SUPPLEMENTARY SOIL BORINGS AND
SOIL PERMEABILITY EVALUATION
PROPOSED DEMOLITION WASTE LANDFILL SITE
KINGSTON STEAM PLANT
KINGSTON, TENNESSEE
TVA REFERENCE NO. 83PAA-38159B

GROUND ENGINEERING AND TESTING SERVICE, INC.
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GROUND ENGINEERING AND TESTING SERVICE, INC.

September 15, 1989

Tennessee Valley Authority
BR 2S83B Blue Ridge Place
1101 Market Street
Chattanooga, Tennessee 37402

ATTENTION: Mr. R. E. Oliver
TVA Project Manager

Subject: SUPPLEMENTARY SOIL BORINGS AND
SOIL PERMEABILITY EVALUATION
PROPOSED DEMOLITION WASTE LANDFILL SITE
KINGSTON STEAM PLANT
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TVA REFERENCE NO. 88PAA-38159B
Our Job No. B5056-S

Gentlemen:

Ground Engineering and Testing Service, Inc., has completed a supplementary subsurface exploration and soil permeability evaluation for the above referenced site. The purpose of this study was to augment the subsurface characterization and soil permeability information contained in our original report No. B5056-D2 dated December 12, 1988.

INVESTIGATION METHODS

A. SOIL BORINGS

On August 9, 1989, six soil borings were drilled within the limits of the proposed landfill at the approximate locations shown on the attached site map. The borings were drilled with 6 in. diameter flight augers driven by a CME-45 soil test rig. The borings were drilled to a minimum depth of 20 ft below existing top of ground or auger refusal. Shallow auger refusal at less than 20 ft was encountered only in borings B-3 and B-3A at a depth of 13 ft.

David Kendrick, Engineering Geologist, observed the encountered soils and drilling rate at each boring location, prepared the attached soil boring logs while at the site, and collected three large bags of representative site soils for laboratory testing.

B. LABORATORY SOIL TESTS

The bag samples were collected from auger cuttings obtained from depths of 10 to 20 ft below the present

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top of ground. These depths were estimated to correspond to the geologic barrier zone at the bottom of the planned landfill trenches.

Initially, Atterberg limits and natural moisture tests were performed on the B-1 and B-2 bag samples. Then a blend of these two samples were remolded using standard Proctor procedures to obtain the maximum dry density at optimum moisture content of the combined sample.

A constant head permeability test using back pressure saturation was performed on remolded, blended soils from borings B-1 and B-2. The permeability test was performed on the blended sample remolded to 100 percent of its maximum dry density.

The above mentioned test results and their general laboratory procedures are included in the laboratory section of the Appendix.

FINDINGS

A. SOIL CONDITIONS

The borings generally encountered residual red-brown, silty clays (CL) mixed with small angular chert fragments. In borings, B-2 and B-4, light brown plastic clays (CH/CL) were encountered below depths of 10 ft. The size and percentage of chert gravel by volume increased below 14.5 ft in B-1, 10 ft in B-2, 8.5 ft in B-3A and 7 ft in B-5. Auger refusal on dense chert gravel lens or boulders was encountered in the remaining borings.

Atterberg limits tests performed on soil samples taken from Borings B-1 and B-2 confirmed that the sampled site soils ranged from silty to plastic clays (CL-CH). Samples from B-1 and B-2 were found to have liquid limits of 50 and 83, respectively. Laboratory permeability tests performed on 100 percent of its standard Proctor maximum dry density indicated a coefficient of permeability of 8×10^{-6} cm/sec. We judge the degree of compaction to be representative of the insitu materials.

B. GROUND WATER

No ground water was observed in any of the six borings during or at the completion of site drilling.

SITE EVALUATION

The proposed landfill area is underlain by a stable, clayey overburden that generally is greater than 20 ft in depth. Ground water levels are expected to be at a depth of greater than 20 ft below the present top of ground.

The laboratory permeability data indicate that the on site clays in a compacted state, have a coefficient of permeability of less than 1×10^{-5} cm/sec. The results of Atterberg limit tests also indicate that the soil should have a low permeability.

Should you have any questions or comments concerning this site evaluation, please contact the undersigned.

Very truly yours,

GROUND ENGINEERING AND TESTING SERVICE, INC.

A. David Kendrick
Engineering Geologist

Richard A. Bourquard, P.E.
Senior Geotechnical Engineer

ALABAMA REGISTERED No. 12455 PROFESSIONAL ENGINEER RICHARD A. BOURQUARD

ADK/ro

APPENDIX A

FIELD DATA

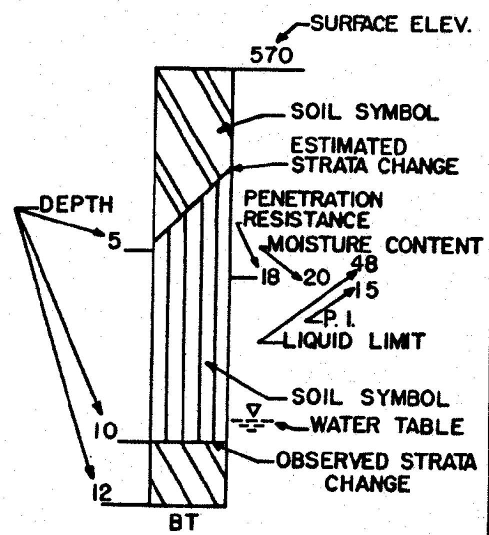
BORING LEGEND

SOIL SYMBOLS

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAIN SOILS MORE THAN 50% RETAINED ON NO. 200 SEIVE	GRAVELS 50% OR MORE OF COARSE FRACTION RETAINED ON NO. 4 SEIVE	CLEAN GRAVELS	GW	WELL-GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN 50% OF COARSE FRACTION PASSES NO. 4 SEIVE	CLEAN SANDS	SW	WELL-GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-SILT MIXTURES
FINE GRAIN SOILS 50% OR MORE PASSES NO. 200 SEIVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS

ABBREVIATIONS

SS- SPLIT SPOON SAMPLE
UD- UNDISTURBED SAMPLE
REC- SAMPLE RECOVERY
USC- VISUAL UNIFIED SOIL CLASSIFICATION
POCKET PENET- POCKET PENETROMETER READING, TSF
B.T.- BORING TERMINATED
REF.- REFUSAL TO SOIL TESTING PROCEDURE
RQD- ROCK QUALITY DESIGNATATION
FF- FRACTURE FREQUENCY PER FOOT OF CORE



KEY TO BORING RECORDS OR PROFILES

ROCK SYMBOLS

SANDSTONE

SHALE

GNEISS OR SCHIST

CONGLOMERATE

LIMESTONE OR DOLOMITE

BORING LEGEND-SYMBOLS & NOTES

GROUND ENGINEERING AND TESTING SERVICE INC.
BIRMINGHAM, ALABAMA

TESTING PROCEDURE

INVESTIGATING AND SAMPLING SOIL AND ROCK FOR ENGINEERING PURPOSES

I. INTRODUCTION

Sampling and identification of subsurface materials involve complex techniques and procedures with numerous interpretation methods. These are influenced by the geological, geographical and environmental conditions of the site, as well as the purpose of the investigation, the type and grades of proposed construction and the experience of the engineers. On our projects, the subsurface studies are typically supervised directly by experienced engineers who specialize in geotechnical studies. Subsurface conditions can be very complex and varying procedures may be needed to evaluate the general subsurface conditions.

The American Society for Testing Materials, ASTM, has established certain recommended procedures for sampling and testing soils and rock samples. The procedures, when appropriate, are generally followed to establish uniformity in testing and evaluation.

There are other investigative tools that may be used in geotechnical explorations. These include geophysical testing and remote sensing techniques, review of available information and data, and past engineering studies on nearby sites or in similar subsurface conditions. When appropriate, or when available, such tools and information may also be used to increase the knowledge of the subsurface conditions.

In a way, each study is a discovery process, with the borings or tests used as preliminary or initial diagnostic tool. Boring data must be considered applicable only at the boring location and correlations between borings must be recognized as interpretations and subject to variations. The discovery process continues until the proposed structure is constructed and is performing satisfactorily. Any new or different data on the subsurface conditions, discovered later during the design or construction process, should be reviewed by the soil consultant to determine the impact on the proposed project.

I. APPLICABLE STANDARDS

The recommended testing practices and methods are described in detail in ASTM Annual Book of ASTM Standards. Most often followed procedures include:

ASTM D420	Practice for Investigating and Sampling Soil and Rock for Engineering Purposes
ASTM D1452	Method for Soil Investigation and Sampling by Auger Borings
ASTM D1586	Method for Penetration Test and Split-Barrel Sampling of Soils
ASTM D1587	Method for Thin-Walled Sampling of Soils
ASTM D2113	Practice for Diamond Core Drilling for Site Investigation
ASTM D2487	Method for Classification of Soils for Engineering Purposes
ASTM D2488	Practice for Descriptions of Soils (Visual-Manual Procedure)

The standard methods for testing are briefly described in the following sections.

TESTING PROCEDURE

CLASSIFICATION OF SOILS
FOR ENGINEERING PURPOSES
ASTM SPECIFICATIONS D2487 AND D2488

I. INTRODUCTION

There are several soil classification systems,including those for highway departments, aviation authorities, and various government agencies. Ground Engineering and Testing Service, Inc., primarily uses the general procedures recommended by ASTM Specification, D2488, Practice for Description of Soils (Visual-Manual Method), supplemented by ASTM Specification D2487, Standard Method for Classification of Soils for Engineering Purposes, when more precise classifications are needed and are confirmed with laboratory test data.

II. PROCEDURE

Soil samples obtained in the various sampling operations are visually classified by our engineer or geologist in the field. He uses various small items of equipment to assist him including a small hand lens, pocket knife, water, diluted hydrochloric acid, and a pocket penetrometer. Based on his observations, each soil sample is assigned to one of three primary divisions: (1) coarse grained soils, (2) fine grained soils, or (3) organic soils. Although each soil may be representative of more than one division, it is generally possible to discern the most important component and assign that division. Next the soil is classified by groups within the division. There are 15 soil groups as shown on the attached Boring Legend enclosed with the Soil Boring Records.

Coarse grained soils are then described by a checklist which includes in order: (1) typical name, (2) gradation, (3) maximum particle size, (4) size distribution, (5) grain shape, (6) mineralogy, (7) color, (8) odor, (9) moisture content, (10) natural density, (11) structure, (12) cementation, (13) local or geologic name, and (14) group symbol. The checklist for fine grained or organic soils include: (1) typical name, (2) maximum particle size, (3) size distribution, (4) dry strength, (5) dilatancy, (6) plastic thread, (7) plasticity of fines, (8) color, (9) odor, (10) moisture content, (11) consistency, (12) structure, (13) cementation, (14) local or geologic name, and (15) group symbol.

If more precise classification systems are needed, the field classification is verified by laboratory testing including grain size tests and Atterberg limits tests. The results of these tests as well as the soil moisture are given on the Soil Data Sheet that is a part of the Soil Boring Record.

The field classifications are depicted graphically on the Soil Boring Record along with the results of any pocket penetrometer test.

TESTING PROCEDURE

**METHOD FOR PENETRATION TEST
AND SPLIT-BARREL SAMPLING OF SOILS
ASTM D-1586**

I. SCOPE

The split-barrel sampler is used to obtain soil samples in borings and to measure resistance of the soil to penetration by driving the sampler. The resistance to penetration by the sampler, referred to as the "blow count", N value, SPT (Standard Penetration Test), or penetration resistance, is often used as a correlation for relative strength or relative density. These values must be considered as crude approximations and significant variations in the values of 30 percent or more and not uncommon.

II. APPARATUS

1. Drilling Equipment - Any drilling equipment is acceptable which can provide a reasonably clean and stable hole. Augers are normally used in clayey soils and above the water table in sands. Below the water table in sands or in soft or unstable conditions, wash boring techniques are often needed.

2. Sampling Equipment - The split-barrel sampler or "split-spoon" is a cylindrical thick walled tube with an outside dimension of 2 in. and an inside diameter of 1 3/8 in.. The tube is 21 in. long with an open-end. The split tube nomenclature comes from the fact that it can be "split open" easily for removal of the soil specimen.

3. Driving Equipment - The split spoon is driven into the soil with a 140-lb hammer that free falls 30 in..

4. Accessory Equipment - This equipment includes sample protection equipment such as jars plus data sheets and labels.

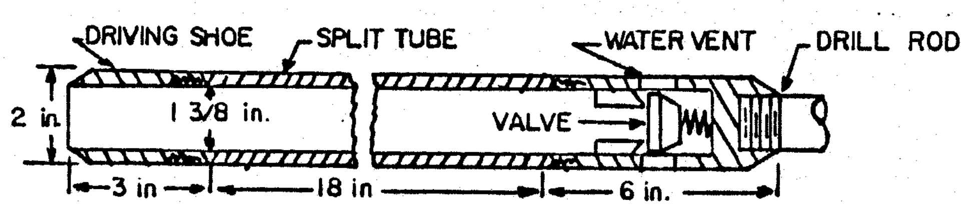
III. PROCEDURE

The boring is drilled to the desired sampling level using augers or wash boring techniques and the drilling tools removed. The sampler is then lowered to the bottom and driven into the soils with the 140-lb hammer falling 30 in.. The driving is continued until the sampler is either driven 18 in. or until 100 blows have been applied. The penetration resistance is the number of blows required to drive the final foot or fraction thereof for resistances greater than 100 blows/ft.

After driving has ceased, the sampler is brought to the surface and opened. The soils are described for composition color, structure, consistency and condition. Representative portions are placed in sealed jars, labeled, and returned to the laboratory.

IV. REPORTS

During the drilling operation, the soils encountered in the boring are visually classified by our engineer or geologist. A Soil Boring Record is prepared giving descriptions of the soils encountered, ground water levels, and other data concerning the drilling operation. The various items recommended to be reported by ASTM Standards are noted on the Soil Boring Record and the Drilling Summary Sheet.



JOB NO. B5056-S JOB NAME KINGSTON STEAM PLANT BORING NO. B-1

DATE 8-9-89 LOCATION S.E. QUADRANT OF PROPOSED LANDFILL PAGE 1 OF 1

DEPTH FT.	SYM	SOIL-ROCK DESCRIPTION	ELEV. 865±	SAMPLE TYPE	SAMPLE DEPTH FT.	SAMPLE REC IN.	STANDARD PENETRATION BLOWS/6 IN.	POCKET PENET TSF
.2		TOPSOIL/SURFACE ORGANICS						
		Silty CLAY, red-brown, stiff, small angular chert fragments, (CL) RESIDUUM						
5								
		becomes moist @ 6.0 ft. firm to stiff consistency						
10								
15		CHERT boulders @ 14.5 ft. approximately 6" thick		LG BAG SAMPLE	10-20'			
20		cherty gravel lens with very stiff soils						
		Auger refusal @ 20.5 ft.						
		At drill completion no ground water and hole open to 20.0 ft.						
25								
		Hole checked 1.5 hours after drilling open to 20.0 ft. No ground water.						

SEE LEGEND SHEET FOR SYMBOLS AND NOTES

SOIL BORING RECORD

GROUND ENGINEERING AND TESTING SERVICE INC.

JOB NO. B5056-S JOB NAME KINGSTON STEAM PLANT BORING NO. B-2

DATE 8-9-89 LOCATION N.E. QUADRANT OF PROPOSED LANDFILL NEAR WOODS LINE PAGE 1 OF 1

DEPTH FT.	SYM	SOIL-ROCK DESCRIPTION	ELEV. 852±	SAMPLE TYPE	SAMPLE DEPTH FT.	SAMPLE REC IN.	STANDARD PENETRATION BLOWS/6 IN.	POCKET PENET TSF
.2		TOPSOIL and GRASS ROOTLETS						
		Silty CLAY, orange- brown, firm, trace very small angular chert fragments (CL) RESIDUUM						
5								
		Becomes moist below 7.0 ft.						
10								
		isolated small angular chert gravel 10-20 ft.						
15				Large bag 10-20'				
20								
		Boring terminated @ 20.0 ft. No ground water encountered @ time of drillng.						
		Hole checked 1 hour following drilling, open to 19.0 ft. No ground water.						
		No ground water						

SEE LEGEND SHEET FOR SYMBOLS AND NOTES

SOIL BORING RECORD

GROUND ENGINEERING AND TESTING SERVICE INC.

JOB NO. B5056-S JOB NAME KINGSTON STEAM PLANT BORING NO. B-3

DATE 8-9-89 LOCATION N.W. QUADRANT PAGE 1 OF 1

DEPTH FT.	SYM	SOIL-ROCK DESCRIPTION	ELEV. 852 ±	SAMPLE TYPE	SAMPLE DEPTH FT.	SAMPLE REC IN.	STANDARD PENETRATION BLOWS/6 IN.	POCKET PENET TSF
		TOPSOIL and SURFACE ORGANICS						
		Silty, CLAY, orange-brown, firm to stiff, moist, angular chert gravel, (CL) RESIDUUM						
5								
10								
		CHERT gravel/boulders @ 13.0 ft.						
15		Auger refusal @ 13.0 ft.		Large bag	10-13'			
		No ground water encountered @ time of drilling.						
		Boring offset 10.0 ft. north						
20		See B-2						

SEE LEGEND SHEET FOR SYMBOLS AND NOTES

SOIL BORING RECORD

GROUND ENGINEERING AND TESTING SERVICE INC.

TVA-00013764

JOB NO. B5056-S JOB NAME KINGSTON STEAM PLANT BORING NO. B-3A

DATE 8-9-89 LOCATION N.W. QUADRANT OF PROPOSED LANDFILL PAGE 1 OF 1

DEPTH FT.	SYM	SOIL-ROCK DESCRIPTION	ELEV. 852±	SAMPLE TYPE	SAMPLE DEPTH FT.	SAMPLE REC IN.	STANDARD PENETRATION BLOWS/6 IN.	POCKET PENET TSF
		TOPSOIL AND SURFACE ORGANICS						
		Silty CLAY, orange-brown, firm to very stiff, some angular chert gravel (CL) RESIDUUM						
5								
		very stiff chert gravel lens 8.5-13.0 ft.						
10								
15		Auger refusal @ 13.0 ft.						
		No ground water encountered during drilling operations						
20								

SEE LEGEND SHEET FOR SYMBOLS AND NOTES

SOIL BORING RECORD

GROUND ENGINEERING AND TESTING SERVICE INC.

JOB NO. B5056-S JOB NAME KINGSTON STEAM PLANT BORING NO. B-4

DATE 8-9-89 LOCATION S.W. QUADRANT OF PROPOSED STEAM PLANT PAGE 1 OF 1

DEPTH FT.	SYM	SOIL-ROCK DESCRIPTION	ELEV. 855±	SAMPLE TYPE	SAMPLE DEPTH FT.	SAMPLE REC IN.	STANDARD PENETRATION BLOWS/6 IN.	POCKET PENET TSF
		Silty CLAY, orange-brown, stiff, small angular chert fragments (CL) RESIDUUM						
5								
10								
		Plastic clay, light brown, stiff, moist, very small weathered chert fragments (CH/CL) RESIDUUM						
15								
20								
25								
		Boring terminated @ 24.5 ft. Following drill completion no ground water, and hole open to 23.0 ft.						

SEE LEGEND SHEET FOR SYMBOLS AND NOTES

SOIL BORING RECORD

GROUND ENGINEERING AND TESTING SERVICE INC.

JOB NO. B5056- S JOB NAME KINGSTON STEAM PLANT BORING NO. B-5

DATE 8-9-89 LOCATION N.W. QUADRANT OF PROPOSED LANDFILL PAGE 1 OF 1

DEPTH FT.	SYM	SOIL-ROCK DESCRIPTION	ELEV. 851±	SAMPLE TYPE	SAMPLE DEPTH FT.	SAMPLE REC IN.	STANDARD PENETRATION BLOWS/6 IN.	POCKET PENET TSF
		Silty CLAY, red-brown, firm, small angular chert fragments, (CL) RESIDUUM						
5								
		becomes stiffer and chert gravel is more abundant below 7.0 ft.						
10								
15								
20								
		Boring terminated @ 20.0 ft. No ground water encountered during drilling operations						

SEE LEGEND SHEET FOR SYMBOLS AND NOTES

SOIL BORING RECORD

GROUND ENGINEERING AND TESTING SERVICE INC.

APPENDIX B

LABORATORY DATA

TESTING PROCEDURE

LABORATORY ORGANIZATION FOR TESTING OF SOILS OR ROCK OR ROCK SPECIMENS FOR ENGINEERING PURPOSES

I. INTRODUCTION

Laboratory testing of soils is often required to qualitatively classify soil and rock specimens and determine specific soil properties. The adequacy and accuracy of laboratory testing is very dependent on the engineer's understanding of the test procedures and the application of the test results, as well as the laboratory's ability to test and report in an accurate and complete manner. The accuracy of the test is dependent on the training of the technician and the condition of his equipment. ASTM has developed a complete procedure outlining the management, human resources, and physical resources of any agency that provides testing and inspection services. Ground Engineering follows that outline. Our work in the laboratory is initiated and supervised by qualified engineers, our technicians are highly skilled and trained and our equipment is well maintained and calibrated.

II. PROCEDURE

Soil samples returned to the laboratory may include jar samples, undisturbed samples, or disturbed bulk samples. Each sample is examined by the engineer and individual test method. Some of the more common tests include:

1. Grain Size Tests - ASTM D421, D422 and D2217
2. Plasticity Index Tests - ASTM D4318
3. Moisture Content - ASTM D2216
4. Laboratory Compaction Test - ASTM D698 and D1557
5. Soil Strength - ASTM D2166 and D2850
6. Consolidation - ASTM D2435
7. Classification - ASTM D2487

The methods are briefly described on the following Test Procedures where appropriate, more complete descriptions of each test are presented in the Annual Book of Standards.

TEST METHOD OF ATTERBERG LIMITS

I. INTRODUCTION

The Atterberg limits and related indices have proven to be useful in identifying and classifying fine grained soils and relating certain significant properties and behavioral characteristics of the soil. These values are often used directly in specifications controlling fill soils and are often correlated to other engineering properties, including shrink and swell properties, compressibility, and CBR design values for pavements.

The Atterberg limits, named for an early soil scientist, A. Atterberg, recognizes the interaction of fine grained soils and moisture. Fine grained soils exist in four states depending on the moisture content, including the liquid, plastic, semi-solid, and solid states. The values obtained in the tests of liquid and plastic limits determine the moisture content at the arbitrary boundaries of the liquid and plastic state and the plastic and semi-solid states, respectively.

II. APPLICABLE STANDARDS

ASTM D-4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

III. GENERAL PROCEDURE

The tests are conducted on soil passing the No. 40 sieve. The liquid limit is determined by mixing the soil sample with water, placing the mixture in a special testing cup, cutting a groove in the specimen with a special tool, and dropping the cup a specified distance until the soil flows and closes the groove. This may be accomplished three or more times until a consistency of the soil-water mixture flows into the groove in a specified number of blows or until a graphical solution of the moisture for closure can be determined. The soil-water mixtures are removed from the cup each time and a moisture sample obtained. The liquid limit is the moisture content which closes the groove after 25 repetitions of the dropping.

The plastic limit of a soil is defined as the moisture content at the boundary of the plastic and semi-solid state. The water content at this boundary is arbitrarily defined as the lowest water content at which the soil can be rolled into threads 1/8 in. in diameter without the threads breaking into pieces. A small mixture of soil and water is rolled with the fingers on a ground glass plate or a piece of paper. When the soils are rolled sufficiently that the thread begins to crumble near the specified diameter of 1/8 in., the moisture content is determined as the plastic limit.

The liquid limit (LL) minus the plastic limit (PL) gives a value referred to as the plasticity index (PI). This value is commonly used in foundation and earthwork construction. The liquid limits and plastic limits are given on the Soil Data Record accompanying the Soil Boring Record.

LABORATORY COMPACTION TEST

I. INTRODUCTION

The laboratory compaction test is frequently used as a standard for comparison of the degree compaction in earthwork construction. Early research by R. R. Proctor determined that densification or compaction of soils was related to the soil type, the moisture content of the soil, and the compactive effort. Using a standard compactive effort, Proctor determined a relationship between moisture and density for a selected soil. The relationship, when graphically depicted, formed a bell-shaped curve with a "Y" axis representing the density and the "X" axis representing the moisture. The test demonstrated that when a standard compactive effort is applied to a particular soil, the dry density will increase until an "optimum moisture" content has been obtained. Thereafter, increasing the moisture will decrease the dry density. The highest density is referred to as the maximum dry density or the Proctor maximum dry density (PMDD).

II. APPLICABLE STANDARDS

The two most widely used laboratory compaction methods include:

1. ASTM D-698 - Standard Test Methods for moisture-Density Relations of Soil and Soil Aggregate Mixtures using a 5.5 lb Rammer and 12 in. Drop (Standard Proctor).
2. ASTM D-1557 - Standard Testing Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using a 10 lb Rammer and an 18 in. Drop (Modified Proctor).

III. METHODS

Four alternate procedures, based on the soil particle size and the size of the compaction mold are usually followed:

1. Method A - A 4 in. diameter mold; material passing a No. 4 sieve
2. Method B - A 6 in. mold; material passing a No. 4 sieve
3. Method C - A 6 in. mold; material passing a 3/4 in. sieve; and
4. Method D - A 6 in. mold; material passing a 3/4 in. sieve, corrected by replacement for material retained on a 3/4 in. sieve.

IV. PROCEDURE

The soils to be tested are divided in four or more test specimens with varying moisture contents. In the procedure for ASTM D-698, the materials is placed in the required mold in three layers and each layer receives 25 blows of the hammer in method A and 56 blows in the other methods. In the procedure for ASTM D-1557, five layers are compacted with method A receiving 25 blows, an in the other methods the 56 blows are applied. After compaction, the weight of the wet soil is determined and a moisture content obtained. The procedure is continued until a density-moisture curve can be determined.

V. REPORTS

The results of the test, including the test method used, the origin of the sample, a visual sample description, the maximum dry density and optimum moisture, as well as the curve defining the moisture-density relationship, are given on the attached Laboratory Compaction Test Sheet.

CONSTANT HEAD PERMEABILITY
USING BACK PRESSURE SATURATION

I. INTRODUCTION

The coefficient of permeability (k) (referred to as "permeability") is an application of Darcy's Law. Darcy's Law indicates that the rate of discharge of water (q) through a soil is equal to a coefficient (k) times the hydraulic gradient (i) times the cross-sectional area (A). This formula is given as follows:

$$q = kiA$$

The stated conditions for standard measurements are: (1) the temperature is corrected to 20 degrees celsius; and (2) the flow is measured under condition of laminar flow.

The permeability of a soil is most often used in design of dams and holding ponds, lagoons, and filter systems to determine the water holding characteristics or the amount of water flowing through the structure. The permeability of a soil is effected by the size and shape of the soil's grains, the void ratio, the size and shape of the voids, and the degree of saturation of the soil, and other factors.

II. APPLICABLE STANDARDS

ASTM D-2434 Permeability of Granular Soil (Constant Head)
Corps Engineers - EM 1110-2 Appendix VII Permeability Tests

III. GENERAL PROCEDURE

Permeability tests are performed on remolded or undisturbed test specimens. The test specimens are generally 1.4 in. or 2.8 in. in diameter with a length at least 1 in. The test specimen is encased in a thin rubber membrane and placed inside a permeability cell. The cell is filled with a fluid. By applying pressure to this fluid in the cell, the specimen is subjected to an ambient or confining stress condition. The sample is saturated and a hydraulic gradient is created to simulate the anticipated field conditions. The test is performed under constant hydraulic gradient (head) or falling hydraulic gradient depending on the anticipated field conditions. Measurements of the flow of water through sample or the head loss are made and the coefficient of permeability is calculated and corrected to standard temperature.

LABORATORY DATA SUMMARY SHEET

JOB NAME TVA - Kingston Landfill JOB NO. B5056-S

BORING NO.	DEPTH FT.	UNIFIED CLASS	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PI	PASSING NO. 200	SPECIFIC GRAVITY	WET UNIT WT. pcf	DRY UNIT WT. pcf	REMARKS
B-1	10-20		23.8	50	27	23					
B-2	10-20		38.8	83	39	54					

GROUND ENGINEERING & TESTING SERVICE, INC.

4764 FIRST AVE NORTH
BIRMINGHAM, ALABAMA

C O N S T A N T   H E A D   P E R M E A B I L I T Y

DATE: 08-23-1989

PROJECT NAME: TVA - DEMOLITION LANDFILL - KINGSTON   PROJECT NUMBER: B-5056-S

BORING NUMBER: B1 B2   DRY DENSITY (PCF): 100.6   MOISTURE (%): 23.1

SAMPLE IDENTIFICATION: REMOLDED @ 100% + OPTM BLEND

GRAPHIC DISPLAY of CONSTANT HEAD PERMEABILITY DATA

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POINT     *-------*-------*-------*-------*-------*-------*-------*-------*-------*
 ##

 1       *                                         +
 2       *                                         +
 3       *                                         +
 4       *                                         +
 5       *                                         +
 6       *                                         +
 7       *                                         +
 8       *                                         +
 9       *                                        +
 10      *                                         +

          *-------*-------*-------*-------*-------*-------*-------*-------*-------*
POWER>   -10>    -9>     -8>     -7>     -6>     -5>     -4>     -3>     -2>     -1>
```

COEFFICIENT of PERMEABILITY x 10 ^ POWER (log 10 scale)

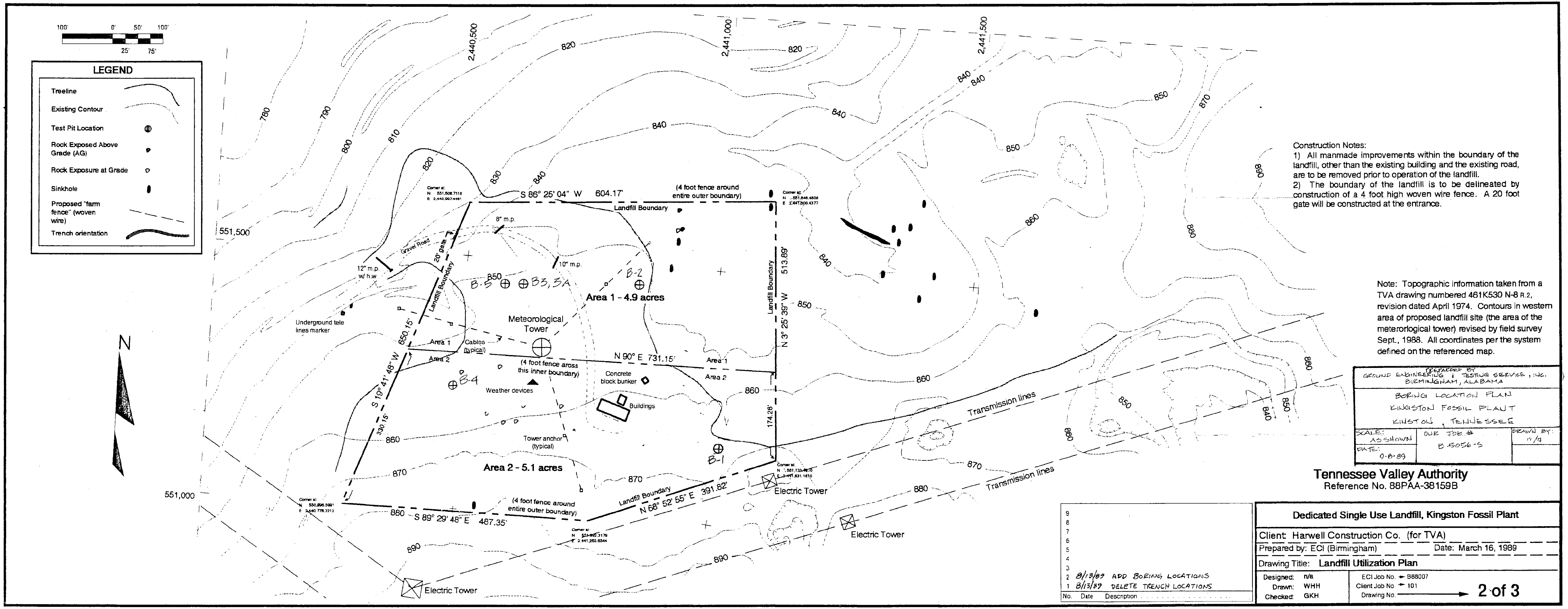
COEFFICIENT of PERMEABILITY (20 DEG. C)= 8.47E-06 Cm/Sec

TEST PROCEDURE: CORPS ENGINEERS EM 1110-2-1906 APPENDIX VII

GROUND ENGINEERING & TESTING SERVICE, INC.

APPENDIX C

DRAWINGS


LEGEND
Treeline
Existing Contour
Test Pit Location
Rock Exposed Above Grade (AG)
Rock Exposure at Grade
Sinkhole
Proposed "farm fence" (woven wire)
Trench orientation
Construction Notes:
1) All manmade improvements within the boundary of the landfill, other than the existing building and the existing road, are to be removed prior to operation of the landfill.
2) The boundary of the landfill is to be delineated by construction of a 4 foot high woven wire fence. A 20 foot gate will be constructed at the entrance.
Note: Topographic information taken from a TVA drawing numbered 461K530 N-8 R.2, revision dated April 1974. Contours in western area of proposed landfill site (the area of the meterorlogical tower) revised by field survey Sept., 1988. All coordinates per the system defined on the referenced map.
Area 1 - 4.9 acres
Area 2 - 5.1 acres
Meteorological Tower
Landfill Boundary
S 86° 25' 04" W 604.17'
N 3° 25' 39" W 513.89'
N 90° E 731.15'
S 19° 41' 48" W 650.15'
S 89° 29' 48" E 487.35'
N 68° 52' 55" E 391.82'
(4 foot fence around entire outer boundary)
(4 foot fence across this inner boundary)
Gravel Road
20' gate
Underground tele lines marker
Weather devices
Concrete block bunker
Buildings
Tower anchor (typical)
Cables (typical)
Transmission lines
Electric Tower
B-1
B-2
B3, 3A
B-4
B-5
N
Prepared by Ground Engineering & Testing Service, Inc. Birmingham, Alabama
Boring Location Plan
Kingston Fossil Plant
Kinston, Tennessee
Scale: As shown
Our Job # B-5056-S
Date: 9-8-89
Tennessee Valley Authority
Reference No. 88PAA-38159B
2 8/13/89 Add boring locations
1 8/13/89 Delete trench locations
No. Date Description
Dedicated Single Use Landfill, Kingston Fossil Plant
Client: Harwell Construction Co. (for TVA)
Prepared by: ECI (Birmingham)
Date: March 16, 1989
Drawing Title: Landfill Utilization Plan
Designed: n/a
Drawn: WHH
Checked: GKH
ECI Job No. B88007
Client Job No. 101
Drawing No. 2 of 3