SECTION 5

ESI
ECOLOGICAL SERVICES, INC.

P.O. Box 12146, Charlotte, North Carolina 28220

Phone (704) 522-1111
Fax (704) 521-8004

January 18, 1995

Mr. Bobby Lutfy
North Carolina Department of Environment
Health and Natural Resources
P.O. Box 27687
Raleigh, North Carolina 27611-7687

Subject: Hydrogeologic Review and Monitoring Plan
North Mecklenburg Construction and Demolition Landfill
Permit # 60-13
ESI Project No. ES-0675

Dear Mr. Lutfy:

As discussed during our meeting at North Mecklenburg landfill on January 12, 1995, I am providing the following letter to document certain hydrogeologic aspects discussed during the meeting and to provide a monitoring plan for the site.

During our meeting we discussed two primary concerns associated with the subject site:

- The minimum four foot vertical separation between the bottom elevation of solid waste and the seasonal high water table and /or bedrock; and
- The development of an effective groundwater monitoring plan to account for shallow groundwater characteristics at the site.

Given the undulatory nature of the bedrock surface at the subject site and the relatively shallow depth to bedrock identified in soil boring SB-3, the landfill base elevations were revised by Frank Hick's Engineering in order to maintain the appropriate 4 foot minimum separation above this point. Having performed a site walkover during our January 12th meeting, it appears that numerous discontiguous large boulders have been encountered and removed during grading operations at the site. Two 20 foot trenches were advanced during the site walkover to demonstrate the ability to remove cover soil from the Phase II area and to observe soil characteristics at depth. Based on the results of the January 12th meeting and site walkover, it is my understanding that a sufficient comfort level with the current grading plan and the depth to bedrock has been established.

Monitoring well construction details and locations were also reviewed during the January 12th meeting. A summary table of well construction details and depth to water gauging data has been included with this letter to provide a portion of the necessary information required to formulate a monitoring plan for the subject site. A phreatic surface contour map using the latest gauging data has also been included.

Based on the relatively deep screened intervals present in monitoring wells MW-1, MW-4, and MW-6, additional monitoring wells screened at a shallower depth will be required in these areas. A new shallow monitoring well will also be required in the northeastern most corner of the site. The locations of each proposed monitoring well are illustrated on the attached figure.

Following the installation of the new wells, existing monitoring wells MW-2, MW-3, MW-6, and all peizometers will be abandoned in accordance with State guidelines. To provide adequate perimeter monitoring the following wells will be sampling:

- MW-1a (new)
- MW-4a (new)
- MW-4 (existing)
- MW-6 (new)
- MW-8 (existing)
- MW-10 (existing)
- MW-11 (new shallow well in NE corner)

All groundwater samples will be properly preserved and shipped to a North Carolina approved analytical laboratory for chemical analysis as outlined in the attached Solid Waste Section Sampling and Analysis Requirements (Appendix A). Appropriate chain-of-custody records will be maintained during each stage of sample collection and transportation.

At the completion of each semi-annual sampling event, a summary of our field activities, collected data, and laboratory results will be forwarded to the DEHNR-Solid Waste Management in a letter report.

ESI trusts the information provided will meet the remaining requirements for permit approval at the North Mecklenburg Construction and Demolition Landfill. Please do not hesitate to contact me if you have any questions or require additional information.

Sincerely,
ECOLOGICAL SERVICES, INC.

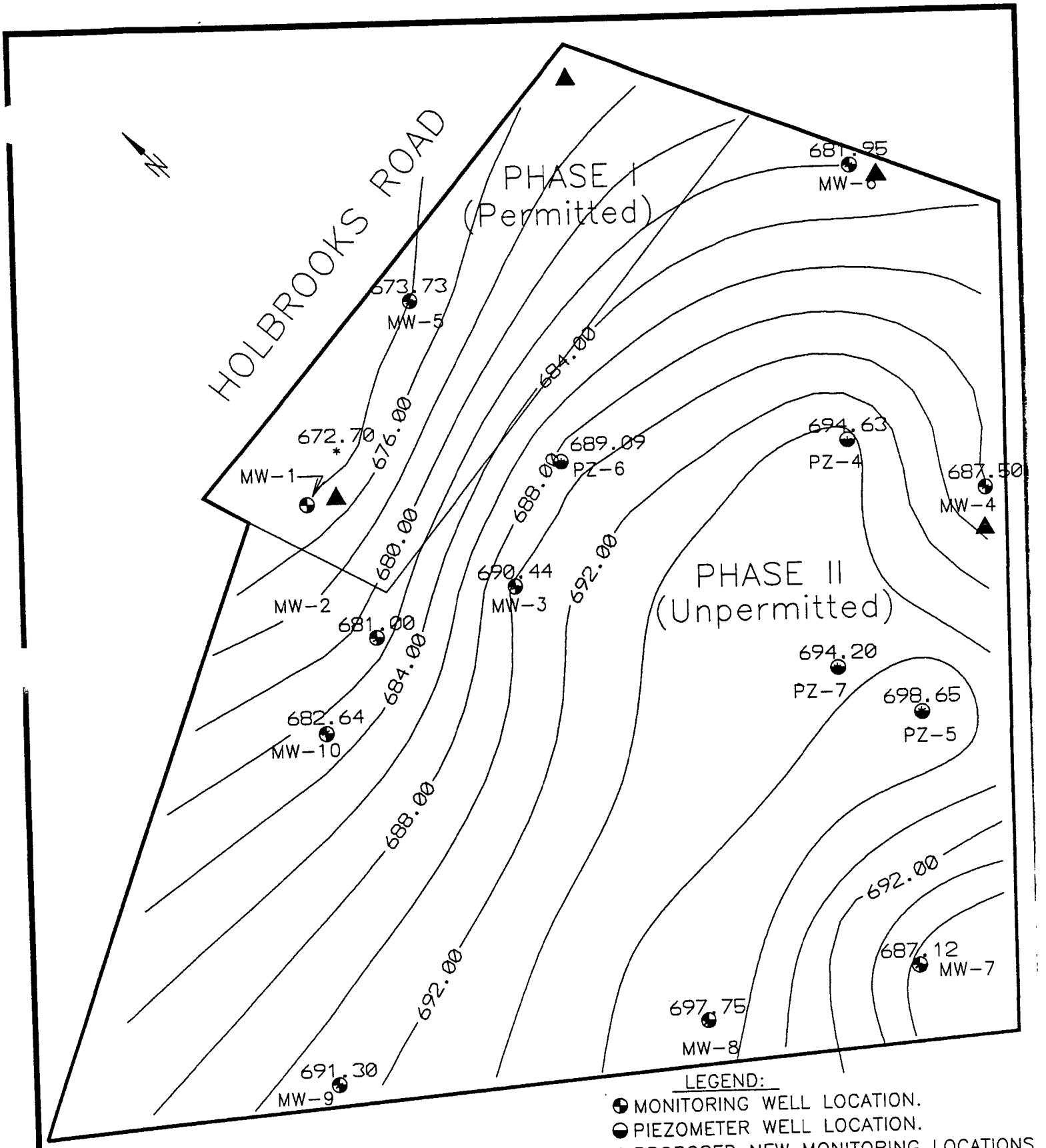
Paul A. Banks
Project Geologist

cc: Mr. Larry Griffin, Sr.
Ms. Janis McHargue

SUMMARY TABLE OF WELL CONSTRUCTION DETAILS AND GAUGING DATA

I.D.	Total Well Depth	Screen Interval	Feb. 10, 94 DTW	May 5, 94 DTW	May 27, 94 DTW	Jan. 13, 95 DTW
MW-1	40	25-40	14.61	NG	NG	15.00
MW-2	19	9-19	13.59	12.4	16.8	10.00
MW-3	53	38-53	16.96	14.58	17.57	16.00
MW-4	97	65-90	28.99	28.95	29.22	30.50
MW-5	55	40-55	NG	NG	NG	27.50
MW-6	98	78-98	58.59	58.15	50.15	58.67
MW-7	83	63-83	51.36	50.93	50.91	51.50
MW-8	80	60-80	69.71	69.42	69.45	69.50
MW-9	22	12-22	18.73	18.42	18.92	17.80
MW-10	19	9-19	11.85	12.2	11.01	10.00

NG = Not Gauged
Shaded piezometers are abandoned



LEGEND:

- MONITORING WELL LOCATION.
- PIEZOMETER WELL LOCATION.
- PROPOSED NEW MONITORING LOCATIONS

NOTE: Gauging Data Obtained on Jan. 13, 1995

DATE: 01-19-95
SCALE: 1" = 200'
DWG. NO.: NMECKLET

ESI

PHREATIC SURFACE MAP AND
PROPOSED MONITORING LOCATIONS
N. MECK. LANDFILL
HUNTERSVILLE, NC

APPENDIX A
Sampling and Analysis Requirements

SAMPLING AND ANALYSIS REQUIREMENTS
N.C. SOLID WASTE SECTION

AB CERTIFICATION REQUIREMENTS:
he Solid Waste Section now requires water quality sample analysis y a laboratory certified by the Division of Environmental anagement for groundwater analysis (15A NCAC 2H .0800). The aboratories used for water quality analysis for Solid Waste ection facilities shall be certified under the Division of nvironmental Management (DEM) Certification program for the pproved methods and at the approved levels of certification.

ANPLING ANALYTICAL METHODS AND REPORTING LIMITS:
ach parameter on the following constituent list shall be certified t the designated level and an appropriately certified method used or the sample analysis. The data shall be reported at the pecified Practical Quantitation Limit (PQL).

Parameter	Certification by DEM	PQL in ppb
Arsenic	Metals, Group I - low level	10
Barium	Barium (20)	500
[illegible]nium	Metals, Group I - low level	1
[illegible]omium	Metals, Group I - low level	10
Lead	Metals, Group I - low level	10
Mercury	Metals (21)	1
Selenium	Metals, Group I - low level	20
Silver	Metals, Group II - low level	10

Volatile Organic Compounds
For the parameters and PQLs required for volatile organic compound analysis, refer to the next page of this attachment. For volatile organic analysis the laboratory shall be certified for an SW-846 GC/MS Method (8240 or 8260). The recommended method of analysis is EPA Method 8260.

SAMPLING AND ANALYSIS:
In addition to sampling for the constituents referenced above, all sampling should also include field testing of pH, temperature, and specific conductivity. EPA requires analysis for total metals. No filtering of samples is allowed. The 3030C preparation method for metals analysis is not allowed.

VOLATILE ORGANIC COMPOUNDS

ANIC TUENT	PQL (UG/L)	ORGANIC CONSTITUENT	PQL (UG/L)
ACETONE	100	(40) T-1,3-DICHLOROPROPENE	10
ACRYLONITRILE	200	(41) ETHYLBENZENE	5
BENZENE	5	(42) METHYL BUTYL KETONE	50
BROMOCHLOROMETHANE	5	(43) METHYL BROMIDE	10
BROMODICHLOROMETHANE	5	(44) METHYL CHLORIDE	10
BROMOFORM	5	(45) METHYLENE BROMIDE	10
CARBON DISULFIDE	100	(46) METHYLENE CHLORIDE	10
CARBON TETRACHLORIDE	10	(47) MEK; 2-BUTANONE	100
CHLOROBENZENE	5	(48) METHYL IODIDE	10
CHLOROETHANE	10	(49) METHYL ISOBUTYL KETONE	100
CHLOROFORM	5	(50) STYRENE	10
CHLORODIBROMOMETHANE	5	(51) 1,1,1,2-TETRACHLOROETHANE	5
CPBCP	25	(52) 1,1,2,2-TETRACHLOROETHANE	5
THYLENE DIBROMIDE	5	(53) TETRACHLOROETHYLENE	5
-DICHLOROBENZENE	5	(54) TOLUENE	5
HLOROBENZENE	5	(55) 1,1,1,-TRICHLOROETHANE	5
1,4-DICHLORO-2-BUTENE	100	(56) 1,1,2-TRICHLOROETHANE	5
-DICHLOROETHANE	5	(57) TRICHLOROETHYLENE	5
THYLENE DICHLORIDE	5	(58) CFC-11	5
NYLIDENE CHLORIDE	5	(59) 1,2,3-TRICHLOROPROPANE	15
-1,2-DICHLOROETHENE	5	(60) VINYL ACETATE	50
,2-DICHLOROETHENE	5	(61) VINYL CHLORIDE	10
OPYLENE DICHLORIDE	5	(62) XYLENES	5
-1,3-DICHLOROPROPENE	10		

OWN AS: (21)-TRIBROMOMETHANE, (25)-ETHYL CHLORIDE, (26)-TRICHLOROMETHANE,
OMOCHLOROMETHANE, (28)-1,2-DIBROMO-3-CHLOROPROPANE, (29)-1,2-DIBROMOETHANE,
ICHLOROBENZENE, (31)-1,4-DICHLOROBENZENE, (33)-ETHYLIDENE CHLORIDE,
CHLOROETHANE, (35)-1,1-DICHLOROETHENE (ETHYLENE), (36)-CIS-1,2-DICHLOROETHYLENE,
S-1,2-DICHLOROETHYLENE, (38)-1,2-DICHLOROPROPANE, (42)-2-HEXANONE, (43)-BROMOMETHANE,
ROMETHANE, (45)-DIBROMOMETHANE, (46)-DICHLOROMETHANE, (47)-METHYL ETHYL KETONE,
METHANE, (49)-4-METHYL-2-PENTANONE, (53)-TETRACHLOROETHENE, PERCHLOROETHYLENE,
TYLCHLOROFORM, (57)-TRICHLOROETHENE, (58)-TRICHLOROFLUOROMETHANE

SECTION 6

ESI
ECOLOGICAL SERVICES, INC.

P.O. Box 12146, Charlotte, North Carolina 28220

Phone (704) 522-1111
Fax (704) 521-8004

December 22, 1994

Ms. Janis D. McHargue
North Carolina Department of Health,
Environment and Natural Resources
585 Waughtown Street
Winston-Salem, North Carolina 27107-2241

Subject: Hydrogeologic Considerations Response
(justifications in response to DEHNR December 16, 1994 Memorandum letter)

Dear Ms. McHargue:

Ecological Services, Inc. (ESI), on behalf of Mr. Larry Griffin, offers the following in response to additional hydrogeologic considerations outlined in Jim Bateson's December 16, 1994 memorandum.

Groundwater Monitoring Well MW-2

In order to accommodate ground surface elevation increases around monitoring well MW-2, 10 feet of 2-inch PVC riser was added to the existing monitoring well. In turn, the elevation of the top of casing was increased from 681.00 feet to 691.00 feet. Furthermore, all depth to water elevation data collected during the May gauging events were adjusted to accommodate the additional riser section. Ground surface elevation increases around monitoring well MW-2 were necessary during the holding pond construction. It is ESI's understanding that no grading or surface cover removal associated with the land fill operations will be conducted in this area.

As noted in ESI's November 18, 1994 Hydrogeologic Considerations Response letter, anomalous depth to water levels noted in MW-2 are thought to be due to recharge from the adjacent holding pond. Just as storm events contribute to the projected base flow of a stream, storm events which influence the water level in the holding pond are expected to contribute to the monitoring well in a similar fashion.

Based on the above, ESI maintains that the originally modeled phreatic surface map, constructed from gauging data collected on May 27, 1994 is an accurate depiction of piezometric surface conditions at the site.

Proposed Monitoring Plan

ESI recommends that a groundwater monitoring program be implemented following the Phase II permitting of the subject site. To ensure adequate site coverage, ESI proposes that the following groundwater monitoring well locations should sampled:

Site Monitoring Points
- MW-4 (deep monitoring point near Council well)
- MW-3
- MW-9
- MW-10
- PZ-6

**Monitoring well construction information is included as Appendix A*

Water levels will be measured prior to each sampling event with an oil/water interface probe to determine groundwater elevation. The monitoring wells will then be purged by bailing or pumping at least 4 times the water volume within the well, including the sand pack, or to dryness. After allowing each well to recover at least 60% of the initial head, or 24 hours, whichever occurs first, the monitoring well will be sampled using disposable approved sampling bailers. At the time the water samples are collected from the wells, pH, temperature, and specific conductivity will be recorded in the field to ensure that representative groundwater is being obtained for chemical analysis. One field blank sample will be obtained in the field by pouring distilled water into a sampling bailer and then decanting the contents of the bailer into the appropriate glass container. A laboratory trip blank will also accompany the groundwater samples.

All groundwater samples will be properly preserved and shipped to a North Carolina approved analytical laboratory for chemical analysis as outlined in the attached Solid Waste Section Sampling and Analysis Requirements (Appendix B). Appropriate chain-of-custody records will be maintained during each stage of sample collection and transportation.

At the completion of each semi-annual sampling event, a summary of our field activities, collected data, and laboratory results will be forwarded to the DEHNR-Solid Waste Management in a letter report.

Sincerely,
ECOLOGICAL SERVICES, INC.

Paul A. Banks
Project Geologist

cc: Jim Bateson

SECTION 7

ES675

ESI
ECOLOGICAL SERVICES, INC.

P.O. Box 12146, Charlotte, North Carolina 28220

Phone (704) 522-1111
Fax (704) 521-8004

November 18, 1994

Ms. Janis D. McHargue
North Carolina Department of Health,
Environment and Natural Resources
8028 North Point Blvd., Suite 100
Winston-Salem, North Carolina 27106

Subject: Hydrogeologic Considerations Response
(justifications in response to DEHNR November 7, 1994 letter)

Dear Ms. McHargue:

Ecological Services, Inc. (ESI), on behalf of Mr. Larry Griffin, offer the following justifications in responce to the noted hydrogeologic considerations outlined in your November 7, 1994 letter.

Long-term seasonal high water table levels -

Upon the submission of the ESI September 1, 1994 Report of Hydrological Assessment Addendum, ESI had compiled groundwater gauging data from February 10, 1994, May 5, 1994, and May 27, 1994. Additional gauging data of select monitoring wells was collected during in-situ permeability testing on November 9, 1994. The compilation of this data represents gauging data collected in the first, second, and fourth quarters of this year. Although gauging data was not collected during the third quarter, ESI considers this period to be a representative trend for seasonal ground water fluctuations. ESI has constructed a hydrograph of depth to water measurements for groundwater monitoring wells MW-7, MW-8, and MW-10 from gauging data collected during the previously mentioned gauging events (Figure 1). In May, wells MW-7 and MW-8 showed an increase in water table recharge which is typical for this time of year. Fourth quarter monitoring (November) indicates a seasonal low for well MW-7. The maximum change in depth to water levels within these wells is 1.65 feet.

In-situ determination of hydraulic conductivity in bedrock -

In order to better characterize the hydraulic conductivity within the bedrock zone at the subject site, ESI conducted a permeability test on monitoring well MW-7. The Bouwer and Rice (1976) Method was used, assuming a partially penetrating screen and a radius which included the sand pack. The hydraulic conductivity calculated for monitoring well MW-7 is (9.42×10^{-6} cm/sec). Appendix A contains a graph of the in-situ permeability test and the calculations used.

In-situ determination of hydraulic conductivity in partially weathered rock -

In order to better characterize the hydraulic conductivity within the partially weathered rock zone at the subject site, ESI conducted additional permeability tests on monitoring wells MW-9 and MW-10. The Bouwer and Rice (1976) Method was used, assuming a partially penetrating screen and a radius which includes the sand pack. The hydraulic conductivity calculated for monitoring wells MW-9 and MW-10 are (2.64×10^{-6} cm/sec) and (7.92×10^{-5} cm/sec) respectively. The higher hydraulic conductivity value calculated for MW-10 is thought to be due to the close proximity of the water holding pond located approximately 20 feet to the west. Considering this additional recharge source, this well could be considered not representative of the in-situ conditions across the remaining portion of the landfill. Appendix A contains graphs of the in-situ permeability tests and the calculations used.

Lithologic logs and well construction data for MW-2, MW-3, MW-4, and MW-5 -

Lithologic logs and well construction data for monitoring wells MW-2, MW-3, MW-4, and MW-5 are included in Appendix B of this letter report.

Monitoring wells MW-2 and MW-3 -

Due to the close proximity of monitoring well MW-2 to the on-site water holding pond (within 5 feet), ESI suggests that the combination of monitoring wells MW-3 and MW-10 be used to monitor groundwater characteristics in the area between the lowest part of the pit and Cane Creek. Although monitoring well MW-2 is intact, it may not present data indicative of groundwater which has moved through the landfill area, due to recharge to the well from the holding pond.

Cross Sections -

All geologic cross sections previously submitted in ESI's September 1, 1994 Report of Hydrogeologic Assessment Addendum were constructed utilizing May 26, 1994 topographic information; therefore, changes to the cross-sections are not warranted.

ESI trusts the information provided will meet the hydrogeologic requirements set forth in the DEHNR November 7, 1994 Technical Review Letter. Please do not hesitate to contact us if you have any questions or require additional information.

Sincerely,
ECOLOGICAL SERVICES, INC.

Paul A. Banks
Project Geologist

Ronald C. Gilkerson
Vice President

FIGURE

	February	May 5th	May 27th	November
MW-7	51.36	50.93	50.91	51.5
MW-8	18.73	18.42	18.92	18.52
MW-9	11.85	12.2	11.01	10.55

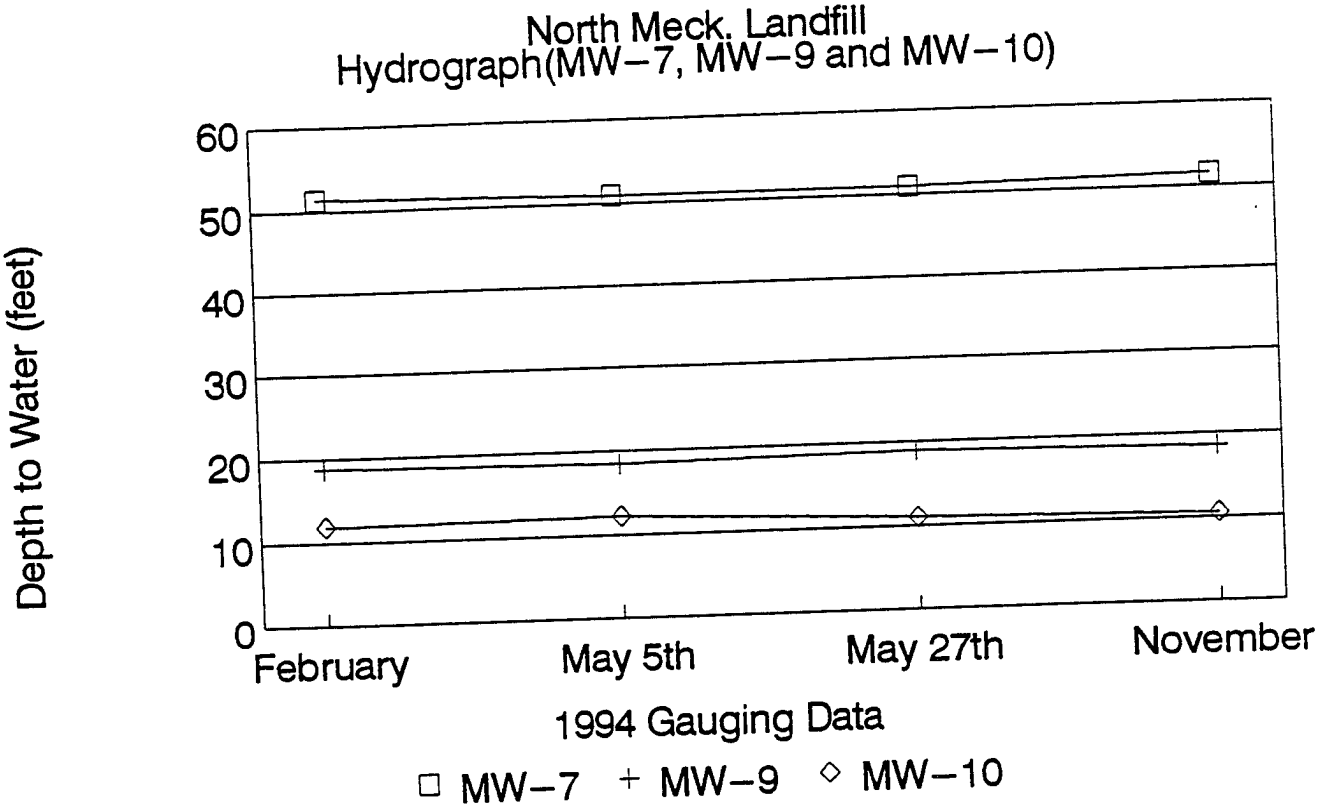


FIGURE 1

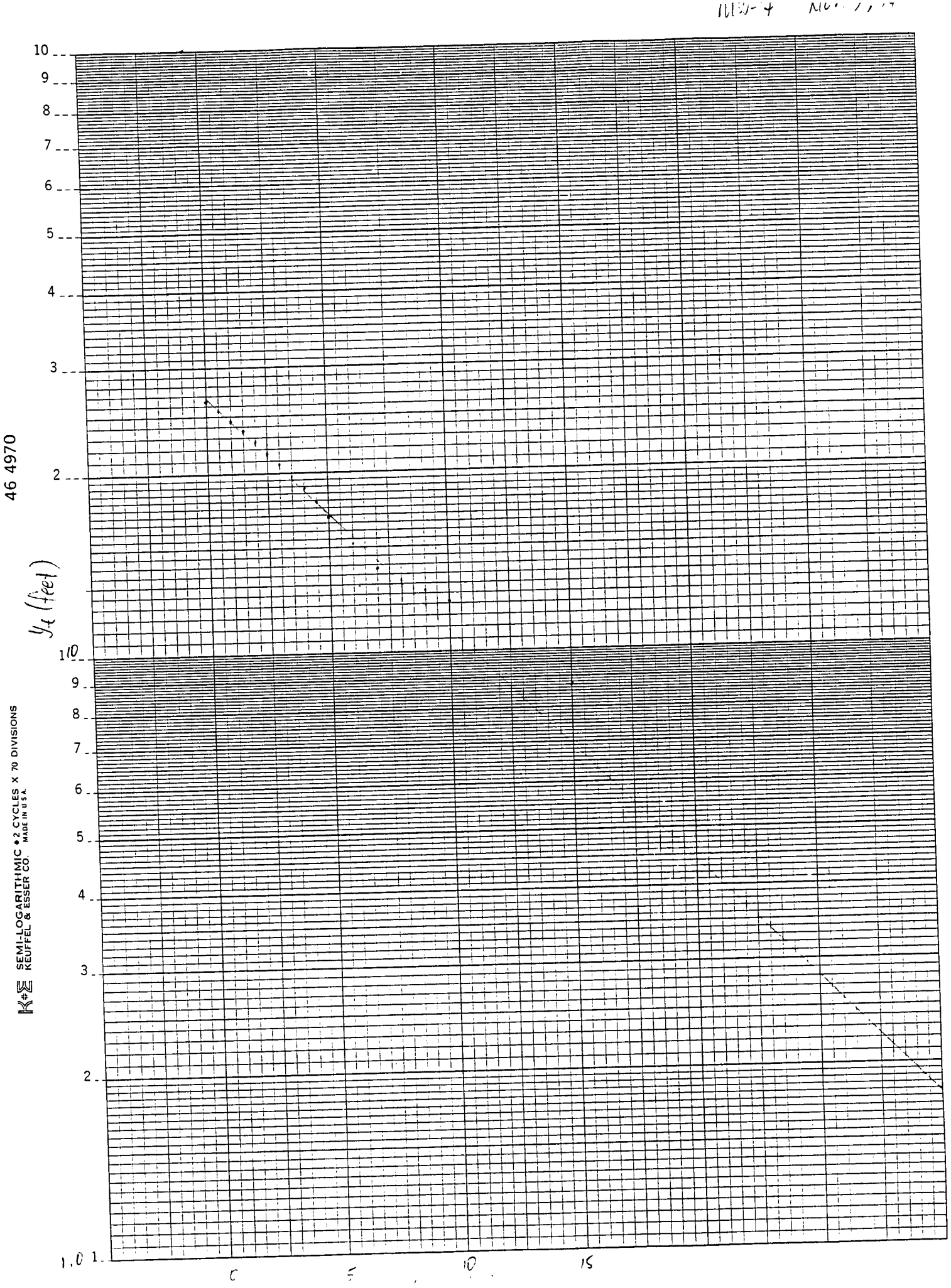
APPENDIX A
In-flow Permeability Calculations

BAIL TEST RECOVERY DATA
N. MECK. LANDFILL

MW–7, NOVEMBER 9, 1994

INITIAL DTW: 51.5

ELAPSED TIME (Min)	DEPTH TO WATER TABLE (feet)	MEASURED W.T. DEPTH MINUS EQUILIBRIUM W.T. DEPTH (feet)
0.00	77.55	26.45
0.25		
0.50	76.64	25.54
0.75		
1.00	75.66	24.56
1.25		
1.50	74.70	23.60
1.75		
2.00	73.85	22.75
2.50	72.87	21.77
3.00	71.98	20.88
3.50	70.89	19.79
4.00	69.91	18.81
4.50	68.97	17.87
5.00	68.01	16.91
5.50		
6.00	66.32	15.22
6.50		
7.00	64.87	13.77
7.50		
8.00	64.30	13.20
8.50		
9.00	63.76	12.66
9.50		
10.00	63.19	12.09
11.00		
12.00		
13.00		
14.00		
15.00	59.81	8.71
16.00		
17.00		
18.00		
19.00		
20.00		
25.00		
30.00		
35.00		
40.00		


46 4970
y_t (feet)
10
9
8
7
6
5
4
3
2
1.10
9
8
7
6
5
4
3
2
1.0
1
10
15
SEMI-LOGARITHMIC • 2 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

ESI COMPUTATION SHEET

PROJECT TITLE: N. MECK. LANDFILL PROJECT NO. ES675
DESCRIPTION: IN-FLOW PERMEABILITY TEST MW-7 SHEET ___ OF ___
PREPARED BY: ___ DATE: ___ CHK'D BY: ___ DATE: ___

BOUWER AND RICE METHOD

Variables:

$Y_t = 13'$

$t = 8$ min

$Y_0 = 26.45'$

$L = 20'$

$r_c = 0.08'$

$r_w = 0.25'$

$L/r_w = 80$

$H = 31.5'$

$C = 3.5$

$\mu =$

Equations:

$$\ln R_e/r_w = \left(\frac{1.1}{\ln(31.5/0.25)} + \frac{3.5}{80} \right)^{-1}$$

$$\ln R_e/r_w = 3.69$$

$$K = \frac{r_c^2 \ln (R_e/r_w)}{2L} \cdot \frac{1}{t} \cdot \ln \frac{Y_0}{Y_t}$$

$$K = \frac{0.08^2 \cdot \ln(3.69)}{40} \cdot \frac{1}{8} \cdot \ln \frac{26.45}{13}$$

$K = 1.85 \times 10^{-5}$ ft/min $= 9.42 \times 10^{-6}$ cm/sec.

ESI
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Charlotte, NC 28220
Phone: (704) 522-1111
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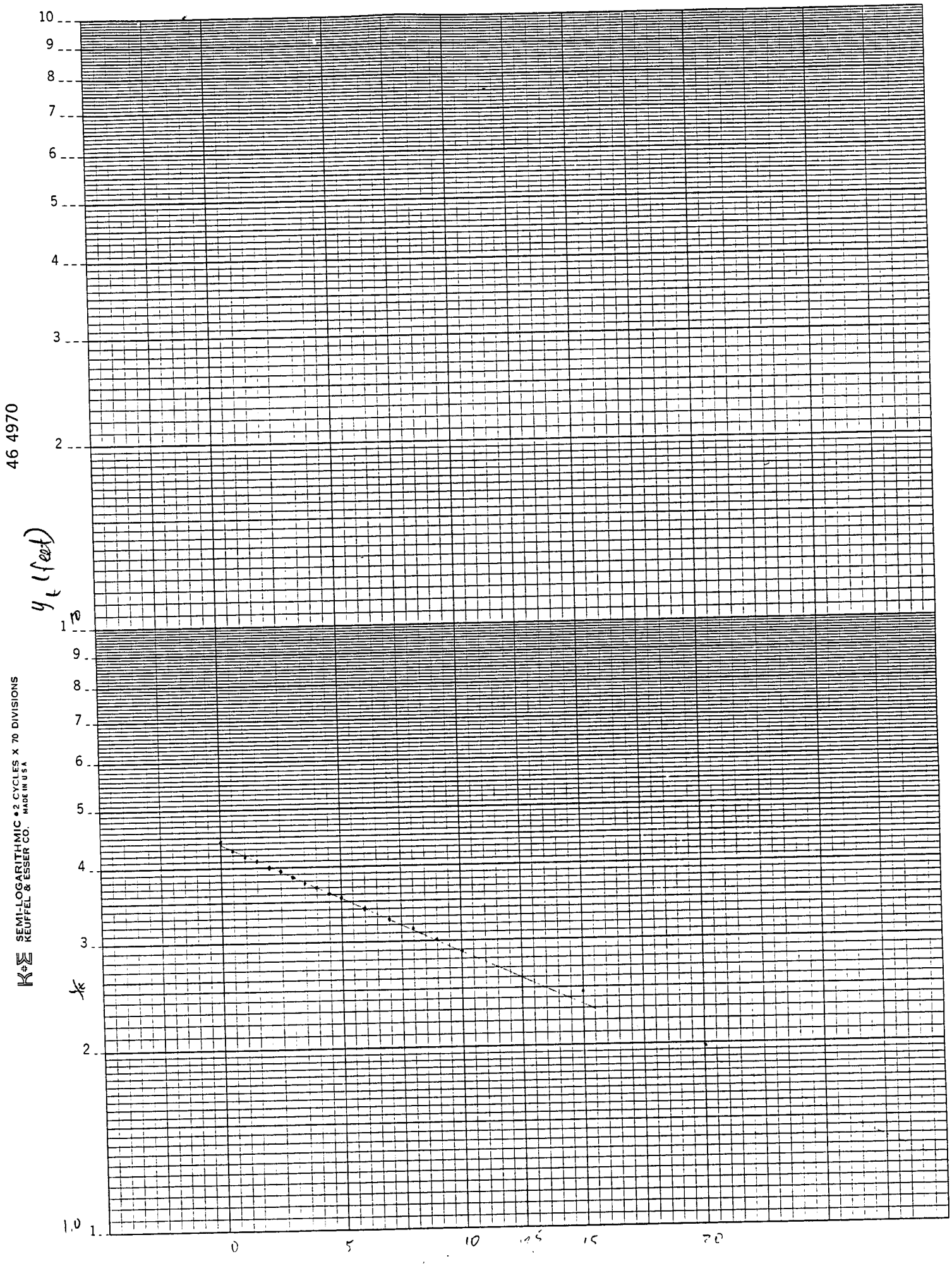
MW-4 NOV. 9,94


10
9
8
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6
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4
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2
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1
0
5
10
15
20
y_t (feet)
t
46 4970
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ESI COMPUTATION SHEET

PROJECT TITLE: N. MEIL LANDFILL — PROJECT NO. ES675
DESCRIPTION: IN-FLOW PERMEABILITY TEST MW-9 — SHEET ___ OF ___
PREPARED BY: ___ DATE: ___ CHK'D BY: ___ DATE: ___

BOUWER AND RICE METHOD

Variables

$y_t = 2.6'$

$t = 12.5$ min

$y_0 = 4.42$

$L = 20'$

$r_c = 0.08'$

$r_w = 0.25'$

$y_{rw} = 80$

$H = 3.42'$

$C = 3.5$

$k =$

Equations:

$$\ln R_e/r_w = \left(\frac{1.1}{\ln(3.42/0.25)} + \frac{3.5}{80} \right)^{-1}$$

$$\ln R_e/r_w = 2.15$$

$$k = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t} \ln \frac{y_0}{y_t}$$

$$k = \frac{0.08^2 \ln(2.15)}{40} \cdot \frac{1}{12.5} \ln \frac{4.42}{2.6}$$

$$k = 5.20 \times 10^{-6} \text{ ft/min} = 2.64 \times 10^{-6} \text{ cm/sec}$$

ESI ECOLOGICAL SERVICES, INC.
P. O. Box 12146
Charlotte, NC 28220
Phone: (704) 522-1111
Fax: (704) 521-8004

BAIL TEST RECOVERY DATA
N. MECK. LANDFILL

MW-9, NOVEMBER 9, 1994

INITIAL DTW: 18.58

ELAPSED TIME (Min)	DEPTH TO WATER TABLE (feet)	MEASURED W.T. DEPTH MINUS EQUILIBRIUM W.T. DEPTH (feet)
0.00	23.00	4.42
0.25		
0.50	22.86	4.28
0.75		
1.00	22.75	4.17
1.25		
1.50	22.68	4.10
1.75		
2.00	22.60	4.02
2.50	22.52	3.94
3.00	22.43	3.85
3.50	22.34	3.76
4.00	22.28	3.70
4.50	22.19	3.61
5.00	22.11	3.53
5.50		
6.00	21.98	3.40
6.50		
7.00	21.86	3.28
7.50		
8.00	21.72	3.14
8.50		
9.00	21.59	3.01
9.50		
10.00	21.47	2.89
11.00		
12.00		
13.00		
14.00		
15.00	21.03	2.45
16.00		
17.00		
18.00		
19.00		
20.00	20.56	1.98
25.00		
30.00		
35.00		
40.00		

BAIL TEST RECOVERY DATA
N. MECK. LANDFILL

MW-10, NOVEMBER 9, 1994

INITIAL DTW: 10.55

ELAPSED TIME (Min)	DEPTH TO WATER TABLE (feet)	MEASURED W.T. DEPTH MINUS EQUILIBRIUM W.T. DEPTH (feet)
0.00	17.15	6.60
0.25		
0.50		
0.75		
1.00	15.92	5.37
1.25		
1.50		
1.75		
2.00	14.93	4.38
2.50	13.88	3.33
3.00	12.90	2.35
3.50	12.10	1.55
4.00	11.53	0.98
4.50	11.21	0.66
5.00	10.99	0.44
5.50		
6.00	10.89	0.34
6.50		
7.00	10.83	0.28
7.50		
8.00	10.79	0.24
8.50		
9.00	10.76	0.21
9.50		
10.00	10.72	0.17
11.00		
12.00		
13.00		
14.00		
15.00	10.58	0.03
16.00		
17.00		
18.00		
19.00		
20.00		
25.00		
30.00		
35.00		
40.00		

ESI COMPUTATION SHEET

PROJECT TITLE: N. MEX. LANDFILL — PROJECT NO. ES675
DESCRIPTION: IN FLOW PERMEABILITY TEST MW-10 — SHEET ___ OF ___
PREPARED BY: ___ DATE: ___ CHK'D BY: ___ DATE: ___

BOUWER AND RICE METHOD

Variables

$y_t = 1.25'$

$t = 3.75$ min

$y_0 = 25$

$L = 10$

$r_c = 0.08$

$r_w = 0.25'$

$L/r_w = 40$

$H = 8.45$

$C = 2.75$

$k =$

Equations

$$\ln \frac{Re}{r_w} = \left(\frac{1.1}{\ln(8.45/0.25)} + \frac{2.75}{40} \right)^{-1}$$

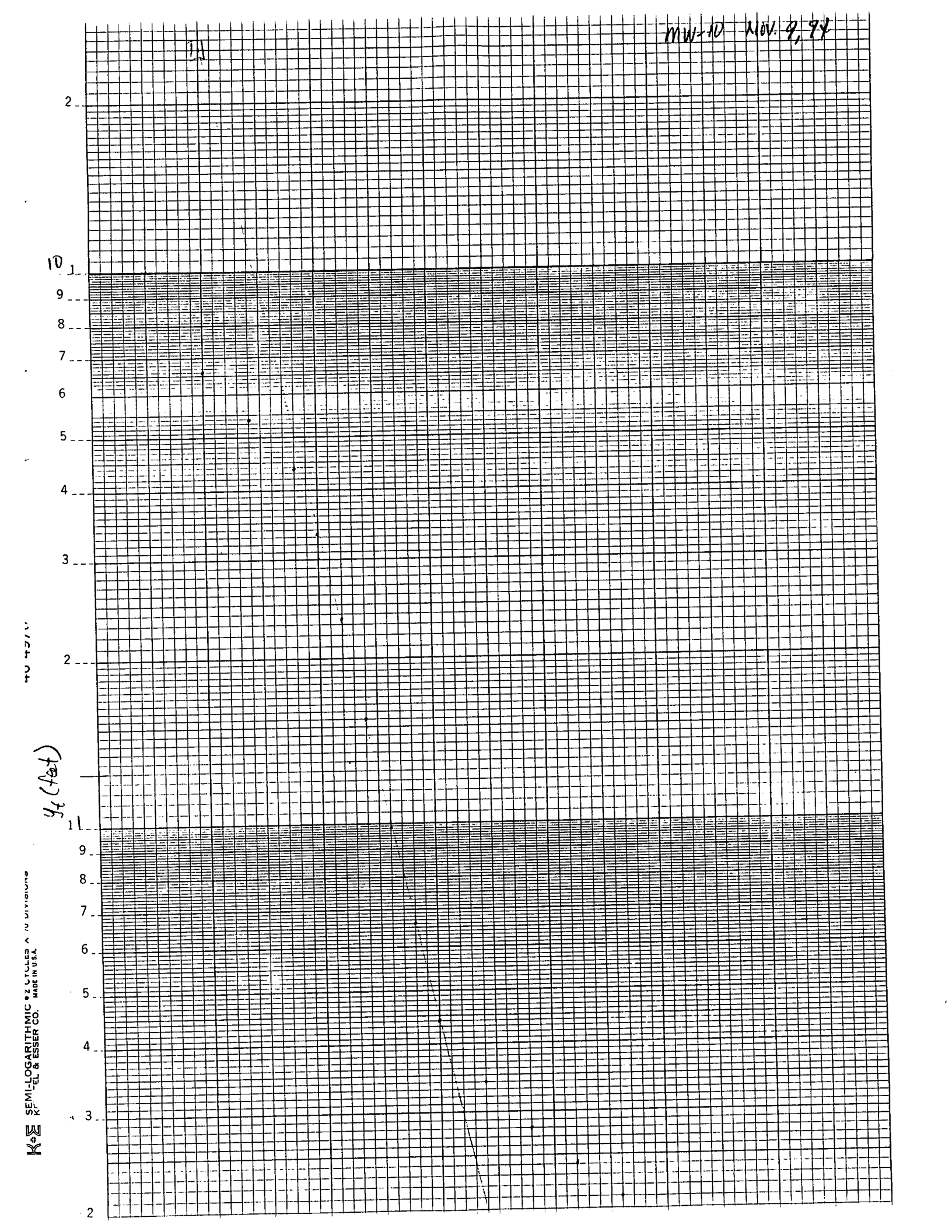
$$\ln \frac{Re}{r_w} = 2.62$$

$$k = \frac{r_c^2 \ln(Re/r_w)}{2L} \cdot \frac{1}{t} \cdot \ln \frac{y_0}{y_t}$$

$$= \frac{0.08^2 \ln(2.62)}{20} \cdot \frac{1}{3.75} \cdot \ln \frac{25}{3.75}$$

$$k = 1.56 \times 10^{-4} \text{ ft/min} = 7.92 \times 10^{-5} \text{ cm/sec}$$

ESI ECOLOGICAL SERVICES, INC.
P. O. Box 12146
Charlotte, NC 28220
Phone: (704) 522-1111
Fax: (704) 521-8004


MW-10 NOV. 9, 84
10
9
8
7
6
5
4
3
2
1
9
8
7
6
5
4
3
2
4 (flat)
SEMI-LOGARITHMIC
KEUFFEL & ESSER CO.
MADE IN U.S.A.

BAIL TEST RECOVERY DATA
N. MECK. LANDFILL

PZ–7, JULY 6, 1994

INITIAL DTW: 48.19

ELAPSED TIME (Min)	DEPTH TO WATER TABLE (feet)	MEASURED W.T. DEPTH MINUS EQUILIBRIUM W.T. DEPTH (feet)
0.00	58.30	10.11
0.25	58.17	9.98
0.50	58.05	9.86
0.75	57.91	9.72
1.00	57.77	9.58
1.25	57.63	9.44
1.50	57.52	9.33
1.75	57.38	9.19
2.00	57.26	9.07
2.50	57.00	8.81
3.00	56.75	8.56
3.50	56.46	8.27
4.00	56.22	8.03
4.50	55.99	7.80
5.00	55.76	7.57
5.50	55.52	7.33
6.00	55.32	7.13
6.50	55.08	6.89
7.00	54.85	6.66
7.50	54.64	6.45
8.00	54.43	6.24
8.50	54.22	6.03
9.00	54.02	5.83
9.50	53.86	5.67
10.00	53.70	5.51
11.00	53.49	5.30
12.00	53.24	5.05
13.00	53.04	4.85
14.00	52.76	4.57
15.00	52.48	4.29
16.00	52.25	4.06
17.00	52.03	3.84
18.00	51.80	3.61
19.00	51.62	3.43
20.00	51.45	3.26
25.00	50.86	2.67
30.00	50.33	2.14
35.00	49.95	1.76
40.00	49.63	1.44

SECTION 8

FILE

ADDENDUM REPORT
of
HYDROGEOLOGICAL ASSESSMENT
(PHASE II UNPERMITTED AREA)

North Mecklenburg Landfill
15300 Holbrooks Road
Huntersville, North Carolina

ESI Project No. ES-0675

September 1, 1994

-Prepared for-

Mr. Larry Griffin, Sr.
19141 Highway 73 West
Davidson, North Carolina 28036

-Prepared by-

Ecological Services, Inc.
P. O. Box 12146
Charlotte, NC 28220

Paul A. Banks
Project Geologist

Thomas H. Bolyard, P.G.
Senior Hydrogeologist
N.C. Registration No. 0492

TABLE OF CONTENTS

1.0 INTRODUCTION

Ecological Services, Inc. (ESI) was contracted by Mr. Larry Griffin, Sr. to perform addendum hydrogeological assessment activities at the North Mecklenburg Landfill located at 15300 Holbrooks Road in Huntersville, North Carolina (Figure 1). Addendum assessment activities included the re-definition of depth to bedrock in the Phase II unpermitted area of the site, and soil sample collection and testing to confirm subsurface soil characteristic testing previously conducted at the site.

2.0 PREVIOUS INVESTIGATIONS

Initial hydrogeological assessment activities associated with the Phase II area were conducted by ESI in June and July, 1994. The initial assessment activities included the installation of seven soil test borings (B-4, B-5, B-6, B-7, SB-1, SB-2, and SB-3), five floor sample excavations (F-1 through F-5) to classify subsurface lithology and determine soil geotechnical characteristics, and seven temporary piezometers (PZ-1 through PZ-7) to assess depth to groundwater and direction of groundwater flow (Figures 2 and 3). Findings of the initial hydrogeological assessment were submitted to the North Carolina Department of Environment, Health and Natural Resources (NCDEHNR) as ESI Report of Hydrogeological Assessment (Phase II Unpermitted Area), dated July 8, 1994.

Based on a preliminary NCDEHNR review of the July 8, 1994 assessment report, it was determined that depth to bedrock required re-definition, and that undisturbed (Shelby Tube) soil samples would be required for the Phase II area to verify permeability test results previously obtained from remolded soil samples.

3.0 ADDENDUM FIELD ACTIVITIES

ESI advanced five soil borings (SB-1A, SB-2A, SB-3A, SB-3B and SB-3C) in the Phase II area on August 18, 1994. Each of the soil borings offset previously advanced soil borings which were

installed during the initial assessment activities conducted in the Phase II area. SB-1A offset SB-1, SB-2A offset SB-2, and SB-3A, SB-3B, and SB-3C offset SB-3 (Figure 3).

During the advancement of soil borings SB-1A, SB-2A, and SB-3A, split spoon soil samples were collected every five feet and standard penetration resistance data was recorded. Each soil sample collected was visually described in the field by an ESI staff geologist. Undisturbed Shelby Tube soil samples were collected from SB-2A and SB-3A for soil geotechnical testing per the following procedures:

ASTM D 5084	"Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"
ASTM D 4318	"Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
ASTM D 422	"Standard Test Method for Particle-Size Analysis of Soils"

Due to the undeveloped terrain of the Phase II area, initial soil borings SB-1, SB-2, and SB-3 were advanced with an all terrain auguring rig. During the installation of these borings it became apparent that the all terrain rig did not have sufficient drilling power to advance more than approximately 18 feet through the saprolite in the Phase II area of the site. Therefore, the off-set wells conducted during the addendum assessment activities were advanced with a "Cantera" auger drilling rig.

Depth to bedrock was re-defined in the areas of initial soil borings SB-1, SB-2, and SB-3. In the area of SB-1, soil boring SB-1A was advanced (Figure 3). During the advancement of SB-1A, soil samples were obtained every five feet, and penetration resistance blow counts were recorded. Auger refusal was encountered at 32 feet in SB-1A, whereas, auger refusal in SB-1 had previously been encountered at 18 feet. Due to the hardness of the subsurface material

recorded during the penetration resistance testing, a Shelby Tube could not be pushed and retrieved from the subsurface material in the area of SB-1A. Soil boring records for all addendum soil test borings are included as Appendix A of this report.

Soil boring SB-2A was located adjacent to the previous SB-2 location (Figure 3). Auger refusal in SB-2A was encountered at 39 feet, as compared with the previous refusal in this area encountered in SB-2 at 18 feet. One undisturbed Shelby Tube soil sample was obtained from SB-2A at a depth of 10 to 12 feet (Appendix A).

Three soil borings (SB-3A, SB-3B, and SB-3C) were advanced in the area of previous soil boring SB-3 due to the relatively shallow auger refusal obtained during the initial assessment activities (Figure 3). Soil Boring SB-3A was located approximately 2 feet from the original SB-3 location. Auger refusal in SB-3A was encountered at 14 feet, corresponding to the refusal depth obtained in SB-3 during the initial assessment activities. One undisturbed Shelby Tube soil sample was obtained from SB-3A at a depth of 12 to 13 feet (Appendix A). Two soil borings, in addition to SB-3A, were advanced in the immediate area surrounding the initial SB-3 location. These additional borings (SB-3B and SB-3C) were advanced to determine if the shallow depth to bedrock encountered in SB-3 and SB-3A was indicative of the depth to bedrock throughout the southern portion of the Phase II area, or if the shallow depth represented only a local undulation in the bedrock surface. Soil boring SB-3B, located 30 feet to the northeast of the SB-3A location, was advanced to an auger refusal depth of 14 feet (Figure 3). However, depth to bedrock in soil boring SB-3C, which was located 40 feet to the southeast of SB-3A, was encountered at 30 feet below ground surface. Soil samples were not collected from soil borings SB-3B and SB-3C due to their close proximity to the SB-3A sampling location. Based on the new depth to bedrock data collected during the addendum assessment activities, the geologic cross sections previously constructed during the initial Phase II assessment activities were reconstructed. The cross section traverse locations are indicated on Figure 4 of this report, which proceeds the A-A' and B-B' cross sections included as Figures 5 and 6, respectively. Lithologic tie lines connecting soil borings in cross sections A-A' and B-B' designate inferred lithologic changes in the residual soils located between borings. Actual lithologic changes may be more gradational or abrupt than depicted.

4.0 SOIL TEST RESULTS

Results of the Constant Head Permeability Testing and Grain Size Distribution Testing on the Shelby Tube samples collected from soil borings SB-2A and SB-3A are summarized in Tables 1 and 2, respectively. The sample intervals selected should be representative of the material in the deeper section of our auger profile. The Report of Laboratory Constant Head Permeability and Classification Tests (Law Job No. 226-09423-01, dated August 30, 1994) is included as Appendix B.

Constant head permeability test results for the Shelby Tube soil samples collected from SB-2A and SB-3A indicate smaller coefficient of permeability values than the re-formed soil samples collected during the initial studies of the Phase II area. The average coefficient of permeability value of five re-formed floor soil samples collected from the Phase II area during the initial investigation was 6.51×10^{-5} cm/sec. In contrast, the average coefficient of permeability value of the two Shelby Tube soil samples is 3.7×10^{-7} cm/sec.

5.0 CONCLUSIONS

Based on the geotechnical results obtained from soil borings SB-1A, SB-2A and SB-3A advanced during this additional assessment, depth to bedrock and subsurface permeability were re-defined for the Phase II area.

Depth to bedrock appears to have some correspondence to the natural topographic changes within the Phase II area. In general, the bedrock appears to be more shallow in the central southern portion of the Phase II area where the natural topography is the highest. However, due to the nature of pluton emplacement, the bedrock surface is expected to be very undulatory, as indicated by the 15 foot drop in bedrock elevation between SB-3A and SB-3C, which are only 40 feet apart. For this reason the vertical fill limits may need to be modified as cell excavation progresses and additional data is obtained.

Based on the coefficient of permeability and grain size distribution test reports, the subsurface in the areas of SB-2A and SB-3A are expected to transmit fluids at a relatively slow rate. Penetration resistance testing collected during the advancement of SB-1A, SB-2A, and SB-3A indicates that the unconsolidated portion of the subsurface is highly competent and is considered "hard" by ASTM standards.

TABLES

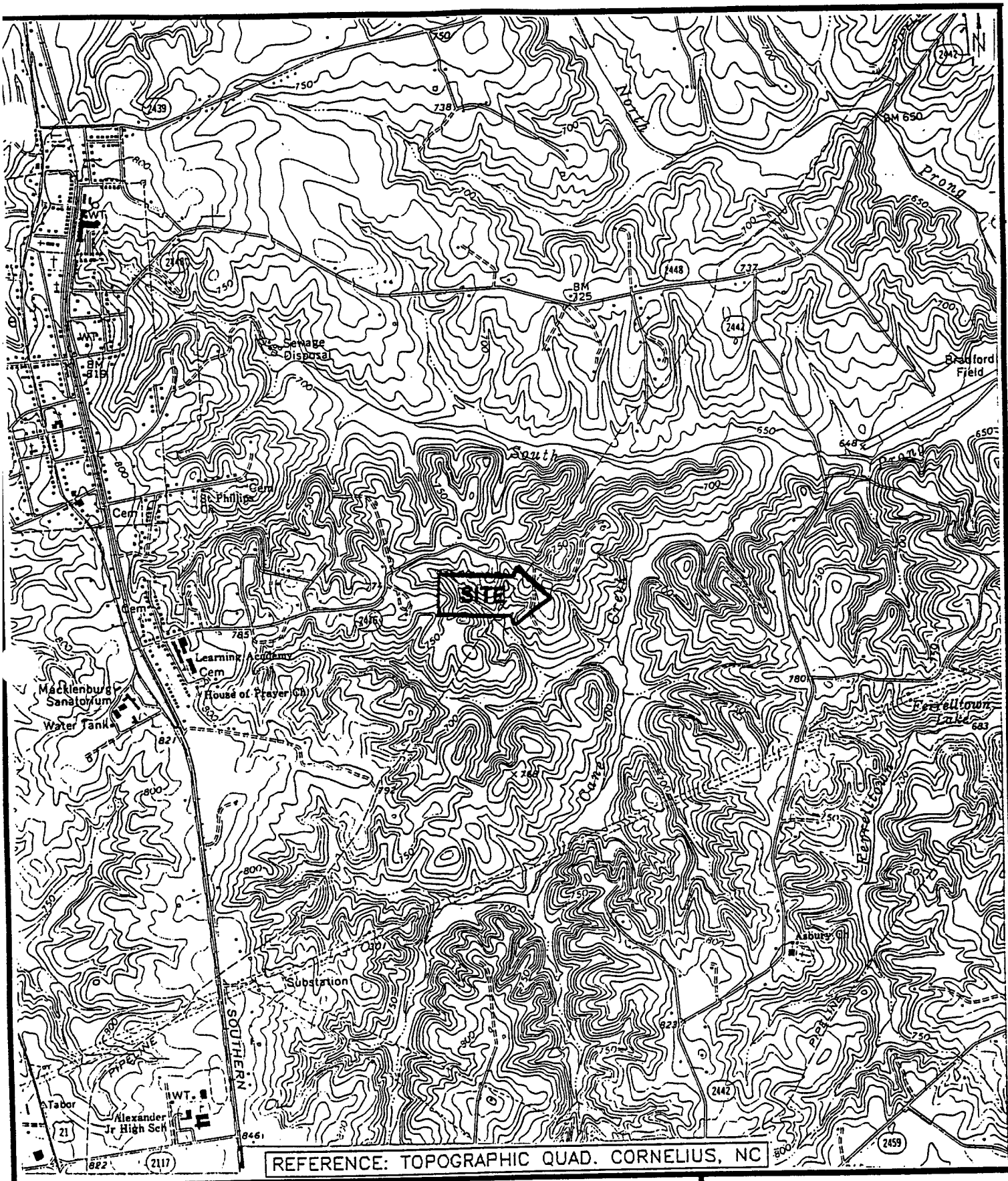
TABLE 1
CONSTANT HEAD PERMEABILITY TESTING DATA
North Mecklenburg Landfill
Huntersville, North Carolina

Sample I.D.	Coefficient of Permeability (cm/sec)
SB-2A	3.0×10^{-7}
SB-3A	4.3×10^{-7}

TABLE 2
SUMMARY OF GRAIN SIZE DISTRIBUTION TESTING
North Mecklenburg Landfill
Huntersville, North Carolina

Sample I.D.	% + 3"	% Gravel	% Sand	% Silt and Clay
SB-2A	0.0	0.4	51.1	48.5
SB-3A	0.0	2.1	58.3	39.6

FIGURES



DATE: 07-07-94

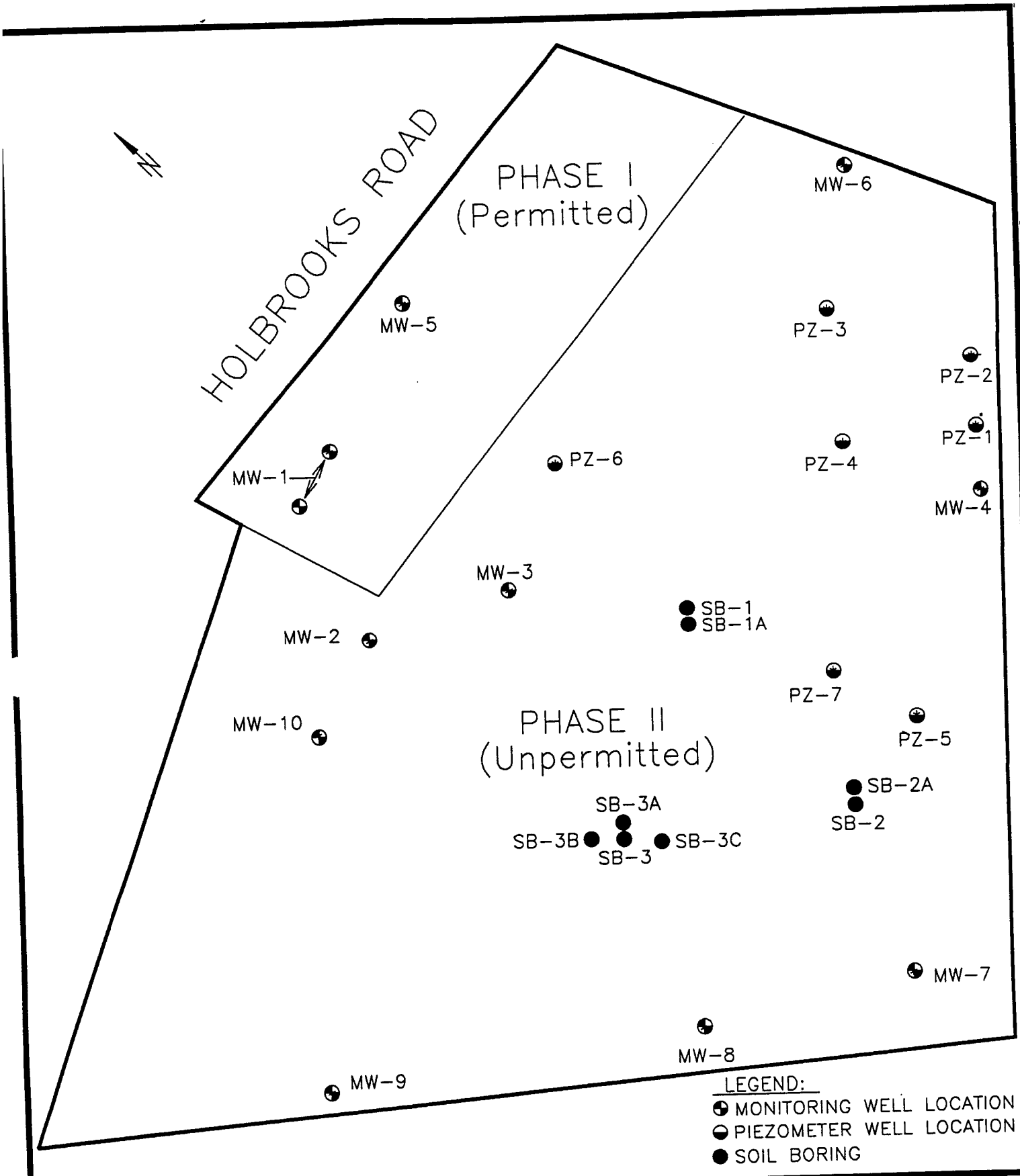
SCALE 1:24,000

ESI

FIGURE 1: SITE LOCATION MAP

N. MECK. LANDFILL

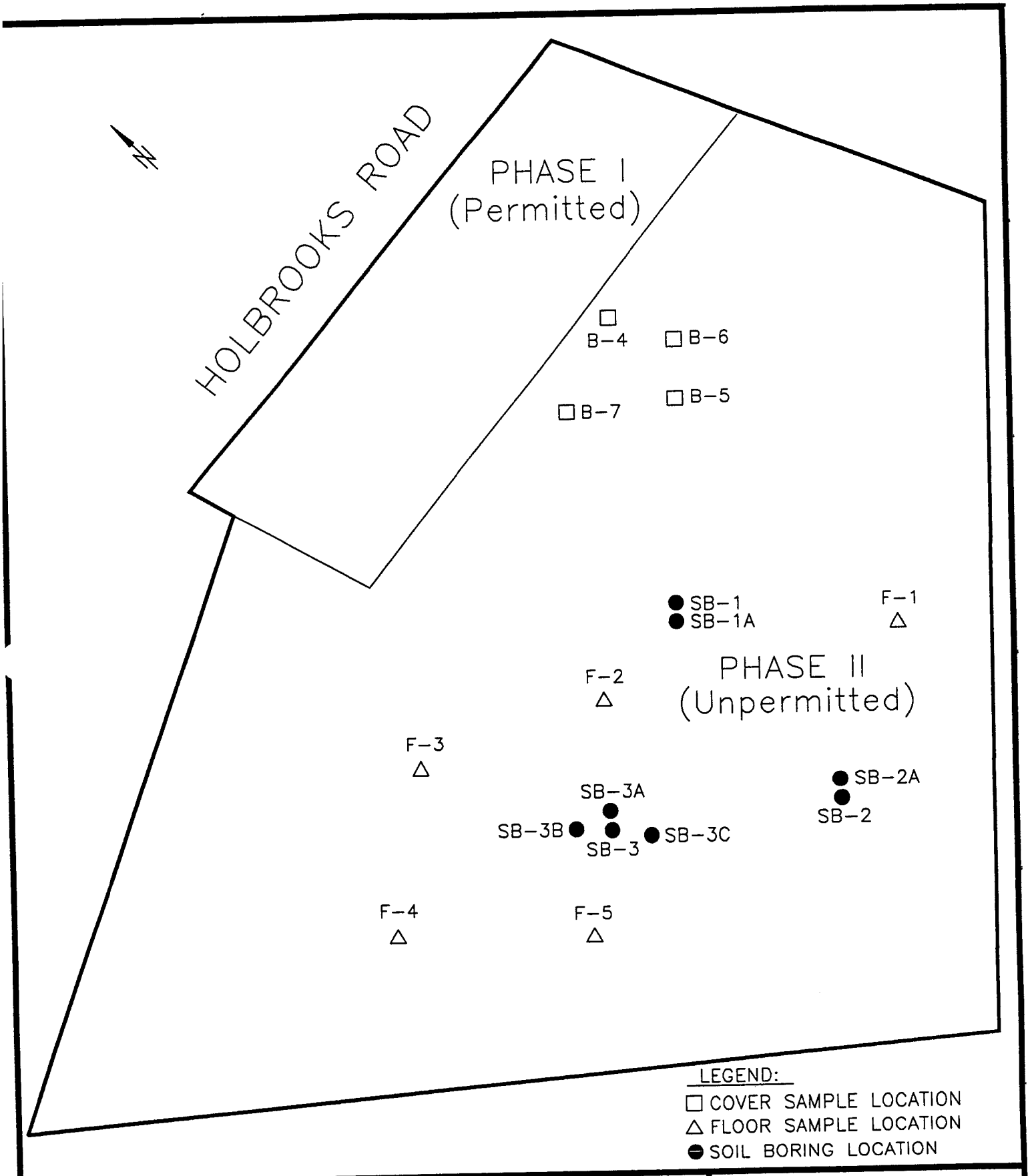
HUNTERSVILLE, NC



DATE: 07-05-94
SCALE: 1" = 200'
DWG. NO.: ES-675-2

ESI

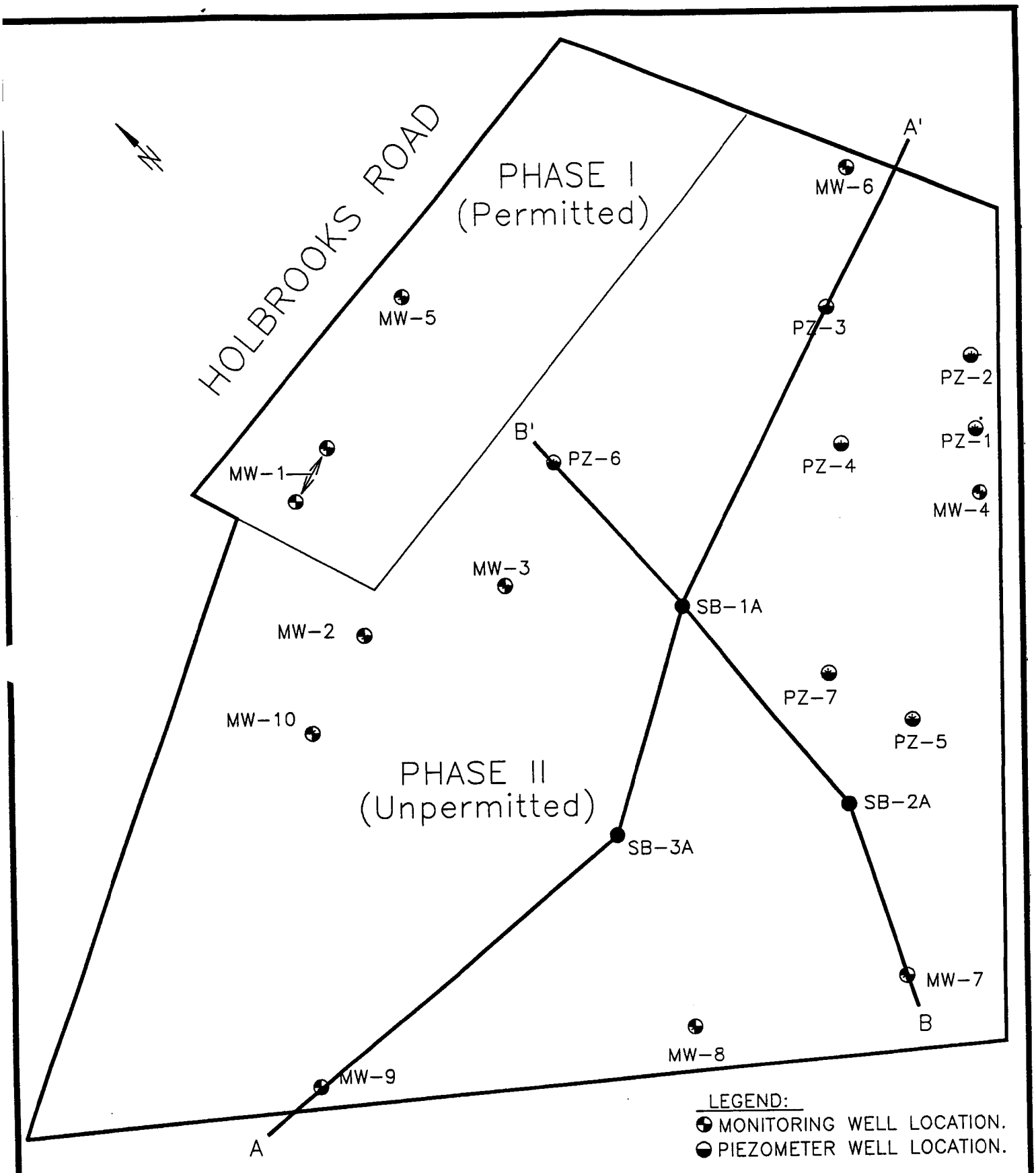
FIGURE 2: SITE CONFIGURATION MAP
N. MECK. LANDFILL
HUNTERSVILLE, NC



DATE: 07-05-94
SCALE: 1" = 200'
DWG. NO.: ES-675-3

ESI

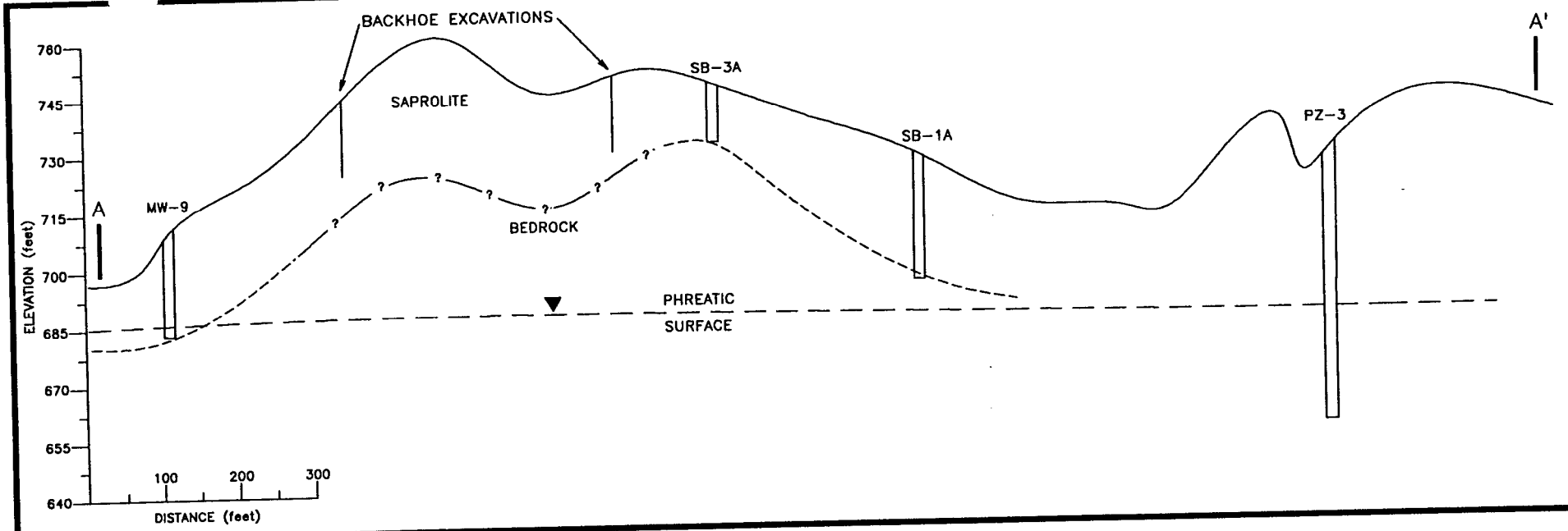
FIGURE 3: SOIL TEST BORING LOCATION MAP
N. MECK. LANDFILL
HUNTERSVILLE, NC

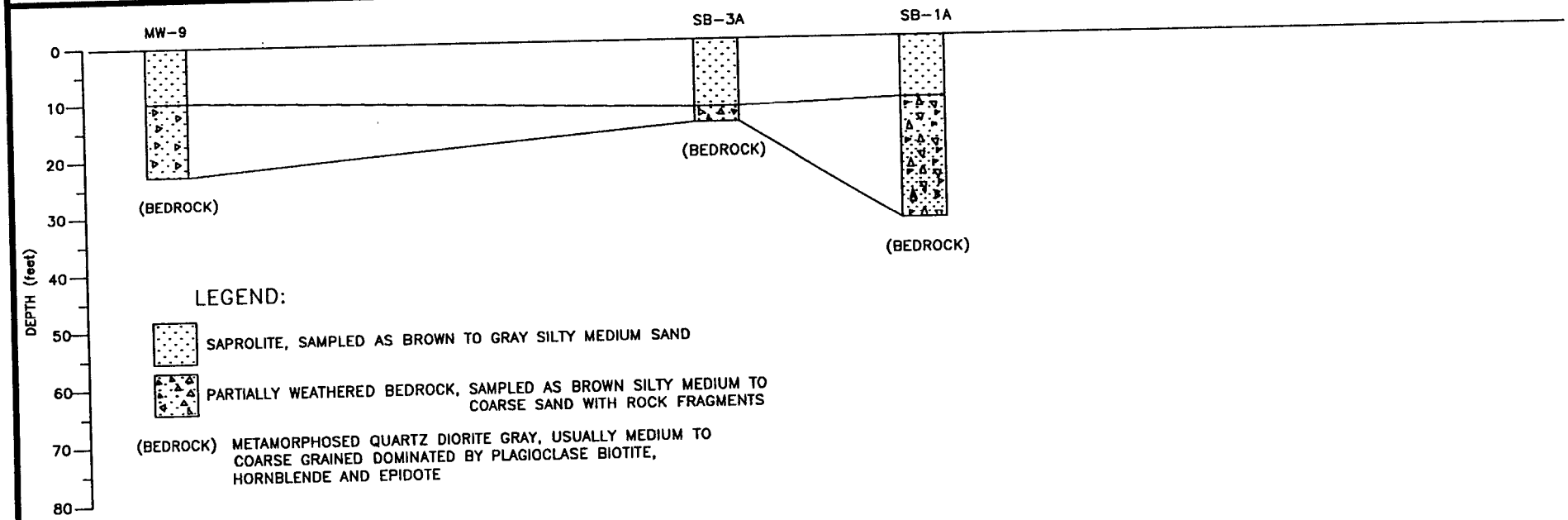


DATE: 07-05-94
SCALE: 1" = 200'
DWG. NO.: ES-675-4

ESI

FIGURE 4: CROSS SECTION DESIGNATION MAP
N. MECK. LANDFILL
HUNTERSVILLE, NC





LEGEND:

SAPROLITE, SAMPLED AS BROWN TO GRAY SILTY MEDIUM SAND

PARTIALLY WEATHERED BEDROCK, SAMPLED AS BROWN SILTY MEDIUM TO COARSE SAND WITH ROCK FRAGMENTS

(BEDROCK) METAMORPHOSED QUARTZ DIORITE GRAY, USUALLY MEDIUM TO COARSE GRAINED DOMINATED BY PLAGIOCLASE BIOTITE, HORNBLENDE AND EPIDOTE

DATE: 08-23-94

SCALE: ON DRAWING

DWG. NO.: ES675-5A

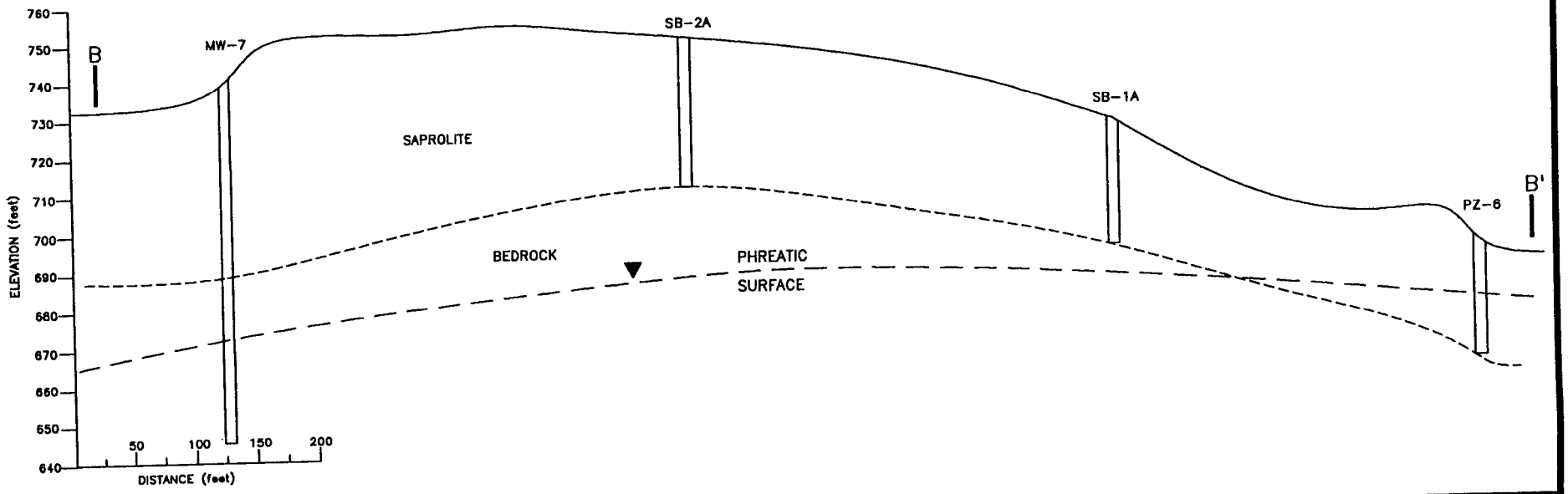
ESI

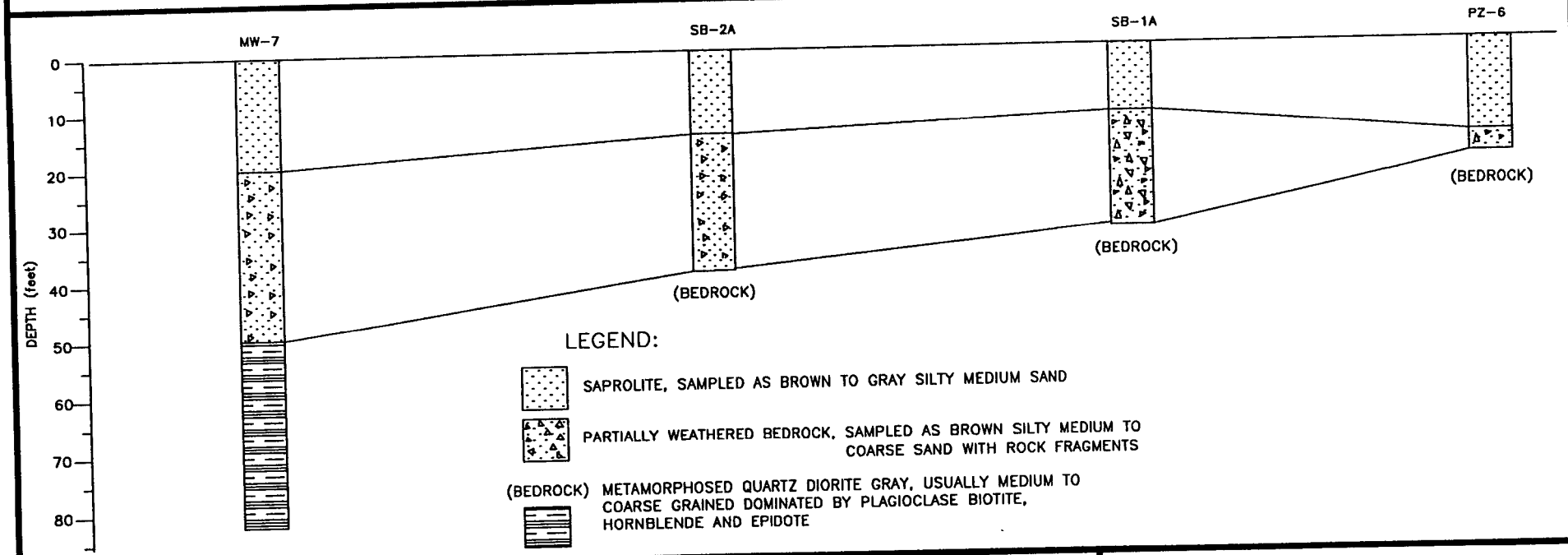
ECOLOGICAL SERVICES, INC.

FIGURE 5: CROSS SECTION A – A'

NORTH MECKLENBURG LANDFILL

HUNTERSVILLE, NC





DATE: 08-23-94

SCALE: ON DRAWING

DWG. NO.: ES675-6a

ESI

ECOLOGICAL SERVICES, INC.

FIGURE 6: CROSS SECTION B - B'

NORTH MECKLENBURG LANDFILL

HUNTERSVILLE, NC

APPENDIX A

Soil Boring Records

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: SB-1A	Page 1 of 1
County: Mecklenburg State: NC	Date Began: 8/18/94 Date End: 8/18/94	Casing Height:	
Lat.: Long.:	Drilled By: Badger Well Drilling	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Hollow Stem Auger	Sampling Method:	
Grout: 5% bentonite	Seal: bentonite	Gravel Pack: 8/20 silica sand	
Casing Type: Sch 40 PVC Diameter: 2"	Depth:		Hole Diameter: 4-1/4"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch	Depth:	Total Depth: 32 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0		0
	11-22-31-38		5 – 7 ft: Saprolite; Brownish Gray Fine to Medium Grained Silty Sand	
	13-50/6"	10	10 – 12 ft: Saprolite; Gray Medium Grained Silty Sand	10
	27-50/3"		15 – 17 ft: Saprolite; Brown Medium Grained Silty Sand	
	50/6"	20	20 – 22 ft: Brown Fine Grained Silty Sand	20
	50/5"		25 – 27 ft: Brown Fine Grained Silty Sand	
	17-50/2"	30	30 – 32 ft: Saprolite; Brown Medium Grained Silty Sand	30
			32 ft: Bedrock Encountered, Boring Terminated	
		40		40
		50		50

Geologist Log — **Ecological Services, Inc**

Job #: ES–0675	North Mecklenburg Landfill	Well #: SB–2A	Page 1 of 1
County: Mecklenburg State: NC	Date Began: 8/18/94 Date End: 8/18/94	Casing Height:	
Lat.: Long.:	Drilled By: Badger Well Drilling	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Hollow Stem Auger	Sampling Method:	
Grout: 5% bentonite	Seal: bentonite	Gravel Pack: 8/20 silica sand	
Casing Type: Sch 40 PVC Diameter: 2"	Depth:		Hole Diameter: 4–1/4"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010–inch	Depth:	Total Depth: 39 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0		0
	50/3"		5 – 7 ft: Brownish Gray Medium Grained Sand with Little Silt	
	50/3"		8 – 10 ft: Brownish Gray Fine to Medium Grained Silty Sand	
		10	10 – 12 ft: Shelby Tube	10
	50/4"		12 – 14 ft: Brownish Gray Medium Grained Silty Sand	
	50/6"		15 – 17 ft: Brown Fine to Medium Grained Silty Sand	
	23 – 50/3"	20	20 – 22 ft: Saprolite; Brown Medium Grained Silty Sand	20
	27 – 50/6"		25 – 27 ft: Saprolite; Brown Medium to Coarse Gray Sand	
	50/6"	30	30 – 32 ft: Saprolite; Brown Fine to Medium Grained Silty Sand	30
	33 – 50/6"		35 – 37 ft: Saprolite; Brown fine to Medium Grained Silty Sand	
			39 ft: Bedrock Encountered; Boring Terminated	
		40		40
		50		50

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: SB-3A — Page 1 of 1
County: Mecklenburg — State: NC	Date Began: 8/18/94 — Date End: 8/18/94	Casing Height:
Lat.: — Long.:	Drilled By: Badger Well Drilling	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Hollow Stem Auger	Sampling Method:
Grout: 5% bentonite	Seal: bentonite	Gravel Pack: 8/20 silica sand
Casing Type: Sch 40 PVC — Diameter: 2"	Depth:	Hole Diameter: 4-1/4"
Screen Type: Sch 40 PVC — Diameter: 2"	Slot: 0.010-inch — Depth:	Total Depth: 14 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0		0
	13 – 50/4"		3 – 5 ft: Brown Medium Grained Sand with Little Silt and Clay	
	50/4"		5 – 7 ft: Saprolite; Brown Medium Grained Silty Sand	
	50/6"		8 – 10 ft: Saprolite; Brown Medium to Coarse Grained Sand with Little Clay	
	22 – 50/2"	10	10 – 12 ft: Saprolite; Brown Medium to Coarse Grained Silty Sand with Rock Fragments	10
			12 – 14 ft: Shelby Tube	
	50/2"		13 – 14 ft: Saprolite; Brownish Gray Medium Grained Silty Sand	
			14 ft: Bedrock Encountered, Boring Terminated	
		20		20
		30		30
		40		40
		50		50

APPENDIX B

Report of Laboratory Constant Head Permeability
and
Classification Tests for Soil Samples

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

August 30, 1994

Mr. Paul Banks
Ecological Services, Inc.
P.O. Box 12146
Charlotte, North Carolina 28220

Subject: **Report of Laboratory**
Constant Head Permeability and
Classification Tests
Ecological Services, Inc.
Charlotte, North Carolina
Law Engineering Project 226-09423-01

Dear Mr. Banks:

As authorized by the acceptance of our Work Authorization Sheet dated December 30, 1993, Law Engineering has completed requested laboratory testing on the two soil samples submitted to our laboratory by Mr. Paul Banks. Testing was performed according to the following ASTM standards:

ASTM D 5084	"Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"
ASTM D 4318	"Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
ASTM D 422	"Standard Test Method for Particle-Size Analysis of Soils"

The results of our testing are summarized on the enclosed data sheets.

We appreciate the opportunity to be of service to you with this project. If you should have any questions concerning this report, or if we may be of further service to you, please do not hesitate to contact this office at (704) 357-8600.

Sincerely,

LAW ENGINEERING, INC.

Steven E. Lawing
Staff Engineer

Michael O. Hamlett /kc
Michael O. Hamlett, C.E.T.
Laboratory Services Manager

SEL/MOH:kac
Enclosure

SUMMARY OF LABORATORY TESTING

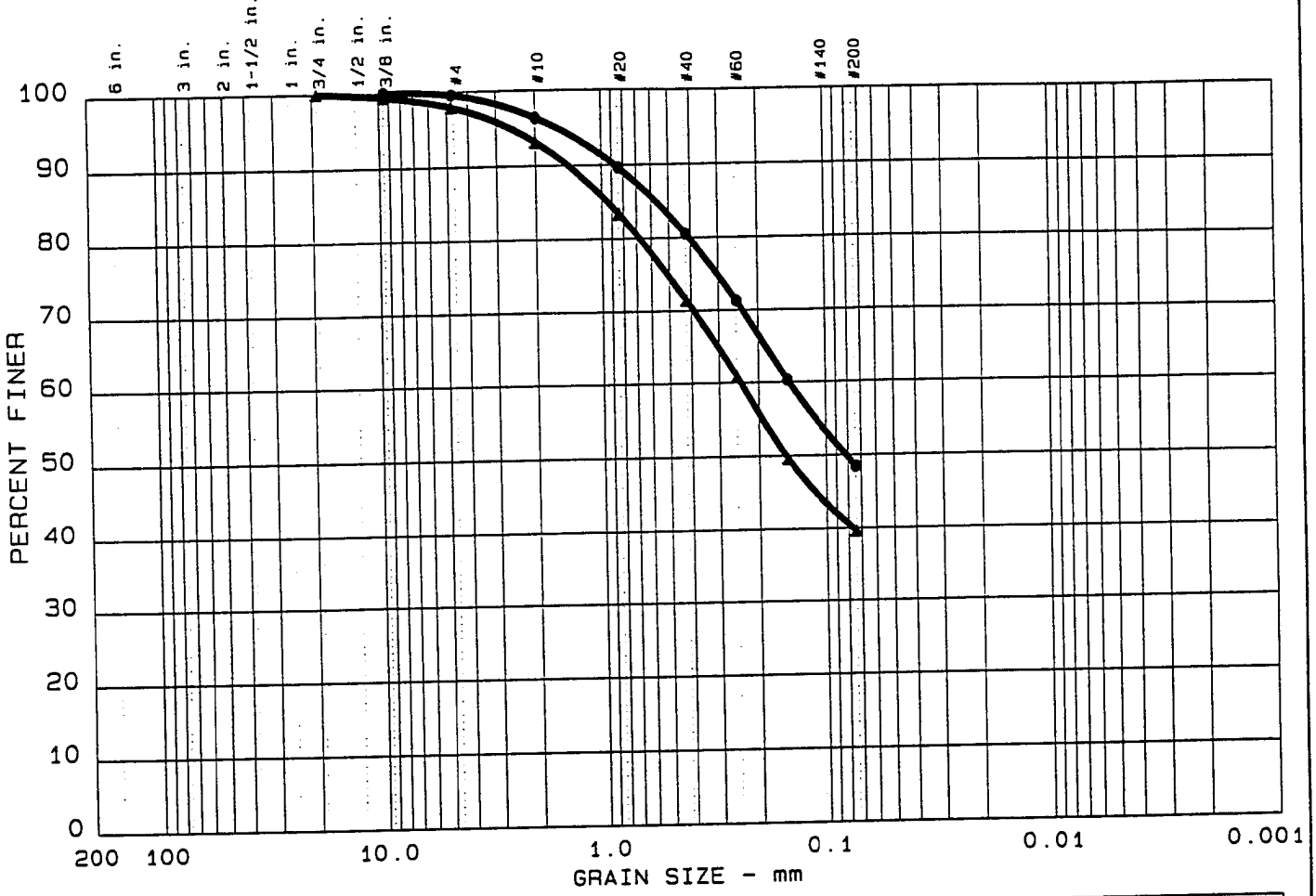
Constant Head Permeability and Classification Tests

Law Engineering Project 226-09423-01

Sample ID	Dry Density (pcf)	Moisture Content (%)	Coefficient of Permeability (cm/sec)	Head (cm)
SB-2A	102.5	8.9	3.0×10^{-7}	140.68
SB-3A	102.1	6.9	4.3×10^{-7}	140.68

Comments: Tested at 2 psi head difference.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.4	51.1	48.5	
▲	0.0	2.1	58.3	39.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	26	11	0.57	0.15	0.08					
▲	24	9	0.93	0.24	0.15					

	MATERIAL DESCRIPTION	USCS	AASHTO
●			
▲			

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.
● Location: SB-2A
▲ Location: SB-3A

Date: AUGUST 29, 1994

Remarks:

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING

Figure No. _____

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-2	Page 1 of 1
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height:	Land Surface Elevation:
Lat: Long:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Hollow Stem	Sampling Method:	
Grout: 5% bentonite 0 – 4.5 ft	Seal: 4.5 – 7 ft	Gravel Pack: FX 50 sand 7 – 19 ft	
Casing Type: Sch 40 PVC	Diameter: 2" Depth: 0 – 9 ft		Hole Dia.: 4"
Screen Type: Sch 40 PVC	Diameter: 2" Slot: 0.010–inch	Depth: 9 – 19 ft	Total Depth: 19 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 19.0 ft: Grayish Brown Sandy Fine Silt	0
				Grout (0 – 4.5 ft)
				Bentonite (4.5 – 7 ft)
		10		10
				Casing to 9 ft
				Sand (7 – 19 ft)
				Screen (9 – 19 ft)
			Boring Terminated at 19 ft	
		20		20
		30		30
		40		40
		50		50
		60		60

c:\123r34\0675mw12.wk3

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-3	Page 1 of 1
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Paul Banks	Development Method:	
Tests:	Drilling Method: Hollow Stem	Sampling Method:	
Grout: 5% Bentonite	Seal: 6 – 8 ft	Gravel Pack: 80/20 Silica Sand (8 to 20 ft)	
Casing Type:	Diameter:	Depth: 0 – 10 ft	Hole Dia.: 4"
Screen Type:	Diameter:	Slot: 0.010 inch Depth: 9 – 19 ft	Total Depth: 20 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0		0
			3.0 – 5.0 ft: Brownish Green Fine Grained Sand with Little Silt	Grout (0 – 6 ft)
				Bentonite (6 to 8 ft)
			8.0 – 10.0 ft: Saprolite: Greenish Brown Fine Grained Silty Sand with Trace Clay	Casing (0 to 10 ft)
		10		10
			13.0 – 15.0 ft: Saprolite: Greenish Brown Fine Grained Silty Sand with Trace Clay	
			18.0 – 20.0 ft: Partially Weathered Bedrock: Brown Silty Coarse Sand with Rock Fragments	Sand (8 – 20 ft)
		20	Boring Terminated at 20 ft	20 Screen (10 to 20 ft)
		30		30
		40		40
		50		50
		60		60

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Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-4 Page 1 of 1
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Air Rotary	Sampling Method:
Grout: 5% bentonite	Seal: 40-44 ft	Gravel Pack: FX 50 sand 44-67 ft
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 - 47 ft	Hole Dia.: 6"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch Depth: 47-67 ft	Total Depth: 67 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0	0 - 30.0 ft: Tan Silty Fine Sand	0
		10		10
		20		20
		30	30.0 - 40.0 ft: Brown Silty Fine Sand	30
				Grout (0 - 40 ft)
		40	40.0 - 50.0 ft: Partially Weathered Bedrock Sampled as Tan Silty Fine Medium Sand with Rock Fragments	40
				Bentonite (40 - 44 ft)
				Casing to 47 ft
		50	50.0 - 67.0 ft: Gray Silty Medium Sand with Rock Fragments	50
		60		60
				Sand (44 - 67 ft)
				Screen (47 - 67 ft)
			Boring Terminated at 67.0 ft	
		70		70

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Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-5	Page 1 of 2
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Air Rotary	Sampling Method:	
Grout: 5% bentonite 0-52 ft	Seal: 47-52 ft	Gravel Pack: FX 50 sand 40-75 ft	
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 - 45 ft		Hole Dia.: 6"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch	Depth: 55-75 ft	Total Depth: 75 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0	0 - 10.0 ft: Light Tan Silty Fine Sand	0
		10	10.0 - 20.0 ft: Light Gray Silty Fine Sand	10
		20	20.0 - 70.0 ft: Bedrock Sampled as Gray Silty Coarse Sand with Rock Fragments Adundant	20
		30		30
		40		40
				Grout (0 - 47 ft)
		50		50 Bentonite (47 - 52 ft)
				Casing to 55 ft
		60		60

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Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-5	Page 2 of 2
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Air Rotary	Sampling Method:	
Grout: 5% bentonite 0-52 ft	Seal: 47-52 ft	Gravel Pack: FX 50 sand 40-75 ft	
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 - 45 ft		Hole Dia.: 6"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch	Depth: 45-75 ft	Total Depth: 75 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		60		60
		70	70 - 75 ft: Gray Silty Medium Sand with a Few Pebbles	70
				Sand (52 - 75 ft) / Screen (55 - 75 ft)
			Boring Terminated at 75 ft	
		80		80
		90		90
		100		100
		110		110
		120		120

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ESI
ECOLOGICAL SERVICES, INC.

P.O. Box 12146, Charlotte, North Carolina 28220

Phone (704) 522-1111
Fax (704) 521-8004

September 1, 1994

Mr. Larry Griffin, Sr.
19141 Highway 73 West
Davidson, North Carolina 28036

Subject: Report of Hydrogeological Assessment Addendum
(Phase II Unpermitted Area)
North Mecklenburg Landfill
15300 Holbrooks Road
Huntersville, North Carolina
ESI Project No. ES-0675

Dear Mr. Griffin:

Based on your authorization to proceed, Ecological Services, Inc. (ESI) has completed addendum hydrogeological assessment activities associated with the Phase II unpermitted area at the subject site. During the addendum activities, depth to bedrock was re-assessed and undisturbed soil samples were obtained. This report describes the work performed during the addendum assessment and presents the results obtained from additional soil testing.

We appreciate the opportunity to continue to provide our environmental services on this project. Please do not hesitate to contact me if you have any questions.

Sincerely,

ECOLOGICAL SERVICES, INC.

Paul A. Banks
Project Geologist

Enc(s)

SECTION 9

FILE

REPORT
of
HYDROGEOLOGICAL ASSESSMENT
(PHASE II UNPERMITTED AREA)

North Mecklenburg Landfill
15300 Holbrooks Road
Huntersville, North Carolina

ESI Project No. ES-0675

July 8, 1994

-Prepared for-

Mr. Larry Griffin, Sr.
19141 Highway 73 West
Davidson, North Carolina 28036

-Prepared by-

Ecological Services, Inc.
P. O. Box 12146
Charlotte, NC 28220

Paul A. Banks
Project Geologist

Thomas H. Bolyard, P.G.
Senior Hydrogeologist
N.C. Registration No. 0492

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Hydrogeologic Assessment

Proposed Monitoring Plan

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1.0 PROJECT INFORMATION

The North Mecklenburg Landfill site is located at 15300 Holbrooks Road in Huntersville, North Carolina (Figure 1). The subject site is an active construction and debris (C & D) landfill and consists of approximately 71.6 acres. The C & D landfill permit was issued on June 24, 1993 by the North Carolina Department of Environment, Health and Natural Resources, Division of Solid Waste Management (NCDEHNR). As a part of the permit application requirements, Ecological Services, Inc. (ESI) was contracted by Mr. Larry Griffin, Sr. to perform a hydrogeological assessment, dated June 18, 1992 (ESI Job No. ES-0153), which was submitted to the State for their review and comment.

The original site survey, which was performed as part of the proposed monitoring well program outlined in our June 18, 1992 report, was incorrectly performed and thus, permanent monitoring well MW-4 was located in an unpermitted section of the landfill. This well was utilized by Mr. Larry Griffin, Sr. and his staff to determine the proposed permitted landfill area. Due to this incorrect survey, construction and debris material was landfilled outside the Phase I permitted area (Figure 2).

As soon as Mr. Larry Griffin, Sr. realized that the landfilling operations extended beyond the permitted area, he contacted the Mecklenburg County Department of Environmental Protection (MCDEP) and the NCDEHNR, Solid Waste Section. Subsequently, a meeting was held on November 30, 1993 with individuals from the Solid Waste Section and the MCDEP. During this meeting, Mr. Julian M. Foscue, III of the Solid Waste Section banned any further landfilling operations in the unpermitted area and ordered that a hydrogeological investigation of this area be performed to determine subsurface conditions and groundwater flow direction. ESI performed a hydrogeological assessment on the portion of the unpermitted area on which landfilling had occurred, and submitted the findings of the assessment to the MCDEP and NCDEHNR on March 8, 1994 (ESI Job No. 0675).

This report documents the continued hydrogeologic assessment of the remaining unpermitted portion of the 71.6 acre Phase II area (Figure 2), and was conducted by ESI during April, May, and June of 1994.

2.0 FIELD EXPLORATION

2.1 Soil Test Borings

Seven soil test borings (B-4, B-5, B-6, B-7, SB-1, SB-2, and SB-3), and five floor sample excavations (F-1, F-2, F-3, F-4, and F-5) were conducted during the assessment to classify subsurface lithology and soil geotechnical characteristics within the Phase II area (Figure 3).

Soil borings B-4, B-5, B-6, and B-7 were advanced to assess cover soil characteristics within the Phase II area. Soil samples were collected from each of these borings at a depth of 0 to 2 feet utilizing a stainless steel hand auger. Subsequent constant head permeability and classification tests were conducted on the soil samples by Law Engineering, Inc.

Soil borings SB-1, SB-2, and SB-3 were advanced on May 11, 1994 to assess subsurface lithologic conditions within the Phase II area. Soil samples were collected and described every five feet during the boring advancement. The borings were drilled with an all terrain drill rig employing hollow stem steel augers. Soil sampling was performed in general accordance with ASTM D1586 utilizing a standard 1.4-inch I.D., 2-inch O.D., split-tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140 pound hammer falling 30 inches. Soil boring records are included in Appendix A of this report.

Five floor soil samples (F-1, F-2, F-3, F-4, and F-5) were collected within the Phase II area to assess soil characteristics at the proposed base of the landfill cell. Each floor soil sample was collected at a depth of approximately 20 feet below ground surface utilizing a trackhoe provided by Mr. Larry Griffin, Sr. Following the collection of the five floor soil samples, constant head permeability and classifications tests were performed on each sample by Law Engineering, Inc.

2.2 Temporary Piezometer Installation

Seven temporary piezometers (PZ-1 through PZ-7) were installed to depths ranging from 20 to 85 feet in the Phase II area to assess depth to groundwater and direction of groundwater flow. The locations of the newly installed piezometers are indicated on the attached Site Configuration Map (Figure 2).

The temporary piezometers were constructed with a 2-inch diameter, Schedule 40, PVC riser section with 10 to 20 feet of 2-inch diameter, schedule 40 PVC 0.010-inch slotted screen. Washed sand backfill was placed in the boring annulus to at least two feet above the top of the well screen, and sealed with at least two feet of bentonite. The remainder of the borehole was then backfilled with native material to the ground surface. Temporary piezometer boring records are included in Appendix A of this report.

2.3 Permanent Monitoring Well Installation

Eight permanent groundwater monitoring wells (MW-2, MW-3, MW-4, MW-6, MW-7, MW-8, MW-9, and MW-10) are located within the Phase II area (Figure 2). Each permanent monitoring well was installed to aid in present and future groundwater flow determination, lithologic characterization, and to provide groundwater monitoring points for semi-annual groundwater quality analysis. Washed sand backfill was placed in the annulus of each monitoring well boring to at least two feet above the top of the well screen, followed by a two-foot thick (minimum) bentonite seal, and overlain by a cement bentonite mixture which filled the boring annulus to the ground surface. In addition, a lockable stand-up steel protective cover was placed over each well and secured with a lock. Groundwater monitoring well boring records are included in Appendix A of this report.

3.0 AREA GEOLOGY

The site is located within the Charlotte Belt Geologic Province of North Carolina. The rocks of the Charlotte Belt range in age from late Proterozoic to Silurian or Middle Paleozoic. The

dominant rock types in the Charlotte Belt are metamorphosed intrusive rocks, with large areas of metavolcanic rocks, and lesser amounts of metasedimentary rocks (Goldsmith and others, 1988). Surface layers in the area of the Charlotte Belt consist of weathered bedrock which granulates readily near the surface of the ground producing cover soils which may be composed of individual quartz, hornblende and feldspar crystals. The bedrock at the subject site is characterized as metamorphosed quartz diorite and toalite, usually medium to coarse-grained with evident foliation. The diorite is composed dominantly of plagioclase, quartz and biotite, with varying amounts of hornblende and epidote.

4.0 SUBSURFACE CONDITIONS

4.1 Cover Soils

Characterization of surface cover soil conditions was conducted on soil samples obtained from borings B-4 through B-7. The cover soil samples were obtained from hand auger cuttings at a depth of 0-2 ft. below grade. Each collected soil sample was placed in a new 5 gallon plastic bucket, covered and delivered to Law Engineering to perform testing according to the appropriate sections of the following ASTM standards:

ASTM D 698	"Standard Test Method for Moisture Density Relations of Soils and Soil Aggregate Mixtures Using a 5.5 lb. (2.49 kg) Rammer and 12 in. (305 mm) Drop"
ASTM D 5084	"Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"
ASTM D 4318	"Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"

ASTM D 422 "Standard Test Method for Particle-Size Analysis of Soils"

The results of Constant Head Permeability Testing and Grain Size Distribution Testing on each of the cover soil samples are summarized in Tables 1 and 2 respectively. The Report of Laboratory Constant Head Permeability and Classification Tests (Law Job No. 226-09423-01, dated January 6, 1994) is included as Appendix B.

The residual soil is fairly consistent across the Phase II area. A 12 to 20 foot surface layer of saprolitic brownish gray silty medium sand was identified at soil boring locations SB-1, SB-2, and SB-3. The soils became more resistant to drilling activities with depth. Evidence of the parent material in the form of rock fragments and increased grain size were also noted with increasing boring depth. Partially weathered bedrock was encountered in soil borings SB-1, SB-2, and SB-3, piezometer PZ-6 and monitoring well MW-7 ranging from 12 feet in SB-3 to 20 feet in MW-7. Cross section traverse orientations associated with the previously mentioned borings are illustrated in Figure 4. Cross sections A-A' and B-B' are included as Figures 5 and 6.

Lithologic tie lines connecting soil borings in cross sections A-A' and B-B' designate inferred lithologic changes in the residual soils located between borings. Actual lithologic changes may be more gradational or abrupt than depicted.

The above descriptions provide a general screening of the subsurface conditions encountered within the cover soils of the Phase II area. The attached soil boring records (Appendix A) contain detailed information recorded at each boring location.

4.2 Cell Floor Soils

Five floor soil samples (F-1 through F-5) were collected in the Phase II area at depths projected to be the floor of the fill area (Figure 3). Each soil sample approximates the soil characteristics associated with the residual/fill material contact in the area sampled.

Characterization of cell floor soil conditions was conducted on each sample obtained from samples F-1 through F-5. The floor soil samples were obtained from excavated soil obtained with a track hoe at an approximate depth of 20 feet below ground surface at each sampling location. Each collected soil sample was placed in a new 5 gallon plastic bucket, covered and delivered to Law Engineering to perform testing according to the appropriate sections of the following ASTM standards:

ASTM D 698	"Standard Test Method for Moisture Density Relations of Soils and Soil Aggregate Mixtures Using a 5.5 lb. (2.49 kg) Rammer and 12 in. (305 mm) Drop"
ASTM D 5084	"Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"
ASTM D 4318	"Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
ASTM D 422	"Standard Test Method for Particle-Size Analysis of Soils"

The results of Constant Head Permeability Testing and Grain Size Distribution Testing on each of the cell floor soil samples are summarized in Tables 3 and 4 respectively. The Report of Laboratory Constant Head Permeability and Classification Tests (Law Job No. 226-09423-01, dated February 14, 1994) is included in Appendix C.

5.0 HYDROGEOLOGIC CONDITIONS

5.1 Regional Hydrogeology

Groundwater recharge in this area of North Mecklenburg County is derived from precipitation. The average annual rainfall of the area is approximately 47 inches. The surficial materials at

many places in the County are composed of relatively impermeable saprolite and the fraction of precipitation that reaches the water table may be less than one-third. Seasonal fluctuation of the water table may be considerable during dry or wet seasons. However, on average the net change in water level elevation is small, which indicates that the average annual discharge of groundwater is about equal to the average annual recharge.

Groundwater movement in crystallized rocks such as metamorphosed quartz diorite, which have little primary pore space is dependent upon secondary permeabilities created by features such as joints, fracture cleavage planes, planes of foliation, bedding planes, and solution channels.

The porosity of a rock is the percentage of the total volume that is occupied by the interstices. The porosity of different rock materials may cover a wide range. For example some clays may have porosity of more than 50 percent, while some crystallized rock may be less than 1 percent pore space.

A material may have a high porosity and yet yield little water. For example, clays have porosities as high as 50 percent, and yet yield little due to the flat particle shape which tends to layer and trap water. The same is true for crystallized rocks such as quartz diorite where the interstices are isolated or poorly interconnected.

5.2 Site Hydrogeology

The site contains an aquifer which appears to extend into bedrock within both the Phase I and Phase II areas of the subject site. Bedrock was encountered at depths ranging from 20 feet below grade in MW-6 to 30 feet below grade in PZ-2. The bedrock consists of a metamorphosed quartz diorite. This diorite, in a semi-weathered state, is a dark blue or gray medium textured rock composed of quartz, hornblende and feldspar, containing varying amounts of biotite, pyroxene and other accessory minerals. Surface layers consist of weathered bedrock or saprolite, which granulates readily near the surface of the ground. The cover soils are typically composed of individual quartz, feldspar and hornblende crystals. In all the wells drilled in this phase of the project, the top of bedrock was encountered prior to the water table, with the exception of PZ-6.

During the installation of PZ-6 groundwater was encountered at approximately 8 feet and bedrock was encountered at 20 feet. Water bearing fractures were encountered in all wells in the top 10 feet of bedrock with the exception of well MW-6. Considering the high topographic elevation of well MW-6, apparent water bearing fractures were not encountered until reaching a vertical depth of approximately 90 feet below grade.

The top of casing elevation for each piezometer and monitoring well was surveyed by Richard Boyd Brooks Surveyors. The original survey was conducted on October 16, 1993, and updated on February 22, 1994 and June 10, 1994, as additional monitoring points were installed. Each survey was conducted using the same common datum point. This information was used to construct a phreatic surface contour map for the subject site (Figure 7). Water levels were measured in monitoring wells MW-2 through MW-10, excluding MW-5, and in piezometers PZ-1 through PZ-5 on February 10, 1994 and May 5, 1994 (Table 5). Each of the aforementioned monitoring points, with the addition of PZ-6 and PZ-7, were also gauged on May 27, 1994 (Table 5). The phreatic surface illustrated in Figure 7 was constructed utilizing the most recent water table elevation data obtained on May 27, 1994. A contour modeling program (SURFER version 4), utilizing X, Y, and Z (water table elevation) coordinate data for each monitoring location, was used in the construction of Figure 7. SURFER creates a regularly spaced grid from the coordinate data utilizing Kriging statistical interpolation.

The first determination in constructing the groundwater contour map was to ascertain if the bedrock monitoring wells are at atmospheric pressure and thus could be used in preparing a groundwater flow map in conjunction with data from the unconfined aquifer wells to the north (MW-1 through MW-5). The upper bedrock can be very competent with a few small fractures, or it can be highly fractured, which causes it to act much like an unconfined aquifer. An analysis of the static water levels and the drilling rates of the bedrock were all considered, and it was concluded that the data from all wells could be used in developing the groundwater contour map.

Groundwater flow within of the unconfined aquifer appears to follow the local topography within the immediate areas of the Phase I and Phase II C & D cell areas. The Phreatic Surface Contour Map indicates that the primary groundwater flow direction is to the northwest in the northern portion of the site and to the southeast in the southern portion of the site.

Geologic media variations in lithology and structures create directional and spatial variances in hydraulic conductivity (K), and well yield. Therefore, subsurface parameters, at best, are averages computed with various mathematical and graphical solutions utilizing empirical data and literature based assumptions of aquifer conditions. The assumptions in the calculation of hydraulic conductivity are that the aquifer is unconfined, homogeneous, isotropic, of infinite areal extent, and tested under non-steady state conditions. In-situ permeability ("slug") testing was conducted using piezometer PZ-7, to determine hydraulic conductivity. The Bouwer and Rice (1976) Method was used, assuming a partially penetrating screen and a radius which included the sand pack. The hydraulic conductivity calculated for PZ-7 is (5.59×10^{-6} cm/sec). This value agrees closely with the K values obtained in an earlier ESI report dated June 18, 1992. Appendix D contains graphs of the in-situ permeability test and the calculations used.

PROPOSED MONITORING PLAN

1.0 MONITORING PLAN OBJECTIVE

The proposed groundwater monitoring plan is intended to determine the on-going groundwater quality associated with the continued operation of the Phase I and Phase II C & D landfill tracts. Groundwater sampling activities will be performed semi-annually. This plan presents our recommended groundwater monitoring program which includes well locations, and groundwater sampling and chemical testing.

2.0 MONITORING WELL SAMPLING PLAN

Ecological Services, Inc. recommends that a groundwater monitoring program be implemented following the Phase II permitting of the subject site. To ensure adequate site coverage, ESI proposes that the following groundwater monitoring locations be sampled:

Site Border Monitoring Points	Site Interior Monitoring Point
MW-4	MW-3
MW-5	
MW-6	
MW-7	
MW-8	
MW-9	
MW-10	

Water levels will be measured prior to each sampling event with an oil/water interface probe and groundwater elevations will be computed. The monitoring wells will then be purged by bailing or pumping at least 4 times the water volume within the well, including the sand pack, or to dryness. After allowing each well to recover at least 60% of the initial head, or 24 hours, whichever occurs first, the monitoring well will be sampled using disposable approved sampling bailers. Prior to the time the water samples are collected from the wells, pH, temperature, and specific conductivity will be recorded in the field to ensure that representative groundwater is being obtained for chemical analysis. One field blank sample will be obtained in the field by

pouring distilled water into a sampling bailer and then decanting the contents of the bailer into the appropriate glass container. A laboratory trip blank will also accompany the groundwater samples.

All groundwater samples will be properly preserved and shipped to a North Carolina approved analytical laboratory for chemical analysis by EPA Method 8260 (volatile organics) and the 15 total metals as required by the Division of Solid Waste Management. Appropriate chain-of-custody records will be maintained during each stage of sample collection and transportation.

3.0 REPORT PREPARATION

Within 30 days of the completion of each semi-annual sampling event, a summary of our field activities, collected data, and laboratory results will be provided to the DEHNR-Solid Waste Management in a letter report.

REFERENCES

Bouwer, H., and Rice, R.C., 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely of Partially Penetrating Wells, American Geophysical Union, 1976.

Goldsmith, R., Milton, D.J., Horton, J.W. Jr., 1988, Geologic Map of the Charlotte 1 X 2 Quadrangle, North Carolina and South Carolina: Department of the Interior U.S. Geologic Survey.

TABLES

TABLE 1
CONSTANT HEAD PERMEABILITY TESTING DATA
(Cover Soil Material)
North Mecklenburg Landfill
Huntersville, North Carolina

Sample I.D.	Coefficient of Permeability (cm/sec)
B-4	3.2×10^{-5}
B-5	1.3×10^{-4}
B-6	1.1×10^{-4}
B-7	5.3×10^{-5}

TABLE 2
SUMMARY OF GRAIN SIZE DISTRIBUTION TESTING
(Cover Soil Material)
North Mecklenburg Landfill
Huntersville, North Carolina

Sample I.D.	% + 3"	% Gravel	% Sand	% Silt	% Clay
B-4	0.0	5.3	67.3	17.5	9.9
B-5	0.0	4.0	85.3	4.8	5.9
B-6	0.0	28.0	68.2	1.4	2.4
B-7	0.0	10.5	82.3	3.3	3.9

TABLE 3 CONSTANT HEAD PERMEABILITY TESTING DATA (Floor Soil Material) North Mecklenburg Landfill Huntersville, North Carolina	
Sample I.D.	**Coefficient of Permeability (cm/sec)**
1	6.7×10^{-6}
2	2.9×10^{-5}
3	5.2×10^{-6}
4	2.9×10^{-4}
5	1.2×10^{-6}

6.508×10^{-5}

TABLE 4
SUMMARY OF GRAIN SIZE DISTRIBUTION TESTING
(Floor Soil Material)
North Mecklenburg Landfill
Huntersville, North Carolina

Sample I.D.	% + 3"	% Gravel	% Sand	% Silt	% Clay
1	0.0	1.0	87.1	8.3	3.6
2	0.0	3.8	78.8	11.0	6.4
3	0.0	0.0	82.4	9.2	8.4
4	0.0	0.0	82.0	13.2	4.8
5	0.0	1.7	84.5	8.9	4.9

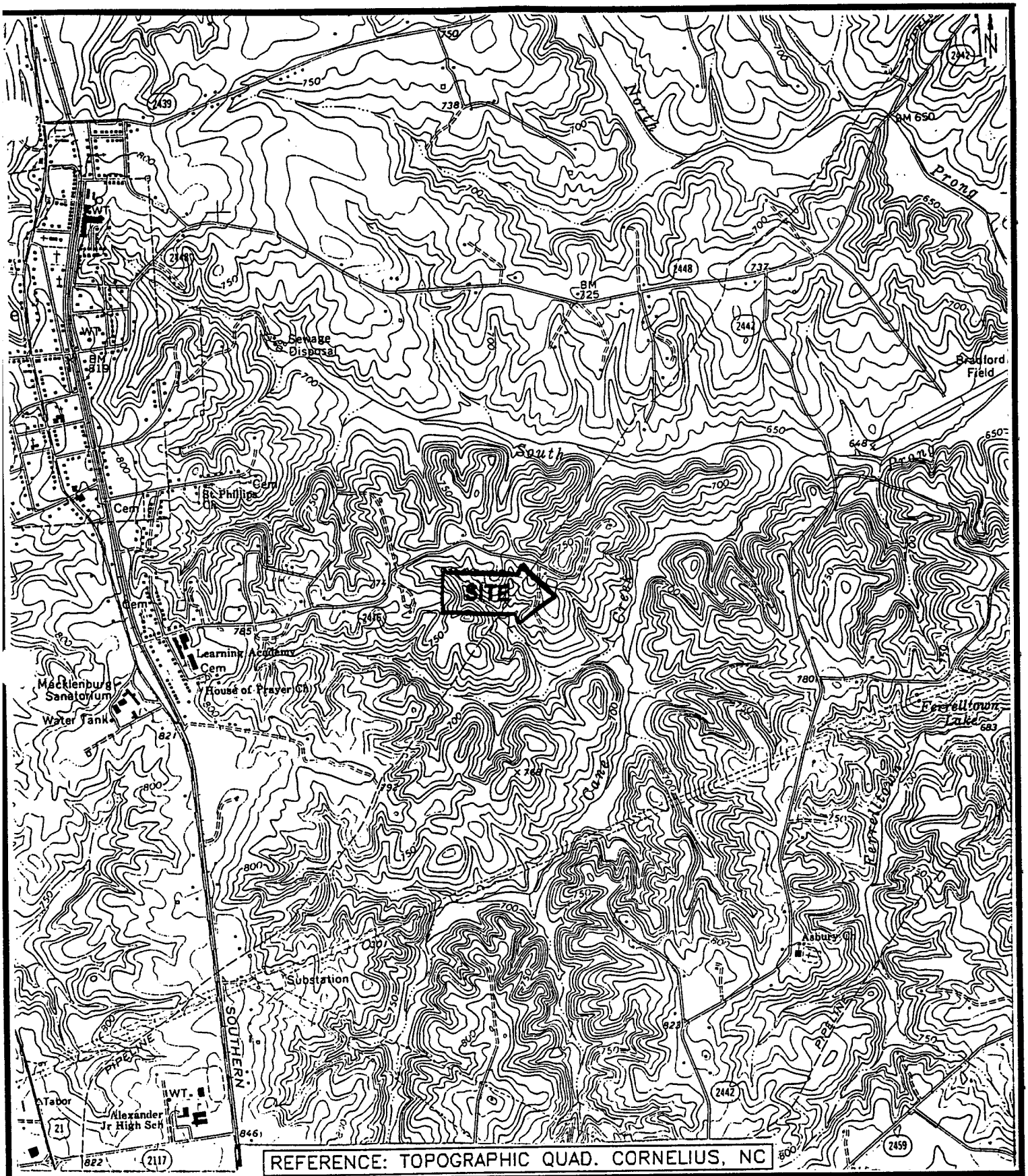
TABLE 5
SUMMARY OF GROUNDWATER ELEVATION DATA
North Mecklenburg Landfill
Huntersville, North Carolina

Well No.	Date	Surveyed Elevation - TOC (Ft)	Depth to Water - TOC (Ft)	Groundwater Elevation (Ft)
MW-2	02-10-94	681.00	13.59	667.41
	05-05-94	681.00	12.40	668.60
	05-27-94	681.00	16.8	664.19
MW-3	02-10-94	706.44	16.96	689.48
	05-05-94	706.44	14.58	691.86
	05-27-94	706.44	17.57	688.87
MW-4	02-10-94	718.00	28.99	689.01
	05-05-94	718.00	28.95	689.05
	05-27-94	718.00	29.22	688.78
MW-6	02-10-94	740.62	58.59	682.03
	05-05-94	740.62	58.15	682.47
	05-27-94	740.62	50.18	690.44
MW-7	02-10-94	738.62	51.36	687.26
	05-05-94	738.62	50.93	687.69
	05-27-94	738.62	50.91	687.71
MW-8	02-10-94	767.25	69.71	697.54
	05-05-94	767.25	69.42	397.83
	05-27-94	767.25	69.45	697.80
MW-9	02-10-94	709.10	18.73	690.37
	05-05-94	709.10	18.42	690.68
	05-27-94	709.10	18.92	690.18
MW-10	02-10-94	692.64	11.85	680.79
	05-05-94	692.64	12.20	680.44
	05-27-94	692.64	11.01	681.63
PZ-1	02-10-94	717.51	27.28	690.23
	05-05-94	717.51	27.66	689.85
	05-27-94	717.51	27.91	689.60
PZ-2	02-10-94	714.54	28.78	685.76
	05-05-94	714.54	29.97	684.57
	05-27-94	714.54	30.61	683.93

TABLE 5
(Continued)

Well No.	Date	Surveyed Elevation - TOC (Ft)	Depth to Water - TOC (Ft)	Groundwater Elevation (Ft)
PZ-3	02-10-94	735.00	38.21	696.79
	05-05-94	735.00	37.77	697.23
	05-27-94	735.00	38.65	696.35
PZ-4	02-10-94	724.63	29.14	695.49
	05-05-94	724.63	28.88	695.75
	05-27-94	724.63	28.83	695.80
PZ-5	02-10-94	737.64	49.26	688.39
	05-05-94	737.65	48.25	689.40
	05-27-94	737.65	49.27	688.38
PZ-6	05-27-94	696.59	8.30	688.29
PZ-7	05-27-94	744.78	47.93	693.85

FIGURES



REFERENCE: TOPOGRAPHIC QUAD. CORNELIUS, NC

DATE: 07-07-94

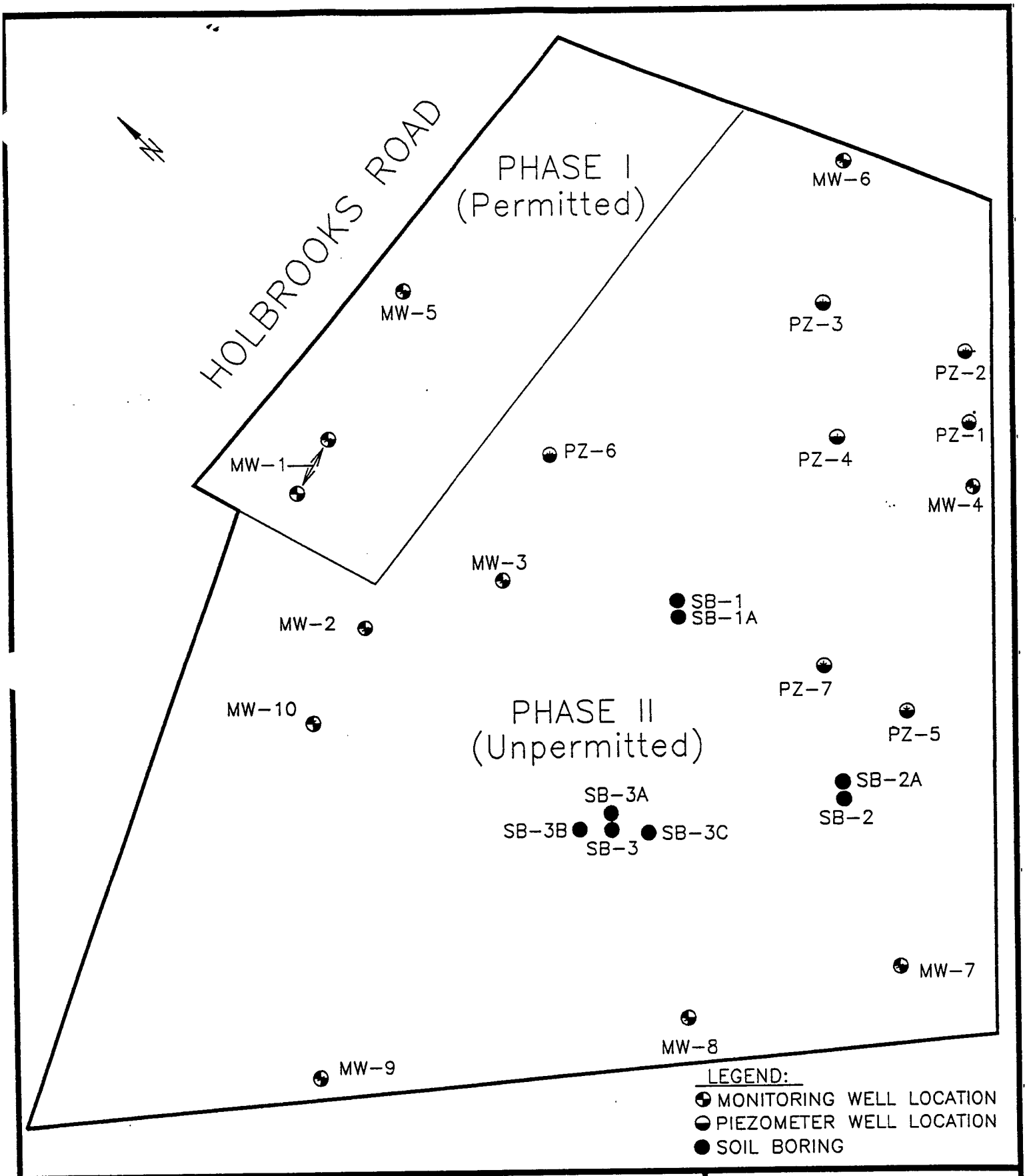
SCALE 1:24,000

ESI

FIGURE 1: SITE LOCATION MAP

N. MECK. LANDFILL

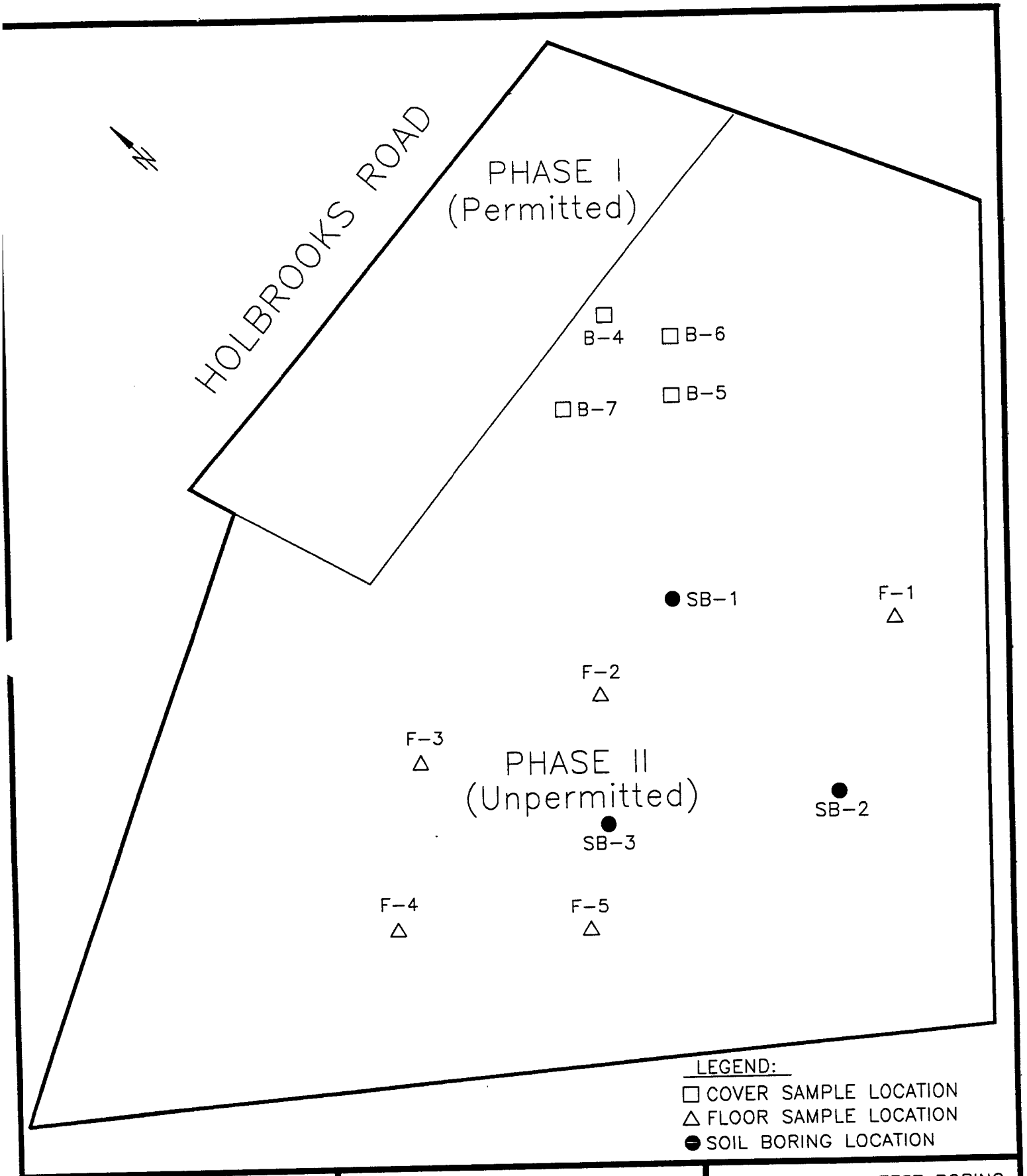
HUNTERSVILLE, NC



DATE: 07-05-94
SCALE: 1" = 200'
DWG. NO.: ES-675-2

ESI

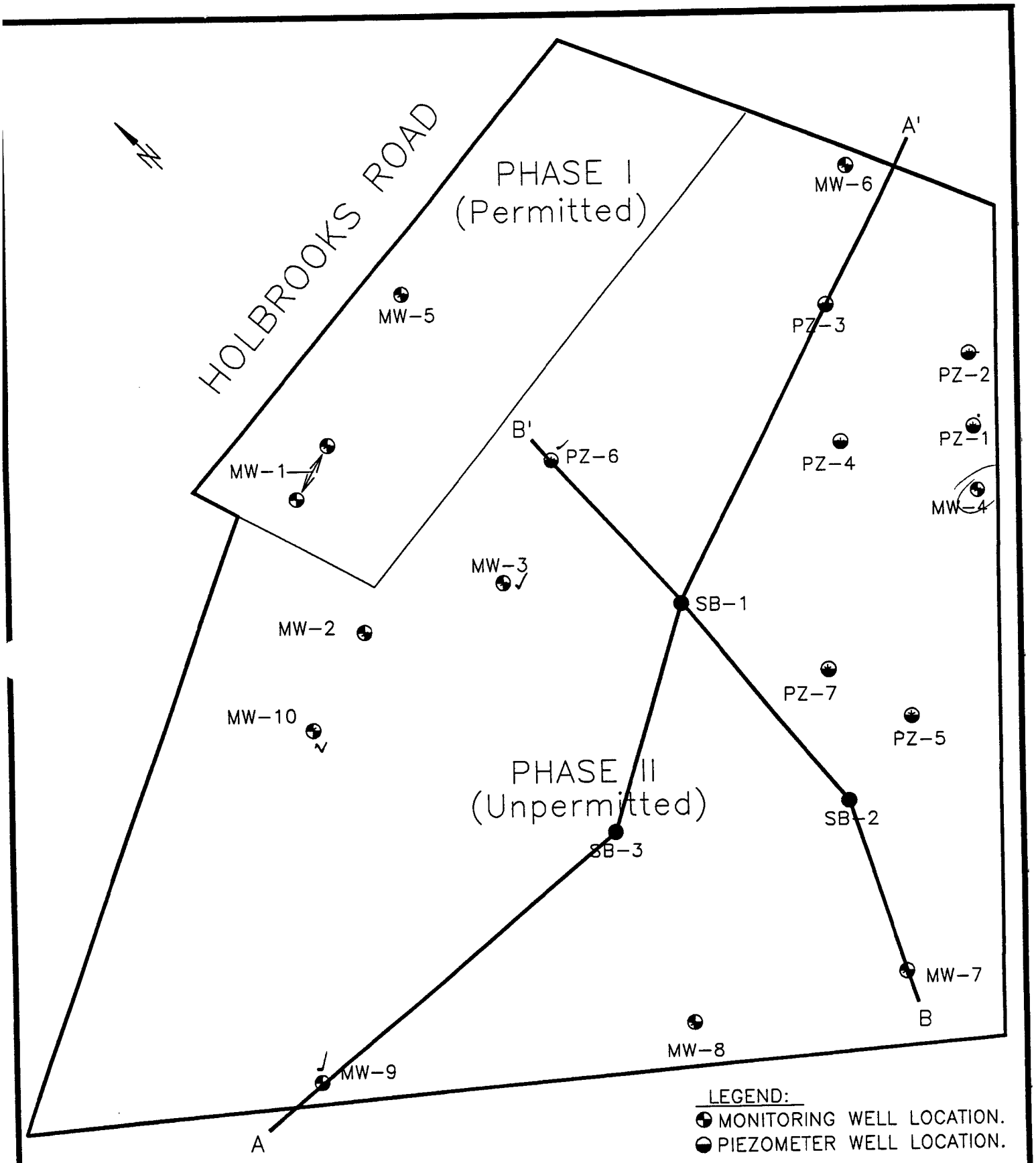
FIGURE 2: SITE CONFIGURATION MAP
N. MECK. LANDFILL
HUNTERSVILLE, NC



DATE: 07-05-94
SCALE: 1" = 200'
DWG. NO.: ES-675-3

ESI

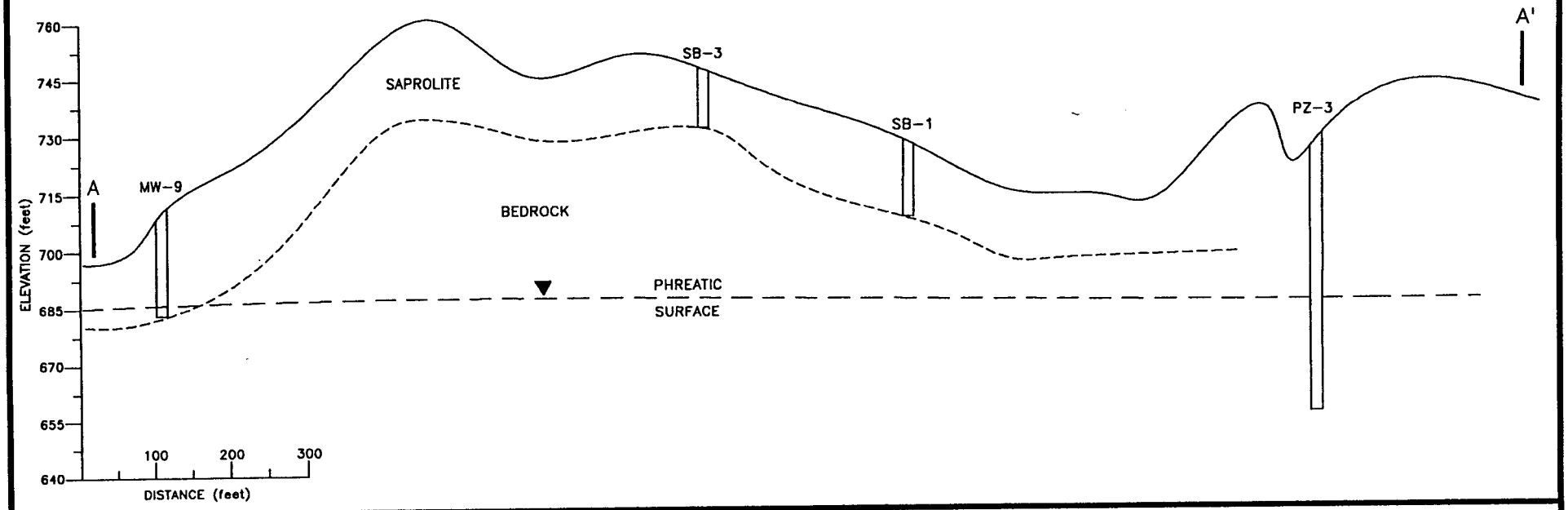
FIGURE 3: SOIL TEST BORING LOCATION MAP
N. MECK. LANDFILL
HUNTERSVILLE, NC

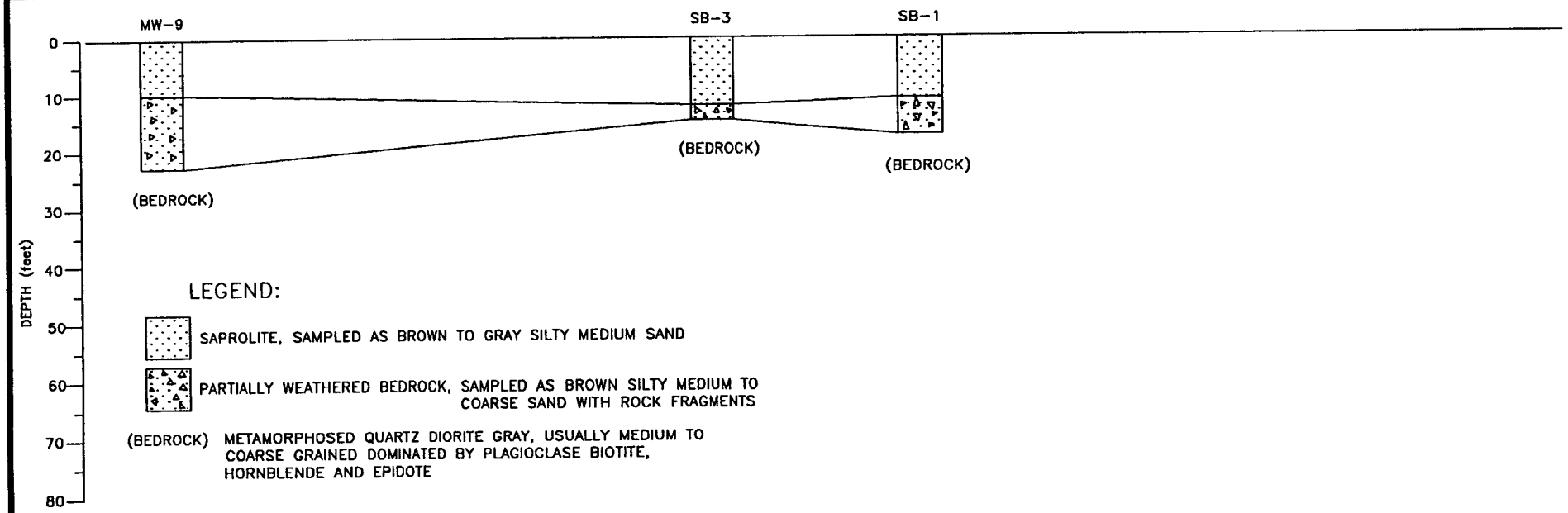


DATE: 07-05-94
SCALE: 1" = 200'
DWG. NO.: ES-675-4

ESI

FIGURE 4: CROSS SECTION DESIGNATION MAP
N. MECK. LANDFILL
HUNTERSVILLE, NC





LEGEND:

SAPROLITE, SAMPLED AS BROWN TO GRAY SILTY MEDIUM SAND

PARTIALLY WEATHERED BEDROCK, SAMPLED AS BROWN SILTY MEDIUM TO COARSE SAND WITH ROCK FRAGMENTS

(BEDROCK) METAMORPHOSED QUARTZ DIORITE GRAY, USUALLY MEDIUM TO COARSE GRAINED DOMINATED BY PLAGIOCLASE BIOTITE, HORNBLENDE AND EPIDOTE

DATE: 07-06-94

SCALE: ON DRAWING

DWG. NO.: ES-675-5

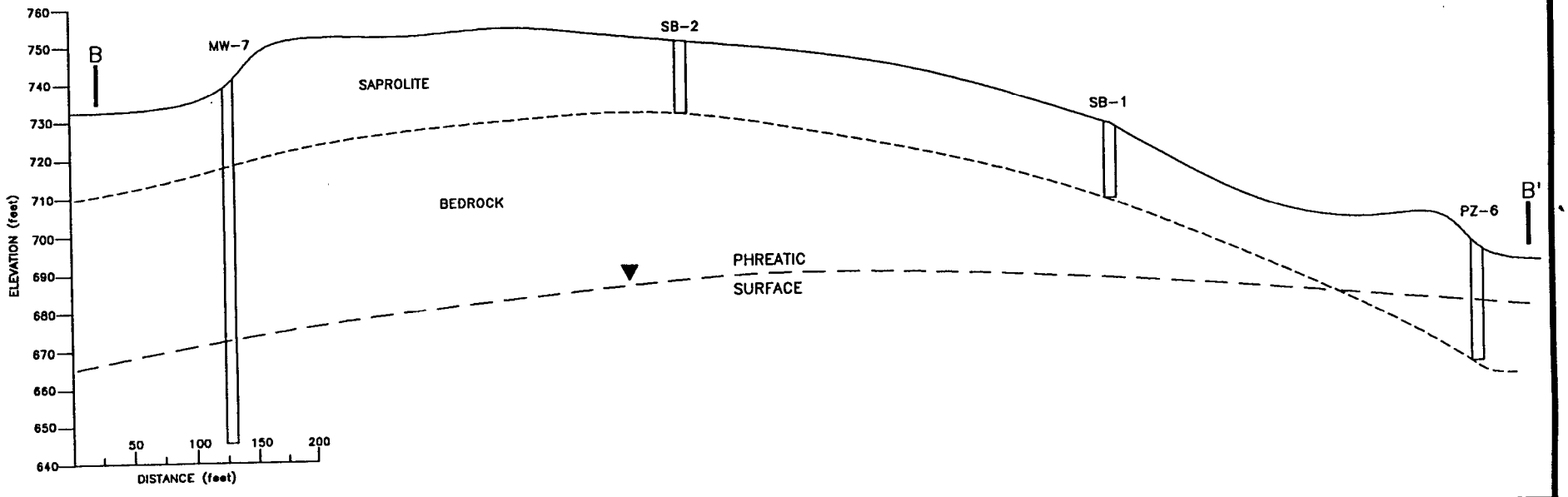
ESI

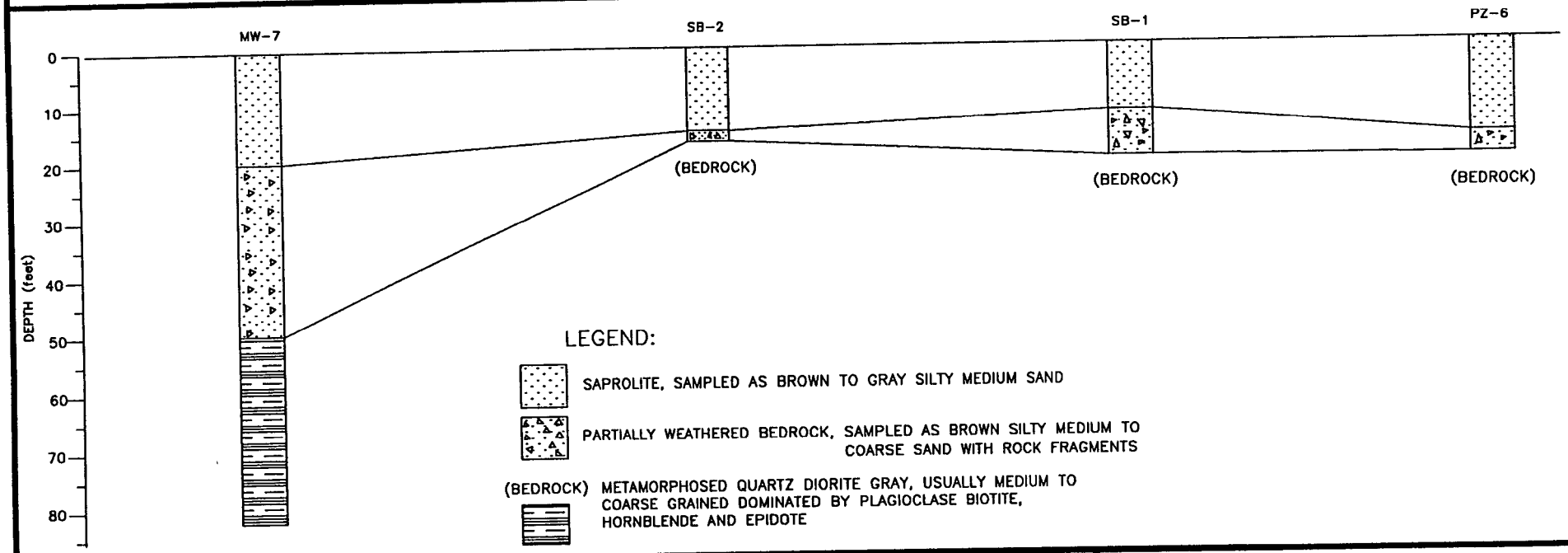
ECOLOGICAL SERVICES, INC.

FIGURE 5: CROSS SECTION A – A'

NORTH MECKLENBURG LANDFILL

HUNTERSVILLE, NC





DATE: 07-06-94

SCALE: ON DRAWING

DWG. NO.: ES-675-6

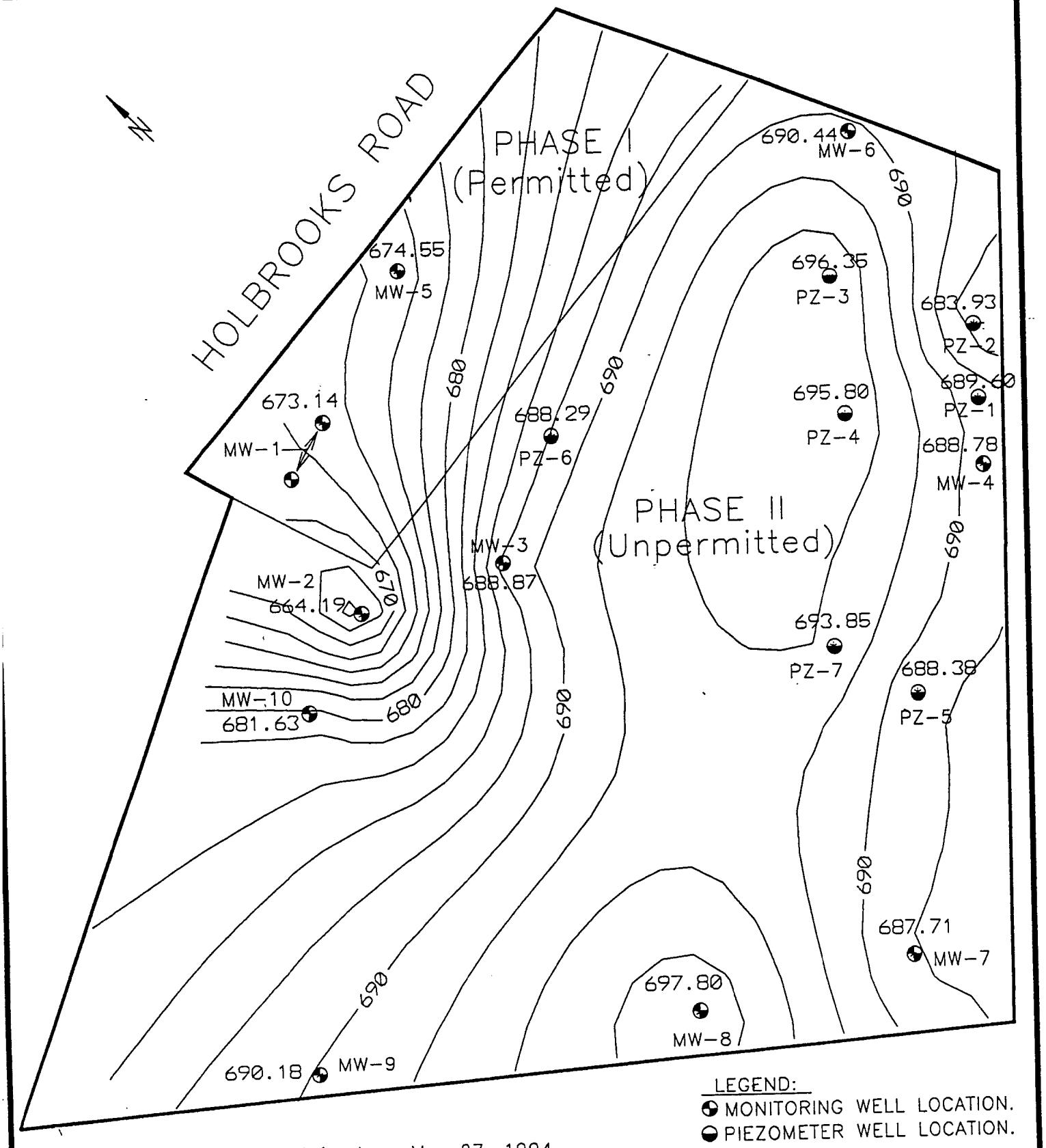
ESI

ECOLOGICAL SERVICES, INC.

FIGURE 6: CROSS SECTION B - B'

NORTH MECKLENBURG LANDFILL

HUNTERSVILLE, NC



LEGEND:
- MONITORING WELL LOCATION.
- PIEZOMETER WELL LOCATION.

NOTE: Gauging Data Obtained on May 27, 1994

DATE: 07-05-94
SCALE: 1" = 200'
DWG. NO.: ES-675-7

ESI

FIGURE 7: PHREATIC SURFACE COUNTOUR MAP
N. MECK. LANDFILL
HUNTERSVILLE, NC

APPENDIX A

Soil Boring Records

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: PZ-6	Page 1 of 1
County: Mecklenburg State: NC	Date Began: 5/11/94 Date End: 5/11/94	Casing Height:	
Lat.: Long.:	Drilled By: Alliance	Static Water Level:	
Grid Coor.:	Logged By: Paul Banks	Development Method:	
Tests:	Drilling Method: Hollow Stem	Sampling Method:	
Grout: 5% Bentonite	Seal: 6 to 8 ft	Gravel Pack: 80/20 Silica Sand (8 to 20 ft)	
Casing Type:	Diameter: Depth: 0 to 10 ft		Hole Diameter: 4"
Screen Type:	Diameter: Slot: 0.010"	Depth: 10 to 20 ft	Total Depth: 20 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 to 5 ft: Brownish Green Fine Grained Sand with Little Silt	0
				Bentonite (6 to 8 ft)
			8 to 10 ft: Saprolite: Greenish Brown Fine Grained Silty Sand with Trace Clay	Casing (0 to 10 ft)
		10		10
			13 to 15 ft: Saprolite: Greenish Brown, Fine Grained Silty Sand with Trace Clay	
			18 to 20 ft: Partially Weathered Bedrock: Brown Silty Coarse Sand with Rock Fragments	Sand (8 to 20 ft)
		20	Boring Terminated at 20 ft	20 Screen (10 to 20 ft)
		30		30
		40		40
		50		50

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-10
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-11-94	Casing Height: Land Surface Elevation:
at.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Hollow Stem	Sampling Method:

Grout: 5% bentonite 0 – 4.5 ft Seal: bentonite 4.5 – 7 ft Gravel Pack: FX 50 sand 7 – 19 ft

Casing Type: Sch 40 PVC Diameter: 2" Depth: 0 – 9 ft Hole Diameter: 4"

Screen Type: Sch 40 PVC Diameter: 2" Slot: 0.010-inch Depth: 9 – 19 ft Total Depth: 19 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 19.0 ft: Grayish Brown Sandy Fine Silt	0
				Grout (0 – 4.5 ft)
				Bentonite (4.5 – 7 ft)
				Casing to 9 ft
		10		10
				Sand (7 – 19 ft)
				Screen (9 – 19 ft)
			Boring Terminated at 19 ft	
		20		20
		30		30
		40		40
		50		50
		60		60

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-9
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-11-94	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Hollow Stem	Sampling Method:

Grout: 5% bentonite Seal: bentonite 7 – 10 ft Gravel Pack: FX 50 sand 10 – 22 ft

Casing Type: Sch 40 PVC Diameter: 2" Depth: 0 – 12 ft Hole Diameter: 4"

Screen Type: Sch 40 PVC Diameter: 2" Slot: 0.010-inch Depth: 12 – 22 ft Total Depth: 22 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 10.0 ft: Brown Silty Medium Sand	0
				Grout (0 – 7 ft)
				Bentonite (7 – 10 ft)
		10	10.0 – 20.0 ft: Grayish Brown Silty Medium Sand with Some Pebbles	Casing to 12 ft
		20	Boring Terminated at 22 ft	20 Sand (10 – 22 ft) Screen (12 – 22 ft)
		30		30
		40		40
		50		50
		60		60

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-3	Page 1 of 1
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Paul Banks	Development Method:	
Tests:	Drilling Method: Hollow Stem	Sampling Method:	
Grout: 5% Bentonite	Seal: 6 – 8 ft	Gravel Pack: 80/20 Silica Sand (8 to 20 ft)	
Casing Type:	Diameter: Depth: 0 – 10 ft		Hole Dia.: 4"
Screen Type:	Diameter: Slot: 0.010 inch	Depth: 9 – 19 ft	Total Depth: 20 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	3.0 – 5.0 ft: Brownish Green Fine Grained Sand with Little Silt	Grout (0 – 6 ft); Bentonite (6 to 8 ft); Casing (0 to 10 ft)
		10	8.0 – 10.0 ft: Saprolite: Greenish Brown Fine Grained Silty Sand with Trace Clay	
			13.0 – 15.0 ft: Saprolite: Greenhish Brown Fine Grained Silty Sand with Trace Clay	
		20	18.0 – 20.0 ft: Partially Weathered Bedrock: Brown Silty Coarse Sand with Rock Pragments	Sand (8 – 20 ft); Screen (10 to 20 ft)
			Boring Terminated at 20 ft	
		30		
		40		
		50		
		60		

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-4	Page 1 of 1
County: Mecklenburg	State: NC	Date Begin: Date End:	Casing Height: Land Surface Elevation:
Lat.: Long.:		Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:		Logged By: Ben Hope	Development Method:
Tests:		Drilling Method: Air Rotary	Sampling Method:
Grout: 5% bentonite		Seal: 40-44 ft	Gravel Pack: FX 50 sand 44-67 ft
Casing Type: Sch 40 PVC	Diameter: 2"	Depth: 0 - 47 ft	Hole Dia.: 6"
Screen Type: Sch 40 PVC	Diameter: 2"	Slot: 0.010-inch	Depth: 47-67 ft Total Depth: 67 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 - 30.0 ft: Tan Silty Fine Sand	0
		10		10
		20		20
		30	30.0 - 40.0 ft: Brown Silty Fine Sand	30
				Grout (0 - 40 ft)
		40	40.0 - 50.0 ft: Partially Weathered Bedrock Sampled as Tan Silty Fine Medium Sand with Rock Fragments	40
				Bentonite (40 - 44 ft)
				Casing to 47 ft
		50	50.0 - 67.0 ft: Gray Silty Medium Sand with Rock Fragments	50
		60		60
				Sand (44 - 67 ft)
				Screen (47 - 67 ft)
			Boring Terminated at 67.0 ft	
		70		70

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Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: SB-1	Page 1 of 1
County: Mecklenburg State: NC	Date Began: 5/11/94 Date End: 5/11/94	Casing Height:	
Lat.: Long.:	Drilled By: Alliance	Static Water Level:	
Grid Coor.:	Logged By: Paul Banks	Development Method:	
Tests:	Drilling Method: Hollow Stem	Sampling Method:	
Grout:	Seal:	Gravel Pack: NA	
Casing Type:	Diameter:	Depth:	Hole Diameter: 4"
Screen Type:	Diameter:	Slot: Depth:	Total Depth: 18 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0		0
	13-12-31		3 to 5 ft: Brownish Green Fine Grained Sand with Little Clay and Organics	
	50/5"		8 to 10 ft: Saprolite: Gray Silty Medium Grained Sand	
		10		10
			13 to 15 ft: Alternating Layers of Weathered/Semi-Weathered Rock	
			Boring Terminated at 18 ft	
		20		20
		30		30
		40		40
		50		50

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: SB-2	Page 1 of 1
County: Mecklenburg State: NC	Date Began: 5/12/94 Date End: 5/12/94	Casing Height:	
Lat.: Long.:	Drilled By: Alliance	Static Water Level:	
Grid Coor.:	Logged By: Paul Banks	Development Method:	
Tests:	Drilling Method: Hollow Stem	Sampling Method:	
Grout:	Seal:	Gravel Pack: NA	
Casing Type:	Diameter: Depth:		Hole Diameter: 4"
Screen Type:	Diameter: Slot:	Depth:	Total Depth: 18 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0		0
	50/5"		3 to 5 ft: Tannish Brown Saprolite, Firm Grained Sand with Some Silt	
	20 – 50/5:		8 to 10 ft: Brownish Gray Fine Grained Silty Sand	
		10		10
	13–20–28		13 to 15 ft: Saprolite: Brown Medium Grained Silty Sand with Some Rock Fragments	
			Boring Terminated at 18 ft	
		20		20
		30		30
		40		40
		50		50

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: SB-3	Page 1 of 1
County: Mecklenburg State: NC	Date Began: 5/12/94 Date End: 5/12/94	Casing Height:	
Lat.: Long.:	Drilled By: Alliance	Static Water Level:	
Grid Coor.:	Logged By: Paul Banks	Development Method:	
Tests:	Drilling Method: Hollow Stem	Sampling Method:	
Grout: 5% bentonite	Seal: bentonite	Gravel Pack: 80/20 Silica Sand	
Casing Type: Diameter:	Depth:		Hole Diameter: 4"
Screen Type: Diameter:	Slot:	Depth:	Total Depth: 14 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0		0
	36 – 50/5"		3 to 5 ft: Brown Medium Graveled Sand with Some Silt and Organics	
	24–35–50/1"		8 to 12 ft: Saprolite: Brown Medium Graveled Silty Sand	
		10		10
	50/1"		12 to 14 ft: Saprolite: Brownish Gray Silty Sand with Some Rock Fragments	
			Boring Terminated at 14 ft	
		20		20
		30		30
		40		40
		50		50

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-2 Page 1 of 1
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Hollow Stem	Sampling Method:
Grout: 5% bentonite 0 – 4.5 ft	Seal: 4.5 – 7 ft	Gravel Pack: FX 50 sand 7 – 19 ft
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 – 9 ft	Hole Dia.: 4"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch Depth: 9 – 19 ft	Total Depth: 19 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0	0 – 19.0 ft: Grayish Brown Sandy Fine Silk	Grout (0 – 4.5 ft); Bentonite (4.5 – 7 ft); Casing to 9 ft; Sand (7 – 19 ft); Screen (9 – 19 ft)
		10		
			Boring Terminated at 19 ft	
		20		
		30		
		40		
		50		
		60		

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Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-5	Page 1 of 2
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Air Rotary	Sampling Method:	

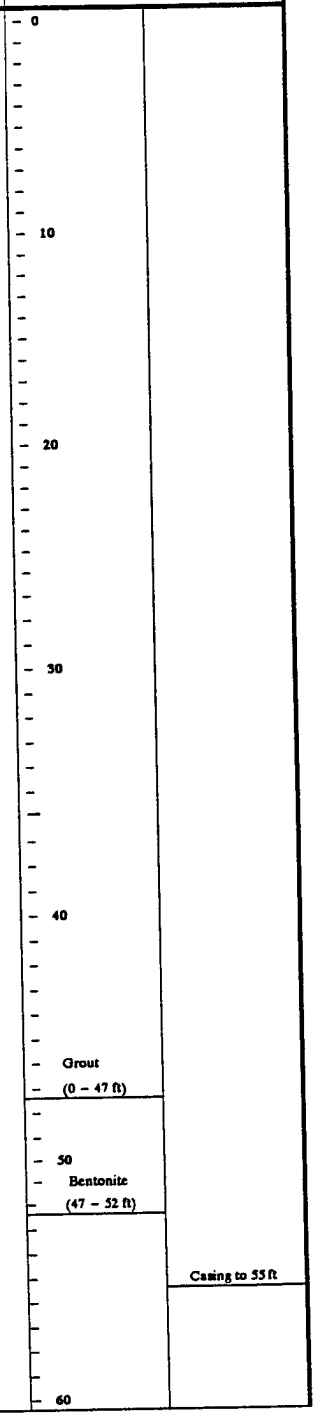
Grout: 5% bentonite 0–52 ft Seal: 47–52 ft Gravel Pack: FX 50 sand 40–75 ft

Casing Type: Sch 40 PVC Diameter: 2" Depth: 0 – 45 ft Hole Dia.: 6"

Screen Type: Sch 40 PVC Diameter: 2" Slot: 0.010–inch Depth: 55–75 ft Total Depth: 75 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks
		0	0 – 10.0 ft: Light Tan Silty Fine Sand
		10	10.0 – 20.0 ft: Light Gray Silty Fine Sand
		20	20.0 – 70.0 ft: Bedrock Sampled as Gray Silty Coarse Sand with Rock Fragments Adundant
		30	
		40	
		50	
		60	

WellCompletion



Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-5 Page 2 of 2
County: Mecklenburg State: NC	Date Begin: Date End:	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Air Rotary	Sampling Method:
Grout: 5% bentonite 0-52 ft	Seal: 47-52 ft	Gravel Pack: FX 50 sand 40-75 ft
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 - 45 ft	Hole Dia.: 6"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch Depth: 45-75 ft	Total Depth: 75 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion	
		60		60	
		70	70 - 75 ft: Gray Silty Medium Sand with a Few Pebbles	70	
				Sand (52 - 75 ft)	Screen (55 - 75 ft)
			Boring Terminated at 75 ft		
		80		80	
		90		90	
		100		100	
		110		110	
		120		120	

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Geologist Log — **Ecological Services, Inc**

Job #: ES–0675	North Mecklenburg Landfill	Well #: MW–6	Page 1 of 2
County: Mecklenburg	State: NC	Date Begin: 1–10–94 Date End: 1–14–94	Casing Height:	Land Surface Elevation:
Lat.:	Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:		Logged By: Ben Hope	Development Method:
Tests:		Drilling Method: Air Rotary	Sampling Method:

Grout: 5% bentonite 0 – 57 ft | Seal: bentonite 57 – 62 ft | Gravel Pack: FX 50 sand 62 – 98 ft

Casing Type: Sch 40 PVC | Diameter: 2" | Depth: 0 – 78 ft | Hole Diameter: 6"

Screen Type: Sch 40 PVC | Diameter: 2" | Slot: 0.010–inch | Depth: 78 – 98 ft | Total Depth: 98 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0	0 – 10.0 ft: Light Tan Silty Fine Sand	0
		10	10.0 – 20.0 ft: Light Gray Silty Fine Sand	10
		20	20.0 – 90.0 ft: Bedrock Sampled as Gray Silty Coarse Sand with Rock Fragments Abundant	20
		30		30
		40		40
		50		50
		60		Grout (0 – 57 ft) 60

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-6	Page 2 of 2
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-14-94	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Air Rotary	Sampling Method:	
Grout: 5% bentonite 0 – 62 ft	Seal: bentonite 57 – 62 ft	Gravel Pack: FX 50 sand 62 – 98 ft	
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 – 78 ft		Hole Diameter: 6"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch	Depth: 78 – 98 ft	Total Depth: 98 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		60		60 – Bentonite (57 – 62 ft)
		70		70
		80		80 – Casing to 78 ft
		90	90.0 – 98.0 ft: Gray Silty Medium Sand with a few Pebbles	90 – Sand (62 – 98 ft) / Screen (78 to 98 ft)
			Boring Terminated at 98.0 ft	
		100		100
		110		110
		120		120

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-7	Page 1 of 2
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-14-94	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Air Rotary	Sampling Method:	

Grout: 5% bentonite 0 – 56 ft | Seal: bentonite 0 – 61 ft | Gravel Pack: FX 50 sand 61 – 83 ft

Casing Type: Sch 40 PVC Diameter: 2" Depth: 0 – 63 ft Hole Diameter: 6"

Screen Type: Sch 40 PVC Diameter: 2" Slot: 0.010-inch Depth: 61 – 83 ft Total Depth: 83 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 20.0 ft: Brown Silty Medium Sand	0
		10		10
		20	20.0 – 50.0 ft: Grayish Brown Silty Coarse Sand with Some Pebbles	20
		30		30
		40		40
		50	50.0 – 60.0 ft: Gray Silty Fine Sand	50
				Grout (0 – 56 ft)
		60	60.0 – 70.0 ft: Gray Silty Medium Sand with Some Pebbles	60

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-7 Page 2 of 2
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-14-94	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Air Rotary	Sampling Method:

Grout: 5% bentonite 0 – 56 ft Seal: bentonite 56 – 61 ft Gravel Pack: FX 50 sand 61 – 83 ft

Casing Type: Sch 40 PVC Diameter: 2" Depth: 0 – 63 ft Hole Diameter: 6"

Screen Type: Sch 40 PVC Diameter: 2" Slot: 0.010-inch Depth: 61 to 83 ft Total Depth: 83 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		60		60 Bentonite (56 – 61 ft) / Casing to 63 ft
		70	70.0 – 83.0 ft: Gray Silty Coarse Sand with Some Rock Fragments	
		80	Boring Terminated at 83 ft	Sand (61 – 83 ft) / Screen (63 – 83 ft)
		90		
		100		
		110		
		120		

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-8	Page 1 of 2
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-14-94	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Air Rotary	Sampling Method:	

Grout: 5% bentonite 0 – 55 ft Seal: bentonite 55 – 57.5 ft Gravel Pack: FX 50 sand 57.5 to 80.0 ft

Casing Type: Sch 40 PVC Diameter: 2" Depth: 0 – 60 ft Hole Diameter: 6"

Screen Type: Sch 40 PVC Diameter: 2" Slot: 0.010-inch Depth: 60 – 80 ft Total Depth: 80 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 20.0 ft: Light Brown Silty Medium Sand with Some Pebbles	0
		10		10
		20	20.0 – 50.0 ft: Brown Silty Fine Sand	20
		30		30
		40		40
		50	50.0 – 80.0 ft: Bedrock Sampled as Gray Silty Coarse Sand with Pebbles and Rock Fragments Abundant	50
		60		60

Grout (0 – 55 ft)

Bentonite (55 – 57 ft)

Casing to 60 ft

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: MW-8	Page 2 of 2
County: Mecklenburg	State: NC	Date Begin: 1-10-94 Date End: 1-14-94	Casing Height: Land Surface Elevation:
Lat.:	Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:		Logged By: Ben Hope	Development Method:
Tests:		Drilling Method: Air Rotary	Sampling Method:

Grout: 5% bentonite 0 – 55 ft Seal: bentonite 55 – 57.5 ft Gravel Pack: FX 50 sand 57.5 to 80 ft

Casing Type: Sch 40 PVC Diameter: 2" Depth: 0 – 60 ft Hole Diameter: 6"

Screen Type: Sch 40 PVC Diameter: 2" Slot: 0.010-inch Depth: 60 to 80 ft Total Depth: 80 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		60		60
		70		70
		80	Boring Terminated at 80.0 ft	Sand (57.5 – 80 ft); Screen (60 to 80 ft); 80
		90		90
		100		100
		110		110
		120		120

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: PZ-1
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-11-94	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Air Rotary	Sampling Method:
Grout: 5% bentonite	Seal: bentonite 33 – 35 ft	Gravel Pack: FX 50 sand 35 – 37 ft
Casing Type: Sch 40 PVC	Diameter: 2" Depth: 0 – 37 ft	Hole Diameter: 6"
Screen Type: Sch 40 PVC	Diameter: 2" Slot: 0.010-inch Depth: 37 – 47 ft	Total Depth: 47 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 30.0 ft: Brown Silty Medium Sand with Some Pebbles	0
		10		10
		20		20
		30	30.0 – 40.0 ft: Gray Silty Medium Sand with Pebbles	30
				Bentonite (33 – 35 ft)
				Casing to 37 ft
		40		40
			Boring Terminated at 47 ft	Sand (35 – 47 ft)
				Screen (37 – 47 ft)
		50		50
		60		

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: PZ-2	Page 1 of 2
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-14-94	Casing Height:	Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:	
Grid Coor.:	Logged By: Ben Hope	Development Method:	
Tests:	Drilling Method: Air Rotary	Sampling Method:	

Grout: 5% bentonite — Seal: bentonite 55 – 63 ft — Gravel Pack: FX 50 sand 63 – 85 ft

Casing Type: Sch 40 PVC — Diameter: 2" — Depth: 0 – 65 ft — Hole Diameter: 6"

Screen Type: Sch 40 PVC — Diameter: 2" — Slot: 0.010-inch — Depth: 65 – 85 ft — Total Depth: 85 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 40.0 ft: Light Gray Silty Fine Sand	0
		10		10
		20		20
		30		30
		40	40.0 – 80.0 ft: Bedrock Material Sampled as Grayish Brown Silty Coarse Sand with Pebbles and Rock Fragments	40
		50		50
		60		60

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: PZ-2 Page 2 of 2
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-14-94	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Air Rotary	Sampling Method:
Grout: 5% bentonite	Seal: bentonite 55 – 63.0 ft	Gravel Pack: FX 50 sand 63 – 85 ft
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 – 65 ft	Hole Diameter: 6"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch Depth: 65 to 85 ft	Total Depth: 85 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		60		60 Bentonite (55 – 63 ft) / Casing to 65 ft
		70		70
		80		80 Sand (63 – 85 ft) / Screen (65 – 85 ft)
			Boring Terminated at 85 ft	
		90		90
		100		100
		110		110
		120		120

Geologist Log — **Ecological Services, Inc**

Job #: ES–0675	North Mecklenburg Landfill	Well #: PZ–3
County: Mecklenburg State: NC	Date Begin: 1–10–94 Date End: 1–14–94	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Air Rotary	Sampling Method:
Grout: 5% bentonite	Seal: bentonite 42 – 45 ft	Gravel Pack: FX 50 sand 45 to 67 ft
Casing Type: Sch 40 PVC	Diameter: 2" Depth: 0 – 47 ft	Hole Diameter: 6"
Screen Type: Sch 40 PVC	Diameter: 2" Slot: 0.010–inch Depth: 47 – 67 ft	Total Depth: 67 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 30.0 ft: Light Gray Brown Silty Fine Sand	
		10		
		20		
		30	30.0 – 40.0 ft: Gray Silty Medium Sand	
		40	40.0 – 50.0 ft: Partially Weathered Bedrock Sampled as Brown Silty Medium Coarse Sand with Rock Fragments	Bentonite (42 – 45 ft)
		50	50.0 – 67.0 ft: Dark Reddish Brown Silty Medium Coarse Sand with Rock Fragments	Casing to 47 ft
		60		Sand (45 – 67 ft)
			Boring Terminated at 67.0 ft	Screen (47 – 67 ft)
		70		

Geologist Log

Ecological Services, Inc

Job #: ES-0675	North Mecklenburg Landfill	Well #: PZ-4
County: Mecklenburg State: NC	Date Begin: 1-10-94 Date End: 1-14-94	Casing Height: Land Surface Elevation:
Lat.: Long.:	Drilled By: Graham & Currie	Static Water Level:
Grid Coor.:	Logged By: Ben Hope	Development Method:
Tests:	Drilling Method: Air Rotary	Sampling Method:
Grout: 5% bentonite	Seal: bentonite 40 – 44 ft	Gravel Pack: FX 50 sand 44 to 67 ft
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 – 47 ft	Hole Diameter: 6"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010-inch Depth: 47 – 67 ft	Total Depth: 67 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	Well Completion
		0	0 – 30.0 ft: Tan Silty Fine Sand	0
		10		10
		20		20
		30	30.0 – 40.0 ft: Brown Silty Fine Sand	30
		40	40.0 – 50.0 ft: Partially Weathered Bedrock Sampled as Tan Silty Fine Medium Sand with Rock Fragments	40
				Bentonite (40 – 44 ft)
				Casing to 47 ft
		50	50.0 – 67.0 ft: Gray Silty Medium Sand with Rock Fragments	50
		60		60
				Sand (44 – 67 ft)
				Screen (47 – 67 ft)
			Boring Terminated at 67.0 ft	
		70		

Geologist Log — **Ecological Services, Inc**

Job #: ES-0675	North Mecklenburg Landfill	Well #: PZ-7 Page 1 of 1
County: Mecklenburg State: NC	Date Began: 5/13/94 Date End: 5/13/94	Casing Height:
Lat.: Long.:	Drilled By: Alliance	Static Water Level:
Grid Coor.:	Logged By: Michael Magnetti	Development Method:
Tests:	Drilling Method: Air Rotary	Sampling Method:
Grout: 5% Bentonite	Seal: 36 to 38 ft	Gravel Pack: 80/20 Silica Sand (38 to 60 ft)
Casing Type: Sch 40 PVC Diameter: 2"	Depth: 0 to 40 ft	Hole Diameter: 6"
Screen Type: Sch 40 PVC Diameter: 2"	Slot: 0.010" Depth: 40 to 60 ft	Total Depth: 60 ft

PID/FID Reading (ppm)	Penetration Resistance	Depth (ft)	Lithology/Remarks	WellCompletion
		0		0
		10	8 to 10 ft: Saprolite: Brown Fine Grained Sand with Trace Clay	10
		20	18 to 20 ft: Saprolite: Brown Fine Grained Silty Sand with Little Clay 20 to 27 ft: Partially Weathered Bedrock: Brownish Gray Silty Medium to Coarse Silty Sand with Rock Fragments	20
		30	27 to 60 ft: Bedrock: Quartz Diorite	30 Bentonite (36 to 38 ft) Casing (0 to 40 ft)
		40		40
		50		50 Sand (38 to 60 ft) Screen (40 to 60 ft)
		60	Boring Terminated at 60 ft	60

APPENDIX B

Report of Laboratory Constant Head Permeability and Classification Tests for Cover Soil Samples

LAW January 6, 1994
ENGINEERING AND ENVIRONMENTAL SERVICES

Ecological Services, Inc.
PO Box 12146
Charlotte North Carolina 28220

Attention: Mr. Ron Gilkerson
Vice President

Subject: Report of Laboratory
Constant Head Permeability and
Classification Tests
Ecological Services, Inc .
Charlotte, North Carolina
LAW Job No. 226-09423-01

Gentlemen:

As authorized by the acceptance of our Work Authorization Sheet dated May 27, 1992, Law Engineering has completed requested laboratory testing on the four soil samples submitted to our laboratory by Mr. Ron Gilkerson. Testing was performed according to the following ASTM standards:

ASTM D 698	"Standard Test Method for Moisture Density Relations of Soils and Soil Aggregate Mixtures Using a 5.5lb (2.49kg) Rammer and 12 in (305mm) Drop"
ASTM D 5084	"Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"
ASTM D 4318	"Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
ASTM D422	"Standard Test Method for Particle-Size Analysis of Soils"

The results of our testing are summarized on the attached data sheets.

We appreciate the opportunity to be of service to you with this project. If you should have any questions concerning this report, or if we may be of further service to you, please do not hesitate to contact this office at (704) 357-8600.

Respectfully submitted,

LAW ENGINEERING

Steven E. Lawing
Staff Engineer

Michael O. Hamlett,C.E.T.
Laboratory Services Manager

SEL:MOH:kc
Attachments

LAW ENGINEERING, INC.
2801 YORKMONT ROAD, SUITE 100 • CHARLOTTE, NC 28208
P. O. BOX 11297 • CHARLOTTE, NC 28220
(704) 357-8600 • FAX (704) 357-8639
ONE OF THE LAW COMPANIES

SUMMARY OF LABORATORY TESTING

Ecological Services, Inc.
LAW Job No. 226-09423-01

CONSTANT HEAD PERMEABILITY TEST

Sample ID	Optimum Proctor Values		Remolding Values		Coefficient of Permeability (cm/sec)
	γ_{MAX}, (pcf)	W_o(%)	γ (pcf)	W_i (%)	
B-4	109.5	15.5	104.0	17.7	3.2×10^{-5}
B-6	119.0	11.5	113.1	13.7	1.1×10^{-4}
B-5	116.5	12.5	110.7	13.8	1.3×10^{-4}
B-7	114.5	13.0	108.8	14.7	5.3×10^{-5}

All samples tested at 2 psi head difference

γ_{MAX} = Maximum Dry Unit Weight of Compacted Specimen

γ = Dry Unit Weight of Remolded Test Sample

W_o = Optimum Moisture Content of Compacted Specimen

W_i = Initial Moisture Content of Remolded Test Sample

F = Final Value

P = Preliminary Value

APPENDIX C

Report of Laboratory Constant Head Permeability and Classification Tests for Floor Soil Samples

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

February 14, 1994

Ecological Services, Inc.
PO Box 12146
Charlotte North Carolina 28220

Attention: Mr. Ron Gilkerson
Vice President

Subject: **Report of Laboratory**
Constant Head Permeability and
Classification Tests
Ecological Services, Inc .
Charlotte, North Carolina
Law Engineering Job No. 226-09423-01

Mr. Gilkerson:

As authorized by the acceptance of our Work Authorization Sheet dated May 27, 1992, Law Engineering has completed requested laboratory testing on the five soil samples submitted to our laboratory by Mr. Ron Gilkerson. Testing was performed according to the following ASTM standards:

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The results of our testing are summarized on the enclosed data sheets.

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Sincerely,

Law Engineering, INC.

Steven E. Lawing
Staff Engineer

Michael O. Hamlett, C.E.T.
Laboratory Services Manager

SEL/MOH:kc

Enclosures (8)

SUMMARY OF LABORATORY TESTING

Ecological Services, Inc.
LAW Job No. 226-09423-01

CONSTANT HEAD PERMEABILITY TEST

Sample ID	Optimum Proctor Values		Remolding Values		Coefficient of Permeability (cm/sec)
	γ_{MAX}, (pcf)	W_o(%)	γ (pcf)	W_i (%)	
1	117.0	12.0	111.2	12.7	6.7×10^{-6}
2	117.5	13.0	111.6	14.8	2.9×10^{-5}
3	115.0	14.0	109.3	14.3	5.2×10^{-6}
4	111.0	14.0	105.5	14.4	2.9×10^{-4}
5	120.5	11.5	114.5	13.0	1.2×10^{-6}

All samples tested at 2 psi head difference

γ_{MAX} = Maximum Dry Unit Weight of Compacted Specimen

γ = Dry Unit Weight of Remolded Test Sample

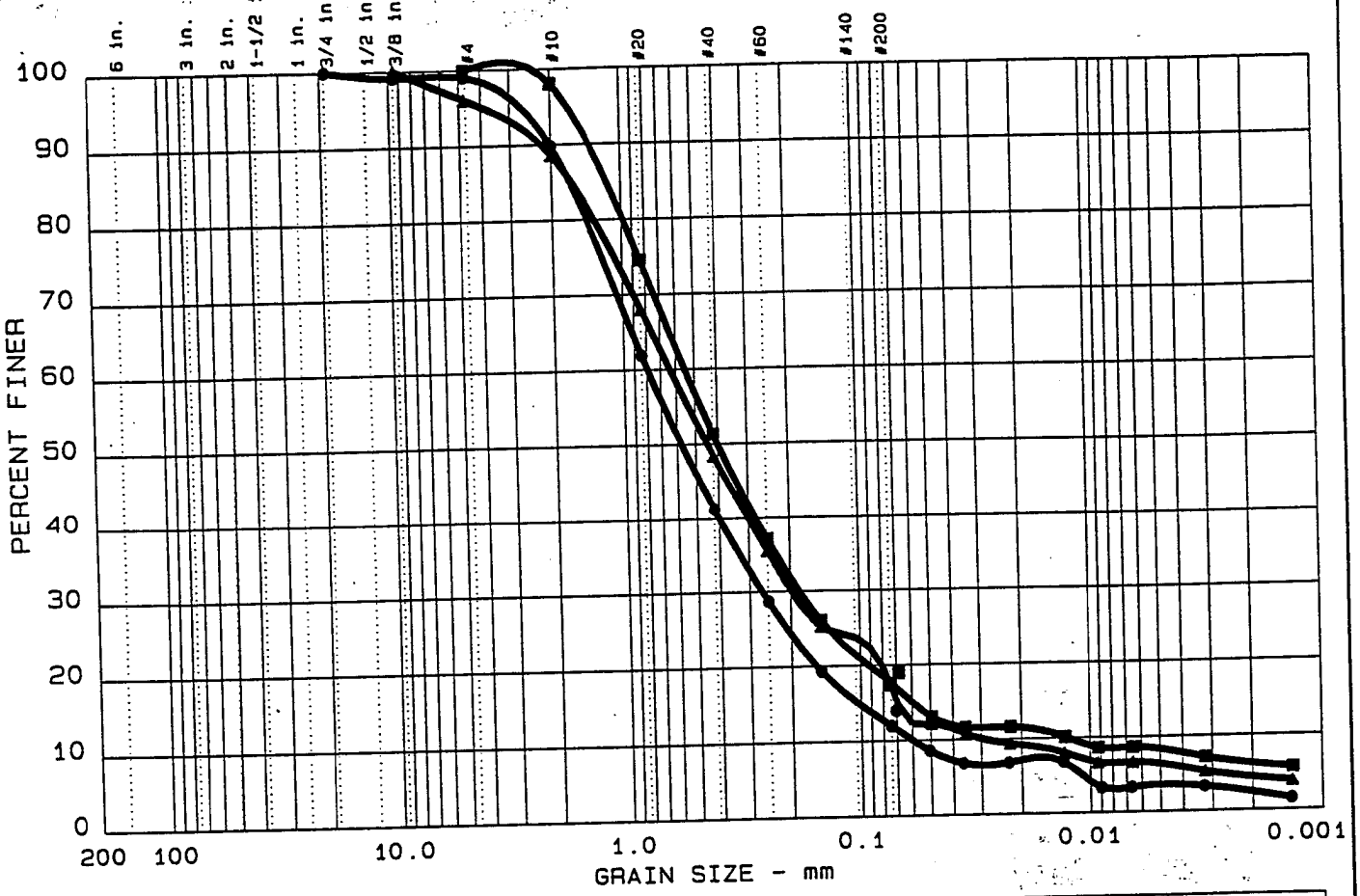
W_o = Optimum Moisture Content of Compacted Specimen

W_i = Initial Moisture Content of Remolded Test Sample

F = Final Value

P = Preliminary Value

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	1.0	87.1	8.3	3.6
▲	0.0	3.8	78.8	11.0	6.4
■	0.0	0.0	82.4	9.2	8.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	1.66	0.79	0.57	0.263	0.1022	0.0595	1.46	13.3
▲	NP	NP	1.64	0.64	0.45	0.198	0.0692	0.0279	2.22	22.8
■	NP	NP	1.15	0.55	0.40	0.183	0.0594	0.0125	4.88	43.8

	MATERIAL DESCRIPTION	USCS	AASHTO
●			
▲			
■			

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES
● Location: SAMPLE 1
▲ Location: SAMPLE 2
■ Location: SAMPLE 3
Date: FEBRUARY 10, 1994

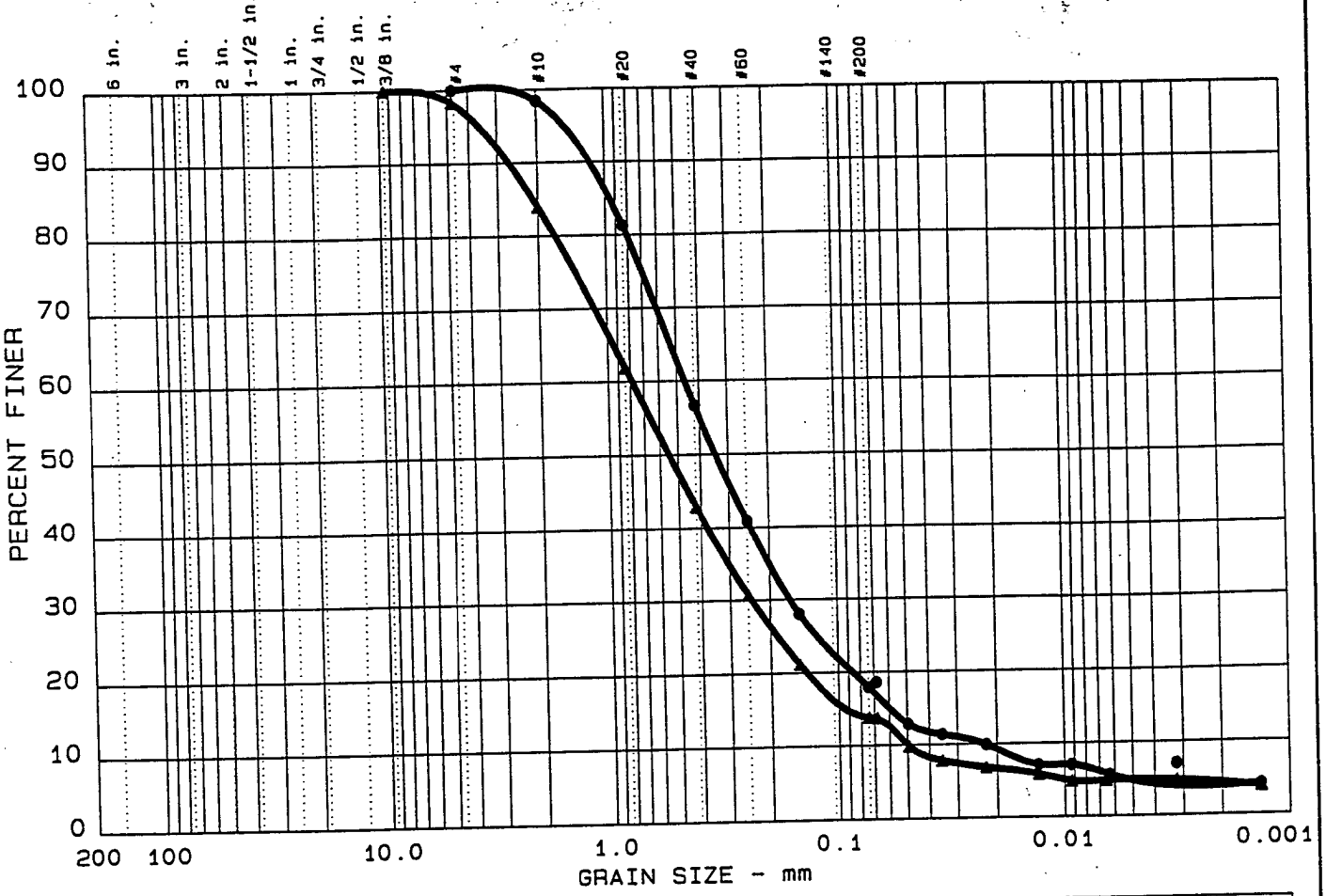
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING

Remarks:

Figure No. _____

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	82.0	13.2	4.8
▲	0.0	1.7	84.5	8.9	4.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_U
●	NP	NP	0.95	0.46	0.34	0.163	0.0594	0.0226	2.57	20.4
▲	NP	NP	2.09	0.78	0.55	0.242	0.0940	0.0499	1.49	15.7

	MATERIAL DESCRIPTION	USCS	AASHTO
●			
▲			

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES
● Location: SAMPLE 4
▲ Location: SAMPLE 5

Date: FEBRUARY 10, 1994

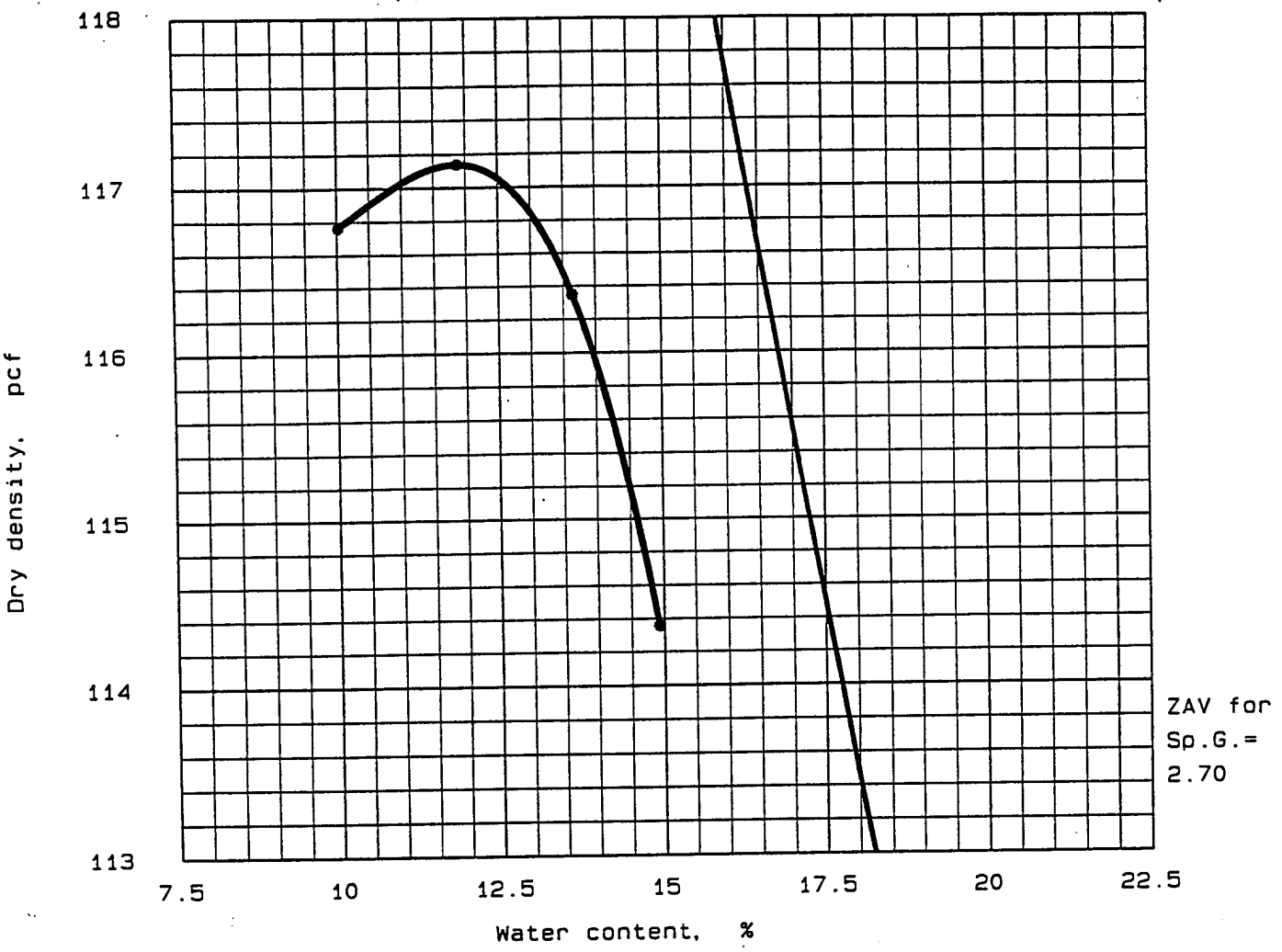
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING

Remarks:

Figure No. ———

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 12.0 % Maximum dry density = 117.0 pcf	BROWN FINE TO COARSE SILTY SAND WITH WEATHERED ROCK

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES

Location: SAMPLE 1
Date: 2-01-1994

Client:
ECLOGICAL SERVICES
Proposed Use:

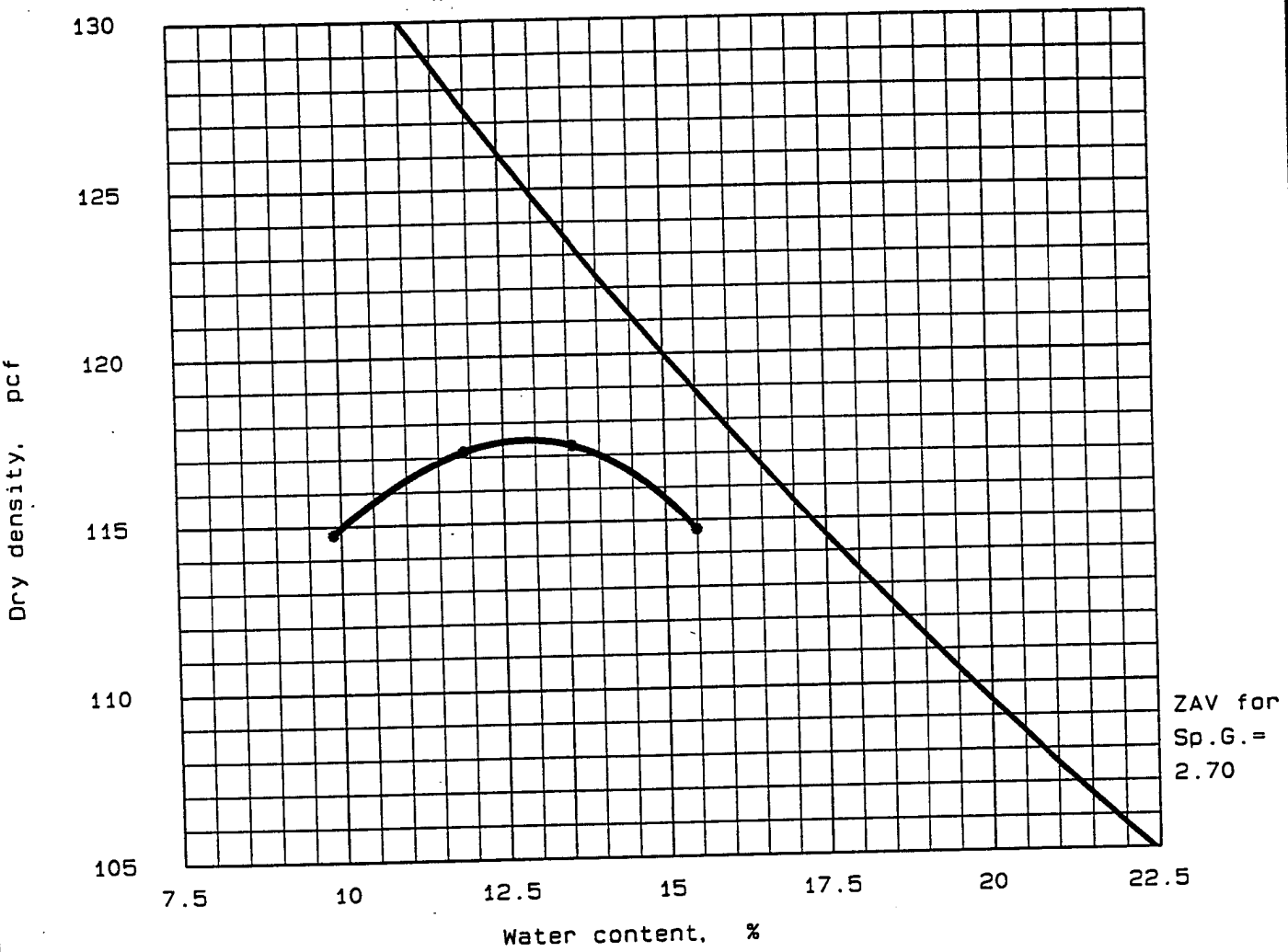
Remarks:

Curve No. 7

PROCTOR TEST REPORT

LAW ENGINEERING, INC.

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 13.0 % Maximum dry density = 117.5 pcf	BROWN MICACEOUS SILTY FINE TO COARSE SAND

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.

Location: SAMPLE 2
Date: 2-01-1994

Client:
ECOLOGICAL SERVICES, INC.
Proposed Use:

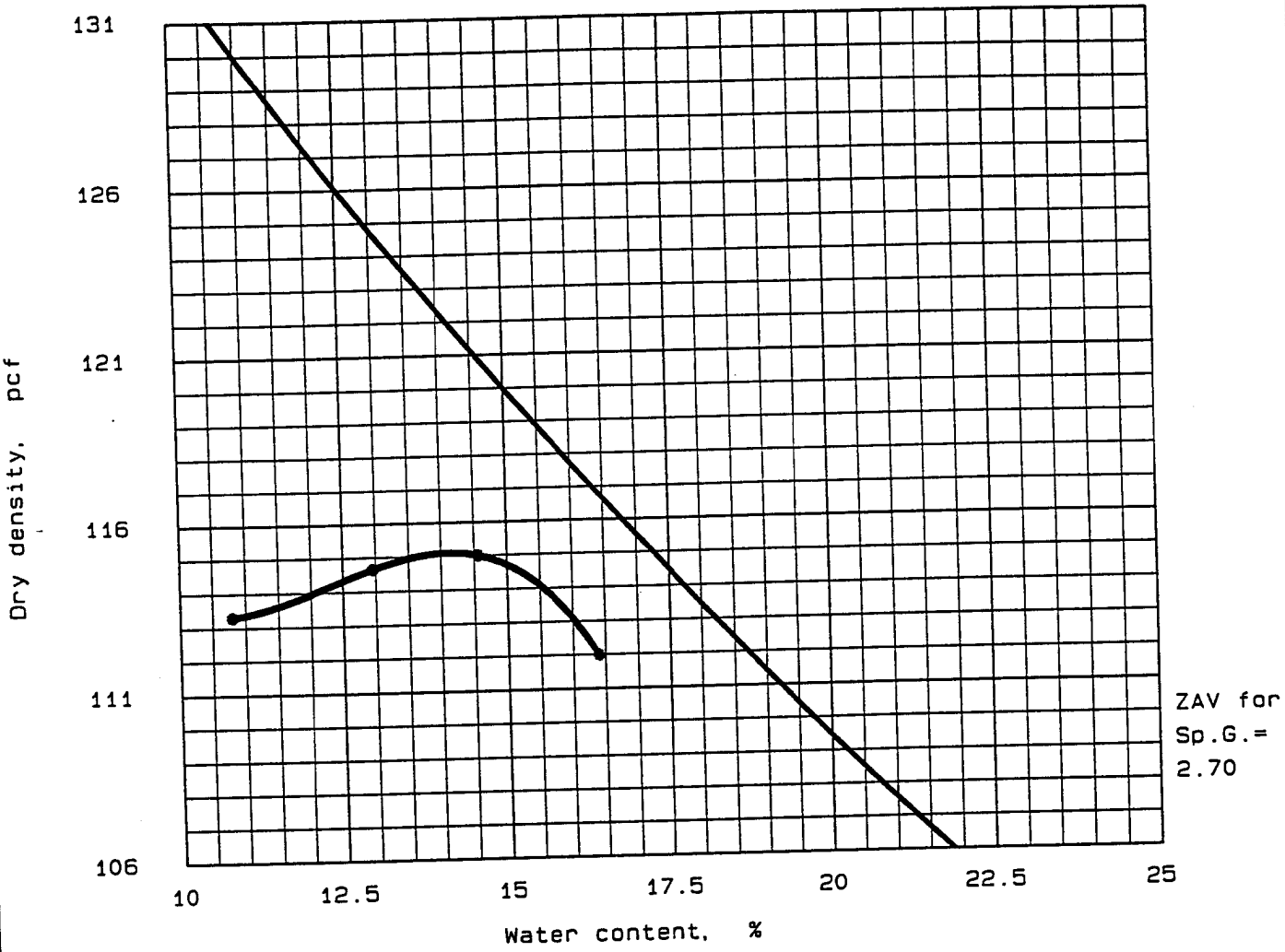
Remarks:

Curve No. 5

PROCTOR TEST REPORT

LAW ENGINEERING, INC.

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 14.0 % Maximum dry density = 115.0 pcf	TAN BROWN FINE TO COARSE SILTY SAND

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.

Location: SAMPLE 3
Date: 2-01-1994

Client:
ECOLOGICAL SERVICES, INC.

Proposed Use:

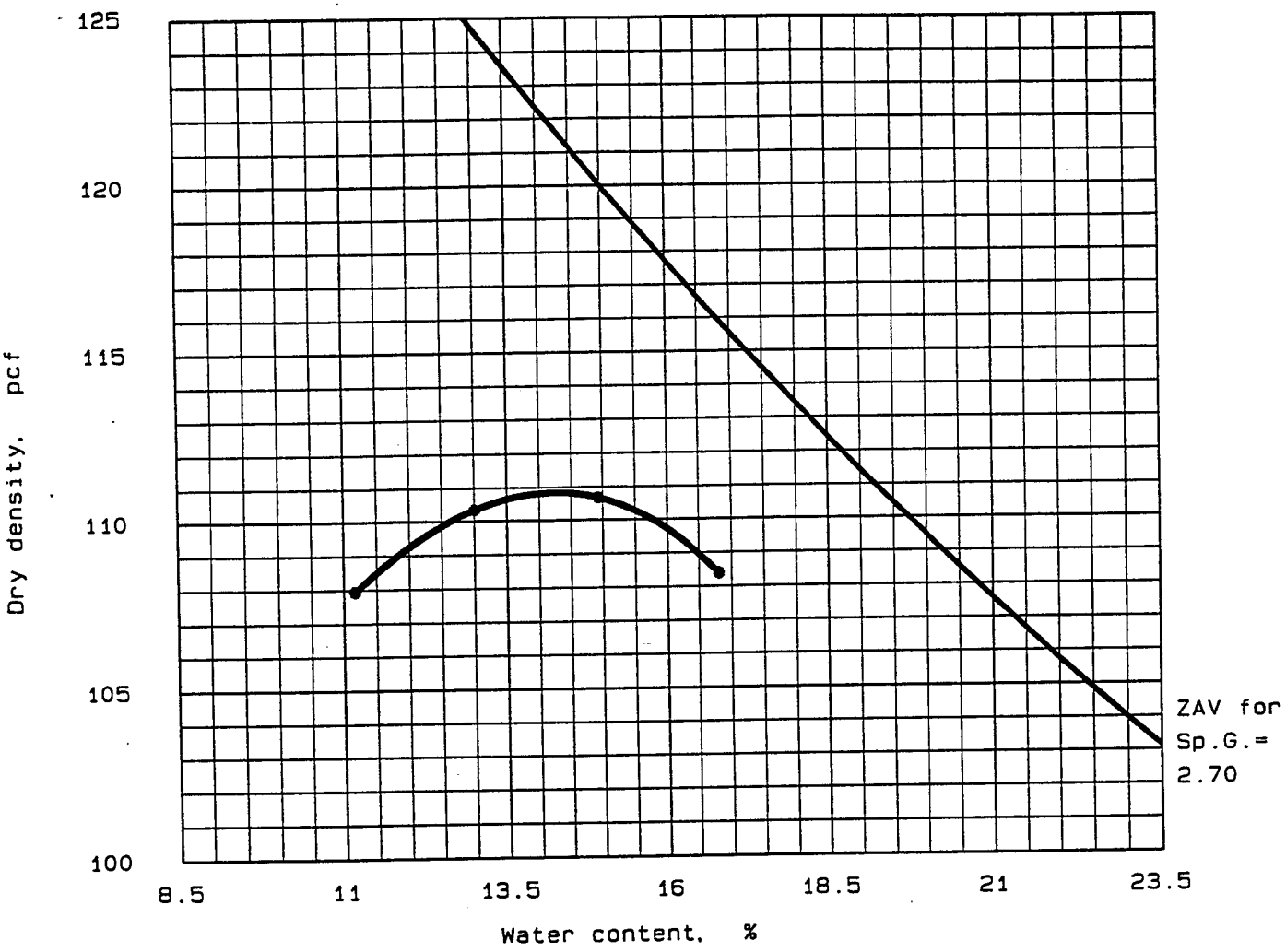
Remarks:

Curve No. 6

PROCTOR TEST REPORT

LAW ENGINEERING, INC.

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 14.0 % Maximum dry density = 111.0 pcf	TAN BROWN MICACEOUS SILTY FINE TO COARSE SANDY SILT

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES

Location: SAMPLE 4
Date: 2-02-1994

Client:
ECOLOGICAL SERVICES
Proposed Use:

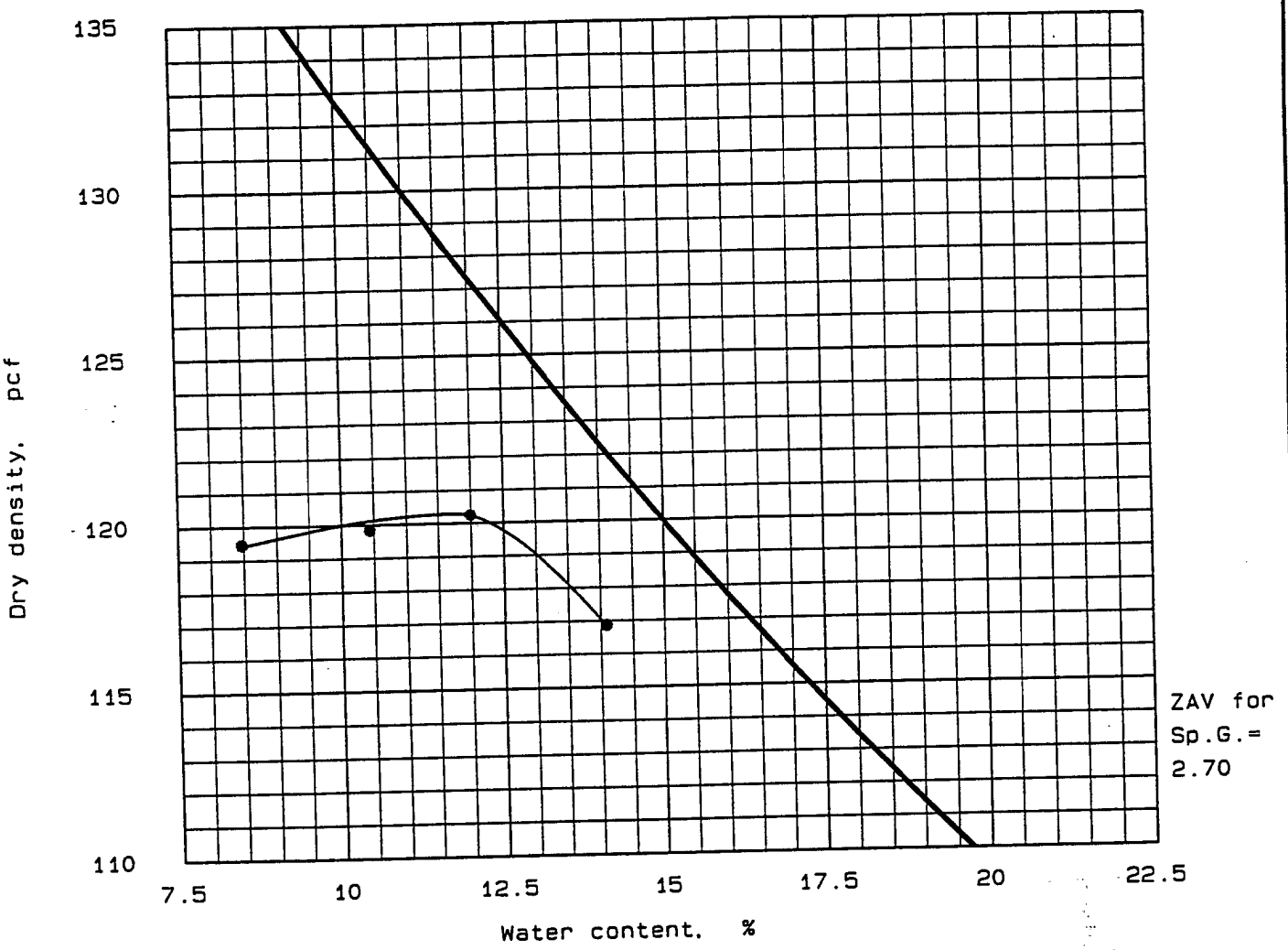
Remarks:

Curve No. 9

PROCTOR TEST REPORT

LAW ENGINEERING, INC.

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = % Maximum dry density = 120.5 pcf	TAN GREEN FINE TO COARSE SILTY SAND WITH WEATHERED ROCK
Project No.: 226-09423-01 Project: ECOLOGICAL SERVICES Location: SAMPLE 5 Date: 2-01-1994	Client: ECOLOGICAL SERVICES Proposed Use: Remarks:
PROCTOR TEST REPORT **LAW ENGINEERING, INC.**	Curve No. 8

ESI COMPUTATION SHEET

PROJECT TITLE: M. MICK LANDFILL — PROJECT NO. ES-675
DESCRIPTION: IN-FLOW PERMEABILITY TEST PZ-7 — SHEET ___ OF ___
PREPARED BY: ___ DATE: ___ CHK'D BY: ___ DATE: ___

BOUWER AND RICE METHOD

Variables:

$y_t = 1.9'$

$t = 27$ min.

$y_o = 10.11'$

$L = 20'$

$r_c = 0.08'$

$r_w = 0.25'$

$L/r_w = 80$

$H = 11.81'$

$C = 3.5$

$K =$

Equations:

$$\ln R_e/r_w = \left(\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right)^{-1}$$

$$\ln R_e/r_w = \left(\frac{1.1}{\ln(11.81/0.25)} + \frac{3.5}{20/0.25}\right)^{-1}$$

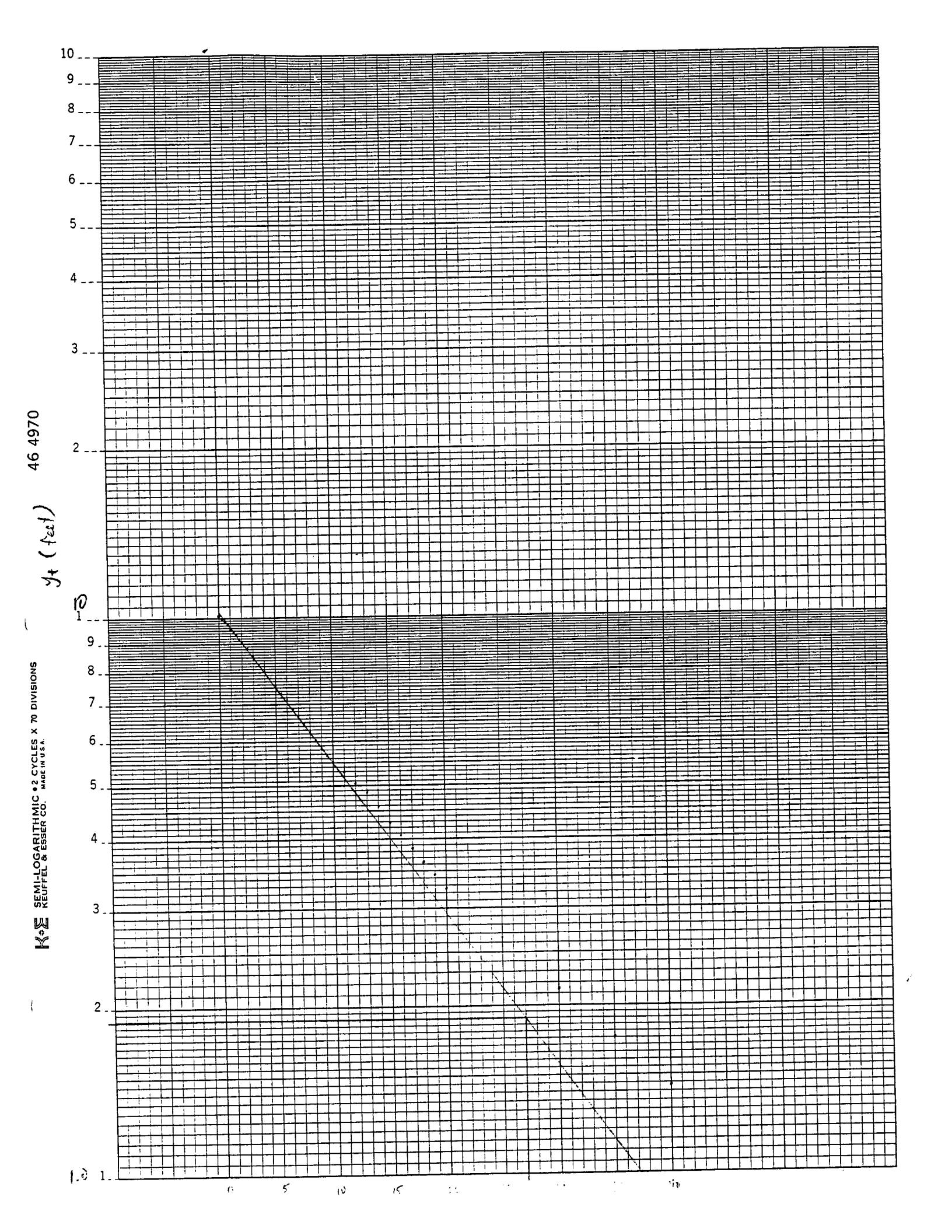
$$\ln R_e/r_w = 3.04$$

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t} \cdot \ln \frac{y_o}{y_t}$$

$$K = \frac{0.08^2 \ln(3.04)}{40} \cdot \frac{1}{27} \cdot \ln \frac{10.11}{1.9}$$

$$K = 1.10 \times 10^{-5} \text{ ft/min} = 5.59 \times 10^{-6}$$

ESI ECOLOGICAL SERVICES, INC.
P. O. Box 12146
Charlotte, NC 28220
Phone: (704) 522-1111
Fax: (704) 521-8004


46 4970
y_t (feet)
SEMI-LOGARITHMIC • 2 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

APPENDIX D

In-Flow Permeability Calculations

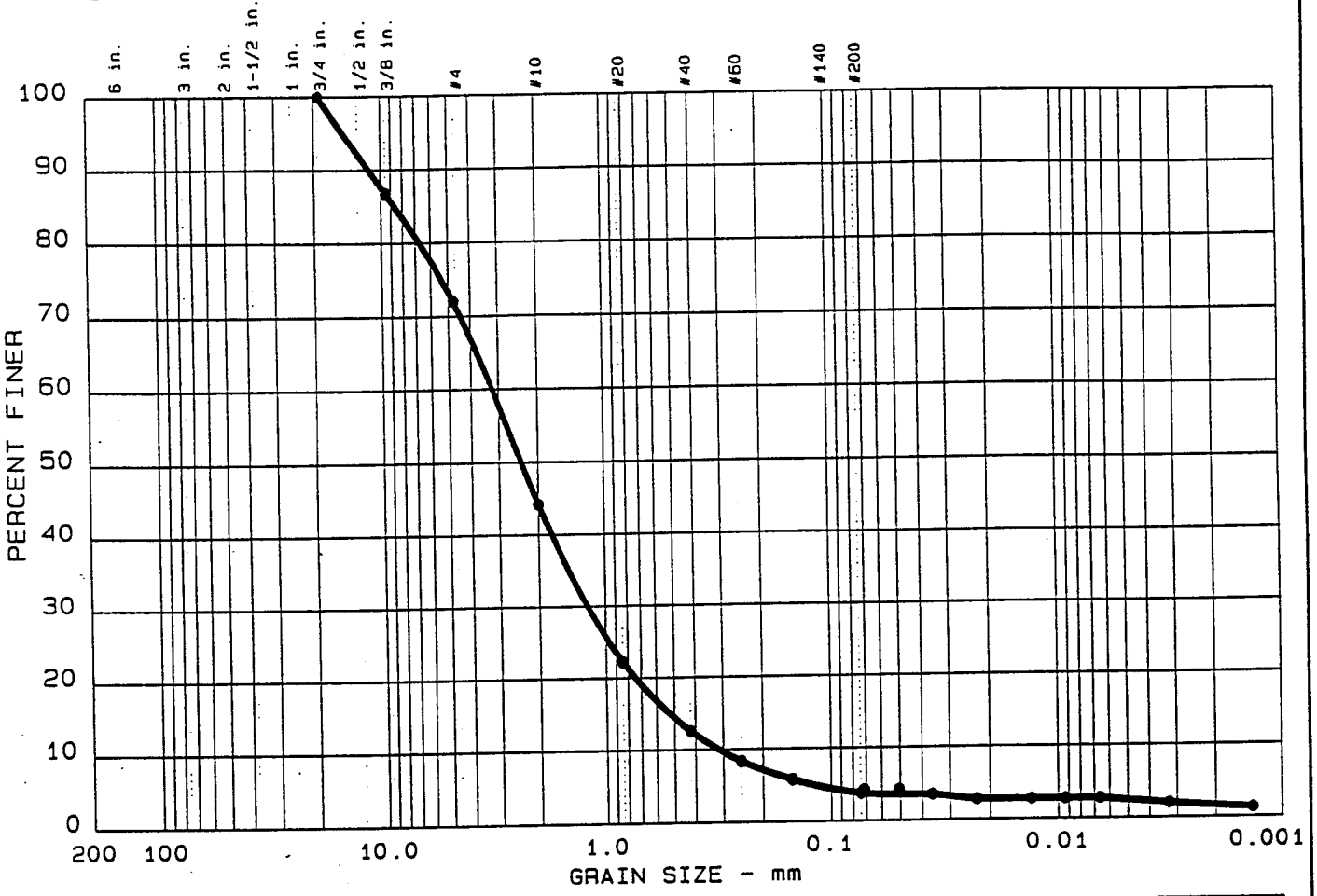
BAIL TEST RECOVERY DATA
N. MECK. LANDFILL

PZ–7, JULY 6, 1994

INITIAL DTW: 48.19

ELAPSED TIME (Min)	DEPTH TO WATER TABLE (feet)	MEASURED W.T. DEPTH MINUS EQUILIBRIUM W.T. DEPTH (feet)
0.00	58.30	10.11
0.25	58.17	9.98
0.50	58.05	9.86
0.75	57.91	9.72
1.00	57.77	9.58
1.25	57.63	9.44
1.50	57.52	9.33
1.75	57.38	9.19
2.00	57.26	9.07
2.50	57.00	8.81
3.00	56.75	8.56
3.50	56.46	8.27
4.00	56.22	8.03
4.50	55.99	7.80
5.00	55.76	7.57
5.50	55.52	7.33
6.00	55.32	7.13
6.50	55.08	6.89
7.00	54.85	6.66
7.50	54.64	6.45
8.00	54.43	6.24
8.50	54.22	6.03
9.00	54.02	5.83
9.50	53.86	5.67
10.00	53.70	5.51
11.00	53.49	5.30
12.00	53.24	5.05
13.00	53.04	4.85
14.00	52.76	4.57
15.00	52.48	4.29
16.00	52.25	4.06
17.00	52.03	3.84
18.00	51.80	3.61
19.00	51.62	3.43
20.00	51.45	3.26
25.00	50.86	2.67
30.00	50.33	2.14
35.00	49.95	1.76
40.00	49.63	1.44

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	28.0	68.2	1.4	2.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	8.61	3.20	2.37	1.202	0.5188	0.3126	1.45	10.2

	MATERIAL DESCRIPTION	USCS	AASHTO
●			

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.
● Location: B-6

Date: JANUARY 6, 1994

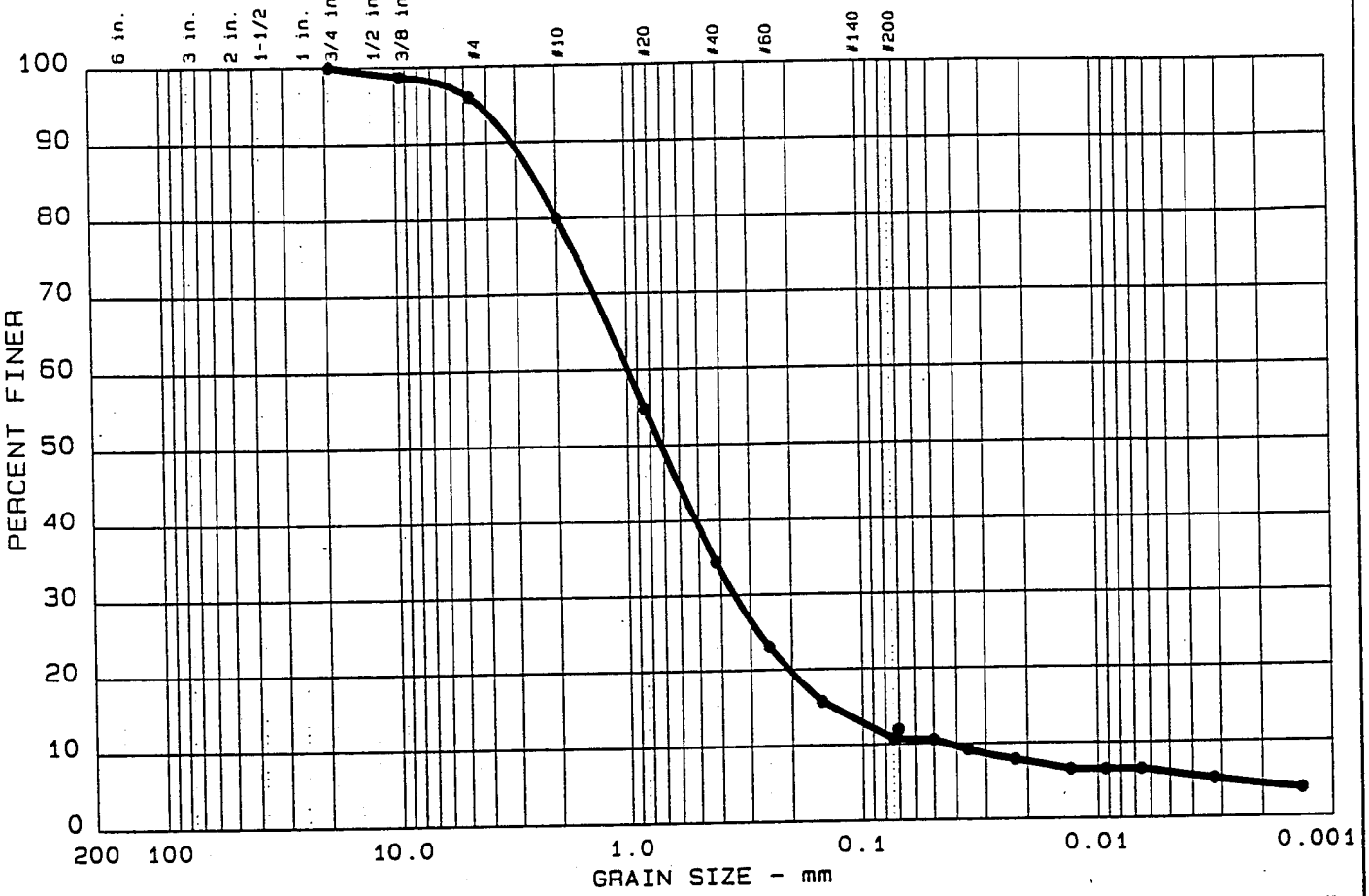
Remarks:

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING

Figure No. _____

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	4.0	85.3	4.8	5.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	2.45	0.99	0.72	0.351	0.1318	0.0442	2.82	22.4

	MATERIAL DESCRIPTION	USCS	AASHTO
●			

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.
● Location: B-5

Date: JANUARY 6, 199493

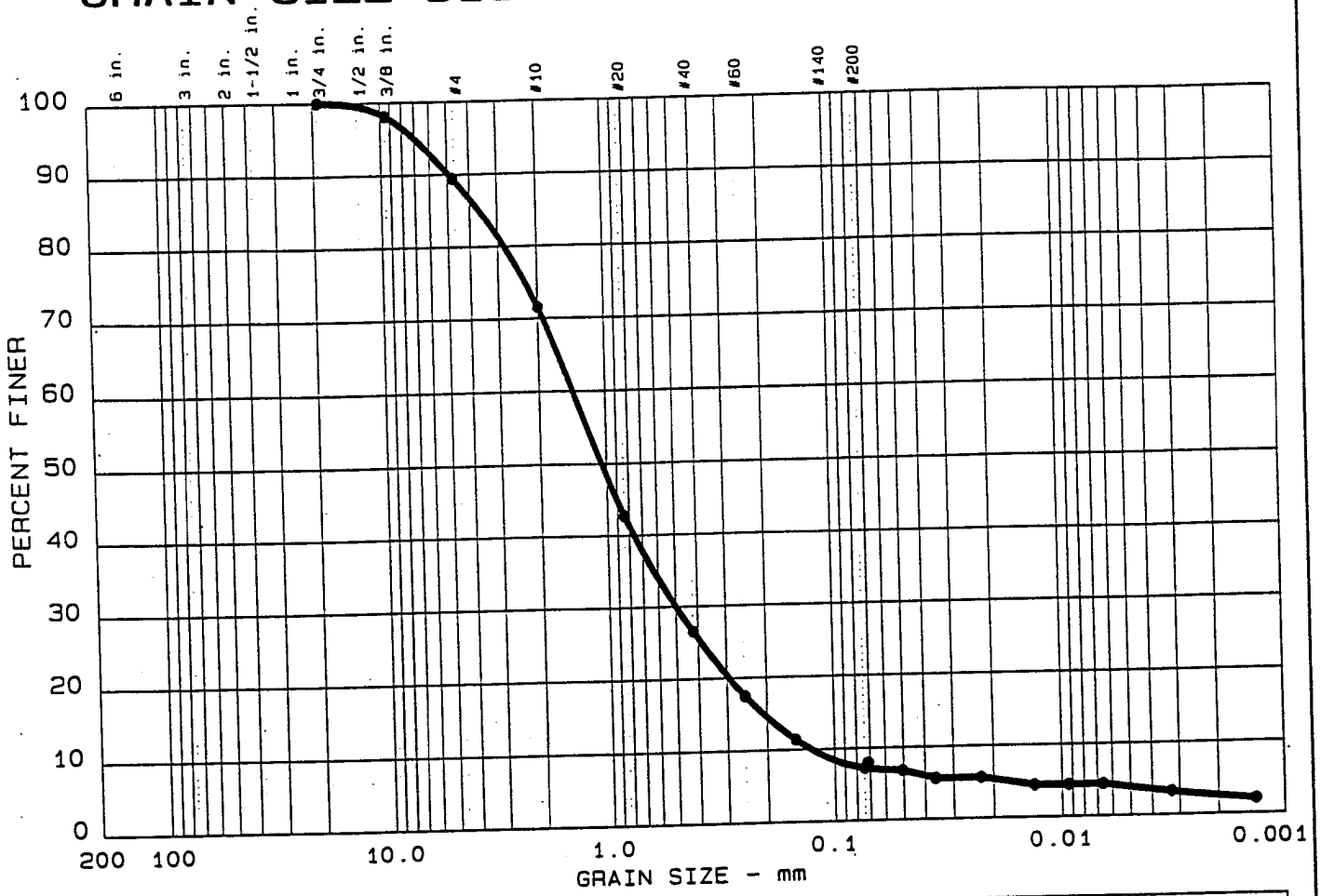
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING

Remarks:

Figure No. ———

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	10.5	82.3	3.3	3.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	3.63	1.40	1.05	0.498	0.2077	0.1266	1.40	11.0

	MATERIAL DESCRIPTION	USCS	AASHTO
●			

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.
● Location: B-7

Date: JANUARY 6, 199493

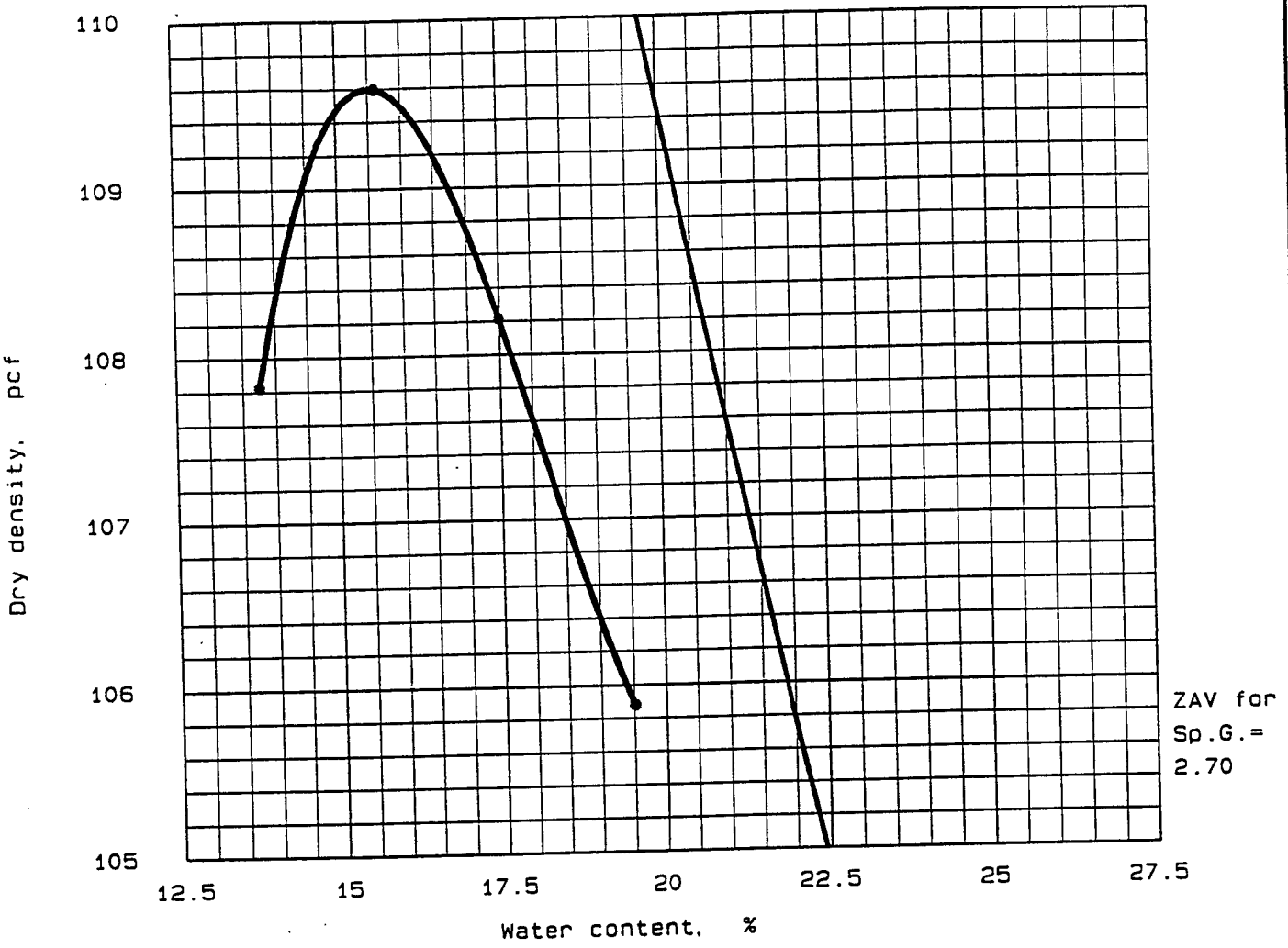
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING

Remarks:

Figure No. ———

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 15.5 % Maximum dry density = 109.5 pcf	WHITE TAN BROWN MICACEOUS SILTY FINE TO COARSE SAND WITH PARTIALLY WEATHERED ROCK

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.

Location: B-4
Date: 12-27-1993

Client:
ECOLOGICAL SERVICES, INC.
Proposed Use:

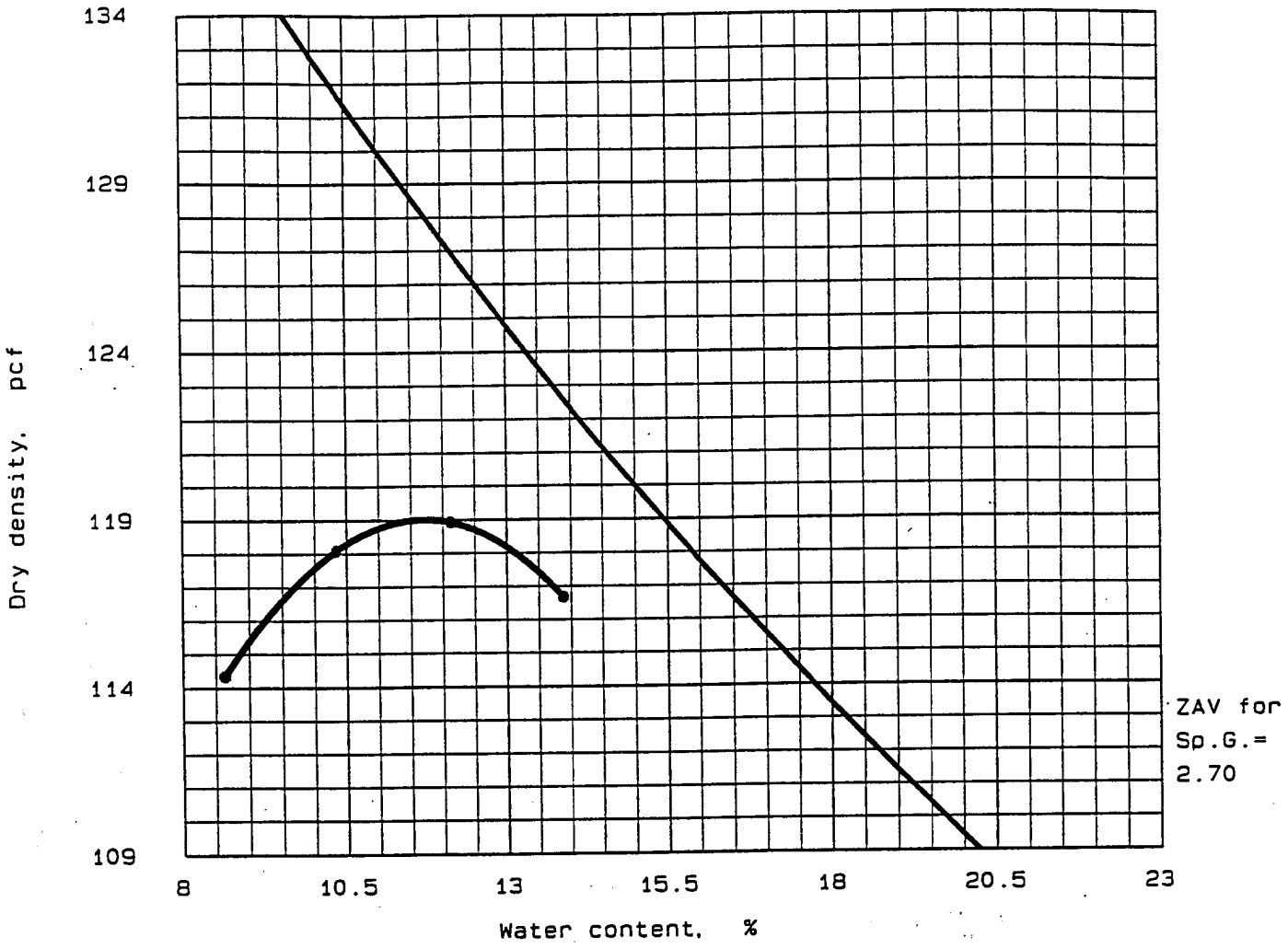
Remarks:

Curve No. 1

PROCTOR TEST REPORT

LAW ENGINEERING, INC.

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 11.5 % Maximum dry density = 119.0 pcf	BROWN MICACEOUS FINE TO COARSE SAND WITH PARTIALLY WEATHERED ROCK

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.

Location: B-6
Date: 12-27-1993

Client:
ECOLOGICAL SERVICES, INC.
Proposed Use:

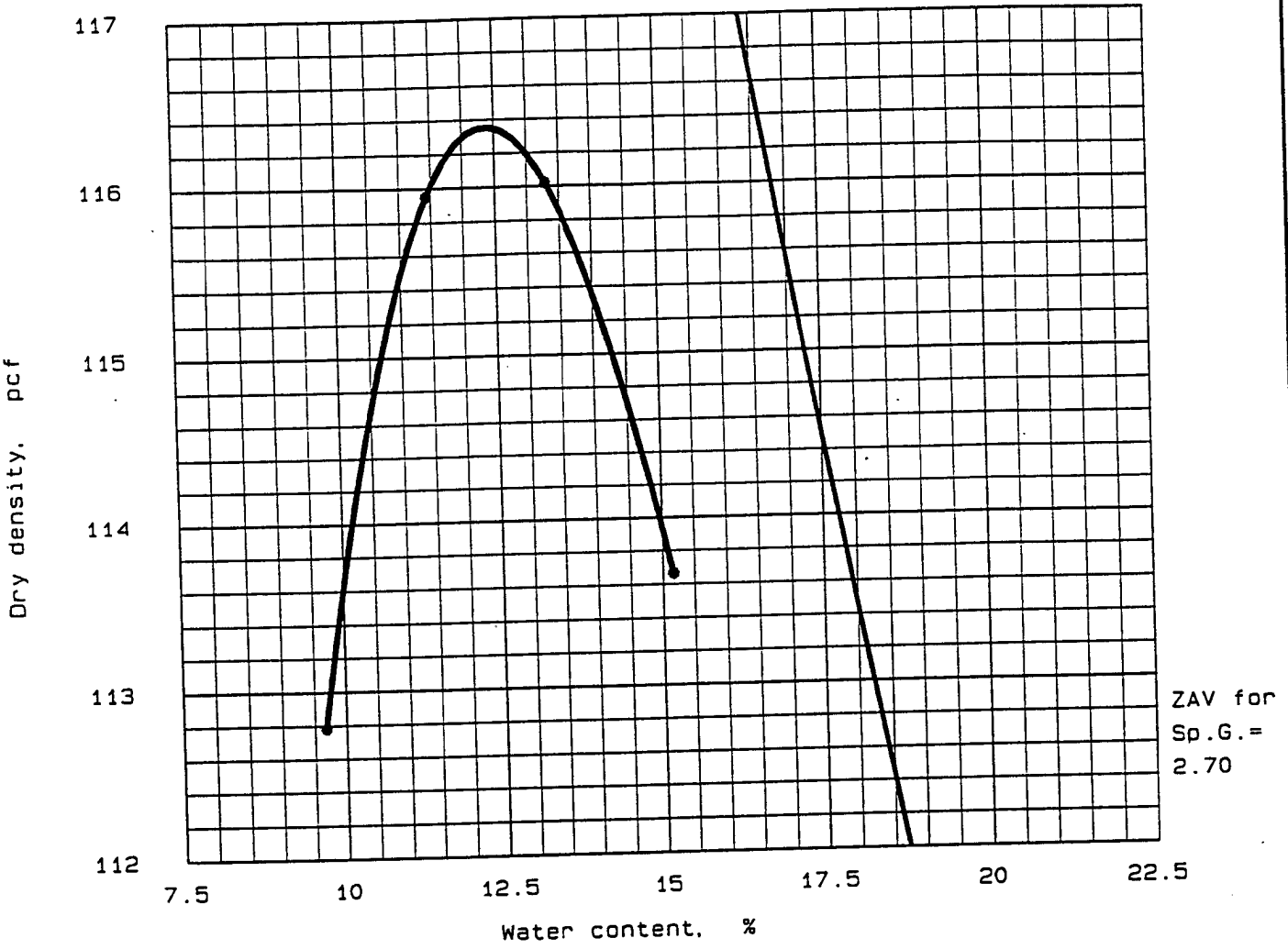
Remarks:

PROCTOR TEST REPORT

LAW ENGINEERING, INC.

Curve No. 3

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 12.5 % Maximum dry density = 116.5 pcf	BROWN MICACEOUS SILTY FINE TO COARSE SAND WITH PARTIALLY WEATHERED ROCK

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES

Location: B-5
Date: 12-27-1993

Client:
ECOLOGICAL SERVICES

Proposed Use:

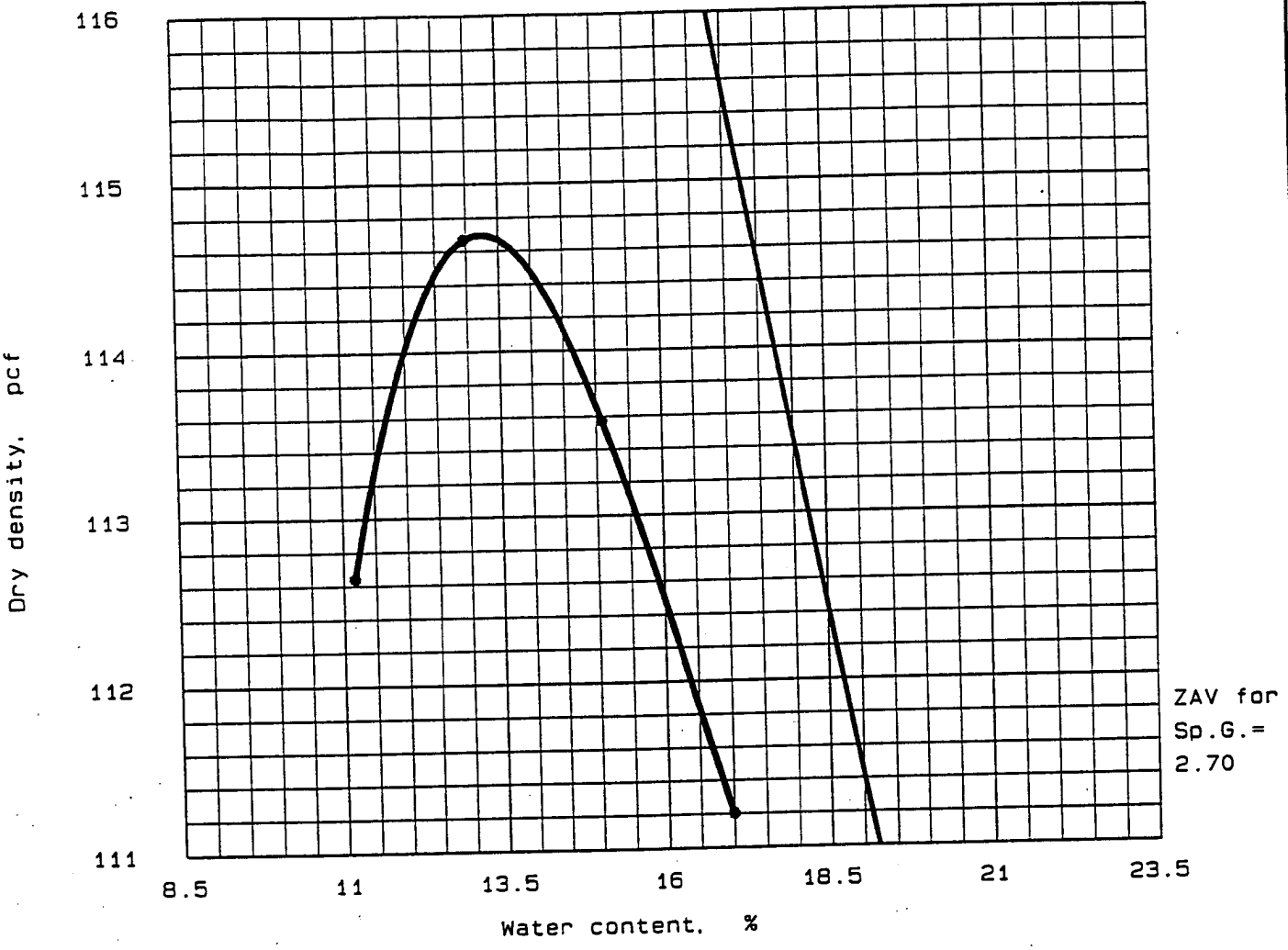
Remarks:

Curve No. 2

PROCTOR TEST REPORT

LAW ENGINEERING, INC.

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 13.0 % Maximum dry density = 114.5 pcf	BROWN MICACEOUS SILTY FINE TO COARSE SAND WITH PARTIALLY WEATHERED ROCK

Project No.: 226-09423-01
Project: ECOLOGICAL SERVICES, INC.

Location: B-7
Date: 12-27-1993

PROCTOR TEST REPORT

LAW ENGINEERING, INC.

Client:
ECOLOGICAL SERVICES, INC.

Proposed Use:

Remarks:

Curve No. 4

SECTION 10 .. DRAWINGS SHT. 11 TO 17, IN PLASTIC POCKETS.

SHEET 11 .. SITE PLAN - FINAL GRADE CONTOURS & ROAD SYSTEM.

12 .. SITE PLAN - LOWEST EXCAVATION GRADES.

13 .. STORM DRAINAGE SYSTEM & EROSSION CONTROL.

14 .. CROSS-SECTIONS THRU LANDFILL.

15 .. STORM DRAINAGE PROFILES AND DETAILS.

16 .. DETAILS - BERMS, ROADS, STORM DRAINAGE & GENERAL NOTES.

17 .. SURVEYORS STAKEOUT PLAN & LANDFILL FILL SEQUENCE FOR LAST PHASE.

SHEET 18 .. AERIAL TOPOGRAPHIC MAP OF LANDFILL.

S E C T I O N 10