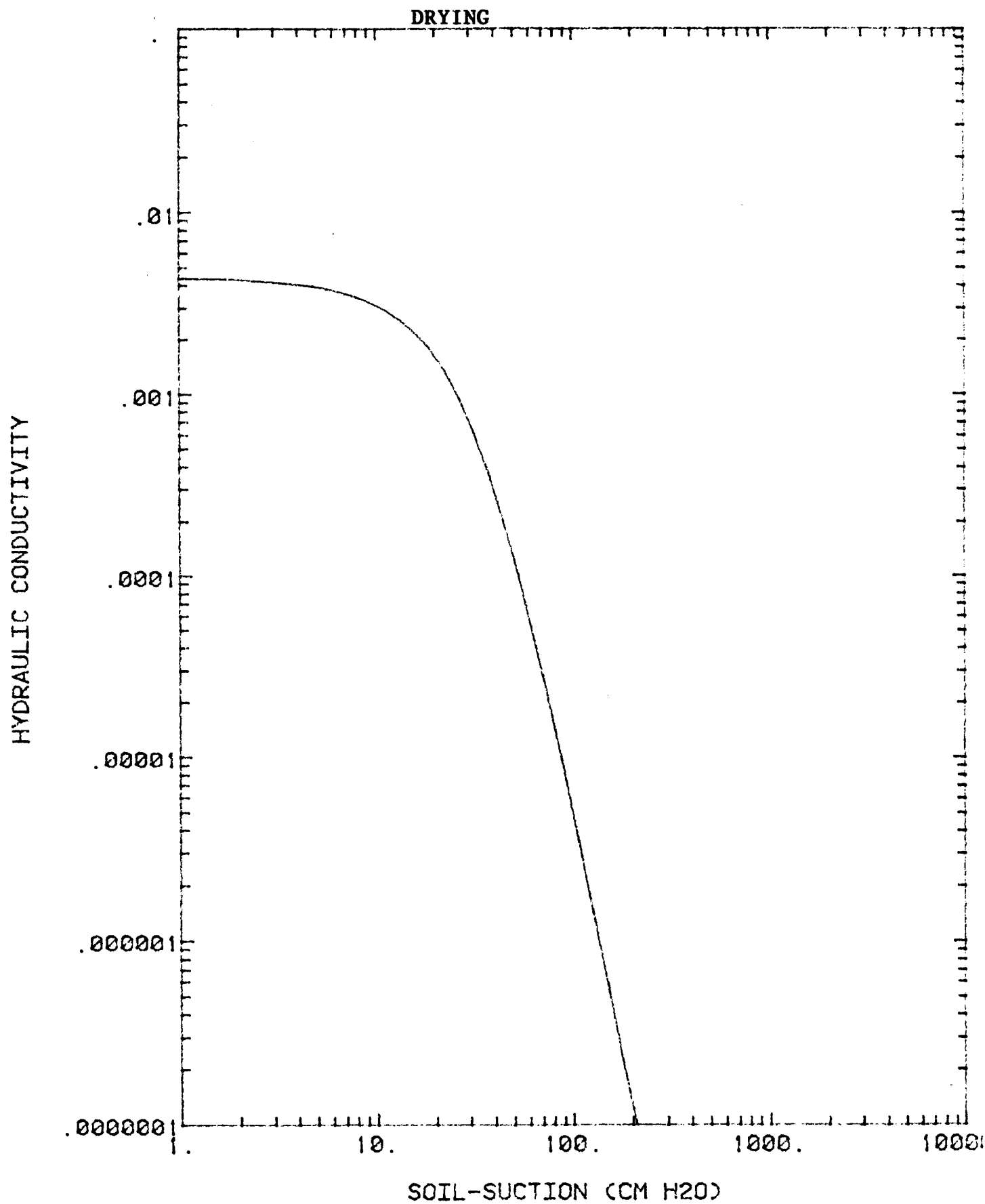


Figure 4-4
Regional and Conductivity
Curves of River Sand Tested
by G. Vachaud (1968) and
sieve analysis compared to
Person Generating Station.



PS-4 25'

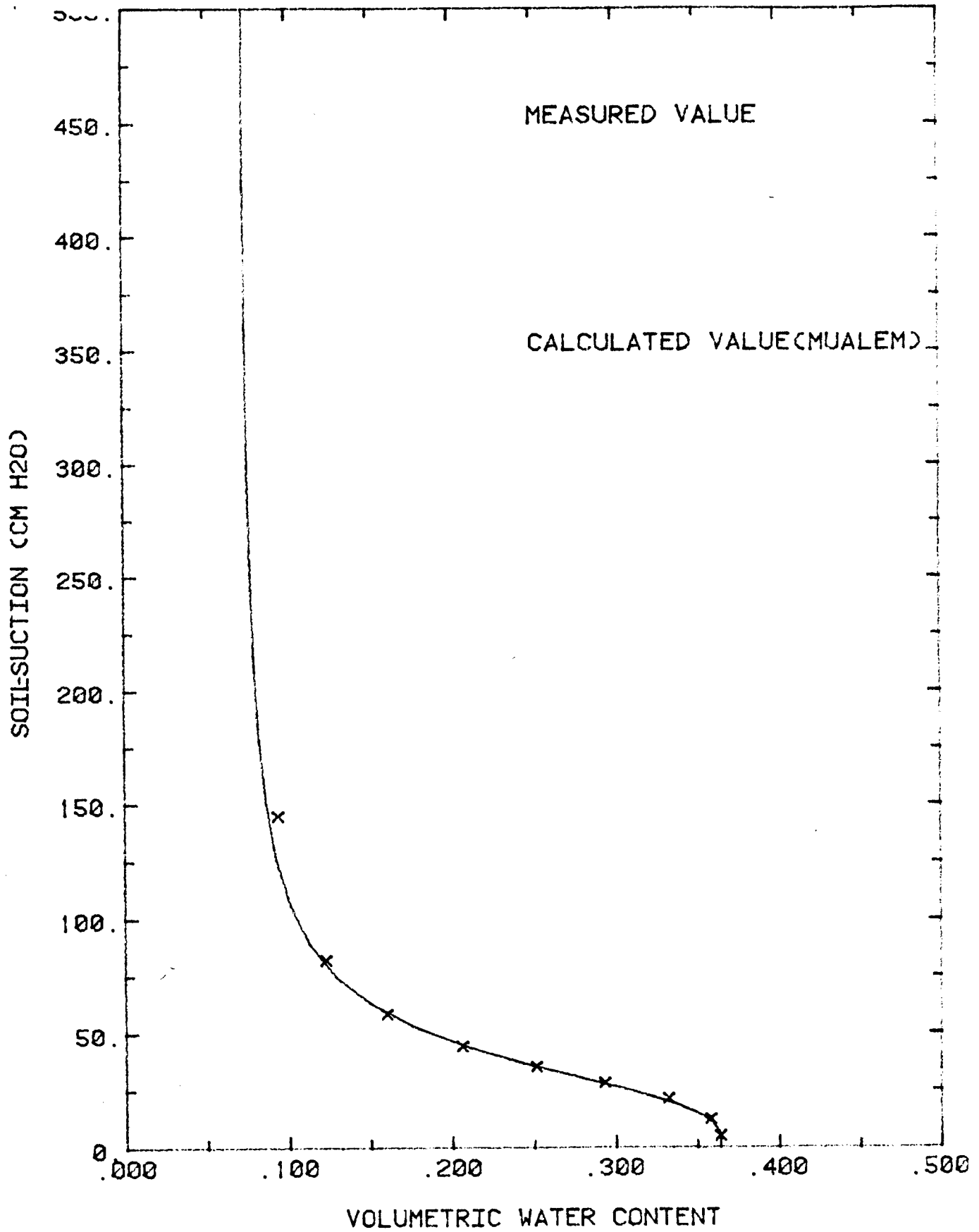
FIGURE 4-5A SOIL SUCTION vs θ



PS-4 25

FIGURE 4-5B K_u vs SOIL SUCTION

DRYING

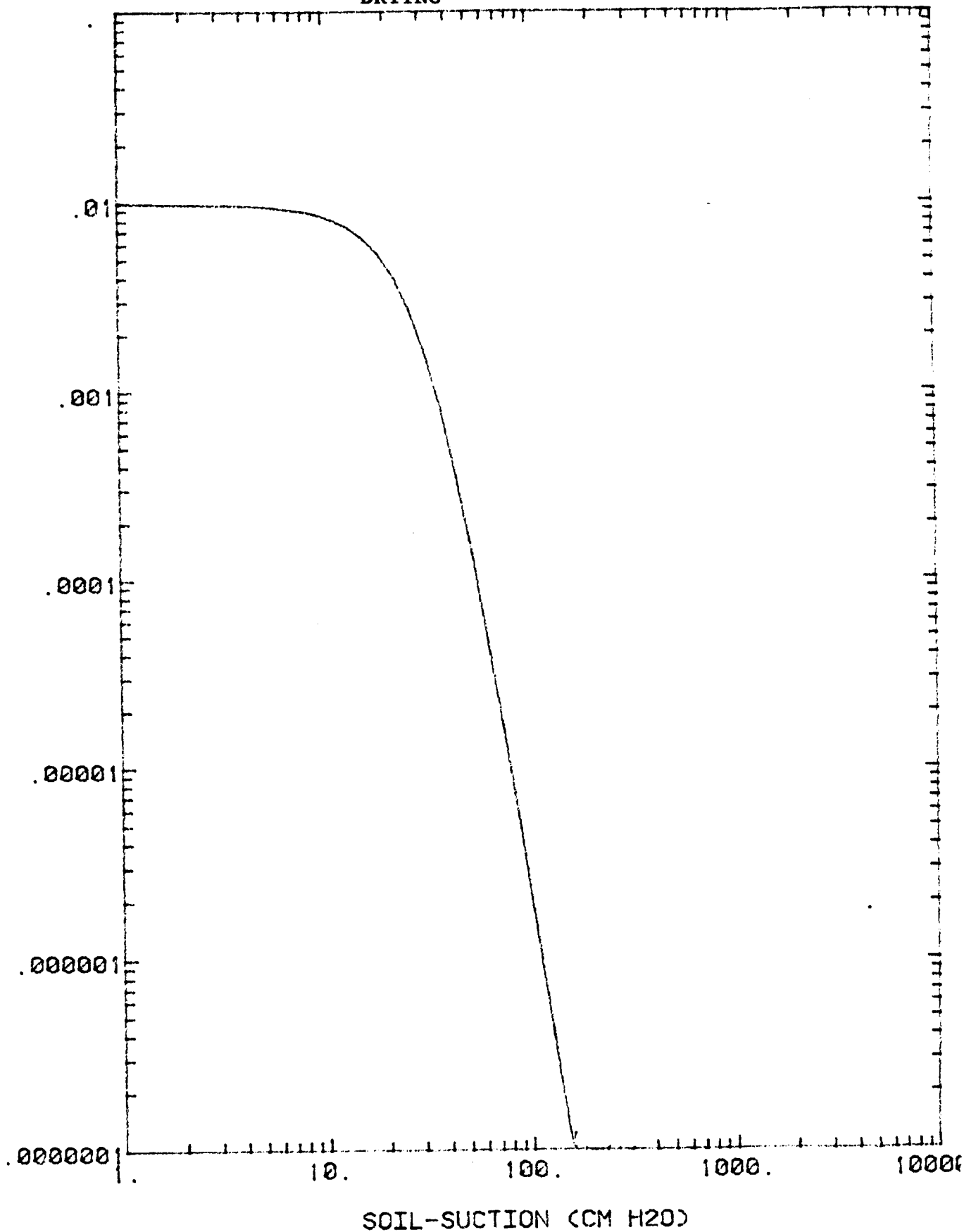


PS-4 40'

FIGURE 4-6A SOIL SUCTION vs θ

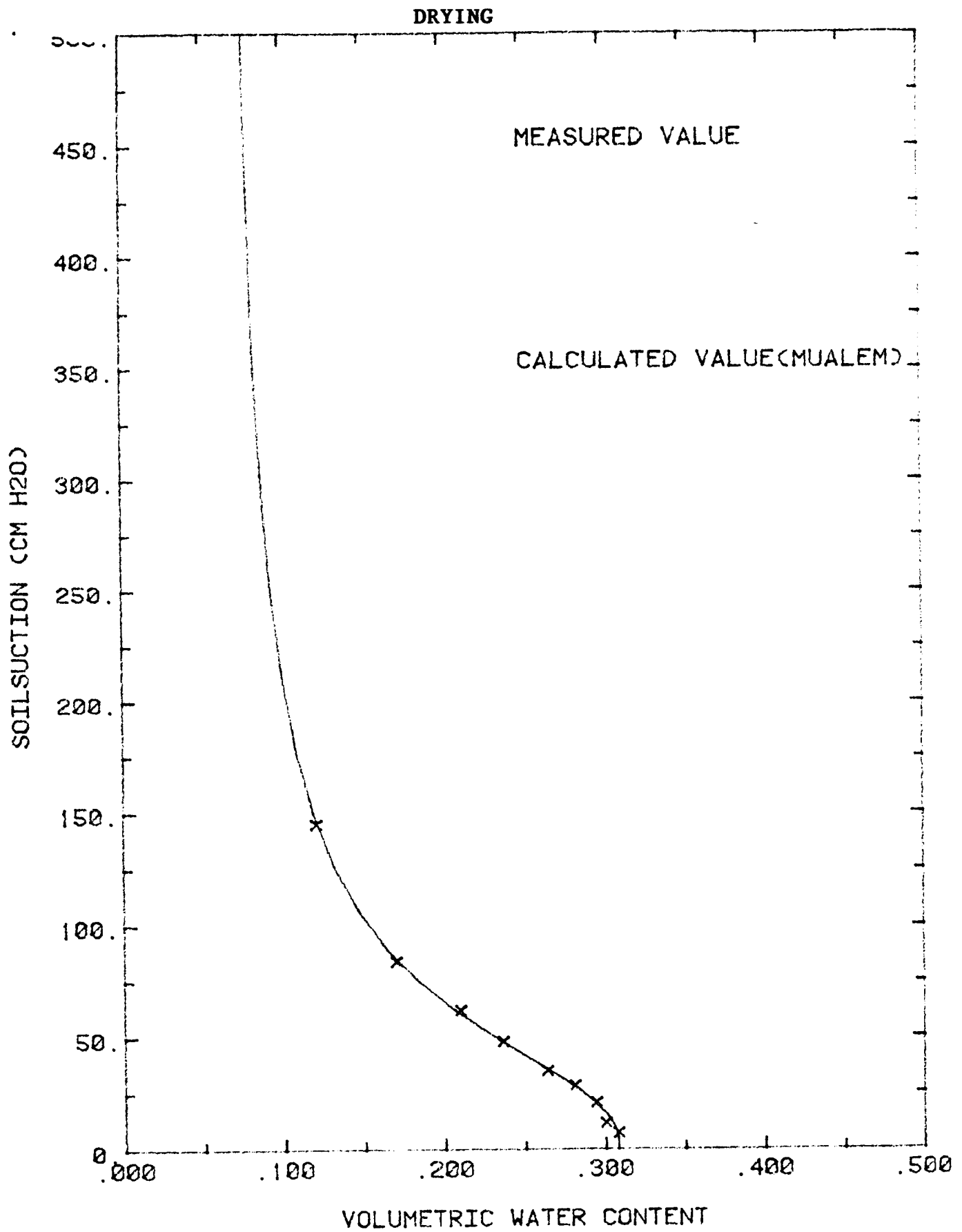
DRYING

HYDRAULIC CONDUCTIVITY



PS-4 40'

FIGURE 4-6B K_u vs SOIL SUCTION

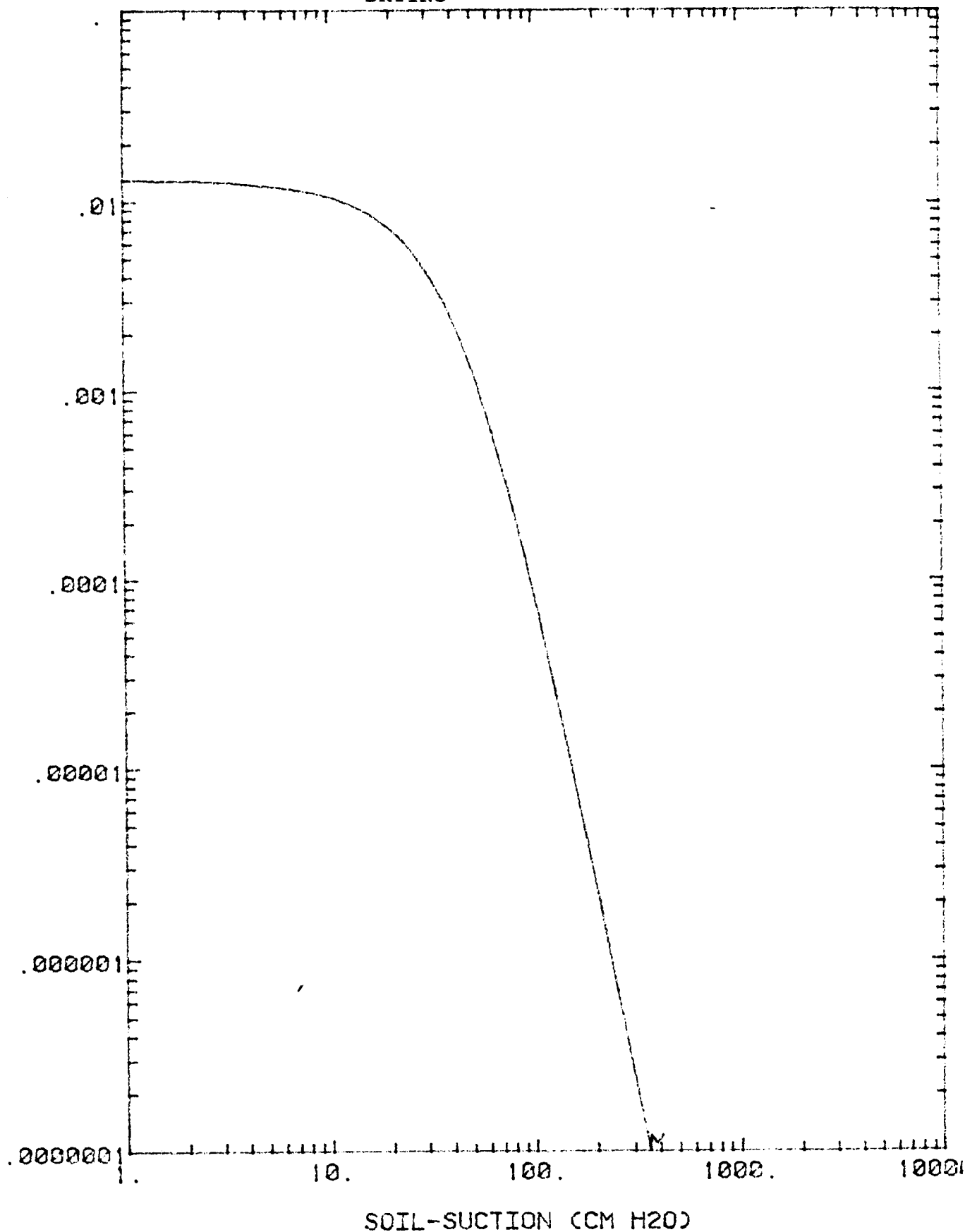


PS-4 70'

FIGURE 4-7A SOIL SUCTION vs θ

DRYING

HYDRAULIC CONDUCTIVITY



PS-4 70'

FIGURE 4-7B K_u vs SOIL SUCTION

to be higher than actual field conditions since the laboratory techniques yield maximum values.

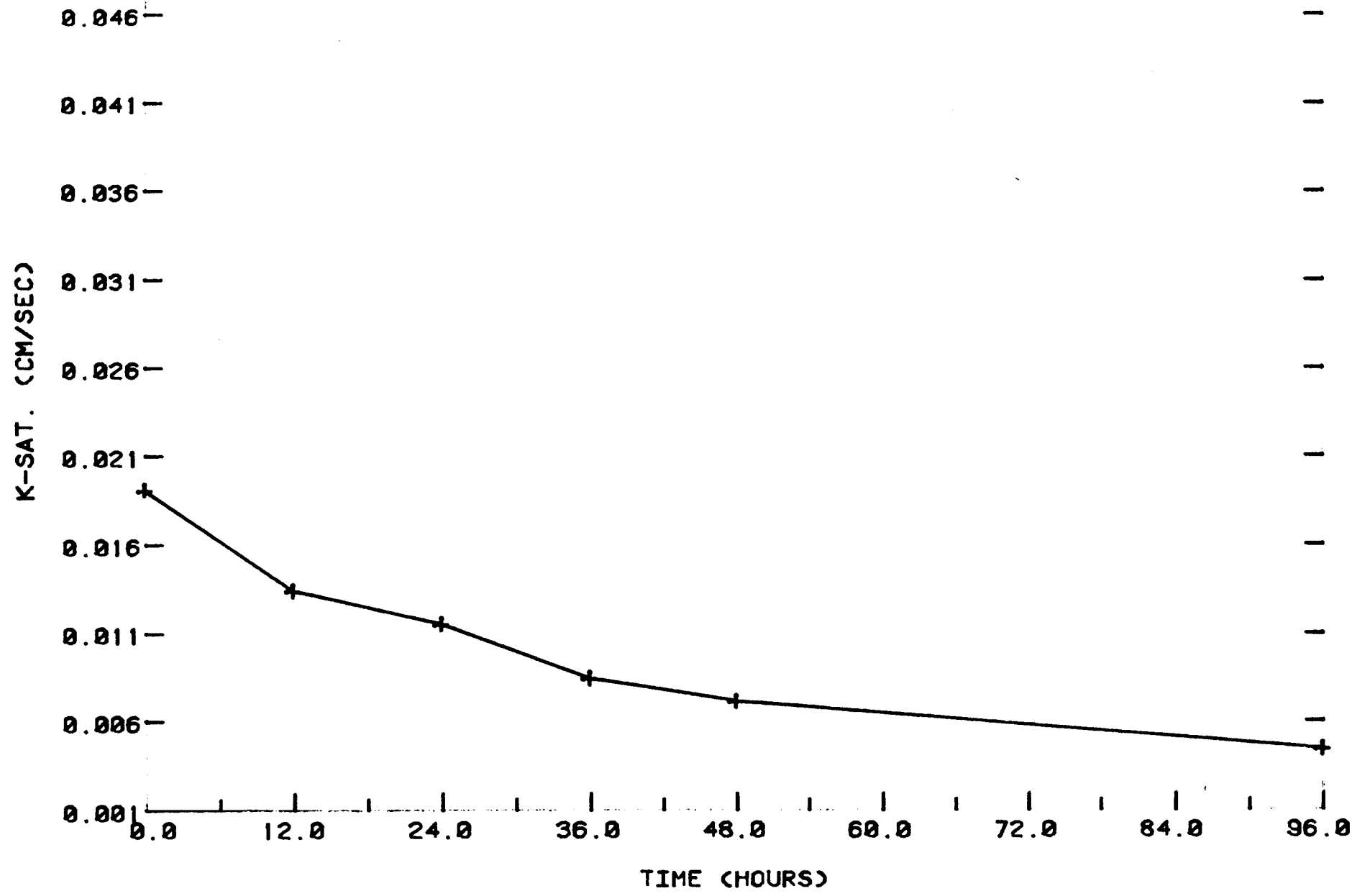
Saturated hydraulic conductivities of samples from the vadose zone average 0.008 cm/sec. Figures 4-8 - 4-10 display the saturated hydraulic conductivity data.

4.4 HYDROLOGY OF THE SATURATED ZONE

Three ground water monitor wells (PSMW-1,2, and 3) were installed 50, 50, and 30 feet away, respectively, from the waste storage tank (Figure 2-1). The wells were surveyed and water level measurements were obtained. The hydraulic gradients in the vicinity of the tank for each measurement are displayed in Figure 4-11. Figure 4-12 is a map of the regional ground water table including the site. Pumping from various water supply wells in the area may have caused a general lowering of the water table in addition to changes in direction and magnitude of gradients.

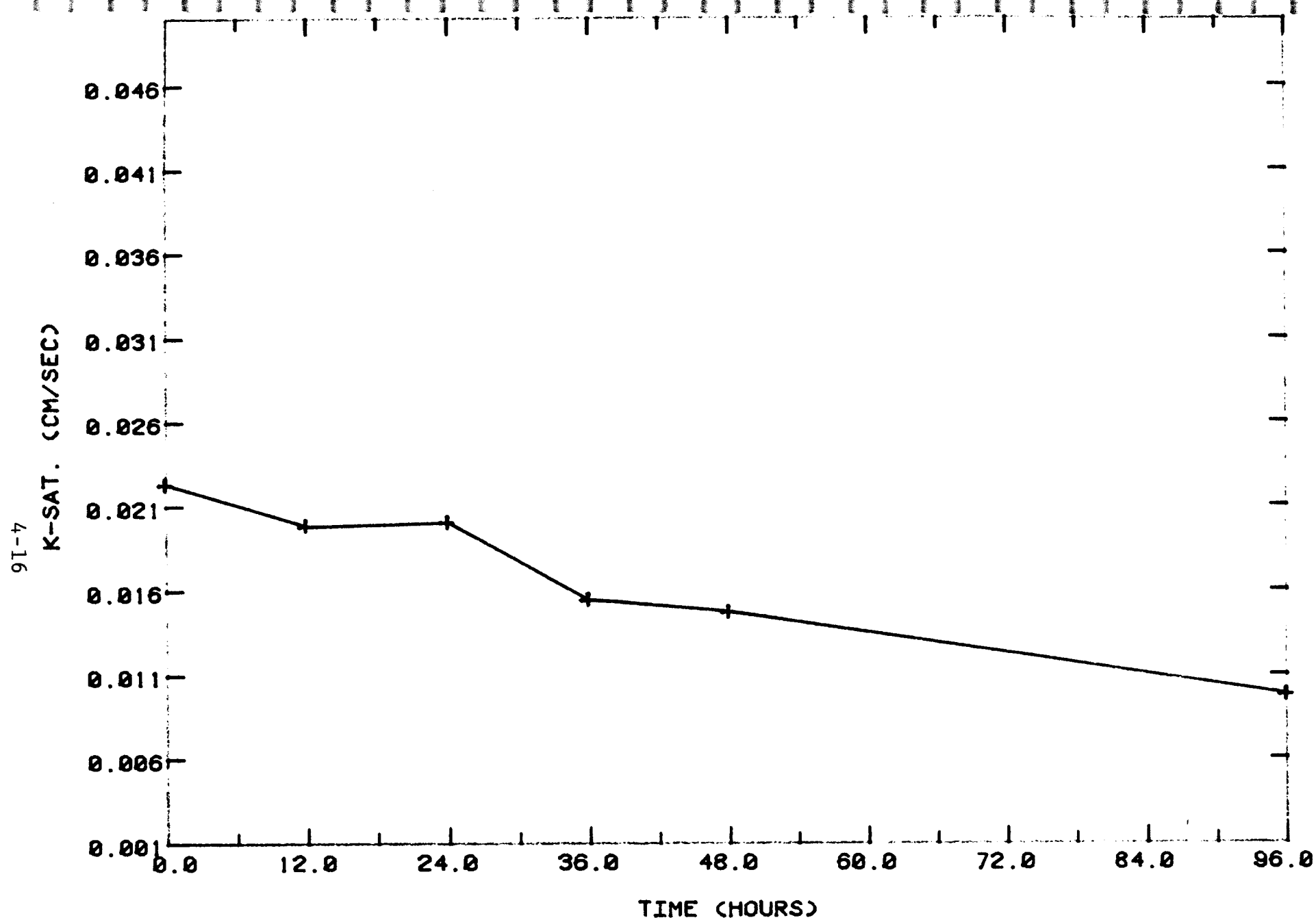
The hydraulic conductivity of the upper 20 feet of the saturated zone as determined in the laboratory is .008 cm/sec. The development bailing and sampling of the monitoring wells supports the laboratory determinations of Ksat.

4-15



SATURATED HYDRAULIC CONDUCTIVITY (SAMPLE #25)

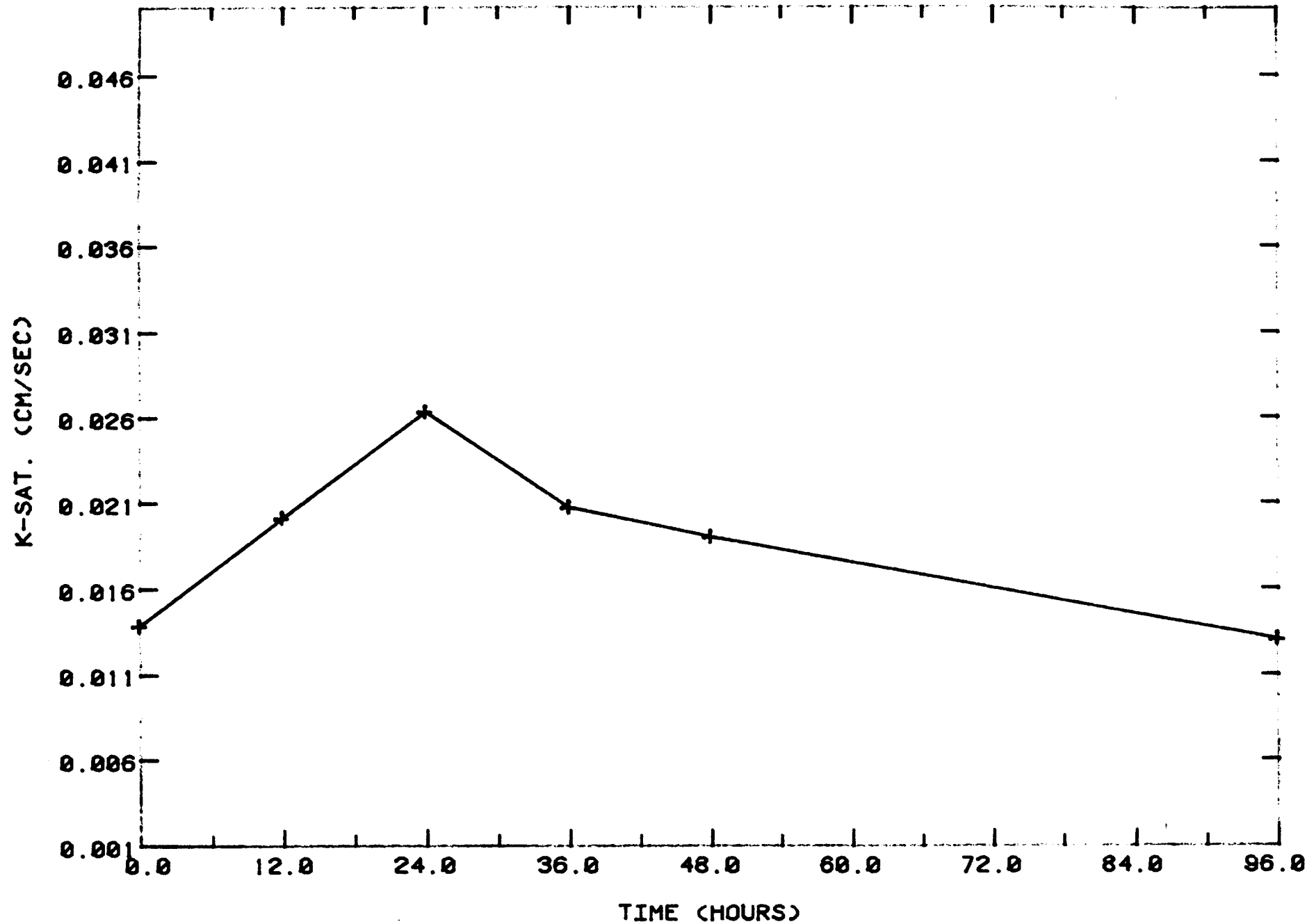
FIGURE 4-8 K_{sat} vs TIME PS-4,25 FEET



SATURATED HYDRAULIC CONDUCTIVITY (SAMPLE #40)

FIGURE 4-9 K_{sat} vs TIME PS-4,40 FEET

4-17



SATURATED HYDRAULIC CONDUCTIVITY (SAMPLE #75)

FIGURE 4-10 K_{sat} vs TIME PS-4,70 FEET

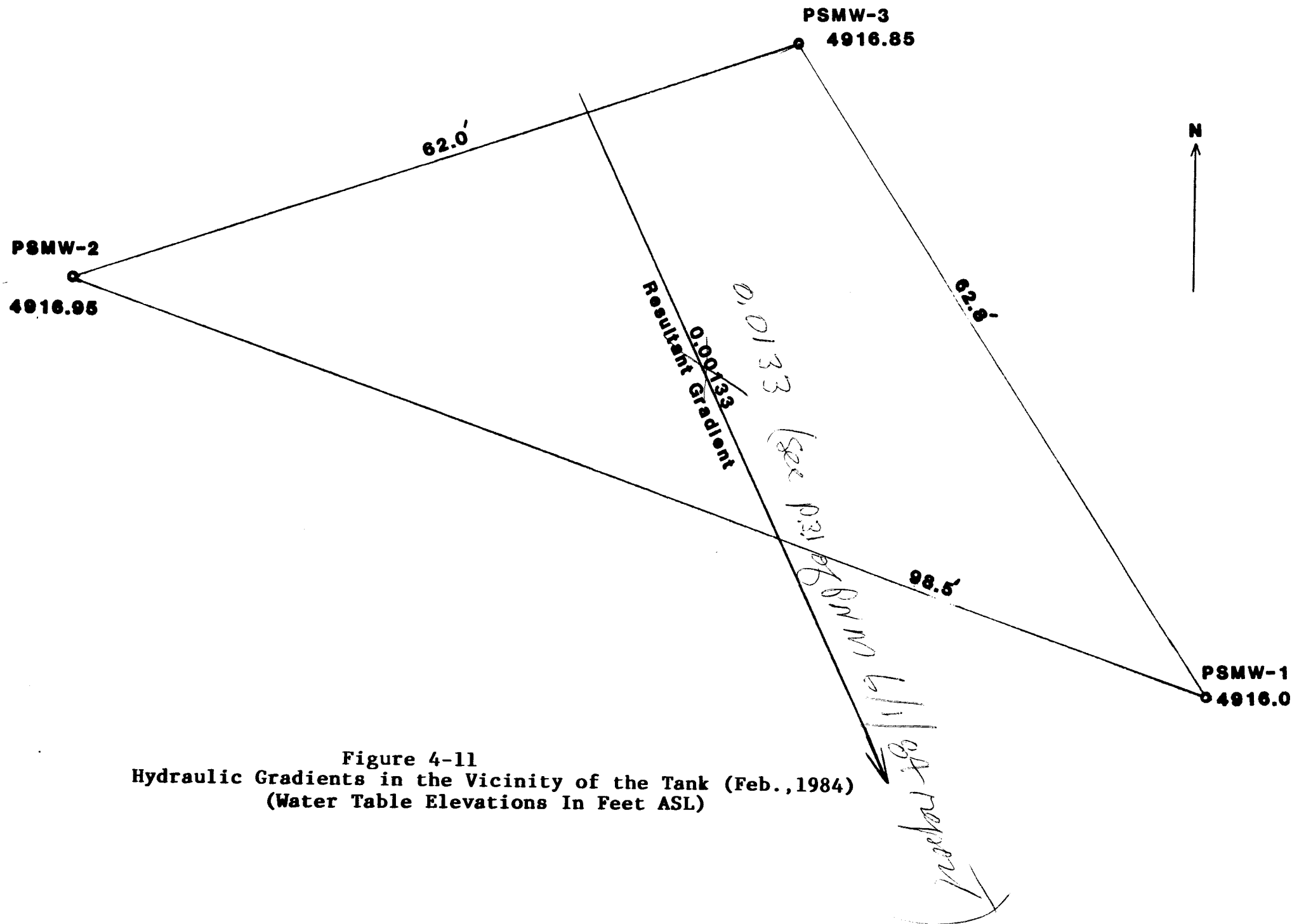


Figure 4-11
Hydraulic Gradients in the Vicinity of the Tank (Feb., 1984)
(Water Table Elevations In Feet ASL)

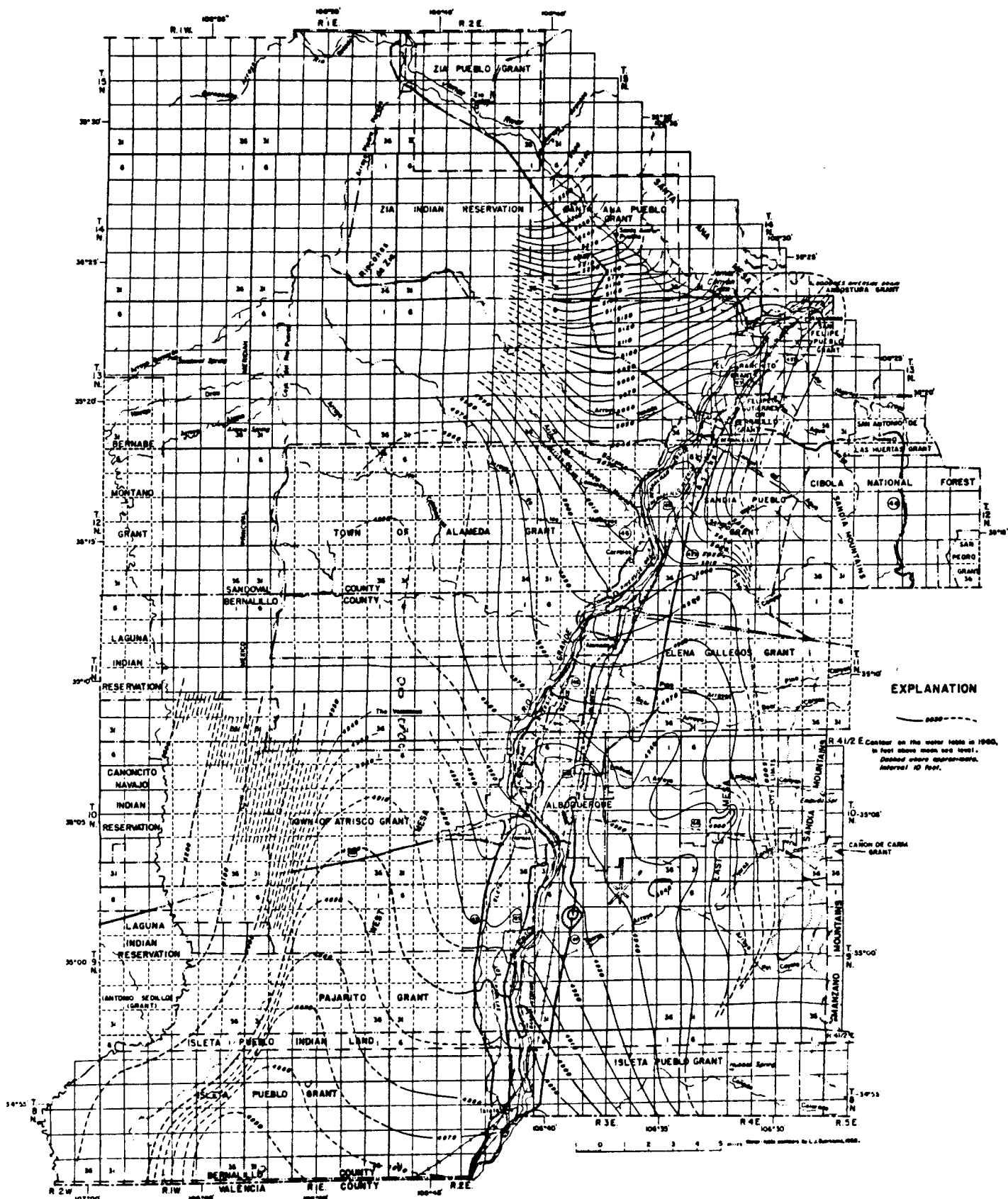


Figure 4-12
Water-Table Contours in the Albuquerque
Area, 1960 (from NMSE Technical Report
33, Reeder et. al, 1967)

5.0 SOIL CONTAMINATION ASSESSMENT

This section provides an analysis of the magnitude and extent of soil contamination and migration potential of the contaminants in the unsaturated (vadose) zone. The shape and extent of the contaminant plume at 10' intervals from surface to 90' has been mapped in detail and the total mass of PCE in the soil determined. The migration potential for the contaminants in the soil is examined by laboratory determination of unsaturated hydraulic conductivities and moisture contents of samples from 22 core holes at PNM Person Station.

Soil data (randomly spaced, 3-D) were sampled and physically and chemically analyzed according to procedures outlined in Section 2.0. These data were analyzed and interpreted by computer using the digital terrain model described in Section 5.1. PCE concentration plumes for each 10' interval are presented and described in Section 5.2. Data on the mass of PCE in the soil and volumes of contaminated soil is discussed in Section 5.3. Section 5.4 discusses the migration potential of the waste based on unsaturated hydraulic conductivity (K_u) of the soils and determination by moisture content (see Section 2.0). Vapor phase concentration gradients and the extent of vapor phase contamination is discussed in Section 5.5.

The calculations presented in Section 5.5 for the PCE vapor concentration gradients and the distance from liquid PCE source formed the basis for the computer modeling of

contaminant plume shape and dimension performed with the results of the soil coring and analyses. PCE distribution and concentration gradients have been determined at 10 foot intervals beginning at the surface to a depth of 90 feet. Boundary conditions were established in each case to be 1 ppb (analytical detection limit) since PCE is not naturally occurring in soils. These boundary conditions were placed at distances of 30-40 feet from the nearest source of liquid PCE according to the results of the analysis of soils in the background boreholes. The attached Figures (5.2 through 5.11) show the PCE concentrations in the soil for each 10' interval. In addition to the contour maps (Figures 5.2 through 5.11), the \log_{10} of the concentrations are represented in the Z axis of three dimensional diagrams (Figures 5.2 through 5.11). These diagrams allow a ready visualization of the areas of high concentrations (peaks) and low concentrations (valleys) at each depth. The diagrams are rotated to an optimum viewing angle that minimizes hidden line problems. N-S and E-W axes are labeled for easy comparision to the contour maps.

5.1 COMPUTER ANALYSIS METHODOLOGY

The position of each borehole PS-1 - PS-13 was assigned X,Y coordinates and for each interval the concentration measured in the sample was considered the Z coordinate. Since the variation in concentrations included 6 orders of magnitude (from 1 ppb to 1443.8 ppm) the concentrations are represented as the log (Table 3-2). The use of

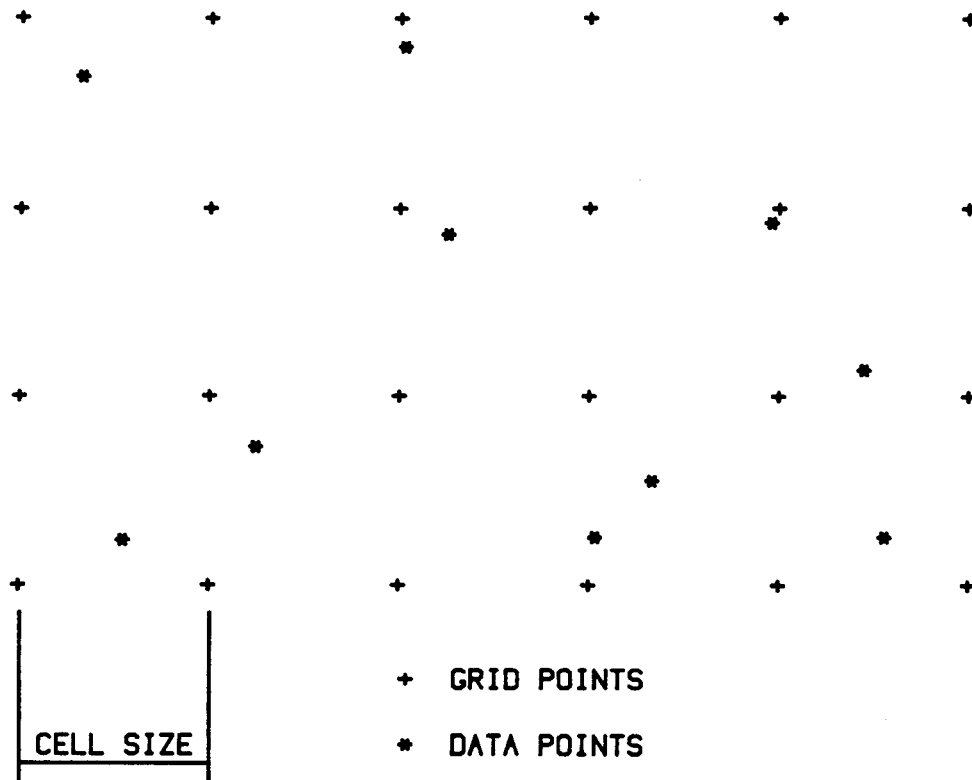
log₁₀ PCE concentrations (ppm) makes it possible to
contour the concentrations at intervals of:

Concentration	Interval (log ₁₀)
1000 ppm	3.0
100 ppm	2.0
10 ppm	1.0
1 ppm	0
100 ppb	-1.0
10 ppb	-2.0
1 ppb	-3.0

X,Y, and Z coordinates are entered for each 10' interval and a grid with a 2.5' cell size is created. The randomly spaced drill hole data is then used to compute a Z coordinate value for each grid cell intersection. These Z coordinate values are calculated by taking the three data points surrounding each grid cell intersection defining a plane and assigning a Z value to the grid intersection (Figure 5-1). All grid cell intersections are solved in this manner. The Z values of these grid intersections are then used to contour the entire grid through interpolation between the values calculated for each grid intersection.

This method of contouring using reliable boundary conditions provides an accurate, unbiased representation of the shape and extent of the contaminant plume. These contour maps have also been modeled in three dimensions with the Z axis elevation being the log₁₀ of the concentration. These three-dimensional representations of the contaminant plume provide an excellent visual display of the steep concentration gradients characteristic of all depth intervals.

The corner of each cell (the intersection of the dividing lines) is called a grid point. The system will compute a value (elevation) at each grid point by interpolating between the surrounding data points.



To compute a grid point value, three of the closest data points are used. These three points are chosen so that they form a triangle which surrounds the grid point.

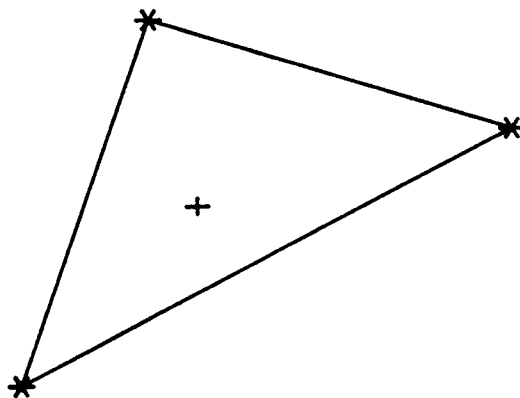


Figure 5-1 Method of Calculating Grid Point Values

5.2 RESULTS OF COMPUTER ANALYSIS OF SOIL DATA

This section briefly describes the shape and extent of PCE contamination at each depth interval from the surface to 90'.

5.2.1 Surface

The distribution of PCE at the surface is shown in Figure 5-2A. The highest concentration (20.9 ppm) is in hole #PS-9. The plume extends slightly to the north and west, although all the concentrations are relatively low and the gradients steep. Figure 5-2B is a 3-D plot of the concentrations at the surface viewed from the southwest in a direction of $N45^{\circ}E$.

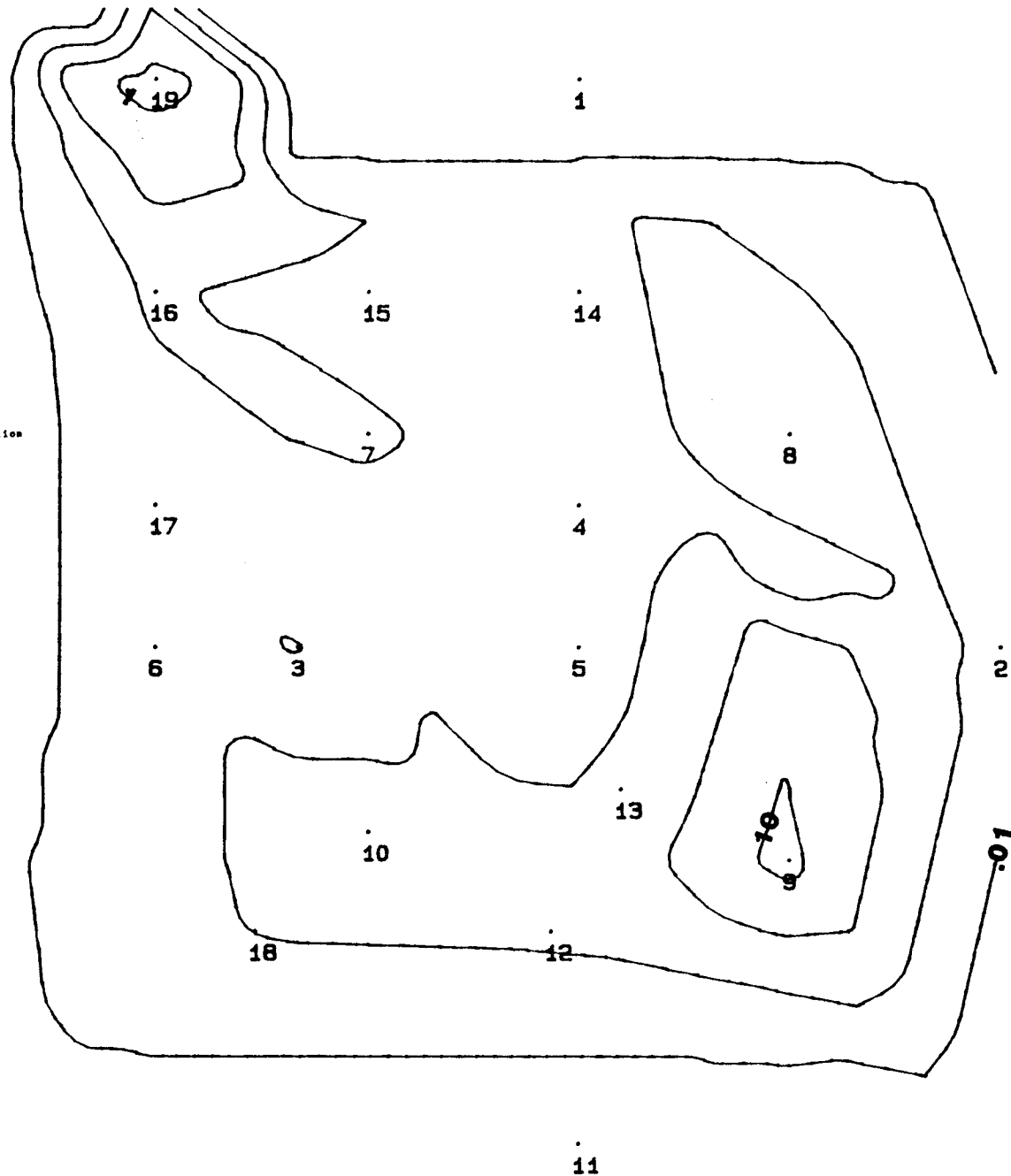
5.2.2 10 Foot Level

At the 10' depth the plume geometry is shown in figure 5-3A. Here the highest concentration (371.5 ppm) is in hole PS-4, north of the storage tank. The plume extends in a north-south direction from the tank. PCE concentrations drop off rapidly to the west, south and east and more gradually to the north. Figure 5-3B is a 3-D representation of the plume viewed from the southwest in $N35^{\circ}E$ direction. This representation shows the steep concentration gradients to the east, south, and west.

5.2.3 20 Foot Level

Figure 5-4A shows the shape and extent of the plume at the 20' level. The highest concentrations (361.7, 230.2,

PNM PERSON STATION



Core Hole #	PCE Concentration (ppm)	Log10 PCE Concentration
SURFACE		
PS-1	.062	-1.208
PS-2	.030	-1.242
PS-3	.015	-2.046
PS-4	.017	-1.760
PS-5	---	---
PS-6	.032	-1.284
PS-7	.156	-.807
PS-8	.575	-.240
PS-9	20.9	1.320
PS-10	.320	-.495
PS-11	---	---
PS-12	.169	-.772
PS-13	.100	-1.000
PS-14	.032	-1.495
PS-15	.030	-1.523
PS-16	.137	-.863
PS-17	.029	-1.538
PS-18	.126	-.900
PS-19	22.5	1.352

SCALE 1"=6'

CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE

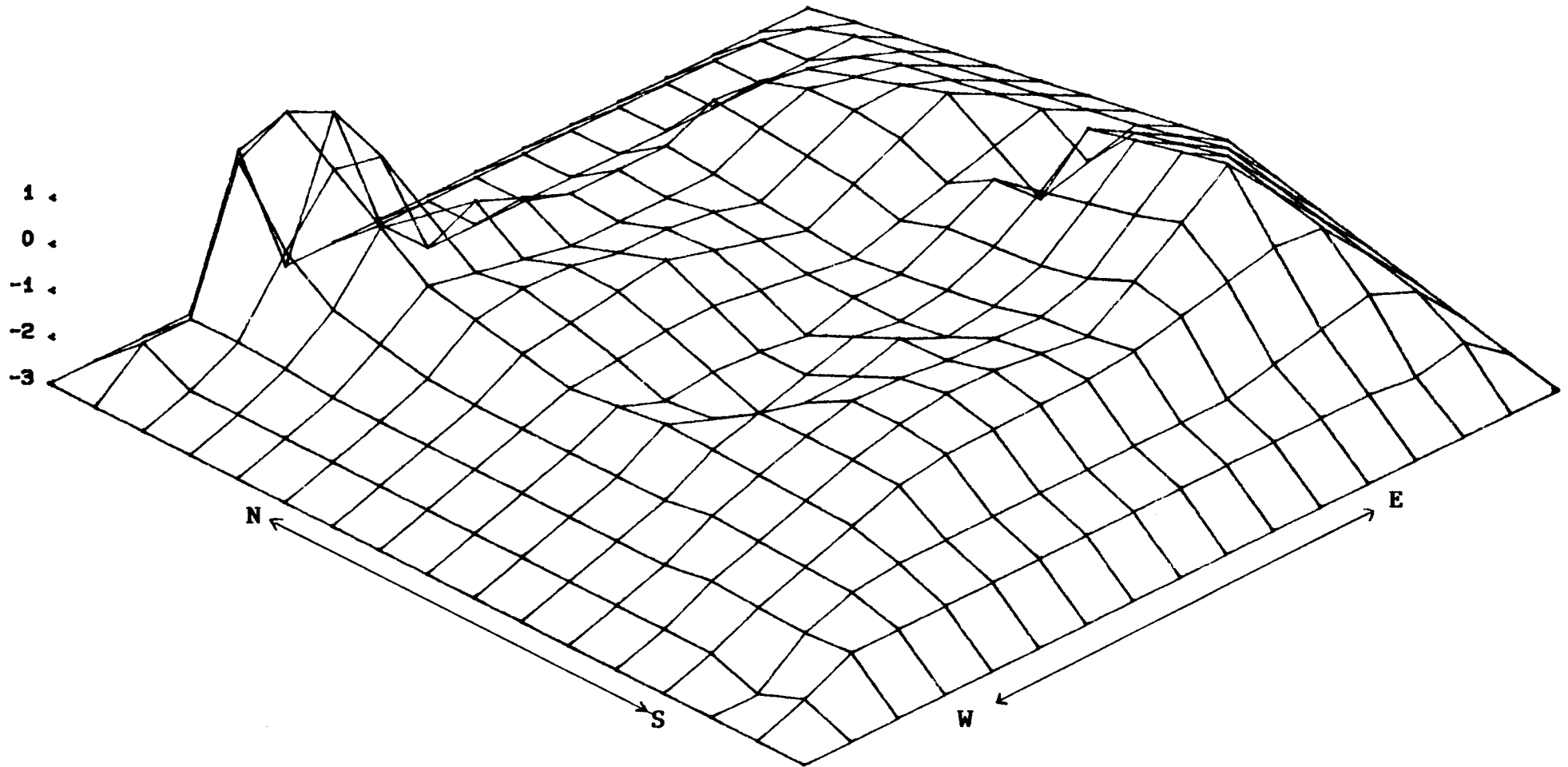
AT THE SURFACE

FIGURE 5- 2A

PNM PERSON STATION

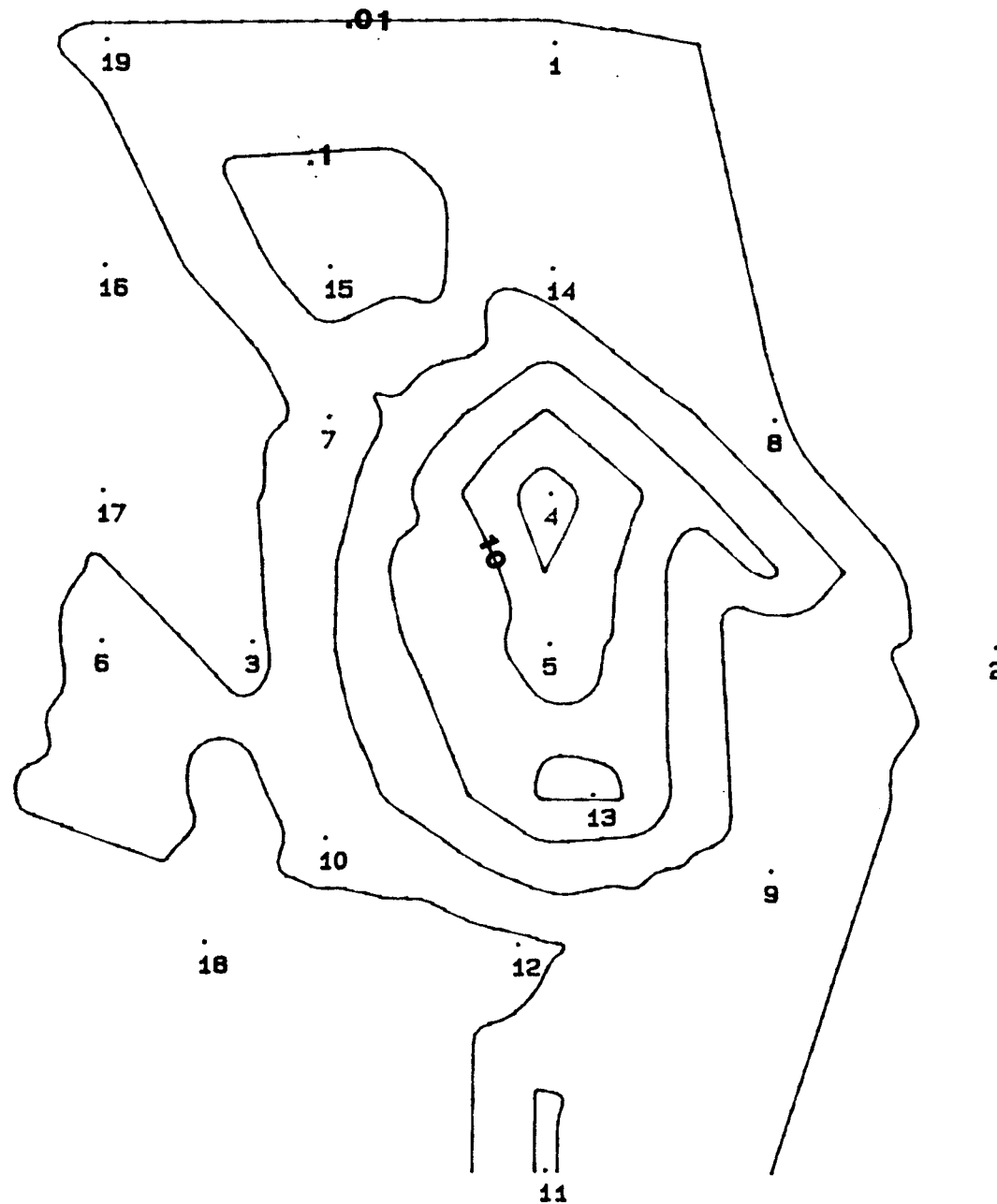
FIGURE 5- 2B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE SURFACE



PNM PERSON STATION

Core Hole #	PCE Concentration (ppm)	Log(PCE Concentration)
10 FOOT LEVEL		
PS-1	.030	-1.523
PS-2	.006	-2.222
PS-3	.005	-2.301
PS-4	371.5	2.570
PS-5	-----	-----
PS-6	.028	-1.553
PS-7	.012	-1.921
PS-8	.011	-1.959
PS-9	.030	-1.523
PS-10	.017	-1.770
PS-11	.121	-.920
PS-12	.004	-2.398
PS-13	23.3	1.367
PS-14	.029	-1.538
PS-15	.447	-.350
PS-16	<.001	-3.000
PS-17	.005	-2.301
PS-18	.007	-2.155
PS-19	.020	-1.699



SCALE 1"=6'

CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE

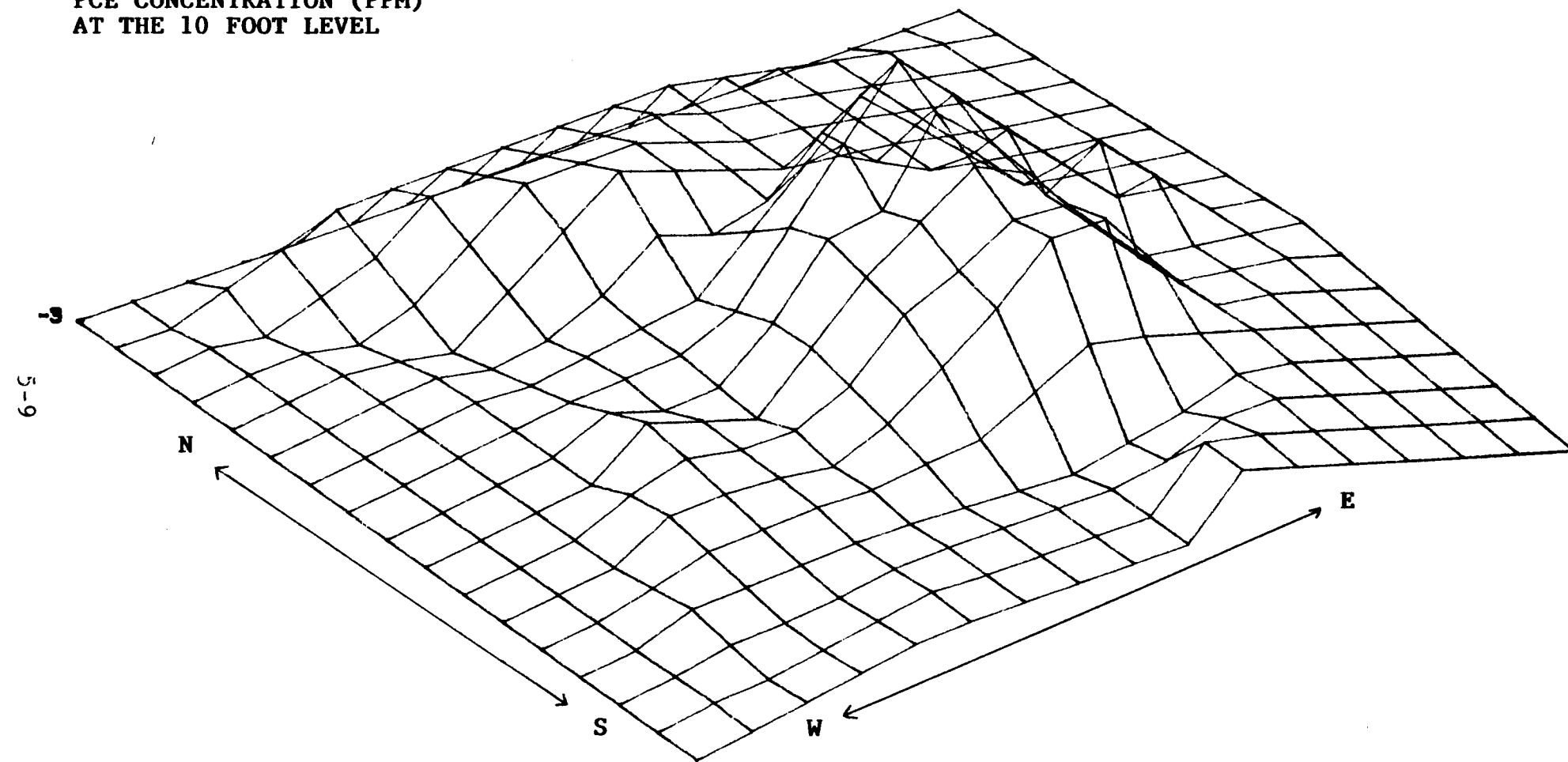
AT THE 10 FOOT LEVEL

FIGURE 5- 3A

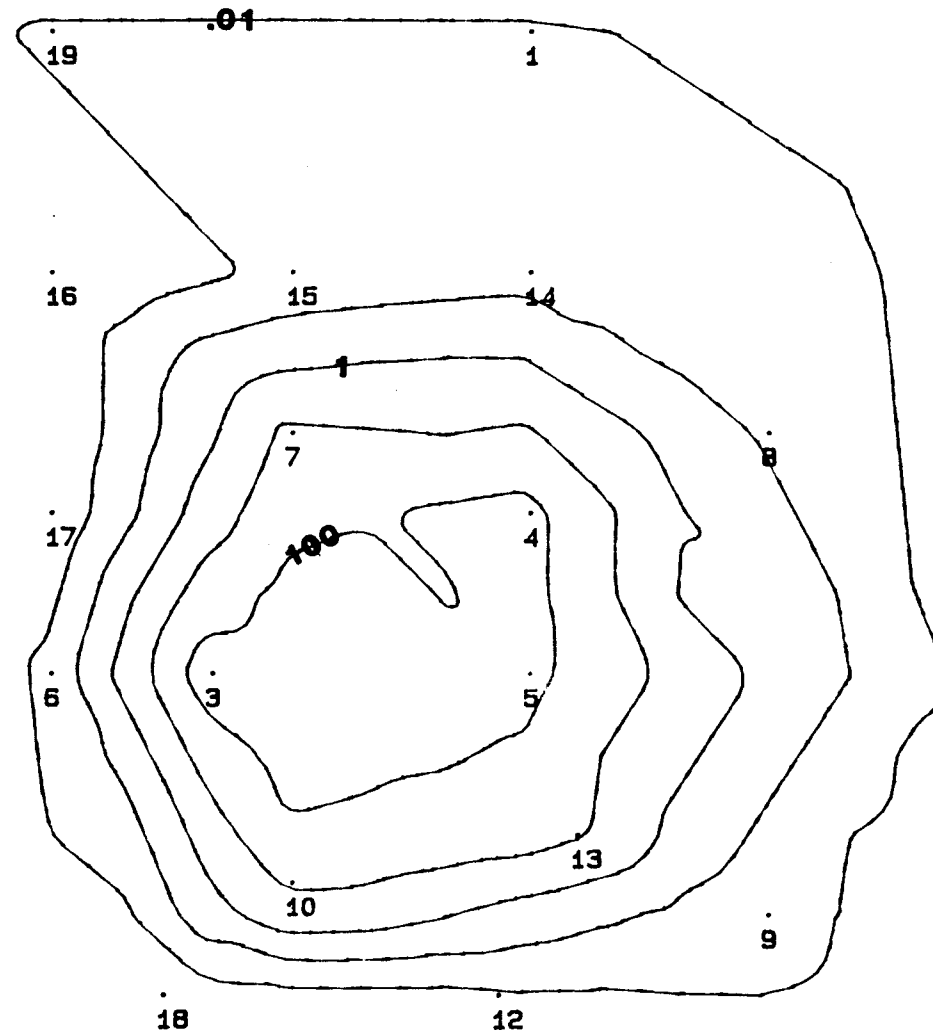
PNM PERSON STATION

FIGURE 5- 3B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 10 FOOT LEVEL



PNM PERSON STATION



5-10

Core Hole #	PCE Concentration (ppm)	Log10 PCE Concentration
20 FOOT LEVEL		
PS-1	.015	-1.824
PS-2	.003	-2.523
PS-3	361.7	2.558
PS-4	230.2	2.362
PS-5	202.7	2.307
PS-6	.018	-1.744
PS-7	15.8	1.199
PS-8	.079	-1.102
PS-9	.021	-1.678
PS-10	59.1	1.772
PS-11	.001	-3.000
PS-12	.005	-2.301
PS-13	21.9	1.340
PS-14	.053	-1.276
PS-15	.017	-1.77
PS-16	<.001	-3.00
PS-17	<.001	-3.00
PS-18	.005	-2.301
PS-19	.015	-1.824

SCALE 1"=6'

CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE AT

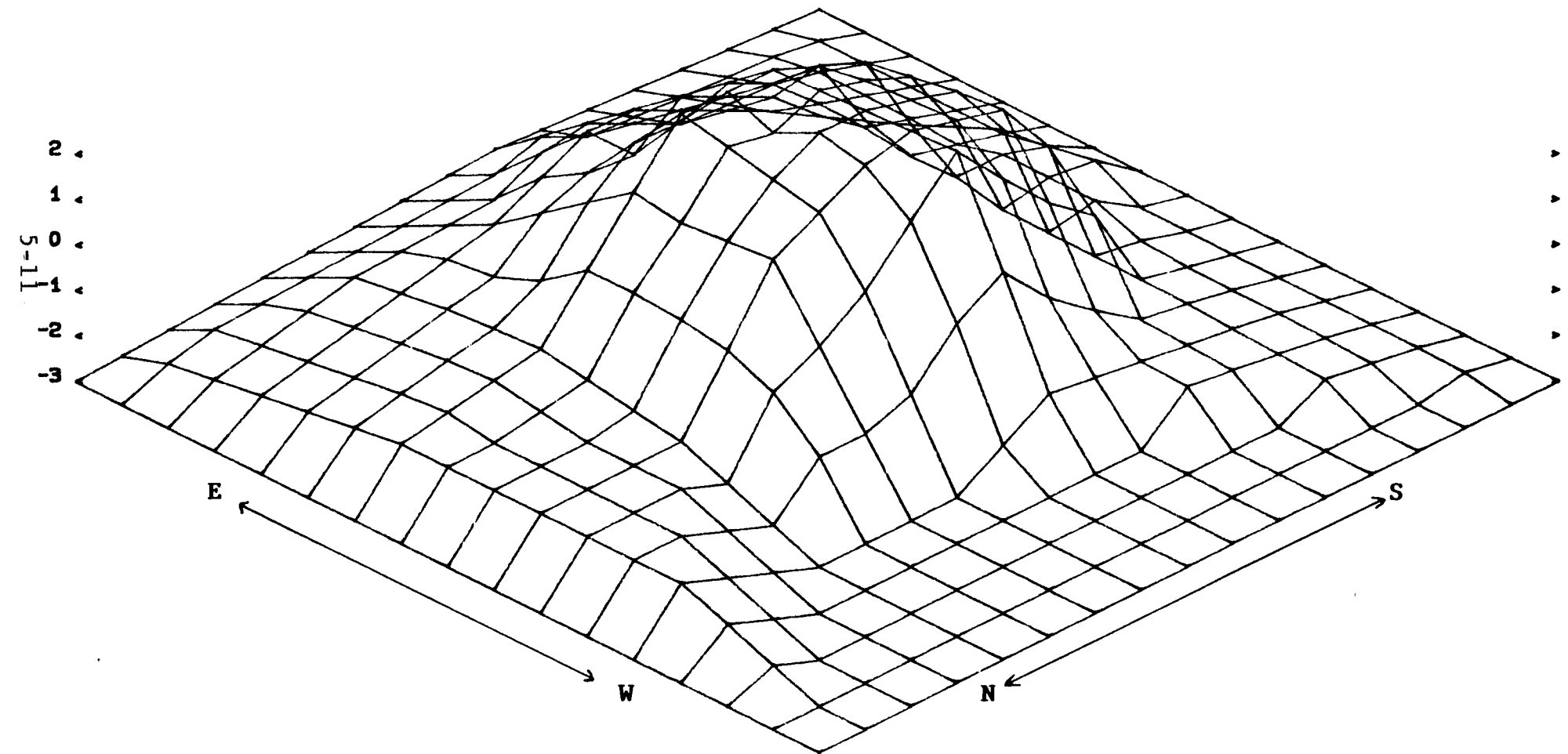
THE 20 FOOT LEVEL

FIGURE 5- 4A

PNM PERSON STATION

FIGURE 5- 4B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 20 FOOT LEVEL



202.7 ppm) are found in PS-3,4 and 5 respectively. The plume extends in a northwesterly direction with steep gradients to the south and east. The 3-D representation, (Figure 5-4B) viewed from the northwest in a S45°E direction, shows the steep concentration gradients and the extension of the plume in a northwesterly direction.

5.2.4 30 Foot Level

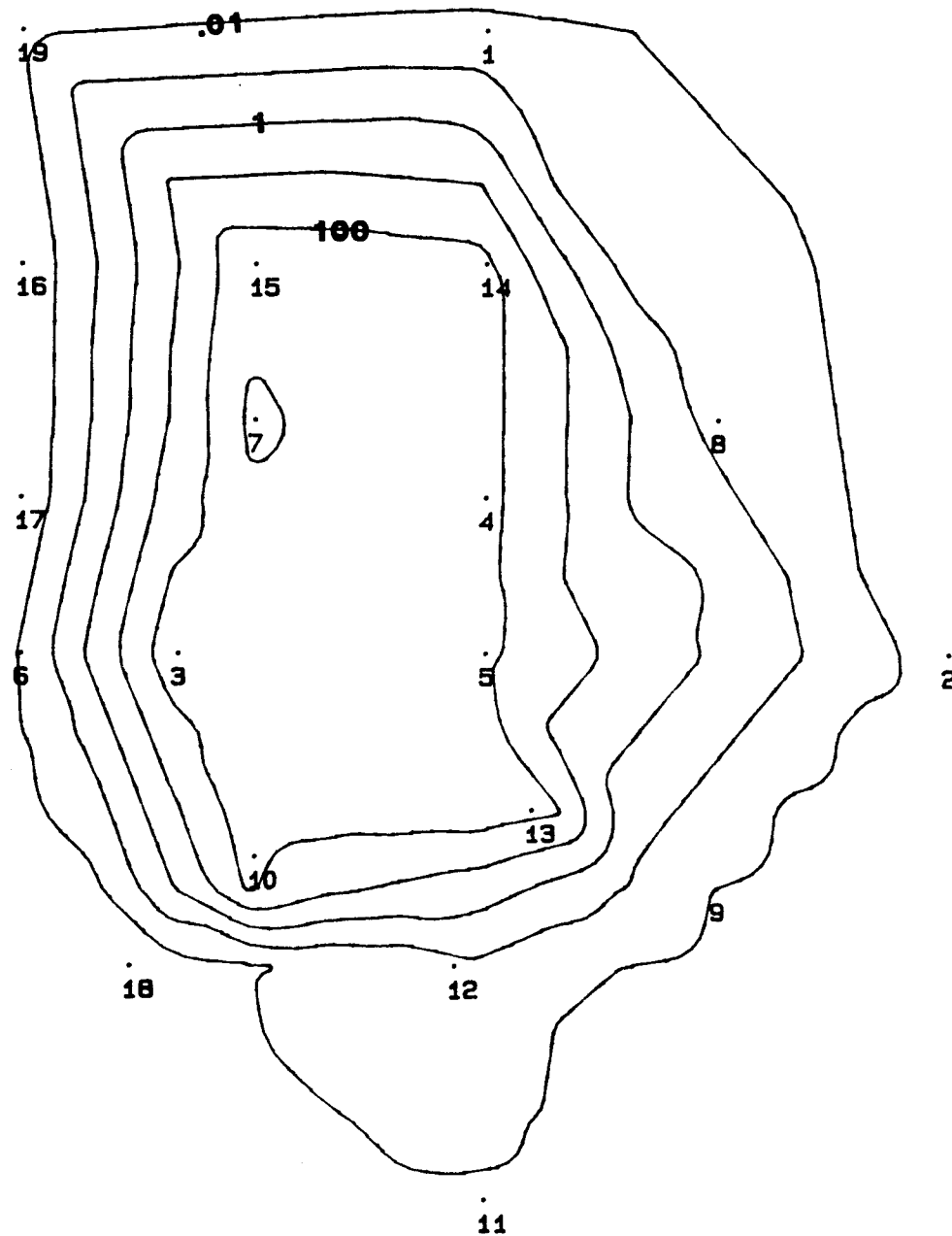
The shape and extent of PCE contamination at the 30 foot depth is shown in figure 5-5A. An area of high concentrations (167.6 to 1443.8 ppm) is found in an area northwest and south of the tank (PS-5). The concentration gradient is very steep (dropping 4 orders of magnitude in 8') to the southeast and to the west. The plume extends to the northwest. These steep gradients are represented well in Figure 5-5B which is viewed from the southwest in a N45°E direction. Steep gradients are shown in the west and southeast with plume extension to the northwest.

5.2.5 40 Foot Level

Figure 5-6 shows the extent and distribution of PCE contamination at the 40 foot level. This shows a definite extension of the plume in a northwesterly direction with very sharp concentration gradients in every other direction. The zone of highest concentration occurs again in PS-3, 4, 5 and 7. Figure 5-6B shows the plume viewed from the northeast in a S45°W direction. The sharp concentration gradients to the

PNM PERSON STATION

Cone Hole #	PCE Concentration (ppm)	Log10 PCE Concentration
30 FOOT LEVEL		
PS-1	.025	-1.602
PS-2	.004	-2.398
PS-3	405.6	2.608
PS-4	236.8	2.374
PS-5	167.6	2.224
PS-6	.009	-2.046
PS-7	1443.8	3.160
PS-8	.032	-1.284
PS-9	.010	-2.000
PS-10	331.4	2.520
PS-11	.006	-2.222
PS-12	.020	-1.699
PS-13	391.1	2.592
PS-14	231.5	2.365
PS-15	580.00	2.763
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	.005	-2.301
PS-19	.008	-2.097



SCALE 1"=6'

CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE AT

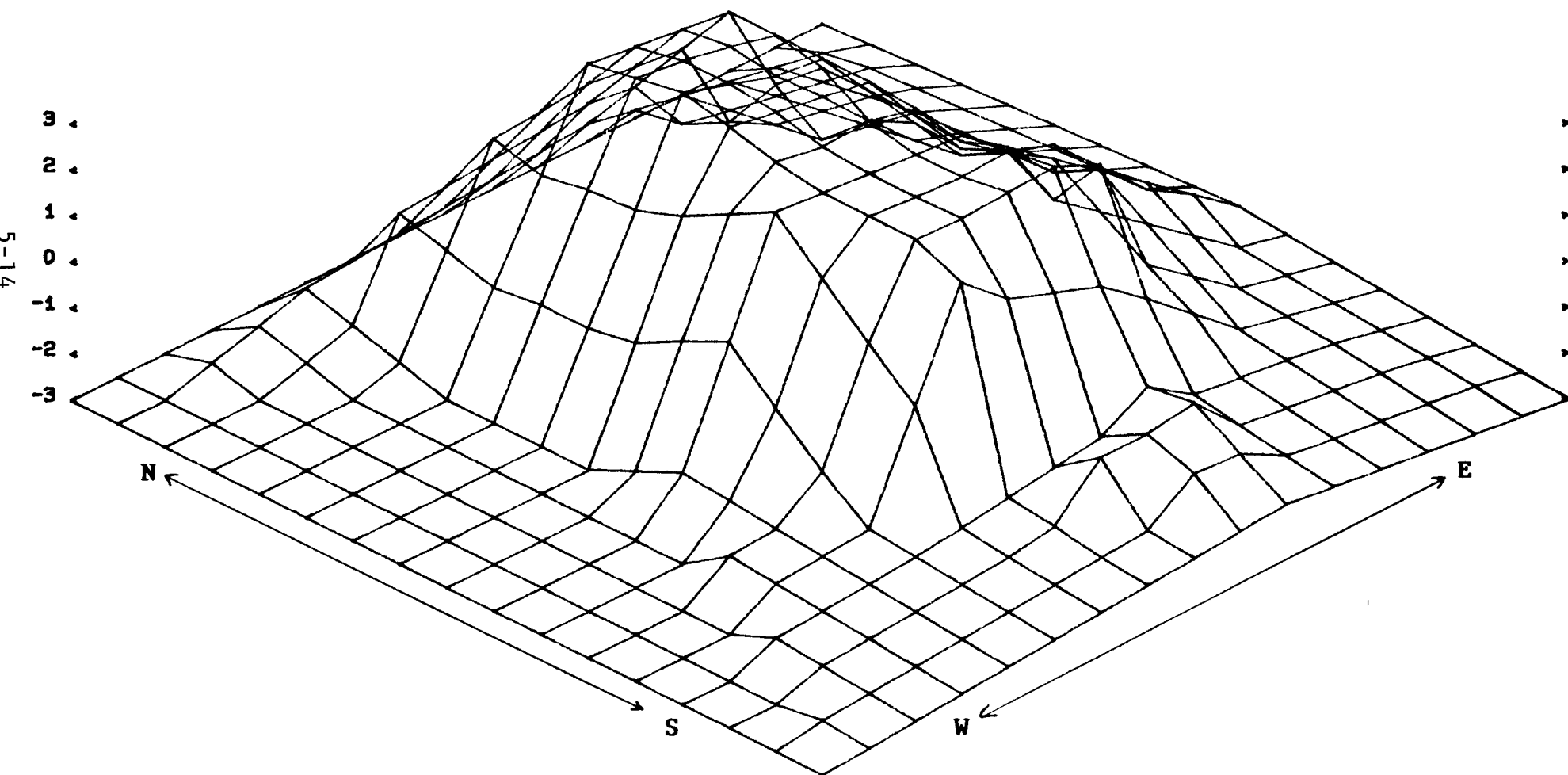
THE 30 FOOT LEVEL

FIGURE 5- 5A

PNM PERSON STATION

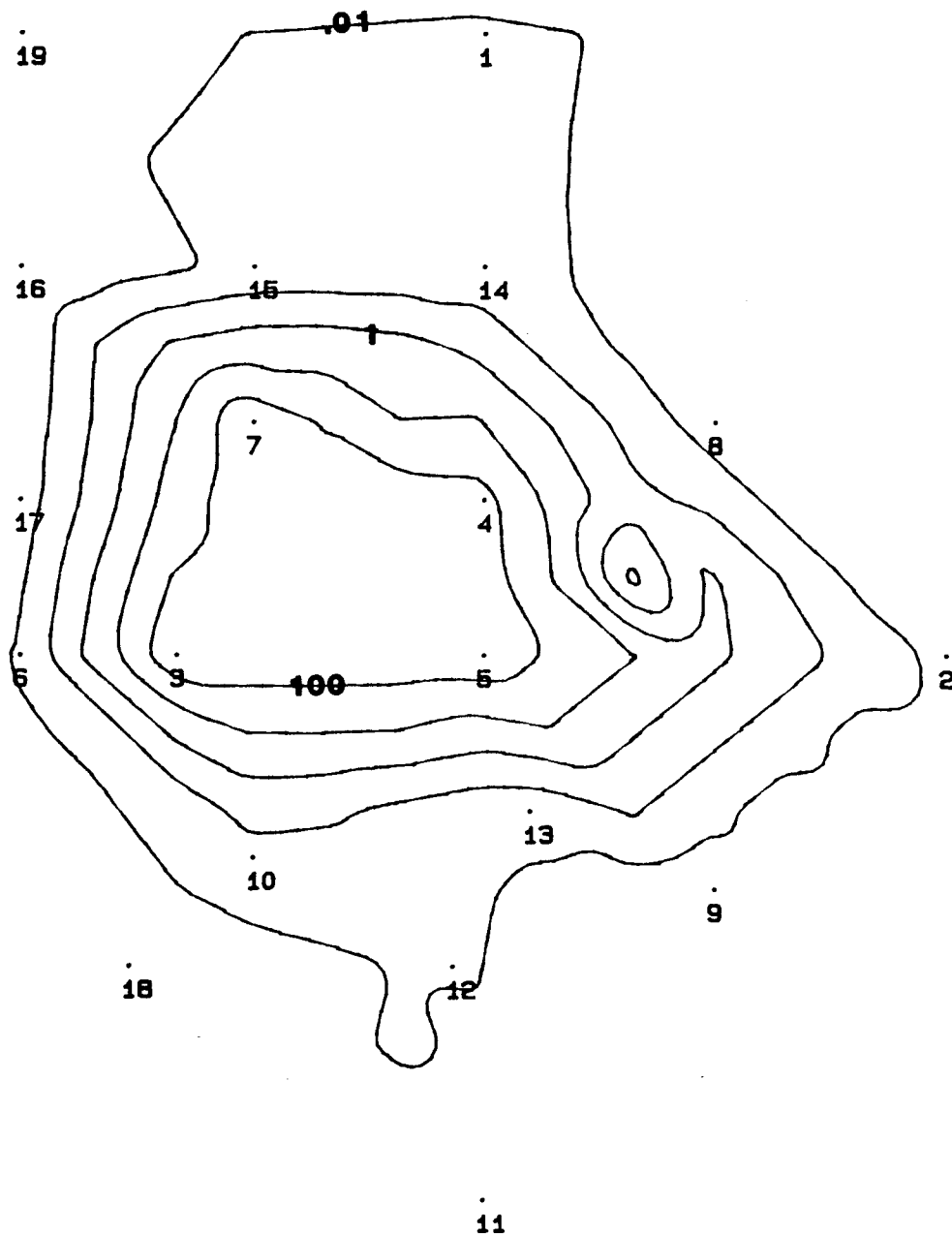
FIGURE 5- 5B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 30 FOOT LEVEL



PNM PERSON STATION

Core Hole #	PCE Concentration (ppm)	Log ₁₀ PCE Concentration
40 FOOT LEVEL		
PS-1	.020	-1.699
PS-2	.007	-2.154
PS-3	451.8	2.655
PS-4	263.3	2.420
PS-5	438.5	2.642
PS-6	.011	-1.959
PS-7	593.6	2.773
PS-8	.003	-2.523
PS-9	.002	-2.700
PS-10	.021	-1.678
PS-11	.007	-2.154
PS-12	.012	-1.921
PS-13	.011	-1.960
PS-14	.024	-1.62
PS-15	.018	-1.743
PS-16	<.001	-3.000
PS-17	.002	-2.70
PS-18	.004	-2.40
PS-19	.005	-2.301



SCALE 1"=6'

CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE AT

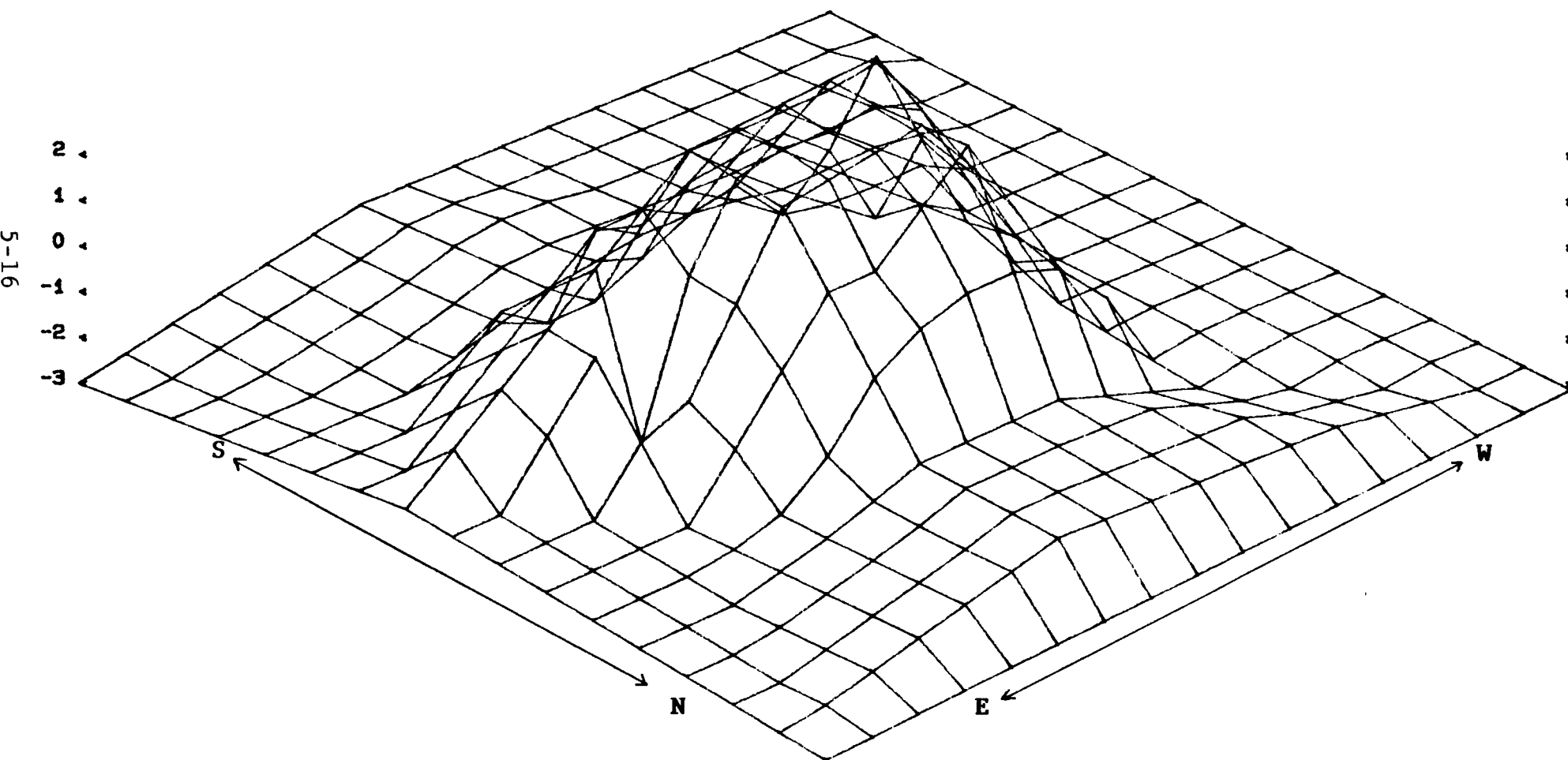
THE 40 FOOT LEVEL

FIGURE 5- 6A

PNM PERSON STATION

FIGURE 5- 6B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 40 FOOT LEVEL



south, east and west are clearly visible with a definite extension of the plume to the northwest.

5.2.6 50 Foot Level

Figure 5-7A shows the PCE contamination at the 50 foot level again extending markedly to the northwest, although the area of highest concentration has decreased significantly. The holes with the highest concentrations are PS-4, 5 and 7. Figure 5-7B shows the rapid decline in concentration to the south and west with an extension of the plume to the northwest. This figure is viewed from the northwest in a S45° E direction.

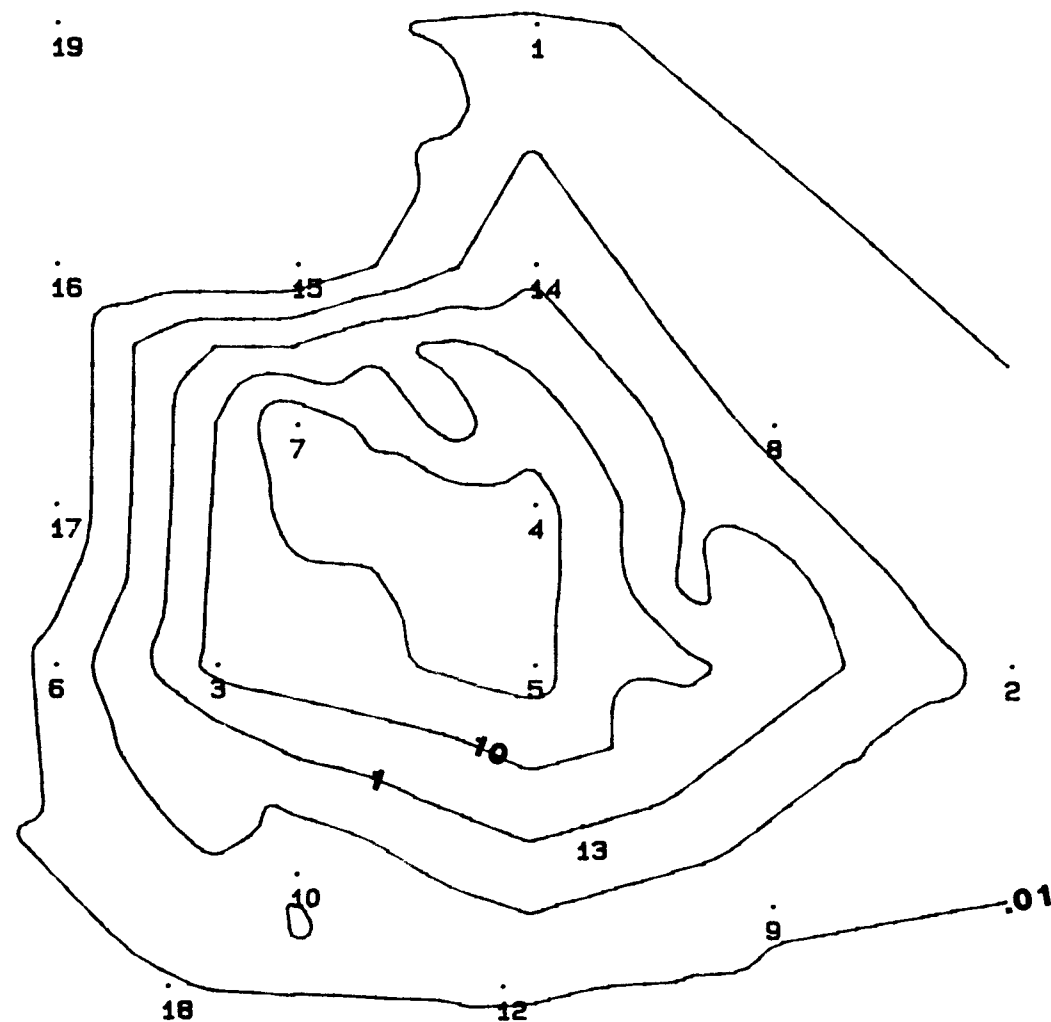
5.2.7 60 Foot Level

Figure 5-8A shows the concentration of PCE at the 60 foot depth. The area of the plume has decreased significantly and concentrations drop off very rapidly to the south (where 9 ppb was found in PS-9, 10 and 12) and east. The plume is again extended to the northwest. The steep gradients to the south and east are shown in Figure 5-9B, a 3-D representation viewed from the southeast in a N45°W direction.

5.2.8 70 Foot Level

Figure 5-10A shows the extent of PCE contamination at the 70 foot level. Note the very pronounced decrease in concentrations between 60' and 70'. The highest concentration at the 70 foot depth is 84 ppb compared with

PNM PERSON STATION



Core Hole #	PCE Concentration (ppm)	Log ₁₀ PCE Concentration
50 FOOT LEVEL		
PS-1	.015	-1.824
PS-2	.052	-1.284
PS-3	18.000	1.255
PS-4	305.7	2.485
PS-5	295.2	2.470
PS-6	.020	-1.699
PS-7	820.9	2.914
PS-8	.045	-1.347
PS-9	.013	-1.886
PS-10	.009	-2.046
PS-11	.002	-2.699
PS-12	.012	-1.921
PS-13	.001	-3.000
PS-14	.727	-1.138
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	.010	-2.000
PS-19	.004	-2.398

SCALE 1"=6'

CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE AT

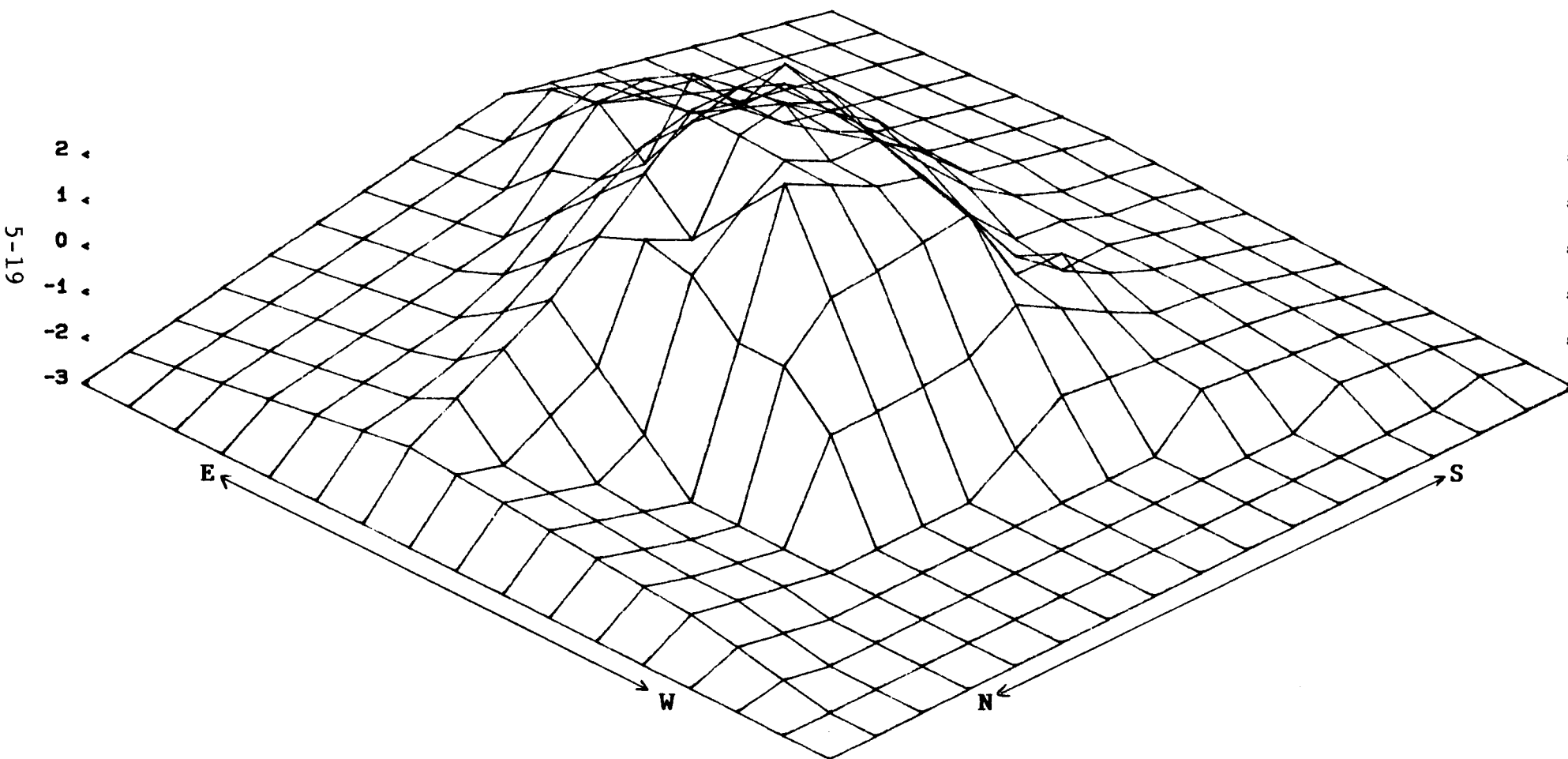
THE 50 FOOT LEVEL

FIGURE 5- 7A

PNM PERSON STATION

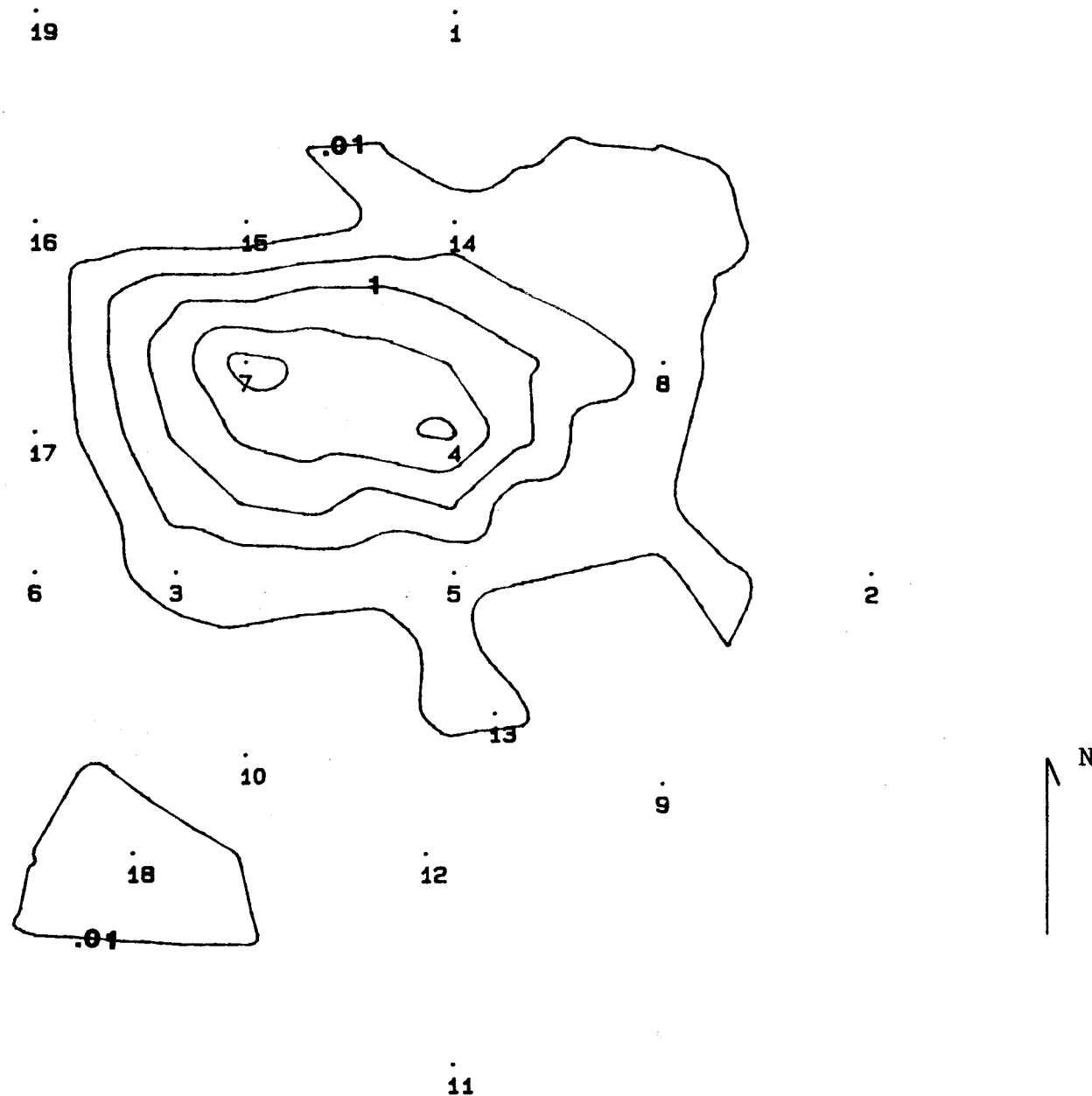
FIGURE 5- 7B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 50 FOOT LEVEL



PNM PERSON STATION

Core Hole #	PCE Concentration (ppm)	Log10 PCE Concentration
60 FOOT LEVEL		
PS-1	-----	-----
PS-2	.032	-1.495
PS-3	156.27	2.194
PS-4	.013	-1.886
PS-5	.001	-3.000
PS-6	240.8	2.382
PS-7	.065	-1.187
PS-8	.001	-3.00
PS-9	.001	-3.00
PS-10	.002	-2.699
PS-11	.001	-3.00
PS-12	.026	-1.585
PS-13	.035	-1.436
PS-14	<.001	-3.000
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	<.039	-1.410
PS-18	<.001	-3.000
PS-19		



SCALE 1"=6'

CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE AT

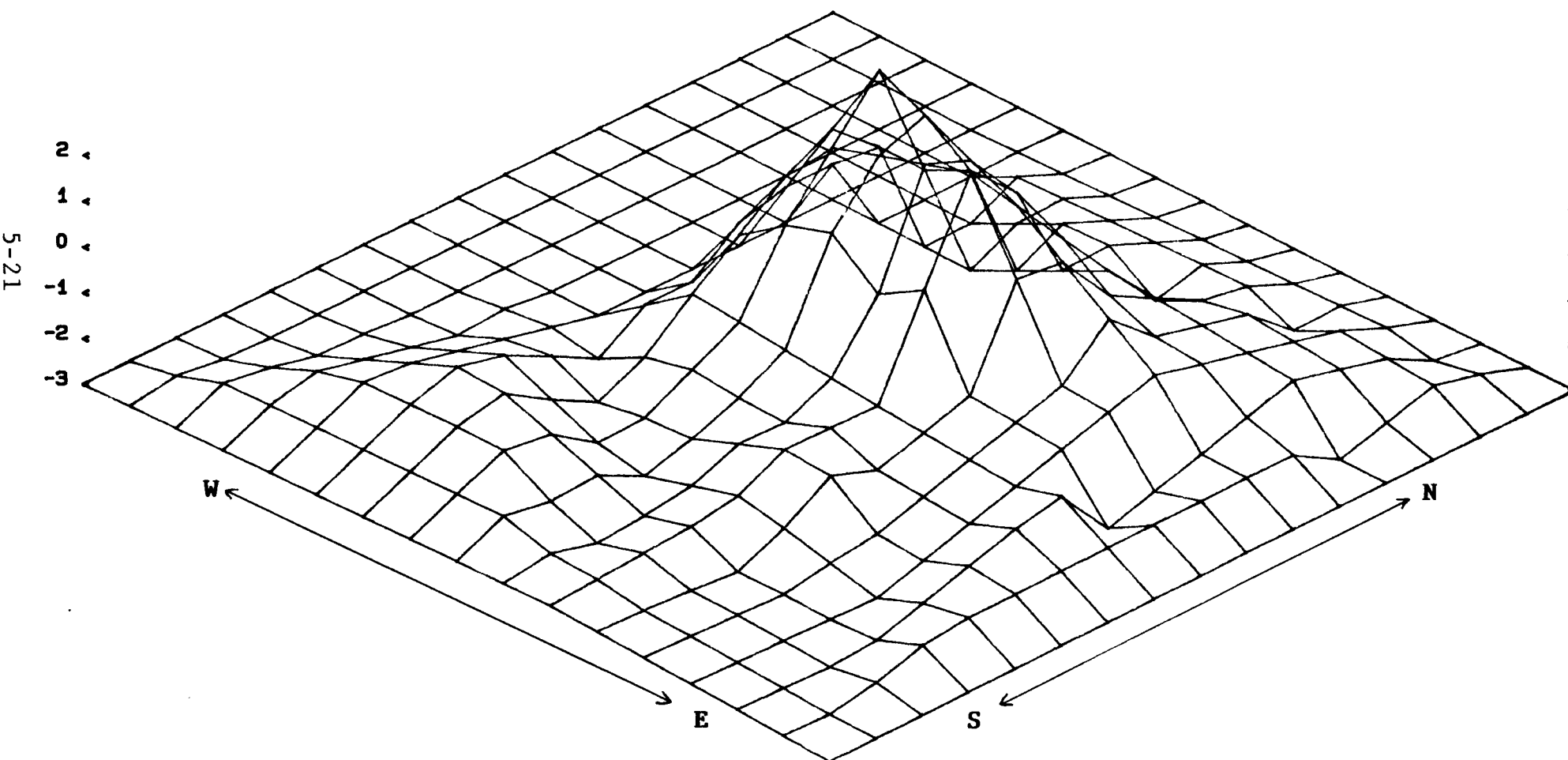
THE 60 FOOT LEVEL

FIGURE 5- 8A

PNM PERSON STATION

FIGURE 5- 8B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 60 FOOT LEVEL



PNM PERSON STATION

Core Hole #	PCE Concentration (ppm)	Log10 PCE Concentration
70 FOOT LEVEL		
PS-1	-----	-----
PS-2	-----	-----
PS-3	-----	-----
PS-4	.006	-2.222
PS-5	.002	-2.699
PS-6	.042	-1.377
PS-7	.028	-1.553
PS-8	.002	-2.699
PS-9	.001	-3.000
PS-10	.061	-1.213
PS-11	.004	-2.398
PS-12	.084	-1.076
PS-13	.002	-2.699
PS-14	.024	-1.62
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	.027	-1.569
PS-18	<.001	-3.000
PS-19	<.001	-3.000

SCALE 1"=6'

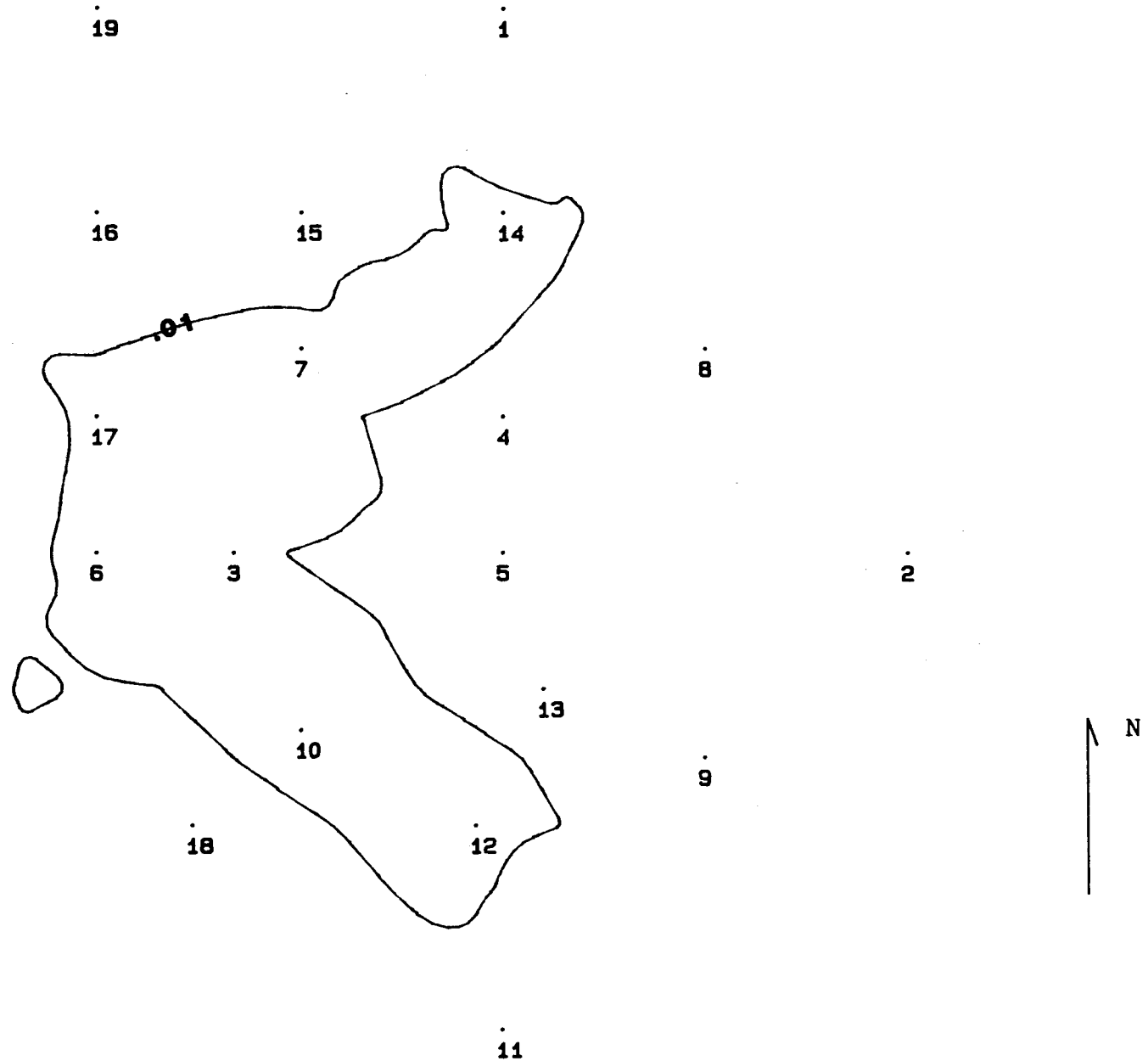
CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE AT

THE 70 FOOT LEVEL

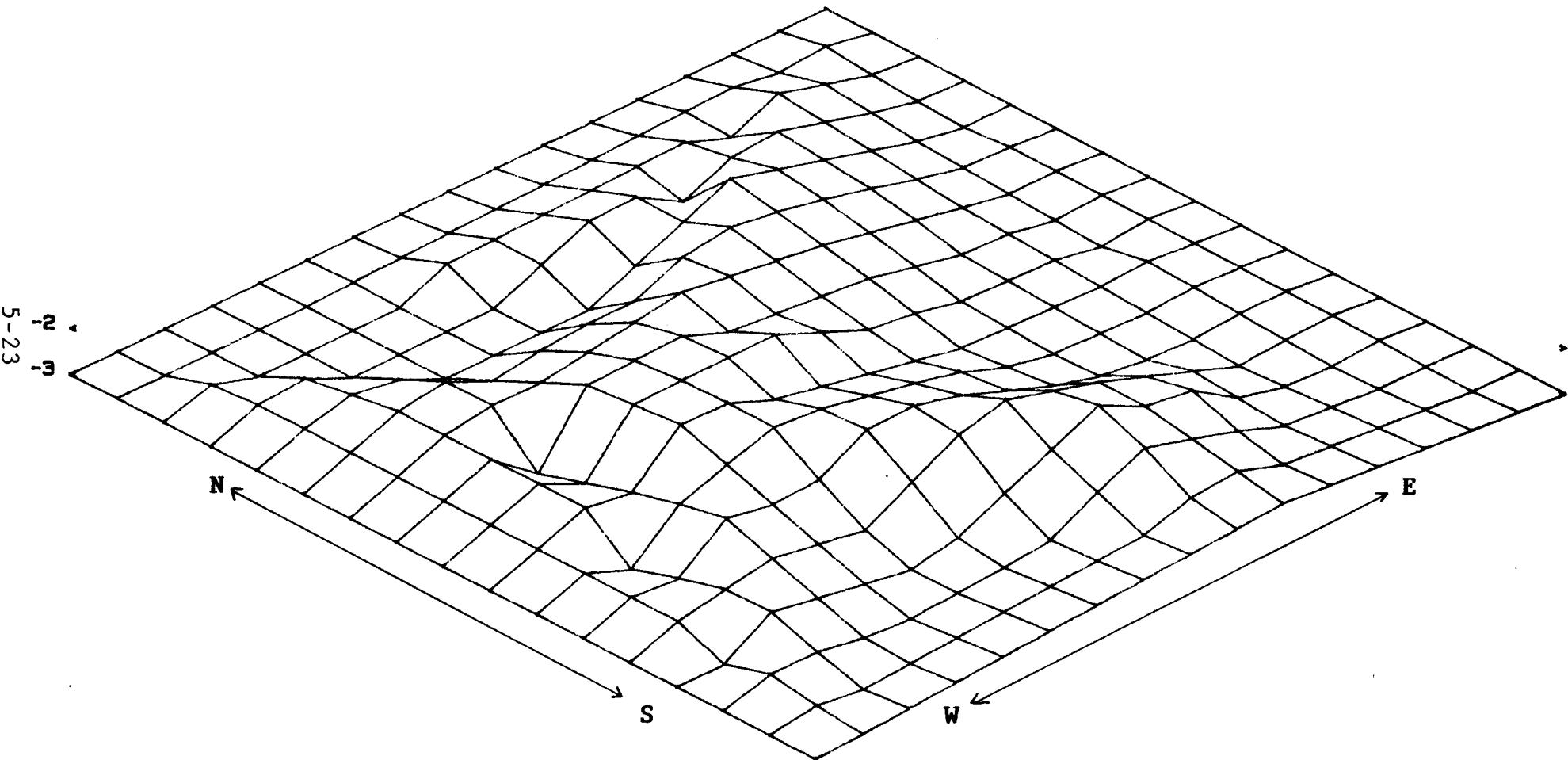
FIGURE 5- 9A



PNM PERSON STATION

FIGURE 5- 9B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 70 FOOT LEVEL



240.8 ppm at the 60' level (Figure 5-8A, 5-12). In general, the plume is still extended to the northwest although the concentrations are 4 orders of magnitude less. Figure 5-9B is a 3-D representation of the plume viewed from the southwest in a N45°E direction.

5.2.9 80 Foot Level

Figure 5-10A shows the plume of PCE contamination at the 80' level. PCE concentrations do not exceed 86 ppb in any of the drill holes at this level. Liquid PCE has probably not gone beyond the 65' depth as demonstrated by the abrupt drop off between the 60' and 70' levels and the consistency of low levels below 65 feet (Section 5.3). Figure 5-10B is a 3-D representation of the plume at the 80' level viewed from the southeast in a N45°W direction.

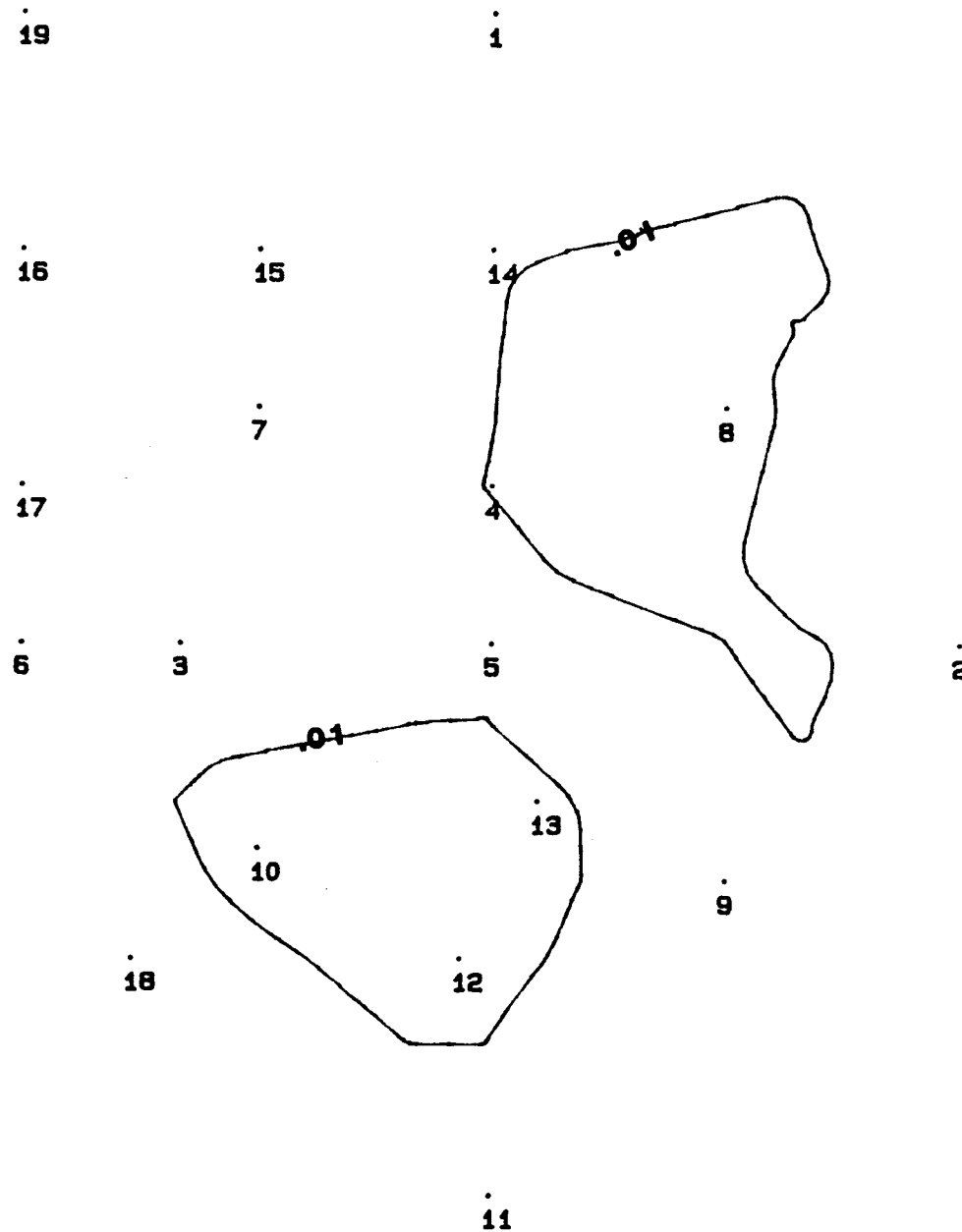
5.2.10 90 Foot Level

Figure 5-11A is a representation of the PCE plume at the 90' level. The concentrations of all boreholes are all below 10 ppb except the area around PS-4, PS-5 and PS-13 which has concentrations up to 19 ppb. Figure 5-11B is a 3-D representation of the plume viewed from the northwest in a S45°E direction.

PNM PERSON STATION

5-25

Core Hole #	PCE Concentration (ppm)	Log ₁₀ PCE Concentration
80 FOOT LEVEL		
PS-1	----	-----
PS-2	----	-----
PS-3	----	-----
PS-4	.010	-2.0
PS-5	.004	-2.398
PS-6	.001	-3.000
PS-7	.003	-2.523
PS-8	.086	-1.066
PS-9	.001	-3.000
PS-10	.040	-1.397
PS-11	.002	-2.699
PS-12	.064	-1.194
PS-13	.031	-1.509
PS-14	.003	-2.097
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	<.001	-3.000
PS-19	<.001	-3.000



SCALE 1"=6'

CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE

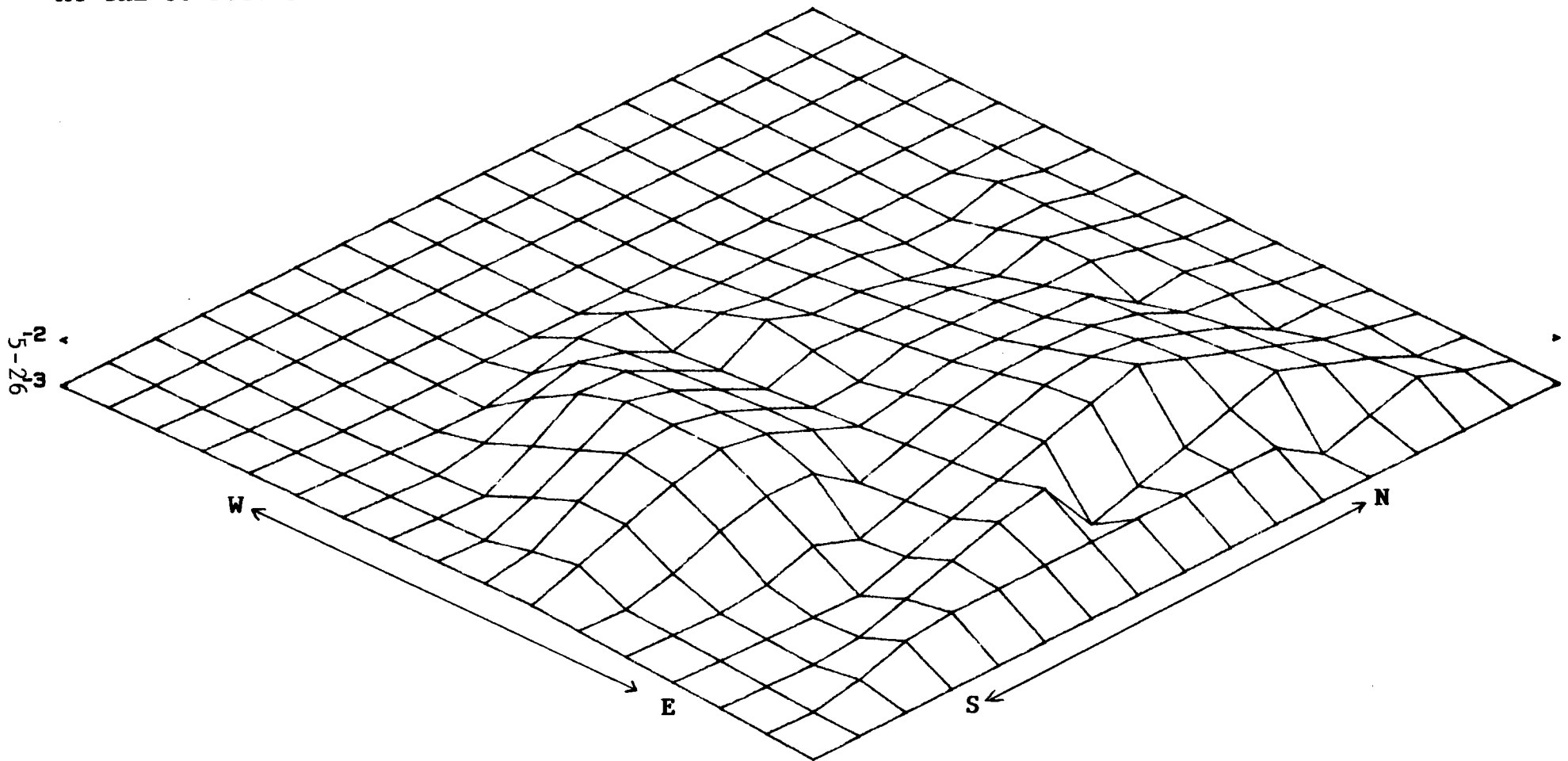
AT THE 80 FOOT LEVEL

FIGURE 5-10A

PNM PERSON STATION

FIGURE 5-10B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 80 FOOT LEVEL



PNM PERSON STATION

Core Hole #	PCE Concentration (ppm)	Log10 PCE Concentration
90 FOOT LEVEL		
PS-1	-----	-----
PS-2	-----	-----
PS-3	-----	-----
PS-4	.019	-1.721
PS-5	.011	-1.959
PS-6	.009	-2.046
PS-7	.002	-2.699
PS-8	.008	-2.097
PS-9	.001	-3.000
PS-10	.006	-2.222
PS-11	.001	-3.000
PS-12	.009	-2.046
PS-13	.013	-1.886
PS-14	.005	-2.301
PS-15	<.001	-3.000
PS-16	<.001	-3.000
PS-17	<.001	-3.000
PS-18	<.001	-3.000
PS-19	<.001	-3.000

SCALE 1"=6'

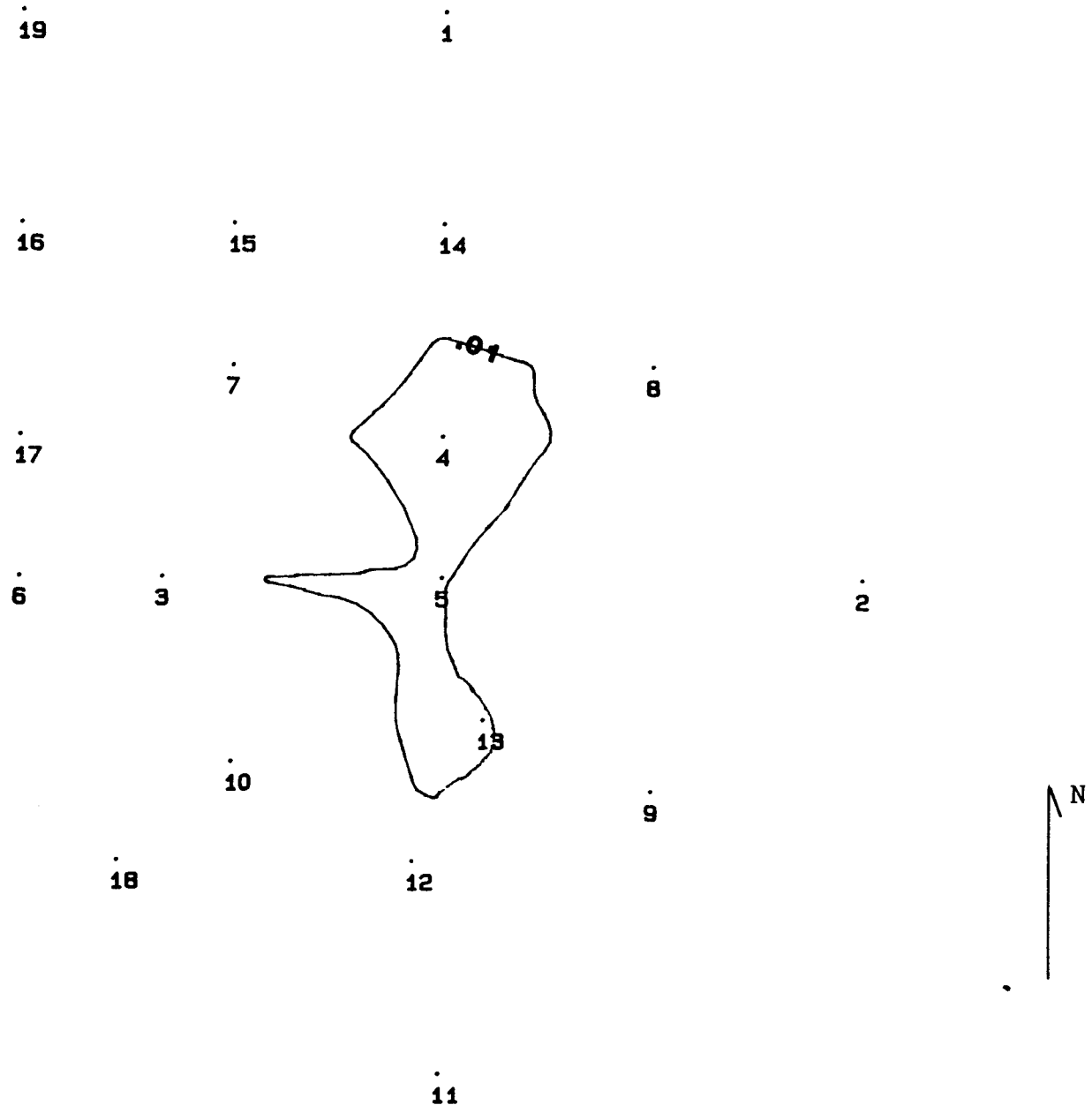
CONTOUR INTERVAL IS

LOGARITHMIC

CONCENTRATION OF PCE AT

THE 90 FOOT LEVEL

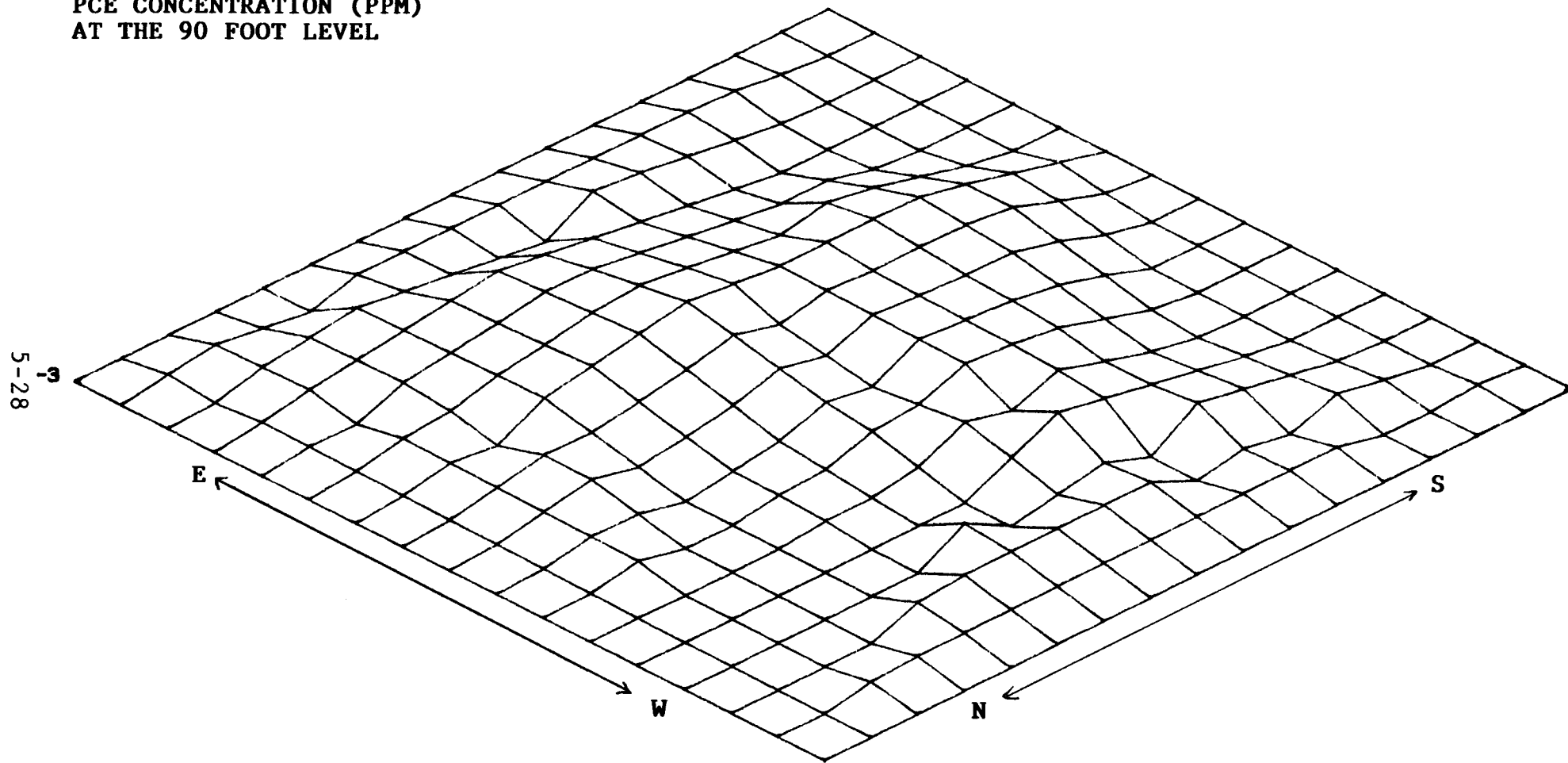
FIGURE 5-11A



PNM PERSON STATION

FIGURE 5-11B

3-D REPRESENTATION OF LOG_{10}
PCE CONCENTRATION (PPM)
AT THE 90 FOOT LEVEL



5.3 EXTENT OF VAPOR PHASE CONTAMINATION

Analysis of soil chemistry data reveal a zone of high levels of PCE (> 10 ppm) which is surrounded by soils with PCE concentrations several orders of magnitude less (0.12 ppm - 0.001 ppm). These sharp gradients, which have been described in Section 5.2 represent the limit of liquid phase contamination. Vapor phase contamination of soils appears to be responsible for the low-level contamination in several boreholes laterally removed from the source (Table 5-1) and for the low level contamination in deeper portions of the more contaminated boreholes.

The predominant direction of liquid phase contamination movement is vertical except where depositional structures of sand, gravel and clay particles are aligned such that some horizontal movement occurs along these planes. This type of liquid phase transport has affected several boreholes which are depositionally down dip of the source. The streams which deposited the sediments found in the vadose zone (Santa Fe Group) flowed generally to the west in this area facilitating liquid transport in a westerly direction. Sedimentary structures will retard horizontal movement in other directions. Hence boreholes to the east, north and south are generally less contaminated than western boreholes.

Molecular diffusion/vapor phase transport will occur in horizontal directions almost as readily as a vertical direction because PCE-saturated air, for example, is not significantly denser than dry air (1.12 vs 1.0 relative

TABLE 5-1

BOREHOLES CONTAMINATED BY VAPOR PHASE TRANSPORT

BOREHOLE	MAXIMUM CONCENTRATION OF PCE IN BOREHOLE	DEPTH OF MAXIMUM* CONCENTRATION
PS-1	0.03	10'
PS-2	0.052	50'
PS-6	0.042	70'
PS-8	0.086	80'
PS-9	0.030	10'
PS-11	0.007	40'
PS-12	0.084	70'
PS-17	0.027	70'
PS-18	0.039	60'
PS-19	0.02	10'

UNCONTAMINATED BOREHOLES

PS-16	<0.001
PSMW1	<0.001
PSMW2	<0.001
PSMW3	<0.001

BOREHOLES CONTAMINATED BY LIQUID PCE

PS-3	700.0	15'
PS-4	371.5	10'
PS-5	2127.0	15'
PS-7	1443.0	30'
PS-10	331.0	30'
PS-13	492.0	25'
PS-14	231.0	30'
PS-15	580.0	30'

*Surface Sample Not Included

density). The density difference between water-saturated air and PCE/water-saturated air would be even smaller. The extent of vapor phase transport in a horizontal direction is similar to transport distances in a vertical direction.

The zone of liquid phase contamination at Person Station is defined by the 10 ppm concentration isopleth. Contaminated soils with concentrations less than 1 ppm have been affected by molecular diffusion/vapor phase transport only and not liquid phase transport.

5.4 MASS OF PCE IN SOIL

The total mass of PCE in the soil has been determined precisely by measuring the area within four (4) concentration ranges:

Average Concentration	Concentration Range
1221.9 ppm	> 1000 < 1443.8 ppm
500 ppm	> 100 < 1000 ppm
50 ppm	> 10 < 100 ppm
1.0 ppm	> .01 < 10 ppm

The volumes of contaminated soil were calculated for each interval within each concentration range. Average concentrations were determined for the four ranges using all available borehole data. These values were multiplied by bulk density to determine mass of PCE for each concentration range for each 10' interval. These calculations are summarized below:

Total Volume Soil Contaminated:	
> 100 ppm	113.88M ³
> 10 ppm < 100 ppm	118.46M ³
> .01 ppm < 10 ppm	1185.26M ³

Total Mass PCE in Soil 103.29 kg

Depth Range	% of Total PCE Mass	PCE Mass (kg)
0-25'	20.8	21.53
0-45'	85.0	87.81
0-55'	98.1	101.36
0-65'	99.7	103.05
0-85'	99.9	103.26
0-95'	99.9	103.28

An elliptical volume of soil 65' deep located as shown in Figure 5-12 encloses all soils with PCE concentrations >10 ppm. The area of the ellipse is $29.78M^2$ and the associated volume is $499.4M^3$. This amount of material contains 99.7% of the PCE (103.05 kg) (Figure 5-13, 5-14).

5.5 ASSESSMENT OF CONTAMINANT MIGRATION MECHANISMS

Movement of contaminants through the vadose zone can take place by three mechanisms:

- Saturated Fluid Flow (Migration of a wetted front)
- Unsaturated Fluid Flow
- Molecular Diffusion/Vapor Phase Transport

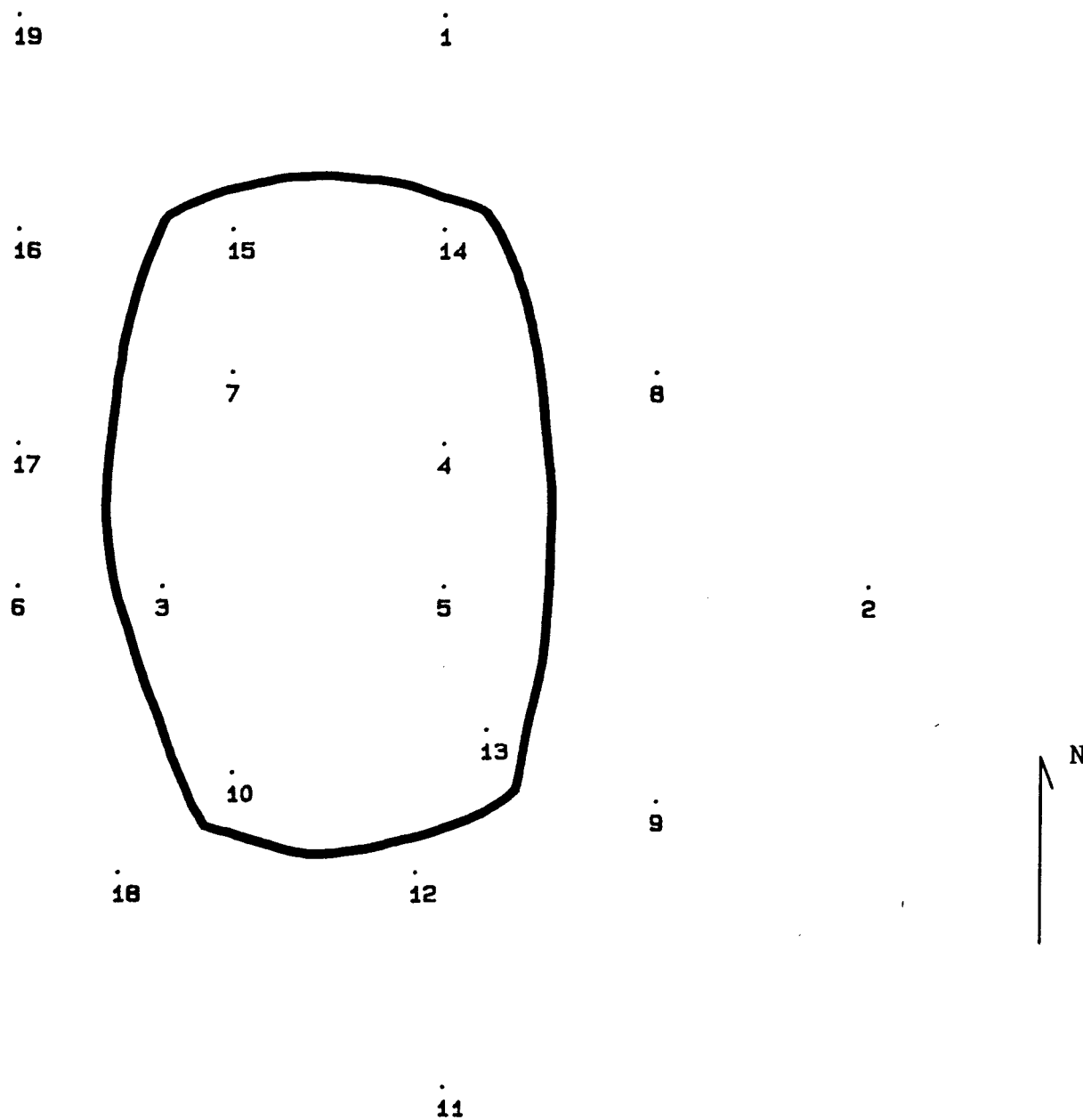
At Person Station a combination of these mechanisms has resulted in the documented soil contamination.

5.5.1 Saturated Fluid Flow

Since saturated conditions do not exist, contamination in the soil cannot be transported by saturated fluid flow. Liquid waste storage ceased 10/13/83 and an asphalt cover prevents precipitation from saturating the contaminated soil.

Figure 5-12
Location of ellipse
required to enclose
soil > 10ppm PCE

1" = 6'



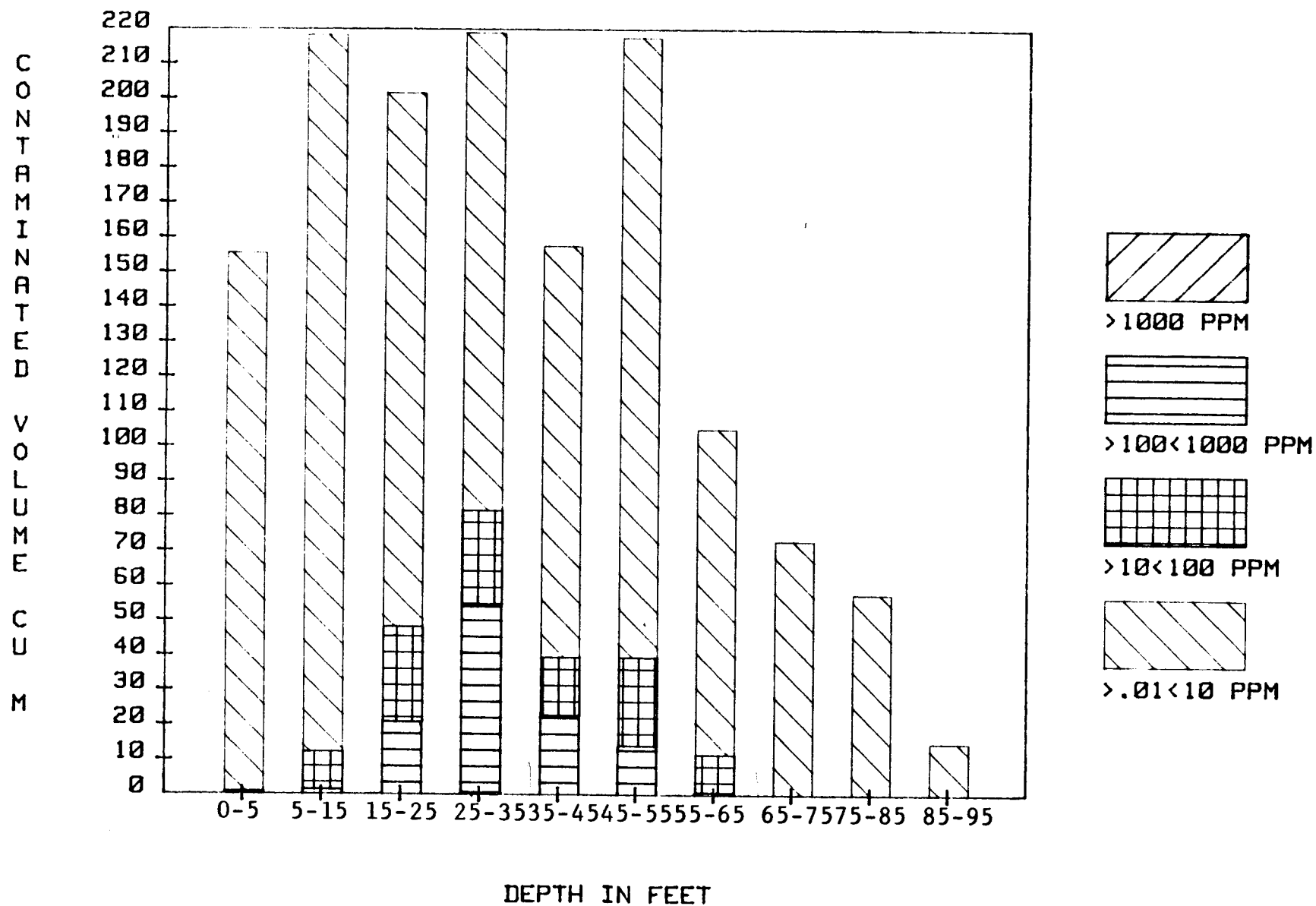


Figure 5-13 Bar Graph of Contaminated Soil Volume (M³) by PPM range and 10' interval.

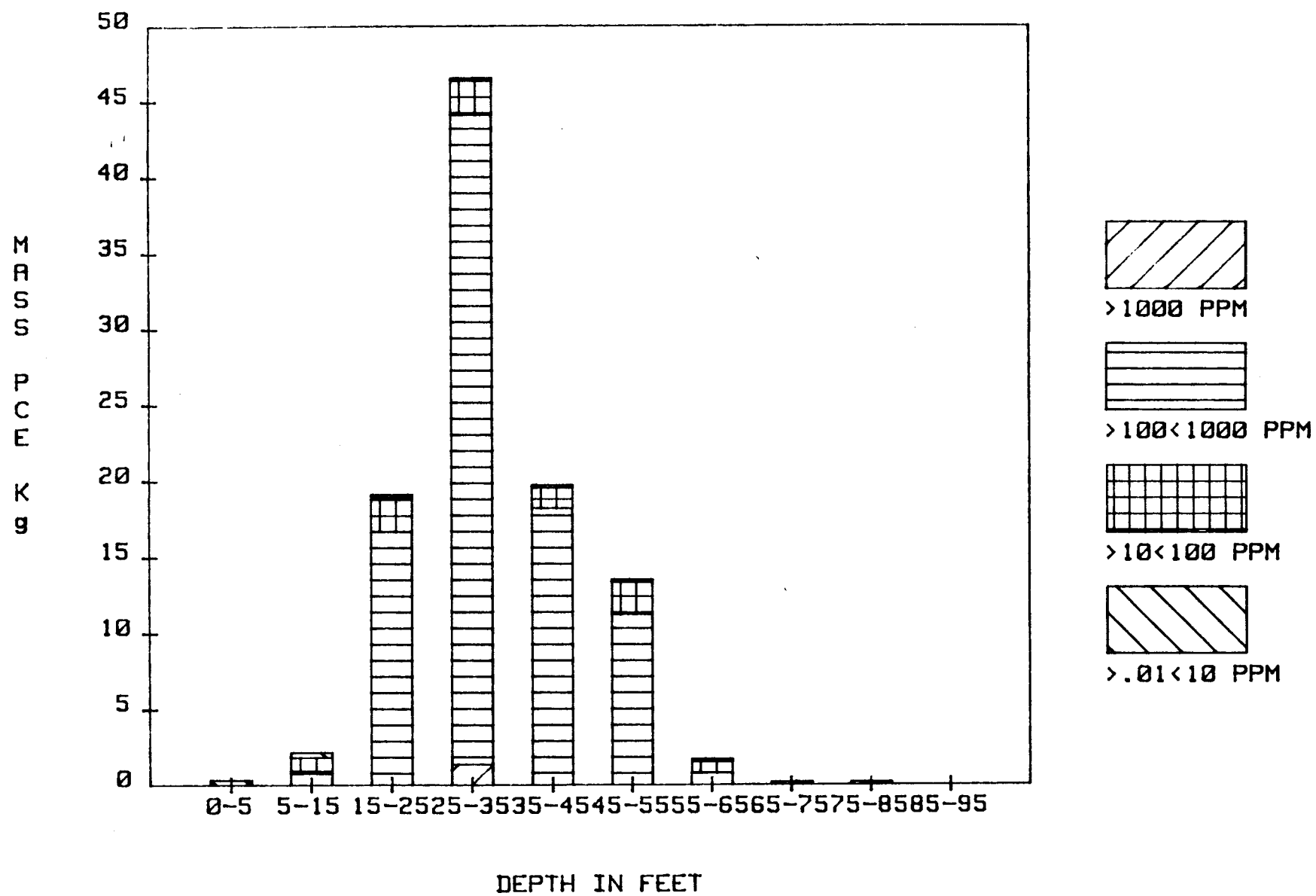


Figure 5-14 Bar Graph of Mass PCE (kg) by PPM range and 10' interval.

Saturated fluid flow was only a significant mechanism for movement of contamination in the immediate vicinity of the tank while it was in use.

5.5.2 Unsaturated Fluid Flow

The very low unsaturated hydraulic conductivities (K_u) of the soils at Person Generating Station (Section 4.0) strongly indicate that transport by unsaturated fluid flow is impossible at the present time. Many of the soil samples have maximum hydraulic conductivities which approach zero. Negative pressures in these soils are significant and a certain amount of moisture redistribution over geologic time can be expected. However, the flux of contaminants through the vadose zone at present from unsaturated fluid flow is zero.

5.5.3 Molecular Diffusion/Vapor Phase Transport

Molecular diffusion and vapor phase transport of contaminants is responsible for soil contamination in several bore holes and contamination of soil below the 60 foot depth. Concentrations of contaminants at these depths are very low. Continued transport of contamination by this mechanism is possible although the total mass of PCE transported would be very small.

6.0 PRELIMINARY GROUND WATER CONTAMINATION ASSESSMENT

Results from an initial sampling of ground water were reported by Radian Corporation on February 15, 1984 (Table 3-3). During preparation of this report this report, more samples are being taken from the wells in order to obtain a more complete database. A comprehensive analysis of ground water data is impossible due to the short period of time between reporting of chemical analyses (soil and ground water) and the February 29, 1984 deadline for this submission. A detailed analysis of ground water chemistry and possible mechanisms for introduction of contamination to the ground water is commencing with receipt of analyses from resampling the wells.

6.1 SOURCE IDENTIFICATION

The monitoring data indicate the presence of PCE and TCA in the ground water below the storage tank; however, at this time, available data do not permit the identification of a specific source of the ground water contamination reported in Table 3-4. This section analyzes the reasons for this uncertainty and rules out most possible transport mechanisms for wastes from the tank entering the ground water system.

6.1.2 Low Concentrations of PCE in the Pore Fluid

Table 6-1 shows the concentration of PCE in the pore fluid as calculated from the weight percent fluid of the

TABLE 6-1

DEPTH	WT % MOISTURE	CONCENTRATION PCE IN SOIL(ppm or µg PCE/g soil)	CALCULATED CONCENTRATION PCE IN PORE FLUID(ppm)
PS-4			
10	3.98	371.5	9350.0
15	----	----	----
20	6.67	230.2	3450.0
30	5.78	236.8	5000.0
40	4.32	263.3	7000.0
50	4.93	305.7	6200.0
60	5.11	156.27	3050.0
70	5.19	0.006	0.116
80	7.06	0.01	0.140
90	5.69	0.019	0.334
PS-5			
10	----	----	----
15	4.45	2127.0	47800.0
20	5.18	202.7	3900.0
30	7.13	167.6	2350.0
40	4.43	438.52	9900.0
50	6.68	295.2	4400.0
60	3.42	0.013	0.380
70	3.1	0.002	0.064
80	2.39	0.004	0.167
90	2.76	0.011	0.399

sample and the concentration of PCE in the soil. PCE concentrations in ground water are higher than observed concentrations in the soil and the calculated PCE concentrations in the pore fluid (Figure 6-1). This situation creates a vapor diffusion gradient from the ground water to the overlying unsaturated zone and is not consistent with the waste storage tank as the source.

6.1.3 Pore Fluid Concentration Gradients

If the waste storage tank were the source of ground water contamination the concentrations in the pore fluids would decrease away from the source. In many boreholes, the concentration gradients are upward between 60' and the water table (110'). These types of soil contamination gradients are inconsistent with the storage tank as a source (Figure 6-1). If the tank was the source, then the concentration of PCE in the pore fluids above the ground water should be significantly higher than the concentration in the groundwater.

6.1.4 Highest Concentrations in Upgradient Well

A measurable hydraulic gradient is present at Person Station (Figure 4-11). If this gradient is constant throughout the year, levels of contamination from the tank should be higher in the downgradient well (PSMW-1); however,

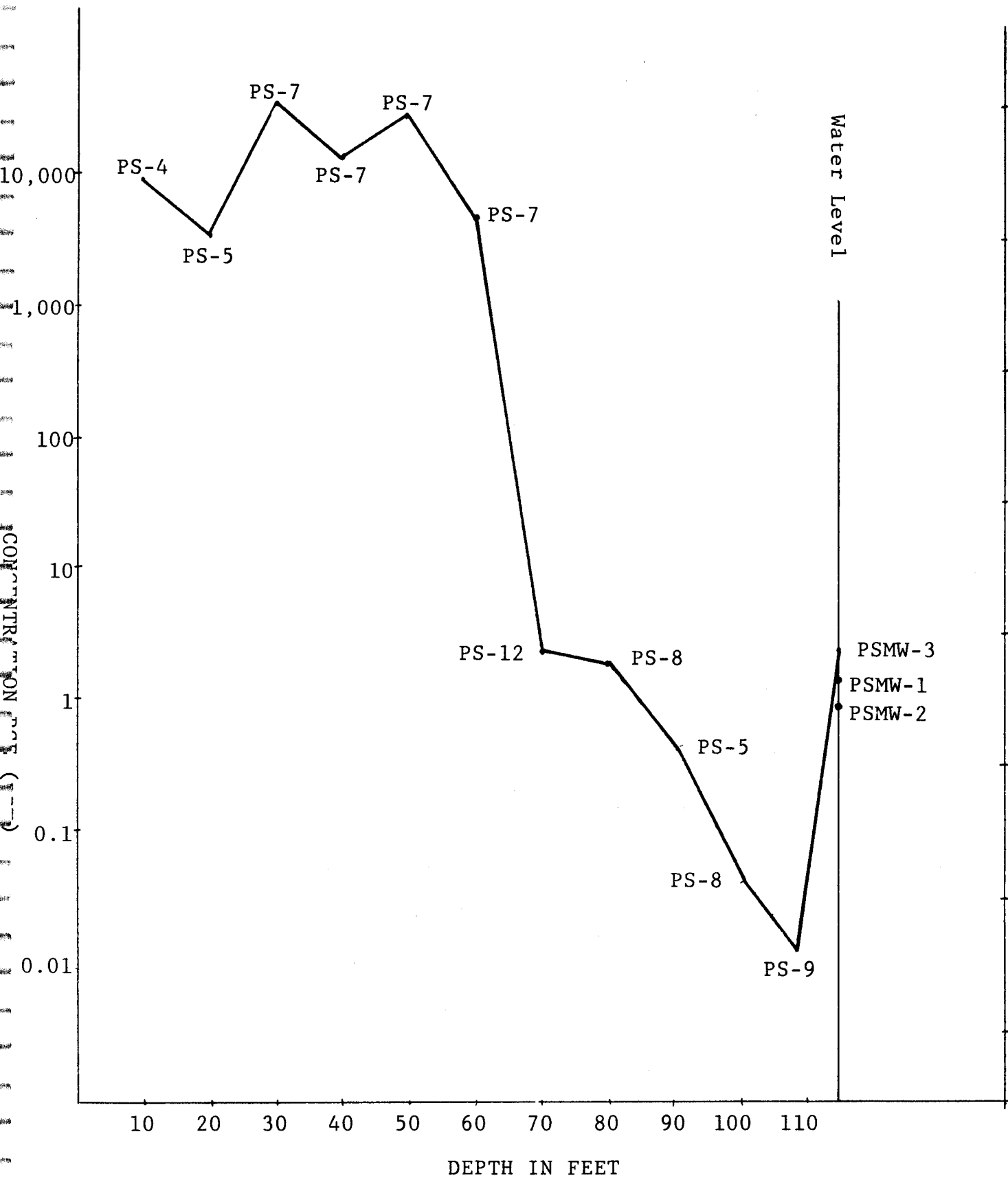


Figure 6-1 Concentration PCE (ppm) in Pore Fluid and ground water vs Depth

the highest concentrations are observed in the upgradient well PSMW-3.

6.1.5 PCE and TCA: Common Contaminants in Other Wells in Area

PCE and TCA have been found in other south valley wells far removed from Person Station. These compounds are commonly used in manufacturing, service, and defense industries. Disposal of such compounds south and west of the airport during 1940's and 1950's, for example, may contribute to a regional ground water contamination in the area.

6.1.6 Flow Through the Unsaturated Zone

If the waste storage tank is the source of contamination another major problem is the lack of viable flow mechanism from the tank to the ground water. Saturated flow, unsaturated flow or transport as a NAPL is not indicated by moisture or chemical data (Section 5.5). Transport by purging contaminants in the 50' to 110' depth interval due to 60' fluctuations in ground water levels is not consistent with the low moisture data nor is it consistent with the hydrology of the south valley. If water levels were to rise to within 50 feet of the ground surface at the site, a series of springs near Broadway Avenue would result at a seepage face.

6.1.7 Vapor Phase Transport

Migration of contaminants by molecular diffusion/vapor phase transport is also inconsistent with chemical data.

Vapor phase contact with minute volumes of soil water should result in higher contaminant concentrations of PCE than vapor phase contact with large volumes of ground water due to dilution. Although one would expect higher concentrations in the pore fluid rather than in the ground water, this is not the case (Figure 6-1). Therefore, vapor phase transport could only cause these concentrations in ground water if the observed concentration gradients (Figure 6-1, Section 6.1.3, Table 6-1) were reversed.

6.1.8 Comparison of Waste Stream and Groundwater Parameters

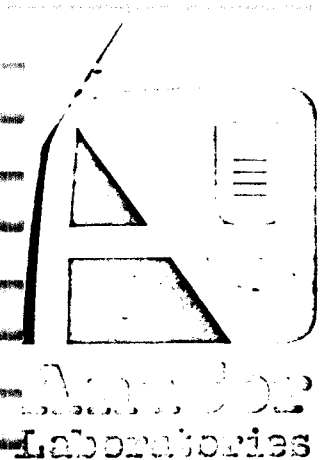
Leakage from the waste storage tank has contaminated the soil (Section 5.2) and chemical parameters have been identified in the groundwater which are consistent with the waste from the tank. The ratio of TCA to PCE is about 4/1 or 5/1 (similar to the 3/1 ratio found in Dowclene). Trace quantities of methylene chloride, 1-1 dichloroethylene, and dichloroethane were also present in ground water samples and not in tank liquids. Therefore, this is inconsistent with the tank as a source.

6.1.9 Higher Concentrations in Well Nearest Storage Tank

PSMW-3 is the closest well to the tank. Periodic reversals in gradients which may occur due to pumping or low hydraulic conductivities of the upper portion of the aquifer would cause the concentrations to be more elevated closer to the tank. If this were the case, the areal extent of the

contaminated ground water would necessarily be small and the dominant transport mechanism for contaminants in the water would be molecular diffusion.

APPENDIX A



(505) 345-8964
7300 Jefferson St. NE
Albuquerque, NM 87109

Analytical and Environmental Services

To: PNM
Alvarado Square
Albuquerque, NM 87102

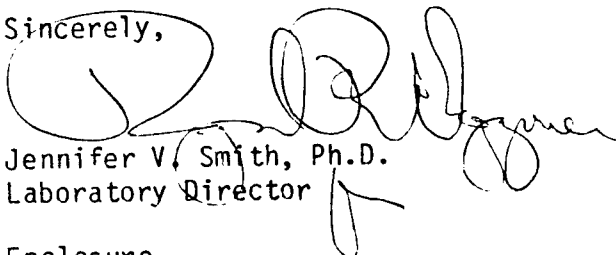
Date: 8 November 1983
JV- 1192

Attention: Jody Plum

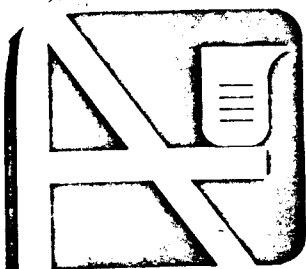
Analyte	Sample ID/Analytical Results			
	PS2 32.7' (0955)	PS2 22.5'	PS2 50.0' (1045)	PS2 42.5' (1025)
% Moisture	4.95 %	7.85 %	6.56 %	3.64 %

An invoice for services is enclosed. Thank you for your consideration in contacting AnaCor Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



AnaCor
Laboratories

To: PNM
Alvarado Square
Albuquerque, NM 87158

(505) 345-8864
7300 Jefferson St. NE
Albuquerque, NM 87109

Analytical and Environmental Services

Date: 15 November 1983
JV- 1292 (Continued)
Page 1 of 2

Attention: Jody Plum

Analyte: % Moisture

Sample ID

Analytical Results

PS-3 30'	3.14 % -(minor gravel to 1/4")
PS-3 40'	3.81 % -(minor gravel to 3/8")
PS-3 50'	2.87 % -(minor gravel to 1/4")
PS-3 60'	5.74 % *
PS-1 30'	3.67 % -(very minor gravel to 3/8")
PS-1 40'	4.27 % -(minor gravel to 1")
PS-1 50'	2.28 % -(common gravel to 1")
PS-4 2.5'	4.90 % -(asphaltic material some gravel to 3/8")
PS-4 5'	3.15 % -(minor gravel to 3/8")
PS-4 10'	3.98 % -(minor gravel to 1/2")
PS-4 15'	5.60 % -(some gravel to 3/8")
PS-4 20'	6.67 % *
PS-4 25'	5.08 % -(some gravel to 1/2")
PS-4 30'	5.78 % *
PS-4 35'	9.24 % *
PS-4 40'	4.32 % *
PS-4 50'	4.93 % -(minor gravel to 3/8")
PS-4 60'	5.11 % -(minor gravel to 1")
PS-4 70'	5.19 % -(some gravel to 3/8")
PS-4 80'	7.06 % *
PS-4 90'	5.69 % -(minor gravel to 3/8")
PS-5 15'	4.45 % -(common gravel to 3/8")
PS-5 20'	5.18 % *
PS-5 25'	5.89 % *
PS-5 30'	7.13 % *
PS-5 35'	7.05 % *
PS-5 40'	4.43 % -(minor gravel to 1/4")
PS-5 45'	5.28 % *
PS-5 50'	6.68 % *
PS-5 60'	3.42 % -(some gravel to 3/4")
PS-5 70'	3.10 % -(common gravel to 3/8")
PS-5 80'	2.39 % -(some gravel to 1/4")
PS-5 90'	2.76 % -(common gravel to 1")

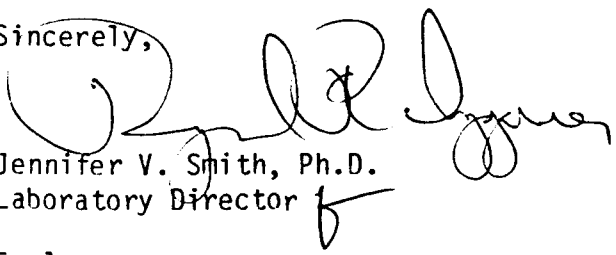
To: PNM

JV-1292 (Continued)
Page 2 of 2

*= Graded Sand

An invoice for services is enclosed. Thank you for your consideration
in contacting AnaCor Laboratories.

Sincerely,



Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



ANALYTICAL LABORATORIES, INC.

Chiviles -
Pescado - Laboratory results

To: PNM
Alvarado Square
Albuquerque, NM 87158

Date: 29 December 1983
0007
Page 1 of 3

Attention: Jody Plum

Sample ID

Analytical Results / % Moisture

PS-6:

10'-11.5'	4.80 %	Sand, minor gravel to 3/4"
20'-21.5'	4.81 %	Graded sand
30'-31.5'	4.25 %	Sand, some gravel to 1/2"
40'-41.5'	5.03 %	Sand, some gravel to 1/4"
50'-51.5'	3.59 %	Sand, some gravel to 1/4", minor gravel to 1"
60'-61.5'	4.77 %	Sand, silt, minor gravel to 1"
70'-71.5'	4.29 %	Sand, minor gravel to 1/4"
80'	4.99 %	Sand, minor gravel to 1/4"
90'	4.93 %	Sand, some gravel to 1"

PS-7:

10'-11.5'	5.55 %	Graded sand
20'-21.5'	3.85 %	Sand, minor gravel to 3/4"
30'-31.5'	4.18 %	Sand, minor gravel to 1/4"
40'-41.5'	4.19 %	Sand, minor gravel to 3/4"
50'-51.5'	2.88 %	Graded sand
60'	4.75 %	Sand, minor gravel to 1/4"
70'	2.81 %	Sand, minor gravel to 3/8"
80'	2.89 %	Sand, gravel to 1/2"
90'	4.93 %	Graded sand

PS-3:

10'	3.37 %	Sand, gravel to 1 1/2"
20'	2.89 %	Sand, minor gravel to 3/8"
30'	3.82 %	Sand, minor gravel to 3/8"
40'	3.24 %	Sand, gravel to 1"
50'	6.02 %	Graded sand, silt
60'-61.5'	7.99 %	Graded sand
70'	4.26 %	Sand, gravel to 3/4"
80'	3.99 %	Sand, gravel to 1"

To: PNM

0007

Page 2 of 3

Sample ID

Analytical Results/% Moisture

PS-8:

90'	3.91 %	Sand, minor gravel to 1/4"
95'	4.50 %	Graded sand
100'	9.27 %	Graded sand, silt
105'	7.31 %	Sand, gravel to 1/2"
110'	11.07 %	Sand, clay, minor gravel to 1/4"

PS-9:

10'	4.80 %	Sand, minor gravel to 1/4"
30'	4.89 %	Graded sand
40'	5.77 %	Graded sand
50'	4.48 %	Sand, gravel to 1/4"
60'	3.57 %	Sand, minor gravel to 1/4"
70'	4.25 %	Sand, gravel to 1 1/4"
80'	7.10 %	Sand, gravel to 1/2"
90'	3.69 %	Graded sand
95'	9.98 %	Sand, minor gravel to 1/2"
100'	3.98 %	Sand, gravel to 1 1/2"
102.5'	3.23 %	Sand, gravel to 1/2"
107.5'	9.83 %	Sand, gravel to 1/2"
No Depth	3.36 %	Graded sand

PS-10:

10.0'	3.47 %	Sand, minor gravel to 3/8"
20.0'	3.39 %	Graded sand
30.0'	5.59 %	Sand, minor gravel to 3/4"
40'	5.34 %	Sand, minor gravel to 3/4"
50'	2.82 %	Sand, gravel to 1/2"
60'	2.32 %	Sand, gravel to 3/4"
65'	3.62 %	Sand, gravel to 1/4"
70'	6.14 %	Sand, gravel to 3/8"
80'	6.52 %	Sand, minor gravel to 3/8"
90'	7.30 %	Graded sand
95'	2.94 %	Sand, gravel to 3/8"
100'	6.04 %	Graded sand
105'	10.59 %	Sand, minor, broken gravel to 3/4"
110'	9.23 %	Graded sand, clay
112.5'	9.80 %	Sand, some gravel to 3/4"
112.5' (top of core barrel)	11.61 %	Sand, clay, gravel to 1/2"

To: PNM

0007

Page 3 of 3

Sample ID

Analytical Results/% Moisture

PS-11:

50'-51.5'	2.99 %	Graded sand
60'-61.5'	4.38 %	Sand, minor gravel to 1/2"
70'	3.51 %	Sand, minor gravel to 1"
80'	4.36 %	Sand, gravel to 1/4"
90'	4.18 %	Sand, gravel to 1/4"

PS-12:

10'-11.5'	3.98 %	Sand, minor gravel to 1/2"
20'-21.5'	3.26 %	Sand, broken gravel to 3/4"
30'-31.5'	2.61 %	Sand, broken gravel to 1"
40'-41.5'	5.77 %	Sand, gravel to 3/4"
50'-51.5'	4.10 %	Graded sand
60'-61.5'	2.10 %	Sand, gravel to 1"
70'-71.5'	3.23 %	Sand, broken gravel to 1 1/2"
80'	3.33 %	Graded sand
90'-91.5'	9.12 %	Graded sand, clay

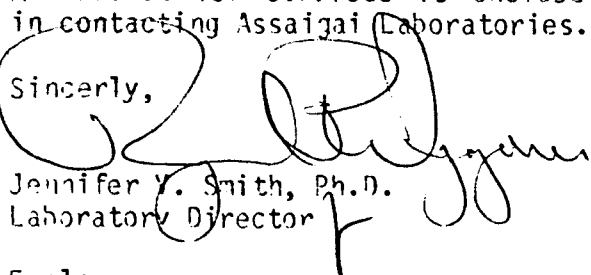
PS-13:

Surface	6.61 %	Sand, some gravel to 3/4"
10'	2.65 %	Sand, minor gravel to 1/4"
20'	3.94 %	Sand, gravel to 3/8"
30'	9.29 %	Graded sand
40'	2.67 %	Sand, some gravel to 1/2"
50'	3.72 %	Sand, gravel to 1/4"
60'	3.59 %	Sand, gravel to 1"
70'	3.64 %	Sand, gravel to 1"
80'	3.47 %	Sand, gravel to 1/4"
90'	4.34 %	Sand, some gravel to 1"

Reference: USDA Handbook, #60, Modified

An invoice for services is enclosed. Thank you for your consideration in contacting Assaigai Laboratories.

Sincerely,


Jennifer Y. Smith, Ph.D.
Laboratory Director

Enclosure



ANALYTICAL LABORATORIES, INC.

P 1065 - LABORATORY RESULTS

To: PNM
Alvarado Square
Albuquerque, NM 87158

Date: 6 February 1984
0176

Attention: Jody Plum

Analyte: % Moisture

Sample Identification

Analytical Results

PS-14:

10'	1.09 % Graded sand
20'	2.73 % Graded sand
30'	3.11 % Graded sand
40'	3.86 % Graded sand
50'	2.32 % Sand, gravel to 1/2"
60'	9.42 % Sand, clay, minor gravel to 3/8"
70'	4.87 % Sand, some gravel to 1"
80'	4.51 % Sand, minor gravel to 1/4"
90'	2.67 % Sand, gravel to 3/4"

PS-15:

10'	2.57 % Graded sand
20'	3.44 % Graded sand
30'	3.02 % Graded sand
40'	3.74 % Sand, minor gravel to 1/2"
50'	2.56 % Graded sand
60'	4.56 % Sand, minor gravel to 1"
70'	4.14 % Sand, some gravel to 3/8"
80'	4.15 % Sand, clay, some gravel to 1/2"
90'	3.83 % Sand, minor gravel to 3/8"

PS-16:

10'	3.19 % Sand, minor gravel to 1/4"
20'	5.24 % Sand, some gravel to 1"
30'	6.16 % Sand, minor gravel to 1/4"
50'	3.40 % Graded sand
60'	3.40 % Sand, minor gravel to 1/4"
70'	3.55 % Sand, some gravel to 1/4"
80'	3.05 % Sand, some gravel to 1"
90'	4.45 % Sand, minor gravel to 3/8"

To: PNM

0176

Page 2 of 2

Sample Identification

Analytical Results

PS-17:

10'	4.20 % Graded sand
20'	3.56 % Sand, very minor gravel to 1/4"
30'	2.27 % Sand, gravel to 1/2"
40'	4.88 % Sand, some gravel to 1"
50'	2.94 % Graded sand
60'	3.22 % Sand, gravel to 3/8"
70'	7.44 % Sand, clay, minor gravel to 1/2"
80'	2.26 % Sand, gravel to 3/8"
90'	7.05 % Sand, clay, some gravel to 3/8"

PS-18:

10'	2.84 % Sand, gravel to 1"
20'	4.49 % Sand, minor gravel to 1/2"
30'	3.55 % Graded sand
40'	8.32 % Sand, clay
50'	3.96 % Sand, minor gravel to 1/4"
60'	3.55 % Sand, some gravel to 1/2"
70'	7.80 % Sand, clay, broken gravel to 1/2"
80'	2.39 % Sand, gravel to 1/2"
90'	10.26 % Sand, clay, minor gravel to 1/2"

PS-19:

10'	5.64 % Graded sand
20'	9.14 % Graded sand
30'	3.97 % Graded sand
40'	3.63 % Sand, some gravel to 1"
50'	4.08 % Sand, minor gravel to 1/4"
60'	8.70 % Sand, some broken gravel to 1/2"
70'	9.70 % Sand, clay, some gravel to 1"
80'	5.49 % Sand, minor gravel to 3/8"
80'	2.75 % Sand, gravel to 1/2"
90'	6.42 % Sand, some gravel to 1/2"

Reference: USDA Handbook, #60, Modified

An invoice for services is enclosed. Thank you for your consideration in contacting Assaigai Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



ANALYTICAL LABORATORIES, INC.

To: PNM
Alvarado Square
Albuquerque, NM 87158

Date: 16 February 1984
0176
Page 1 of 2

Attention: Jody Plum

Analyte: % Moisture

Sample Identification

Analytical Results

PSMW-1

60'	4.84 %	Graded sand
70'	2.82 %	Sand, gravel to 3/4"
80'	1.90 %	Sand, silt, gravel to 3/8"
80'	10.45 %	Sand, silt, gravel to 1"
100'	2.30 %	Sand, gravel to 1 3/4"
115'	11.24 %	Sand, gravel to 3/4"

PSMW-2

10'	1.55 %	Sand, gravel to 1"
20'	4.76 %	Sand, minor gravel to 1/4"
30'	5.05 %	Graded sand
40'	5.86 %	Graded sand
50'	6.61 %	Sand, gravel to 1/2"
60'	3.74 %	Sand, minor gravel to 1/4"
70'	10.46 %	Sand, silt, minor gravel to 1/2"
80'	3.34 %	Graded sand
90'	8.93 %	Sand, silt
110'	11.42 %	Sand, minor gravel to 1"

PSMW-3

10'	3.20 %	Graded sand
20'	10.15 %	Sand, silt
30'	3.45 %	Sand, minor gravel to 1/4"
40'	3.77 %	Sand, minor gravel to 1/4"
50'	2.68 %	Sand, gravel to 1/4"
60'	3.58 %	Sand, gravel to 1/4"
70'	4.02 %	Sand, gravel to 1"
80'	6.38 %	Sand, silt
90'	4.13 %	Sand, some gravel to 1"
110'	8.30 %	Sand, silt, some gravel to 1"

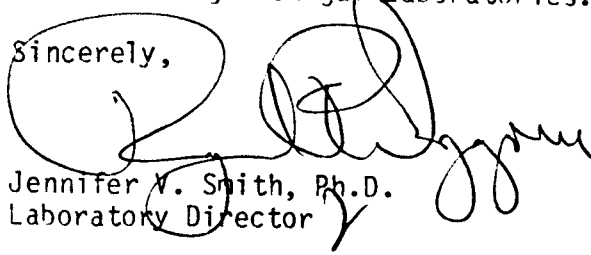
To: PNM

0176
Page 2 of 2

Reference: USDA Handbook, #60 Modified

An invoice for services is enclosed. Thank you for your consideration
in contacting Assaigai Laboratories.

Sincerely,



Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



ENGINEERING SERVICES

Albuquerque Testing Laboratory, Inc.
532 Jefferson N.E. (87108)
P. O. Box 4101 (87106)
Albuquerque, New Mexico
(505) 268-4537

November 11, 1983

ATL Lab. No. 4829-83

Geoscience Consultants
222 Copper Square
500 Copper Avenue
Albuquerque, New Mexico 87102

Attention: Alberto Gutierrez

Gentlemen:

Samples submitted to our laboratory on November 9, 1983 by Alberto Gutierrez of Geoscience Consultants for particle size analyses.

TEST DATA:

Sample No. 1: Combined Samples
PS 4/12.5, 8310260935 and PS 4/17.5', 8310260945

Sample No. 2: Combined Samples
PS 4/60', 8310261350 and PS 4/75', 8310261445

TEST RESULTS:

U.S. Sieve Size	Cumulative Percent Passing Sample #1	Passing Sample #2
3/4"	---	100
12.7mm 1/2"	100	98.9
9.5mm 3/8"	95.5	97.7
4.8mm No. 4	91.8	93.9
2mm No. 10	87.5	87.5
.425mm No. 40	58.5	58.0
.175mm No. 80	21.2	29.4
.075mm No. 200	8.7	13.6
Wash Test	7.9	12.2

Respectfully submitted

ATL ENGINEERING SERVICES

James H. Clary

James H. Clary,
Certified Professional Geologist



ENGINEERING SERVICES

Albuquerque Testing Laboratory, Inc.
532 Jefferson N.E. (87108)
P. O. Box 4101 (87106)
Albuquerque, New Mexico
(505) 268-4537

November 11, 1983

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500 Copper Avenue
Albuquerque, New Mexico 87102

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Sample No. 2: Combined Samples
PS 4/60', 8310261350 and PS 4/75', 8310261445

TEST RESULTS:

U.S. Sieve Size	Cumulative Percent Sample #1	Passing Sample #2
3/4"	---	100
12.7mm 1/2"	100	98.9
9.5mm 3/8"	95.5	97.7
4.8mm No. 4	91.8	93.9
2.0mm No. 10	87.5	87.5
.42mm No. 40	58.5	58.0
.175mm No. 80	21.2	29.4
.075mm No. 200	8.7	13.6
Wash Test	7.9	12.2

Respectfully submitted

ATL ENGINEERING SERVICES

James H. Clary

James H. Clary,
Certified Professional Geologist

(505) 345-8934
7300 Jefferson St. NE
Albuquerque, NM 87109

Analytical and Environmental Services

AMMOR
Laboratories

To: PNM
Alvarado Square
Albuquerque, NM 87158

Date: 8 November 1983
JV- 1192
Page 1 of 2

Attention: Jody Plum

Analyte: Tetrachloroethylene

Sample ID	Analytical Results	Sample ID	Analytical Results
1 - Surface	0.062 ppm	3 - 60'	0.032 ppm
1 - 10'	0.030 ppm	4 - Surface	0.017 ppm
1 - 20'	0.015 ppm	4 - 10'	371.5 ppm
1 - 30'	0.025 ppm	4 - 20'	230.2 ppm
1 - 40'	0.020 ppm	4 - 30'	236.8 ppm
1 - 50'	0.015 ppm	4 - 40'	263.3 ± 70.4 ppm
2 - Surface	57.3 ± 31.9 ppm	4 - 50'	305.7 ± 113.2 ppm
2 - 10'	0.006 ppm	4 - 60'	156.27 ppm
2 - 20'	0.003 ppm	4 - 70'	0.006 ± 0.002 ppm
2 - 30'	0.004 ppm	4 - 80'	0.010 ± 0.003 ppm
2 - 40'	0.007 ppm	4 - 90'	0.019 ± 0.016 ppm
2 - 50'	0.052 ppm	5 - 15'	2127.0 ppm
3 - Surface	0.009 ppm	5 - 20'	202.7 ppm
3 - 10'	0.005 ppm	5 - 30'	167.6 ppm
3 - 15'	700.0 ppm	5 - 40'	438.5 ± 211.0 ppm
3 - 20'	361.7 ppm	5 - 50'	295.2 ± 40.0 ppm
3 - 32.5	613.0 ppm	5 - 60'	0.013 ppm
3 - 30'	405.6 ppm	5 - 70'	0.002 ppm
3 - 40'	451.8 ppm	5 - 80'	0.004 ± 0.0006 ppm
3 - 50'	18.0 ppm	5 - 90'	0.011 ± 0.006 ppm

Normal Detection Limit : .001 mg/l

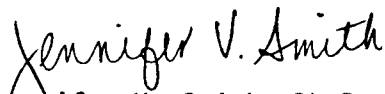
Reference: "Test Methods for Evaluating Solid Waste", 2nd Edition, USEPA,
SWER, SW846, 1982.

To: PNM

JV- 1192
Page 2 of 2

An invoice for services is enclosed. Thank you for your consideration
in contacting AnaCor Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



ANALYTICAL LABORATORIES, INC.

To: PNM
Alvarado Square
Albuquerque, NM 87158

Date: 12 January 1994
0007 (Cont.)
Page 1 of 4

Attention: Jody Plum

Analyte: Tetrachloroethylene (PCE)

Sample ID Analytical Results

Hole 6:

0'	0.052 ± 0.009 ppm
10'	0.028 ± 0.004 ppm
20'	0.018 ± 0.002 ppm
30'	0.009 ± 0.004 ppm
40'	0.011 ± 0.010 ppm
50'	0.020 ± 0.004 ppm
60'	<0.001 ppm
70'	0.042 ± 0.006 ppm
80'	<0.001 ppm
90'	0.009 ppm

Hole 7:

0'	0.156 ± 0.005 ppm
10'	0.012 ppm
20'	15.8 ppm
30'	1443.8 ± 134.4 ppm
40'	593.6 ppm
50'	820.9 ppm
60'	240.8 ppm
70'	0.028 ± 0.011 ppm
80'	0.003 ppm
90'	0.002 ppm

Hole 8:

0'	0.575 ppm
10'	0.011 ± 0.004 ppm
20'	0.079 ppm
30'	0.052 ppm
40'	0.003 ppm
50'	0.045 ± 0.005 ppm

Sample ID

Analytical Results

Hole 8:

50'	0.065 ppm
70'	0.002 ppm
80'	0.086 ppm
90'	0.008 ppm
100'	0.004 ± 0.003 ppm

Hole 9:

0'	20.9 ppm
10'	0.030 ppm
20'	0.021 ppm
30'	0.010 ppm
40'	0.002 ppm
50'	0.013 ppm
60'	<0.001 ppm
70'	<0.001 ppm
80'	<0.001 ppm
90'	<0.001 ppm
100'	<0.001 ppm
107.5'	<0.001 ppm

Hole 10:

0'	0.320 ppm
10'	0.017 ppm
20'	59.1 ppm
30'	331.4 ± 16.5 ppm
40'	0.021 ppm
50'	0.009 ppm
60'	<0.001 ppm
70'	0.061 ppm
80'	0.040 ppm
90'	0.006 ppm

To: PNM

0007

Page 2 of 4

Analyte: Tetrachloroethylene

Sample ID Analytical Results

Hole 10:

100'	<0.001 ppm
------	------------

Hole 11:

10'	0.121 ppm
20'	<0.001 ppm
30'	0.006 ppm
40'	0.007 ppm
50'	0.002 ppm
60'	0.002 ± 0.0005 ppm
70'	0.004 ppm
80'	0.002 ppm
90'	<0.001 ppm

Hole 12:

0'	0.169 ppm
10'	0.004 ppm
20'	0.005 ppm
30'	0.020 ppm
40'	0.012 ± 0.001 ppm
50'	0.012 ± 0.013 ppm
60'	0.001 ppm
70'	0.084 ± 0.053 ppm
80'	0.064 ppm
90'	0.009 ppm

Hole 13:

0'	0.100 ppm
10'	23.3 ppm
20'	21.9 ppm
25'	492.4 ± 65.1 ppm
30'	391.1 ± 48.1 ppm
40'	0.011 ± 0.007 ppm
50'	0.001 ppm
55'	0.090 ± 0.017 ppm
60'	0.025 ± 0.009 ppm
70'	0.002 ± 0.0005 ppm
80'	0.031 ppm
90'	0.013 ± 0.010 ppm

To: PNM

0007

Page 3 of 4

Analyte: Trichloroethane

Sample ID Analytical Results

Hole 7:

30'	168.3 ± 5.9 ppm
60'	30.16 ppm

Hole 8:

0'	0.152 ppm
50'	0.017 ± 0.002 ppm

Hole 9:

0'	1.388 ppm
40'	< 0.001 ppm

Hole 10:

0'	0.28 ppm
20'	0.146 ppm

Hole 11:

60'	0.003 ppm
80'	< 0.001 ppm

Hole 12:

10'	0.002 ppm
40'	0.003 ppm

Hole 13:

10'	0.173 ppm
60'	< 0.001 ppm

Analyte

Sample ID/Analytical Results

5-15

Jar, Blow Sand
next to casing
#83-10-18-1431

Trichloroethane	12.6 ppm	13.7 ppm
Tetrachloroethylene	43.7 ppm *	239.0 ppm
EP-Toxicity Pb	< 0.002 ppm	1.6 ppm

* Sample has been opened many times.

To: PNM

0007

Page 4 of 4


Normal Detection Limits:

Trichloroethane	0.01 mg/l
Tetrachloroethylene	0.01 mg/l
Pb	0.002 mg/l

Reference: "Organic Analysis Using Gas Chromatography/Mass Spectrometry",
1979, Budde & Eichelberger, Ann Arbor Science.

An invoice for services is enclosed. Thank you for your consideration
in contacting Assaigai Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



ANALYTICAL LABORATORIES, INC.

To: PNM
Alvarado Square
Albuquerque, NM 87158

Date: 14 February 1994
0169

Page 1 of 3

Attn: Jody Plum

Analyte: Tetrachloroethylene

Sample ID	Analytical Results	Sample ID	Analytical Results
14:		17:	
0'	0.032 ppm	40'	0.002 ppm
10'	0.029 ppm	50'	<0.001 ppm
20'	0.053 ± 0.016 ppm N=2	60'	<0.001 ppm N=2
30'	231.5 ppm	70'	0.027 ppm
40'	0.024 ± 0.010 ppm N=4	80'	<0.001 ppm
50'	0.727 ± 0.103 ppm N=4	90'	<0.001 ppm
60'	0.035 ppm		
70'	0.024 ± 0.001 ppm N=2	18:	
80'	0.003 ppm	0'	0.126 ppm
90'	0.005 ppm	10'	0.007 ppm
		20'	0.005 ppm
15:		30'	0.005 ± 0.002 ppm N=2
0'	0.030 ppm	40'	0.004 ppm
10'	0.447 ppm	50'	0.010 ppm
20'	0.017 ± 0.007 ppm N=4	60'	0.039 ppm
30'	580.0 ppm	70'	<0.001 ppm
40'	0.018 ± 0.006 ppm N=2	80'	<0.001 ppm
50'	<0.001 ppm	90'	<0.001 ppm
60'	<0.001 ppm		
70'	<0.001 ppm	19:	
80'	<0.001 ppm	0'	22.5 ± 0.45 ppm N=2
90'	<0.001 ppm N=2	10'	0.020 ppm
		20'	0.015 ppm
16:		30'	0.008 ppm
0'	0.137 ± 0.030 ppm N=2	40'	0.005 ppm
10'	<0.001 ppm	50'	0.004 ppm
20'	<0.001 ppm	60'	<0.001 ppm
30'	<0.001 ppm	70'	<0.001 ppm
40'	<0.001 ppm	80'	<0.001 ppm
50'	<0.001 ppm N=2	90'	<0.001 ppm N=2
60'	<0.001 ppm		
70'	<0.001 ppm	PSMW1:	
80'	<0.001 ppm	0'	<0.001 ppm
90'	<0.001 ppm	10'	<0.001 ppm
		20'	<0.001 ppm
17:		30'	<0.001 ppm N=2
0'	0.029 ppm	40'	<0.001 ppm
10'	0.005 ± 0.002 ppm N=2	50'	<0.001 ppm
20'	<0.001 ppm	60'	<0.001 ppm
30'	<0.001 ppm	70'	<0.001 ppm N=2

Analyte: Tetrachloroethylene

Sample ID	Analytical Results	Sample ID	Analytical Results
PSMW1:		PSMW3:	
30'	<0.001 ppm	10'	<0.001 ppm N=2
90'	<0.001 ppm	20'	<0.001 ppm
100'	<0.001 ppm	30'	<0.001 ppm
		40'	<0.001 ppm
		50'	<0.001 ppm N=2
SMW2:		60'	<0.001 ppm
0'	<0.001 ppm	70'	<0.001 ppm
10'	<0.001 ppm	80'	<0.001 ppm
20'	<0.001 ppm	90'	<0.001 ppm
30'	<0.001 ppm	100'	<0.001 ppm
40'	<0.001 ppm N=2	110'	<0.001 ppm
50'	<0.001 ppm		
60'	<0.001 ppm		
70'	<0.001 ppm		
80'	<0.001 ppm N=2		
90'	<0.001 ppm		
100'	<0.001 ppm		

Analyte: Trichloroethane

14:		19:	
50'	0.009 0.051 ppm	0'	1.83 ppm
90'	<0.001 ppm	40'	<0.001 ppm
15:		PSMW1:	
30'	0.252 ppm	20'	<0.001 ppm
80'	<0.001 ppm	60'	<0.001 ppm
16:		PSMW2:	
0'	0.002 ppm	30'	<0.001 ppm
70'	<0.001 ppm	70'	<0.001 ppm
17:		PSMW3:	
20'	<0.001 ppm	10'	<0.001 ppm
80'	<0.001 ppm	90'	<0.001 ppm
18:			
0'	0.040 ppm		
60'	<0.001 ppm		

Normal Detection Limits:

Trichloroethane	0.01 mg/l
Tetrachloroethylene	0.01 mg/l

Reference: "Organic Analysis Using Gas Chromatography/Mass Spectrometry",
1979, Budde & Eichelberger, Ann Arbor Science.

To: PNM

0159

Page 3 of 3

An invoice for services is enclosed. Thank you for your consideration in contacting Assaiqai Laboratories.

Sincerely,

Jennifer V. Smith

Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



ANALYTICAL LABORATORIES, INC.

Person - Laboratory analyses

To: PNM
Alvarado Square
Albuquerque, NM 87158

Date: 24 January 1984
0007 (Cont.)

Attention: Jody Plum

Analyte: Pb

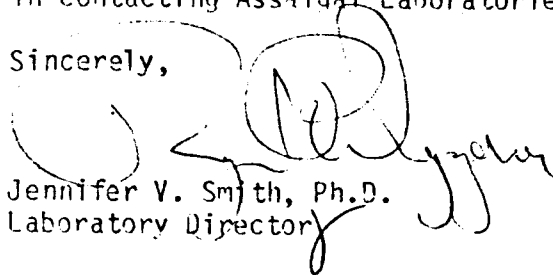
Sample ID	Analytical Results	Sample ID	Analytical Results
6-30	<0.002 ppm	11-10	<0.002 ppm
6-40	<0.002 ppm	11-20	<0.002 ppm
7-20	<0.002 ppm	12-0	<0.002 ppm
7-30	<0.002 ppm	12-30	<0.002 ppm
8-20	<0.002 ppm	13-25	<0.002 ppm
8-30	<0.002 ppm	13-30	<0.002 ppm
9-0	<0.002 ppm	13-40	<0.002 ppm
9-10	<0.002 ppm	13-55	<0.002 ppm
10-20	<0.002 ppm	13-90	<0.002 ppm
10-30	<0.002 ppm		

Normal Detection Limit: 0.002 mg/l

Reference: "Standard Methods for the Examination of Water and Wastewater",
15th Edition, APHA, N.Y., 1980.

An invoice for services is enclosed. Thank you for your consideration
in contacting Assaigai Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



PERSON - LABORATORY

ANALYTICAL LABORATORIES, INC.

To: PNM
Alvarado Square
Albuquerque, NM 87109

Date: 24 January 1984
0007 (Cont.)

Attention: Jody Plum

Analyte: PCB

Sample Identification

Analytical Results

#1 13-25	ND *
#2 13-40	ND
#3 13-55	ND
#4 13-90	ND

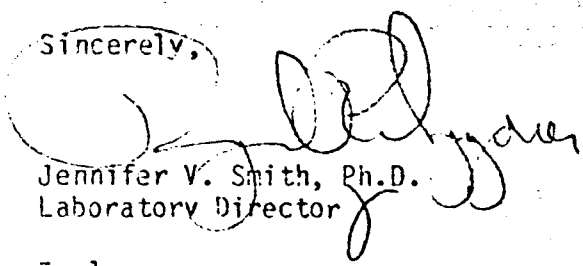
Normal Detection Limit: 1.0

*ND= None Detected, <1.0

Reference: EPA Method 604

An invoice for services is enclosed. Thank you for your consideration in contacting Assaigai Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



ANALYTICAL LABORATORIES, INC.

Final - Analytical Results

To: PNM
Alvarado Square
Albuquerque, NM 87153

Date: 16 February 1984
0176

Attention: Jody Plum

Analyte: Pb

Sample Identification

Analytical Results

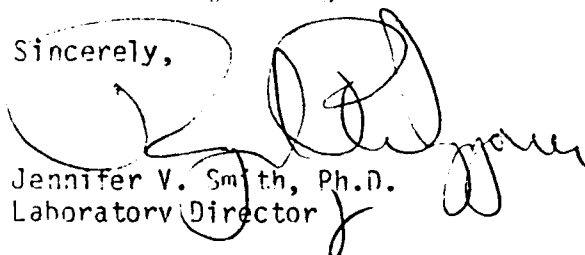
PS-15 20'	<0.001 ppm
PS-16 90'	<0.001 ppm
PS-17 40'	<0.001 ppm
PS-17 25'	<0.001 ppm
PS-18 50'	<0.001 ppm
PS-19 30'	<0.001 ppm
PS-18 20'	<0.001 ppm
PSMW-2 30'	<0.001 ppm
PS-19 20'	<0.001 ppm
PSMW-1 20'	<0.001 ppm
PSMW-1 10'	<0.001 ppm
PS-14 Surface	<0.001 ppm
PS-14 70'	<0.001 ppm
PSMW-2 20'	<0.001 ppm
PS-15 30'	<0.001 ppm
PS-15 10'	<0.001 ppm
PSMW-3 90'	<0.001 ppm
PSMW-3 40'	<0.001 ppm

Normal Detection Limit: 0.001 mg/l

Reference: 40 CFR Part 261

An invoice for services is enclosed. Thank you for your consideration in contacting Assaigai Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



IT ANALYTICAL SERVICES

WEST COAST TECHNICAL SERVICE DIVISION

17605 Fabrica Way • Cerritos, California 90701 • 213-921-9831



CERTIFICATE OF ANALYSIS

TO: EID State of New Mexico
P.O. Box 968
Santa Fe, N.M. 87504-0968
Attn: Devon Jercinovic

DATE REPORTED: January 19, 1984
PROJECT CODE: 28152/ykm
ORDER NUMBER: CONTRACT

RECEIVED

JAN 25 1984

One (1) soil sample labeled: # 13

State of New Mexico - EID Sample 1-8312270910
Persons Station Composite sample 25-30'

GROUND WATER/HAZARDOUS WASTE
BUREAU

The sample was analyzed for priority pollutants by gas chromatography, combined gas chromatography/mass spectrometry and by atomic absorption spectrometry. EPA-approved methods were used for all analyses. Results for organics are given in Table I and for inorganics in Table II.

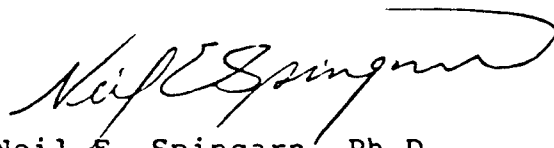
Table I. Organics

624 # 625
BNA - methylene chloride
PCB - hexane

<u>Analyte</u>	<u>Concentration (ug/g)</u>
Tetrachloroethylene	.20
1,1,1-Trichloroethane	0.4
1,1-Dichloroethylene	TR<0.05
C9-C15 Saturated aliphatic hydrocarbons	2000
C8-C12 Unsaturated aliphatic hydrocarbons	2000
PCBs (as PCB-1260)	ND<0.04
Phenols	ND<0.04

ND - This analyte was not detected; the limit of detection for this analysis is less than the amount stated in the table above.

TR - Trace, this compound was present, but was below the level at which concentration could be determined.


Neil E. Spingarn, Ph.D.

Title Staff Chemist

Approved By

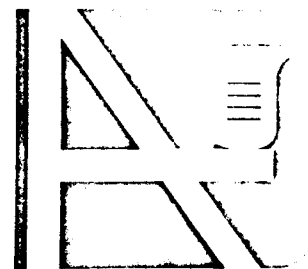
EID State of New Mexico
D. Jercinovic

January 19, 1984
JN 28152 - Page 2

Table II. Inorganics

<u>Analyte</u>	<u>Concentration (ug/g)</u>
Antimony	ND<100
Arsenic	2
Beryllium	ND<1
Cadmium	ND<0.4
Chromium	2.7
Copper	3.5
Lead	5.5
Mercury	ND<0.02
Nickel	4.7
Selenium	ND<0.2
Silver	ND<1
Thallium	ND<10
Zinc	13

ND - This analyte was not detected; the limit of detection for this analysis is less than the amount stated in the table above.



AnaCor
Laboratories

CONFIDENTIAL

(505) 345-8964
7300 Jefferson St. NE
Albuquerque, NM 87109

Analytical and Environmental Services

To: PNM
Alvarado Square
Albuquerque, NM 87158-0085

Date: 13 October 1983
JV- 1088

Attention: Jody Plum

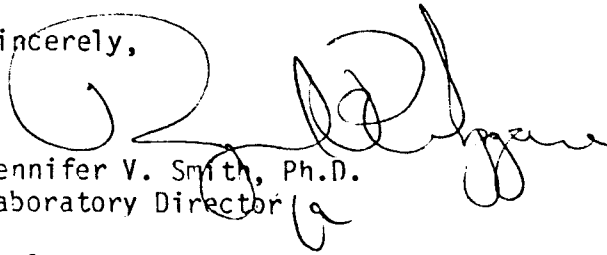
Analyte	Sample Id/Analytical Results		Normal Detection Limits
	A	B	
PCB	<1.0 ppm	<1.0 ppm	1.0 mg/l
Oil & Grease	3.006 ppm	0.3978 ppm	0.1 mg/l
Trichloroethylene	282.0 ppm	2483.0 ppm	0.1 mg/l
Trichloroethane	2132.0 ppm	3810.0 ppm	0.1 mg/l

Reference: "Standard Methods for the Examination of Water and Wastewater",
15th Edition, APHA, N.Y., 1980 .

A - BURIED STORAGE TANK
B - DRAIN PIT INSIDE BUILDING } PERMANENT GENERATING STATION

An invoice for services is enclosed. Thank you for your consideration
in contacting AnaCor Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure



ANALYTICAL LABORATORIES, INC.

To: PNM
Alvarado Square
Albuquerque, NM 87158

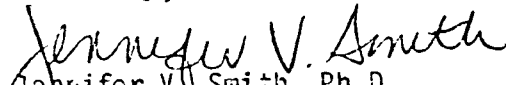
Date: 24 February 1984

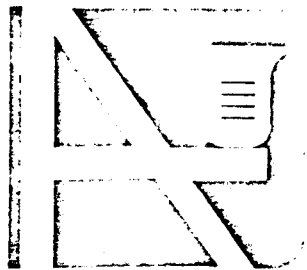
Attention: Jody Plum

Re: October 13, 1983 Laboratory Report

As requested by PNM these two samples labeled A and B were analyzed for a variety of compounds including trichloroethylene. Usage of more rigorous techniques indicated the presence of tetrachloroethylene. Tetrachloroethylene was subsequently found to be the major chlorinated organic contaminant found in the soils.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director



AnaCor
Laboratories

(505) 345-8964
7300 Jefferson St. NE
Albuquerque, NM 87109

Analytical and Environmental Services

To: PNM
Alvarado Square
Albuquerque, NM 87158

Date: 28 November 1983
JV- 1192 (Cont.)

Attention: Jody Plum

Analyte	Sample ID/Analytical Results			
	PS-5 15'	PS-4 90'	PS-5 90'	Tank
Trichloroethane	462.2 ppm			17274.0 ppm
Trichloroethylene	<0.01 ppm			<0.01 ppm
Tetrachloroethylene	1661.7 ppm			3562.4 ppm
Benzene	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm
Toluene	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm
Dichloroethane	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm
Carbon Tetrachloride	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm
1,2 Dichloroethane	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm
1,1 Dichloroethylene	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm

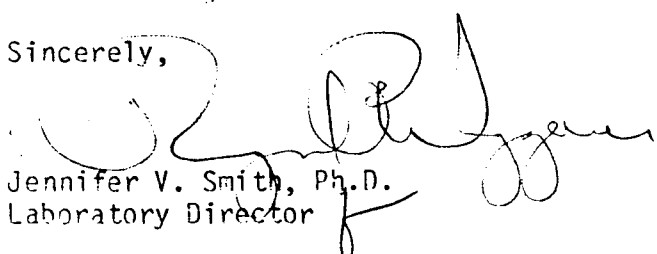
Normal Detection Limits:

Trichloroethane	0.01 mg/l	Dichloroethane	0.01 mg/l
Trichloroethylene	0.01 mg/l	Carbon Tetrachloride	0.01 mg/l
Tetrachloroethylene	0.01 mg/l	1,2 Dichloroethane	0.01 mg/l
Benzene	0.01 mg/l	1,1 Dichloroethylene	0.01 mg/l
Toluene	0.01 mg/l		

Reference: "Organic Analysis Using Gas Chromatography/Mass Spectrometry",
1979, Budde & Eichelberger, Ann Arbor Science.

An invoice for services is enclosed. Thank you for your consideration
in contacting AnaCor Laboratories.

Sincerely,


Jennifer V. Smith, Ph.D.
Laboratory Director

Enclosure

RADIAN
CORPORATION

February 23, 1984

Mr. Kent Kantz
Public Service Company of New Mexico
Alvarado Square
Albuquerque, New Mexico 87158

Dear Mr. Kantz:

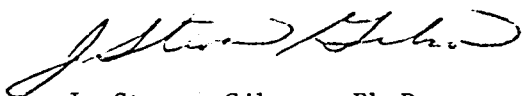
On February 15, I reported to you the results we obtained for the analysis of nine groundwater samples for volatile halocarbons. In addition to the quantitative data, I reported the presence of several compounds we identified but did not quantitate. At your request, we reviewed our chromatograms in order to quantitate as many compounds as possible. This request afforded us the opportunity to review our previously quantitative identifications. This letter is to report quantitation of the additional compounds and correct some qualitative identifications previously reported.

The major volatile halocarbons in the samples were 1,1-dichloroethene, 1,1,1-trichloroethane, and tetrachloroethylene. The concentrations of the latter two compounds were reported in my letter of February 15. The concentrations of 1,1-dichloroethene are listed on the attached table. In addition we found 6.8 $\mu\text{g/L}$ methylene chloride, 4.5 $\mu\text{g/L}$ 1,1-dichloroethane, and 3.7 $\mu\text{g/L}$ trichloroethene in PSMW-A3.

After reviewing the chromatograms, I do not believe that chloroform or dichlorobenzenes were present as previously reported. The high levels of dichloroethene, trichloroethane, and tetrachloroethylene greatly complicated quantitative and qualitative analysis of your samples. I hope our initial qualitative identifications did not cause undue concern or consternation.

Please feel free to contact me if any questions arise or if we can be of further service.

Sincerely,



J. Steven Gibson, Ph.D.
Manager, Organic Laboratory
Radian Analytical Services

JSG:lb

Attachment

Concentration of 1,1-dichloroethene in Ground Water

<u>SAMPLE</u>	<u>CONCENTRATION, $\mu\text{g/L}$</u>
PSMW1-A3	665
PSMW1-B3	915
PSMW1-C3	<u>882</u>
Mean, PSMW1	820
PSMW2-A3	377
PSMW2-B3	350
PSMW2-C3	<u>527</u>
Mean, PSMW2	420
PSMW3-A3	1392
PSMW3-B3	1151
PSMW3-C3	<u>1309</u>
Mean, PSMW3	1280

RADIAN

CORPORATION

February 15, 1984

Mr. Kent Kantz
Public Service Co. of New Mexico
Alvarado Square
Albuquerque, New Mexico 87158

Dear Mr. Kantz:

Enclosed are the results for analyses we recently performed on groundwater samples. These analyses were performed according to EPA Method 601 (EPA-600/4-82-057, July, 1982). We used a Tracor Model 560 gas chromatograph equipped with a Hall electrolytic conductivity detector. Sample introduction was effected using the purge-and-trap technique.

Although we quantitated the two predominant compounds (1,1,1-trichloroethane, tetrachloroethylene), our use of EPA Method 601 allowed us to identify the presence of methylene chloride, 1,1-dichloroethylene, chloroform, trichloroethylene, and dichlorobenzene. Other volatile halocarbons may be present but at levels which are masked by the more plentiful compounds.

Feel free to contact me if I can answer any questions or if we can be of further service.

Sincerely,



J. Steven Gibson, Ph.D.
Manager, Organic Laboratory
Radian Analytical Services

JSG:lb

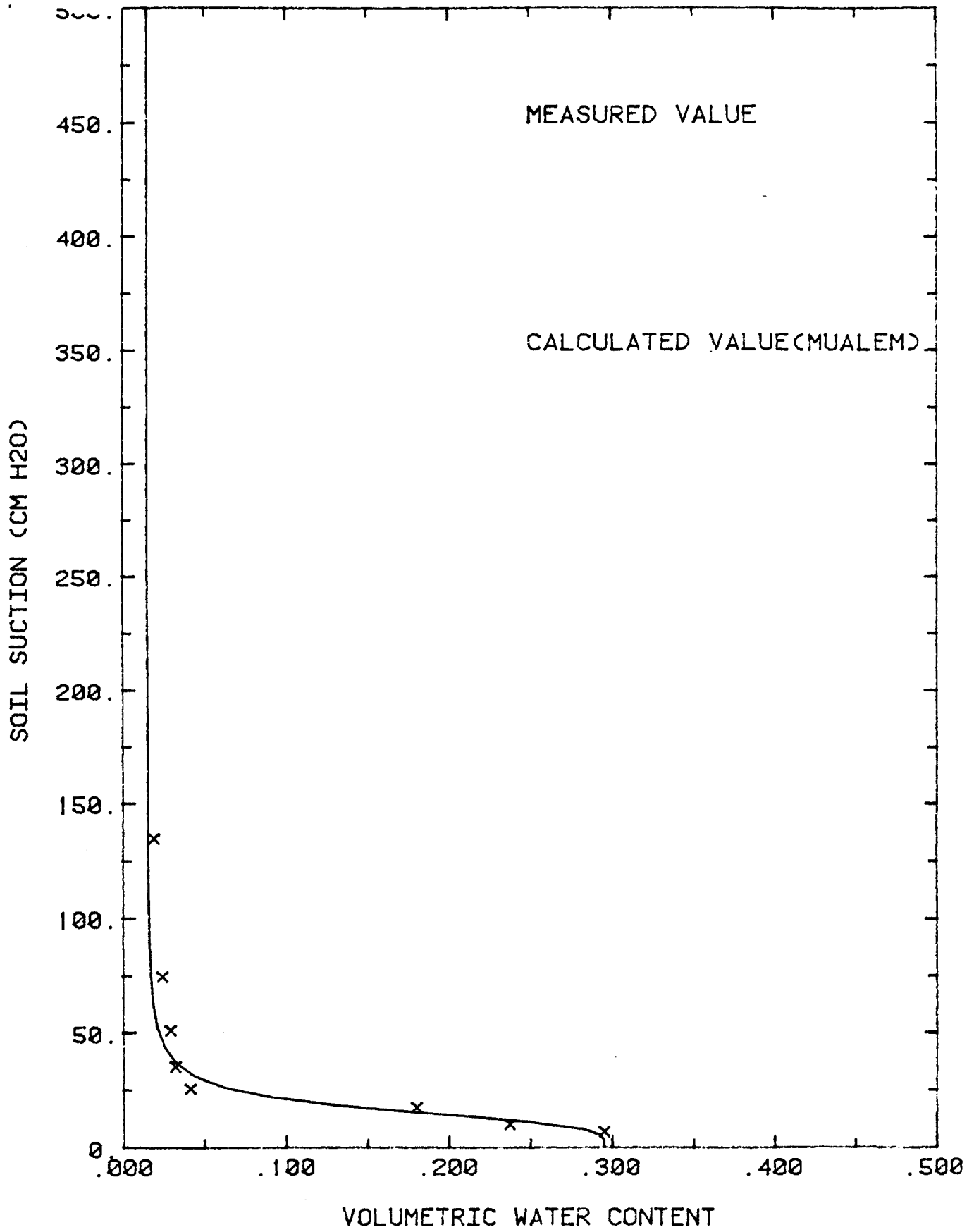
Enclosure

Analysis of Groundwater for Volatile Halocarbons

<u>Sample</u>	<u>Concentration, $\mu\text{g/L}$.</u>	
	<u>1,1,1-trichloroethane</u>	<u>tetrachloroethylene</u>
PSMW1-A3	4960	1330
PSMW1-B3	5900	1190
PSMW1-C3	<u>5620</u>	<u>1090</u>
Mean, PSMW1	5490	1200
PSMW2-A3	4080	842
PSMW2-B3	4630	778
PSMW2-C3	<u>4410</u>	<u>908</u>
Mean, PSMW2	4370	843
PSMW3-A3	10,700	2460
PSMW3-B3	11,400	2360
PSMW3-C3	<u>10,100</u>	<u>2130</u>
Mean, PSMW3	10,700	2320

APPENDIX B

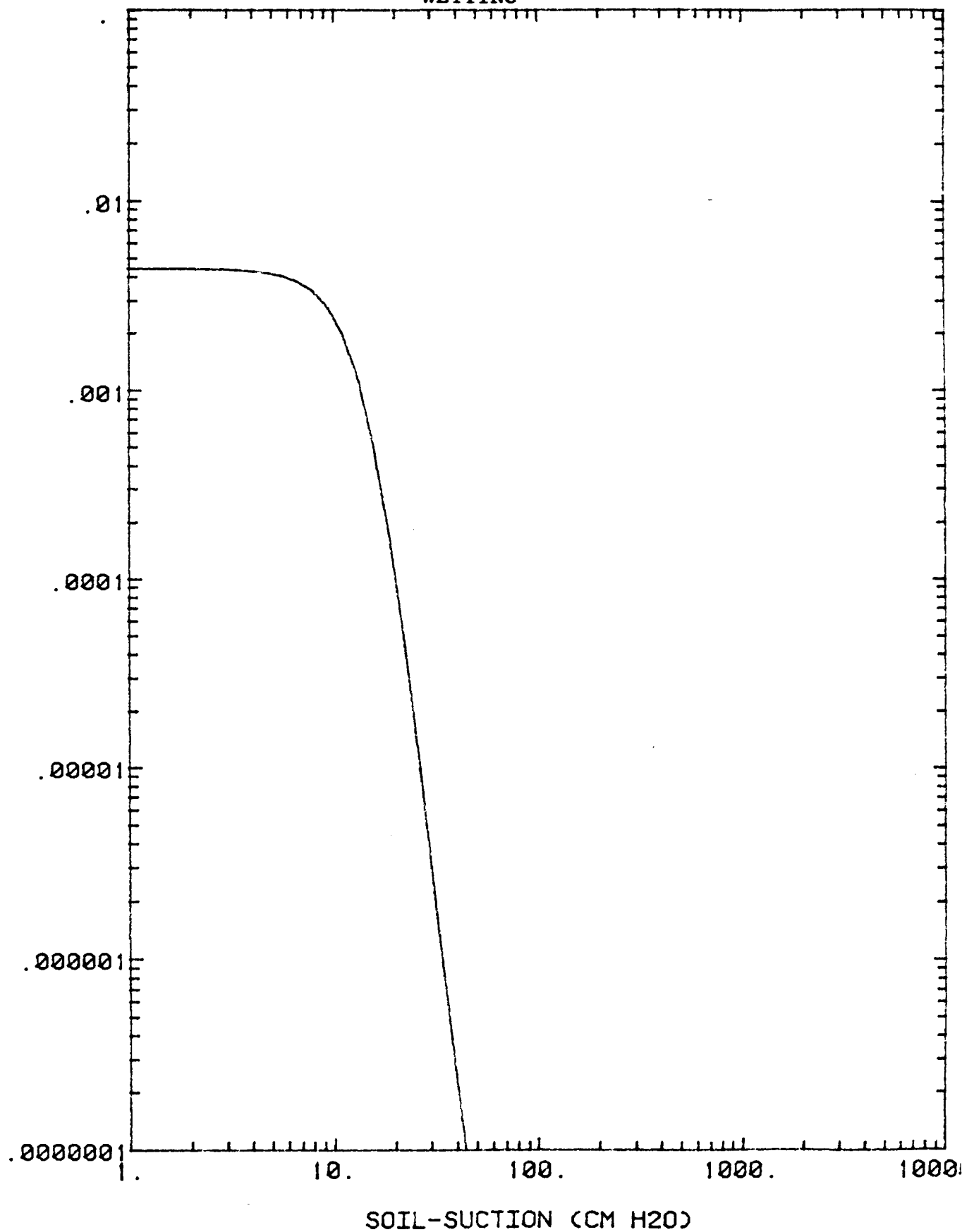
WETTING



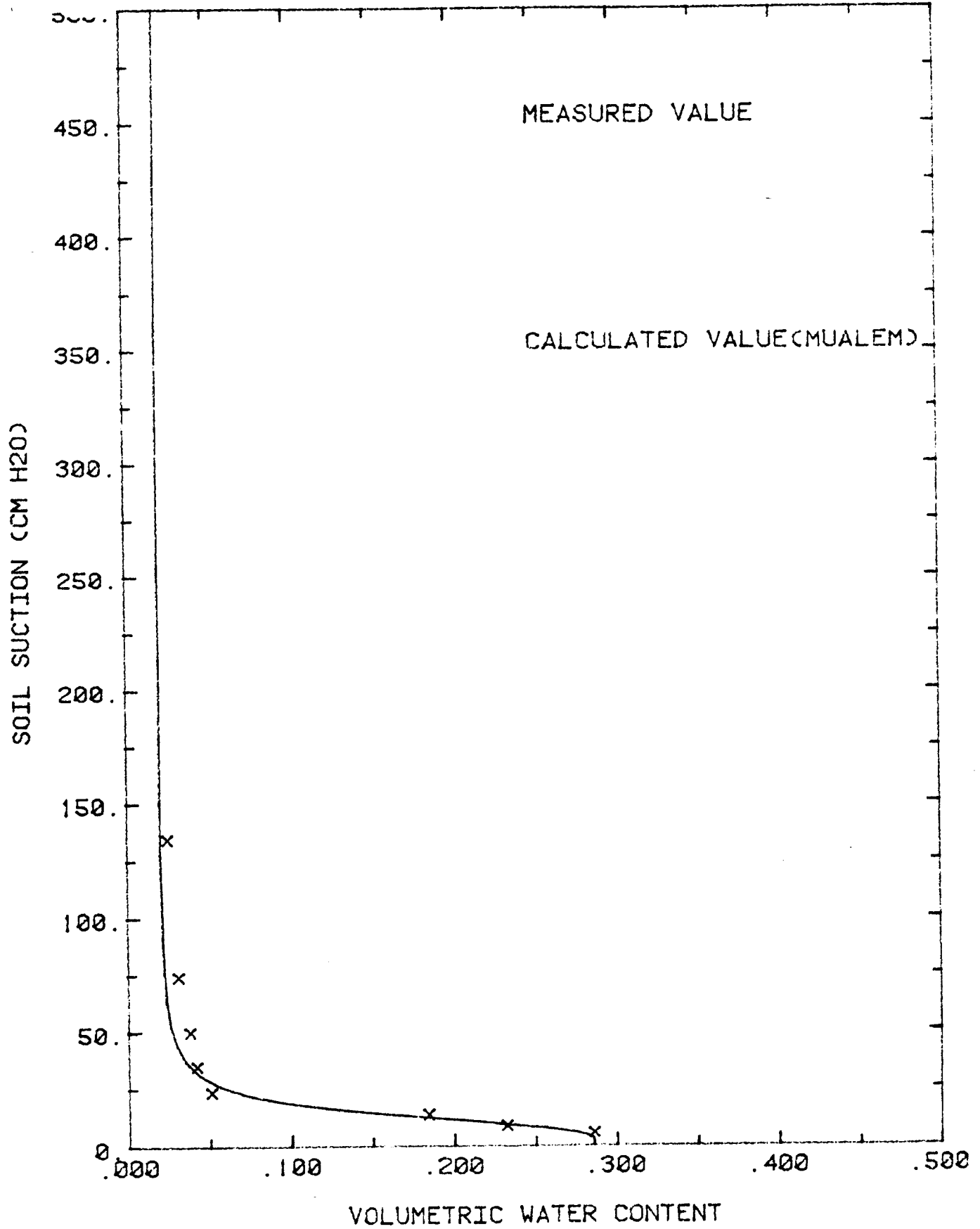
PS-4 25'

WETTING

HYDRAULIC CONDUCTIVITY



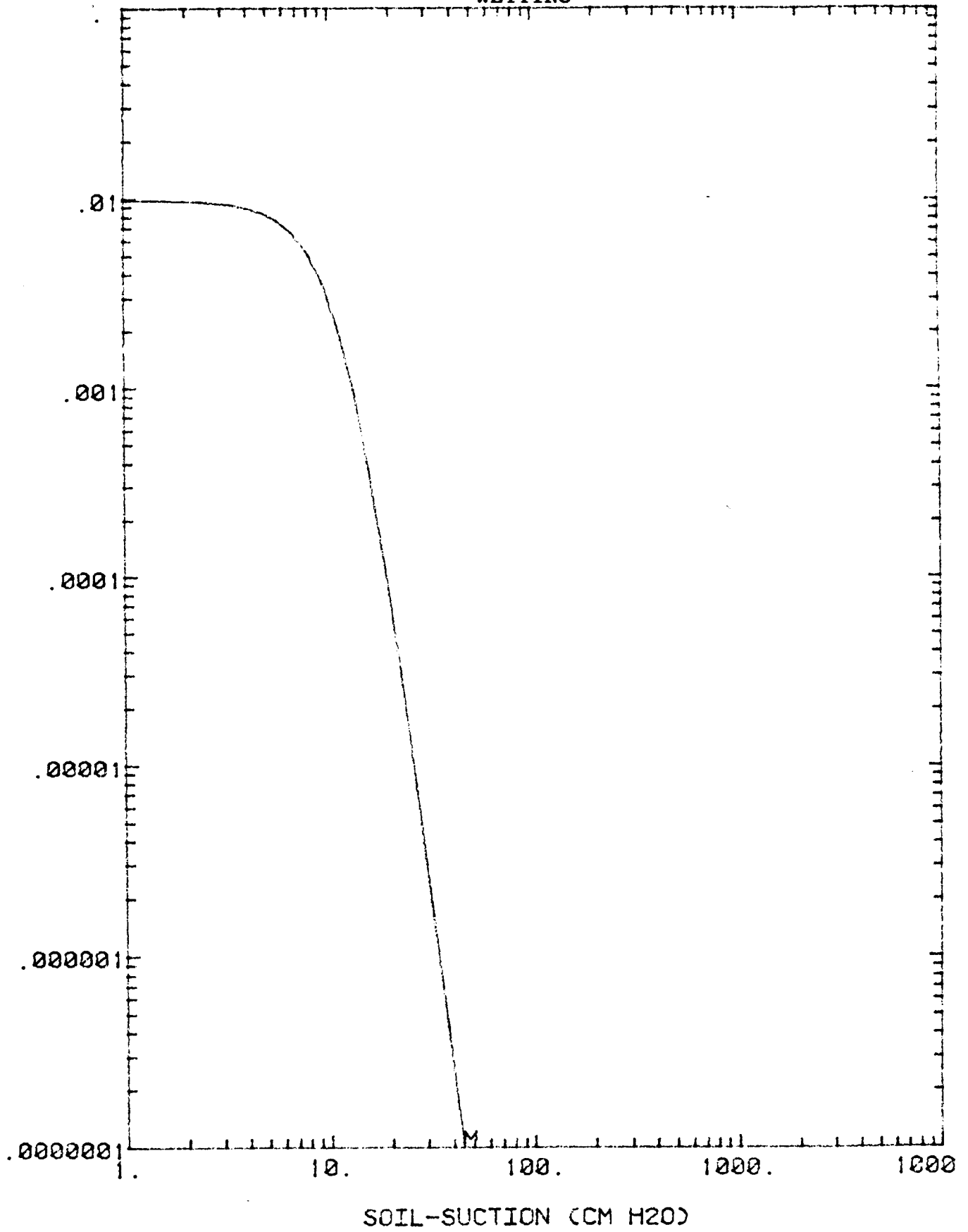
WETTING



PS-4 40'

WETTING

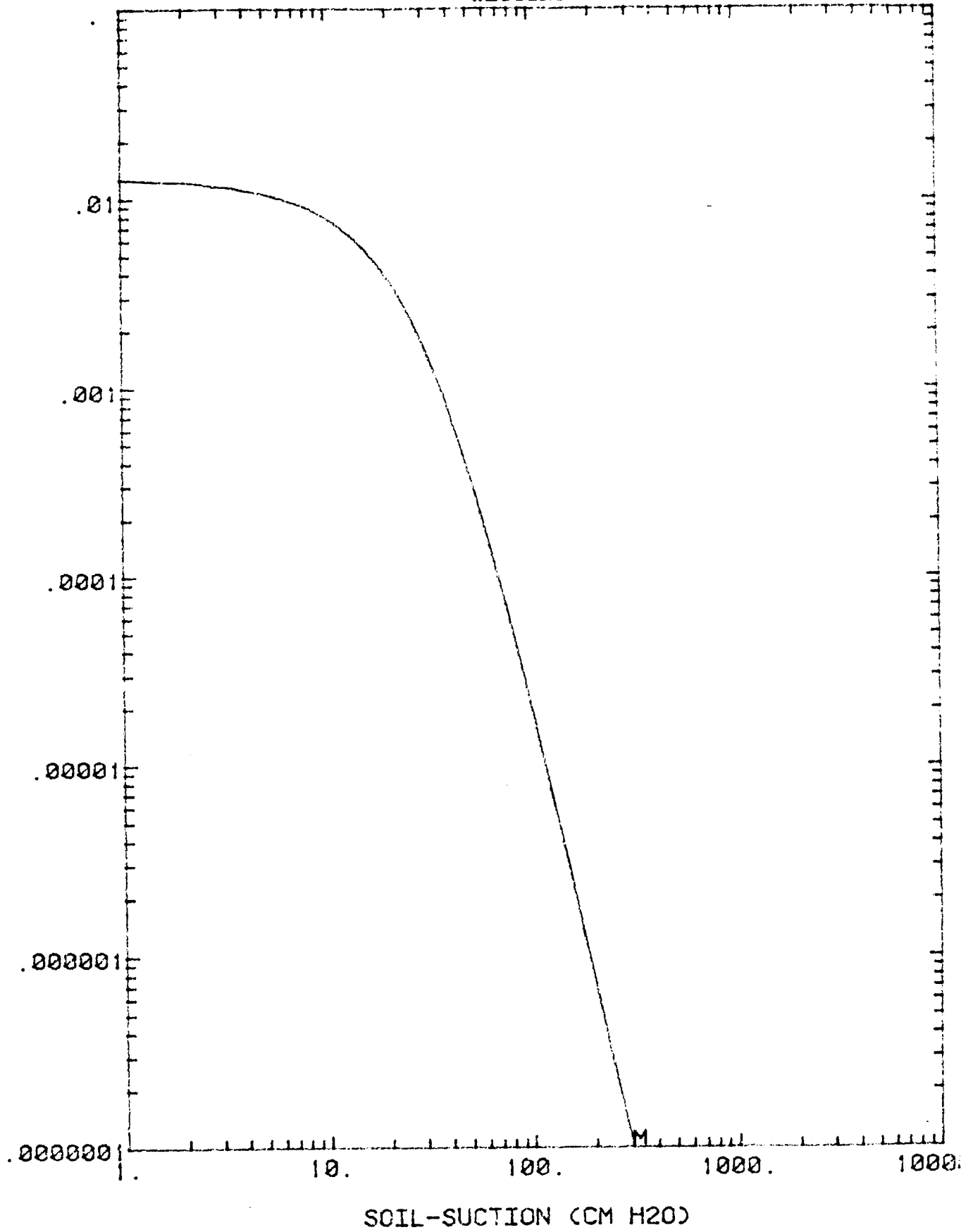
HYDRAULIC CONDUCTIVITY



PS-4 40'

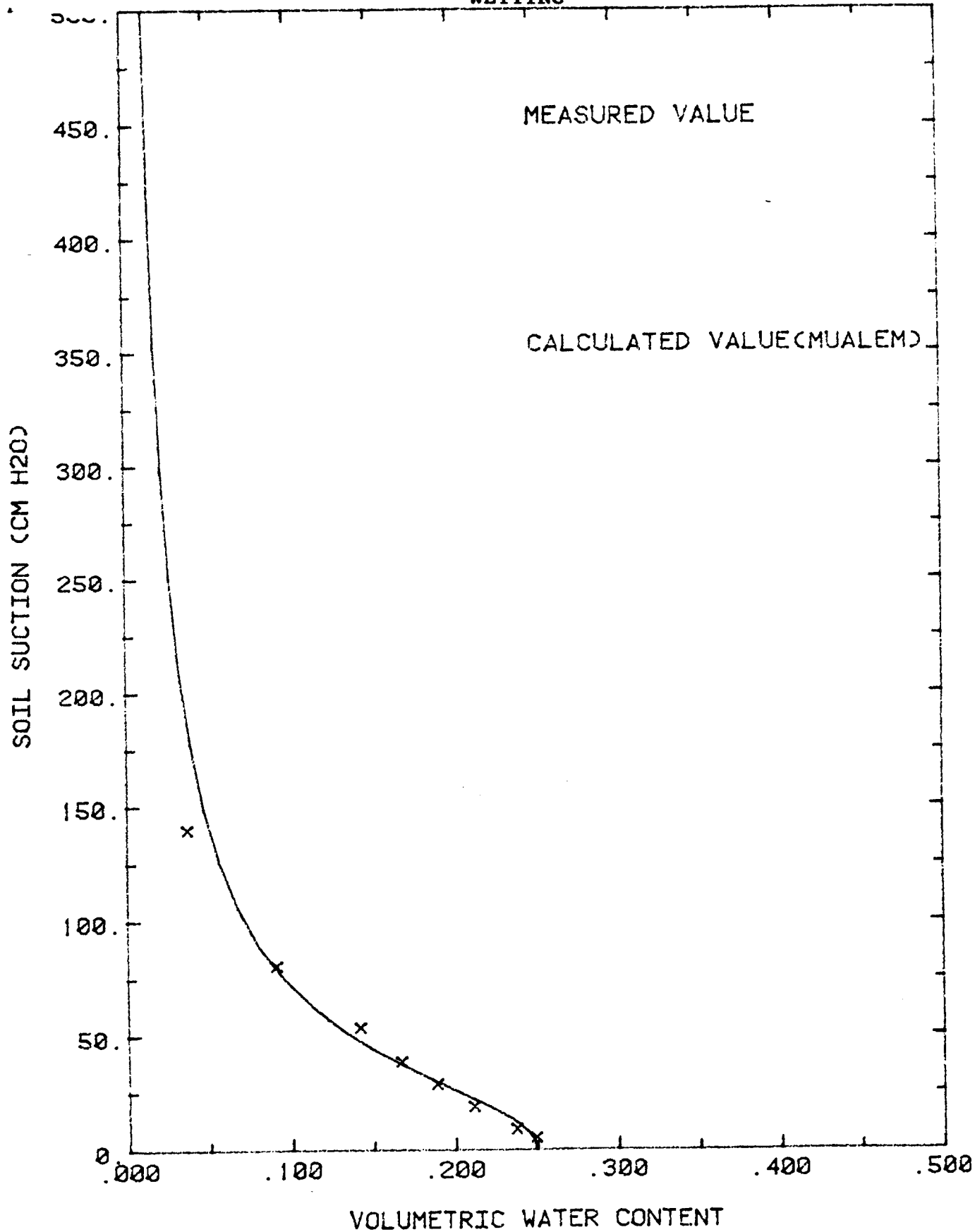
WETTING

HYDRAULIC CONDUCTIVITY



PS-4 25 70

WETTING



PS-4 70'

Attachment 2

Soil Removal and Treatment Program

A proposed remedial action for the contaminated soil can be divided into two parts. Part 1 is the excavation of the soil. Part 2 is treatment of the soil to remove the contaminants or disposal of the contaminated soil in an approved landfill.

Part 1 - Excavation of the Contaminated Soil

All of the material within a 24 ft. x 16 ft. area, 65 ft. deep will be excavated. According to the report presented as Attachment 1 "Final Soil Contamination Assessment and Preliminary Ground Water Contamination Assessment PNM Person Generating Station," approximately 99.7 percent of the total PCE mass will be removed in this volume of soil.

The excavation procedure will require the construction of a retaining wall system (e.g., sheet piles or soldier piles). A clam bucket will be used to remove the material. Clean soil from a borrow area will be used to backfill the excavated area. Mobilization, piling, and removal of the material will require approximately two months.

Part 2 - Treatment or Disposal of the Contaminated Soil

Land farming is the proposed method of treatment for the contaminated soil. The excavated soil will be spread on a liner to a depth of six inches. The halogenated hydrocarbons will be allowed to volatilize to the air. The soil may have to be tilled periodically to facilitate the volatilization process. The duration of the land farming process will be dependent on the soil properties, weather, and extent of reduction of halogenated hydrocarbons. A land farming test with the contaminated soil to determine the concentration reduction as a function of time will be required before a definite schedule can be developed. A preliminary estimate for the duration of the land farming process is two months. At the completion of the land farming operation, the decontaminated soil will be disposed of on site.

The most highly contaminated soil, immediately beneath and adjacent to the subsurface storage tank which may not be amenable to the land farming process being considered, will be transported to an NMEID approved municipal landfill or an EPA permitted Treatment, Storage, Disposal (TSD) facility.

An economic comparison of treatment versus landfill disposal is one of the factors to be considered when making the final decision of how to treat the contaminated soil. Other factors that will be considered are the effectiveness of the proposed land farming process, environmental impact of any decision, and the time required for each proposed plan of action.

Attachment 3

Phase IV Monitoring Person Generating Station

Introduction

The Phase I, II, and III soil coring efforts have provided an extensive and precise three-dimensional description of the amount of soil that has been contaminated (as indicated by the presence of tetrachloroethylene) by leakage from the subsurface waste storage tank. Phase III has also provided a preliminary indication of the water quality in the top twenty feet of the aquifer in the immediate vicinity of the tank. The observation that solvent is present in the top of the aquifer near the tank leads to the questions that follow: (1) What is the horizontal extent of the observed groundwater contamination? (2) Is leakage from the tank the source of the contamination? Phase IV monitoring is designed to address these two questions.

Scope of Phase IV Monitoring

Phase IV monitoring is planned to include the installation of three additional monitoring wells near the Person Generating Station property boundaries. It will also include an attempt at selectively sampling the existing monitoring wells in order to obtain information on possible vertical stratification of solvent concentrations in the top twenty feet of the aquifer. In addition to the installation of three additional groundwater monitoring wells, an effort will be made to obtain water quality data and water table elevation data from wells other than our own. We will analyze all data collected and relevant existing data including NMEID supplied relevant information.

Details of Well Installation

Similar techniques used for design and installation of the Phase III monitoring wells will be used for the three, 2-inch diameter, Phase IV wells. That is, extreme care will be taken to ensure that no organic contaminants or drilling fluids are introduced in the groundwater by well installation technique. In addition, only stainless steel and teflon materials will be used, and each well will have its own dedicated bailer which will be steam cleaned before and after each use.

The wells will be located upgradient, downgradient and off-gradient from the tank. They will be located near the plant site property boundaries at distances of approximately 400 to 800 feet from the waste tank. The wells will be installed at the depth necessary to sample the top twenty feet of the aquifer. The well elevations will be surveyed and water table elevations determined.

Details of Vertical Sampling

Because of the pipe base, wire-wound screen design of the monitoring wells, representative vertical water quality sampling cannot be done with inflatable packers. However, since the question of primary concern is

whether or not the top few feet of the twenty foot zone contains all of the contamination; a selective sampling system has been devised and will be implemented for both Phase III and IV wells.

The selective sampling system involves three steps. First, a bailer is gently lowered into the top few feet of the water in the well and the sample is drawn. Secondly, the well is bailed and a closed-bottom bailer is immediately inserted into the empty well so that the top of the bailer (open end) is a few feet below the water table. This closed-bottom bailer then collects only that water cascading into the well from the top few feet of the aquifer. Thirdly, the well is sampled in the routine manner by evacuating two casing volumes and then sampling the vertically integrated water in the casing. The three different samples from each well are then analyzed for PCE concentration and the results compared to evaluate uniqueness in the top few feet of the aquifer.

Should this technique prove inadequate, PNM will investigate the possibility of using nested wells to obtain vertical samples. We have tentatively decided against using packer systems because of the potential for vertical cross-contamination in attempting to isolate narrow vertical zones regardless of how careful the well and packers were designed. Should nested wells be required, details of such an installation will be discussed with the NMEID.

Schedule of Phase IV

Vertical sampling of the Phase III wells is planned for mid-March 1984 with lab results expected in early April 1984.

Installation of Phase IV wells is planned for mid to late March 1984. Sampling would occur in early to mid-April 1984, with lab results expected by the end of April 1984.

A report summarizing the Phase IV water quality data should be available before the end of May 1984.

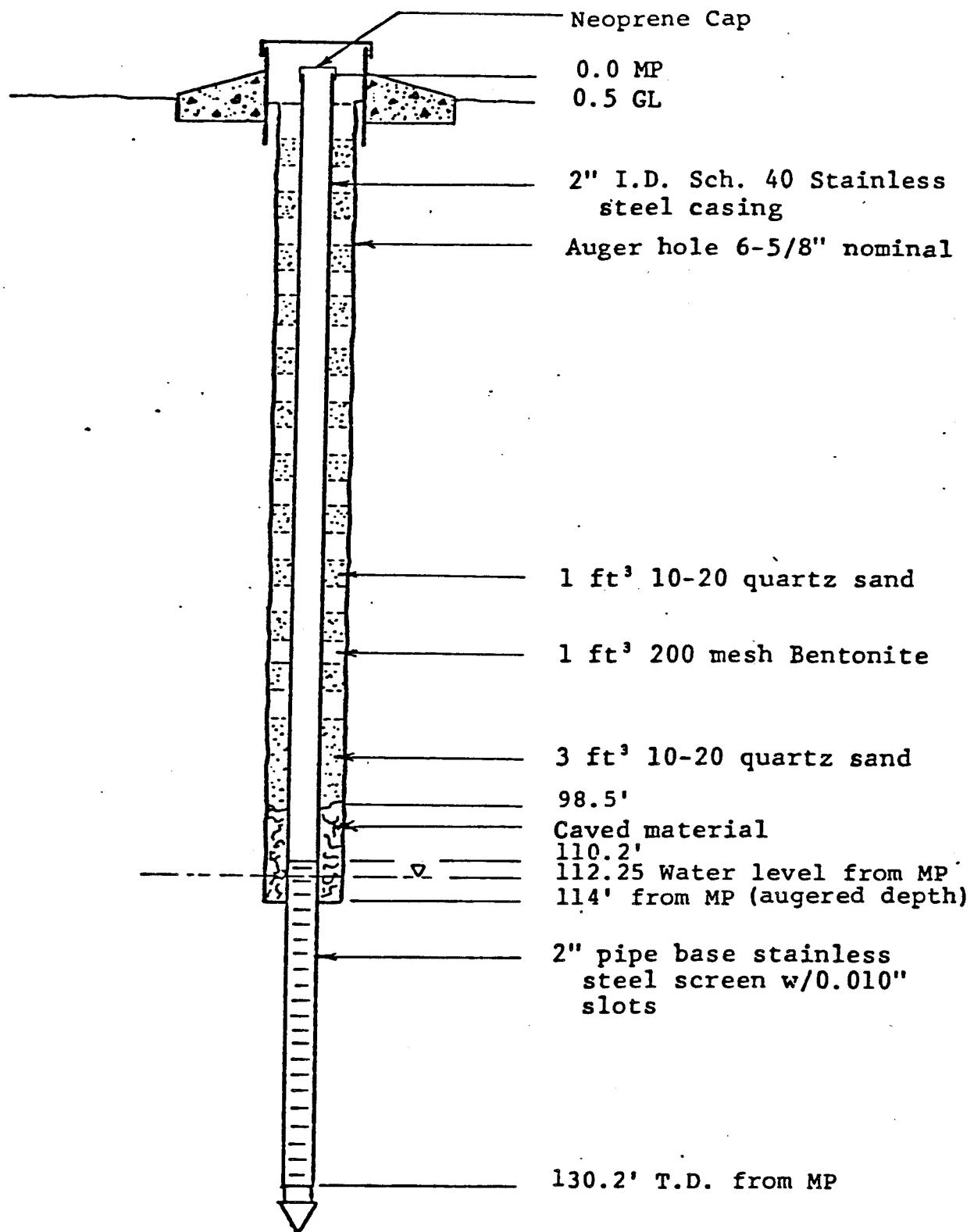
Attachment 4

Response to New Mexico Environmental Improvement
Division's Comments Regarding Groundwater
Monitoring Wells at Person Station

The following responses are provided regarding the six comments presented in NMEID letter of February 16, 1984:

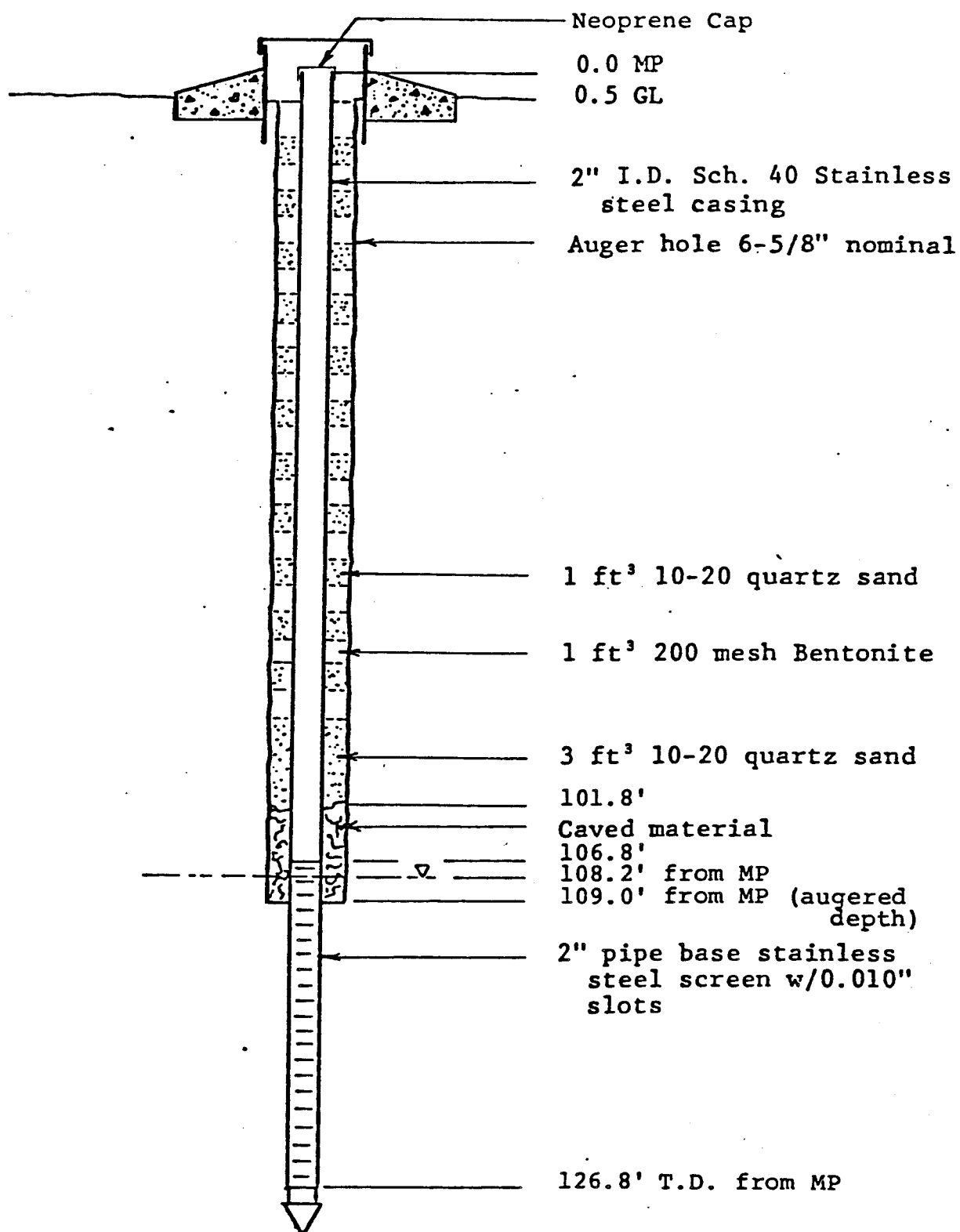
1. Well Screen Interval--The major objective of installing monitor wells was to obtain samples from the upper part of saturated zone. Based on a review of production well logs and laboratory-determined hydraulic conductivity, it was estimated that a well completed very near the top of the saturated zone would likely yield only minimal quantities of water. Thus, it was decided that a screened interval of approximately 20 feet at the top of the saturated zone would allow both representative sampling from the water table and also yield adequate water for well cleanup (i.e., removing silty water from the casing) and sampling. Due to the nature of the stainless steel well screen (i.e., pipe base and wire wound), inflatable packers would not be successful in isolating various vertical sections in the monitoring wells. However, PNM is currently evaluating other techniques for obtaining samples to define vertical variability in water quality.
2. Backfilling--The annular space was backfilled with alternating layers of 10-20 quartz sand and 200 mesh bentonite. A concrete pad (approximately one foot thick; six inches above grade and six inches below grade) was installed for surface protection. Well construction diagrams are attached.
3. Bailer--Each well has a bailer dedicated to sampling only that well. Bailers are steam cleaned prior to and after sampling.
4. Well Elevations--All well elevations have been measured by survey techniques.
5. Water Level Measurements--PNM is currently evaluating plans for continued monitoring of water levels to define temporal changes in hydraulic gradients. Upon completion, the plan will be submitted to NMEID.
6. Additional Monitoring Wells--Plans for additional groundwater monitoring wells are presented in PNM's Phase IV Monitoring Plan found as Attachment B.

3



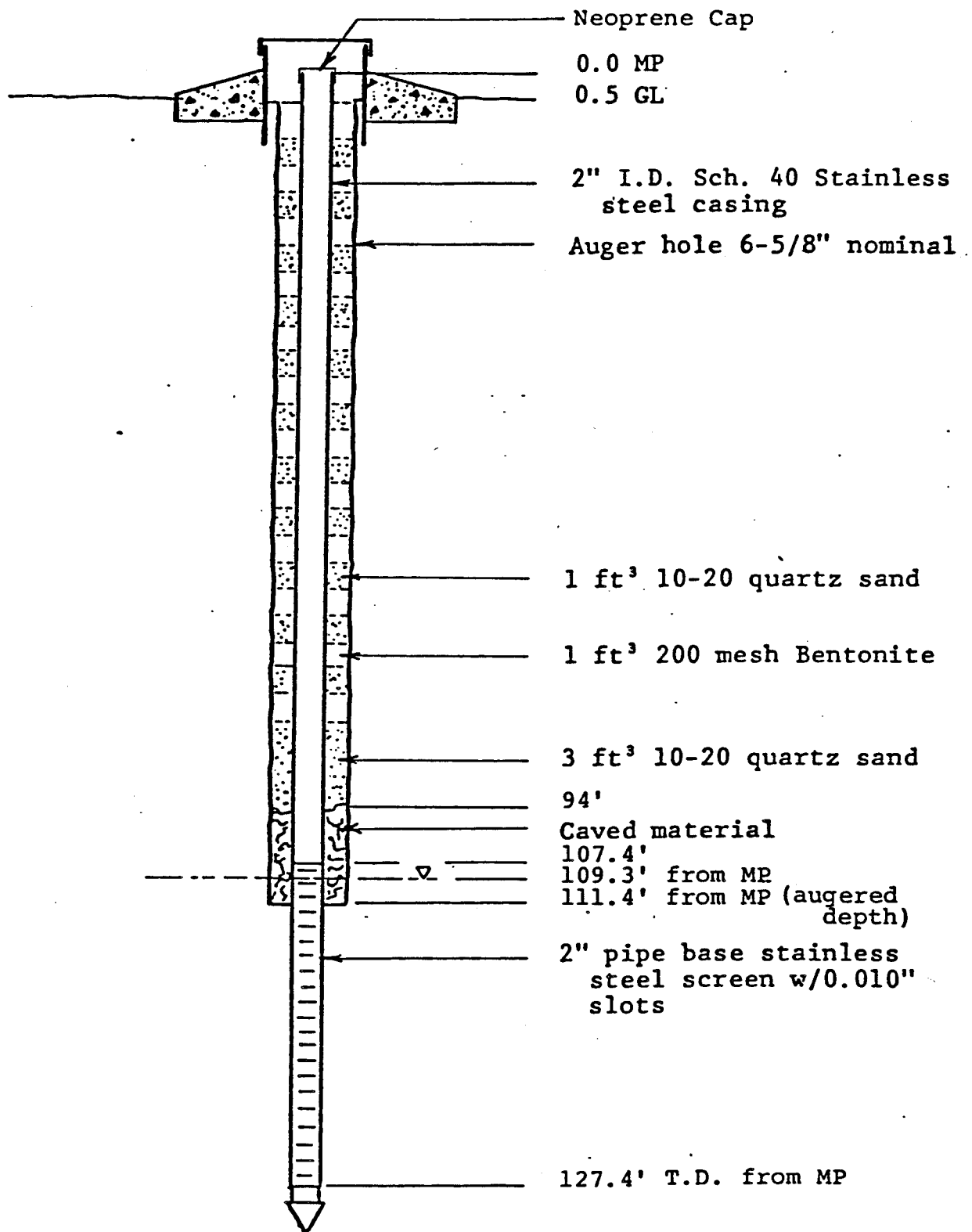
Construction Diagram

PSMW-1



Construction Diagram

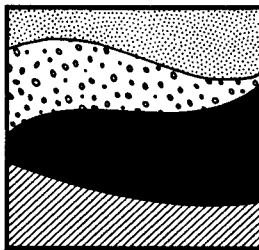
PSMW-2



Construction Diagram

PMSW-3

**Geoscience
Consultants, Ltd.**



Mr. Jody Plum
Public Service Company of NM
Alvarado Square
Albuquerque, NM 87103

February 29, 1984

Dear Jody,

This letter is in response to the comments in Mr Kevin Lambert's memo to Mr. Dave Boyer (2/14/84) included in Boyer's February 21 letter to Mr. Richard Jordan.

In response to point Number 1:

The method described in section 3.2 of the 12/29/83 report (performed by Dr. Dan Stephens, NMIT) does provide an accurate representation of actual K_u ; however, since this technique yields maximum values (due to the utilization of lab determined K_{sat}) the actual field K_u will fall in a range less than or equal to the lab determined value.

In response to point Number 2:

The initial estimate of porosity (22-27%, quoted in the executive summary) based on field inspection should have been corrected to reflect the actual porosities shown on Figures 4-2B, 4-3B, 4-4B (average porosity = 35.6%). These values agree with the estimates in the current literature for medium to coarse grained sands (Chow, 1964 & Todd, 1980). This discrepancy was due to an oversight in updating the executive summary. We apologize for any confusion that this oversight may have caused. The correct average porosity for the material at Person Generating Station is 35.6% (range 31-40%).

I trust this will answer all the questions raised in the above mentioned communication with NMEID.

Sincerely,


Alberto A. Gutierrez
President

AAG/pg