HARTCROWSER

Earth and Environmental Technologies

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699
FAX 206.328.5581
206.324.9530

J-2436

AUG 01 1989

July 24, 1989

Seattle Public Schools
4141 Fourth Avenue South
Seattle, Washington 98134

Attn: Mr. Melvin Smith

Re: Site Characterization
Seattle School District Building
810 Dexter Avenue North
Seattle, Washington

Dear Mr. Smith:

This letter report presents the results of our site characterization of the Seattle Public School's building at the 810 Dexter Avenue North site (Figure 1). The purpose of our work was to collect additional soil and groundwater quality data necessary to develop a remediation work plan.

Our scope of work was based upon our proposal dated May 11, 1989, and conversations with Melvin Smith of Seattle Public Schools.

We completed the following work to make our assessment and develop a conceptual remediation plan:

- Performed a site reconnaissance;
- Drilled four exploratory borings (3 on the property and 1 off-site in the presumed hydraulically upgradient position). See Figure 2;
- Collected subsurface soil samples at 2.5-foot-depth intervals in the borings. Screened the samples in the field for indications of hydrocarbon contamination;

- Submitted 2 soil samples from each boring for total petroleum hydrocarbons (TPH), volatile organic compounds and BTEX (benzene, toluene, ethylbenzene, and total xylenes) analysis;
- Installed groundwater monitoring wells in the four borings;
- Collected 5 groundwater samples (one each from the recently installed wells and one from an existing well) and analyzed selected samples for volatile organic compounds, total metals, TPH, and BTEX;
- Excavated 7 shallow test pits, and collected subsurface soil samples. Selected samples were analyzed for volatile organic compounds, EP Toxicity Metals, PCBs, TPH, and BTEX; and
- Analyzed the data and prepared this letter report.

SITE BACKGROUND

Petroleum-contaminated soil was discovered during the removal of six underground storage tanks (USTs) at the site (Figure 2). These tanks were used for maintenance operations of the Seattle Public Schools.

Free-phased petroleum hydrocarbons were observed in the excavation during removal of two of the petroleum product tanks (unleaded and leaded gasoline). The Washington State Department of Ecology (Ecology) was notified by Seattle Public Schools. The additional site characterization and development of a conceptual remediation plan is in response to this notification.

SUMMARY OF FINDINGS

The following is a summary of our key findings. The remainder of this report should be referred to for supporting information and more in-depth discussion of the data.

- The primary sources of significant on-site contamination appear to be petroleum hydrocarbons. Previous analytical data (Table 3) and data from our study indicate that petroleum hydrocarbon constituents have leaked from previous on-site tanks or piping and some spillage has occurred.

- Concentrations of benzene in soil samples from TP-2 and Test 3 (O'Sullivan Construction Company, OCC) exceed draft Ecology soil cleanup guidelines. Concentrations of total petroleum hydrocarbons in soil samples adjacent to and hydraulically downgradient from each of the previously removed underground storage tanks exceed draft Ecology soil cleanup guidelines;

- Volatile organic compounds were detected in a groundwater sample from MW-4. MW-4 is hydraulically upgradient and may be a potential source for groundwater contamination.

- Acetone and methylene chloride may be present in low concentrations in the groundwater on-site (MW-5, B-1). Confirmatory analysis would be required to determine if this is a concern;

- Low levels of petroleum hydrocarbons were detected in a groundwater sample from MW-1 northeast of the former heating oil tank and from MW-4. These concentrations are below draft Ecology groundwater cleanup guidelines;

- Barium was detected in a groundwater sample from MW-5 (B-1), at concentrations which meet existing drinking water standards; and

- Data from the groundwater assessment indicate a low potential for groundwater contamination to be migrating off-site.

RECOMMENDATIONS

- Localized areas of soil contamination adjacent to and hydrologically downgradient from the former USTs which exceed Ecology's draft (August 1988) cleanup guidelines should be remediated. Landfarming the soils on-site would be an acceptable method of remediation;
- Resample groundwater from MW-5 (B-1) and MW-4, and analyze for volatile organics;
- Develop a site remediation work plan to address intended cleanup; and
- Submit the remediation work plan to Ecology for review.

SITE CONDITIONS

Geologic Materials - Variable Sandy Fill

Within the depth of our explorations, the geologic materials beneath the site consist primarily of unstratified fill. Although the composition of the fill varies considerably across the site, the fill is predominantly a slightly gravelly, slightly silty to silty sand with abundant debris (wood, cinders, glass, etc.). However, the upper 7 feet of fill at MW-2 is composed of very sandy silt. This silt unit thins rapidly toward the west and is less than one foot thick at MW-1. Stiff green and gray fine grained soil was also encountered at a depth of 16 feet at MW-3 in the northeastern corner of the site. Two geologic cross sections showing the relationship of the soil types at the site are presented on Figures 3 and 4.

Water Table

Despite the variable nature of the subsurface materials, the uniformity of water levels across the site indicates that the fill is a single water table. The observed lack of any continuous silt or clay layer through the depth of the borings, which could act as a vertical hydraulic barrier, supports the idea of a single unconfined (water table) aquifer to the depth of exploration. However, if the clayey

unit encountered at MW-3 is continuous across the site, it would probably be the bottom of the zone.

Groundwater Flow Direction - Toward the Northeast

During water level measurements taken on May 31, 1989, the depth to water on-site varied between 7.5 feet and 11.0 feet. The water level data are somewhat inconclusive for accurately delineating groundwater flow direction because the water level elevations measured in MW-1 and MW-2 are identical. Because the water level elevation at MW-3 is lower than at either MW-1 and MW-2, groundwater flow is indicated toward the northeast - toward Lake Union, as would be expected at this location. The highest water level elevation was measured in MW-4, immediately off-site of the northwest corner. The MW-4 water level suggests that groundwater flows on-site from the west-northwest and then curves to flow off-site toward the northeast.

Hydraulic Conductivity Estimates

The hydraulic conductivity of the silty sand fill aquifer appears to be low. Slug test analyses in 3 of the 4 monitoring wells indicate that the hydraulic conductivity of the aquifer ranges between 1×10^{-5} and 7×10^{-4} cm/second. The large range in estimate is reasonable, considering the non-uniformity of the aquifer materials, especially the widely varying percentage of silt (ranging between 5 percent to 40 percent) observed in the borings.

SOIL SAMPLING AND ANALYSIS

Soil Sampling Procedures

Twenty six soil samples were collected during the drilling of monitoring wells MW-1 through MW-4. Previous soil quality analysis were performed by Earth Consultants Inc., primarily for TPHs. Soil samples were collected at 2.5-foot-depth intervals to a depth of 16.5 feet (MW-1 thru MW-3) and 23 feet (MW-4). Samples were immediately screened in the field for volatile organics with a photoionization detector (H-Nu), visually classified as to soil type, placed in the appropriate containers, and refrigerated. H-Nu screening results are shown on the boring logs (Appendix A).

Analysis of Soil Samples

Based on results from the H-Nu screening, 8 samples (2 from each boring) containing the highest H-Nu readings were sent to Analytical Resources, Inc., and Spectra Laboratories, Inc., for analysis.

The following analysis were performed on the soil samples:

Analytical Parameter	Method Number	Number of Samples
Benzene, Toluene, Ethylbenzene, and Total Xylenes (BETX)	EPA 8020	7
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	8
Volatile Organics	EPA 8240	1

Our sampling methodology is presented in Appendix A. Analytical data and laboratory certificates are presented in Appendix B.

Results of Chemical Analysis - Soil

Soil analytical results from the four borings (MW-1 through MW-4) are presented in Table 1. No BTEX compounds were detected in the soil samples collected from MW-3. BTEX compounds were observed in soil samples collected from the three other monitoring well locations:

MW-1, S-6 - toluene 1.03 parts per million (ppm), ethylbenzene 2.84 ppm, and total xylenes 6.25 ppm between 15 and 16.5 feet below ground surface;

MW-2, S-6 - toluene 0.53 ppm, between 15 and 16.5 feet below ground surface;

MW-4, S-6 - ethylbenzene 0.032 ppm, and total xylenes 0.069 ppm between 14.5 and 16 feet below ground surface.

Concentrations of acetone (0.096 ppm) were found in soil samples from MW-4 at depths between 14.5 and 16 feet below ground surface.

Total petroleum hydrocarbon (TPH) concentrations were observed in soil samples collected from all four monitoring well locations: MW-1, S-2 - 4 ppm, between 5 and 6.5 feet and S-6 - 332 ppm between 15 and 16.5 feet below ground surface; MW-2, S-3 - 338 ppm, between 7.5 and 9 feet and S-6 - 71 ppm between 15 and 16.5 feet below ground surface; MW-3, S-5 - 5 ppm between 12.5 and 14 feet below ground surface; and MW-4 - 6 ppm between 14.5 and 16 feet, and 9 ppm between 22 and 23 feet below ground surface.

Interpretation of Results

Ecology recommends a draft cleanup guideline for petroleum-contaminated soil at 200 ppm TPH. Only two soil samples collected from MW-1, S-6 and MW-2, S-3 slightly exceeded this guideline. Sample S-6 from MW-1 collected between 15 and 16.5 feet below ground surface had a TPH concentration of 332 ppm. Sample S-3 from MW-2 collected between 12.5 and 14 feet below ground surface had a TPH concentration of 338 ppm.

Ecology recommends a draft cleanup guidelines for benzene, toluene, and ethylbenzene-contaminated soil at 0.660 ppm benzene, 143 ppm toluene, and 14 ppm ethylbenzene. No soil samples collected exceeded these guidelines.

Concentrations of acetone were detected in soil of boring MW-4 at 0.096 ppm between 14.5 and 16 feet below ground surface. There is currently not a regulatory cleanup level for acetone in soil. MW-4 is located off-site. Based upon our understanding of site conditions, it does not appear that the Seattle Public Schools site is the source of acetone contamination in the soil. The acetone likely originates from off the site.

GROUNDWATER SAMPLING AND ANALYSIS

Groundwater samples were obtained from five monitoring wells MW-1 through MW-4 and MW-5 (B-1: Earth Consultants) on May 30, 1989. Previous groundwater analyses were performed

by Earth Consultants primarily for TPH. Groundwater samples were analyzed for the following parameters:

Analytical Parameter	Method Number	Number of Samples
Benzene, Toluene, Ethyl-benzene, Total Xylenes (BTEX)	EPA 8020	4
Total Petroleum Hydro-carbons (TPH)	EPA 418.1	5
Total Metals	EPA 6000 series	1
Volatile Organics	EPA 624/8240	2

Our sampling methodology is presented in Appendix A. Analytical data and laboratory certificates are presented in Appendix B.

Groundwater Sampling Procedures

Groundwater from 5 monitoring wells (MW-1, MW-2, MW-3, MW-4, and MW-5 (B-1), were analyzed based on proximity to the sources of contamination and on groundwater flow direction. Prior to sampling, the elevation of each well was surveyed relative to a site datum. The depth to water was measured in each well. The relative well elevations and water level measurements are presented in Appendix A.

Results of Chemical Analysis - Groundwater

Analytical results from the 5 groundwater samples are presented in Table 2. No BTEX compounds were detected in the groundwater samples.

Acetone was observed in the groundwater samples collected from MW-4 (5.7 parts per billion (ppb)) and MW-5 (B-1) (2.9 ppb estimated).

Carbon disulfide and Cis-1,2-Dichloroethene was observed in the groundwater sample from MW-4 at 9.1 ppb and 1.8 ppb, respectively.

TPH concentrations were observed in groundwater samples collected from MW-1 (2.0 ppm) and MW-4 (1.0 ppm).

Total metals analysis indicate the presence of barium in MW-5 (B-1) (0.331 ppm).

Interpretation of Results

Volatile organic results from MW-4 and MW-5 (B-1) indicate the presence of low level volatile organic constituents in the groundwater, hydraulically upgradient (MW-4) and on-site (MW-5, B-1). Levels of these compounds are considered to be low. A confirmatory sample collection and analysis is appropriate. The confirmed concentration of these constituents may prove to be below the level of concern.

Total barium concentration observed is less than the EPAs MCL (Human Health Protection and Drinking Water) criteria.

Ecology recommends a draft cleanup guideline for petroleum-contaminated groundwater at 15 ppm TPH. No groundwater samples exceeded this guideline.

TEST PIT SAMPLING AND ANALYSIS

Seven test pits were excavated. Our sampling and test pit exploration procedures are outlined in Attachment A. Previous test pit exploration and sampling were performed by O'Sullivan Construction Company primarily for BTEX and TPH analyses. Test pit locations were determined following assessment of groundwater gradient and flow direction and field observations (see Figure 2). Each test pit was excavated to groundwater depth which ranged from 9 to 10 feet below ground surface. Immediately after excavating a test pit groundwater seeped into the excavated hole.

Soil samples were collected from each test pit at approximate groundwater depth. Petroleum hydrocarbon odors were evident in TP-1, TP-2, and TP-3. An oily sheen was noted in TP-2 as it filled with water along with a strong gasoline-like odor. Petroleum hydrocarbon odors were detected in test pits TP-4, TP-5, TP-6, and TP-7.

Test pit samples were analyzed for the following parameters:

Analytical Parameter	Method Number	Number of Samples
Benzene, Toluene, Ethylbenzene, Total Xylenes (BTEX)	EPA 8020	3
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	7
EP Toxicity Metals	EPA 1310	1
PCB	EPA 8080	1
Volatile Organics	EPA 624/8240	1

Our sampling methodology is presented in Appendix A. Analytical data and laboratory certificates are presented in Appendix B.

Results of Chemical Analysis - Test Pit Soils

Soil analytical results from the seven test pits (TP-1 through TP-7) are presented in Table 1.

BTEX compounds were detected in soil samples collected from TP-2 (benzene 1.39 ppm, toluene 3.62 ppm, ethylbenzene 2.33 ppm, and total xylenes 7.67 ppm), and possibly TP-1 (compounds found and confirmed by analyst but with low spectral match parameters).

Concentrations of acetone (360 ppb estimated) were found in soil samples from TP-1.

PCBs were not observed in the soil sample from TP-1.

TPH concentrations were observed in soil samples collected from all 7 test pits. TP-1 (7,771 ppm), TP-2 (891 ppm), TP-3 (151 ppm), TP-4 (742 ppm), TP-5 (55 ppm), TP-6 (22 ppm), and TP-7 (50 ppm).

Extractable barium (0.193 ppm) was observed in the soil sample collected from TP-1.

Interpretation of Results

Ecology recommends a draft cleanup guidelines for petroleum contaminated soil at 200 ppm TPH. Soil samples collected from TP-1 (7,771 ppm), TP-2 (891 ppm), and TP-4 (742 ppm) exceeded this guideline.

Ecology recommends a draft cleanup guidelines for benzene, toluene, and ethylbenzene contaminated soil at 0.66 ppm benzene, 143 ppm toluene, and 14 ppm ethylbenzene. Benzene (1.39 ppm) concentrations in the soil sample from TP-2 exceeded this guideline.

Extractable barium concentrations observed are less than the regulatory cleanup levels.

Concentrations of acetone were detected at 360 ppb (estimated). There is currently not a regulatory clean level for this constituent in soil.

CONCEPTUAL REMEDIAL PLAN

A general sequence for remediation of the Seattle Public Schools, 810 Dexter Building site would be to:

- Prepare the site remediation work plan;
- Implement the work plan; and
- Monitor status of remediation.

Prepare Site Remediation Work Plan

The following is an outline of a work plan that would be submitted for review or approval by the Ecology.

This work plan would be in a letter format:

Introduction

- Description of the site
- Pertinent background information

Current Status

- Description of soil and groundwater quality on the site;
- Brief description of what is proposed for cleanup;
- List, in outline form, the general approach.

Communication

- Describe how you are going to communicate project status to Ecology (monthly reports, quarterly reports, etc.); and
- Describe notification procedures if there is a release of petroleum hydrocarbons during remediation activities (line rupture, containment rupture, etc.).

Cleanup Goals

- Describe what are the cleanup goals for soil and groundwater quality; or
- You may want to utilize Ecology's draft policy (August 1988) cleanup guidelines for underground storage tanks.

Scope of Work

A detailed description of the scope of work for remediation of the site.

Health and Safety

Description of how you will provide adequate health and safety for remediation of the site.

Quality Assurance/Quality Control (QA/QC)

- Description of sampling and sample custody procedures; and

- Statement describing analytical QA/QC methods.

Implement the Work Plan (Remedial Measures)

Based upon information from this assessment, the following appears to be an appropriate conceptual remedial strategy for this site:

- Remove standing water and free phase hydrocarbons from the excavation adjacent to MW-5 (B-1) (vacuum truck contractor);

- Perform landfarm treatability study;

- Excavate localized areas of soil around former tank locations which contain concentrations of TPH in excess of 200 ppm and benzene in excess of 660 ppb, toluene in excess of 143 ppm, and ethylbenzene in excess of 14 ppm from areas adjacent to borings B-1, B-2, B-3, and B-4 (Figure 2).

A soil's bioremediation area (landfarm) should be constructed in the southwest corner of the site. Landfarming is the biological treatment of soils in a controlled process which enhances the nature degredation of petroleum hydrocarbon concentrations. Biological treatment of petroleum hydrocarbons has been successfully used for over 30 years by the petroleum industry (American Petroleum Institute, 1983). We anticipate the landfarm will be about 100 feet by 50 feet (for about 500 cubic yards of soil). The size of the landfarm may vary and is dependent upon the quantity of soil excavated.

Landfarming of soils should continue until cleanup goals are achieved.

Monitor Status of Remediation

Concentrations of hydrocarbons in the soils being landfarmed should be monitored on a monthly basis in order to assure adequate remediation.

In addition to bioremediation of petroleum-contaminated soils, the groundwater from wells MW-3 and MW-2 should be retested at a later date in order to confirm that contaminants are not migrating off-site.

The work of this project was performed, and this letter report prepared, using generally accepted professional practices in the same or similar localities, related to the nature of the work accomplished at the time the work was performed. It is for the exclusive use of Seattle Public Schools for specific application to the project site and purpose. No other conditions, express or implied, should be understood.

Sincerely,

HART CROWSER, INC.

SCOTT S. FERRIS
Sr. Project Chemical Engineer

JOHN R. FUNDERBURK III
Associate, Environmental Specialist

SSF/JRF:cmr
LR2486/JOBS

Attachments:

Table 1 - Soil Quality Data
Table 2 - Water Quality Data
Table 3 - Previous Analytical Data
Figure 1 - Site Vicinity Map
Figure 2 - Site Exploration Plan
Figure 3 - Generalized Subsurface Cross Section A-A'
Figure 4 - Generalized Subsurface Cross Section B-B'
Appendix A - Field Methodologies and Sample Collection
Appendix B - Laboratory Analysis Certificates

Table 2 - Water Quality Data

Parameters	MW-1	MW-2	MW-3	MW-4	B-1 (MW-5)
Total Petroleum Hydrocarbons (ppm)	2	<1	<1	1	<1
Volatile Organics (ppm)					
Benzene	<0.01	<0.01	<0.01	<0.01	<0.001
Toluene	<0.01	<0.01	<0.01	<0.01	<0.00008
Ethyl Benzene	<0.01	<0.01	<0.01	<0.01	<0.00008
Total Xylene	<0.01	<0.01	<0.01	<0.01	<0.0018
Acetone	NA	NA	NA	0.0057	0.0029J
Methylene Chloride	NA	NA	NA	0.0008JB	0.0008JB
Carbon disulfide	NA	NA	NA	0.0091	<0.0012
Cis-1,1-Dichloroethene	NA	NA	NA	0.0018	NA
Metals (ppm)					
Barium	NA	NA	NA	NA	0.331

NOTES:

NA - Not analyzed.

J - Indicates an estimated value when result is less than specified detection limit.

B - Indicates that the analyte is found in the blank as well as the sample, thus indicating possible/probable blank contamination.

Detection Limits: Total Petroleum Hydrocarbons - 1 ppm
Benzene, Toluene, Ethyl Benzene, Total Xylenes - 0.01 ppm, except for B-1 (MW-5) sample where detection for Benzene is 1 ppb, 0.8 ppb for Toluene and Ethyl Benzene, and 1.8 ppb for Total Xylene.

Table 3 - Previous Analytical Data (1 & 2)
All concentrations in ppm

Sample Number	Depth in Feet	Total Petroleum Hydrocarbons	Benzene	Toluene	Xylenes Para-	Meta-	Ortho-	
B-2a (TLC)	2.5	5000.00	N/A	N/A	N/A	N/A	N/A	
B-2b (TLC)	12.5	<10	N/A	N/A	N/A	N/A	N/A	
B-2W (EPA 418.1)	12.5	<5	N/A	N/A	N/A	N/A	N/A	
T-1	8.0	294.80	0.04	0.07	1.49	1.65	2.34	Former Gasoline Tank Excavation Sidewalls
T-2	8.0	3.70	<0.01	<0.01	1.12	0.07	<0.01	
T-3	8.0	214.70	0.71	2.89	8.17	7.97	9.98	
T-4	8.0	351.90	0.26	3.95	8.73	8.93	11.41	
B-3 (TLC)	7.5	1000.00	N/A	N/A	N/A	N/A	N/A	
T-5	6.0	81.00	<0.01	<0.01	<0.01	<0.01	<0.01	Former Waste Oil Tank Excavation Sidewalls
T-6	6.0	7452.00	<0.01	<0.01	<0.01	<0.01	<0.01	
TP-A4	12.0	1318.00	BCL	BCL	BCL	BCL	BCL	
B-4 (TLC)	12.5	250.00	N/A	N/A	N/A	N/A	N/A	
B-4W?	12.5	?	?	?	?	?	?	
T-9	10.0	<10	BCL	BCL	BCL	BCL	BCL	Former Heating Oil Tank Excavation Sidewalls
T-10	10.0	242.00	BCL	BCL	BCL	BCL	BCL	
B-1 (TLC)	12.5	2500.00	N/A	N/A	N/A	N/A	N/A	
B-1W (EPA 418.1)	12.5	<4	N/A	N/A	N/A	N/A	N/A	
T-7	10.0	107.50	<0.01	<0.01	0.12	0.25	0.39	Former Regular and Unleaded Gasoline Tank Excavation Sidewalls
T-8	8.0	34.70	0.09	0.32	1.43	5.91	8.10	
T-14	8.0	220.00	BCL	BCL	BCL	BCL	BCL	
TP-A1	10.6	47.00	BCL	BCL	BCL	BCL	BCL	
TP-A2	10.6	217.00	BCL	BCL	BCL	BCL	BCL	
TP-A3	10.6	247.00	BCL	BCL	BCL	BCL	BCL	

Notes: BCL = Below Cleanup Levels for BTEX; N/A = Not Applicable

(1) Earth Consultants, Inc.
(2) O'Sullivan Construction Company

Table 1 - Soil Quality Data

Parameters	MW-1 S-2	MW-1 S-6	MW-2 S-3	MW-2 S-6	MW-3 S-2	MW-3 S-5	MW-4 S-6	MW-4 S-9	TP-1	TP-2	TP-3	TP-4	TP-5	TP-6	TP-7
Total Petroleum Hydrocarbons (ppm)	4	322	338	71	<1	5	6	9	7771	891	151	742	55	22	50
Volatile Organics (ppm)															
Benzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.036	1.39	<0.01	<0.01	NA	NA	NA
Toluene	<0.01	1.03	<0.01	0.53	<0.01	<0.01	<0.01	<0.01	0.280M	3.62	<0.01	<0.01	NA	NA	NA
Ethyl Benzene	<0.01	2.84	<0.01	<0.01	<0.01	<0.01	0.032	<0.01	0.280M	2.33	<0.01	<0.01	NA	NA	NA
Total Xylene	<0.01	6.25	<0.01	<0.01	<0.01	<0.01	0.069	<0.01	0.720M	7.67	<0.01	<0.01	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA	0.096	NA	0.360J	NA	NA	NA	NA	NA	NA
Methylene Chloride	NA	NA	NA	NA	NA	NA	0.014JB	NA	1.200JB	NA	NA	NA	NA	NA	NA
Metals (mg/l)															
Barium	NA	NA	NA	NA	NA	NA	NA	NA	0.193	NA	NA	NA	NA	NA	NA

NOTES:

NA - Not analyzed.

J - Indicates an estimated value when result is less than specified detection limit.

B - Indicates that the analyte is found in the blank as well as the sample, thus indicating possible/probable blank contamination.

M - Indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters.

Detection Limits: Total Petroleum Hydrocarbons - 1 ppm
Benzene, Toluene, Ethyl Benzene, Total Xylenes - 0.01 ppm

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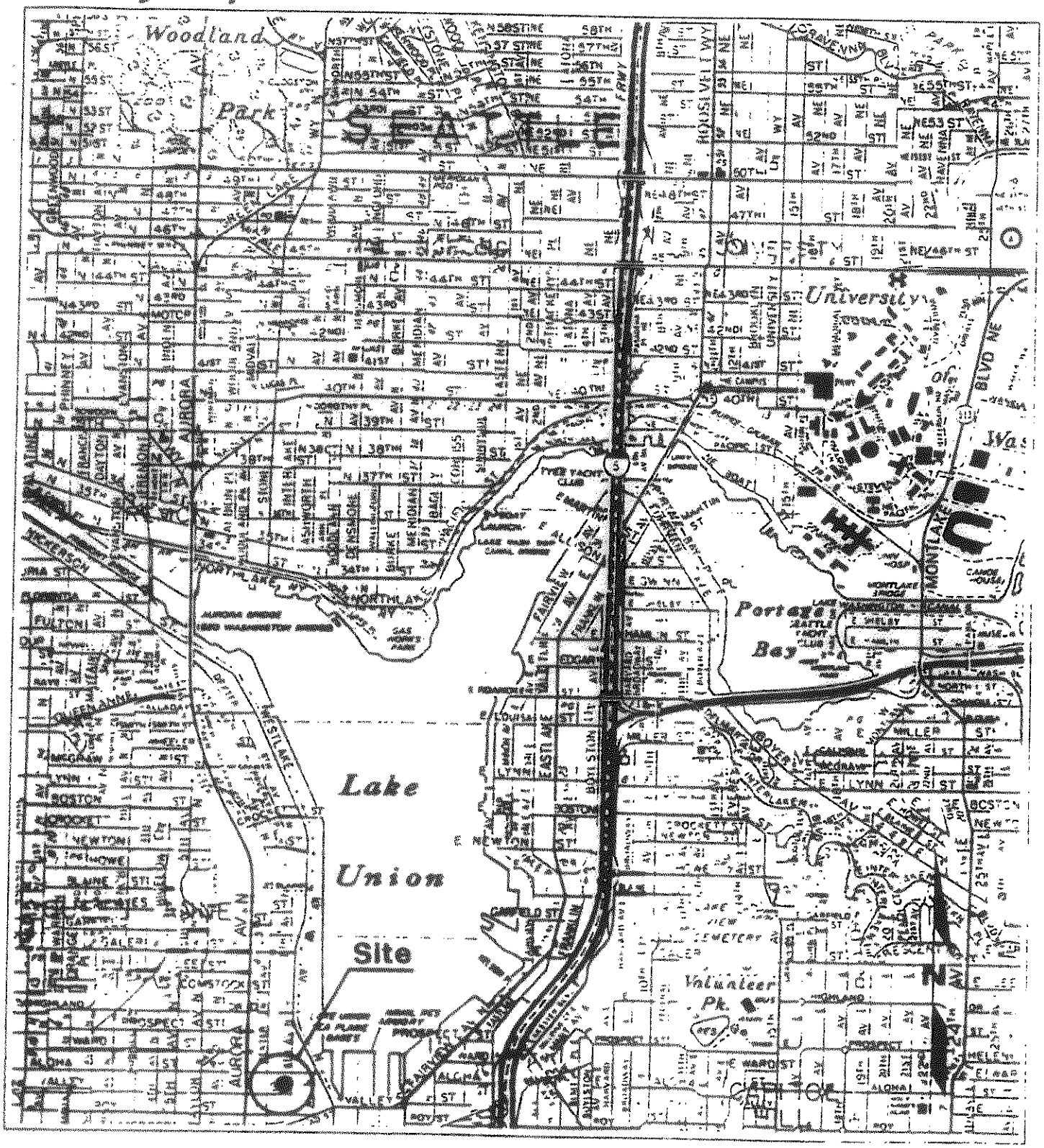
Vicinity Map



0 2000 4000

Scale in Feet

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Figure 1

Site and Exploration Plan

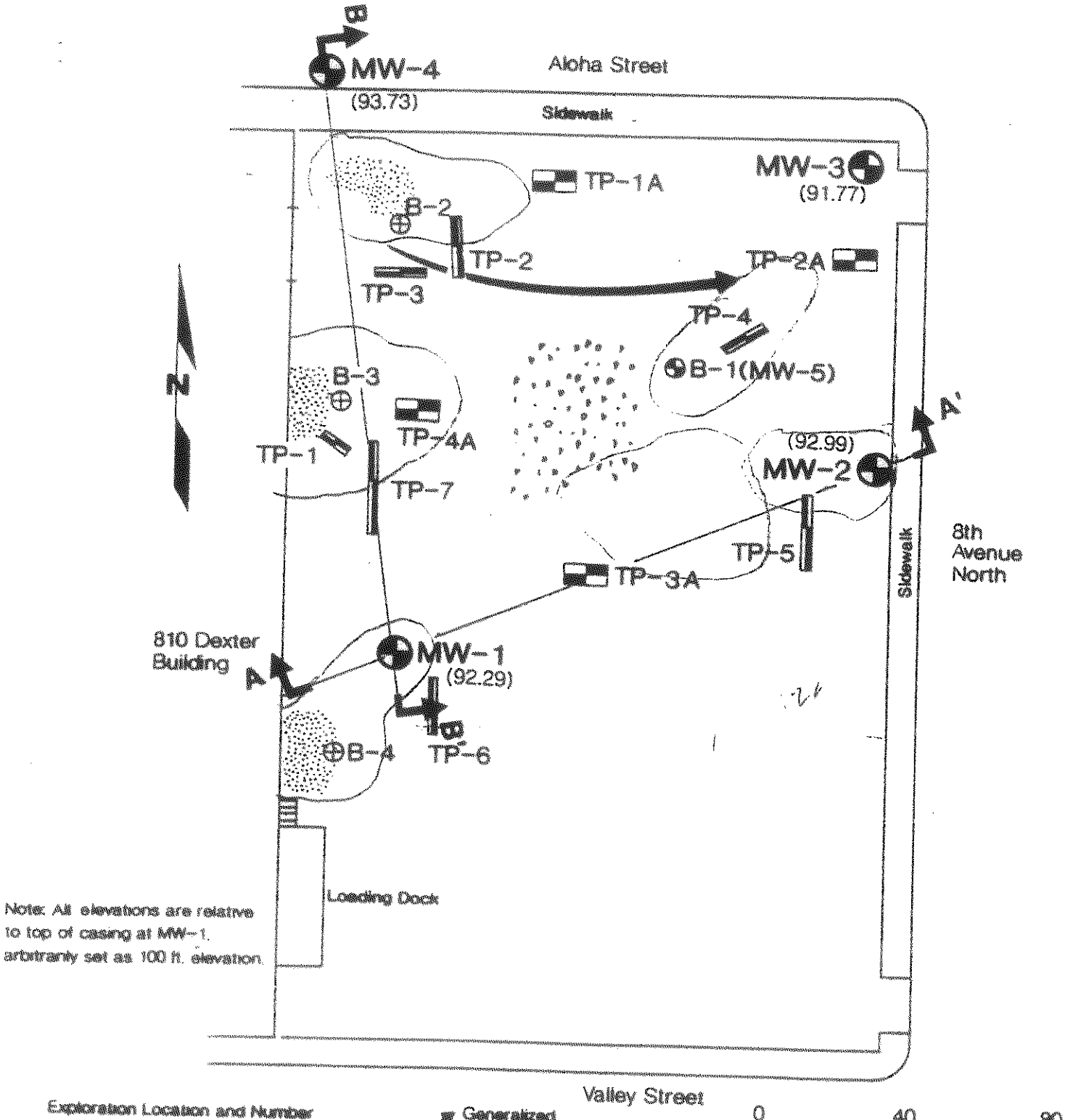

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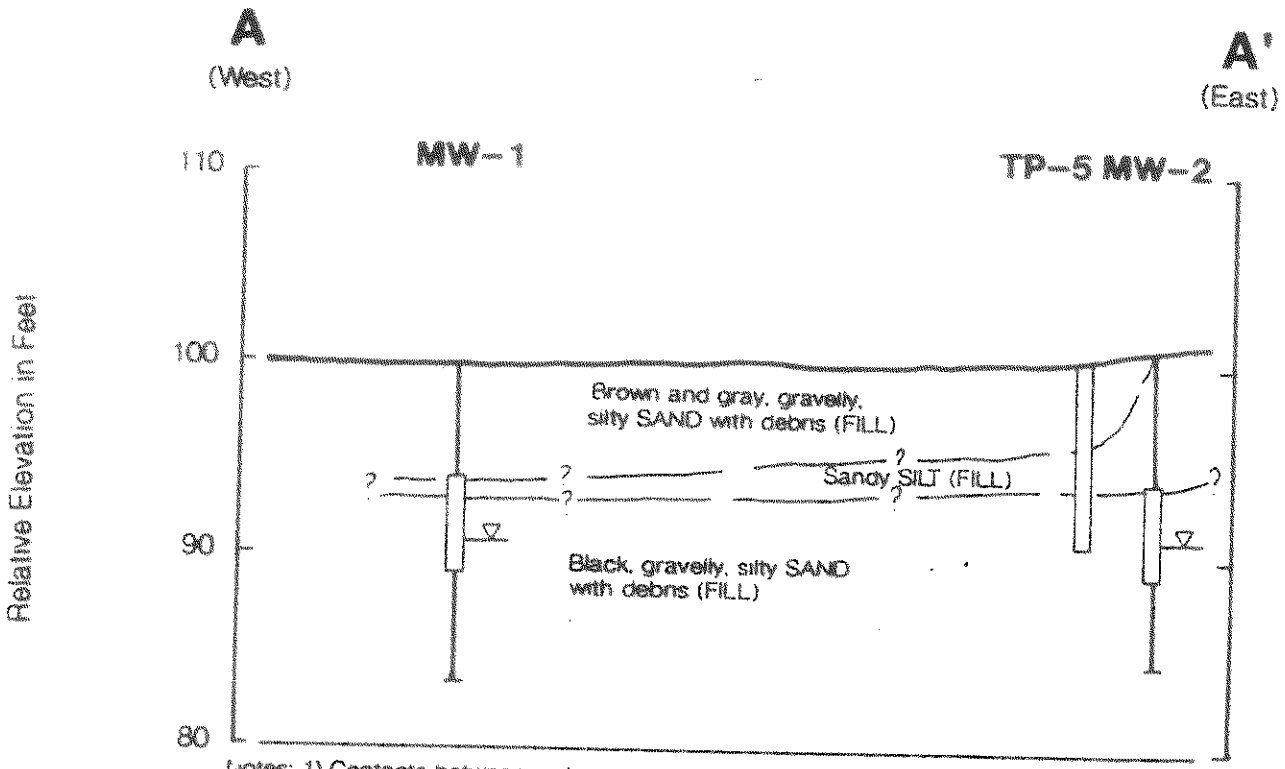
Figure 2

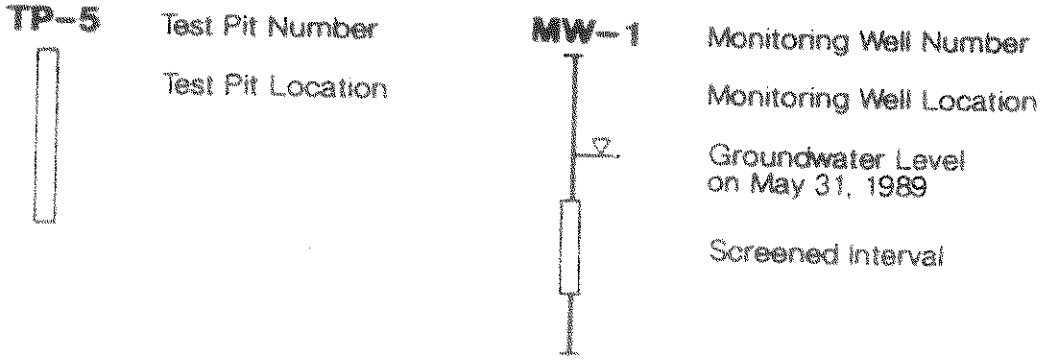
Generalized Subsurface Cross Section A – A'



Notes: 1) Contacts between soil units are based on interpolation between explorations and represent our interpretation of subsurface conditions based on currently available data.

2) See Figure 2 for cross section locations.

3) All elevations are relative to top of casing at MW–1, arbitrarily set as 100 feet elevation



Horizontal Scale in Feet

0 20 40

0 5 10

Vertical Scale in Feet

Vertical Exaggeration x 4

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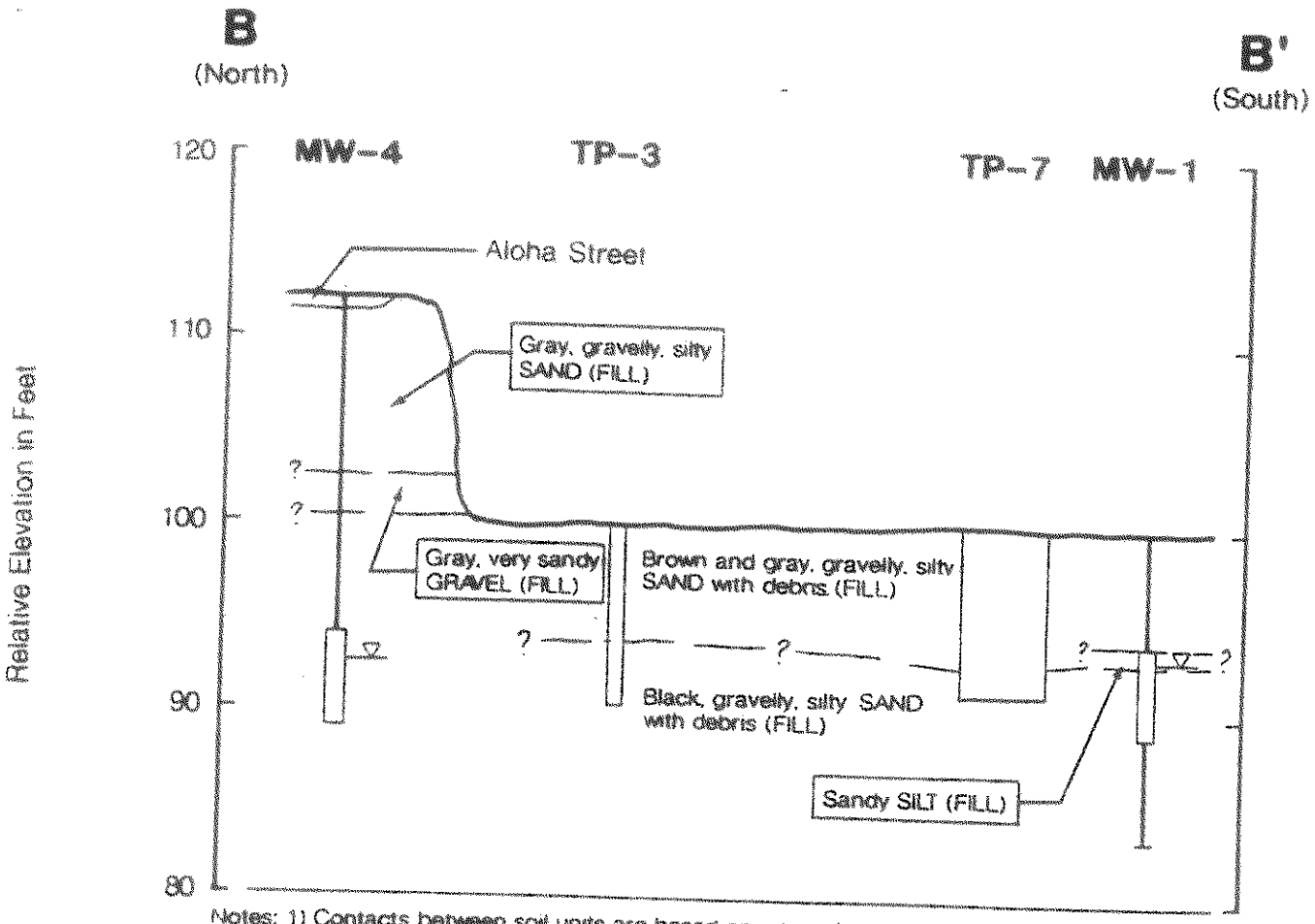
Figure 3

Generalized Subsurface Cross Section B – B'



Notes: 1) Contacts between soil units are based on interpolation between explorations and represent our interpretation of subsurface conditions based on currently available data.

2) See Figure 2 for cross section locations.

3) All elevations are relative to top of casing at MW-1, arbitrarily set as 100 feet elevation

TP-3 Test Pit Number

Test Pit Location

MW-1 Monitoring Well Number

Monitoring Well Location

Groundwater Level on May 31, 1989

Screened Interval

Horizontal Scale in Feet

0 20 40

0 5 10

Vertical Scale in Feet

Vertical Exaggeration x 4

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Figure 4

APPENDIX A
FIELD METHODOLOGIES AND SAMPLE COLLECTION

Hollow-Stem Auger Borings

Four soil borings were drilled on May 24, 1989 and May 25, 1989, by Geoboring and Development, Inc., of Puyallup, Washington. Groundwater monitoring wells were completed in each of the four borings. The borings were advanced using a truck-mounted 4-inch hollow-stem auger. A Hart Crowser geologist observed the drilling and prepared a geologic log for each boring. Interpretive logs and monitoring well construction diagrams are presented on Figures A-2 through A-5. An explanation of the terms and symbols used in these logs is presented on Figure A-1.

Soil Sample Collection: Soil samples were generally collected at 2.5-foot-depth intervals using the Standard Penetration Test procedure described in ASTM D 1857. The procedure involves driving a standard 2-inch outside diameter split-spoon sampler a distance of 18 inches by means of a 140-pound hammer free falling 30 inches. The number of hammer blows required to drive the sampler the last 12 inches is the Standard Penetration Resistance recorded at the respective depths on the boring logs. This resistance provides a measure of the relative density of granular soils (sands and gravels) and the consistency of cohesive fine grained soils (silts and clays). Samples were recovered from the split-spoon samplers and described using the soil classification system presented on Figure A-1.

H-Nu Measurements: A portable H-Nu photoionization detector (PID) was used to perform a field screen for organic vapors in the soil samples. This screen was used to help determine which soil samples would be sent to a certified laboratory for chemical analyses. In performing the field screen, a portion of each soil sample from the split-spoon was retained in a separate glass jar and covered with aluminum foil prior to capping to prevent vapor escape. After the sample had sat for at least 15 to 20 minutes, the H-Nu measurements were taken by pushing the instrument probe through the aluminum foil. The H-Nu probe was equipped with

a 10.2 ev lamp and the instrument was calibrated prior to use.

Test Pit Explorations

Seven test pits, designated TP-1 through TP-7, were excavated across the site with a tractor-mounted backhoe subcontracted by our firm. The sides of these excavated pits offer direct observation of the subsurface soils to depths of approximately 10 feet. The test pits were located by and excavated under the direction of a Hart Crowser geologist. The geologist observed the soil exposed in the test pits and reported the findings on a field log. He also took a single representative sample from each pit for potential further laboratory testing. The water level, if encountered, was also noted on the field log. The test pit logs are presented on Figures A-6 through A-12.

Monitoring Well Installation

Hart Crowser installed a groundwater monitoring well in each of the four soil borings. The wells (MW-1, MW-2, MW-3, and MW-4) were constructed of 2-inch-diameter Schedule 40 PVC with 10-foot sections of 0.020-inch slotted screen. Sand was used to backfill the annulus around the screen to a level approximately two feet above the top of screen. The annulus around the riser pipe was filled with bentonite chips. The four wells have concrete/bentonite surface seals and are protected by tamper-resistant flush-mount steel monuments.

We developed the four monitoring wells using a decontaminated stainless steel bailer to purge approximately 10 well-casing volumes. The wells were developed in order to remove fine-grained material from the well bottom and clear material from the well screen, thus increasing the well's hydraulic connection with the surrounding formation. The bailer was decontaminated after developing each well.

We surveyed the horizontal well locations to within 0.1 foot (relative to structures and property lines) and the well top-of-casing elevations to within the 0.01 foot. The top-of-casing elevations were not surveyed relative to a known elevation. Therefore, the top of casing at MW-1 was given an arbitrary elevation of 100.00 feet and all other

elevations were measured relative to this assumed datum.

Groundwater Sampling

A groundwater sample was collected from each of the four monitoring wells. Prior to sampling, we purged at least three casing volumes from the well. Both purging and sampling were conducted using a decontaminated stainless steel bailer. All filled sample bottles were immediately placed in insulated coolers with frozen blue ice to keep samples cool. At the end of the sampling day, the samples were delivered to the certified laboratory for the appropriate chemical analyses.

Prior to purging and groundwater sampling, depth to water was measured to 0.01 foot accuracy in each of the four wells. The water level elevation was then calculated relative to the arbitrary 100.00 foot elevation at the MW-1 top of casing. Using these four data points, we calculated the generalized shallow groundwater flow direction across the site.

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Water Level Measurements and Elevations - May 31, 1989

Relative Top of Casing Elevation in Feet	Depth to Water Below Top of Casing in Feet	Relative Water Level Elevation in Feet
100.00	7.71	92.29
101.04	8.75	92.29
102.55	10.78	91.77
112.06	18.33	93.73

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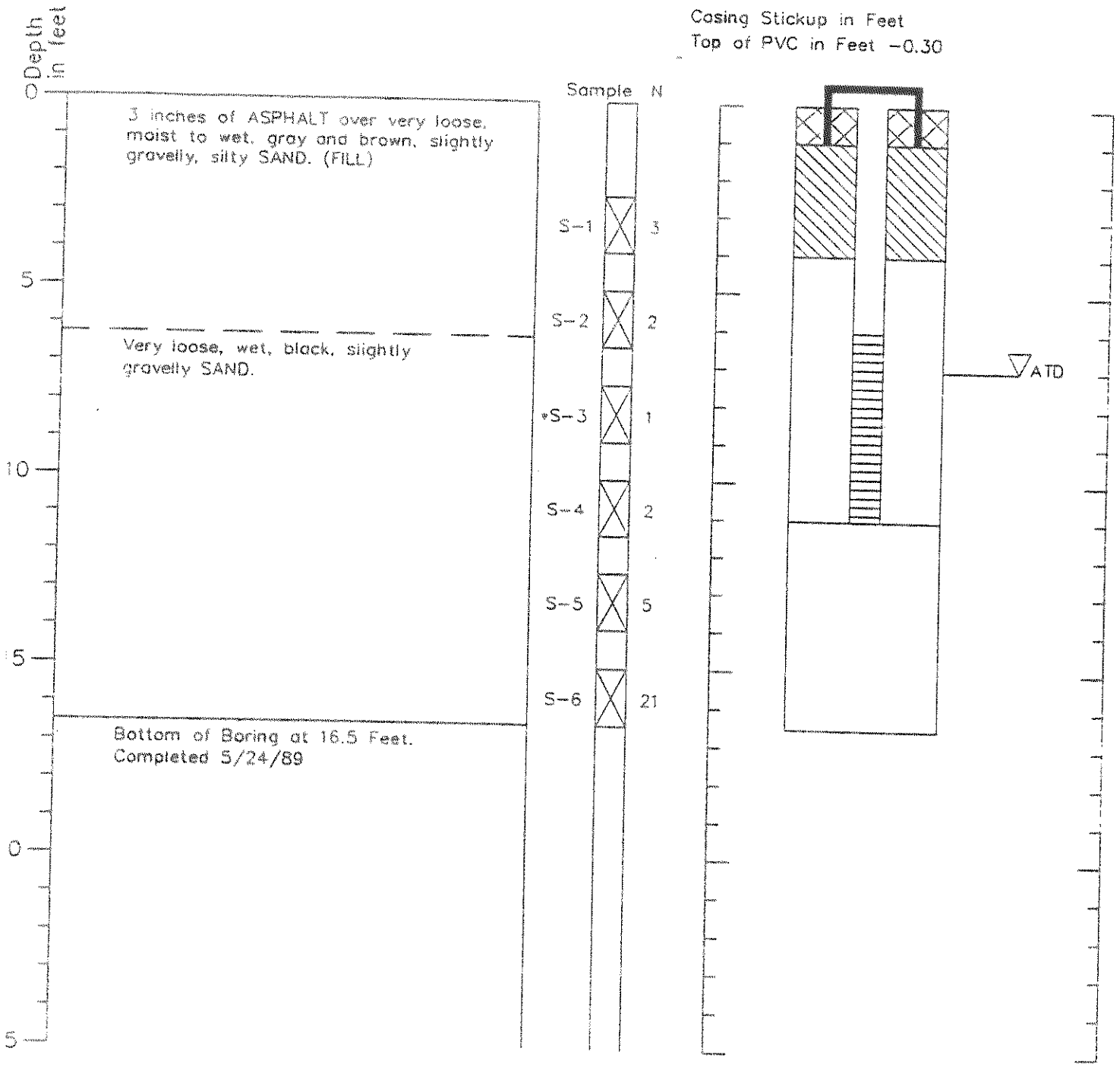
Boring Log and Construction Data for Monitoring Well MW-1

Geologic Log

Monitoring Well Design

Casing Stickup in Feet
Top of PVC in Feet −0.30



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-2

Boring Log and Construction Data for Monitoring Well MW-2

Geologic Log

Monitoring Well Design

Casing Stickup in Feet
Top of PVC in Feet −0.60

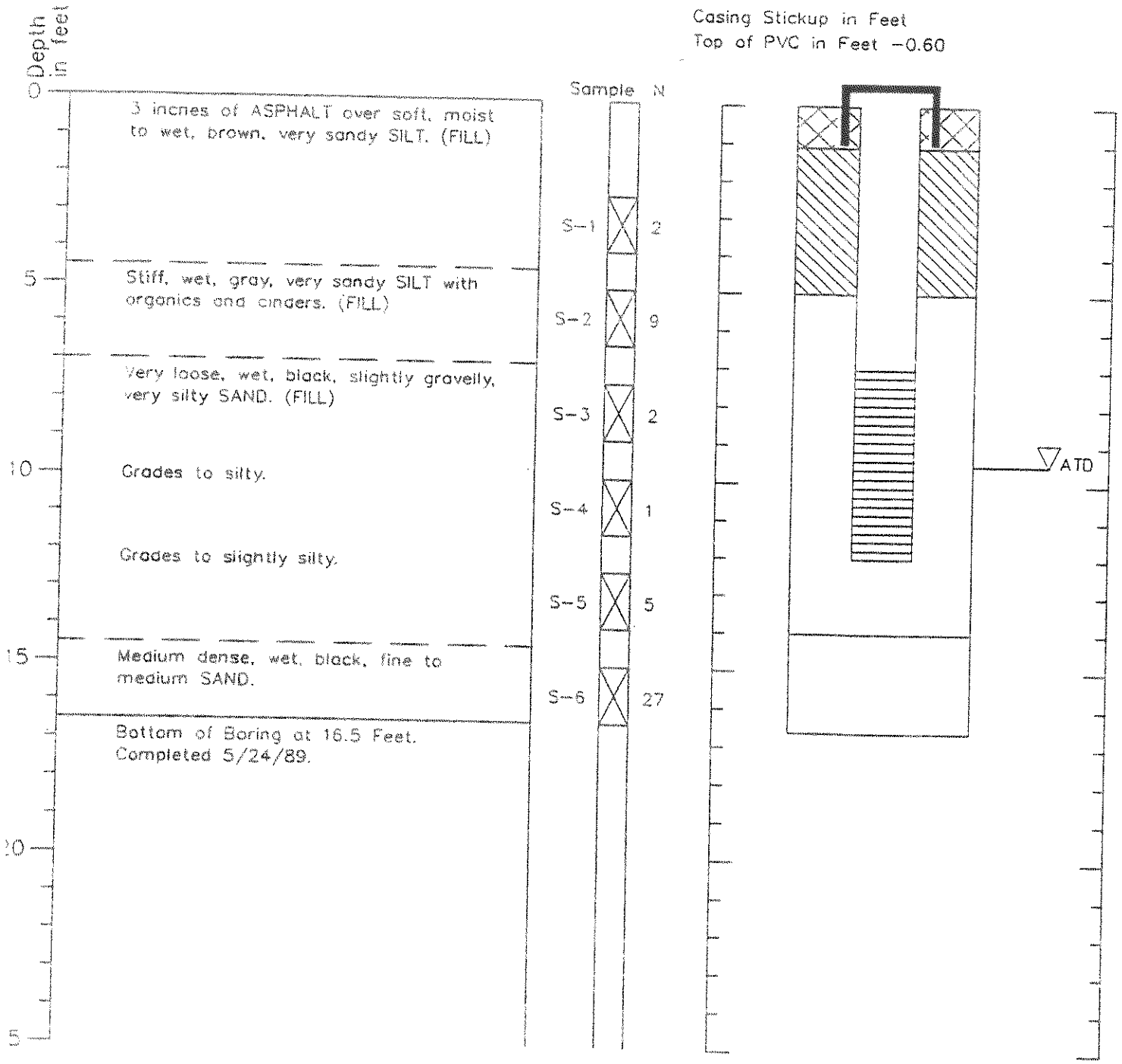

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Figure A-3

Boring Log and Construction Data for Monitoring Well MW-3

Geologic Log

Monitoring Well Design

Casing Stickup in Feet
Top of PVC in Feet −0.30

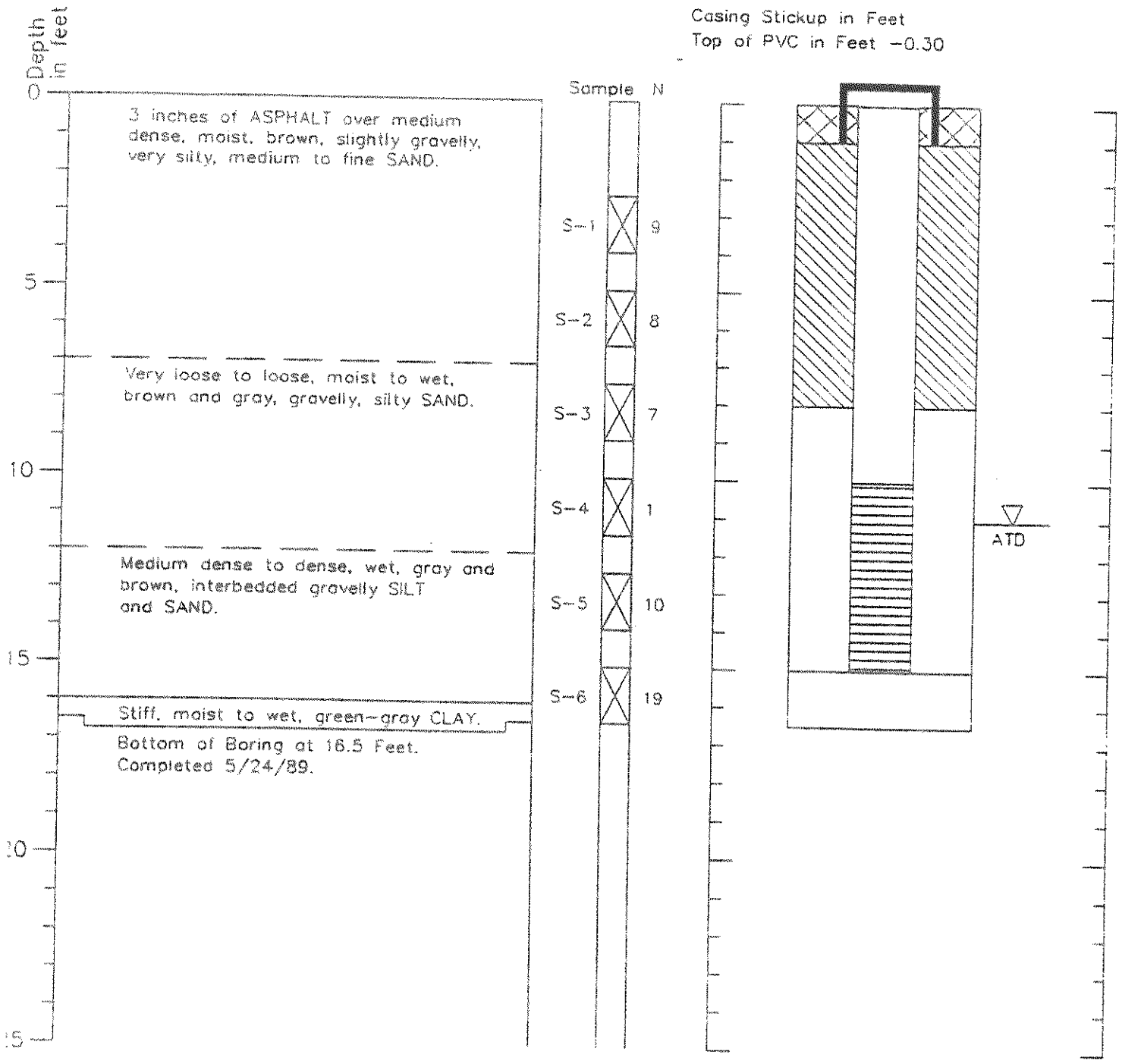

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Figure A-4

Boring Log and Construction Data for Monitoring Well MW-4

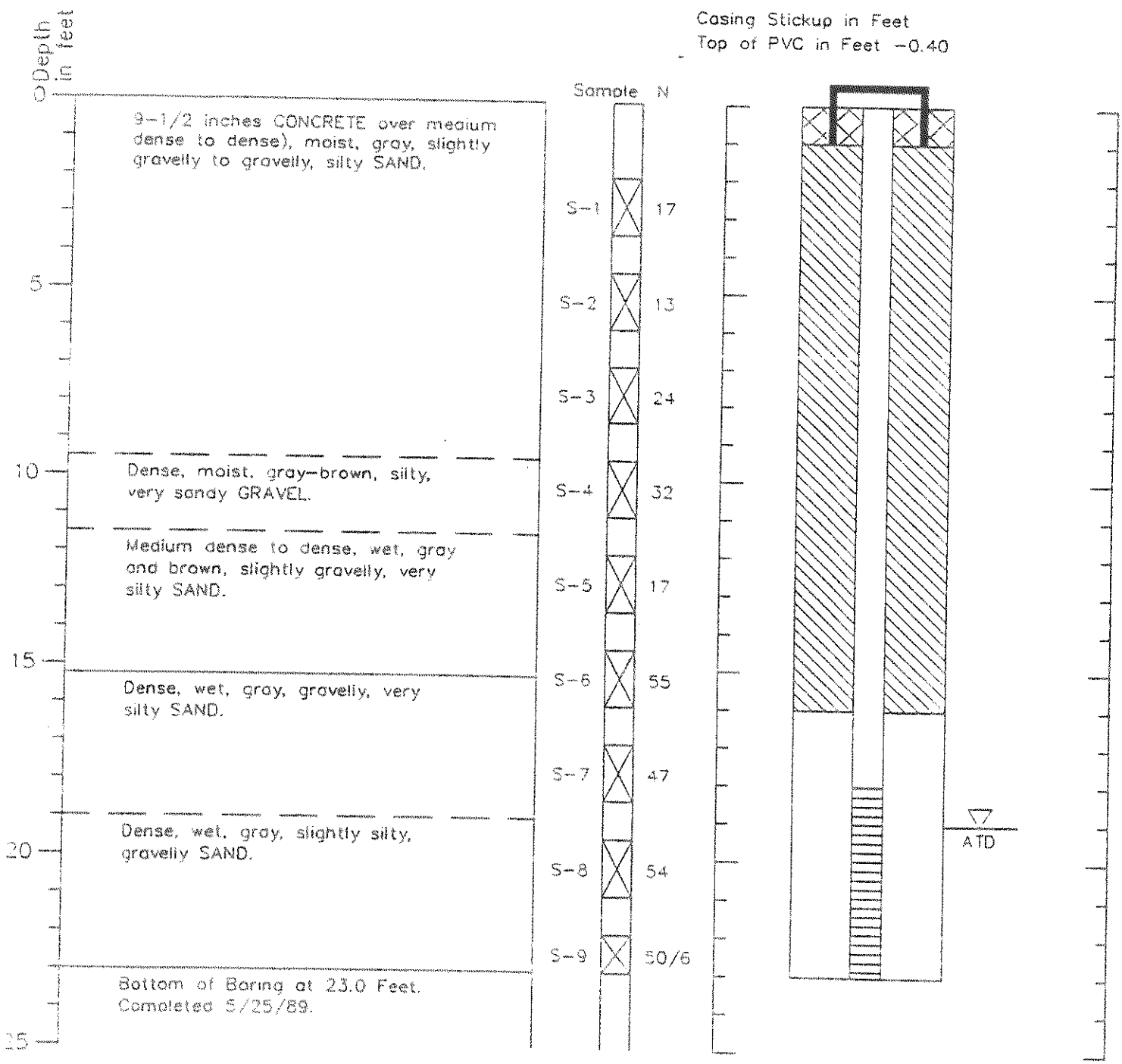

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Figure A-5

Test Pit Log TP-1

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS
			0–2	2 inches of ASPHALT over (loose), damp, gray, sandy GRAVEL.
			2–5	Damp, brown gray, slightly gravelly, silty SAND with mixed rubble, brick, wood, garbage, bones, glass, substantial cinder type material.
			5–8	Some (loose), black–stained FILL.
S–1			8–9½	Light brown SAND. Black–and brown–stained soil.
			9½–15	Bottom of Test Pit at 9–1/2 Feet. Completed 6/6/89. Note: Groundwater seepage encountered at 9–foot depth.

Test Pit Log TP-2

Sample	Water Content in Percent	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS
			0–1	4 inches of ASPHALT over (loose), damp, gray, sandy GRAVEL.
			1–7	(Loose), damp to moist, rust brown to black, slightly gravelly, slightly silty SAND with mixed debris and substantial cinder type material.
S–1			7–9½	(Medium dense), damp, black, slightly gravelly, slightly silty SAND with mixed debris.
			9½–15	Bottom of Test Pit at 9–1/2 Feet. Completed 6/6/89. Note: Strong odor at bottom of test pit. Sheen on water. Groundwater seepage at nine–foot depth.

1. Refer to Figure A–1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at time of excavation. Conditions may vary with time.

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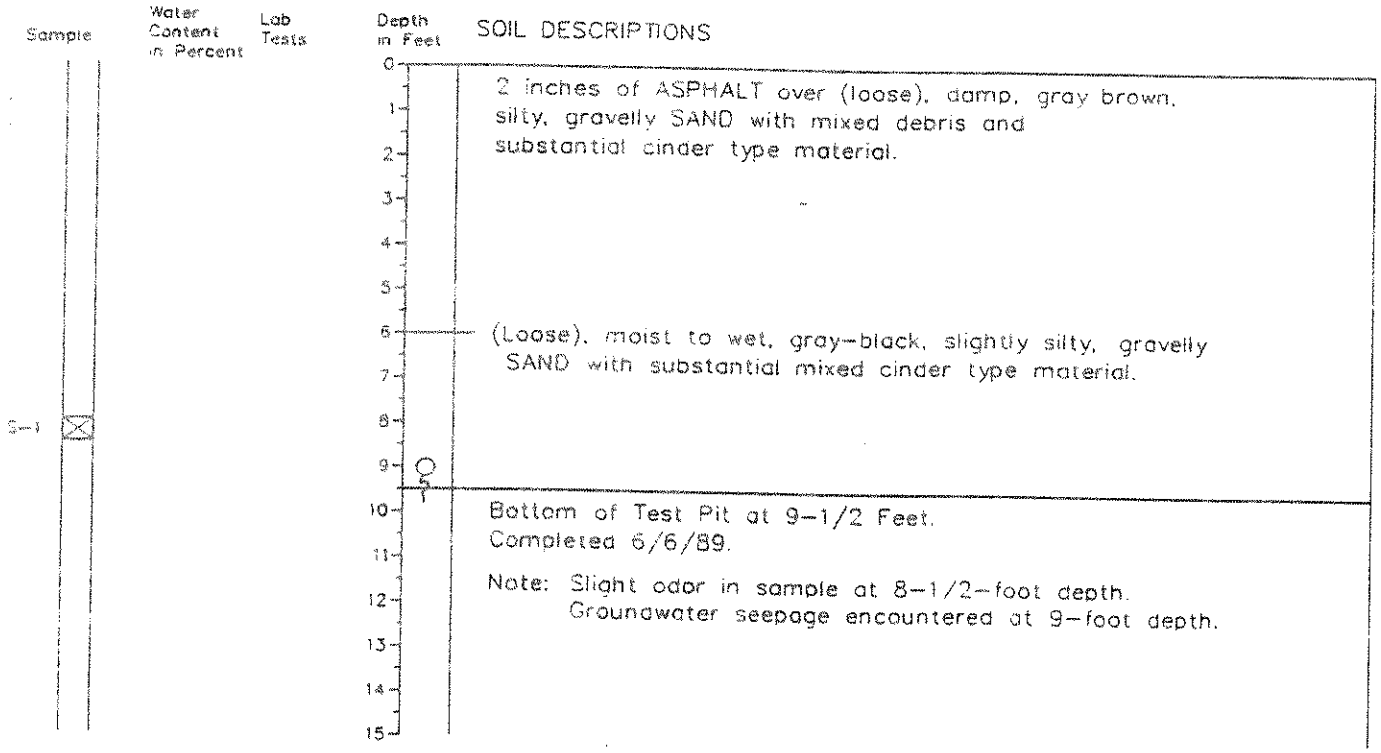
Figure A-6

Test Pit Log TP-3



Test Pit Log TP-4

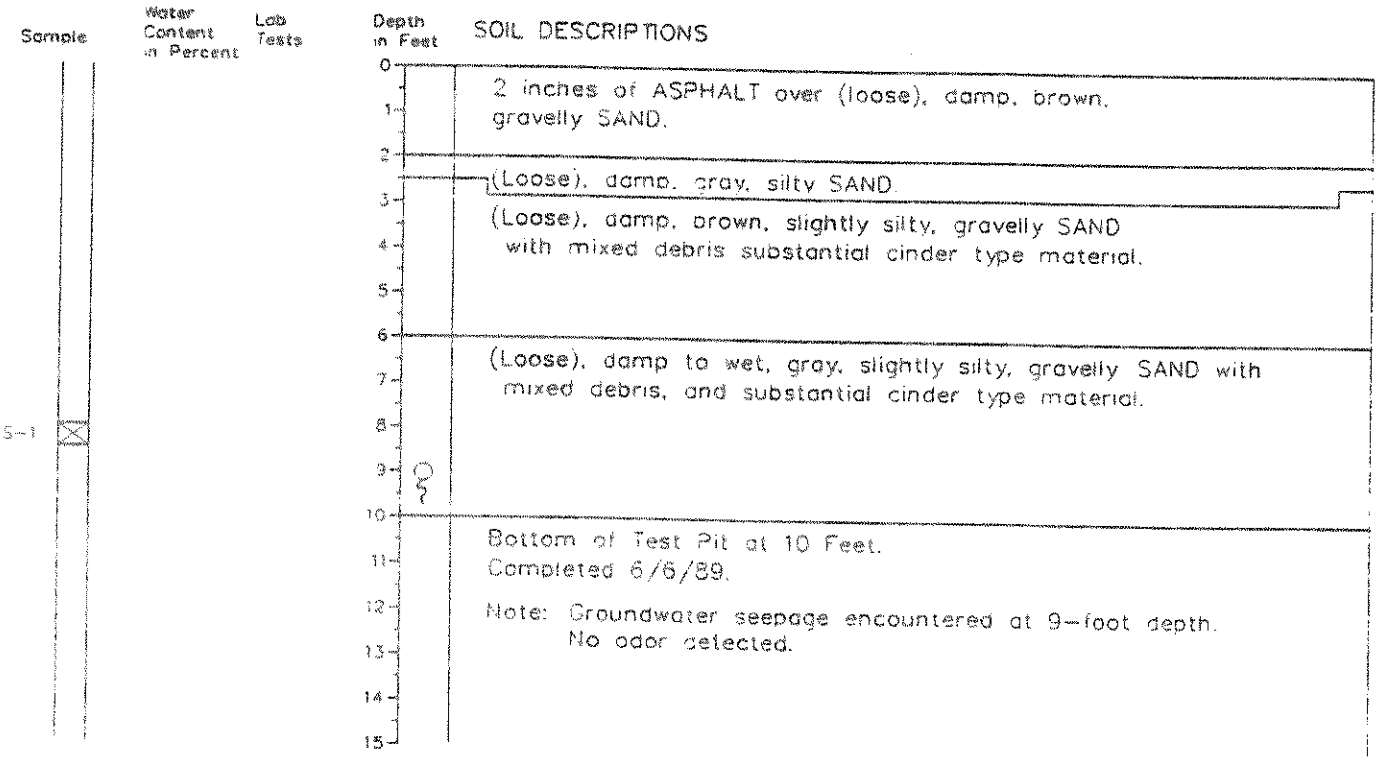


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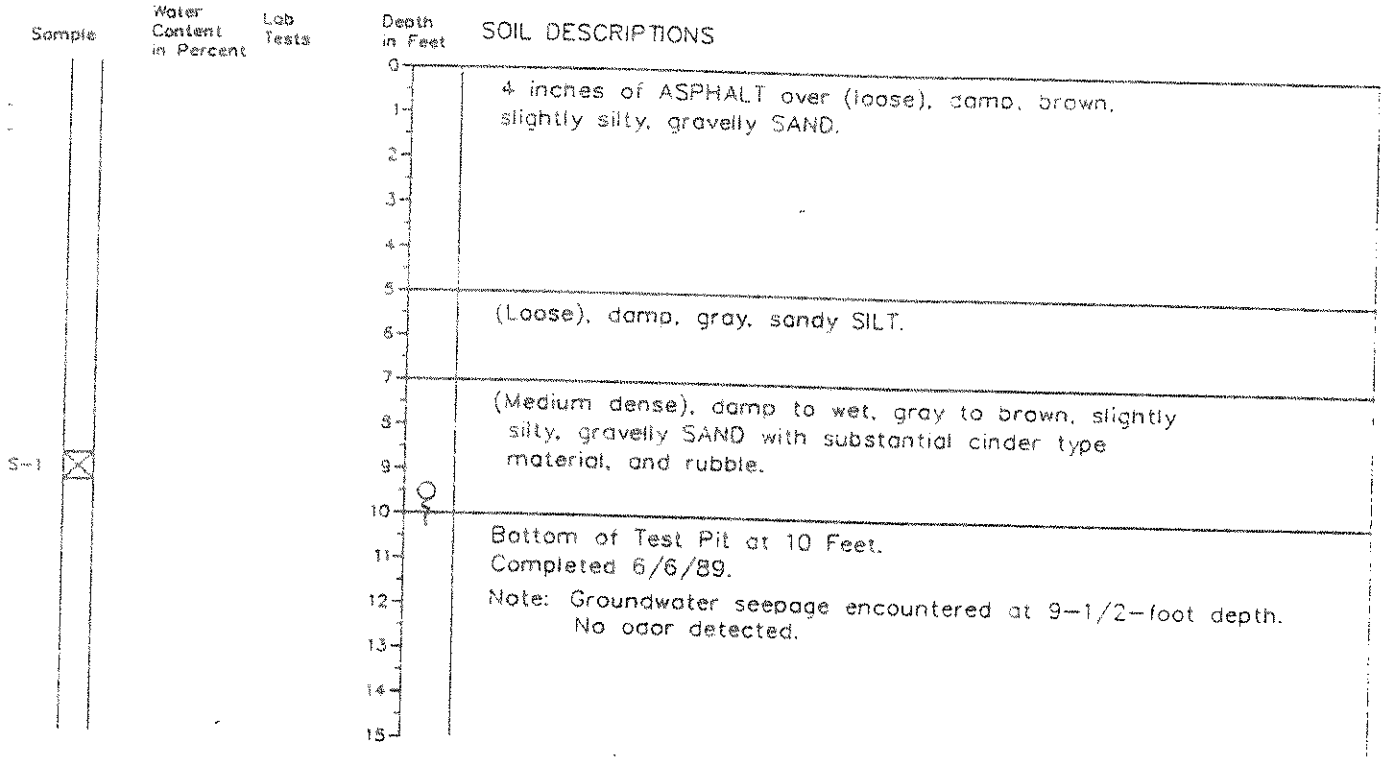
Figure A-7

Test Pit Log TP-5



Test Pit Log TP-6

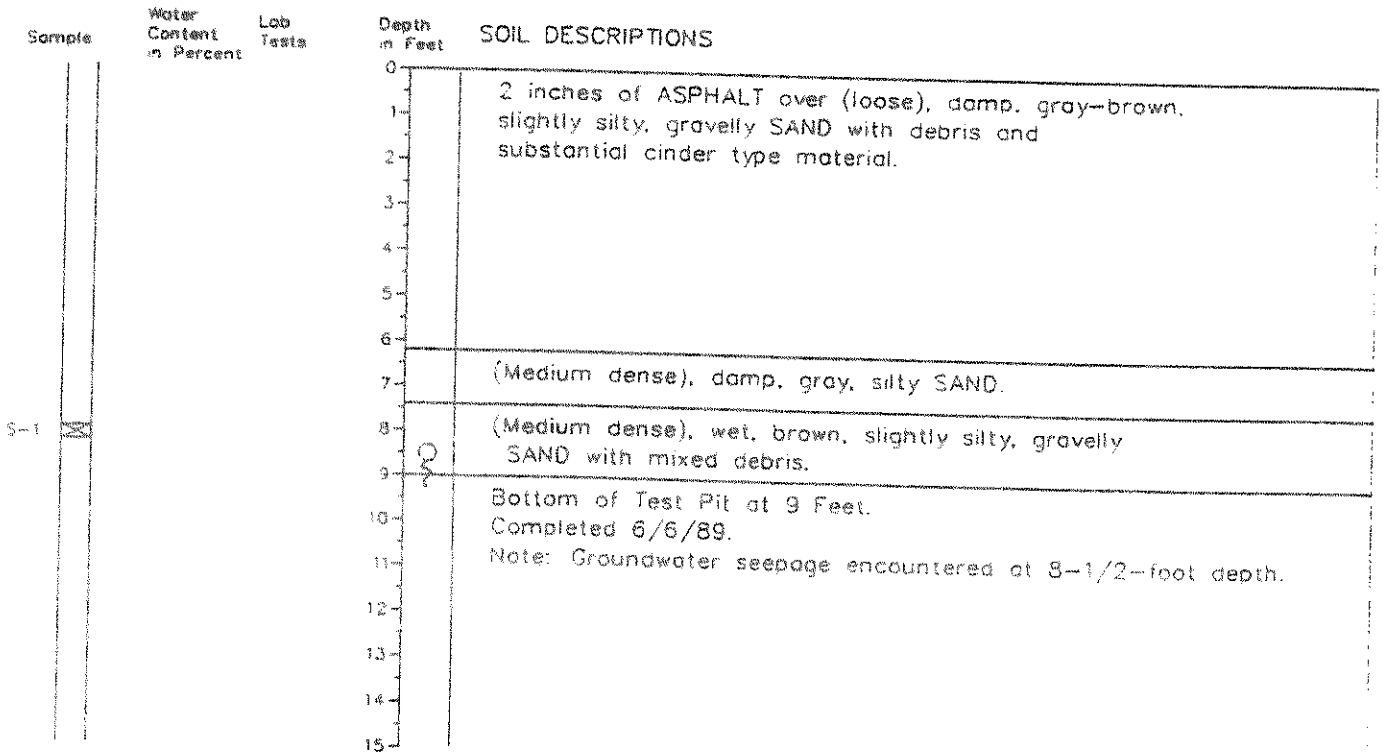


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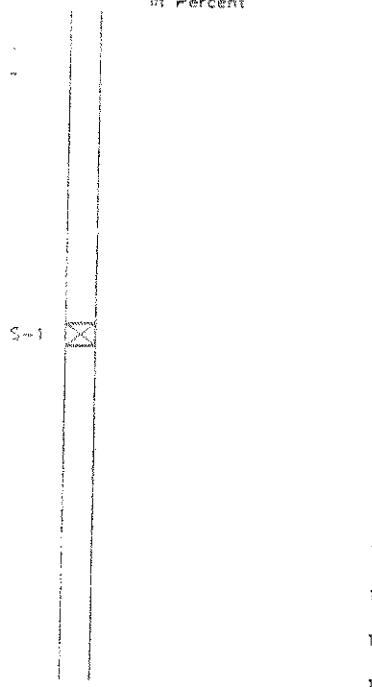
Figure A-8

Test Pit Log TP-7



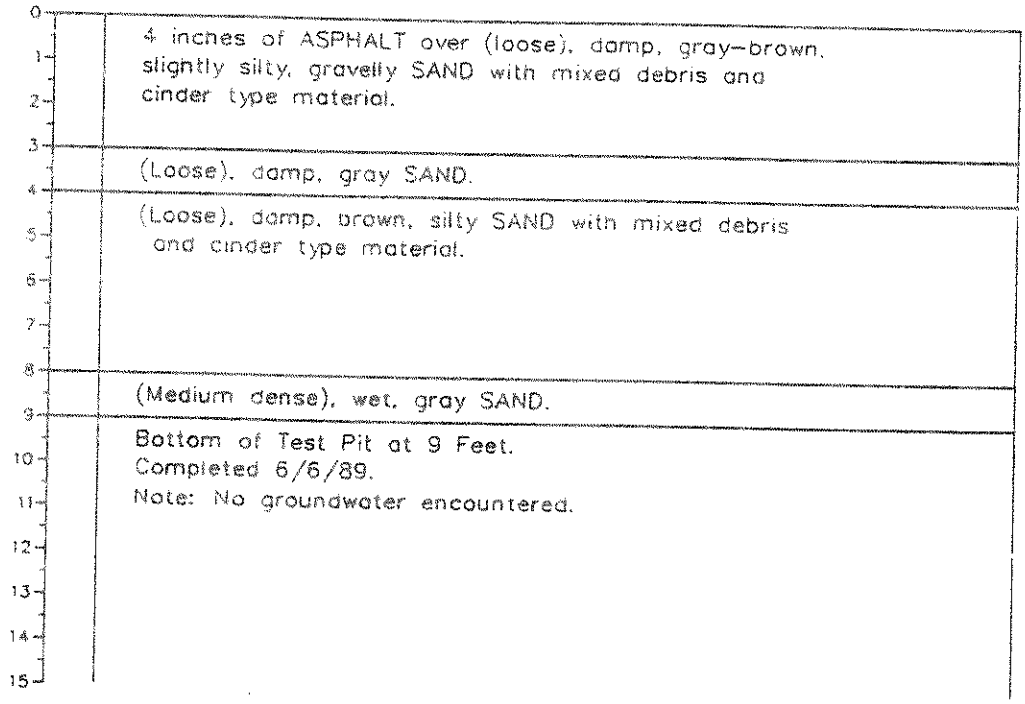


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Figure A-9