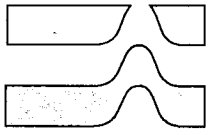
EVALUATION OF PROPOSED SOIL BORROW AREA FOR POTENTIAL USE AS LOW PERMEABILITY SOIL LINER FOR PHASE II LINED EXPANSION OF NORTH CENTRAL SANITARY LANDFILL COUNTY ROAD 540 LAKELAND, FLORIDA



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Ardaman & Associates, Inc.
Geotechnical, Environmental and
Materials Consultants

Revised September 6, 1995
August 24, 1995
File Number 95-51-9051

Envisors, Inc.
P.O. Box 9309
Winter Haven, Florida 33883-9309

Attention: Mr. Douglas Darden, P.E.

Subject: Evaluation of 44-Acre Site for Potential Use as Low Permeability Soil Liner for Phase II Lined Expansion of North Central Sanitary Landfill, County Road 540, Lakeland, Florida

Gentlemen:

As requested, we have completed an evaluation of certain native ground subgrade material at the 44-acre Phase II site area with regard to its potential use as clay liner material for the proposed Phase II lined expansion of the Class I municipal landfill area, at the North Central Sanitary Landfill complex. Samples for testing were obtained from 10 borehole locations at the site. The boring location plan is shown in Figure 1. The boring log profiles are shown in Figures 2 through 4. Representative samples were selected for Standard Proctor compaction tests, laboratory permeability tests, and determination of Atterberg limits, fines content and natural moisture content. The results of these laboratory tests and our recommendations are presented herein. This study was prepared in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied is made.

Low Permeability Soil Liner Requirments

For a soil to satisfy this project's requirements for the clayey soil component of one of its liners, the saturated hydraulic conductivity (coefficient of permeability) of the compacted soil must be equal to or less than $1x10^{-5}$ cm/sec. Furthermore, the soil must be compatible with the landfill leachate as demonstrated by the absence of change in the hydraulic conductivity of a soil test specimen when permeated with leachate similar to that which will contact the liner material.

Index Properties

The results of the moisture content and fines content (i.e., soil fraction by dry weight finer than the U.S. Standard No. 200 sieve size) and Atterberg limits testing indicated the following conditions:

Moisture Content

The as-received moisture content (ASTM D2216) determined on 5 samples over the depth interval of 6.0 to 15.3 feet below land surface varied from 13.0 to 18.9 percent. In general, the moisture content of the samples increased with depth. A plot of the moisture content of samples vs. the depths from which they were retrieved is shown in Figure 5. The average moisture content of the soil samples was 16.6 percent, by dry weight.

Fines Content

The fines content (ASTM D1140) determined on 10 samples over the depth interval of 6.0 to 15.3 feet below land surface varied from 19.5 to 46.5 percent, with an average fines content of 33.9 percent. There was no apparent correlation between the fines content of the samples and the depths from which they were retrieved. A plot of the fines content of samples vs. the depths from which they were retrieved is shown in Figure 6.

The results of the moisture and fines content of selected samples are presented in the following table.

BORING/ SAMPLE No.	SAMPLE DEPTH [feet]	MOISTURE CONTENT [%]	FINES CONTENT [% passing U.S. 200 sieve]
TB-9/5	6.0 - 6.3	-	34.2
TB-9/8	8.5 - 8.8	-	36.3
TB-9/9	9.0 - 9.3	15.8	-
TB-9/13	12.0 - 12.3	-	19.5
TB-9/14	13.0 - 13.3	18.9	-
TB-10/8	6.5 - 6.8	-	34.5
TB-10/10	8.5 - 8.8	16.3	-
TB-10/11	9.0 - 9.3	-	33.3
TB-11/8	6.0 - 6.3	13.0	-
TB-11/9	7.0 - 7.3	-	28.5
TB-11/12	10.0 - 10.3	-	39.2
TB-15/10	14.5 - 14.8	-	24.6
TB-15/11	15.0 - 15.3	18.8	-
TB-16/08	8.5 - 8.8	-	42.6
TB-16/12	11.5 - 11.8	-	46.5

Atterberg Limits

The Atterberg limits (ASTM D2487) were determined from 5 samples over the depth interval of 6.5 to 15.3 feet. The liquid limits ranged from 21 to 43 percent with an average of 30 percent. The plasticity index ranged from 8 to 29, with an average of 15.

The results of the Atterberg limits of selected samples are presented in the following table and are shown in Figure 7.

BORING/SAMPLE NO.	SAMPLE DEPTH [feet]	ATTERBERG LIMITS		
		LL [%]	PL [%]	PI [%]
TB-9/9	9.5 - 9.8	32	16	16
TB-9/14	13.0 - 13.3	26	18	8
TB-10/10	8.5 - 8.8	43	14	29
TB-11/8	6.5 - 6.8	21	13	8
TB-15/11	15.0 - 15.3	29	15	14

LL= Liquid Limit PL= Plastic Limit PI= Plasticity Index

Standard Proctor Compaction Tests

Standard Proctor compaction tests (ASTM D 698) were performed on samples retrieved by mechanical auger (MA) borings performed in the immediate vicinity of SPT borings TB-9 and TB-15. Results of the Standard Proctor tests are summarized in the following table. The fines content and in-situ moisture content associated with each proctor test were determined from soil samples collected from the associated SPT boring, within the same vertical reach as the soil samples collected for the Standard Proctor test. The results of the compaction tests are plotted in Figure 8.

A summary of the proctor compaction test results, and other pertinent information are contained in the following table.

BORING NUMBER	SAMPLE DEPTH [feet]	$\gamma_{d\ max}$ [pcf]	OPTIMUM MOISTURE CONTENT [%]	IN-SITU MOISTURE CONTENT [%]	FINES CONTENT [%]	ATTERBERG LIMITS		
						LL [%]	PL [%]	PI [%]
TB-9A	7.0 - 11.5	114.4	12.7	15.8	36.3	32	16	16
TB-15A	13.5 - 17.5	109.0	17.2	18.8	24.6	29	15	14

γ_d = Maximum dry density based on Standard Proctor Test

As can be seen from the table above, the in-situ moisture content of the potential borrow soils is slightly higher than the Standard Proctor optimum moisture content. This is a desirable characteristic in terms of soil placement and compaction.

Permeability Tests

Permeability tests were performed, with tap water, in general accordance with ASTM D 5084 on fine grained compacted soils, collected from MA borings TB-9A and TB-15A. Permeability tests performed with leachate, obtained from the existing landfill, were also performed in general accordance with EPA 9100. The compacted soil densities, molding moisture contents and fines contents are shown along with the saturated hydraulic conductivity of the samples. Permeability tests performed on samples are shown in the table below.

BORING	PERMEANT	SAMPLE DEPTH [feet]	MOLDING CONDITIONS γ_d [pcf]	MOLDING CONDITIONS ω [%]	FINES CONTENT [%]	HYDRAULIC CONDUCTIVITY [cm/sec]
TB-9A	WATER ASTM D5084	7.0 - 11.5	111.6	11.1	33	5.5×10^{-9}
TB-9A	WATER ASTM D5084	7.0 - 11.5	111.0	13.3	32	1.5×10^{-8}
TB-15A	WATER ASTM D5084	13.5 - 17.5	106.2	17.1	28	1.2×10^{-8}
TB-15A	WATER ASTM D5084	13.5 - 17.5	105.3	17.6	27	9.3×10^{-9}
TB-9A	LEACHATE EPA 9100	7.0 - 11.5	111.0	13.3	32	5.8×10^{-9}
TB-15A	LEACHATE EPA 9100	13.5 - 17.5	105.3	18.7	27	8.1×10^{-9}

γ_d - Molded dry density at the associated moisture content
ω - Moisture content by dry weight

Each sample was thoroughly homogenized prior to preparation of the permeability test specimens. The test specimens were then prepared at molding moisture contents from approximately optimum to 2.0 percent above optimum moisture content. The first permeability test performed on the sample collected from TB-9A was slightly different from the remaining samples, in that it was molded at a moisture content which was 1.5 percent below optimum. Test specimens were tamped in four equal thickness lifts in a 3.57 cm diameter by 8.0 cm long rigid steel mold to dry densities equalling or less than the Standard Proctor dry density at the corresponding molding moisture content. The test specimens were then extruded from the mold, mounted in a triaxial-type permeameter, encased in a soil membrane, and isotropically consolidated under effective stresses of 6 lb/in^2 with backpressures of 92 to 94 lb/in^2. Adequate saturation of the specimens was confirmed by measured B-factors exceeding 95 percent. The quantity of flow into and out of each specimen was recorded with time, and the tests were continued until a relatively constant hydraulic conductivity was measured, and the ratio of the outflow to inflow was in the range of 0.75 to 1.25, in accordance with ASTM D 5084.

The results of permeability tests performed on samples retrieved from the 44-acre site indicate that these selected soils are capable of achieving a hydraulic conductivity less than 1×10^{-5} cm/sec when properly homogenized, moisture-conditioned, and compacted.

Cut and Fill Considerations

We estimate that on the order of 40,400 cubic yards of in-place compacted clayey soil fill are required for the low permeability soil liner. The actual quantity will need to be determined from final design drawings. Above the base grade elevation, we estimate that up to 23,000 cubic yards of in-place clayey soils are available for borrow and use in the liner construction. Sufficient additional clayey soils can be excavated from below the base grade as make-up borrow material for liner construction, however, excavations should not be allowed below elevation 100 feet, MSL. Base soil excavations must be replaced with compacted soils which meet the project's requirements for compacted base grade.

The above quantities are only estimates of available in-place material and do not take into account waste and shrinkage resulting from earthwork operations. The contractor must make appropriate adjustments for waste and shrinkage in determining his cut and fill quantities.

Summary and Implications

It is our opinion that a sufficient number of index tests, which include percent fines, Atterberg limits and moisture content determinations and laboratory hydraulic conductivity tests, have been completed to-date to indicate that the select clayey sands from the 44-acre expansion site, when properly homogenized and compacted at the appropriate molding moisture content, can consistently achieve hydraulic conductivities less than $1x10^{-5}$ cm/sec. Specifically, the results of our analysis show that the selected cohesive soil layers demonstrate permeability values, whose 98 percent upper bound confidence limit was calculated to be $1.7x10^{-8}$ cm/sec. Accordingly, our analysis demonstrates that the select clay soil source layers will attain a laboratory permeability which is equal to or less than $1.7x10^{-8}$ cm/sec. when compacted to 97 percent of the Standard Proctor maximum dry density at optimum moisture content. Therefore, it is our opinion that the subject soils may be used to construct the $1x10^{-5}$ cm/sec. clayey soil barrier layer component of the bottom liner of the proposed Phase II Class I landfill expansion, at the North Central Landfill Complex. Select fill for the compacted low permeability soil liner should be compacted to at least 98 percent of the Standard Proctor maximum dry density (one-point test) at molding water contents in the range of optimum to not greater than 3 percent higher than the Standard Proctor optimum moisture content (ASTM D 698).

Closure

The analyses submitted in this report are based on the data obtained from ten (10) SPT borings performed at the locations indicated on the attached Figure 1. This report does not reflect any variation which may occur in-between the borings, the nature and extent of which may not become evident until during the course of construction. If variations then appear evident, it will be necessary for you to engage our firm to re-evaluate the recommendations of this report, on the basis of pertinent on-site observations made by us during the construction period, wherein the characteristics of any variations are noted.

When the final design and specifications are completed, we would like the opportunity to review them in order to determine whether changes in the original concept may have affected the

validity of our recommendations, and whether these recommendations have been implemented in the design and specifications.

The recovered soil samples are available for examination at our Bartow office. Unless otherwise instructed in writing, the soil samples will be discarded 60 days after the issuance of this report.

It has been a pleasure assisting you with this phase of your project. If there are any questions or when we may be of further assistance, please contact the undersigned at (813) 533-0858.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

Larry L. Odom, E.I.
Staff Engineer III

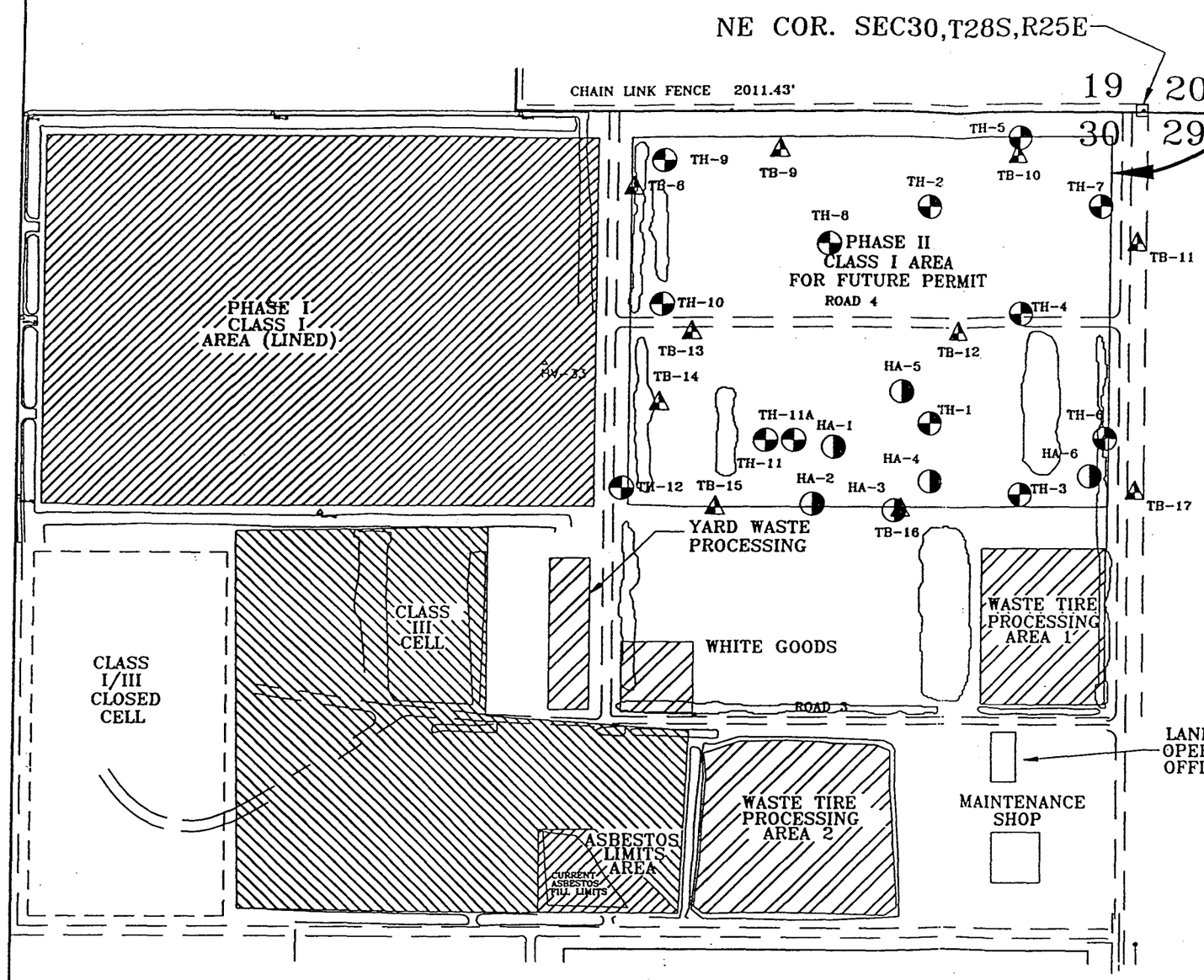
Thomas J. Leto, P.E.
Vice President
Florida Registration No.12458

Joseph A. Eduardo, P.E.
Senior Project Engineer
Florida Registration No. 33318

TJL/LLO/JAE:dd
Enclosures
B5\95-9051.RV1

FIGURES

SOIL BORING LOCATION PLAN



LEGEND

TB-6 – TB-17	STANDARD PENETRATION TEST BORING (ASTM D-1586) PERFORMED UNDER FILE NO. 95-9051
TH-1 – TH-7	STANDARD PENETRATION TEST BORING (ASTM D-1586) PERFORMED UNDER FILE NO. 93-9115
TH-8 – TH-12	STANDARD PENETRATION TEST BORING (ASTM D-1586) PERFORMED UNDER FILE NO. 94-9117
HA-1 – HA-6	HAND AUGER BORING PERFORMED UNDER FILE NO. 94-9117

DRAWING NO. 1, JOB NO. 3127 SUPPLIED BY

POLK COUNTY, FLORIDA
BOARD OF COUNTY COMMISSIONERS
ENVIRONMENTAL MANAGEMENT
DEPARTMENT

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLERS LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR. ABSENCE OF WATER DATA ON CERTAIN BORINGS IMPLIES THAT NO GROUNDWATER DATA IS AVAILABLE, BUT DOES NOT NECESSARILY MEAN THAT GROUNDWATER WILL NOT BE ENCOUNTERED AT THOSE LOCATIONS OR WITHIN THE VERTICAL REACHES OF THESE BORINGS IN THE FUTURE

DATE DRILLED: 2-3, 2-8, 2-9-93
7-12, 7-13, 7-14, 7-15-94
3-24, 3-27, 4-4-95

SCALE: 1" = 400'

N22684

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Geotechnical, Environmental and Materials Consultants

SOIL BORING LOCATION PLAN
PROPOSED CLAY LINER BORROW AREA
NORTH-CENTRAL LANDFILL
POLK COUNTY, FLORIDA

DRAWN BY: NPS	CHECKED BY: JOE	DATE: 8-18-95	
FILE NO. 959051	APPROVED BY: Joseph A. Edrosa		FIGURE: 1

LEGEND

① LIGHT GRAY SAND (SP)

② ORANGE–BROWN, BROWN OR GRAY VARIABLY MOTTLED SAND WITH SILT (SP–SM)

③ GRAY & BROWN MOTTLED SILTY SAND (SM)

④ DARK GRAY SILTY SAND (SM)

⑤ GRAY & BROWN MOTTLED SILTY, CLAYEY SAND (SM–SC)

⑥ GRAYISH–BROWN CLAYEY SAND (SC)

⑦ LIGHT GRAYISH–BROWN CLAYEY SAND (SC) OCCASIONALLY WITH PHOSPHATE

⑧ BLUISH–GRAY CLAYEY SAND, OCCASIONALLY GRADING TO SANDY FAT CLAY (SC TO CH)

⑨ ORANGE, BROWN & LIGHT GRAY MOTTLED CLAYEY SAND (SC)

⑩ GRAY CLAYEY SAND (SC) OCCASIONALLY INTERBEDDED WITH SAND LENSES

⑪ GREEN & LIGHT GRAY MOTTLED CLAYEY SAND (SC)

⑫ VERY LIGHT GRAY ELASTIC SILT WITH LIMESTONE FRAGMENTS (ML) –CAP ROCK–

⑬ BROWN & BLUE MOTTLED CLAYEY SILT WITH PHOSPHATE (MH)

⑭ VERY LIGHT BROWN VARIABLY WEATHERED CLAYEY ELASTIC SILT {BEDROCK FORMATION} (ML–MH)

⑮ DARK GRAY CLAYEY SILT WITH TRACES OF PHOSPHATE (MH)

⑯ BLACK SANDY ORGANIC SILT (OL)

⑰ WASH BORING NO SAMPLE TAKEN

⑱ MIXED BROWN TO REDDISH–BROWN SANDS & SILTY SANDS, OCCASIONALLY WITH CLAYEY SAND (SP+SM+SC) – FILL –

TB–8 STANDARD PENETRATION TEST BORING (ASTM D–1586)

N STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT

50/5" 50 BLOWS PER 5 INCH PENETRATION

▽ GROUNDWATER TABLE, OBSERVED ON DATE SHOWN, (IF DIFFERENT FROM DATE OF BORING)

N.M. NATURAL MOISTURE CONTENT, IN PER CENT

–200 PER CENT OF SAMPLE PASSING THROUGH THE U.S. NUMBER 200 SIEVE

FILL

SP UNIFIED SOIL CLASSIFICATION SYMBOL

N22684

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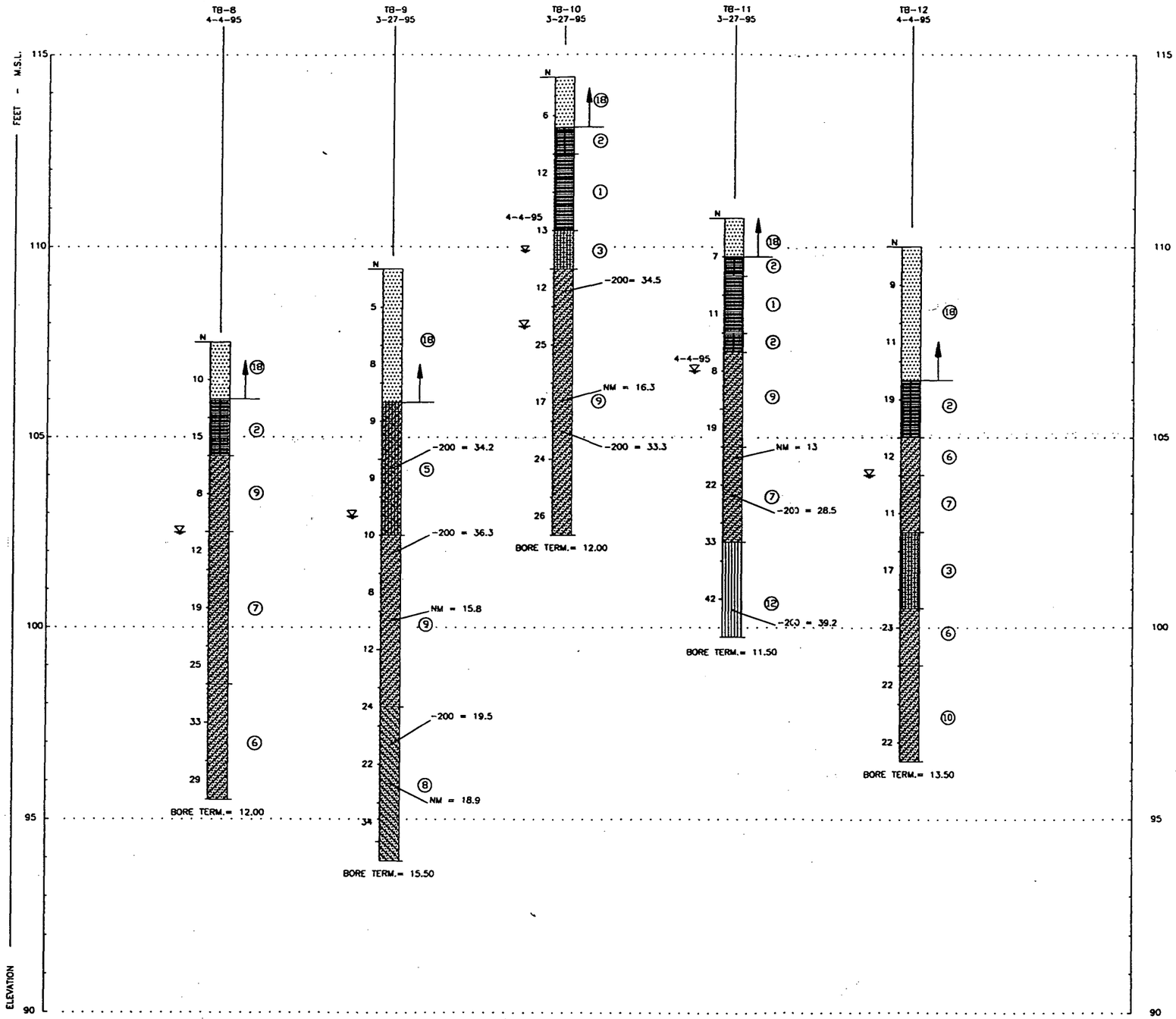
FINAL BORING LOG PROFILES
LEGEND
PROPOSED CLAY LINER BORROW AREA
NORTH CENTRAL LANDFILL
POLK COUNTY, FLORIDA

DRAWN BY: AJS	CHECKED BY: LU	DATE: 8-30-95
FILE NO. 95-9051	APPROVED BY:	FIGURE: 2

FINAL BORING LOG PROFILES



ENGINEERING CLASSIFICATION

COHESIONLESS

DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

COHESIVE

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH T.S.F.	BLOW COUNT "N"
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLERS LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED.

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DATE DRILLED: 3-27, 4-4-95

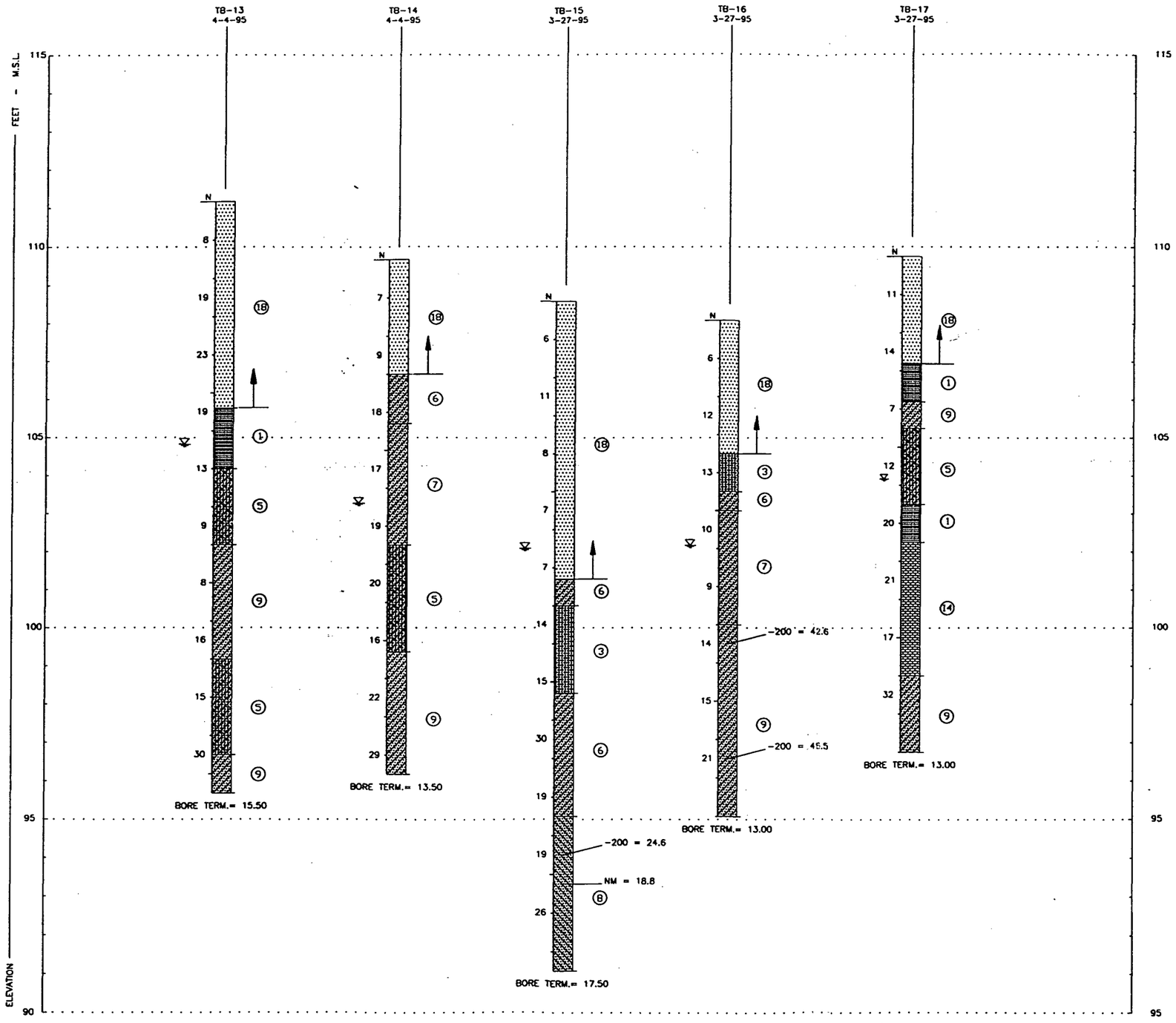
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

FINAL BORING LOG PROFILES
PROPOSED CLAY LINER BORROW AREA
NORTH-CENTRAL LANDFILL
POLK COUNTY, FLORIDA

DRAWN BY: WPS	CHECKED BY: RO	DATE: 8-30-95
FILE NO. 95-9051	APPROVED BY:	FIGURE: 3

N22684

FINAL BORING LOG PROFILES



ENGINEERING CLASSIFICATION

——— COHESIONLESS

DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

——— COHESIVE

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH T.S.F.	BLOW COUNT "N"
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

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DATE DRILLED: 3-27, 4-4-95

Ardaman & Associates, Inc.
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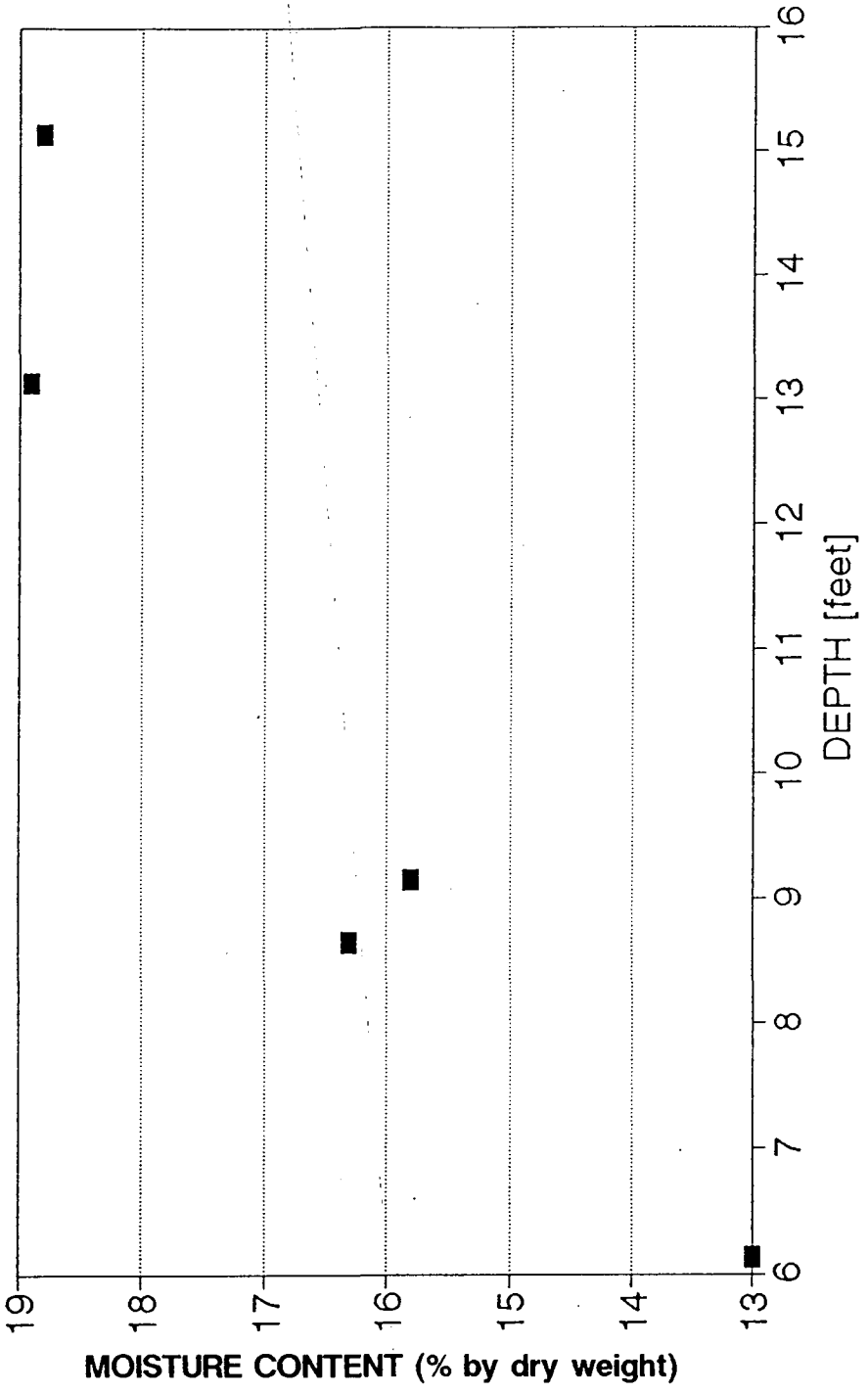
FINAL BORING LOG PROFILES
PROPOSED CLAY LINER BORROW AREA
NORTH-CENTRAL LANDFILL
POLK COUNTY, FLORIDA

DRAWN BY: PS | CHECKED BY: | DATE: 8-30-95
FILE NO. 95-7051 | APPROVED BY: | FIGURE: 4

N22684

DEPTH vs. MOISTURE CONTENT

44 - ACRE SITE



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Consulting Engineers in Soil Mechanics, Foundations, and Materials Testing

DEPTH vs MOISTURE CONTENT
NORTH CENTRAL LANDFILL
POLK COUNTY, FLORIDA

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FILE NO. 959051	APPROVED BY:	

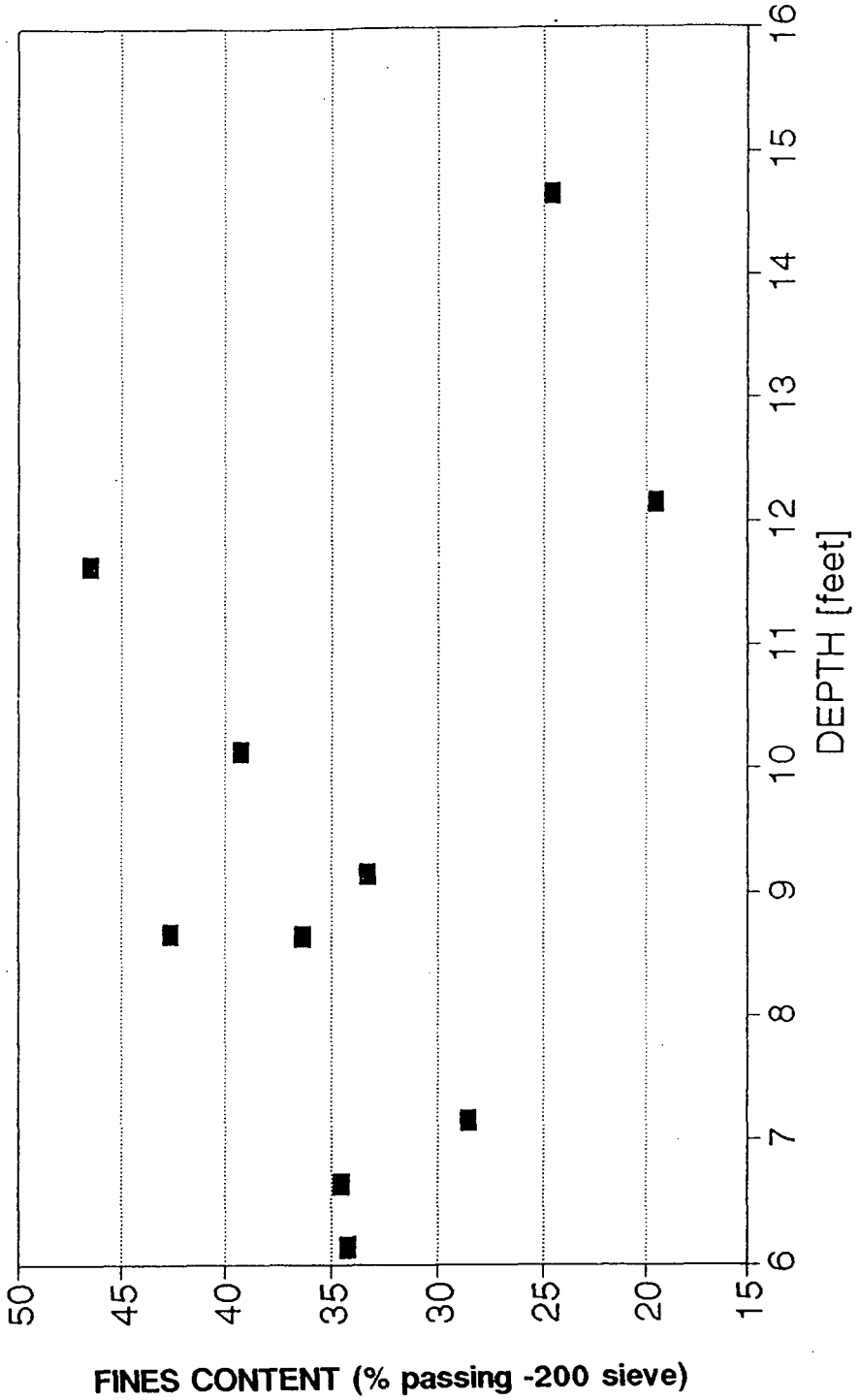
REVISED 9/5/95

N39695

FIGURE 5

DEPTH vs. FINES CONTENT

44 - ACRE SITE



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DEPTH vs FINES CONTENT
NORTH CENTRAL LANDFILL
POLK COUNTY, FLORIDA

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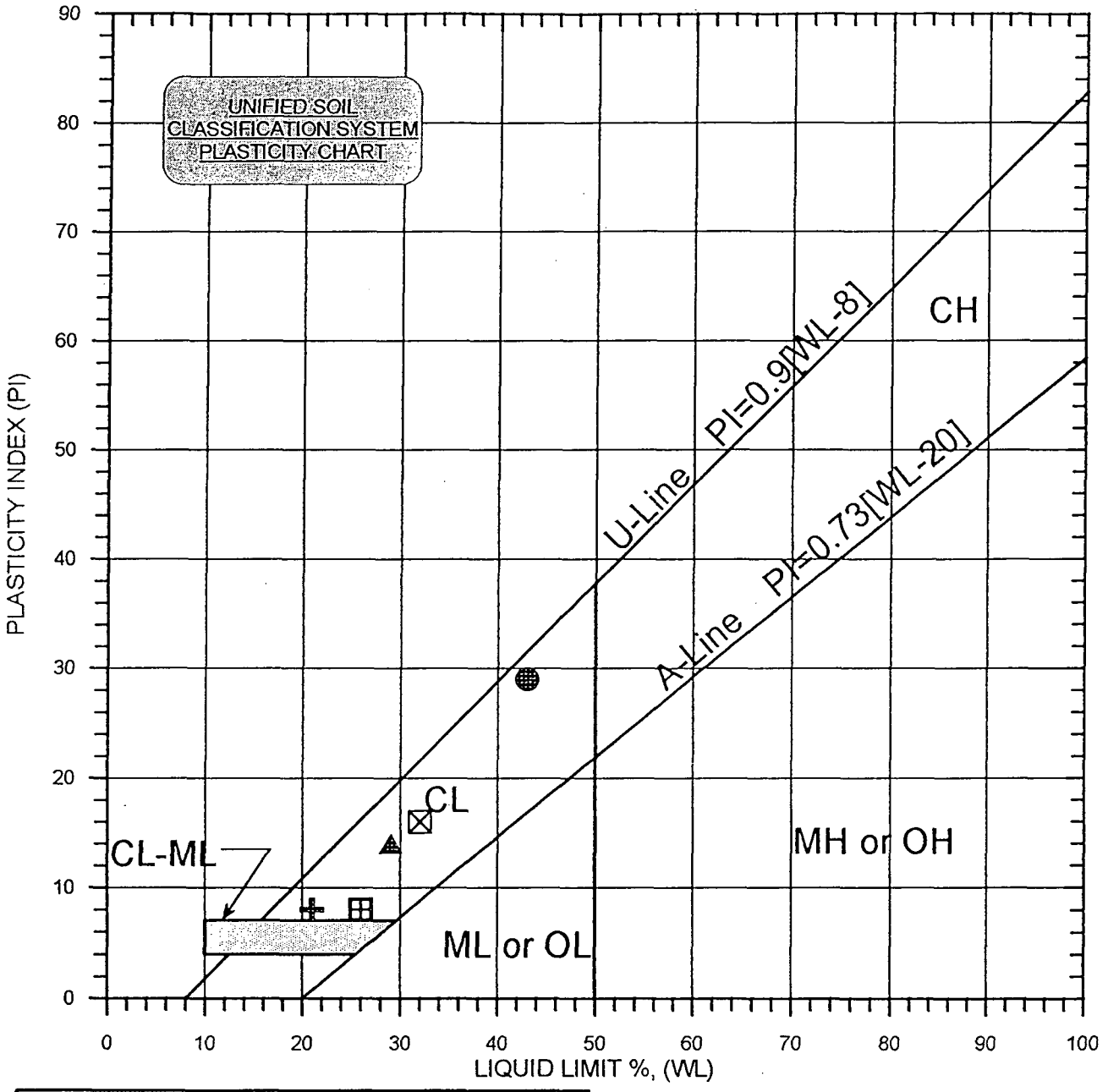
REVISED 9/5/95

FIGURE 6

N39695

ATTERBERG LIMITS TEST RESULTS



LEGEND		
⊠	BORING TB-9 SAMPLE NO. 9	9.5' TO 9.8'
⊞	BORING TB-9 SAMPLE NO. 14	13.0' TO 13.3'
●	BORING TB-10 SAMPLE NO. 10	8.5' TO 8.8'
+	BORING TB-11 SAMPLE NO. 8	6.5' TO 6.8'
▲	BORING TB-15 SAMPLE NO. 11	15.0' TO 15.3'

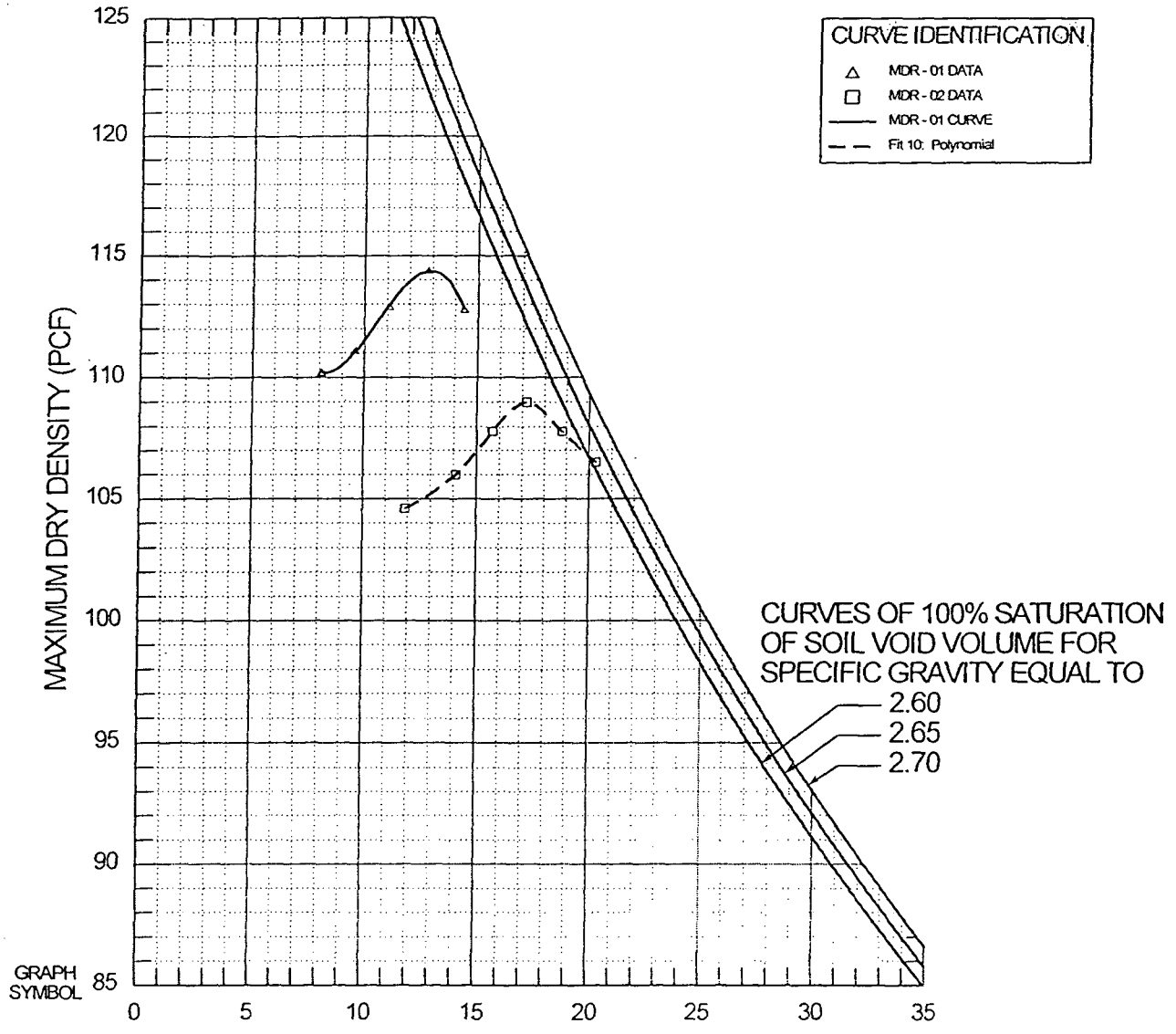
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ENVISORS, INC.
PROPOSED CLAY LINER MATERIAL
48 ACRE SITE
NORTH CENTRAL LANDFILL
POLK COUNTY, FLORIDA

DRAWN BY: K.R.H. | CHECKED BY: L.L.O. | DATE: 08-16-95
FILE NO. 95-9051 | APPROVED BY: | FIGURE NO. 7

grf4win\95-9051.grf

MOISTURE - DENSITY RELATIONSHIP



SAMPLE NO.	SAMPLED BY	DATE TESTED	TEST METHOD	MAXIMUM DRY DENSITY (PCF)	OPTIMUM WATER CONTENT (%)	% SOIL FINES	SOIL DESCRIPTION	U.S.C.S. SYMBOL
MDR - 01	A.G.	4-07-95	ASTM D-698	114.4	12.7	36.3	Orangish-brown clayey sand	SC
MDR - 02	A.G.	4-07-95	ASTM D-698	109.0	17.2	24.6	Light brown to gray silty clayey sand	SC

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

PROJECT: NORTH CENTRAL LANDFILL
REPORTED TO: ENVISORS, INC.

DRAWN BY: KRH | CHECKED BY: L.L.O. | DATE: 07-31-95
FILE NO. 95-9051 | APPROVED BY: | FIGURE NO. 8

grf4win/B:MDR/95-9051.grf

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. ASFE/The Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risks.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include: the general nature of the structure involved, its size, and configuration; the location of the structure on the site; other improvements, such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report's recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report:

- when the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size, elevation, or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership; or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report's development have changed.

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report whose adequacy may have been affected by time. Speak with your geotechnical consultant to learn if additional tests are advisable before construction starts.Note, too, that additional tests may be required when subsurface conditions are affected by construction operations at or adjacent to the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS

Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

A REPORT'S RECOMMENDATIONS CAN ONLY BE PRELIMINARY

The construction recommendations included in your geotechnical engineer's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Because actual subsurface conditions can be discerned only during earthwork, you should retain your geotechnical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

GEOENVIRONMENTAL CONCERNS ARE NOT AT ISSUE

Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations

about the potential for hazardous materials existing at the site. The equipment, techniques, and personnel used to perform a geoenvironmental exploration differ substantially from those applied in geotechnical engineering. Contamination can create major risks. If you have no information about the potential for your site being contaminated, you are advised to speak with your geotechnical consultant for information relating to geoenvironmental issues.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid misinterpretations, retain your geotechnical engineer to work with other project design professionals who are affected by the geotechnical report. Have your geotechnical engineer explain report implications to design professionals affected by them, and then review those design professionals' plans and specifications to see how they have incorporated geotechnical factors. Although certain other design professionals may be familiar with geotechnical concerns, none knows as much about them as a competent geotechnical engineer.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE REPORT

Geotechnical engineers develop final boring logs based upon their interpretation of the field logs (assembled by site personnel) and laboratory evaluation of field samples. Geotechnical engineers customarily include only final boring logs in their reports. Final boring logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes, and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, give contractors ready access to the complete geotechnical engineering report prepared or authorized for their use. (If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared and that developing construction cost estimates was not one of the specific purposes for which it was prepared. In other words, while a contractor may gain important knowledge from a report prepared for another party, the contractor would be well-advised to discuss the report with your geotechnical engineer and to perform the additional or alternative work that the contractor believes may be needed to obtain the data specifically appropriate for construction cost estimating purposes.) Some clients believe that it is unwise or unnecessary to give contractors access to their geotechnical engineering reports because they hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems. It also helps reduce the adversarial attitudes that can aggravate problems to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical engineers. To help prevent this problem, geotechnical engineers have developed a number of clauses for use in their contracts, reports, and other documents. Responsibility clauses are not exculpatory clauses designed to transfer geotechnical engineers' liabilities to other parties. Instead, they are definitive clauses that identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report. Read them closely. Your geotechnical engineer will be pleased to give full and frank answers to any questions.

RELY ON THE GEOTECHNICAL ENGINEER FOR ADDITIONAL ASSISTANCE

Most ASFE-member consulting geotechnical engineering firms are familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a construction project, from design through construction. Speak with your geotechnical engineer not only about geotechnical issues, but others as well, to learn about approaches that may be of genuine benefit. You may also wish to obtain certain ASFE publications. Contact a member of ASFE of ASFE for a complimentary directory of ASFE publications.

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