PERMIT RENEWAL
LANDFILL EXPANSION
DESIGN HYDROGEOLOGIC REPORT
REV 1

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PREPARED FOR

WHITE OAK SANITARY LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

JULY, 1998

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Consulting Engineers and Scientists

APPROVED
DIVISION OF SOLID WASTE MANAGEMENT
DATE 10-27-98 BY WDS

WOLF WASTE CELL 4 DESIGN
HYDROGEOLOGIC REPORT REV 1
WHITE OAK SANITARY LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

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SRK Project No. 83507

WHITE OAK LANDFILL
WASTE CELL 4 DESIGN HYDROGEOLOGIC REPORT REV 1

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1 Introduction

This report presents findings and conclusions of Steffen, Robertson and Kirsten (NC), Inc. (SRK) regarding the hydrogeological conditions within the proposed Waste Cell 4 area. The proposed Waste Cell 4 area is within the current landfill permit boundary of the White Oak Landfill (WOLF) in Haywood County, North Carolina (See Sheet 1, White Oak Landfill Construction Plans).

The investigations in this report were prepared in accordance with Rule 15A NCAC 13B .1623(b), which outlines conditions for preparing a "Design Hydrogeologic Report." This report contains the findings of subsurface and surface hydrogeological investigations relating to the suitability of the construction and operation of a new municipal solid waste landfill (MSWLF) cell designated "Waste Cell 4."

SRK has structured this report in accordance with a meeting held between WOLF representatives, Department of the Environment and Natural Resources (DENR) personnel, and SRK personnel on July 31, 1997 in Raleigh, NC and other subsequent meetings. SRK has utilized past data developed in pursuit of the original MSWLF permit in addition to new information and applied this data to the proposed cell, which is within the property limits of previous investigations.

Because this proposed expansion is within the property already characterized, these previous subsurface investigations augmented by recent groundwater measurements and other investigations are adequate to describe the current conditions at WOLF.

2 Description of Proposed Expansion

The subject site consists of 2 acres of cleared land located adjacent to the current landfill footprint to the west. This area is delineated on Sheet 1 of the proposed construction drawings already submitted to DENR. This drawing set is entitled "Construction Plans for the White Oak Sanitary Landfill Permit Modification, Landfill Expansion: Waste Cell 4 Construction" dated June 1997. A permit modification report was also submitted to DENR to accompany the construction plans.

3 Design Hydrogeologic Report – Rule .1623(b)(2)

This Design Hydrogeological Report is intended to fulfill the requirements of Rule .1623(b)(2) for the proposed landfill expansion. Numerous existing documents are utilized to fulfill the investigation requirements.

In May of 1990, Law Engineering, Inc. prepared a report entitled Report of Hydrogeological Study to present their findings of a full hydrogeological investigation of the then-proposed WOLF property. This extensive study included soil borings, rock corings, surface and groundwater analyses, and chemical analyses of soils.

3.1 Site Hydrogeologic Report Excerpts – Rule .1623(b)(2)(A)

Commingled with information previously gathered and reported in previous reports, information outlining compliance of Waste Cell 4 is included below. This Design Hydrogeologic Report contains the information as outlined in Rule .1623(b)(2)(A). The items listed below are intended to fulfill the requirements of that rule.

3.1.1 Testing Program for Borings – Rule .1623(a)(4)

The testing program used for all borings performed in the Law Engineering report is described in Section 4.2 on pages 6-7 of that report (See Appendix I). Both split spoon and Shelby tube samples were collected during extensive soil boring activities. Soil classification and stratification were determined along with physical properties of the "undisturbed" Shelby tube samples. A total of 27 borings were drilled during the Law Engineering study and nineteen borings were drilled in 1988 by Froehling & Robertson, Inc. Six of the borings were converted into 2-inch, Type I monitoring wells.

Two of the borings (AT-2 and B-114) were actually drilled in the proposed Waste Cell 4. AT-2 penetrated a total of 85 feet without refusal. The soil types encountered were red brown micaceous fine to medium sandy silt with rock horizons interlayered. B-114 was drilled 100 feet south to southeast from AT-2 and encountered auger refusal at only 33.5 feet. Although boring AT-2 was drilled using an air track rig, one can assume that it didn't encounter bedrock from the cuttings that the on-site geologist described, "red brown micaceous fine to medium sandy silt with rock horizons interlayed ". For the purpose of determining the exact nature of the rock at auger refusal, an equipment

operator for the White Oak landfill was asked to dig down in the area of B-114, which was previously identified as having auger refusal material. The test excavation revealed an isolated boulder which was removed by the machinery on-site. The rock is composed of a biotite gneiss as observed throughout the area. In order to delineate any other boulders or bedrock occurences, nine additional test pits were dug to verify the absence of bedrock (see Figure 1 and survey record in Appendix IV). None of the test pits encountered bedrock. The bottom elevations of these pits were used to help generate the maximum possible bedrock contour map, also found on Figure 1.

In addition to the previous investigation holes of B-114 and AT-2, two borings (P2-1 and P2-2) were made on the western side of the proposed cell location on April 25 and 26, 1998. These two borings encountered auger refusal at 34-ft and 31-ft, respectively. Based on the four test holes and the test pits in the proposed waste cell, the extent of rock has been clearly delineated and the cell has been designed to maintain the required 4 feet of separation between bedrock and the lower boundary of the liner (See Figure 2).

Boring logs, well construction records, and soils test results of the holes and pits are included in the following appendices: Appendix I - Report of Hydrogeological Study, by Law Engineering and Appendix IV - Cell Specific Investigations. From the most recent investigations (P2-1 and P2-2), lithologies similar to those present in the current landfill site were found. Laboratory testing of the most recent bore holes revealed that the proposed cell site is underlain by silty sand, sandy silt, sandy fat clay, and sandy lean clay. Previous hydrogeological investigations encountered soils that were the same classification or very similar.

One difference in the recent investigations was the saturated hydraulic conductivity calculated for the sandy silt. In previous laboratory testing, the sandy silts had conductivities in the $1x10^{-7}$ range; however for this sample, the conductivity was calculated at $1.3x10^{-5}$. The low dry density of the sample may be one of the factors that results in the high conductivity; however, there are many factors that may result in a higher conductivity, including, but not limited to, field and laboratory disturbances to the sample.

An effective porosity value of the screened stratum is required to calculate the flow rate at an individual well location. Laboratory testing of remolded soil samples can be used to estimate total porosity, however, various authors believe that effective porosity is typically less than total porosity. Fetter (1990) concludes that effective porosity is

approximately equivalent to specific yield which can be determined through pumping tests in unconfined aquifers. A ternary diagram developed by Johnson (1967) illustrates the relationship between specific yield and soil particle size in terms of percent sand, silt, and clay. This diagram can be used to estimate effective porosity by Fetter's (1990) definition. According to Johnson's diagram, the specific yield (and therefore, effective porosity) of the soil samples taken from P2-1 and P2-2 are listed below along with porosity values based on the clay and sand percentages:

Sample	USCS Classification	Porosity *	Specific Yield Range**
P2-1 @ 1-5'	CH-Sandy Fat Clay	0.48	0.04 - 0.06
P2-1 @ 6-10'	CL-Sandy Lean Clay	0.48	0.042 - 0.06
P2-1 @10-12'	SM-Silty Sand	0.47	0.047 - 0.13
P2-1 @ 21-23'	ML-Sandy Silt	0.48	0.06 - 0.08
P2-2 @ 3-4'	SM-Silty Sand	0.49	0.046 - 0.15

* From Rawls and Brakensiek, 1989

** From Johnson, 1967

3.1.2 Other Techniques for Subsurface Investigation – Rule .1623(a)(5)

Robert D. Hatcher, Jr. prepared a "Summary of Geologic Observations at the Proposed White Oak Landfill Site, Haywood County, North Carolina" in December, 10-11, 1989. His observations include a thorough description of bedrock and local geology viewed at outcrops in the landfill area. According to Dr. Hatcher, "the bedrock unit underlying the proposed landfill consists of coarse to very coarse grained foliated granitic gneiss (metamorphosed granite) cut by veins of pegmatite and quartz." "Rock exposed within the proposed site generally contain relatively few joints (average spacing one to five feet or more), except locally."

Dr. Hatcher's report gives a much more thorough description of local geology including bedrock than could be obtained in drilling logs and tests only. The report is included in Section 5 of the Appendix to the Law Engineering Report (See Appendix I).

The location of the nine test pits that were dug on the new cell site are included on Figure 1. Information concerning the depth of the pits and any encountered bedrock is included in Appendix IV - Cell Specific Investigations.

3.1.3 Stratigraphic Cross Sections – Rule .1623(a)(6)

Section 2 of the Appendix of the Law Engineering report contains three geologic cross-sections and key map from which the cross-sections were taken. Cross-section A-A' passes through the study area through B-114 (See Appendix I). This cross-section shows auger refusal at 33.5 feet below ground surface (BGS). The resulting terminating mean sea level (MSL) elevation is 2586.2 feet for this auger boring. However, the highest elevation of the rock ridge as determined in the field is 2587.27 feet. The proposed waste cell is designed for 4 feet of separation between this ridge of rock and the lower boundary of the cell liner.

In addition to that cross-section, cell specific cross-sections have been included with this report (See Figure 3).

3.1.4 Water Table Information – Rule .1623(a)(7)

The groundwater characteristics of this site have been extensively studied during both the pre-construction and post-construction phases in accordance with North Carolina regulations. Currently, WOLF is required to conduct semi-annual sampling of groundwater elevations in all on-site groundwater monitoring wells (See Table of Historical Groundwater Elevations). Sampling and laboratory analysis of the groundwater is also required on a semi-annual basis for the purpose of detecting possible impact to groundwater from waste disposal activities.

The most recent such sampling event occurred in June 1997, and the resulting potentiometric surface map, groundwater analytical laboratory results, and statistical analysis were sent to DENR as required. See Figure 1 for the most recent potentiometric surface map.

The water table in both the pre-construction and post-construction phases of the subject property is characterized by a single unconfined aquifer flowing through sandy silt material overlaying fractured bedrock. A quantitative study of groundwater flow was performed by Law Engineering. in their 1990 report (See Appendix I). Groundwater flow for the unconfined aquifer is toward the Pigeon River.

3.1.4.1 Initial Groundwater Level Measurements – Rule .1623(a)(7)(A)

At the time of drilling, the groundwater elevations were measured to determine the initial, 24-hour, and stabilized readings. Borings B-101 through B-115 and AT-1 through AT-8

were constructed by Law Engineering, Inc. and are included in their report as reproduced in Appendix I.

3.1.4.2 Tabulations of Stabilized Groundwater Levels Over Time – Rule .1623(a)(7)(B)

Semi-annual elevations for three years are included in the Table of Groundwater Elevations. The measurements were taken between the April 1994 and June 1997. Little fluctuation (< 3.0 feet) between sampling events was observed in the water table elevations from the wells, except for MW-04.

At MW-04, the groundwater elevation has varied by 6.85 feet over the three-year sampling period. This higher variation may be due to the close proximity of the well to the landfill liner. The close proximity to the landfill liner would indicate that the water-bearing media in the vicinity of MW-04 would not be readily recharged by rainwater infiltration from upgradient, because rainfall infiltration is prevented by the lined landfill for over 800 feet upgradient of MW-04.

3.1.4.3 Long-term Seasonal High Groundwater Table – Rule .1623(a)(7)(C)

Precipitation in the area of Haywood County averages three to five inches per month with no extremely dry season on average (see Appendix III). Dry periods are observed in this region, but on the average, precipitation is evenly distributed throughout the year. Thus, the seasonal high groundwater table will include little fluctuation between seasons.

The historical groundwater elevation measurements listed in the Table of Historical Groundwater Elevations in Appendix II were taken in the months of February, April, May, June, September, and October. Of these months, May and June exhibit relatively high rainfall averages (approximately 4.2 to 4.4 inches), while April and October exhibit lower rainfall averages (approximately 3.5 to 3.9 inches). Thus, the measurements have likely been taken during periods of highest average rainfall.

As shown in the hydrographs of the monitoring wells at the landfill site (MW-01 through MW-09), the fluctuations in groundwater levels between the wells do not correspond to one another. For example, MW-03 and MW-07 have rising and falling readings in opposition to each other in all of 1994 and in 1996. Therefore, no single sampling event can establish the long-term seasonal high groundwater elevations.

With the available data, the seasonal high groundwater table can be estimated from the recorded high in each monitoring well on the landfill site (see the "Maximum" column of the Table of Groundwater Elevations and Appendix II). This hypothetical potentiometric surface represents the highest recorded values over the entire site. This surface should define the upper limits of groundwater levels for the site to within a reasonable tolerance.

3.1.5 Natural or Man-made Changes Activities Which Influence Groundwater – Rule .1623(a)(7)(D)

The Pigeon River is located 1500 feet to the north of the proposed expansion and represents the primary influence on local groundwater. Groundwater recharged from the landfill moves toward and discharges to the Pigeon River. The elevation of the lower grade of the landfill will be over 300 feet higher elevation than the average river elevation. Therefore, flooding of the Pigeon River will not affect the proposed cell.

The current landfill cells and the proposed Cell 4 have been strategically placed to isolate runoff and groundwater flow to within the boundaries of the landfill property. Because of the highly variable relief of the area's potentiometric surface, groundwater flow is isolated by pronounced hydraulic divides. These divides prevent groundwater from flowing into the landfill site from the east, south, and west. Therefore, activities (e.g. high-volume production wells, injection wells, etc.) occurring outside the landfill property should have little or no effect on the groundwater table elevations on the landfill property, because of its isolation.

3.1.6 Horizontal and Vertical Dimensions of Groundwater Flow – Rule .1623(a)(8)

A groundwater flow study was prepared by Law Engineering in their 1990 study (See Appendix I, Section 5.1). Their study showed groundwater flow to move between 30 feet and 1500 feet per year. Potentiometric data indicate that groundwater movement is toward the Pigeon River (See Figure 1).

Near the proposed Waste Cell 4 area, there are two pairs of nested (shallow and deep) wells for which long-term groundwater data exists: wells MW-07 and MW-07D and wells MW-05 and MW-05D. The MW-07 well pair indicated a vertical head difference of 0.03 feet during the most recent sampling event (June 1997). The resulting vertical gradient is (0.03/21.84) or 1.37×10^{-3}. This small difference in potentiometric head indicates negligible vertical groundwater flow near MW-07.

The MW-05 well pair indicated a vertical head difference of 0.66 feet. Since the groundwater surface elevation of MW-05D is lower than MW-05, the vertical groundwater flow direction near MW-05 tends to be downward. The greatest historical vertical head difference is 1.26 feet recorded on April 29, 1997, the minimum vertical head difference is 0.29 feet on September 14, 1995, and the median vertical head difference is 0.46 feet. The standard deviation of vertical head differences is 0.34 feet with a coefficient of variation of 56%. To estimate the flow rate per cross-sectional area (specific discharge), one may use the vertical gradient, the vertical hydraulic conductivity, and Darcy's Law. Darcy's Law may be expressed as

$$q = K \cdot i = K \cdot \frac{\Delta h}{\Delta L}$$

where q is equal to Q/A and is the specific discharge ($m^3/s\text{-}m^2$ or cfm/ft^2), K is the hydraulic conductivity (cm/s or feet/day), Δh is the head difference (feet), and ΔL is the length between head measurements (feet).

The following steps are used to compute the specific discharge near the MW-05 nested pair (the pair of greatest potential vertical flow). Assign to K_x (horizontal conductivity) the average of the slug test results from Law Engineering on 3-15-94 for MW-05 and MW-05D of 1.2 feet/day (4.1×10^{-4} cm/s). The vertical conductivity K_z must be modified from the horizontal conductivity K_x. Assume that $K_z = 0.1 \cdot K_x$. Thus, $K_z = 0.12$ feet/day. Also, Δh can be taken as the maximum of the vertical head differences of 1.26 feet, and ΔL can be taken as the vertical distance between the top of the screen portions of MW-05 and MW-05D of 2,497.13 feet – 2,476.19 feet = 20.94 feet. The resulting specific discharge q is 0.0072 $ft^3/day\text{-}ft^2$, which is 2.6 $ft^3/yr\text{-}ft^2$.

The two newest wells, P2-1 and P2-2, have been drilled near the western limit of the proposed Cell 4. Drilling logs and well construction details for these wells confirm prior assumptions concerning the potentiometric surface. The slug test data in these wells indicate a hydraulic conductivity as high as $1.4\text{x}10^{-2}$ cm/sec. Since the slug tests were performed in bedrock, fractures are most likely present. Also, the field geologist indicated that after the first well evacuation, the water level did not return to its original height, indicating that the recharge could have been from an isolated pocket of water. The slug test data from P2-2 indicates a hydraulic conductivity of $9.3\text{x}10^{-4}$ only 30 feet away, which may substantiate the isolated pocket theory. If isolated pockets are present, then that would explain the difference in hydraulic conductivities, as much as the presence of fractures.

3.1.7 Groundwater Contour Map – Rule .1623(a)(9)

See the enclosed potentiometric surface map in Figure 1 for the surficial aquifer at the WOLF site. These groundwater level measurements were taken over a period of less than 3 hours on June 19, 1997.

3.1.8 Topographic Site Map with Borings – Rule .1623(a)(10)

Borings taken during the Law Engineering report investigation are detailed on Figure 4 of that report. The Law report is included in Appendix I of this submittal. The borings immediately in and around the proposed waste cell (B-113A, B-114, and AT-2) are shown in Plan View in Figure 1.

3.1.9 Boring Logs, Field Logs, Well Construction Records, and Piezometer Construction Records – Rule .1623(a)(11)

Please see Appendix I, Section 3 of the Law Engineering report for the boring logs for B-113A, B-114, and AT-2 which are the closest borings to the proposed cell. Boring 113A cored bedrock. B-114 and AT-2 are within the proposed Waste Cell 4 study area. All other borings described in the Law Engineering report have been submitted with the approved application documents and are included in Appendix 1, Section 3.

3.1.10 Identification of Other Geologic and Hydrologic Considerations – Regulations .1623(a)(12)

Locally groundwater is recharged in the higher elevations around the landfill and discharged at the Pigeon River located approximately 1500 feet north. As is normally the case in crystalline terrains, groundwater recharge tends to take place through preferential pathways in the saprolite around more consolidated areas. In the area of the two acre expansion, a small isolated section of harder rock exists in the area where B-114 was placed. Landfill earthmoving equipment was used to test this material and surrounding material to determine the extent. The material's horizontal extent is approximately 45 feet wide and trends northwest - southeast (See Figure 1). A nearby test hole (AT-2) penetrated to 85 feet without encountering competent rock.

3.2 Design of Monitoring System per .1631(c) – Rule .1632(b)(2)(B)

The water quality monitoring system consists of an approved set of wells and surface water monitoring points. The entire proposed Waste Cell 4 area is within the boundary circumscribed by the existing groundwater monitoring wells. The Waste Cell 4 area is

downgradient from the existing background wells (MW-07 and MW-07D), and the existing and approved groundwater quality network should detect any potential releases.

Surface water monitoring points as shown in the approved application and the Transition Plan under review by DENR are sufficient to detect potential releases into stormwater from the proposed Waste Cell 4 area. All surface water drainage from the cell would be carried via the existing and newly designed perimeter drainage system.

3.3 Relevant Point of Compliance per .1631(a)(2)(B) – Rule .1623(b)(2)(C)

The relevant point of compliance is identified in the original permit application documentation and has been approved by DENR.

3.4 Rock Corings – Rule .1623(b)(2)(D)

Rock corings performed for this site were done as part of the Law Engineering investigation in the initial hydrogeological report. Section 4.4.6 on page 11 of the Law Engineering report summarizes the findings of the rock corings (Appendix I).

In addition, the rock coring logs from P2-1 and P2-2 are included in Appendix IV. These logs indicate a biotite gneiss that varies from 59% to 100% recovery and 0% to 92% RQD. The corings included highly weathered and slightly weathered rock with some banding.

3.5 Groundwater Contour Map – Rule .1623(b)(2)(E)

See the seasonal high potentiometric surface map displayed in Figure 1. The seasonal high water table was taken from the highest recorded event from the monitoring wells and borings located at the site. Although these readings come from different sampling events, all of the readings come from a Spring event. Climatological and Meteorological data (See Appendix III) for the surrounding area do not show any patterns that would contradict the use of Spring sampling event data.

3.6 Bedrock Contour Map – Rule .1623(b)(2)(F)

See Figure 1 for the contour map of bedrock. Test boring AT-2 penetrated to a depth of 85 feet without encountering bedrock. Boring B-114 had auger refusal at an elevation of approximately 2585 feet msl. Recent investigation with earth moving equipment has

revealed a ridge of competent rock in the proposed cell. This rock is located in the southernmost end of the proposed cell and trends northwest - southeast. Recent investigations include the two borings, P2-1 and P2-2. These two holes encountered auger refusal at 34 feet and 31 feet, respectively. All of this information was used to estimate the top of bedrock information indicated on Figure 1. In the area with the shallow ridge of bedrock, the landfill expansion will be designed to maintain the 4 foot separation between the bedrock and the lower limits of the liner. The separation will be verified on-site during construction using hand augers prior to any liner placement, and the design will be amended as needed.

3.7 3-D Flow Net or Several Hydrogeologic Cross-Sections for Vertical Groundwater Movement – Rule .1623(b)(2)(G)

Near the proposed Waste Cell 4 area, there are two pairs of nested shallow and deep wells: wells MW-07 and MW-07D and wells MW-05 and MW-05D. The MW-07 well pair indicated a vertical head difference of 0.03 feet for the June, 1997 measurement. This small difference in potentiometric head indicates negligible vertical groundwater flow near MW-07.

The MW-05 well pair indicated a vertical head difference of 0.66 feet. Since the groundwater surface elevation of MW-05D is lower than MW-05, the vertical groundwater flow direction near MW-05 tends to be downward.

Even though recharge can be anticipated in the vicinity of the landfill, all recharged water is projected to discharge 1500 feet to the north at the Pigeon River. Due to the fractured nature of the saprolite and bedrock aquifers, there is a continuous unconfined aquifer with a hydraulic gradient toward the local discharge point (Pigeon River).

Figure 2 of this report includes four cross-sections of the site. The paths for the four sections are as follows: MW-07D to B-114 to MW-05D, MW-01 to B-114 to B-113, MW-01 to AT-2 to P2-1 to MW-06, B-114 to P2-2 to MW-06.

3.8 Area Groundwater Flow Regime Report – Rule .1623(b)(2)(H)

Groundwater flow in the land surrounding the WOLF property is generally to the north and to the east towards the Pigeon River. This river is also the major discharge for the surficial aquifer system in the local region. Site specific information can be found in

Section 3.1.6 Horizontal and Vertical Dimensions of Groundwater Flow - Rule .1623(a)(8). Information gathered indicates that most if not all of the are in the proposed expansion are is a recharge area.

3.9 Geologist's Certification of Proper Temporary Boring Abandonment per 15A NCAC 2C Rule .0113(a)(2)

Two new temporary borings (P2-1 and P2-2) were installed for this submittal. Both of these borings have been converted to piezometers. The well construction diagrams and borings logs are included in Appendix IV.

Leonard B. Burgess, Jr., PG (#1518)

4 Water Quality Monitoring Plan – Rule .1623(b)(3)

4.1 Groundwater Monitoring Plan per Rules .1630 through .1637 – Rule .1623(b)(3)(A)

The groundwater monitoring plan submitted in the 1992 application and supporting documents and approved by DENR for the WOLF facility is sufficient to monitor any potential releases of contaminants from the proposed Waste Cell 4 area. No changes to that plan are required or recommended in this submittal. The current monitoring well network includes 5 wells that have the ability to detect any potential releases. The wells are as follows: MW-03, MW-03D, MW-04, MW-08, MW-09. Because of the potentiometric surface of the site, all potential releases from the new waste cell would flow with the ground water and eventually cross MW-09 (See Figure 1). Advection, dispersion, and mechanical diffusion would all contribute to the other monitoring wells detecting leachate in the groundwater.

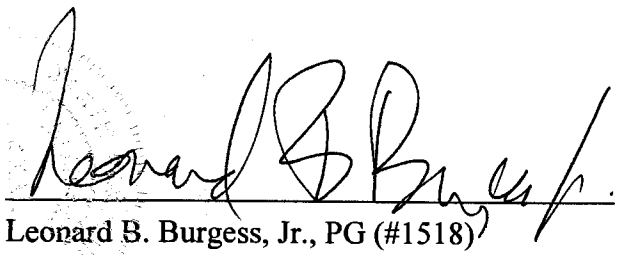
4.2 Surface Water Monitoring Plan per Rule .0602 of Section .0600 – Rule .1623(b)(3)(B)

The surface water monitoring plan as submitted in the 1992 application documents and approved by DENR for the WOLF facility is sufficient to monitor any potential releases

of contaminants from the proposed Waste Cell 4 area. No changes to that plan are required or recommended in this submittal.

4.3 Geologist's Certification for Water Quality Monitoring Plan – Rule .1623(b)(3)(C)

I have reviewed the existing groundwater monitoring plan and existing monitoring well network. The monitoring plan should be effective in providing early detection of any release of hazardous constituents from any point in the proposed Waste Cell 4 or the surface impoundment to the uppermost aquifer. This monitoring system should be protective of public health and the environment.



Leonard B. Burgess, Jr., PG (#1518)

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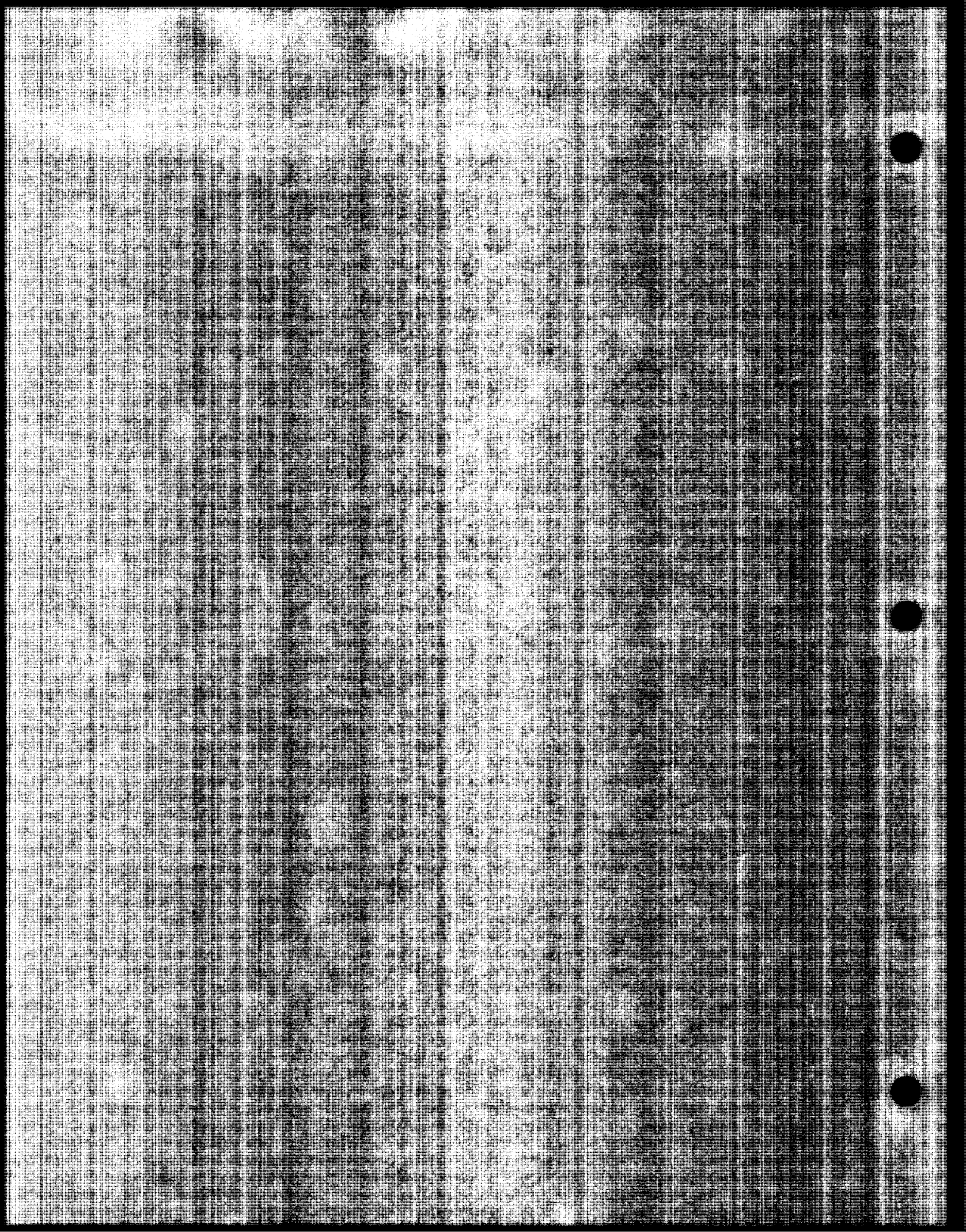
APPENDIX I

Hydrogeological Study



LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

August 27, 1990

Dr. Richard Rust
Tribble & Richardson, Inc
4020 West Chase Boulevard, Suite 515
Raleigh, North Carolina 27607

SUBJECT: Water Table Measurements
Proposed White Oak Landfill
Haywood County, North Carolina
Law Engineering Project No. 11300142.01

Dear Dr. Rust:

We understand that the regulators with the State of North Carolina have inquired as to why water table levels at the subject site were not measured at the intervals denoted in their regulations (i.e. time of boring, 24 hours, and 7 days). Briefly, due to events beyond our control, work on the site was interrupted a number of times and we were prevented from entering the site at the required times.

Since we were able to obtain only some of the readings at the proper intervals, we considered it most appropriate to complete all borings before obtaining stabilized water level readings. Note that the water level data presented represents water levels which were taken anywhere from 1 to 3 months after the borings were drilled.

Although data is not available which might show short term response time of the water table, we believe the water level measurements obtained give a good indication of stabilized levels at the site.

Please note that Figure 5 - Generalized Water Table Map indicates that the projected water table contours were based on data obtained on May 22, 1990. This date is incorrect and should read May 21, 1990 as is shown on the boring logs and Table 3.

396 PLASTERS AVENUE, N.E.
ATLANTA, GEORGIA 30324
404-873-4761
TELEFAX 404-881-0508

Law Engineering, Inc. appreciates the opportunity to be of service on this project. If you have any questions concerning this submittal or if we may be of further service, please contact us.

Very truly yours,

LAW ENGINEERING, INC.

M. Whitt Walker

M. Whitt Walker, P.G.
Department Manager
Geological Services Group

James W. Niehoff, P.E.
Senior Geotechnical Engineer

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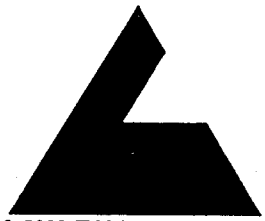

REPORT OF HYDROGEOLOGICAL STUDY

PROPOSED WHITE OAK SANITARY LANDFILL HAYWOOD COUNTY, NORTH CAROLINA

LAW PROJECT No. 11-300142.01

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

May 22, 1990

Dr. Richard Rust
Tribble & Richardson, Inc.
4020 West Chase Boulevard, Suite 515
Raleigh, North Carolina 27067

SUBJECT: Report of Hydrogeological Study
Proposed White Oak Sanitary Landfill
Haywood County, North Carolina
Law Engineering Project No. 11-300142.01

Dear Dr. Rust:

Law Engineering, Inc. is pleased to submit this report of our hydrogeological study recently performed at the subject site. The purpose for the study was to evaluate the site's suitability for development as a sanitary landfill relative to hydrogeological considerations.

The study was conducted to meet the requirements for landfill site acceptability permitting outlined in the North Carolina Rules for Solid Waste Management as amended through March 1, 1989, Section .0504 relative to geological and hydrological studies. The work was performed substantially as outlined in our proposal No. 574-89253, dated December 7, 1989.

This report briefly discusses our understanding of the project, describes our exploratory procedures and presents our findings and conclusions. We appreciate the opportunity of working with you on this project and look forward to our continued association. Please contact us if any questions arise or if we may be of further service in any way.

Very truly yours,

LAW ENGINEERING, INC.

M. Whitt Walker

M. Whitt Walker, P.G.
Project Geologist

James W. Niehoff, P.E.
Senior Geotechnical Engineer

mww\rep\014201.rmy

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1.0 INTRODUCTION

This report was prepared by Law Engineering, Inc. and presents our understanding and interpretation of site hydrogeological conditions. The purpose of the study was to obtain sufficient surface and subsurface data to allow for the evaluation of the site for suitability relative to its future development potential as a sanitary landfill.

The work and test procedures utilized in the study consisted of: 1) a review of published geological, water resources and agronomic literature and maps, 2) a site reconnaissance, 3) a subsurface exploration program, 4) a stream flow analysis, and 5) selected physical and chemical laboratory analyses.

In preparing this report, numerous sources of published data were consulted and utilized. Although not referenced at the point of use in most cases, the authors acknowledge the fact that much of this report is based on work performed by others. The bibliography lists those sources of information.

2.0 PROJECT INFORMATION

Haywood County, North Carolina currently operates a sanitary landfill which is nearing capacity. In order to meet future solid waste disposal requirements, the subject site was selected as a potential location for a future landfill. This site was the subject of an earlier (1988), limited subsurface exploration performed by Froehling & Robertson, Inc. Although this study obtained information relative to overburden soil conditions within the parcel, it was not of sufficient scope to define the groundwater flow patterns or the nature of the underlying rock. This study was designed to supplement existing information to provide sufficient data to evaluate the site for landfill permitting under current regulations.

3.0 GENERAL SITE AREA

3.1 DESCRIPTION OF GENERAL SITE AREA

The subject site consists of approximately 109 acres located in the White Oak Community of rural Haywood County, approximately 20

miles north of Waynesville (see Figure 1 - Site Location Map). The general site area is characterized by sparse development consisting of single family houses and small farms.

Currently, the subject property is undeveloped. The major portion of the site, which includes the southern two-thirds, primarily consists of pasture land. The remaining portion of the site, adjacent to the Pigeon River, is wooded.

Topographically, the site is dominated by four major ridgelines trending in a north-south direction. The property line generally follows the crests of the easternmost and westernmost ridges, the Pigeon River to the north and a local high point to the south. Three small springs emanate from the lower elevations of the swales between the ridgelines. These springs join to form a small creek within the northern third of the parcel. Overall site grades generally fall moderately, then more steeply northward toward the Pigeon River at the northern property boundary.

3.2 PROXIMITY TO ROADS, AIRPORTS, AND RAILROADS

The site is located approximately 2000 feet west of the Fines Creek exit on the south side of Interstate 40. Site access is presently gained from a gravel and asphalt paved road which exits White Oak Road south of the site.

The nearest railroad is the Southern Railroad which runs approximately 20 miles west of the site.

No airports are present within 10,000 feet of the site in any direction.

3.3 PROXIMITY TO COUNTY BOUNDARIES AND NATIONAL HISTORICAL SITES

The nearest county boundary to the site is that between Haywood County and Madison County located approximately 6 miles northeast of the site. The nearest National Historic Site is Walters Hydroelectric Plant which is located approximately 5 miles northwest of the site.

3.4 PROXIMITY TO PUBLIC AND DOMESTIC WATER WELLS

A survey of residences located within a radius of approximately 2 miles was performed by Johanna Wood and Mary Henigbaum who work for the Haywood County Board of Commissioners. Approximately 100 people from the White Oak and Shelton Laurel communities were interviewed as to the source or sources of drinking water at their homes or businesses. Generally, the majority of the people interviewed obtain their drinking water from surface springs or wells. A copy of the information obtained is attached in the Appendix.

3.5 PROXIMITY TO STREAMS

The nearest significant surface water body is the Pigeon River, referred to as Walters Lake in the site area. Two creeks or streams, Messer Branch and Rocky Branch, are located south and west of the site approximately 2000 and 3000 feet away, respectively.

4.0 SURFACE AND SUBSURFACE INVESTIGATION

4.1 TOPOGRAPHIC DESCRIPTION

The site is characterized by 4 major ridgelines which are dissected by swales occupied by wet weather springs (Figure 3). The ridgelines are oriented generally in a north-south pattern. Ridgeline and valley elevations differ by as much as 100 to 125 feet across the site. The overall or general slope of the site is toward the north and northwest with increasing steepness as the site nears the Pigeon River. The highest point within the site is located along the southern property line at approximate elevation 2651 feet (msl). The lowest point topographically is around elevation 2260 feet along the northern property boundary.

4.2 BORING AND SAMPLING PROGRAM

Nineteen borings were drilled in 1988 by Froehling & Robertson, Inc. and 27 borings were drilled during the Law Engineering, Inc. study. Law Engineering Borings B-101 through B-115 were drilled in general accordance with ASTM D-1586. Hollow-stem augers were used to advance each soil boring to refusal depths. Split spoon

soil samples were obtained every five feet and their standard penetration test resistance (N-value) recorded.

The soil samples obtained in the split spoon sampler are adequate for classification purposes, but are not sufficiently undisturbed for tests of physical properties. Consequently, undisturbed soil samples were obtained by the Shelby tube method (ASTM D-1587) of representative strata in borings B-103, B-111A, and B-113A for further laboratory testing.

As the availability of adequate cover fill material is a major issue in landfill siting, bulk samples of soil were obtained from auger cuttings at depths of 0 to 10 feet and 0 to 15 feet in borings B-111 and B-112, respectively for evaluation.

In borings B-105, B-109A, and B-111A, and 113A, materials below refusal elevations were sampled by means of diamond coring to permit an evaluation of the composition and continuity of the rock. Packer tests to evaluate in-situ hydraulic conductivity were conducted at selected levels within the cored holes in borings B-109A, and B-113A. The results of the tests are presented in Table 1 in the Appendix.

Ground water is present in each of the borings except B-106, B-107, B-112, and B-114 which are located atop ridge lines (see Figure 4). To evaluate ground water elevations in these areas, an air percussion drilling rig (air track) was utilized to advance borings through the soil and rock. Eight borings were drilled, designated AT-1 through AT-8, atop ridgelines and in areas where ground water was not encountered during the initial boring phase. After drilling, three-quarter-inch PVC casing with the lower ten feet slotted, was installed in 21 of the borings for the purpose of obtaining stabilized water table readings. The remaining borings (B-108, B-109, B-109A, B-111A, B-113, and B-113A) were converted into 2-inch Type-I monitoring wells. Slug tests (in-situ hydraulic conductivity) were run on each of the Type-I wells.

4.3 LABORATORY TESTING PROGRAM

A number of laboratory tests were performed on the soil samples to evaluate various physical properties. Among these were

falling head permeability tests, Standard Proctor density tests, and classification tests including grain size analyses and atterberg limits tests. In addition, cation exchange capacity tests were performed on selected samples to evaluate the ability of the soil to adsorb leachate ions. The laboratory test results are appended and are summarized in Table 1.

4.4 DESCRIPTION OF GEOLOGY, SOILS AND ROCKS

4.4.1 Regional Geologic Setting

The site and immediate vicinity are located in the eastern Blue Ridge Mountains, an area underlain by metamorphic rocks of Pre-Cambrian age. The rock units present include the Pre-Cambrian Basement Complex (which directly underlies the site), the Thunderhead Sandstone of the Great Smoky Group (which is in fault contact with the basement) and the Wading Branch Formation and the Longarm Quartzite of the Snowbird Group which unconformably overlies the basement a short distance west of the site. The Snowbird and Great Smoky Groups are part of the Ocoee Series.

4.4.2 Lithology

The lithologic descriptions which follow were taken from Hadley and Goldsmith (1963).

The basement is comprised of a complex assemblage of plutonic rocks and layered gneiss (Hadley and Goldsmith,1963). The plutonic rocks include massive augen gneiss, granitoid gneiss, and little foliated granitic rocks. The layered rocks are paragneiss derived from ancient sedimentary and possibly volcanic rocks and are defined throughout the Blue Ridge and Piedmont as the Carolina Gneiss.

The Wading Branch formation is the lower-most unit of the Snowbird Group and unconformably overlies the basement rocks. The type area is Wading Branch Ridge northwest of Walters Lake and consists of a 1500 foot interval of dark fine- to coarse-grained poorly sorted clastic rocks ranging from sandy slate to very coarse pebbly sandstone.

The Longarm Quartzite conformably overlies the Wading Branch formation and is named for Longarm Mountain in the core of the Cataloochee Anticlinorium a few miles northwest of the site. The formation consists of several thousand feet of clean feldspathic quartzite and arkose. Being the most resistant unit within the Snowbird Group, the Longarm Quartzite forms several major ridges in the area including Longarm and Whiteoak Mountains.

The other prominent rock unit in the area is the Thunderhead Sandstone of the Great Smoky Group. The formation is named for Thunderhead Mountain on the crest of the Great Smoky Mountains west of the study area. The Thunderhead consists of 6,000 to 12,000 feet of medium-to coarse-grained feldspathic sandstone or arkose but is interbedded with various amounts of arkosic pebble conglomerate, finer-grained feldspathic sandstone, argillaceous metasandstone, dark-gray slate. Within the study area the Thunderhead is apparently in fault contact with the basement complex.

4.4.3 Structure

The major structural features present in the vicinity are the Cataloochee Anticlinorium a short distance west of the site and the Greenbrier Fault which bounds the eastern edge of the Cataloochee Anticlinorium. A smaller fault is present about a half mile east of the Greenbrier.

Regional foliation trends are oriented northeast with southeast dips which is sub-parallel to the regional structural features. Joints are oriented northwest and northeast and are generally very steeply dipping. Regional joint patterns can be inferred from stream patterns which are often controlled by bedrock fractures.

4.4.4 Site Geology

A geologic reconnaissance was made by Robert D. Hatcher in December, 1989 (report appended). The reconnaissance concentrated on observing and recording measurements of geologic structures and the character of the bedrock exposed within the immediate site vicinity. According to Hatcher, the bedrock underlying the

site consists of a coarse- to very coarse-grained foliated granitic gneiss cut by veins of pegmatite and quartz. Premetamorphic mylonitic gneiss formed by ductile faulting was observed at one locality (Location 6 of Hatcher's report). The rocks observed by Hatcher apparently correlate with the plutonic basement rocks of Hadley and Goldsmith (1963).

Rock outcrops observed by Law Engineering geologists in areas adjacent to the site are shown on Figure 2. Local foliation strikes between 10 to 70 degrees to the northeast with dips of 30 to 65 degrees to the southeast. Measurements are presented on Table 2. Deeply weathered outcrops of gneiss, monzonite, and pegmatite occur within the site.

4.4.5 Soil Conditions

The soils mantling the site are a result of in-place chemical and physical weathering of the parent bedrock. Consequently, the soil mineralogy reflects that of the source rock. The profile of the overburden soil includes a surficial stratum of slightly clayey sandy silt or silty sand, underlain by more coarsely grained sandy silts with depth. Soil consistency tends to increase with depth in inverse proportion to the degree of weathering. In general, the overburden soils represent the upper 30 to 50 feet of the subsurface profile. Cross sections representing typical subsurface conditions within the site are presented on Figures 7 through 9 in the Appendix. Conditions at specific boring locations are presented on the individual Test Boring Records, also in the Appendix.

In-situ and laboratory tests indicate that hydraulic conductivity values for the undisturbed soil ranged from 2.3×10^{-4} to 8×10^{-5} cm/sec. When remolded in accordance with ASTM D-698, a maximum dry density ranging from 109 to 116 pounds per cubic foot was determined. Compacted fill soils from this site typically have hydraulic conductivities ranging from 3×10^{-7} cm/sec to 5×10^{-7} cm/sec, according to the tests conducted by Froehling and Robertson, Inc. in their 1988 study.

Six of the soil samples obtained from the field were submitted for cation exchange capacity testing to provide data upon which to estimate the sorptive capacity of the site soils. The

laboratory tests results indicate the soils have a relatively low potential for adsorbing leachate ions.

Near the interface of intact bedrock, a transitional material known as partially weathered rock is often encountered. This material can be penetrated by soil augers, yet exhibits standard penetration values of greater than 100 blows per foot. In general, partially weathered rock was found to be less than 5 feet in thickness, where encountered.

4.4.6 Rock

Rock cores were obtained from 4 of the borings on-site. The rock was determined to consist primarily of a biotite gneiss with some segments consisting primarily of quartz. The rock is described as being slightly to moderately weathered and fractured with RQD (rock quality designation) values ranging from 0 to 100 percent, typically a function of core depth. Some vertical jointing was noted in boring B-111A between a depth of about 29 to 33.5 feet.

Pressure testing was performed on borings B-109A, B-111A, and B-113A at depth intervals of 25 to 30 feet, 32 to 44 feet, and 22 to 27 feet, respectively. The rock interval tested in B-111A did not take water. The estimated hydraulic conductivities obtained in the rock within borings B-109A and B113A are 8×10^{-5} and 8×10^{-4} centimeters per second (cm/sec), respectively. Larger, open fractures in the bedrock likely have significantly higher conductivities.

4.5 DESCRIPTION AND OCCURRENCE OF SURFACE WATER

Three springs were observed on-site which originate within the valleys. The locations of the stream heads at the time of our site work are shown on Figure 5 in the Appendix. A V-notch weir was constructed at each of the streams at two locations to evaluate the flow rate at the time of our study. From this data, we estimated the flow rates for the small streams to range from about 6 to 15 gallons per minute.

4.6 DESCRIPTION OF UNCONFINED AQUIFERS

Ground water at the site occurs under water table conditions. The phreatic surface may be affected by fluctuations in barometric pressure, surface water systems, aquifer pumping, a lack of recharge, and other manmade and/or natural occurrences.

Within the site area, groundwater recharge results from rain water which filters down through the soil overburden until it reaches the phreatic surface. The borings suggest that the water table within the site generally flows along or near the top of the rock surface. However, in some locations along the crests of ridgelines, the phreatic surface is within the bedrock. The springs represent areas where the upper surface of the groundwater table intercepts the ground surface. A water table map has been constructed from measurements of surface water and water levels in boreholes. This map is presented as Figure 5 in the Appendix. The water table, as shown, follows the general topography of the site with gradients falling toward the north.

In an effort to determine if a separate groundwater regime exists within the bedrock, cluster wells, extending into both the overburden soil and underlying bedrock, were installed at four locations. The groundwater elevations measured in each of the cluster wells were similar. Consequently, there does not appear to be a significant vertical flow component between the soil mass and the underlying rock. Therefore, ground water present in the soil overburden and the underlying bedrock appear to act as one unconfined aquifer system.

4.6.1 Water Bearing Characteristics of Bedrock

Well records were obtained for five domestic wells located within a 1 to 2 mile radius of the site to estimate the typical water bearing characteristics or properties for the bedrock. The information was obtained from Mr. Don Link of the North Carolina Department of Environment, Health, and Natural Resources. The information is listed in Table 4 in the Appendix. In general, the five wells surveyed were installed at depths which range from 245 to 375 feet. The static water levels for the wells range from 15 to 105 feet and typical well yields range from 1 to 25 gallons per minute.

Water derived from wells located in the bedrock is the primary source of drinking water in the general site area. Although no deep wells were installed at the site, the bedrock underlying the site would most likely yield sufficient quantities of water to support domestic supplies.

4.7 SEISMIC CONSIDERATIONS

Holocene faults were not observed in the immediate vicinity nor were they shown on published maps or discussed in the literature reveiwed.

Seismicity in the project area has been studied and assessed by the U.S. Geological Survey and the results of their studies have been published as Open-File Report 82-1033 (Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States, 1982). According to this document, the maximum probable acceleration in rock with a 90 percent probability of not being exceeded in a 250 year period is less than 0.2 g.

5.0 PATHWAY ANALYSIS

5.1 GENERAL

Based upon the results of water level measurements in the boreholes and observations of surface waters, the predominant groundwater flow direction is toward the north and the Pigeon River. Although not specifically detected by our borings, flows through more pervious joints in the rock could be oriented in a somewhat different direction in the vicinity of the joints.

5.2 CALCULATED GROUNDWATER FLOW VELOCITIES

Figure 5 shows the interpreted hydraulic gradient at the site which ranges from approximately 0.16 at the south end of the site to about 0.46 along the northern property boundary at the river. Using the hydraulic conductivity data obtained in this study which ranges from 8×10^{-4} to 4.4×10^{-5} cm/sec, and applying it to Darcy's Law (assuming steady state laminar flow), groundwater flow velocities at this site should be on the order of 30 to 1500 feet per year.

6.0 EVALUATION/RECOMMENDATIONS

In general, given the proper engineering controls, the proposed White Oak site appears to be suitable for development as a municipal solid waste landfill. The parcel is hydrologically down-gradient or cross-gradient of adjacent properties, has a moderate depth to groundwater in most areas, has no significant wetlands, and is topographically favorable for the disposal of large quantities of waste.

Based upon the results of our study, we believe the most favorable part of the site for waste disposal includes that portion above elevation 2400. Parts of the site below this elevation are characterized by relatively steep slopes, and a high hydraulic gradient. Within the upper elevations, the lower portions of the swales are presently considered restricted for waste disposal due to the presence of springs. However, these springs are of relatively low volume and may be captured in a series of filtered drains. Once properly intercepted in this manner, the lower portions of swales may be filled with controlled, compacted fill to provide adequate separation between the waste and the ground water. A minimum buffer of 4 feet is required by the State.

The installation of an engineered liner and leachate collection system is central to acceptance of the site for development as a sanitary landfill. Although not specifically addressed in the currently published North Carolina Rules for Solid Waste Management, liners and leachate collection systems are being required by the State for all newly proposed sanitary landfill sites.

Subsurface water presently flows toward the northern portion of the site and the river. A properly designed groundwater monitoring system should be incorporated into the overall landfill design. Although the final configuration of the wells should be evaluated after the waste cells have been located, it is anticipated that the upgradient well will be located within the south central portion of the site.

Although the site is not in a particularly active area geologically, a reasonable design should consider the possibility of ground motion from tectonic activity. In consideration of recently published risk maps, we recommend that waste cells and liner systems be designed to be stable under a lateral earthquake acceleration of 0.2 g.

Based upon our laboratory tests, the on-site soils appear to be suitable for use as daily cover material and, potentially, for a landfill cap.

Geologic and geotechnical factors will be important considerations in the design of this landfill. Therefore, it will be important to involve geotechnical engineers and geologists in the design phase of this project.

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APPENDICES

SECTION 1

TABLE 1 - Summary of Physical and Chemical Properties

TABLE 2 - Summary of Outcrop Measurements

TABLE 3 - Observation Well Elevation Data

TABLE 4 - Water Bearing Characteristics of Nearby Water Wells

Table 1
Summary of Physical and Chemical Properties

HYDRAULIC CONDUCTIVITY MEASUREMENTS

Laboratory Falling Head

Boring B-103 @ 15 to 17 feet	2.3×10^{-4} cm/sec
Boring B-113 @ 5 to 7 feet	4.4×10^{-5} cm/sec

In-situ Falling Head (Slug Tests

Boring B-108 screened @ 6.6 to 16.6 feet	2×10^{-4} cm/sec
Boring B-109 screened @ 11.5 to 16.5 feet	8×10^{-5} cm/sec
Boring B-109A screened @ 25 to 30 feet	9×10^{-5} cm/sec
Boring B-111A screened @ 39 to 44 feet	5×10^{-4} cm/sec
Boring B-113 screened @ 16 to 21 feet	2×10^{-4} cm/sec
Boring B-113A screened @ 27.5 to 32.5 feet	2×10^{-4} cm/sec

In-place Pressure Testing, in Rock

Boring B-109A packer interval @ 25 to 30 feet	8×10^{-5} cm/sec
Boring B-111A packer interval @ 32 to 44 feet	no take
Boring B-113A packer interval @ 22 to 27 feet	8×10^{-4} cm/sec

CHEMICAL PROPERTIES

Cation Exchange Capacity (CEC)

Boring B-101 @ 15 feet	14 meq/100g
Boring B-104 @ 15 feet	19 meq/100g
Boring B-106 @ 15 feet	25 meq/100g
Boring B-110 @ 5 feet	26 meq/100g
Boring B-112 @ 15 feet	19 meq/100g
Boring B-115 @ 10 feet	21 meq/100g

Table 2
Summary of Outcrop Measurements

Outcrop No.	Designation	Strike/Dip (degrees)
1	Foliation	N60E/65SE
	Foliation	N70E/62SE
	Foliation	N70E/63SE
	Joint	N75W/80SW
2	Foliation	N10E/38SE
	Foliation	N12E/30SE
	Foliation	N58E/78SE
	Fault	N15E/90
3	Foliation	N33E/52SE
	Joint	N20E/26SE
4	Foliation	N38E/48SE
	Joint	N15E/48SE
	Joint	N55W/75SW
	Fault	N40E/35SE
5	Foliation	N22E/48SE
	Foliation	N34E/58SE
	Fault	N30W/7SW
	Fault	N30E/90

Table 3
Observation Well Elevation Data
Water Levels Measured on 5/21/90#

Boring	Top of Ground	Depth to Ground Water (FT.)	Groundwater Elevation	Date Drilled
B-101	2538.46	19.2	2519.26	2/20/90
B-102	2516.16	4.0	2512.16	2/27/90
B-103	2509.03	44.7*	2463.33	3/28/90
B-104	2543.65	19.1	2524.55	3/28/90
B-105	2555.75	16.1	2539.65	2/21/90
B-105A	2555.63	16.6	2539.03	2/23/90
B-106	2632.63	DRY	N/A	2/24/90
B-107	2579.57	DRY	N/A	2/24/90
B-108	2513.50	6.8	2506.67	2/22/90
B-109	2441.50	3.1	2438.40	3/27/90
B-109A	2442.12	2.6	2439.55	3/27/90
B-110	2517.57	5.7	2511.88	2/19/90
B-111	2491.96	1.7	2490.23	2/20/90
B-111A	2491.33	0.7	2490.63	3/29/90
B-112	2506.50	DRY	N/A	2/21/90
B-113	2542.95	2.1	2540.85	3/28/90
B-113A	2541.83	3.4	2538.48	3/28/90
B-114	2619.68	26.9	2592.78	2/23/90
B-115	2649.17	DRY	N/A	2/23/90
AT-1	2544.72	41.9	2502.82	4/24/90
AT-2	2615.07	78.6	2536.47	4/24/90
AT-3	2620.18	68.5	2551.68	4/23/90
AT-4	2593.16	68.0	2525.19	4/23/90
AT-5	2630.63	DRY	N/A	4/23/90
AT-6	2567.03	54.5	2512.43	4/23/90
AT-7	2527.29	43.8	2483.45	4/24/90
AT-8	2509.19	43.1	2466.11	4/24/90

- All water level data provided by Haywood County officials.

* - Monitoring point knocked out after last measurement taken at 44.7 feet on 4/23/90.

TABLE 4
Water Bearing Characteristics
of Nearby Water Wells

Owner/Address	Depth (feet)	Static Water Level (ft.)	Casing (ft.)	Yield (gpm)
Mike Mendenhal State Road 1347 P.O. Box 467 Silver City 27344	375	105	to 30	1
Von Bramitt, Jr. 1021 Notingham La. Crystal Lake	305	40	to 189	10
Claude Woody State Road 1346 Rt. 4, Box 200A Waynesville 28786	365	75	to 24	8
William Higgins State Road 1338 P.O. Box 891 Maggie	245	15	to 32	25
William Carver State Road 1338 Rt. 3 Waynesville 28786	245	50	to 42	2

SECTION 2

FIGURE 1 - SITE LOCATION MAP

FIGURE 2 - MAP OF OBSERVED OUTCROPS

FIGURE 3 - SITE TOPOGRAPHIC MAP

FIGURE 4 - BORING LOCATION PLAN

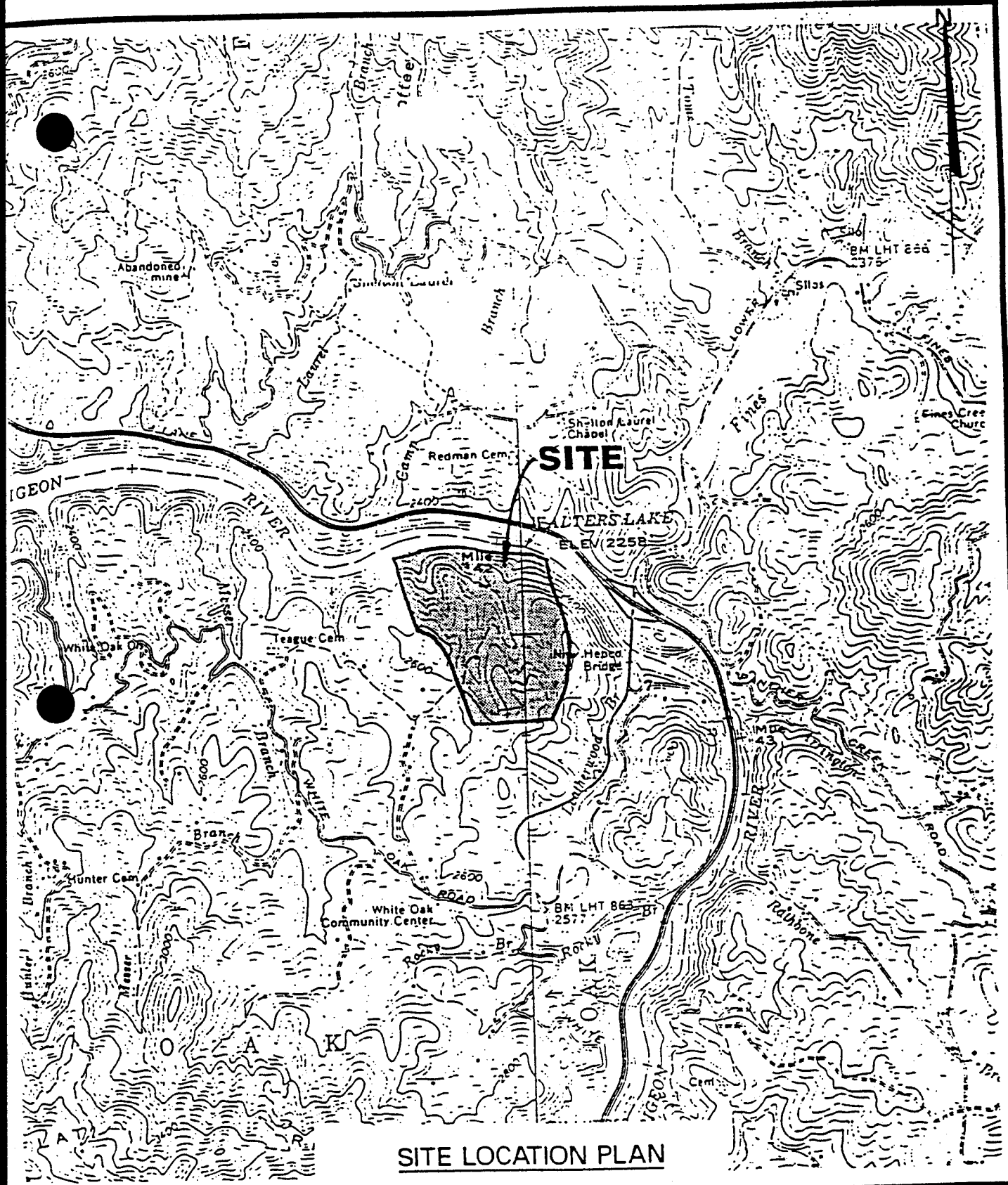
FIGURE 5 - GENERALIZED WATER TABLE MAP

FIGURE 6 - MAP OF CROSS SECTION PROFILE LINES

FIGURE 7 - CROSS SECTION A - A'

FIGURE 8 - CROSS SECTION B - B'

FIGURE 9 - CROSS SECTION C - C'



SITE LOCATION PLAN

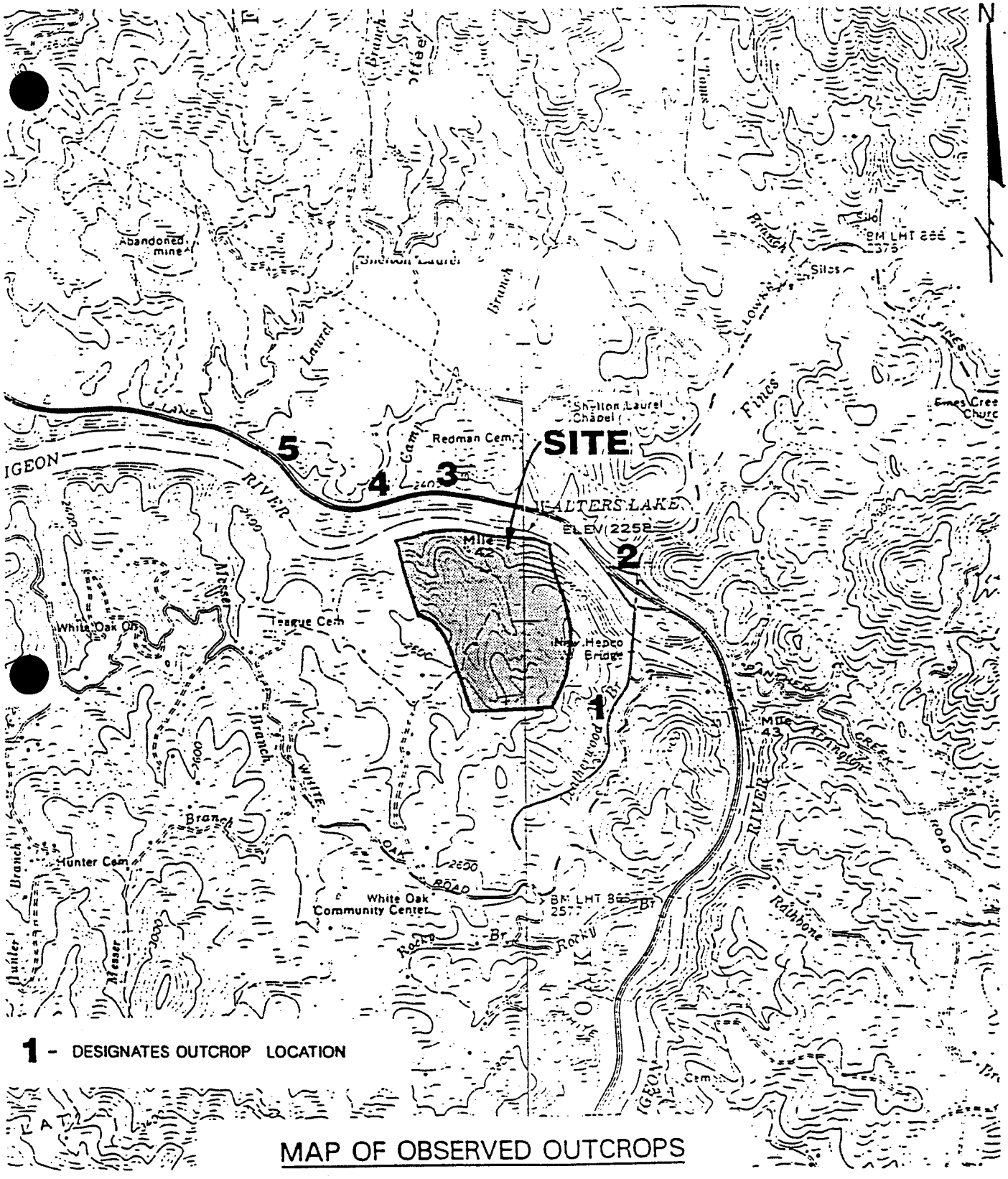
Law Engineering
Atlanta, Georgia

Geotechnical, Materials & Environmental Consultants

PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

FIG. 1

Job Number	Scale
11300142.01	1"= 2000'



1 - DESIGNATES OUTCROP LOCATION

MAP OF OBSERVED OUTCROPS

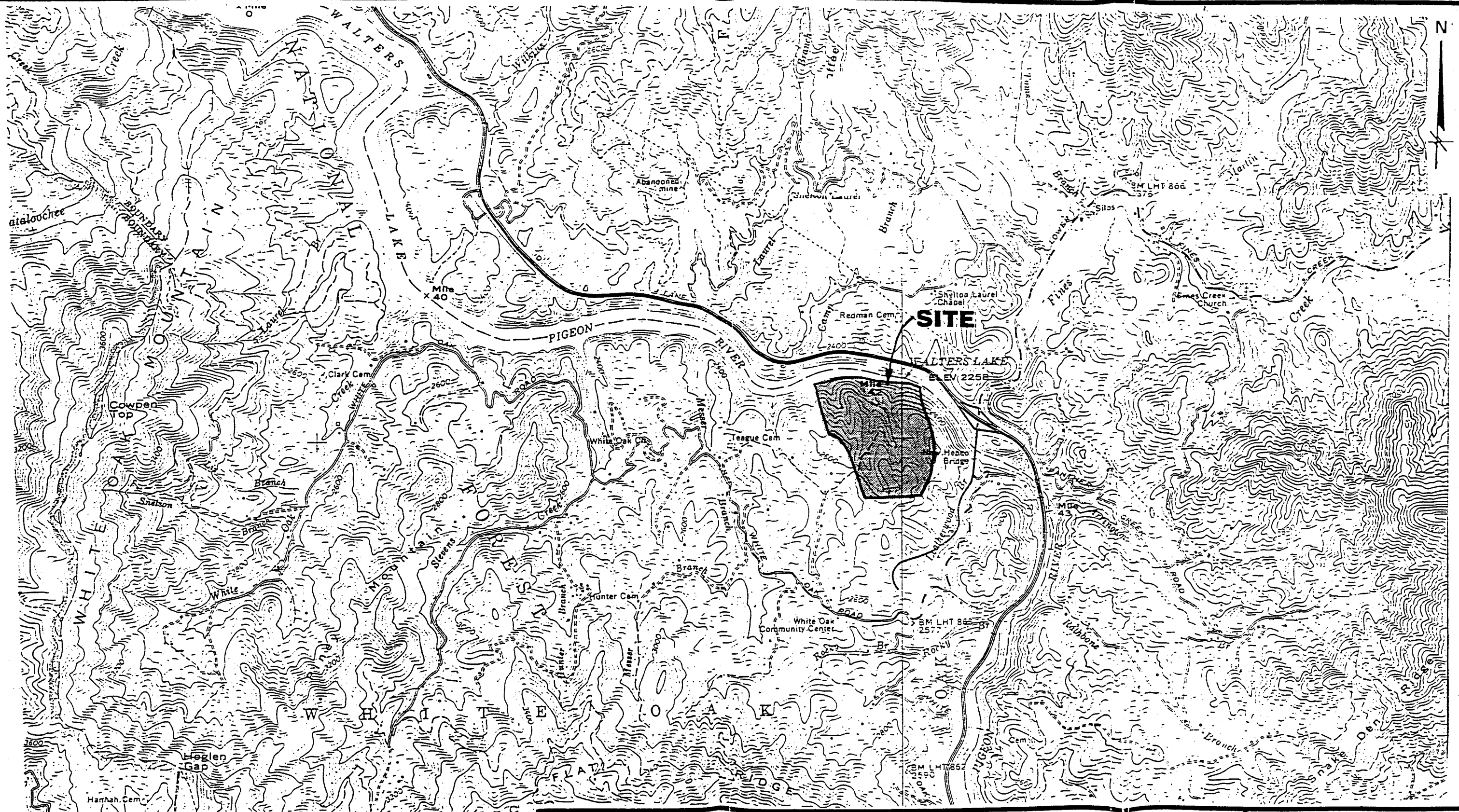
Law Engineering
Atlanta, Georgia

Geotechnical, Materials & Environmental Consultants

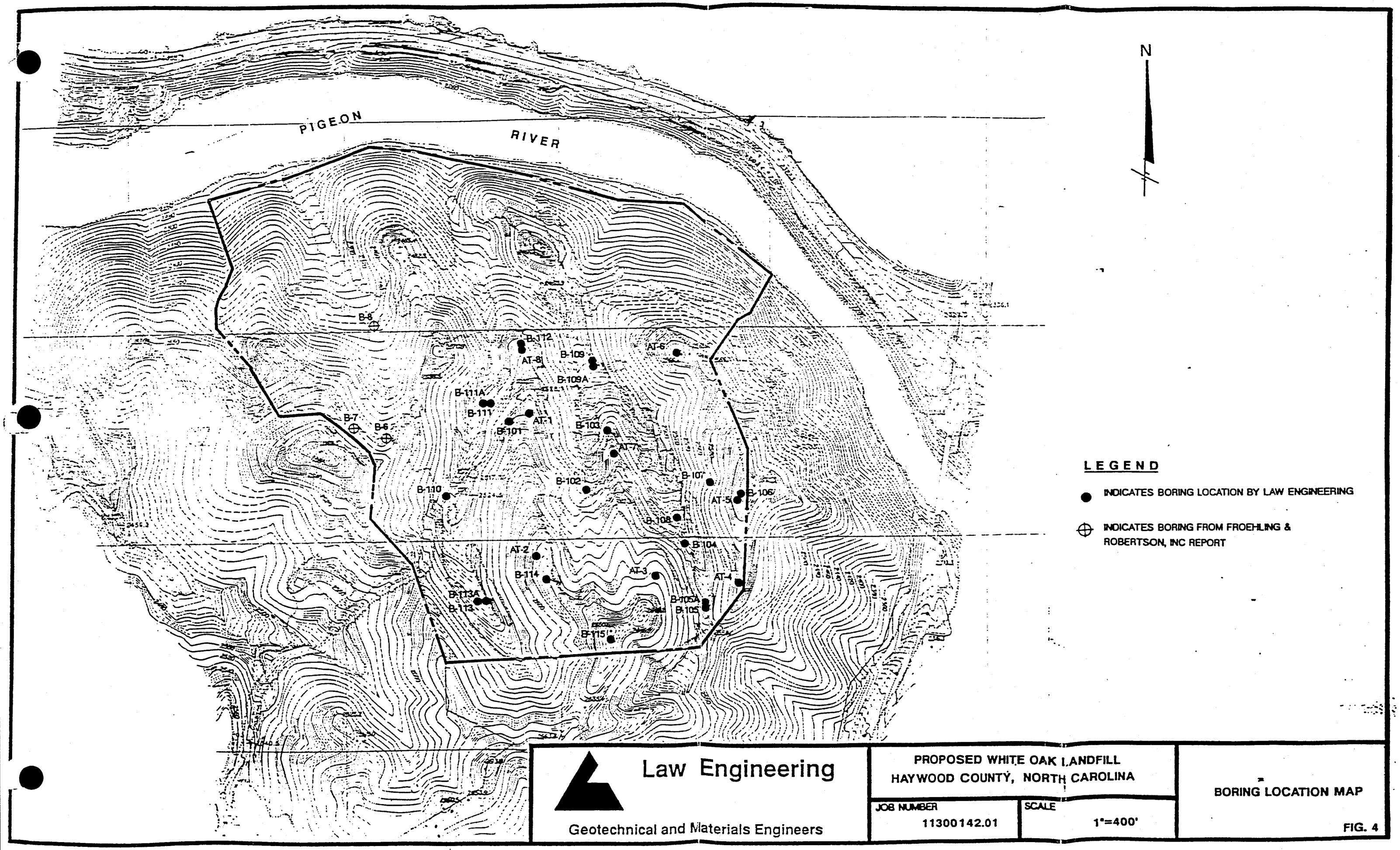
PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

FIG. 2

Job Number	Scale
11300142.01	1"= 2000'



Law Engineering Geotechnical and Materials Engineers	PROPOSED WHITE OAK LANDFILL HAYWOOD COUNTY, NORTH CAROLINA		SITE TOPOGRAPHIC PLAN
	JOB NUMBER 1130014201	SCALE 1"= 2000'	FIG. 3



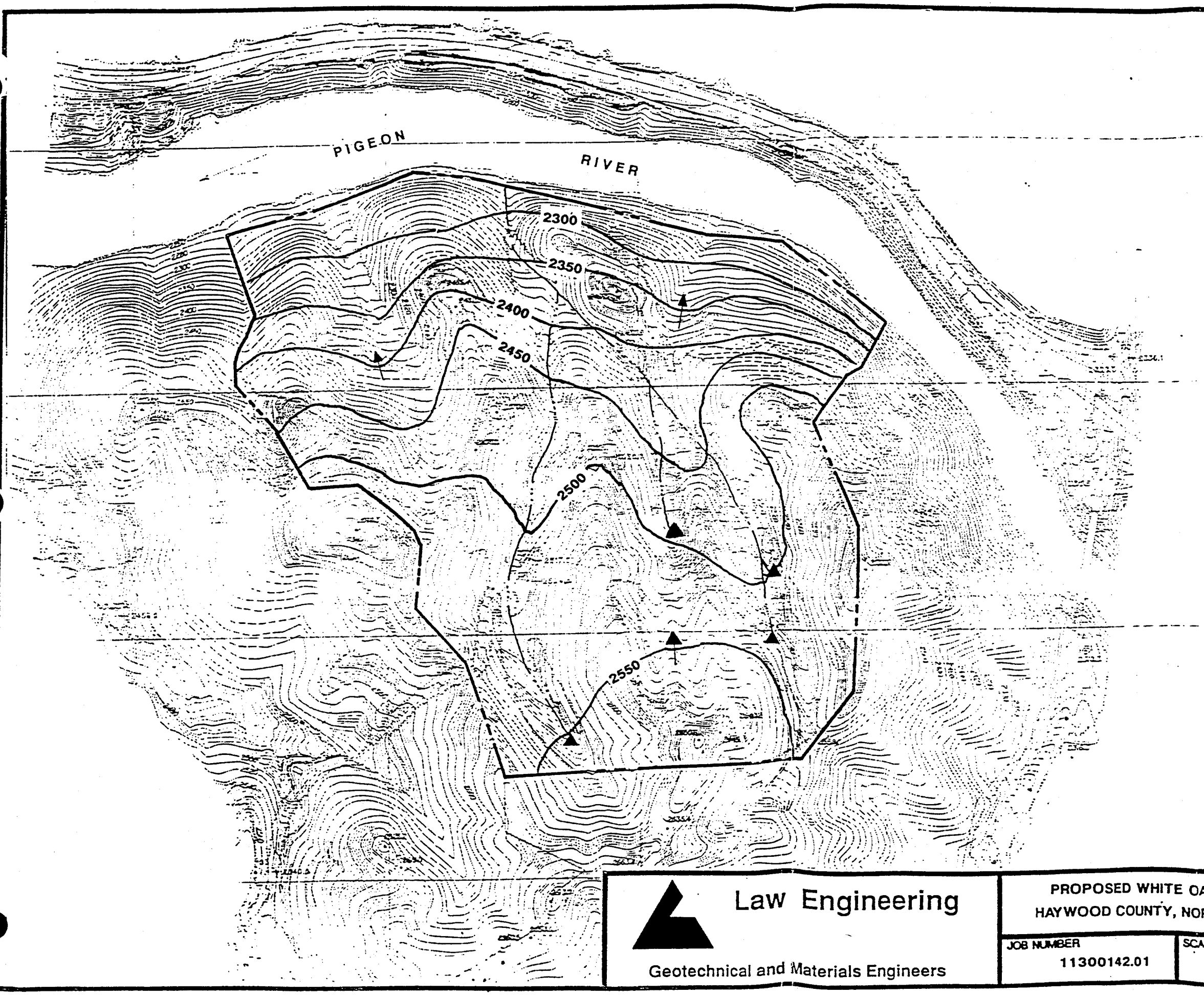
Law Engineering

Geotechnical and Materials Engineers

PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

BORING LOCATION MAP

JOB NUMBER	SCALE	
11300142.01	1"=400'	FIG. 4



N

LEGEND

INTERPRETED GROUNDWATER FLOW DIRECTION

INTERPRETED GROUNDWATER CONTOUR LINE

SPRING HEAD

- WATER TABLE CONTOURS BASED ON WATER LEVEL DATA OBTAINED ON MAY 22, 1990

Law Engineering

Geotechnical and Materials Engineers

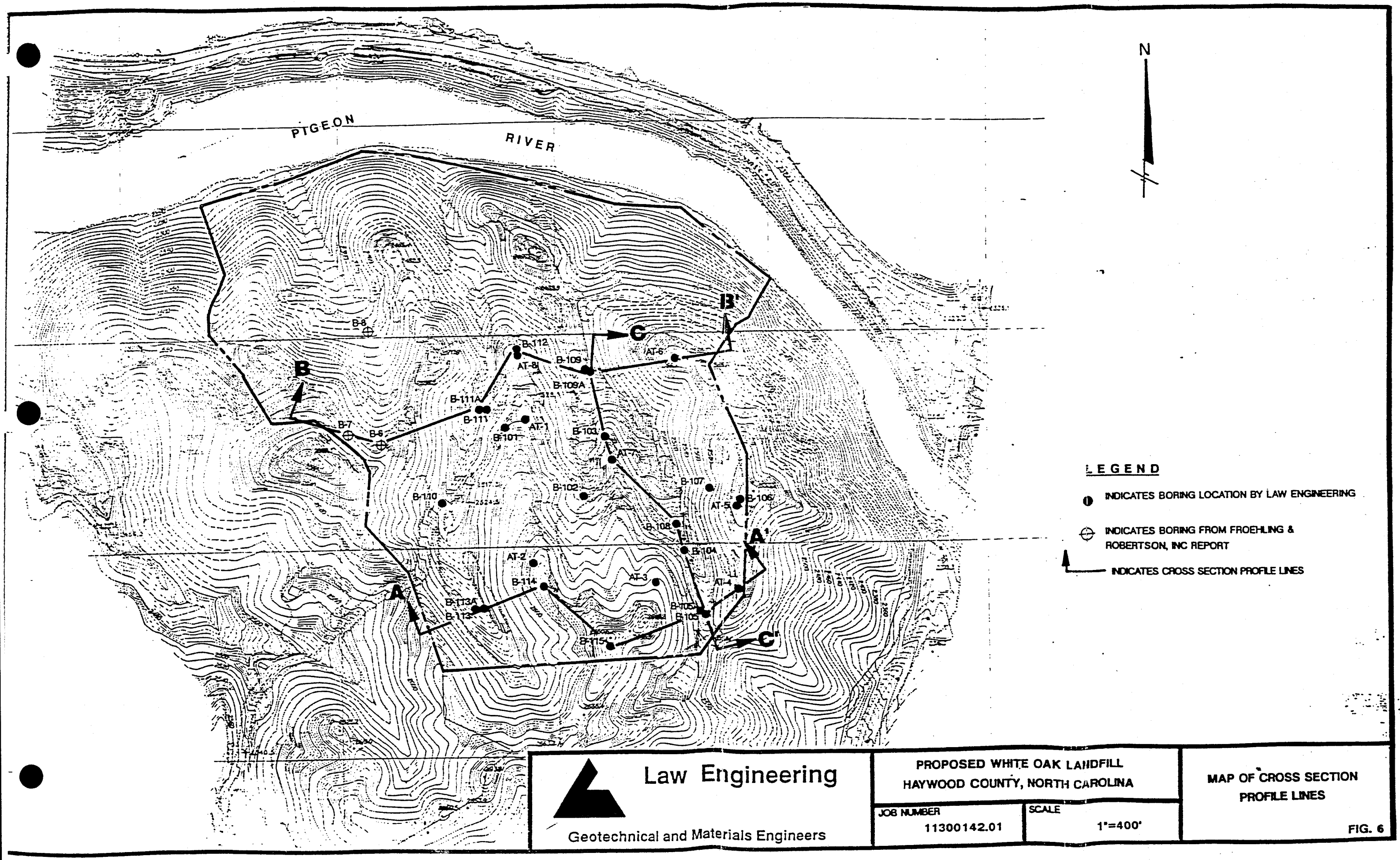
PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

JOB NUMBER 11300142.01

SCALE 1"=400'

GENERALIZED WATER TABLE MAP

FIG. 5



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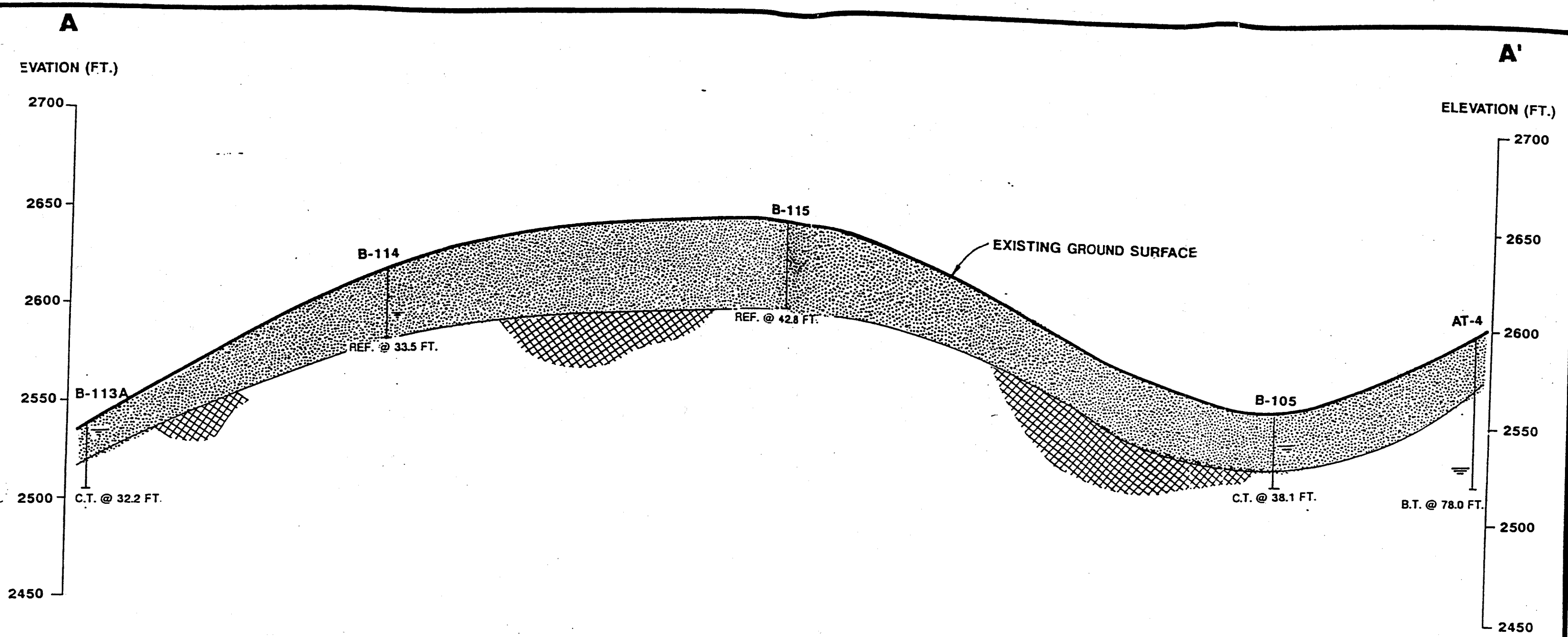
PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

JOB NUMBER 11300142.01

SCALE 1"=400'

MAP OF CROSS SECTION PROFILE LINES

FIG. 6



LEGEND

SANDY SILT OVERBURDEN

ROCK

WATER TABLE

WHILE INDIVIDUAL TEST BORING RECORDS ARE CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS ON THE DATES SHOWN, IT IS NOT WARRANTED THAT THEY ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

THE SUBSURFACE CONDITIONS SHOWN ON THESE PROFILES ARE NOT WARRANTED BUT ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND PRACTICES AND REASONABLE ENGINEERING JUDGMENT.

Law Engineering

Geotechnical and Materials Engineers

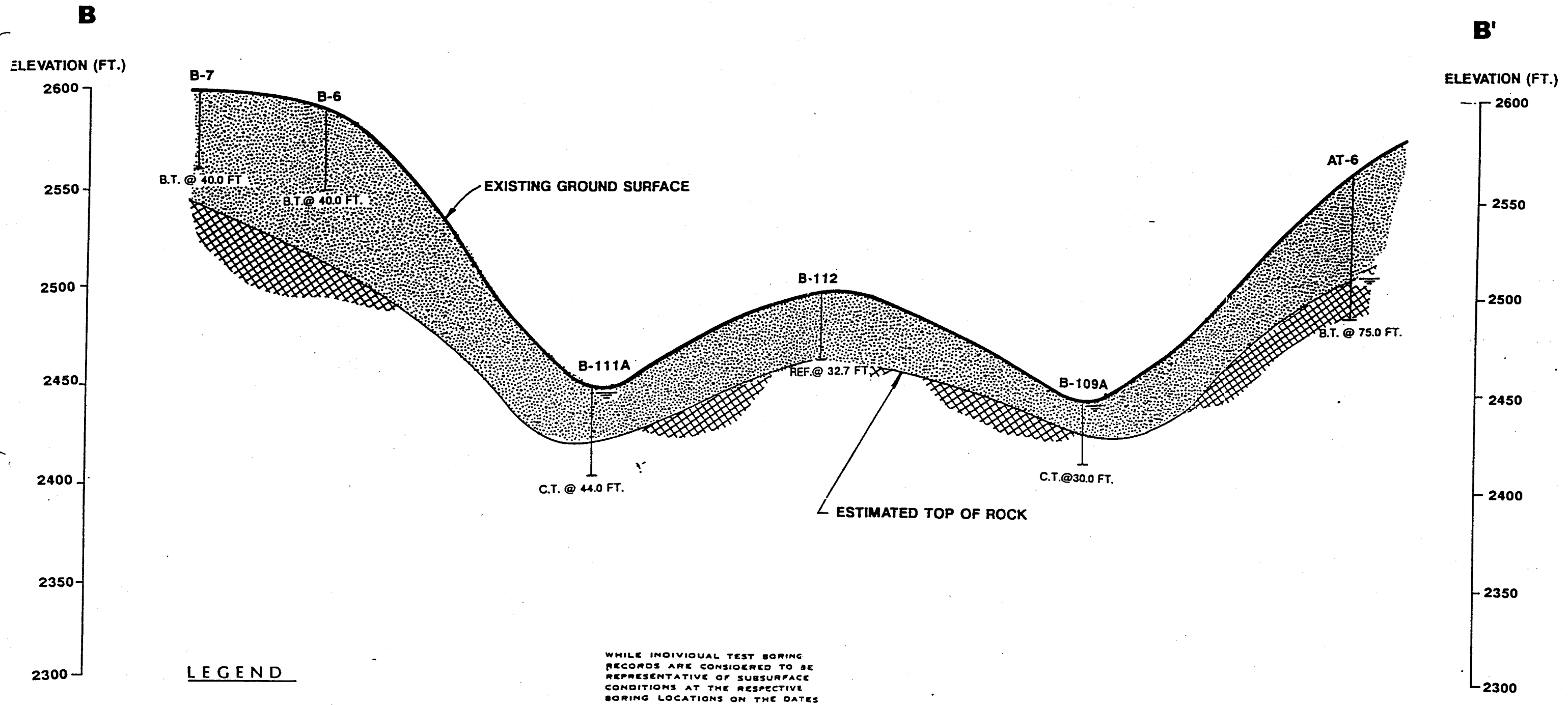
PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

JOB NUMBER 11300142.01

SCALE 1"=50'(V) 1"=100'(H)

SUBSURFACE PROFILE
A - A'

FIG 7



LEGEND

- SANDY SILT OVERBURDEN
- ROCK
- WATER TABLE

WHILE INDIVIDUAL TEST BORING RECORDS ARE CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS ON THE DATES SHOWN, IT IS NOT WARRANTED THAT THEY ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

THE SUBSURFACE CONDITIONS SHOWN ON THESE PROFILES ARE NOT WARRANTED BUT ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND PRACTICES AND REASONABLE ENGINEERING JUDGMENT.

Law Engineering

Geotechnical and Materials Engineers

PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

JOB NUMBER 11300142.01

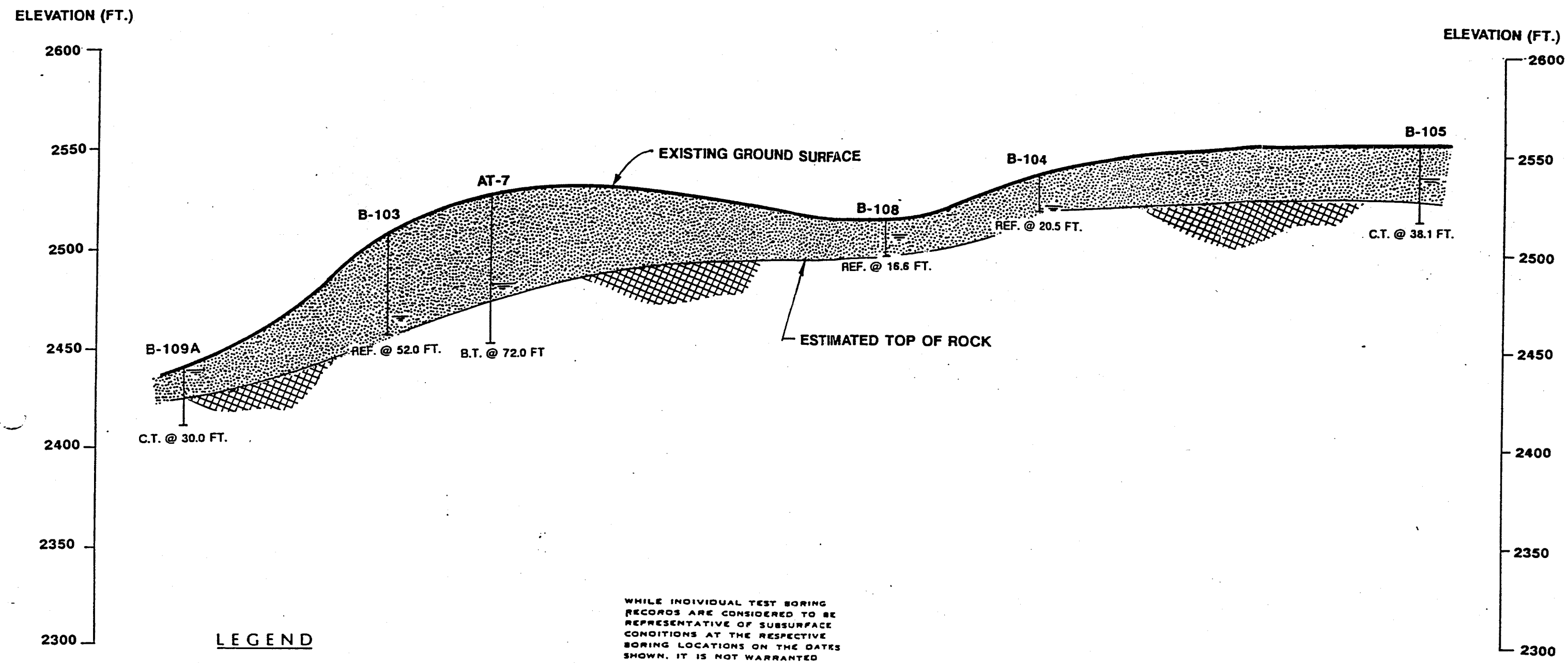
SCALE 1"=50'(V) 1"=100'(H)

SUBSURFACE PROFILE
B - B'

FIG 8

C

C'



LEGEND

SANDY SILT OVERBURDEN

ROCK

WATER TABLE

WHILE INDIVIDUAL TEST BORING RECORDS ARE CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS ON THE DATES SHOWN, IT IS NOT WARRANTED THAT THEY ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

THE SUBSURFACE CONDITIONS SHOWN ON THESE PROFILES ARE NOT WARRANTED BUT ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND PRACTICES AND REASONABLE ENGINEERING JUDGMENT.

Law Engineering

Geotechnical and Materials Engineers

PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

JOB NUMBER 11300142.01

SCALE 1"=50'(V) 1"=100'(H)

SUBSURFACE PROFILE
C - C'

FIG 9

SECTION 3

BORING LOGS

TYPICAL TYPE I GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	NO. OF BLOWS, N	RELATIVE DENSITY
SANDS:	0-4	Very Loose
	5-10	Loose
	11-30	Firm
	31-50	Dense
	OVER 50	Very Dense

		CONSISTENCY
SILTS & CLAYS:	0-2	Very Soft
	3-4	Soft
	5-8	Firm
	9-15	Stiff
	16-30	Very stiff
	31-50	Hard
	OVER 50	Very Hard

PARTICLE SIZE IDENTIFICATION

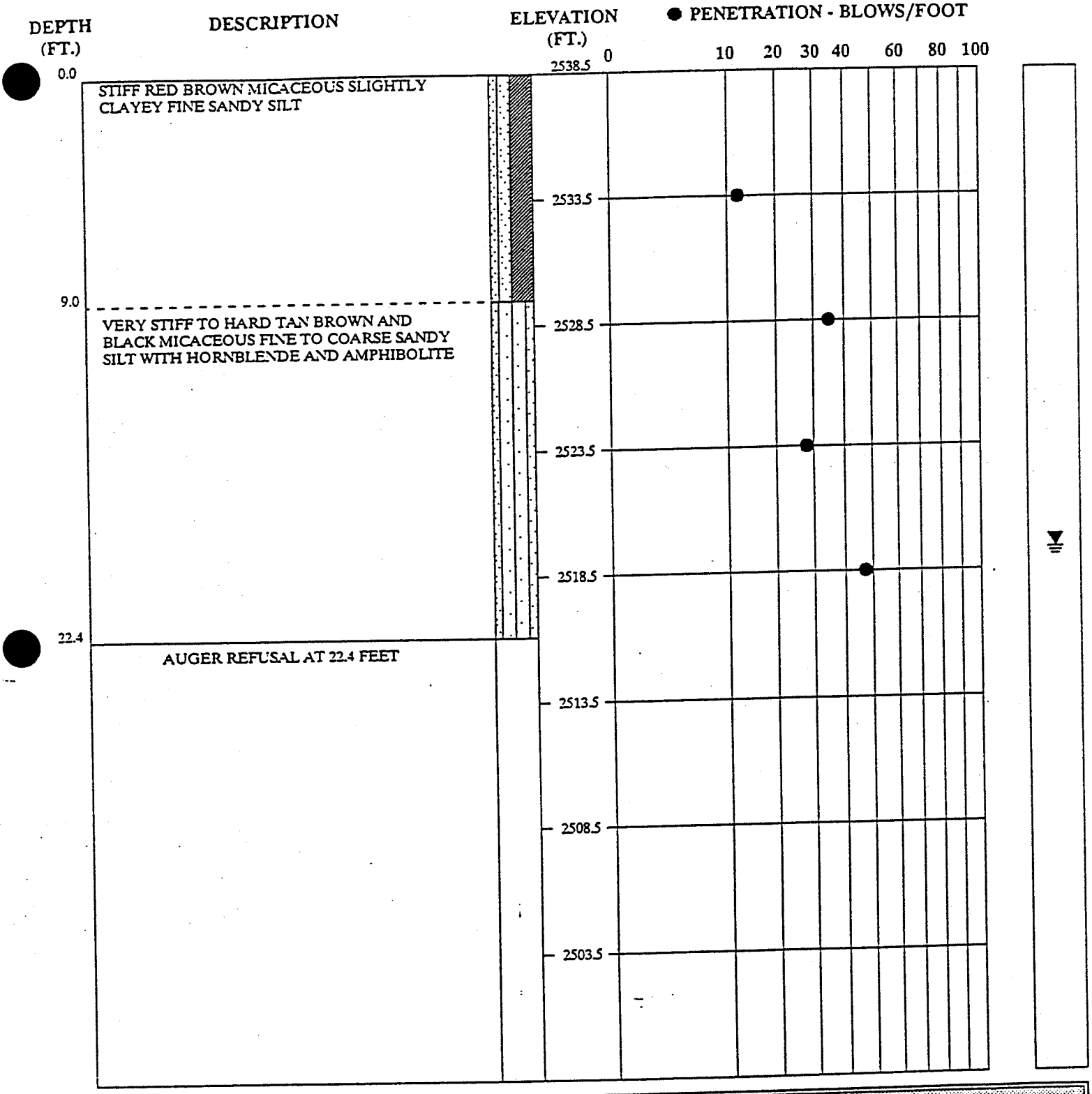
BOULDERS:		12 inches OR GREATER
COBBLES:		3 inches to 12 inches
GRAVEL:	Coarse -	3/4 inches to 3 inches
	Fine -	NO. 4 to 3/4 inches
SANDS:	Coarse -	NO. 10 to NO. 4
	Medium -	NO. 40 to NO. 10
	Fine -	NO. 200 to NO. 40
SILTS & CLAYS:		PASSING NO. 200

KEY TO DRILLING SYMBOLS

- Undisturbed Sample
- Split Spoon Sample
- Water Table After 24 Hours
- Water Table at Time of Drilling

KEY TO SOIL CLASSIFICATIONS

- SILTY CLAY
- SILT
- CLAYEY SILT
- SANDY SILT
- SAND
- SILTY SAND
- CLAYEY SAND
- PARTIALLY WEATHERED ROCK - A transitional material between soil and rock which retains the relic structure of the parent rock.
- ASPHALT
- CONCRETE
- GRAVEL
- TOPSOIL
- FILL
- ALLUVIUM
- ROCK



REMARKS:

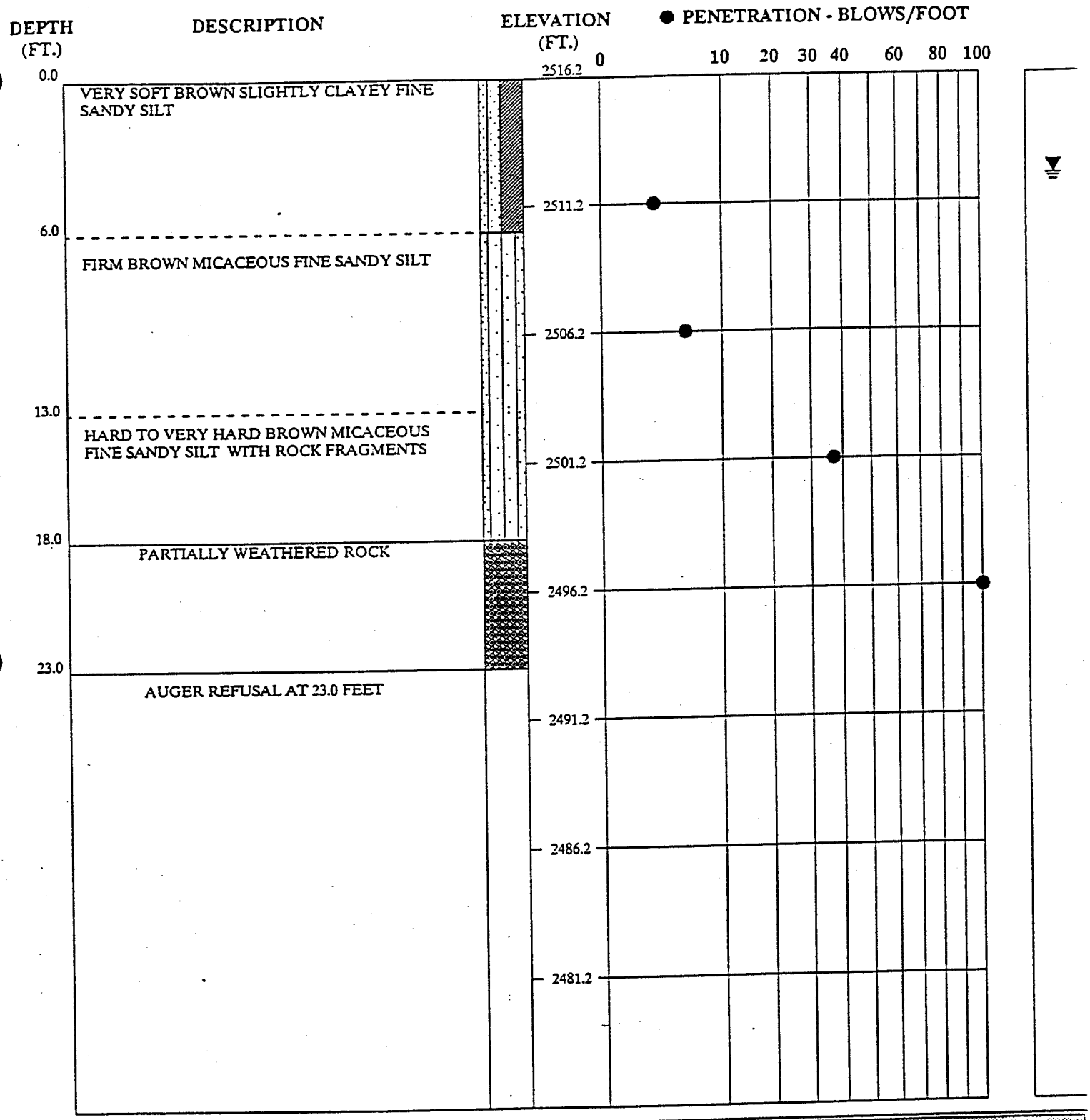
GROUND WATER MEASURED AT 19.2 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-101
DATE DRILLED	February 20, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

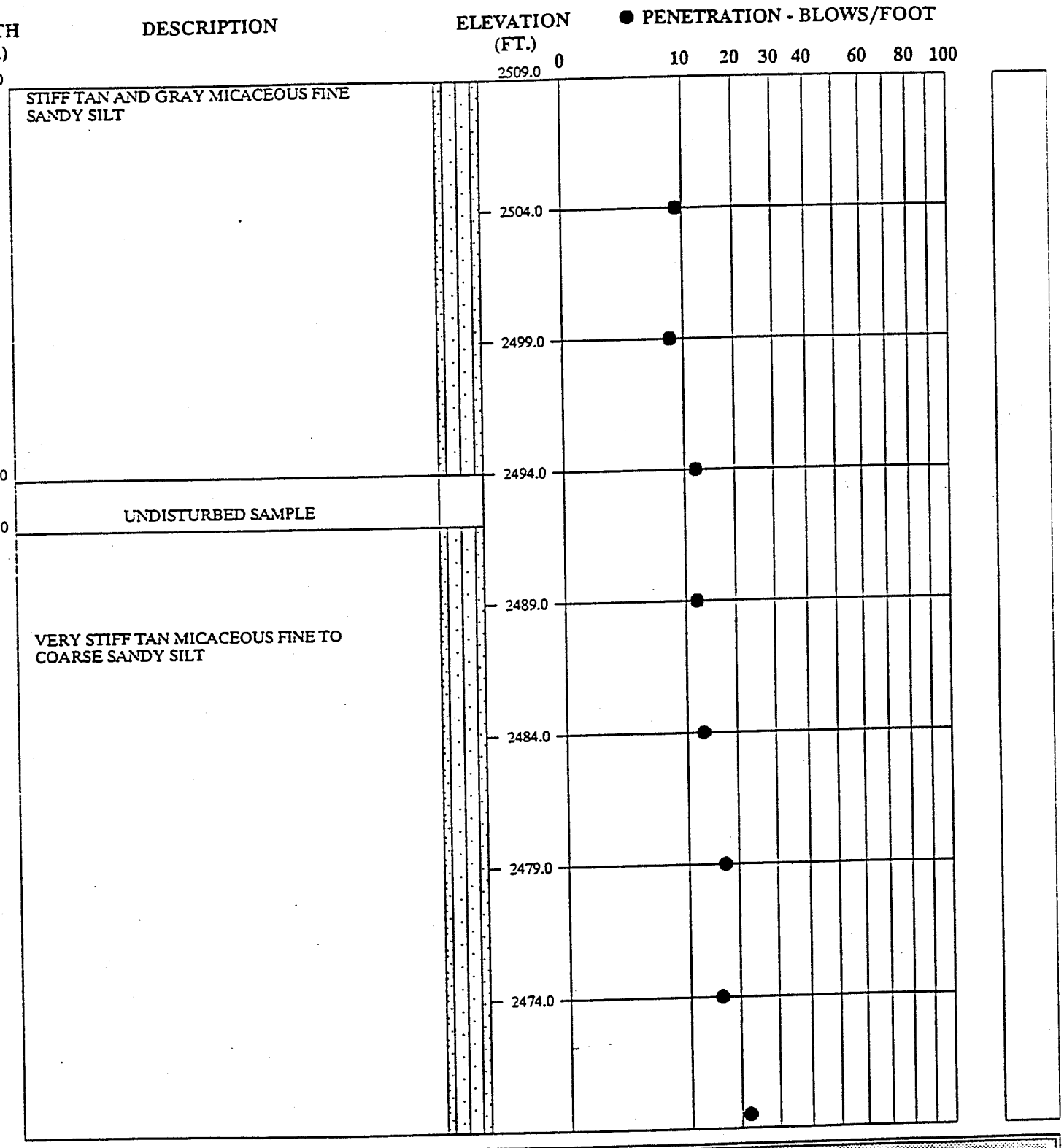
GROUND WATER MEASURED AT 4.0 ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-102
DATE DRILLED	March 27, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

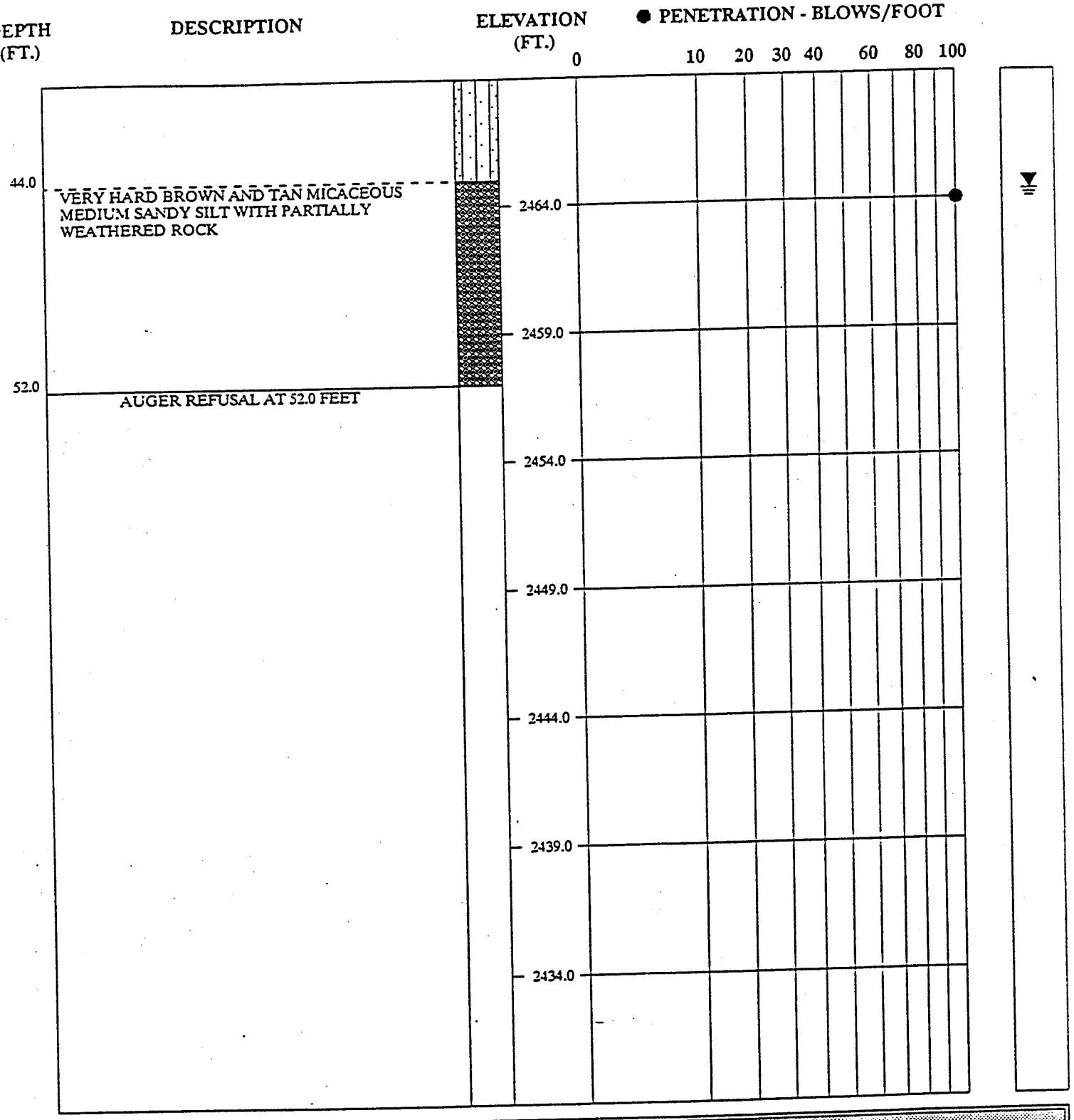
GROUND WATER MEASURED AT 44.7 FEET ON 4-23-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-103
DATE DRILLED	March 28, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 2	

LAW ENGINEERING



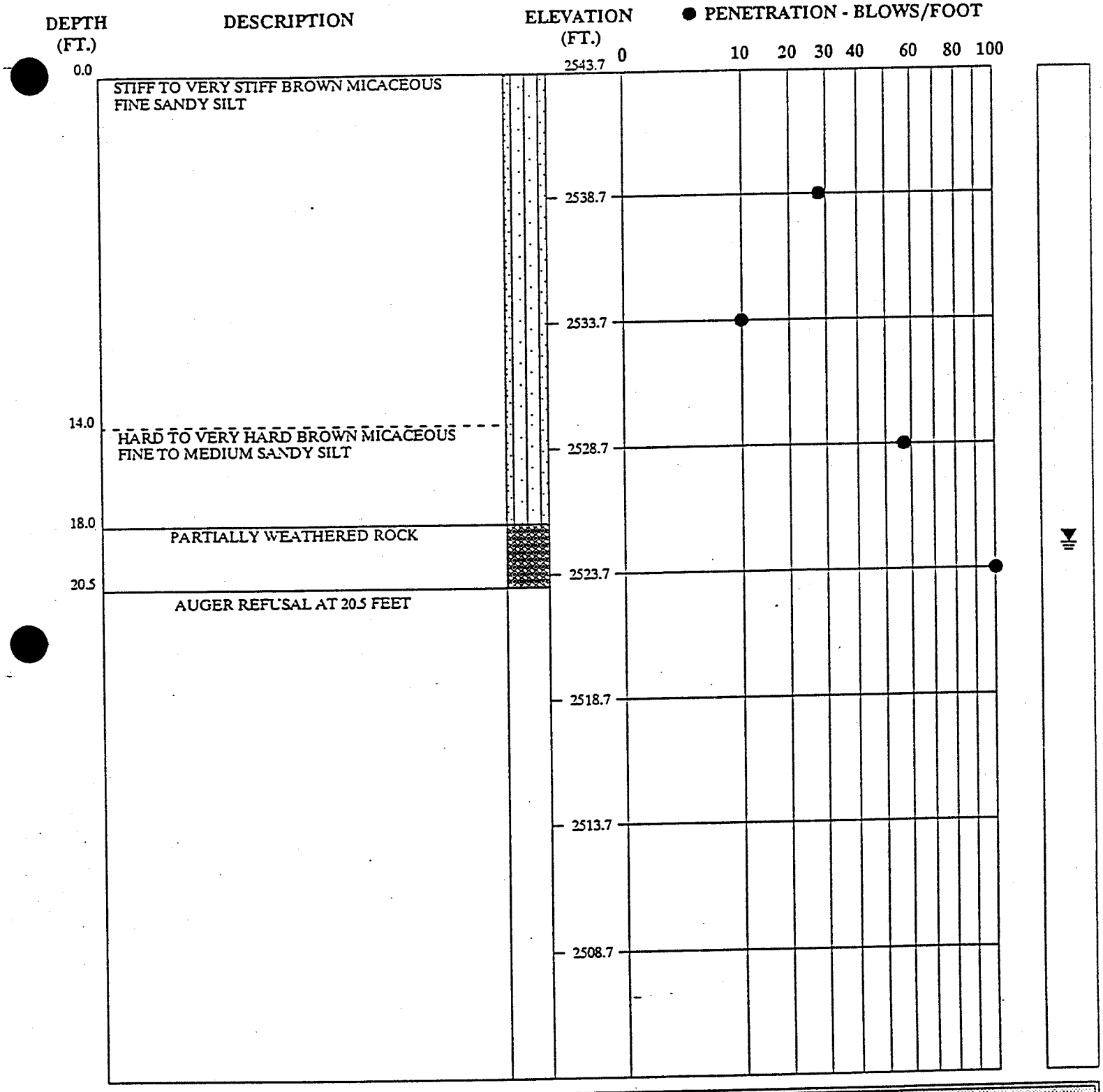
REMARKS:
GROUND WATER MEASURED AT 44.7 FEET ON 4-23-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-103
DATE DRILLED	March 28, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 2 OF 2	

LAW ENGINEERING



REMARKS:

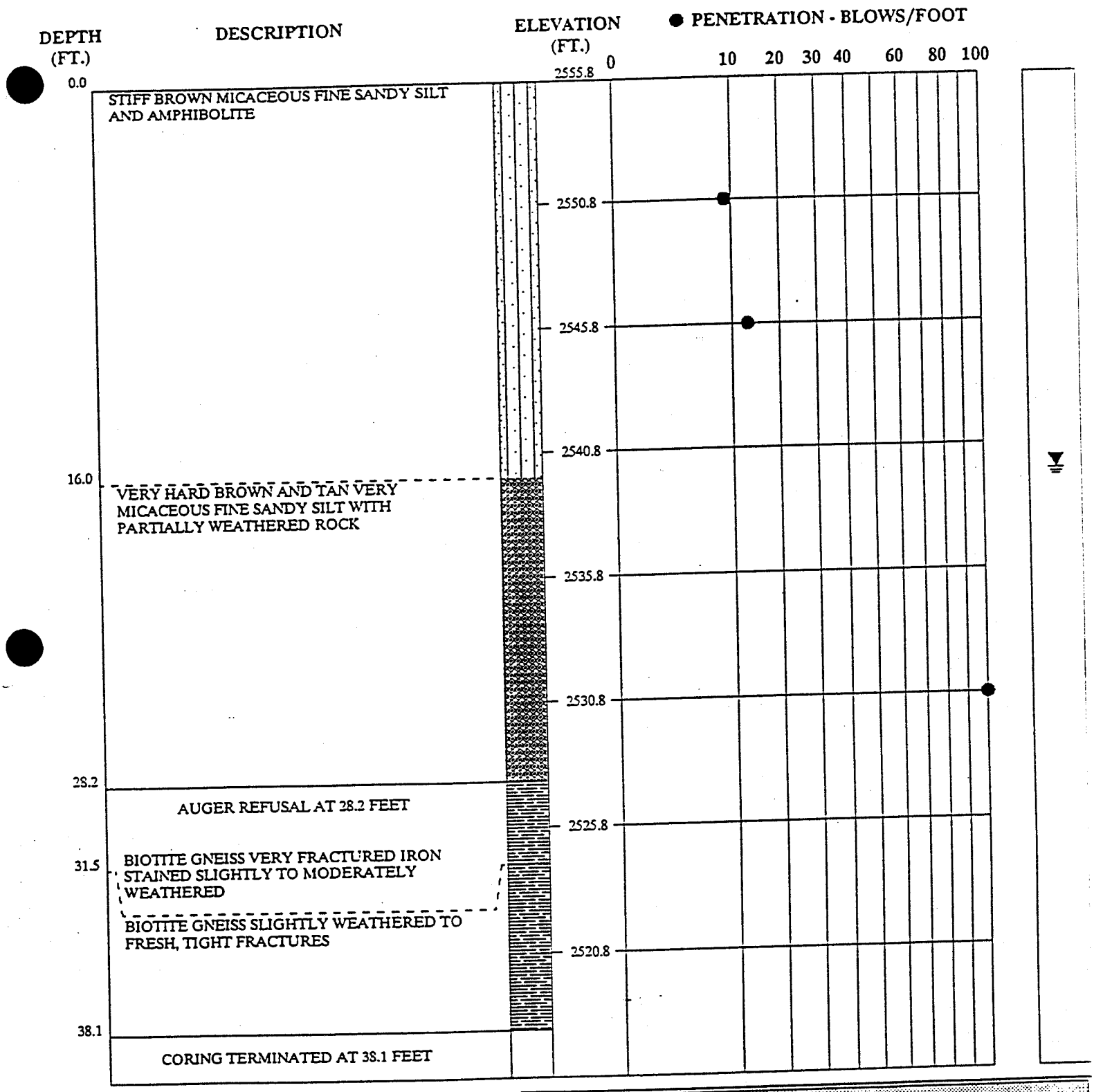
GROUND WATER MEASURED AT 19.1 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-104
DATE DRILLED	March 28, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

GROUND WATER MEASURED AT 16.1 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-105
DATE DRILLED	February 21, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	* REC. 100% RQD. 0% ** REC. 50% RQD. 0% *** REC. 114% RQD. 84% **** REC. 83% RQD. 100%	2510.8 2505.8 2500.8 2495.8 2490.8 2485.8 2480.8	

REMARKS:

GROUND WATER MEASURED AT 16.1 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-105
DATE DRILLED	February 21, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 2 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	STIFF TO VERY HARD TAN AND BROWN VERY MICACEOUS FINE TO MEDIUM SANDY SILT	2555.6
23.5	AUGER REFUSAL AT 23.5 FEET	2530.6

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100

2550.6
2545.6
2540.6
2535.6
2525.6
2520.6

▼

REMARKS:

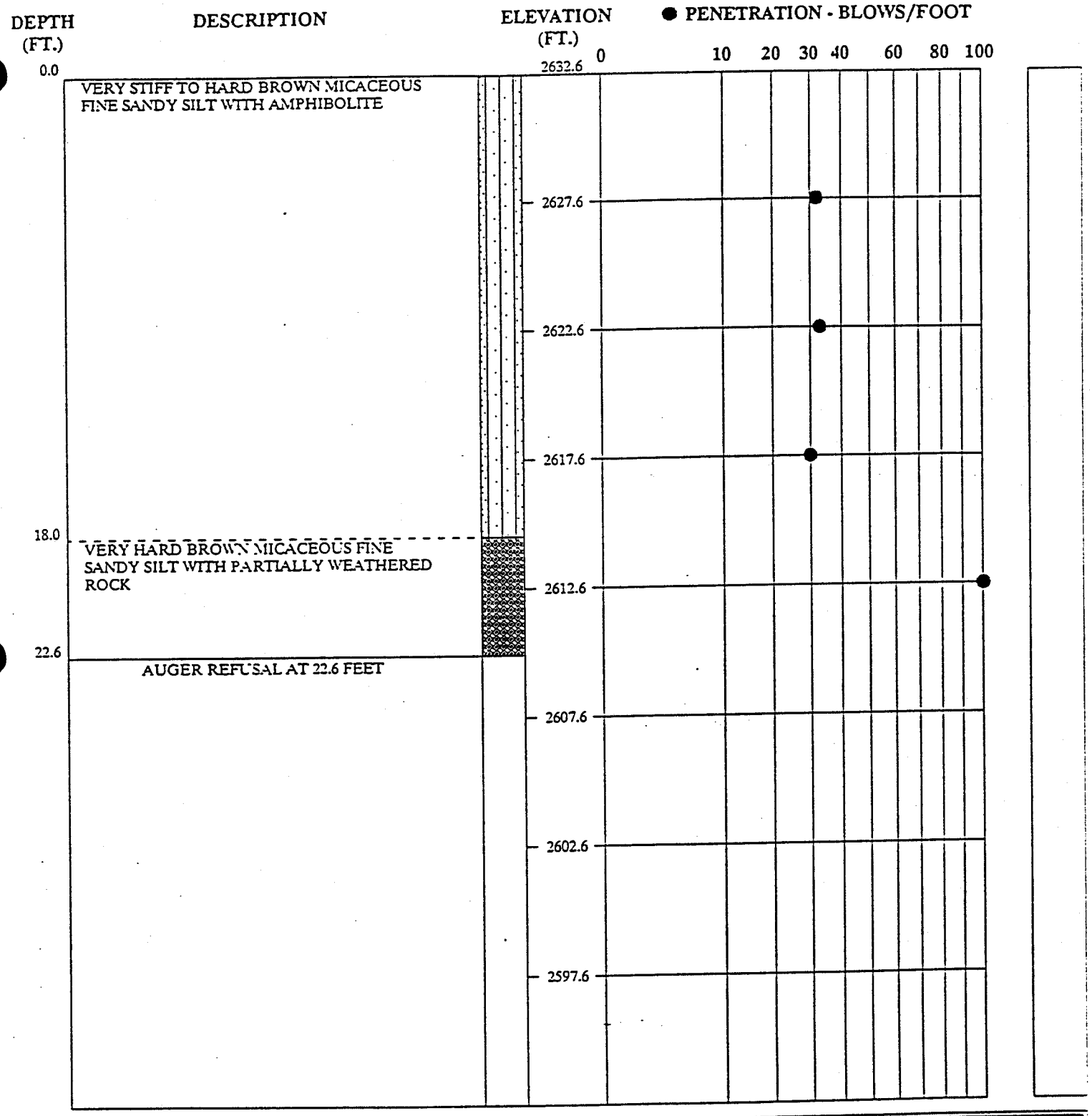
NO SAMPLES TAKEN. SOIL DESCRIPTIONS BASED ON VISUAL CLASSIFICATION OF THE AUGER CUTTINGS. GROUND WATER MEASURED AT 16.6 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-105A
DATE DRILLED	February 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

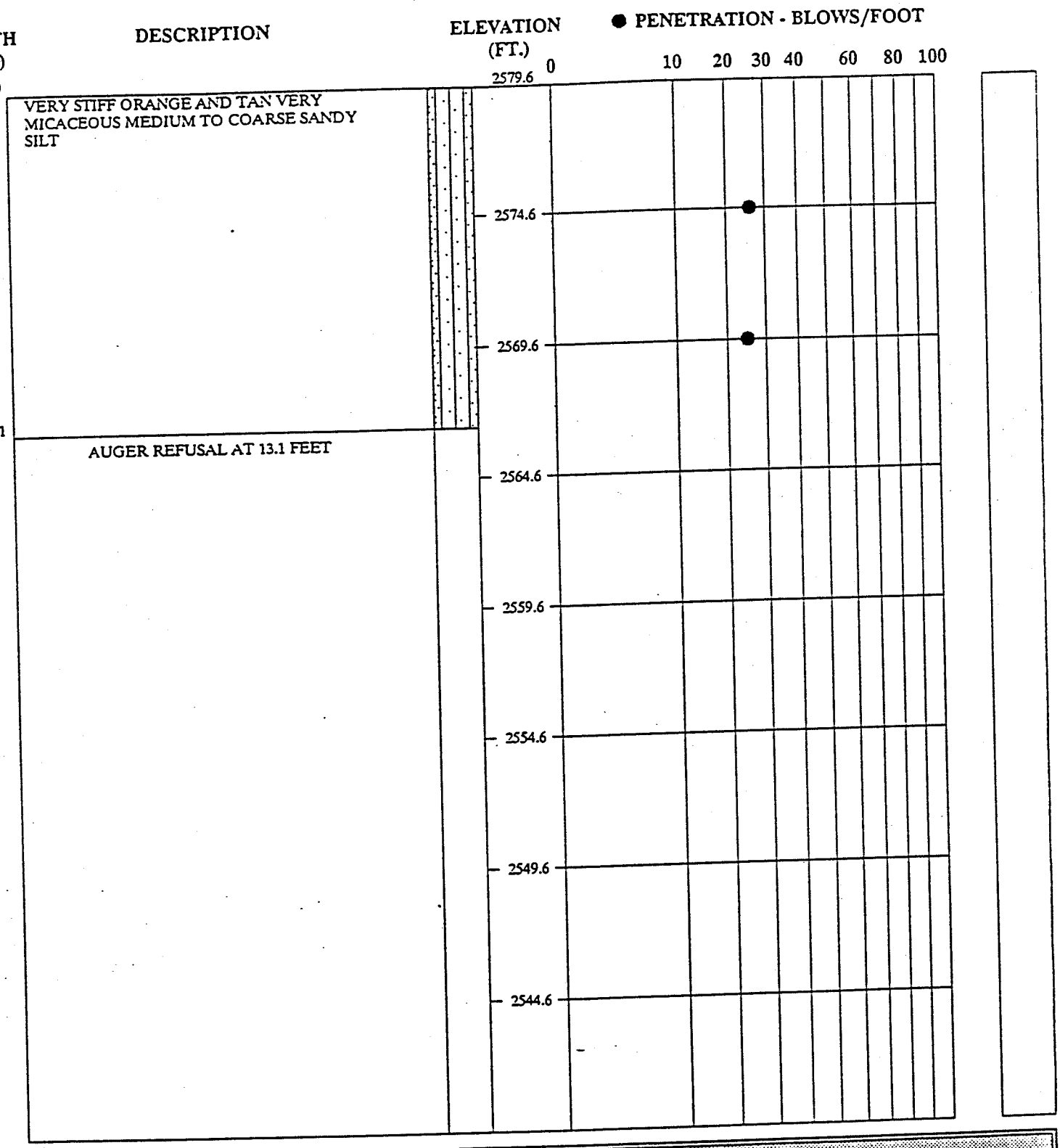
NO GROUND WATER ENCOUNTERED AS OF 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-106
DATE DRILLED	February 24, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

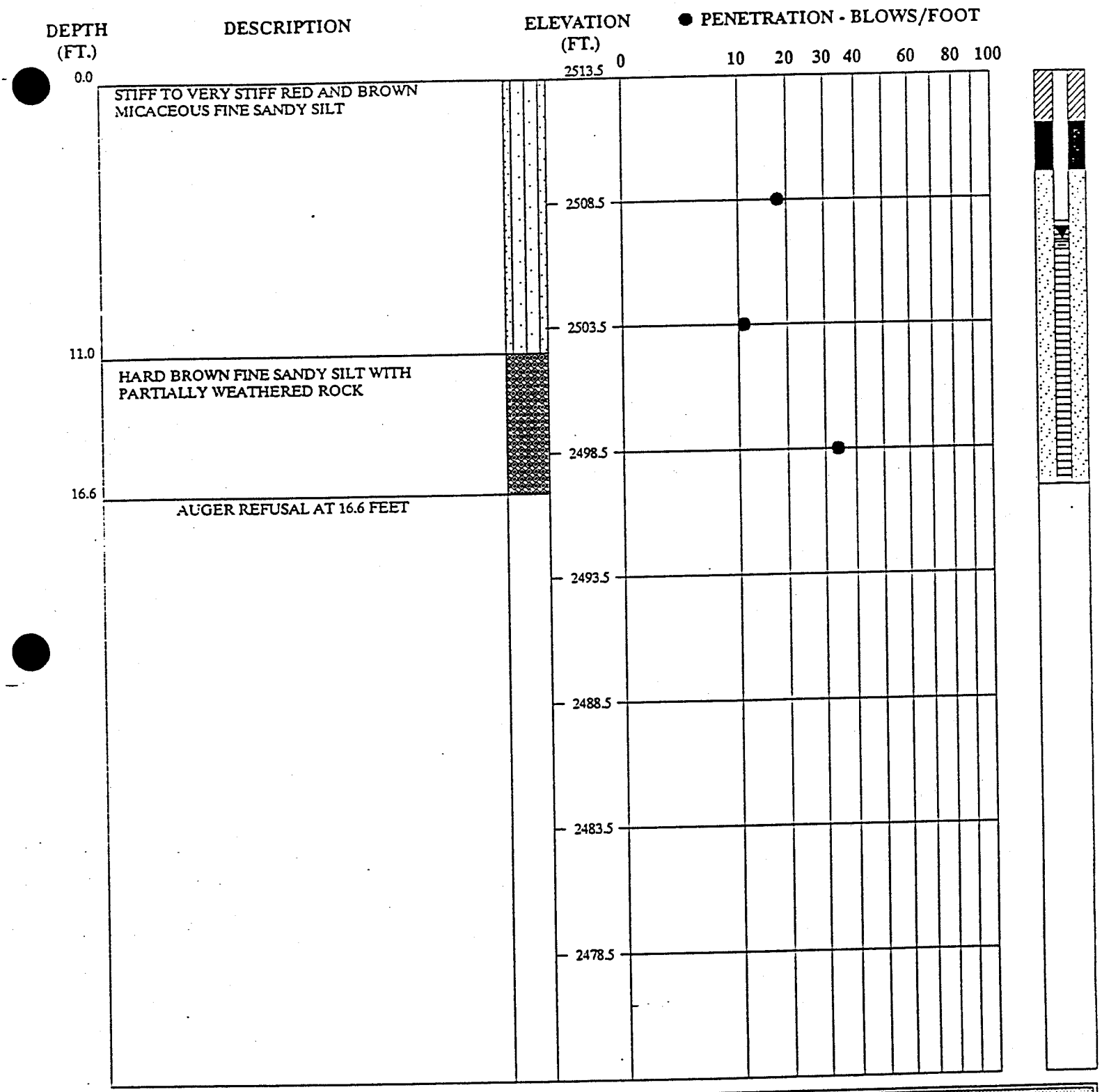
NO GROUND WATER ENCOUNTERED AS OF 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-107
DATE DRILLED	February 24, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

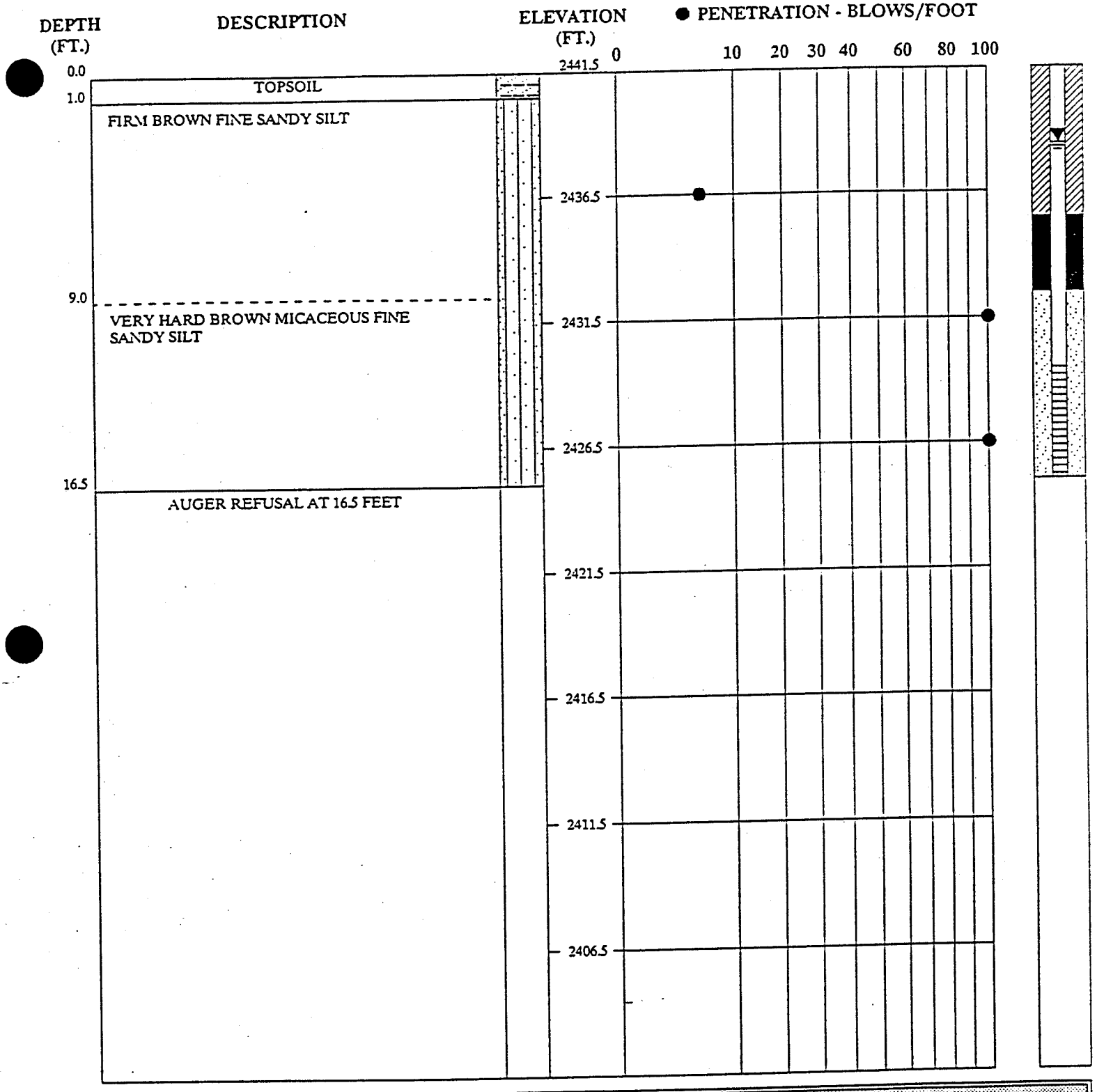
GROUND WATER MEASURED AT 6.8 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-108
DATE DRILLED	February 22, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

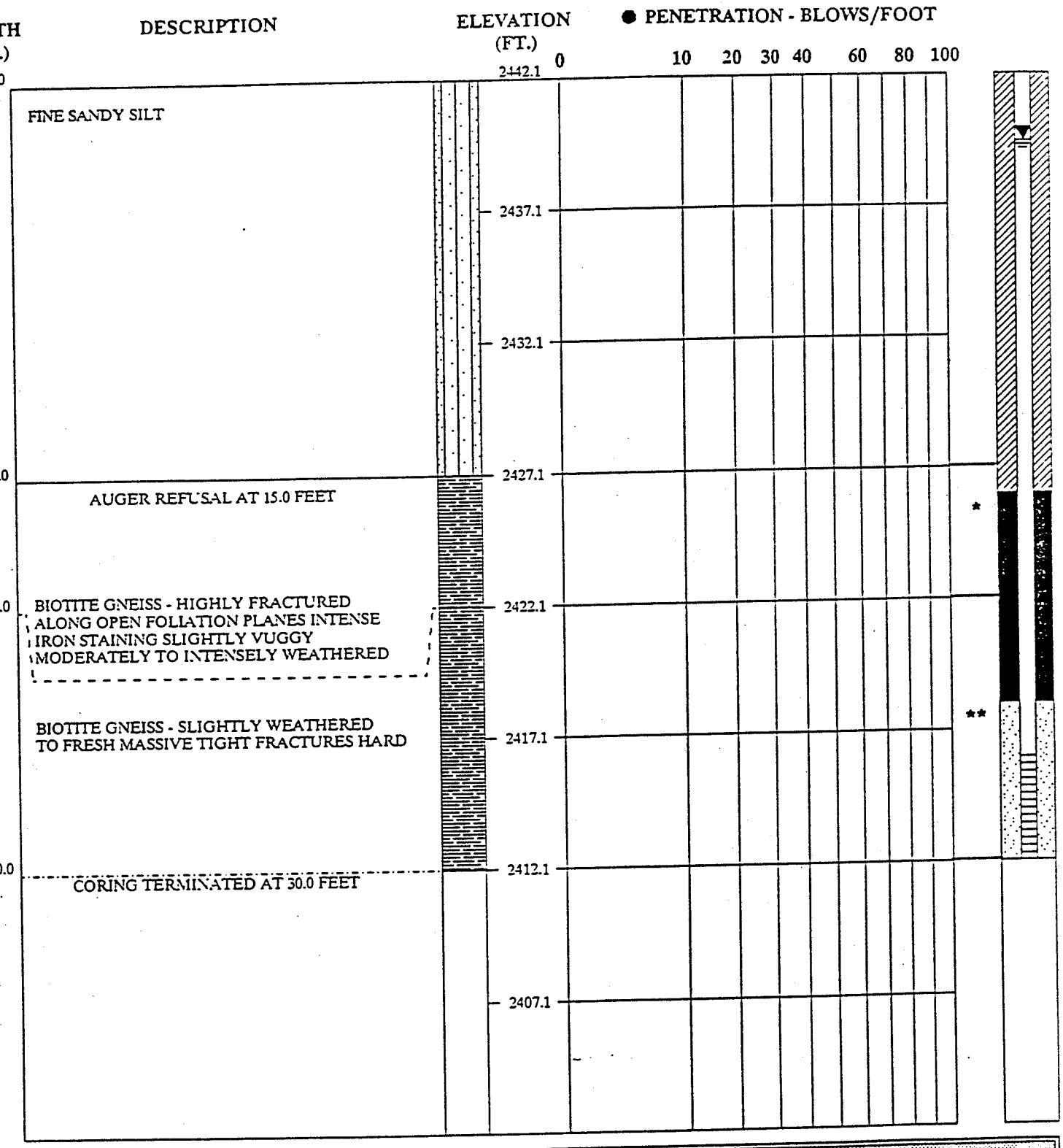
GROUND WATER MEASURED AT 3.1 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-109
DATE DRILLED	March 27, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

NO SAMPLE TAKEN. SOIL DESCRIPTIONS BASED ON VISUAL CLASSIFICATION OF THE AUGER CUTTINGS. GROUND WATER MEASURED AT 2.6 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-109A
DATE DRILLED	March 27, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	• REC. 90% RQD. 14%	2397.1	
	•• REC. 83% RQD. 83%	2392.1	
		2387.1	
		2382.1	
		2377.1	
		2372.1	
		2367.1	

REMARKS:

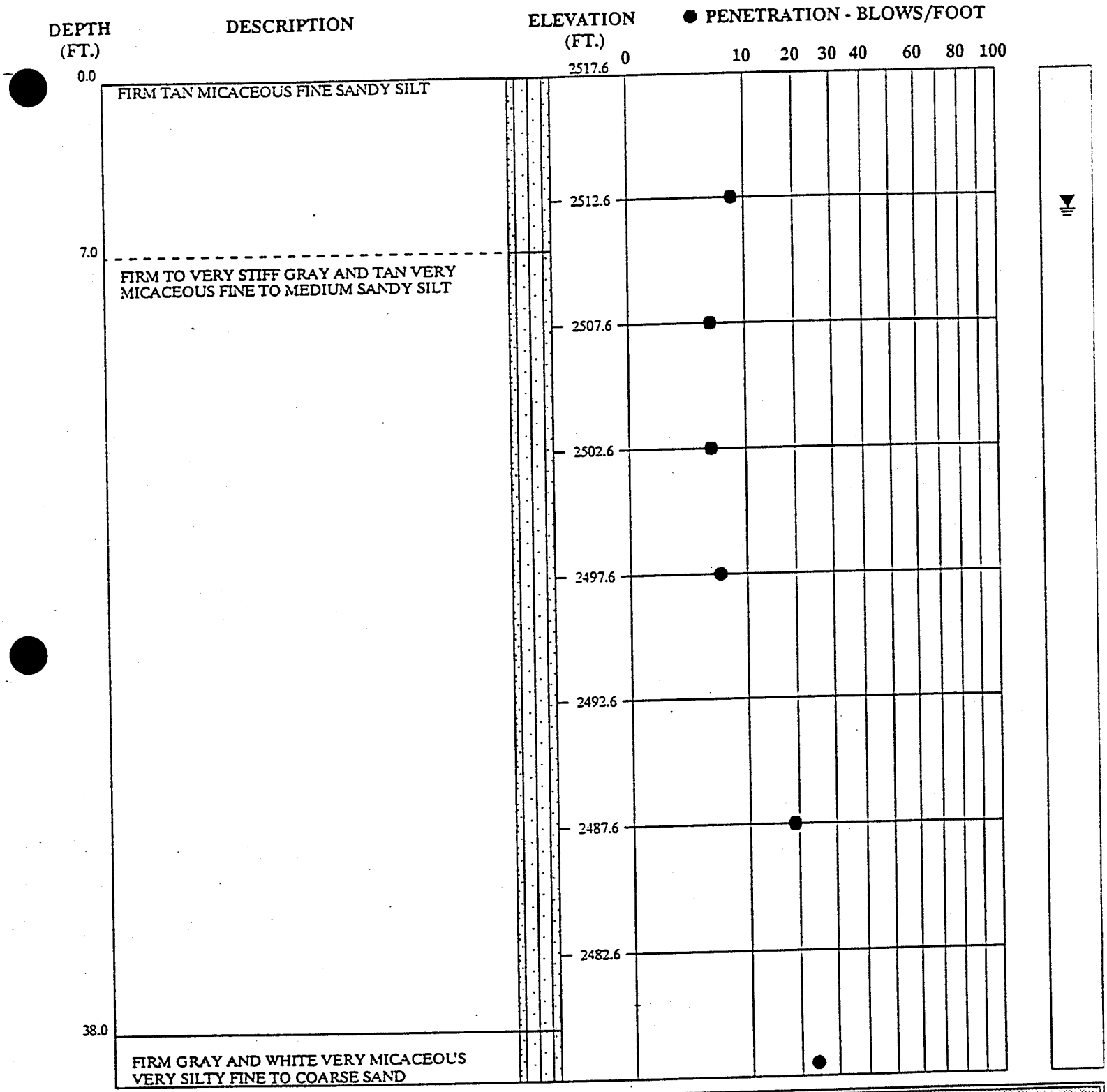
NO SAMPLE TAKEN. SOIL DESCRIPTIONS BASED ON VISUAL CLASSIFICATION OF THE AUGER CUTTINGS. GROUND WATER MEASURED AT 2.6 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-109A
DATE DRILLED	March 27, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 2 OF 2	

LAW ENGINEERING



REMARKS:

GROUND WATER MEASURED AT 5.7 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

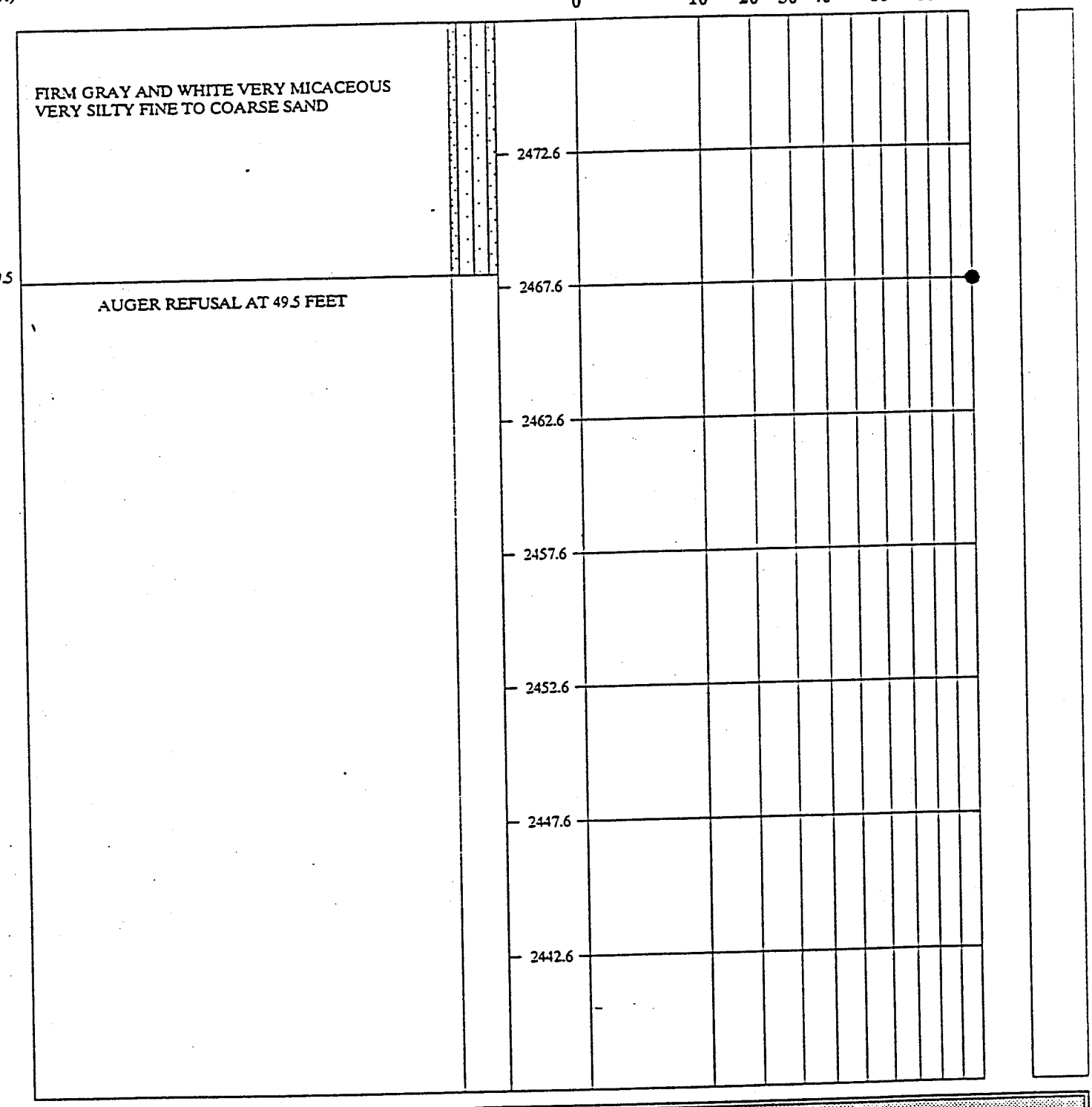
BORING NUMBER	B-110
DATE DRILLED	February 19, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
	FIRM GRAY AND WHITE VERY MICACEOUS VERY SILTY FINE TO COARSE SAND	2472.6
49.5	AUGER REFUSAL AT 49.5 FEET	2467.6
		2462.6
		2457.6
		2452.6
		2447.6
		2442.6

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100



REMARKS:

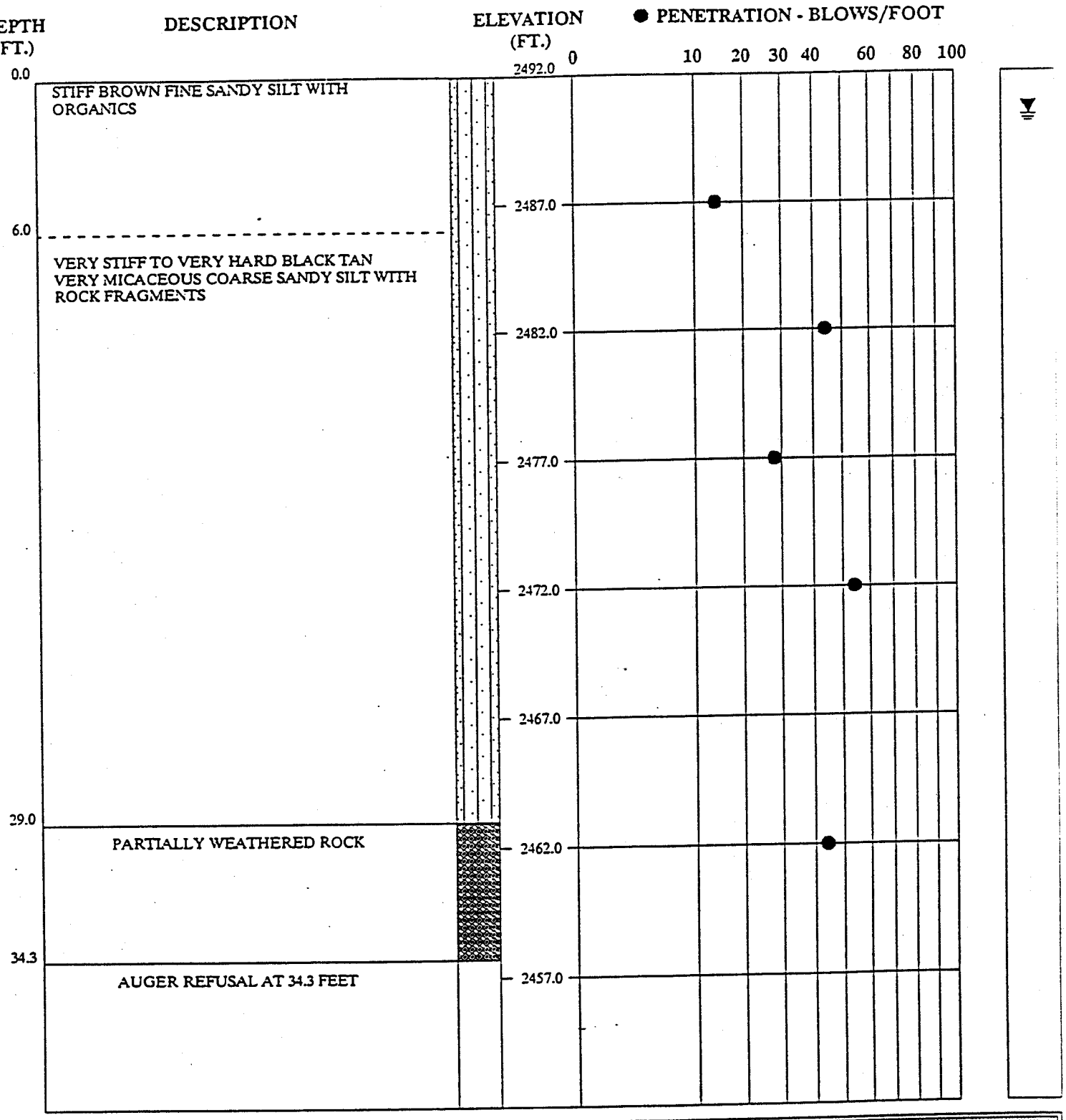
GROUND WATER MEASURED AT 5.7 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-110
DATE DRILLED	February 19, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 2 OF 2	

LAW ENGINEERING



REMARKS:

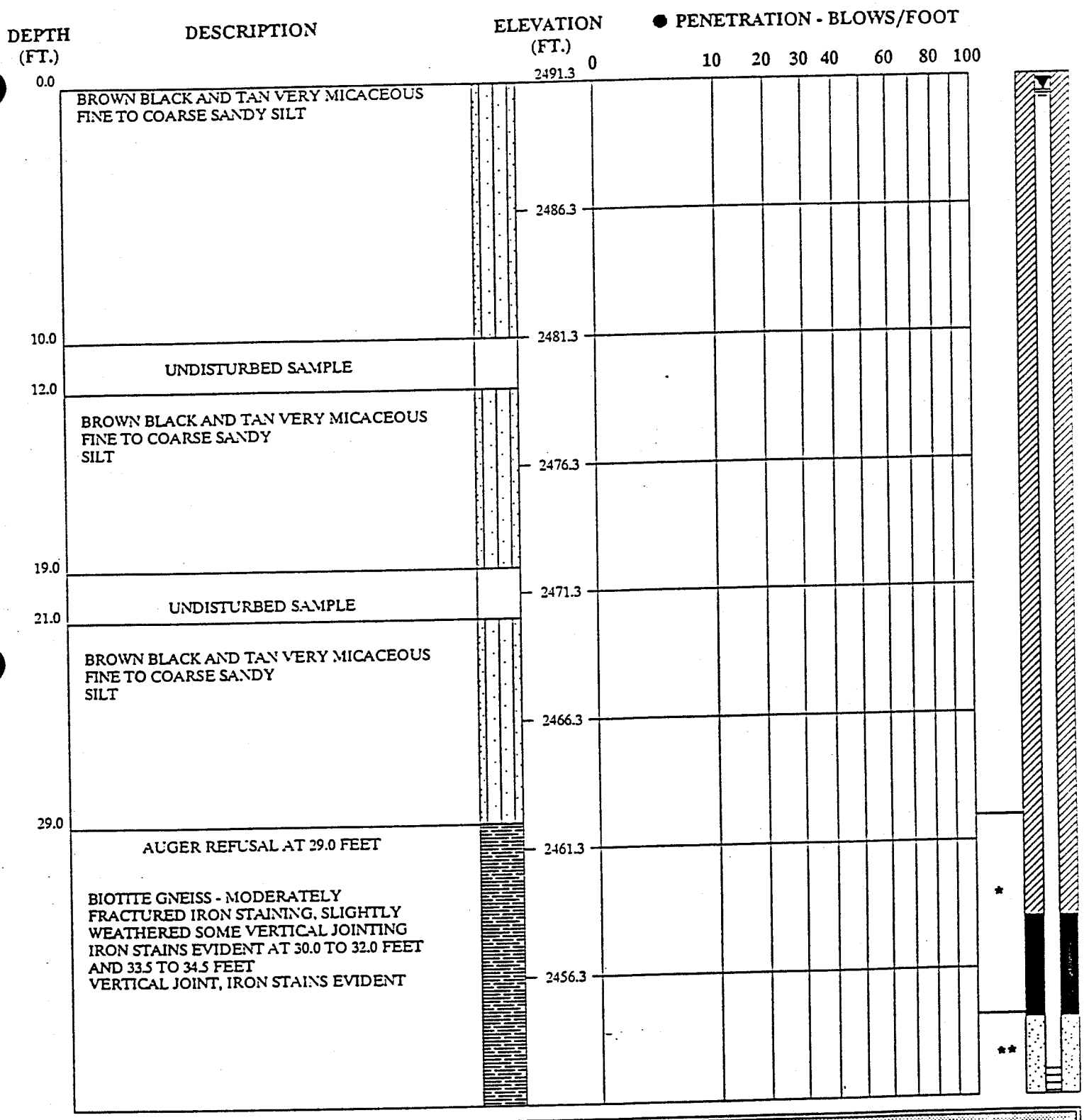
GROUND WATER MEASURED AT 1.7 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-111
DATE DRILLED	February 20, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

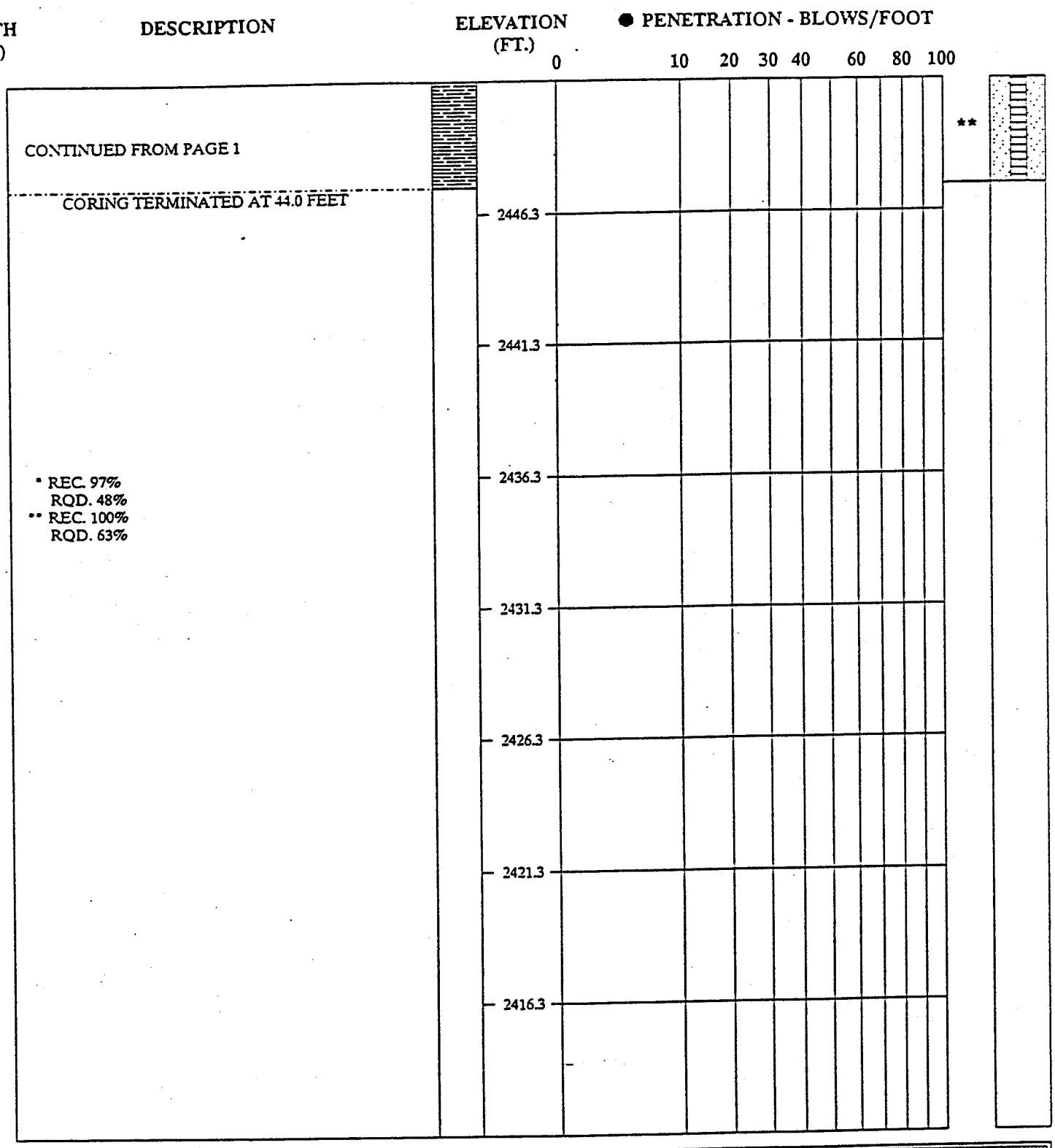
NO SAMPLES TAKEN. SOIL DESCRIPTIONS BASED ON VISUAL CLASSIFICATION OF THE AUGER CUTTINGS. GROUND WATER MEASURED AT 0.7 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-111A
DATE DRILLED	March 29, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 2	

LAW ENGINEERING



REMARKS:

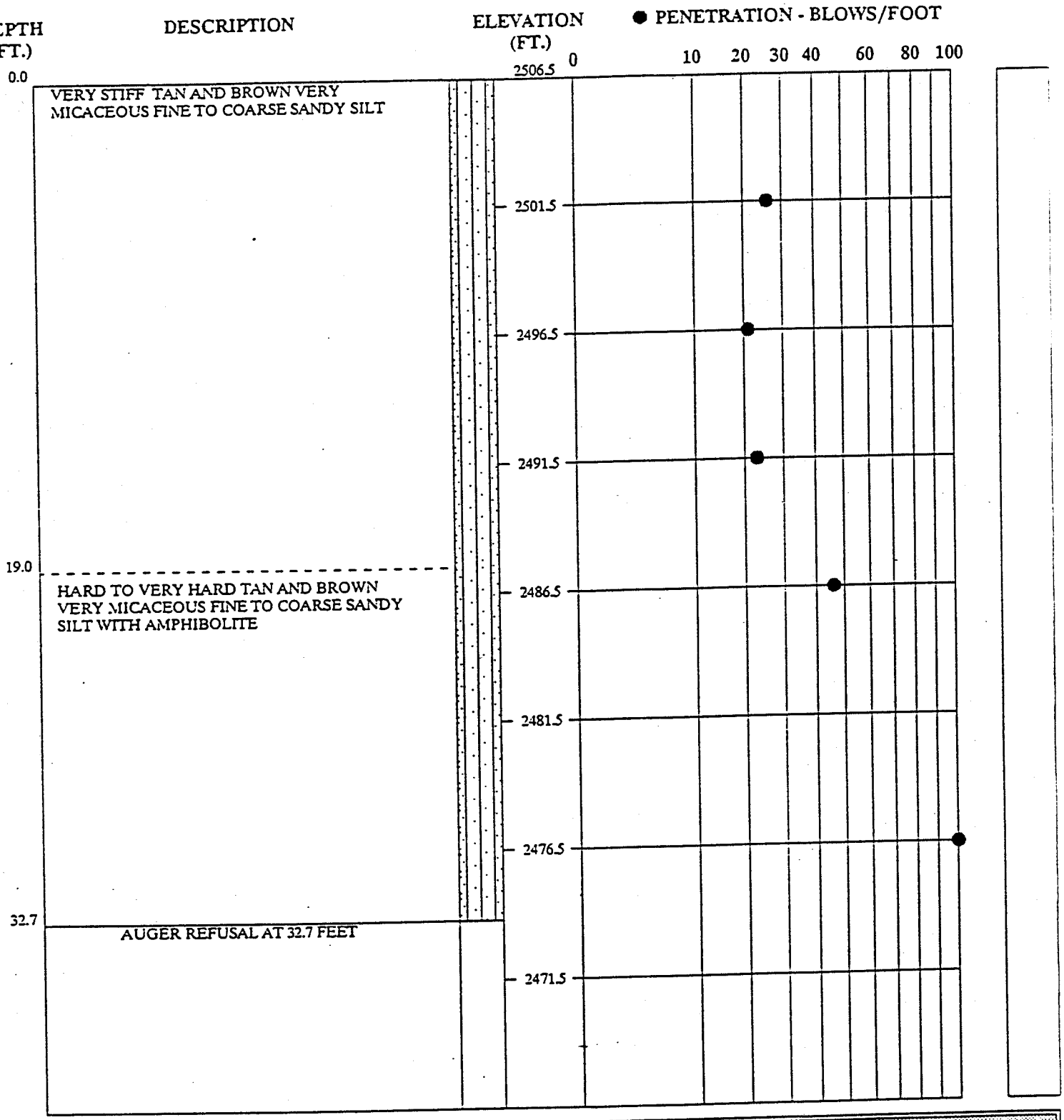
NO SAMPLES TAKEN. SOIL DESCRIPTIONS BASED ON VISUAL CLASSIFICATION OF THE AUGER CUTTINGS. GROUND WATER MEASURED AT 0.7 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-111A
DATE DRILLED	March 29, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 2 OF 2	

LAW ENGINEERING



REMARKS:

NO GROUND WATER ENCOUNTERED AS OF 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-112
DATE DRILLED	February 21, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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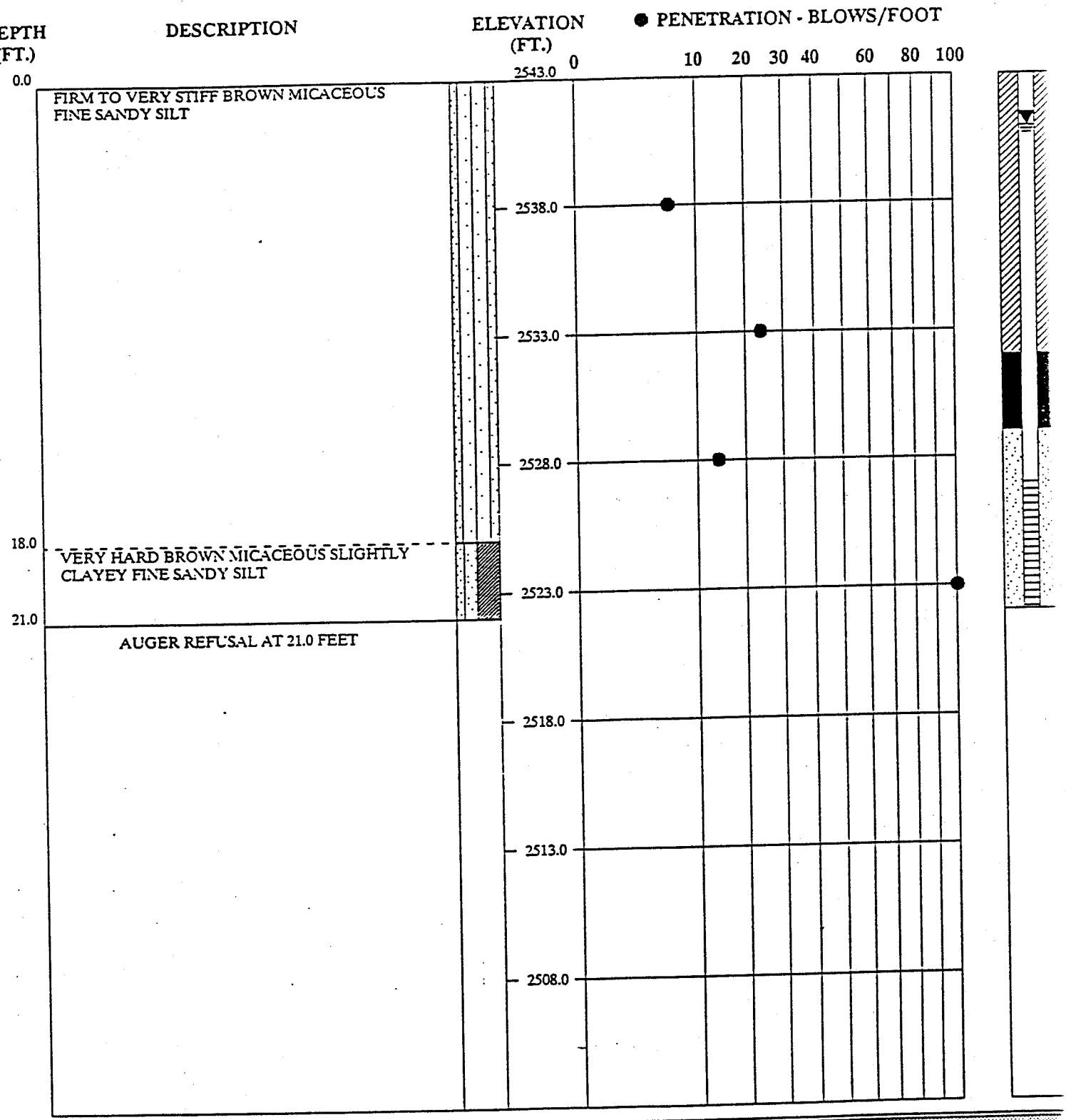
LAW ENGINEERING



REMARKS:

GROUND WATER MEASURED AT 2.1 FEET ON 5-21-90

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-113
DATE DRILLED	March 28, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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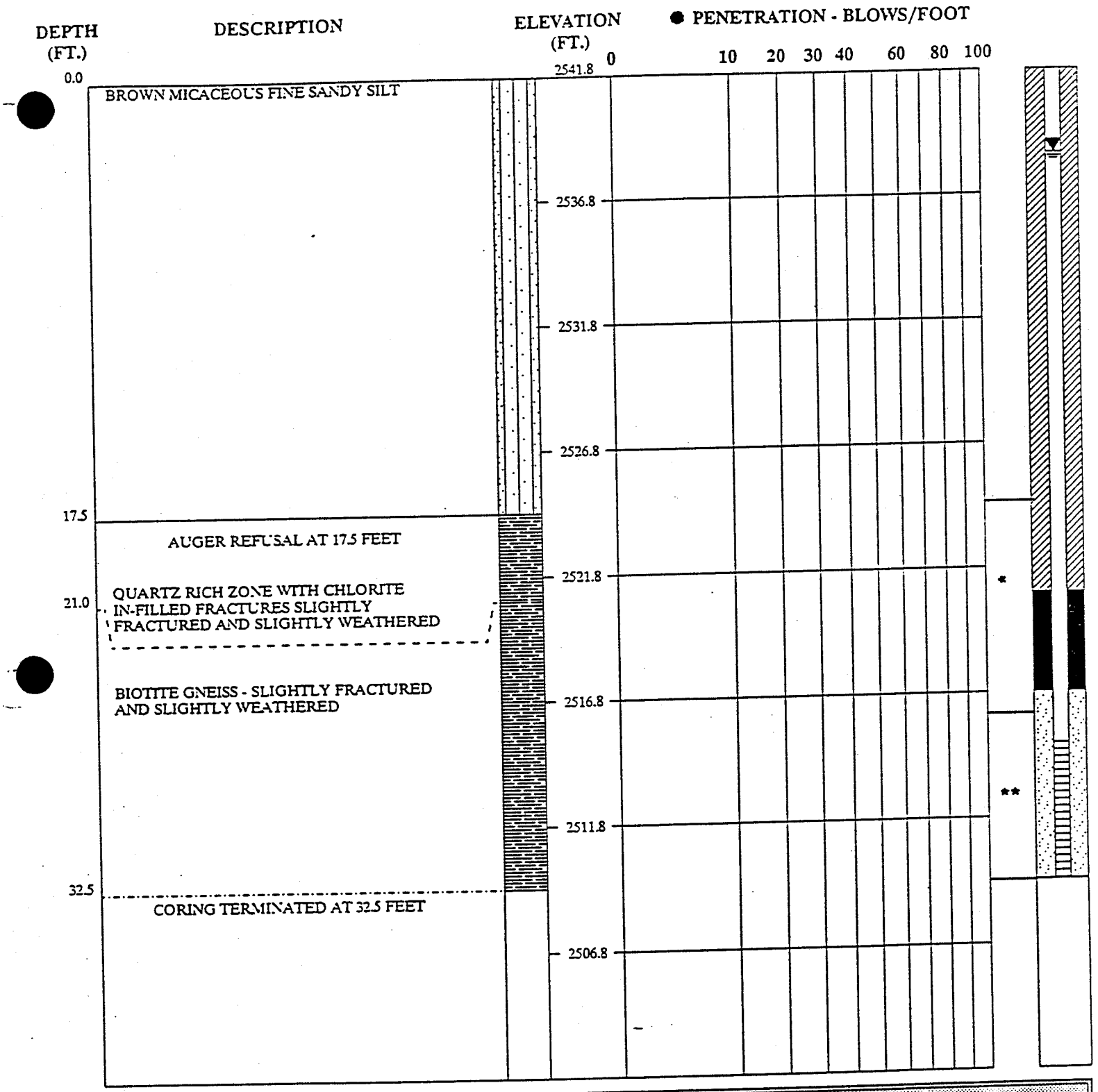
LAW ENGINEERING



REMARKS:

NO SAMPLES TAKEN SOIL DESCRIPTION ARE BASED ON VISUAL CLASSIFICATION OF THE AUGER CUTTINGS. GROUND WATER MEASURED AT 3.4 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-113A
DATE DRILLED	March 28, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	* REC. 94% RQD. 81% ** REC. 100% RQD. 100%	2496.8	
		2491.8	
		2486.8	
		2481.8	
		2476.8	
		2471.8	
		2466.8	

REMARKS:

NO SAMPLES TAKEN SOIL DESCRIPTION ARE BASED ON VISUAL CLASSIFICATION OF THE AUGER CUTTINGS. GROUND WATER MEASURED AT 3.4 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-113A
DATE DRILLED	March 28, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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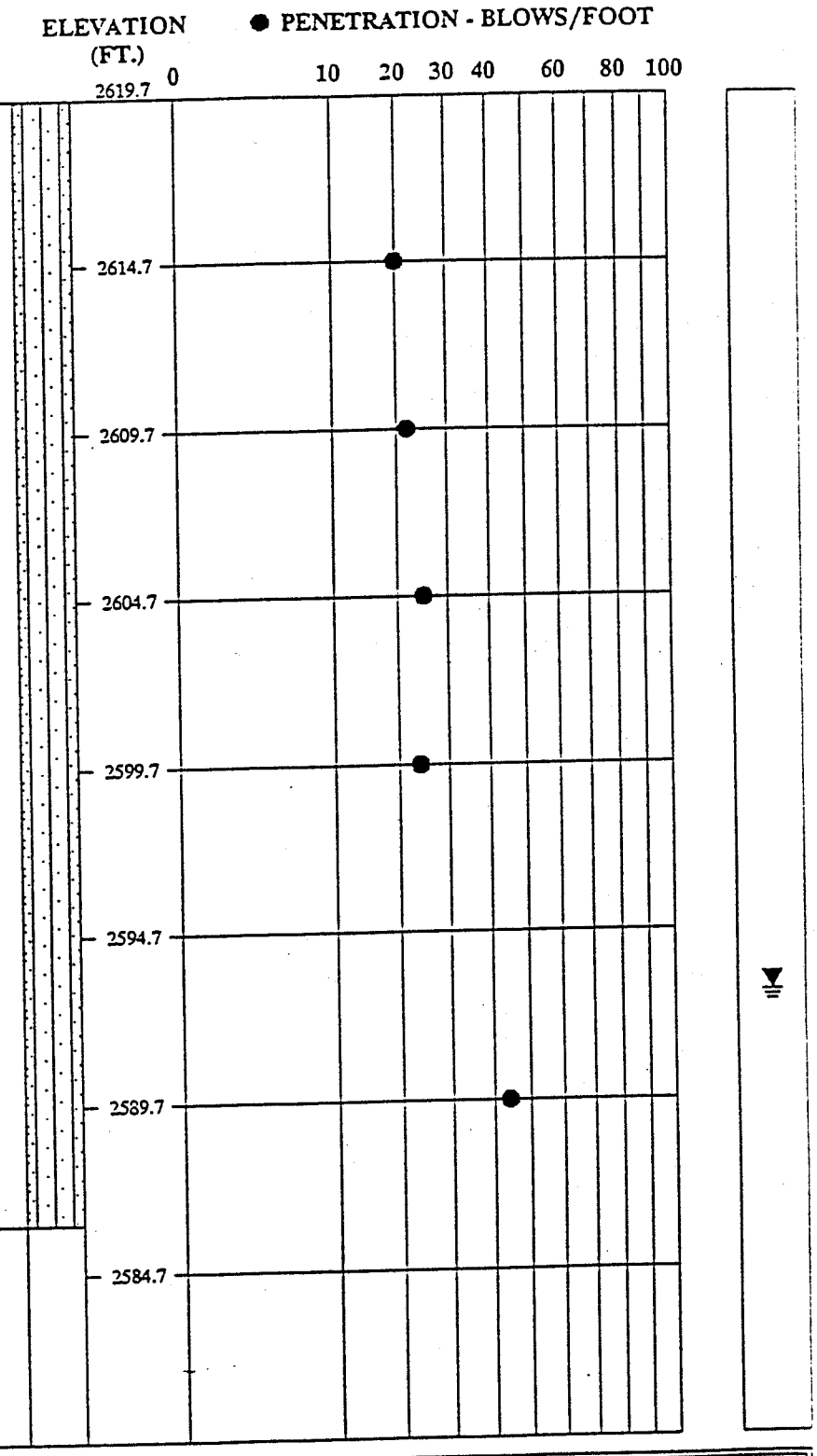
LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	STIFF TO VERY STIFF GRAY RED BROWN PINK AND TAN VERY MICACEOUS FINE TO MEDIUM SANDY SILT	2619.7
		2614.7
		2609.7
		2604.7
		2599.7
		2594.7
		2589.7
33.5	AUGER REFUSAL AT 33.5 FEET	2584.7



REMARKS:

GROUND WATER MEASURED AT 26.9 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-114
DATE DRILLED	February 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	HARD BROWN AND GRAY VERY MICACEOUS FINE SANDY SILT	2649.2
18.0	VERY HARD BROWN AND TAN FINE TO MEDIUM SANDY SILT WITH PARTIALLY WEATHERED ROCK	

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100

2644.2
2639.2
2634.2
2629.2
2624.2
2619.2
2614.2

REMARKS:

NO GROUND WATER ENCOUNTERED AS OF 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

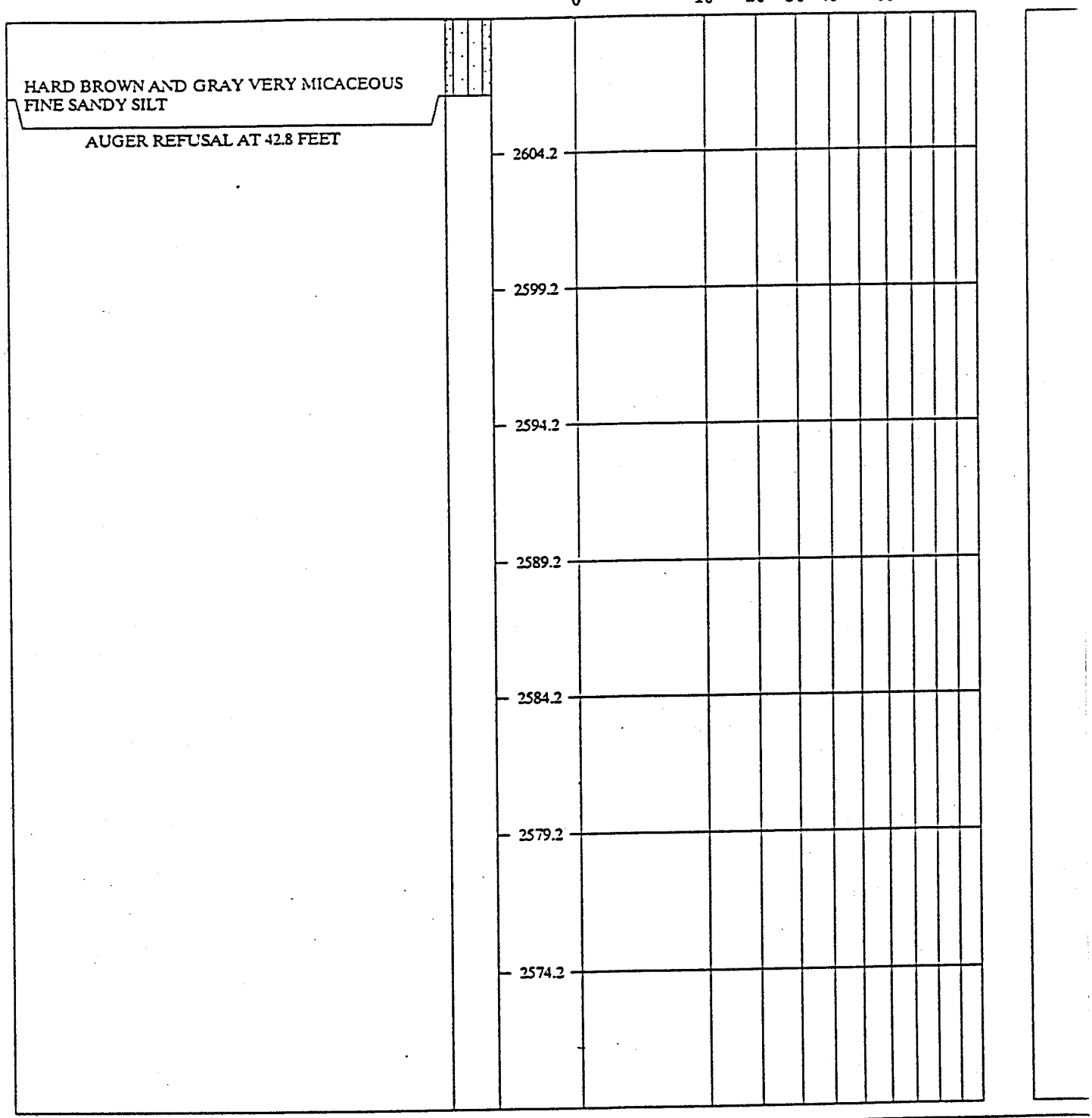
BORING NUMBER	B-115
DATE DRILLED	February 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
42.8	HARD BROWN AND GRAY VERY MICACEOUS FINE SANDY SILT AUGER REFUSAL AT 42.8 FEET	2604.2 2599.2 2594.2 2589.2 2584.2 2579.2 2574.2

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100



REMARKS:

NO GROUND WATER ENCOUNTERED AS OF 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	B-115
DATE DRILLED	February 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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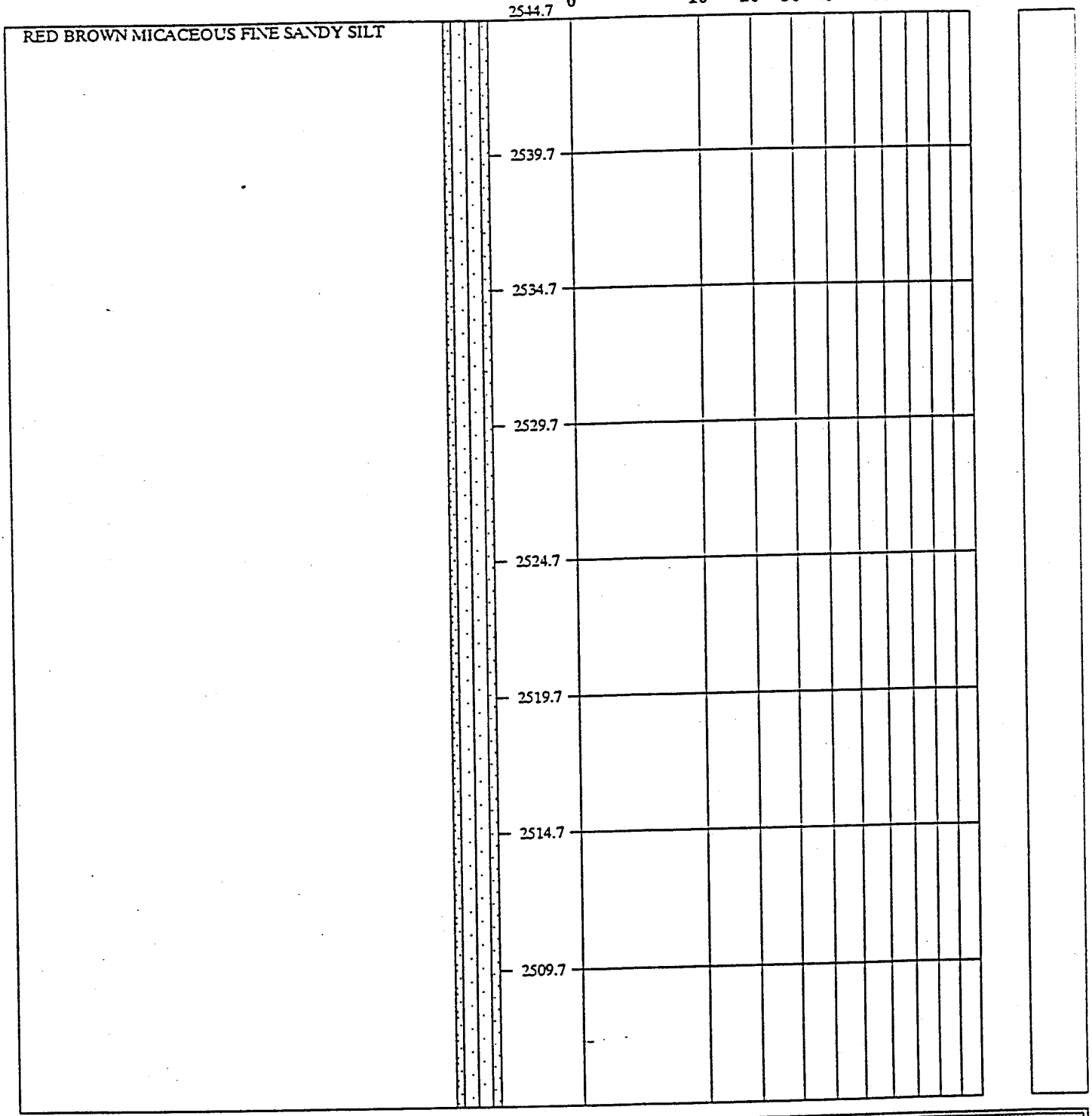
LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT
0.0	RED BROWN MICACEOUS FINE SANDY SILT	2544.7	0 10 20 30 40 60 80 100
		2539.7	
		2534.7	
		2529.7	
		2524.7	
		2519.7	
		2514.7	
		2509.7	



REMARKS:
GROUND WATER MEASURED AT 41.9 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-1
DATE DRILLED	April 24, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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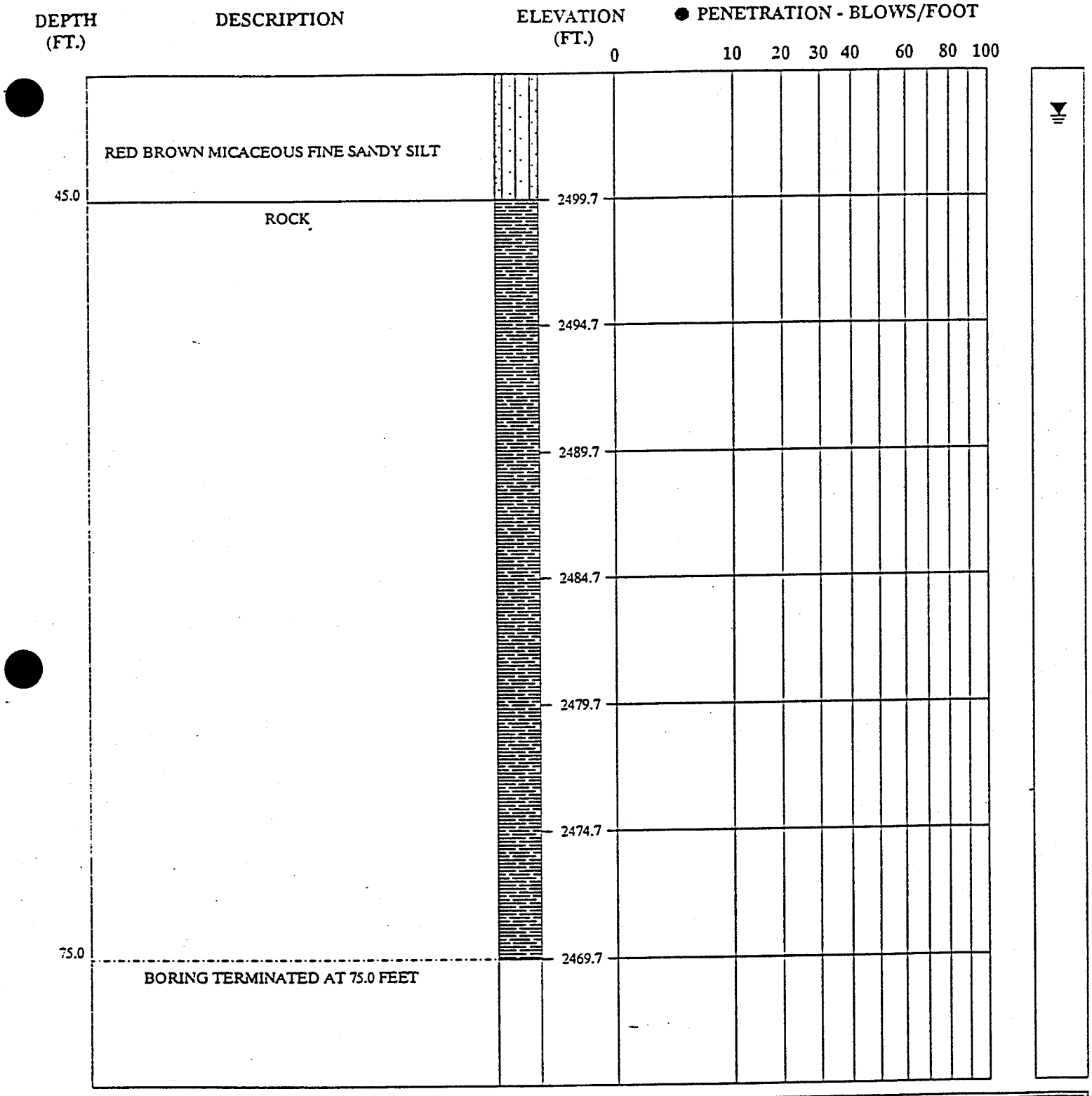
LAW ENGINEERING



REMARKS:

GROUND WATER MEASURED AT 41.9 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-1
DATE DRILLED	April 24, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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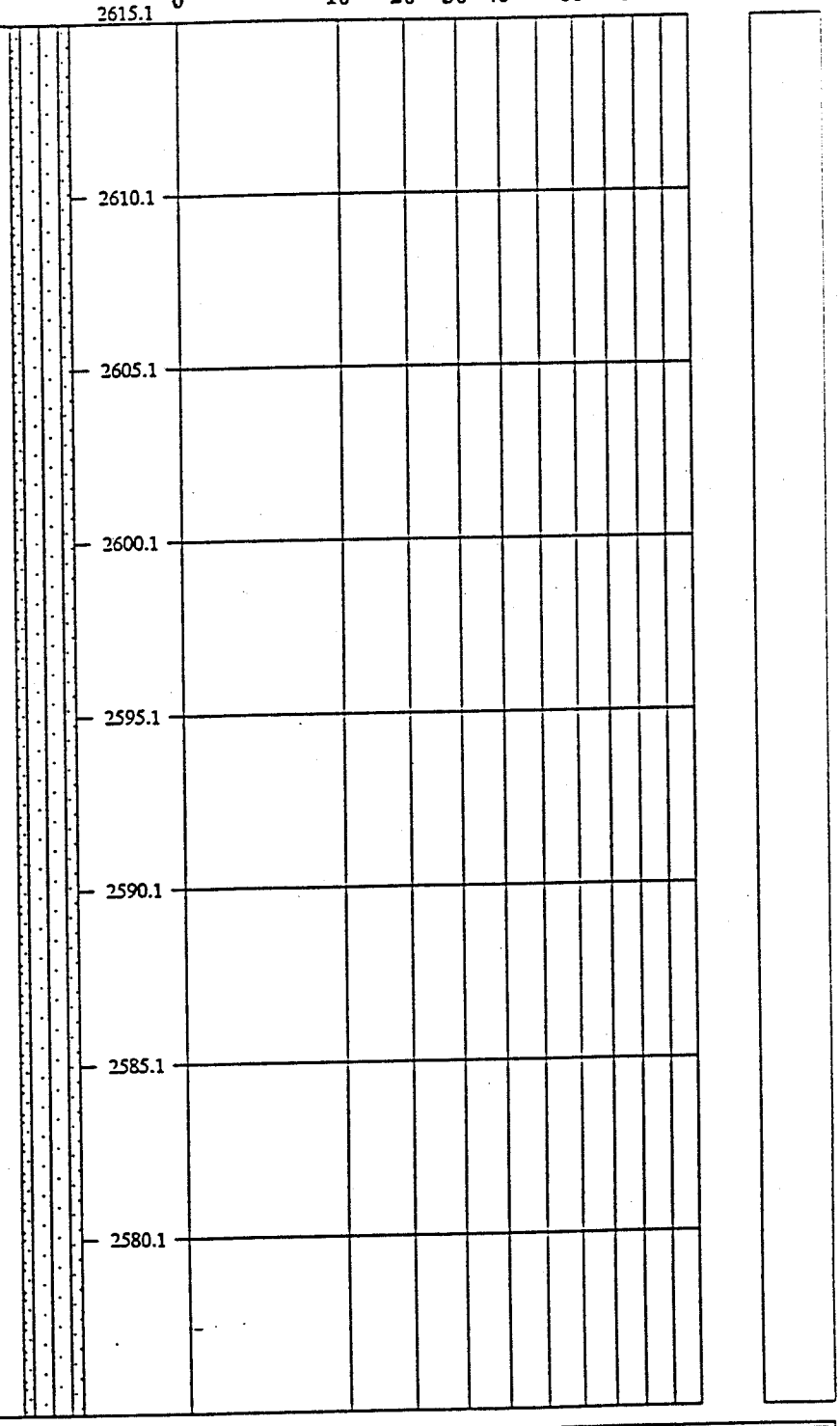
LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT
0.0	RED BROWN MICACEOUS FINE TO MEDIUM SANDY SILT WITH ROCK HORIZONS INTERLAYERED	2615.1	0 10 20 30 40 60 80 100
		2610.1	
		2605.1	
		2600.1	
		2595.1	
		2590.1	
		2585.1	
		2580.1	



REMARKS:

GROUND WATER MEASURED AT 78.6 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-2
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	RED BROWN MICACEOUS FINE TO MEDIUM SANDY SILT WITH ROCK HORIZONS INTERLAYERED	2570.1	
		2565.1	
		2560.1	
		2555.1	
		2550.1	
		2545.1	
		2540.1	

REMARKS:

GROUND WATER MEASURED AT 78.6 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-2
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
85.0	RED BROWN MICACEOUS FINE TO MEDIUM SANDY SILT WITH ROCK HORIZONS INTERLAYERED BORING TERMINATED AT 85.0 FEET	2530.1

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100

2525.1
2520.1
2515.1
2510.1
2505.1
2500.1

REMARKS:
GROUND WATER MEASURED AT 78.6 FEET ON 5-21-90.

SOIL TEST BORING RECORD

BORING NUMBER	AT-2
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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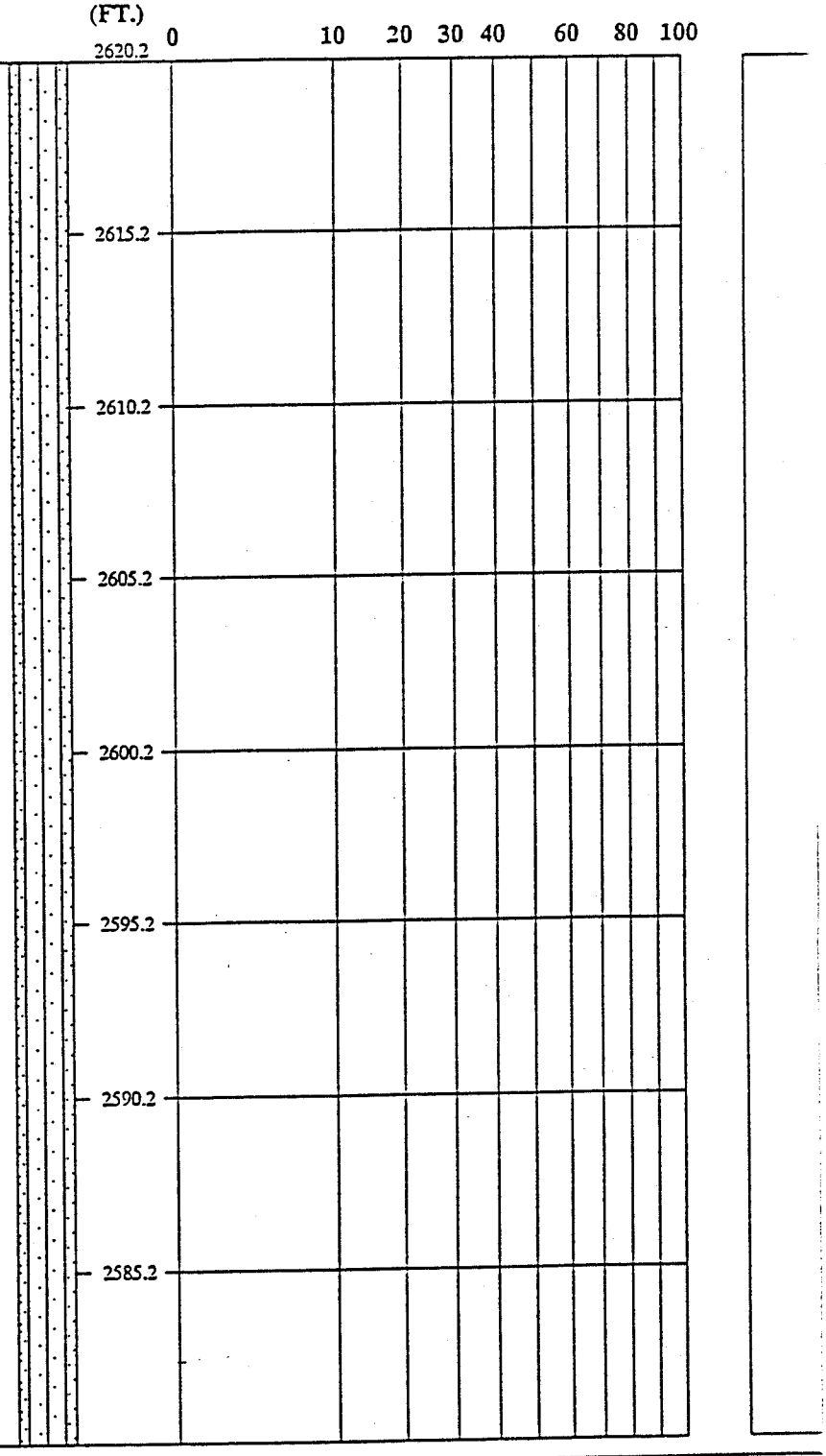
SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	RED BROWN VERY MICACEOUS FINE TO COARSE SANDY SILT	2620.2



REMARKS:

GROUND WATER MEASURED AT 68.5 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-3
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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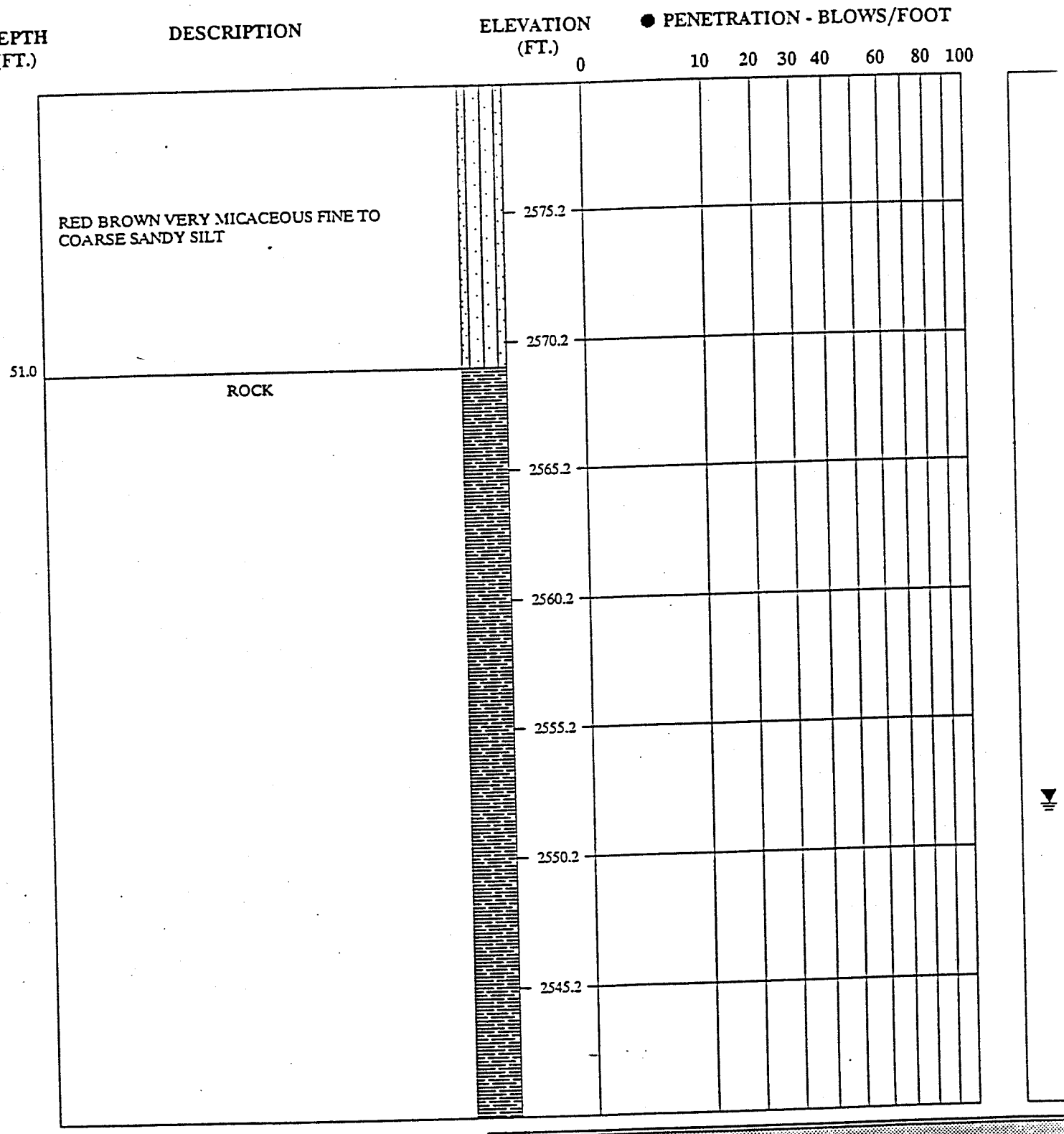
LAW ENGINEERING



REMARKS:

GROUND WATER MEASURED AT 68.5 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-3
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	ROCK	2535.2	
86.0	BORING TERMINATED AT 86.0 FEET	2530.2	
		2525.2	
		2520.2	
		2515.2	
		2510.2	
		2505.2	

REMARKS:

GROUND WATER MEASURED AT 68.5 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-3
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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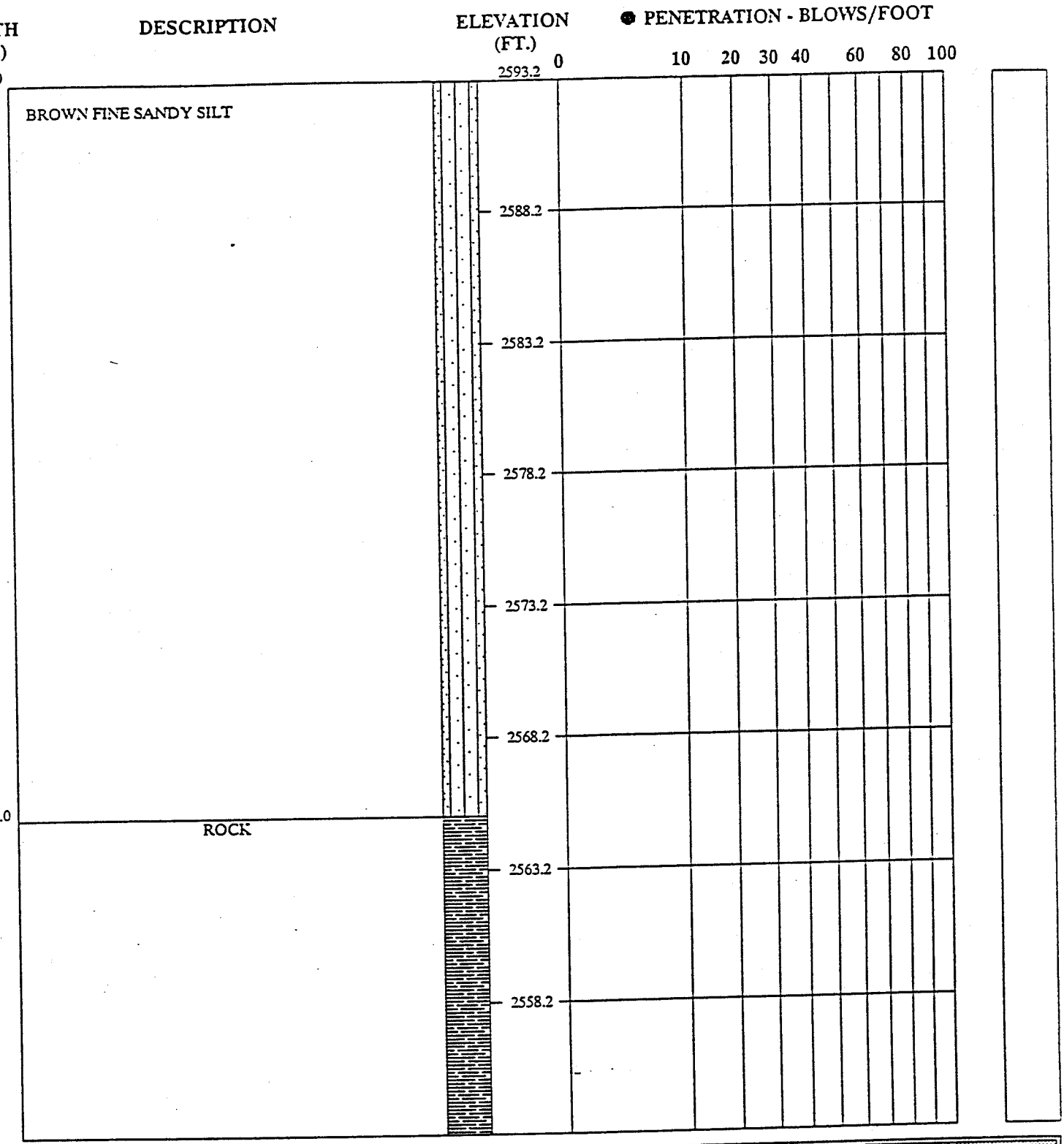
LAW ENGINEERING



REMARKS:

GROUND WATER MEASURED AT 68.0 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-4
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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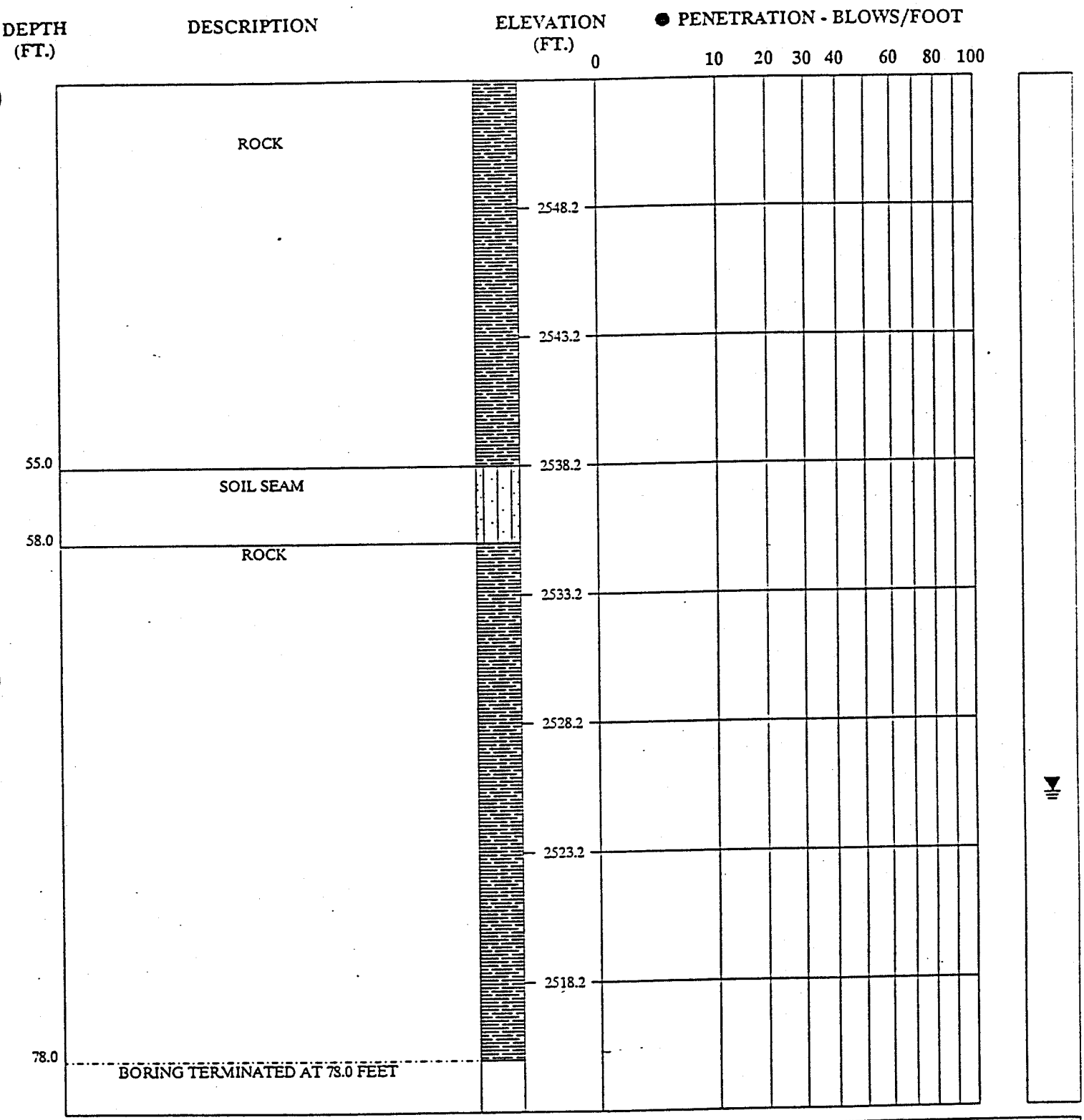
LAW ENGINEERING



REMARKS:

GROUND WATER MEASURED AT 68.0 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-4
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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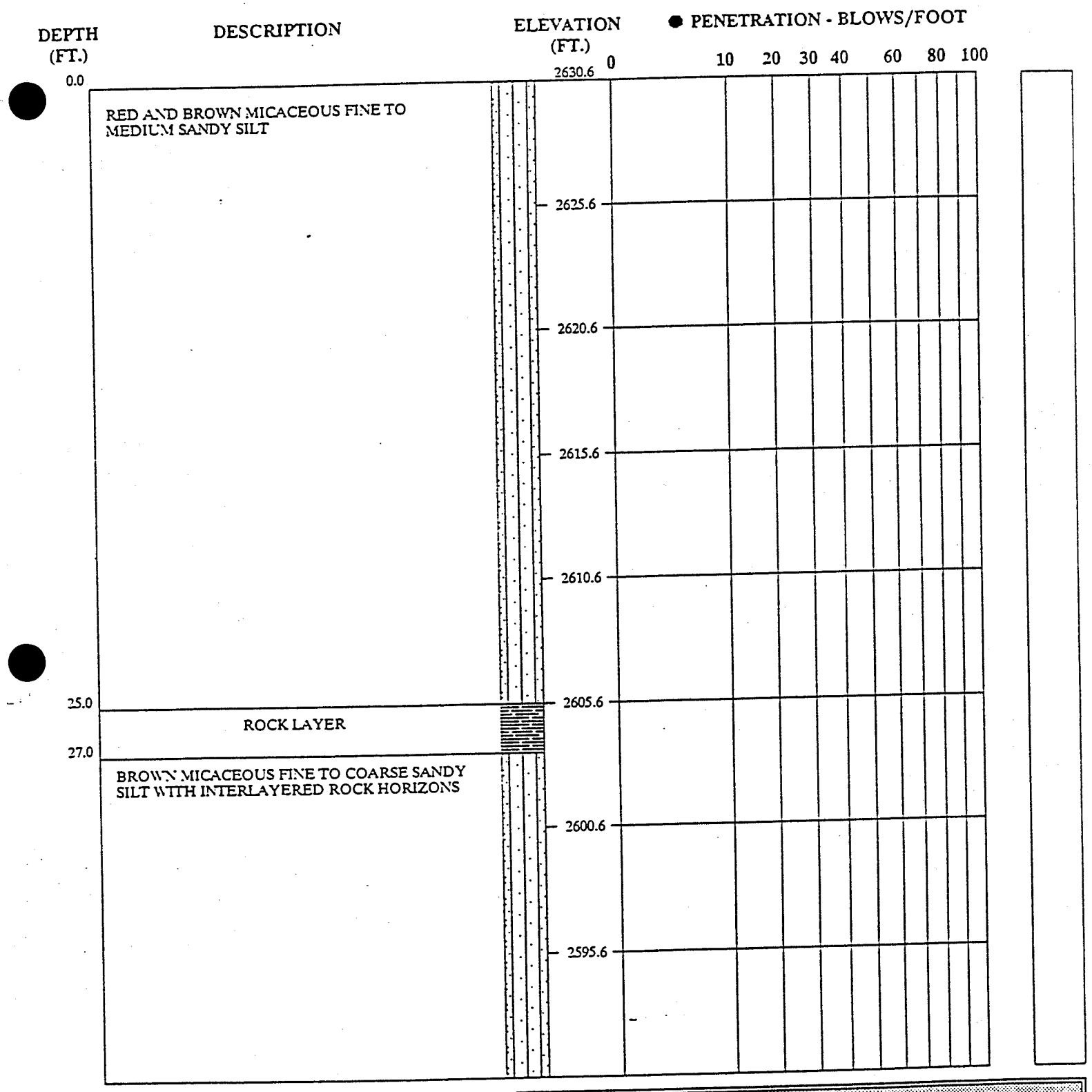
LAW ENGINEERING



REMARKS:

NO GROUND WATER ENCOUNTERED AT TIME OF BORING.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-5
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
	BROWN MICACEOUS FINE TO COARSE SANDY SILT WITH INTERLAYERED ROCK HORIZONS	2585.6
		2580.6
		2575.6
60.0	BORING TERMINATED AT 60.0 FEET	2570.6
		2565.6
		2560.6
		2555.6

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100

REMARKS:

NO GROUND WATER ENCOUNTERED AT TIME OF BORING.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-5
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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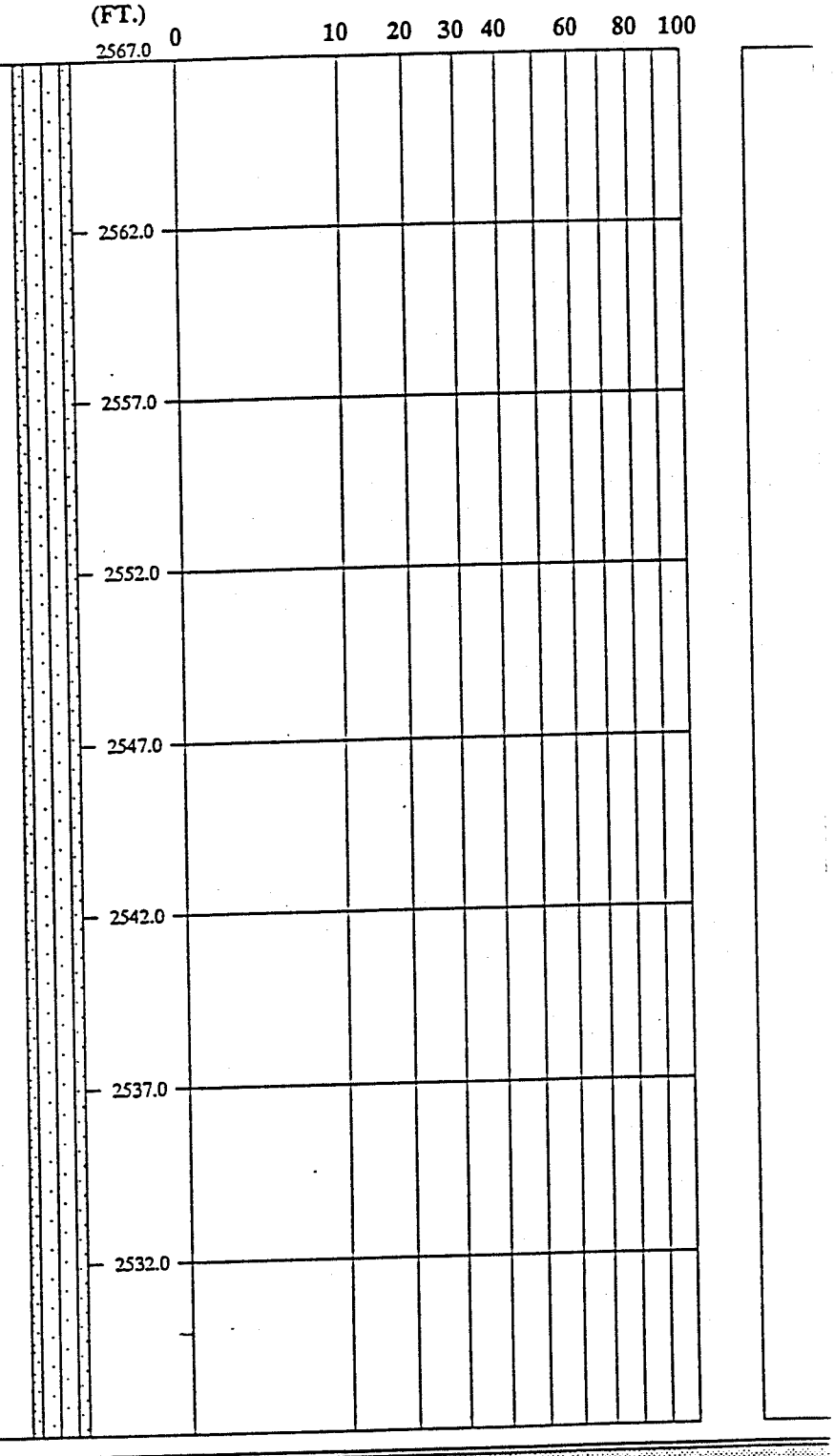
LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	BROWN MICACEOUS FINE SANDY SILT	2567.0



REMARKS:

GROUND WATER MEASURED AT 54.5 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-6
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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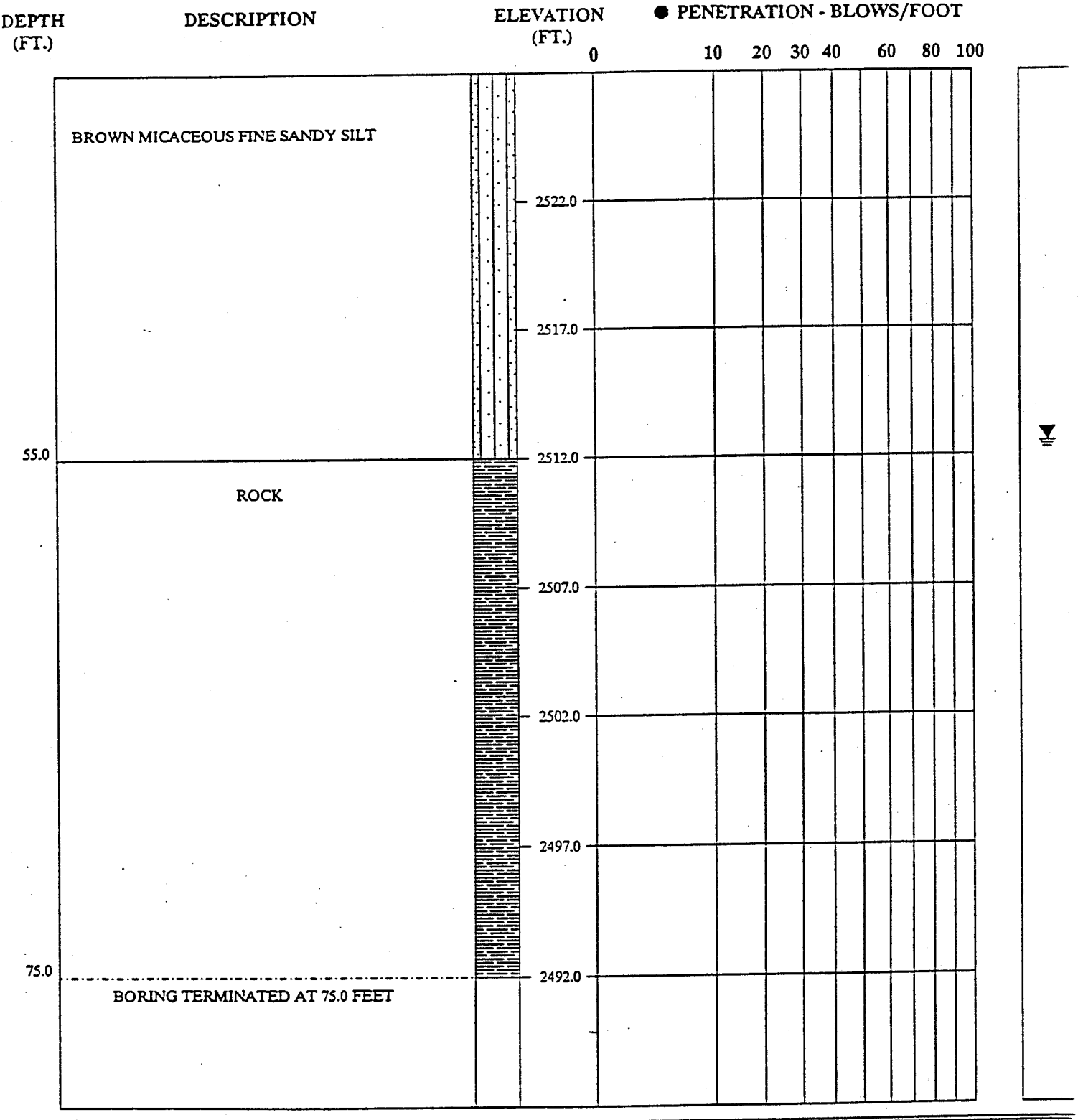
LAW ENGINEERING



REMARKS:

GROUND WATER MEASURED AT 54.5 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-6
DATE DRILLED	April 23, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	BROWN AND RED MICACEOUS FINE TO MEDIUM SANDY SILT WITH ROCK HORIZONS INTERLAYERED	2527.3

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100

2522.3

2517.3

2512.3

2507.3

2502.3

2497.3

2492.3

REMARKS:

GROUND WATER MEASURED AT 43.8 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-7
DATE DRILLED	April 24, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	BROWN AND RED MICACEOUS FINE TO MEDIUM SANDY SILT WITH ROCK HORIZONS INTERLAYERED	2482.3	
		2477.3	
		2472.3	
		2467.3	
		2462.3	
		2457.3	
72.0	BORING TERMINATED AT 72.0 FEET	2452.3	

REMARKS:

GROUND WATER MEASURED AT 43.8 FEET ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-7
DATE DRILLED	April 24, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 2 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
0.0	RED AND DARK BROWN MICACEOUS FINE SANDY SILT	2509.2

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100

2504.2

2499.2

2494.2

2489.2

2484.2

2479.2

2474.2

REMARKS:

GROUND WATER MEASURED AT 43.1 ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-8
DATE DRILLED	April 24, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
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LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
	RED AND DARK BROWN MICACEOUS FINE SANDY SILT	2464.2
50.0	BORING TERMINATED AT 50.0 FEET	2459.2
		2454.2
		2449.2
		2444.2
		2439.2
		2434.2

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100

REMARKS:

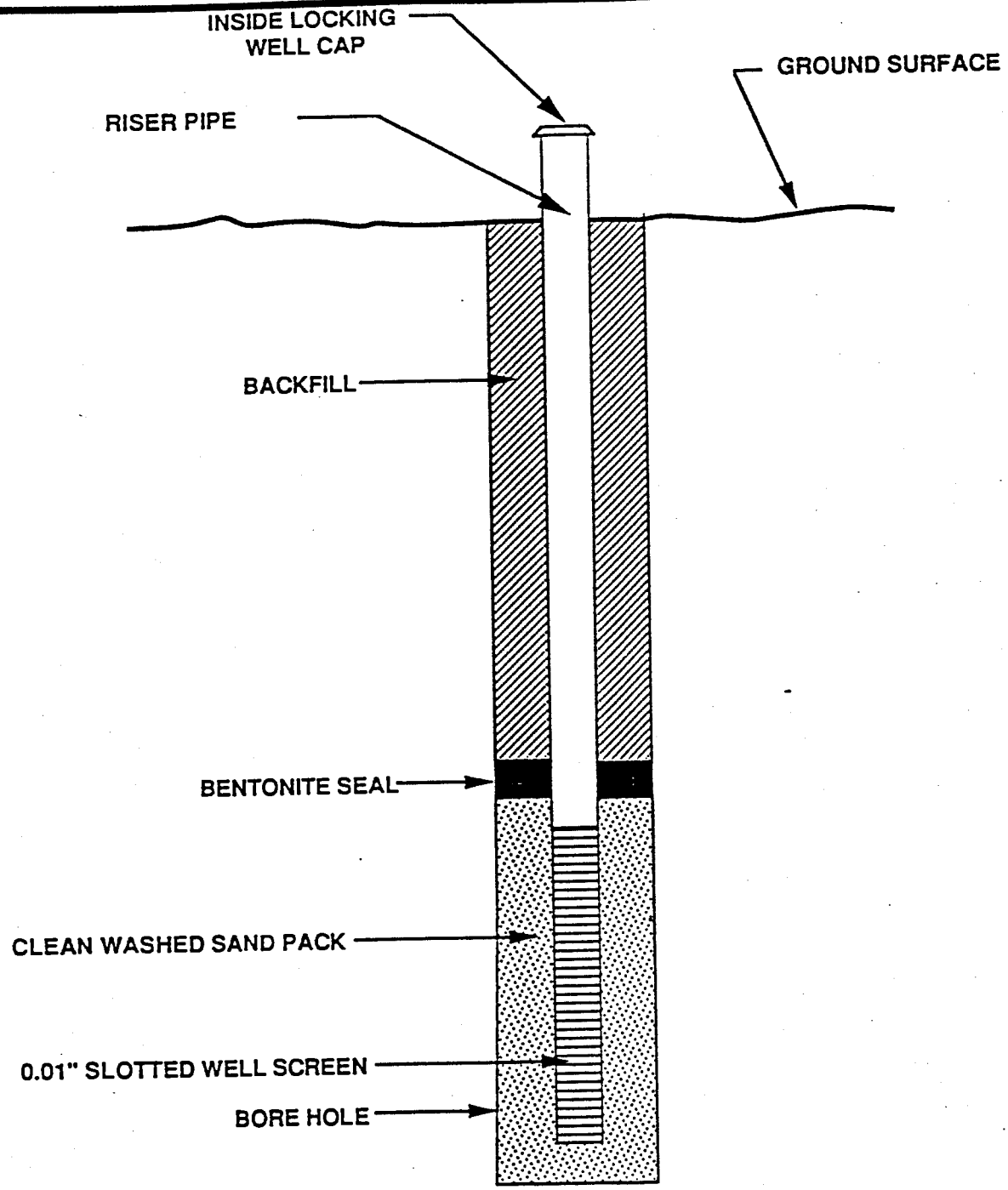
GROUND WATER MEASURED AT 43.1 ON 5-21-90.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

SOIL TEST BORING RECORD

BORING NUMBER	AT-8
DATE DRILLED	April 24, 1990
PROJECT NUMBER	11-300142.01
PROJECT	HAYWOOD CO. LANDFILL
PAGE 2 OF 2	

LAW ENGINEERING



TYPICAL TYPE I MONITORING WELL CONSTRUCTION

Law Engineering
Atlanta, Georgia
Geotechnical, Materials & Environmental Consultants

PROPOSED WHITE OAK LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

Job Number 11300142.01

Scale N.T.S

SECTION 4

LABORATORY ANALYSIS REPORT

SIEVE ANALYSIS REPORTS

MOISTURE DENSITY RELATIONSHIP CURVES

LAW ENVIRONMENTAL, INC.

112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

April 11, 1990

Law Engineering, Inc.
396 Plasters Avenue
Atlanta, GA 30324

Attention: Michael Talbot

LE Job Number: 1130014201

Subject: Chemical analysis of samples received on 04/03/90.

Dear Mr. Talbot:

Law Environmental National Laboratories has completed its analysis of your samples and reports the results on the following pages. These results relate only to the contents of the samples as submitted. This report shall not be reproduced except in full without the approval of Law Environmental National Laboratories.

If there are any questions, please do not hesitate to contact us.

Sincerely,

LAW ENVIRONMENTAL NATL LABS

C H McBride

Clifford H. McBride
QA/QC Coordinator

Attachment: Data Report
Invoice

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 04/11/90
Page 1

--- Project Information ---

Lab Number : 90-5657-01
Project No. :
Project Name : HAYWOOD COUNTY LANDFILL

Cust. No. :

Manager: MICHAEL TALBOT

--- Sample Information ---

Station ID : B-101 15'
Matrix : W
Type : GRAB
Collector : MT

Sampled Date/Time : / /
Received Date/Time : 04/03/90 15:50
Received From/By : MT/RKB
Chain of Custody : 8666
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Anal
-- INORGANIC RESULTS --						
Cation Exchange Capacity(*meq/100g)	EPA 9080M	*	1	14	04/09/90	OR
Moisture (Oven Dried @ 105 C)	EPA 160.3M	wt %	1	19	04/05/90	GW
--- SERIES 18000						
Exchangeable Bases, Ca (*meq/100g)	EPA 6010			ND	04/10/90	KE
Exchangeable Bases, K (*meq/100g)	EPA 6010			0.42	04/09/90	KE
Exchangeable Bases, Mg (*meq/100g)	EPA 6010			0.34	04/11/90	KE
Exchangeable Bases, Na (*meq/100g)	EPA 6010			28	04/10/90	KE

Signed C McBride

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 04/11/90
Page 1

--- Project Information ---

Lab Number : 90-5657-02
Project No. :
Project Name : HAYWOOD COUNTY LANDFILL

Cust. No. :

Manager: MICHAEL TALBOT

--- Sample Information ---

Station ID : B-104 15'
Matrix : W
Type : GRAB
Collector : MT

Sampled Date/Time : / /
Received Date/Time : 04/03/90 15:50
Received From/By : MT/RKB
Chain of Custody : 8666
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Anal
-- INORGANIC RESULTS --						
Cation Exchange Capacity(*meq/100g)	EPA 9080M	*	1	19	04/09/90	OR
Moisture (Oven Dried @ 105 C)	EPA 160.3M	wt %	1	6.7	04/05/90	GW
--- SERIES 18000						
Exchangeable Bases, Ca (*meq/100g)	EPA 6010			1.8	04/10/90	KE
Exchangeable Bases, K (*meq/100g)	EPA 6010			0.22	04/09/90	KE
Exchangeable Bases, Mg (*meq/100g)	EPA 6010			0.39	04/11/90	KE
Exchangeable Bases, Na (*meq/100g)	EPA 6010			0.76	04/10/90	KE

Signed C McBride

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 04/11/90
Page 1

--- Project Information ---

Lab Number : 90-5657-03
Project No. :
Project Name : HAYWOOD COUNTY LANDFILL

Cust. No. :

Manager: MICHAEL TALBOT

--- Sample Information ---

Station ID : B-106 15'
Matrix : W
Type : GRAB
Collector : MT

Sampled Date/Time : / /
Received Date/Time : 04/03/90 15:50
Received From/By : MT/RKB
Chain of Custody : 8666
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Anal
-- INORGANIC RESULTS --						
Cation Exchange Capacity(*meq/100g)	EPA 9080M	*	1	25	04/09/90	OR
Moisture (Oven Dried @ 105 C)	EPA 160.3M	wt %	1	19	04/05/90	GW
--- SERIES 18000						
Exchangeable Bases, Ca (*meq/100g)	EPA 6010			ND	04/10/90	KE
Exchangeable Bases, K (*meq/100g)	EPA 6010			0.12	04/09/90	KE
Exchangeable Bases, Mg (*meq/100g)	EPA 6010			1.2	04/11/90	KE
Exchangeable Bases, Na (*meq/100g)	EPA 6010			ND	04/10/90	KE

Signed C McBride

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 04/11/90
Page 1

--- Project Information ---

Lab Number : 90-5657-04
Project No. :
Project Name : HAYWOOD COUNTY LANDFILL

Cust. No. :

Manager: MICHAEL TALBOT

--- Sample Information ---

Station ID : B-110 5'
Matrix : W
Type : GRAB
Collector : MT

Sampled Date/Time : / /
Received Date/Time : 04/03/90 15:50
Received From/By : MT/RKB
Chain of Custody : 8666
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Anal
-- INORGANIC RESULTS --						
Cation Exchange Capacity(*meq/100g)	EPA 9080M	*	1	26	04/09/90	OR
Moisture (Oven Dried @ 105 C)	EPA 160.3M	wt %	1	25	04/05/90	GW
-- SERIES 18000						
Exchangeable Bases, Ca (*meq/100g)	EPA 6010			0.47	04/10/90	KE
Exchangeable Bases, K (*meq/100g)	EPA 6010			0.10	04/09/90	KE
Exchangeable Bases, Mg (*meq/100g)	EPA 6010			0.45	04/11/90	KE
Exchangeable Bases, Na (*meq/100g)	EPA 6010			0.89	04/10/90	KE

Signed C McBride

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 04/11/90
Page 1

--- Project Information ---

Lab Number : 90-5657-05
Project No. :
Project Name : HAYWOOD COUNTY LANDFILL

Cust. No. :

Manager: MICHAEL TALBOT

--- Sample Information ---

Station ID : B-112 15'
Matrix : W
Type : GRAB
Collector : MT

Sampled Date/Time : / /
Received Date/Time : 04/03/90 15:50
Received From/By : MT/RKB
Chain of Custody : 8666
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Analy
-- INORGANIC RESULTS --						
Cation Exchange Capacity(*meq/100g)	EPA 9080M	*	1	19	04/09/90	OR
Moisture (Oven Dried @ 105 C)	EPA 160.3M	wt %	1	15	04/05/90	GW
-- SERIES 18000						
Exchangeable Bases, Ca (*meq/100g)	EPA 6010			0.15	04/10/90	KE
Exchangeable Bases, K (*meq/100g)	EPA 6010			0.20	04/09/90	KE
Exchangeable Bases, Mg (*meq/100g)	EPA 6010			0.52	04/11/90	KE
Exchangeable Bases, Na (*meq/100g)	EPA 6010			0.35	04/10/90	KE

Signed C M Brick

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 04/11/90
Page 1

--- Project Information ---

Lab Number : 90-5657-06
Project No. :
Project Name : HAYWOOD COUNTY LANDFILL

Cust. No. :

Manager: MICHAEL TALBOT

--- Sample Information ---

Station ID : B-115 10'
Matrix : W
Type : GRAB
Collector : MT

Sampled Date/Time : / /
Received Date/Time : 04/03/90 15:50
Received From/By : MT/RKB
Chain of Custody : 8666
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Anal
-- INORGANIC RESULTS --						
Cation Exchange Capacity(*meq/100g)	EPA 9080M	*	1	21	04/09/90	OR
Moisture (Oven Dried @ 105 C)	EPA 160.3M	wt %	1	17	04/05/90	GW
--- SERIES 18000						
Exchangeable Bases, Ca (*meq/100g)	EPA 6010			0.15	04/10/90	KE
Exchangeable Bases, K (*meq/100g)	EPA 6010			ND	04/09/90	KE
Exchangeable Bases, Mg (*meq/100g)	EPA 6010			0.76	04/11/90	KE
Exchangeable Bases, Na (*meq/100g)	EPA 6010			0.14	04/10/90	KE

Signed C McBride

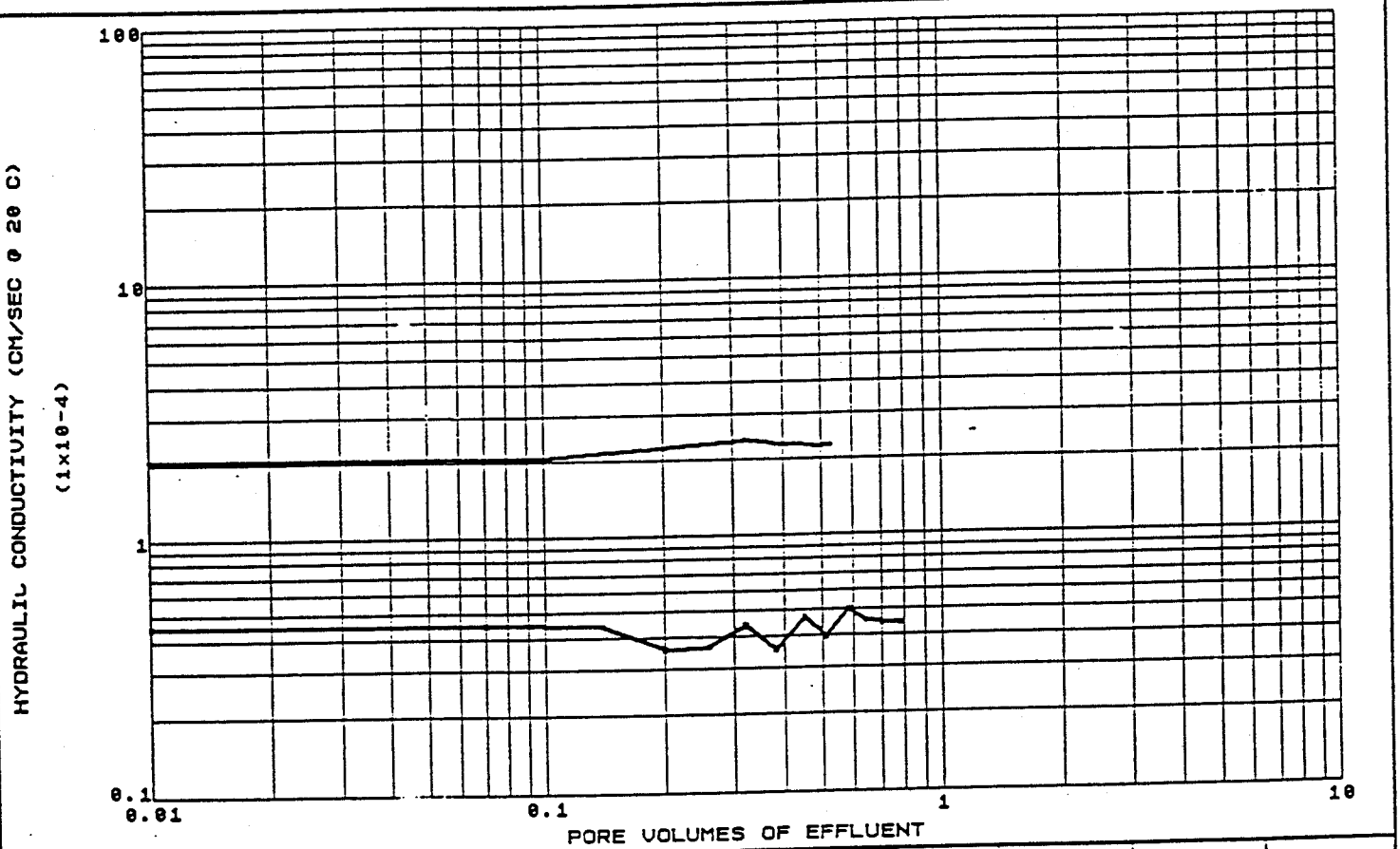
LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

HYDRAULIC CONDUCTIVITY

CLIENT Law Engineering, Inc.
396 Plasters Avenue
Atlanta, Georgia 30324

JOB NO. 41-8902.05 DATE April 10, 1990
TESTED BY JTM, MAO PAGE 1

PROJECT Haywood Co.Law Engr.#1130014201 TEST METHOD US Army Corps of Engrs. EM1110-2-1906.



LAB NO.	9836	9839				
SAMPLE IDENTIFICATION	B-103 15.0'- 17.0'	B-113 5.0'- 7.0'				
RECEIPT DATE	4/3/90	4/3/90				
TEST COMPLETION DATE	4/9/90	4/9/90				
SAMPLE TYPE	Undist	Undist				
INITIAL WATER CONTENT (% BY DRY WEIGHT)	14.5	20.9				
DRY UNIT WEIGHT (PCF)	96.7	106.5				
PERCENT COMPACTION IF REMOLDED	N/A	N/A				
ONE PORE VOLUME (CC)	131	94				
HYDRAULIC CONDUCTIVITY (CM/SEC @ 20 C)	2.3E-04	4.4E-05				

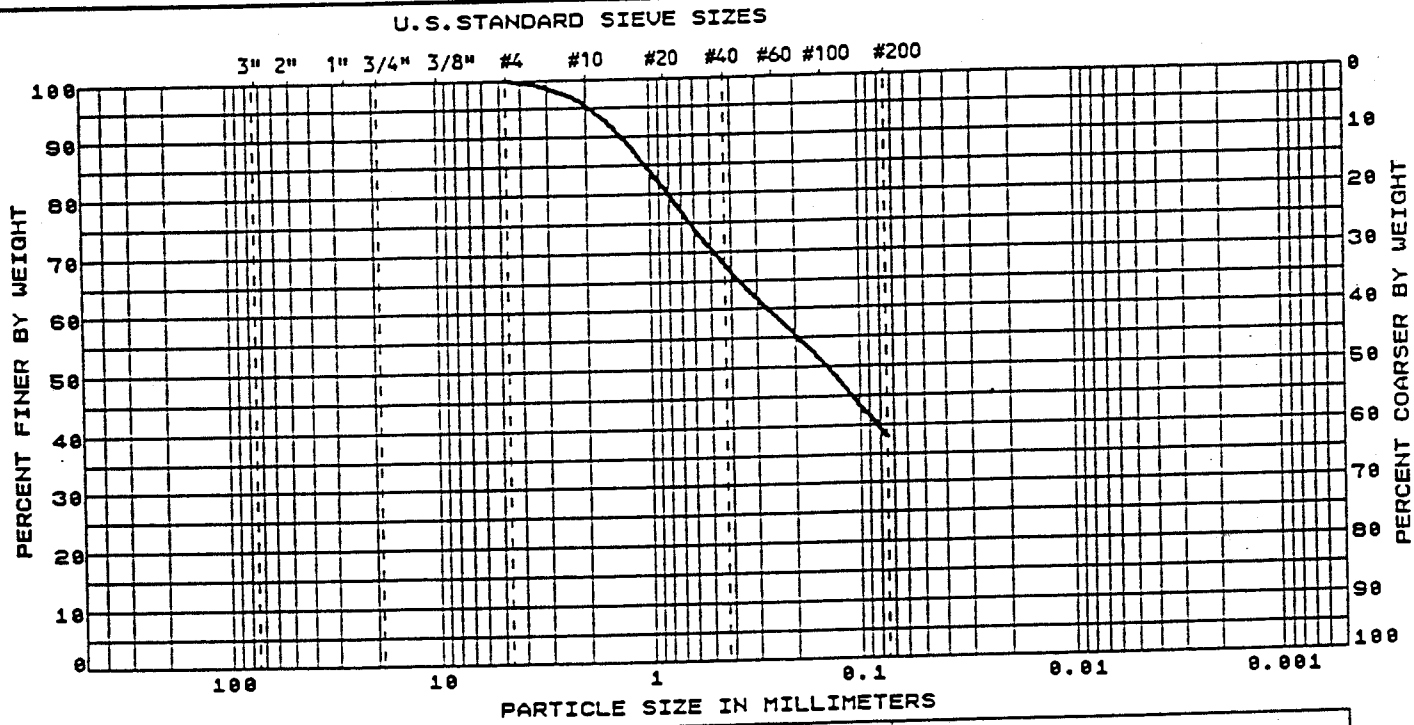
LAW ENVIRONMENTAL, INC.
M.A. O'Kelley

LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Law Engineering, Inc.
396 Plasters Avenue
Atlanta, Georgia 30324

JOB NO. 41-8902.05 DATE April 10, 1990
LAB NO. 9840 PAGE 1
PROJECT Haywood Co.Law Engr.#1130014201
SAMPLE ID B-103 20.0'



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75			0.050
2"	50			0.020
1-1/2"	37.5			0.005
1"	25			0.002
3/4"	19			0.001
1/2"	12.5			
3/8"	9.5			
#4	4.75	100.0		
#10	2.00	95.6		
#20	0.850	81.0		
#40	0.425	67.4		
#60	0.250	58.9		
#100	0.150	50.9		
#200	0.075	37.9		

POROSITY (%) _____
EFFECTIVE SIZE (mm) _____
COEFFICIENT OF UNIFORMITY _____
COEFFICIENT OF CURVATURE _____
LIQUID LIMIT _____
PLASTIC LIMIT _____
PLASTICITY INDEX _____
CLASSIFICATION ( )

WATER CONTENT (%) _____
DRY DENSITY (PCF) _____
SPECIFIC GRAVITY _____
HYDRAULIC CONDUCTIVITY (cm/sec - 20C) _____
TEST PROCEDURES: ASTM D422.

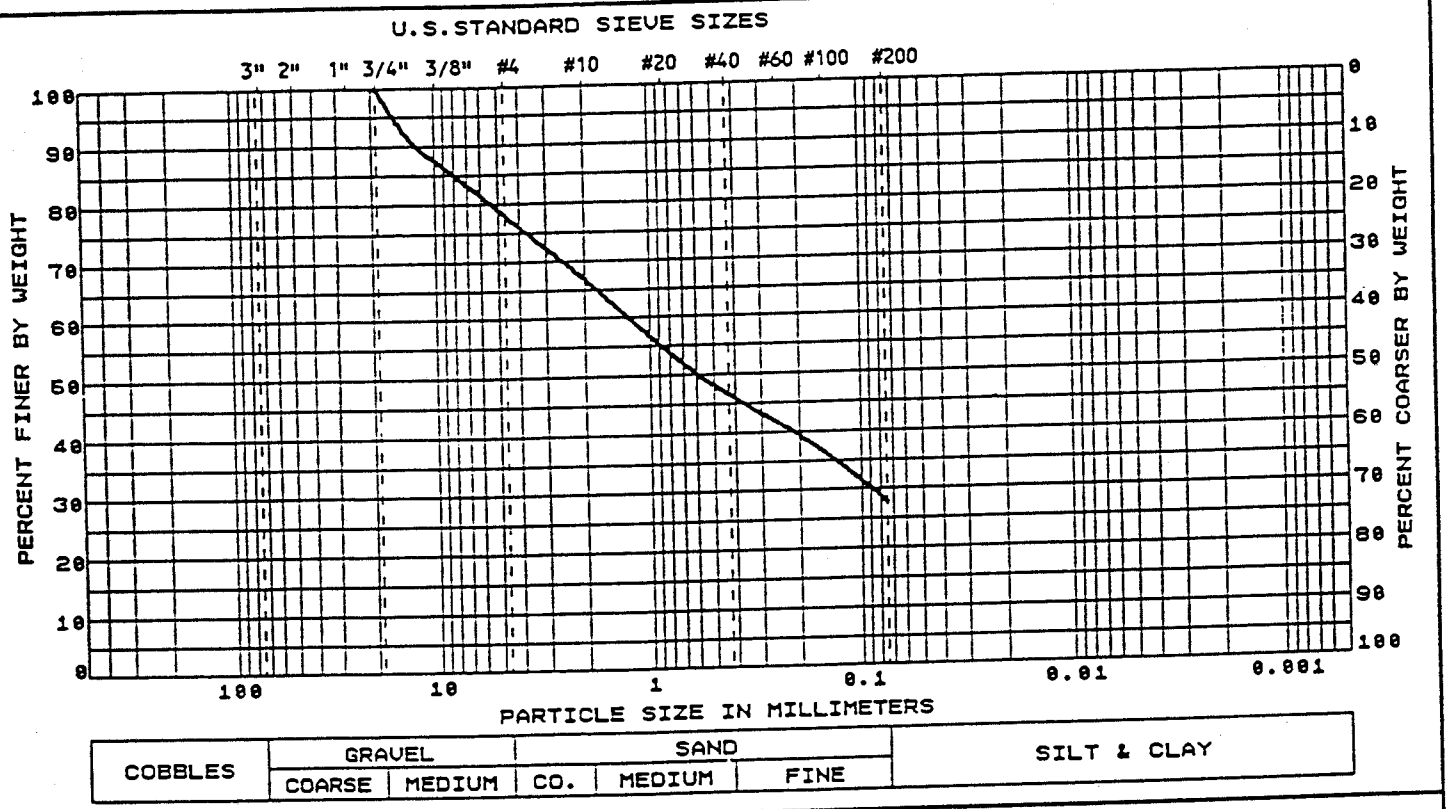
LAW ENVIRONMENTAL, INC.
M.A.O'Kelley

LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Law Engineering, Inc.
396 Plasters Avenue
Atlanta, Georgia 30324

JOB NO. 41-8902.05 DATE April 10, 1990
LAB NO. 9841 PAGE 2
PROJECT Haywood Co.Law Engr.#1130814201
SAMPLE ID B-104 10.0'



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75			0.050
2"	50			0.020
1-1/2"	37.5			0.005
1"	25			0.002
3/4"	19	100.0		0.001
1/2"	12.5	90.5		
3/8"	9.5	87.1		
#4	4.75	78.2		
#10	2.00	66.8		
#20	0.850	54.6		
#40	0.425	46.4		
#60	0.250	41.5		
#100	0.150	36.4		
#200	0.075	27.9		

POROSITY (%) _____
EFFECTIVE SIZE (mm) _____
COEFFICIENT OF UNIFORMITY _____
COEFFICIENT OF CURVATURE _____
LIQUID LIMIT _____
PLASTIC LIMIT _____
PLASTICITY INDEX _____
CLASSIFICATION ( )
WATER CONTENT (%) _____
DRY DENSITY (PCF) _____
SPECIFIC GRAVITY _____
HYDRAULIC CONDUCTIVITY (cm/sec - 20C) _____
TEST PROCEDURES: ASTM D422.

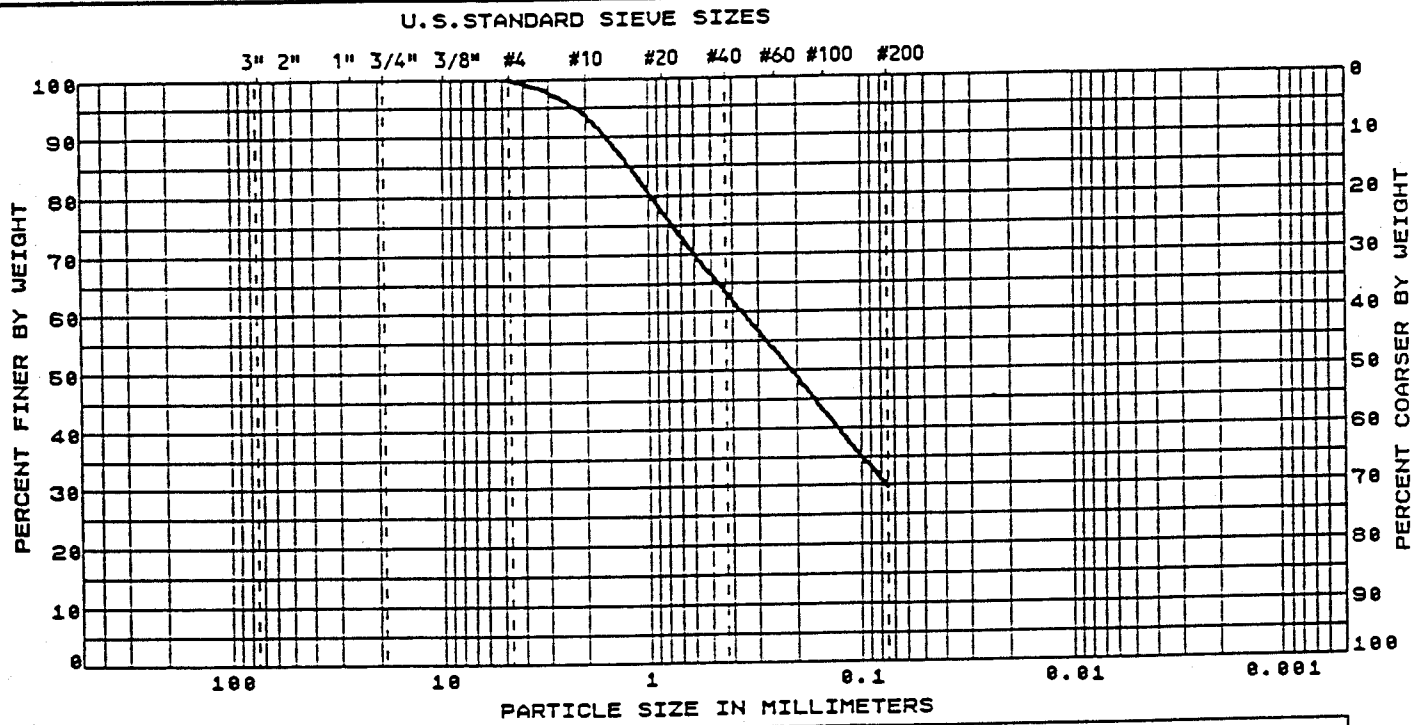
LAW ENVIRONMENTAL, INC.
M.A. O'Kelley

LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Law Engineering, Inc.
396 Plasters Avenue
Atlanta, Georgia 30324

JOB NO. 41-8902.05 DATE April 10, 1990
LAB NO. 9842 PAGE 3
PROJECT Haywood Co.Law Engr.#1130014201
SAMPLE ID B-112 4.0'-5.5'



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75			0.050
2"	50			0.020
1-1/2"	37.5			0.005
1"	25			0.002
3/4"	19			0.001
1/2"	12.5			
3/8"	9.5			
#4	4.75	100.0		
#10	2.00	93.7		
#20	0.850	77.2		
#40	0.425	63.1		
#60	0.250	53.2		
#100	0.150	43.1		
#200	0.075	29.6		

POROSITY (%) _____
EFFECTIVE SIZE (mm) _____
COEFFICIENT OF UNIFORMITY _____
COEFFICIENT OF CURVATURE _____
LIQUID LIMIT _____
PLASTIC LIMIT _____
PLASTICITY INDEX _____
CLASSIFICATION ( )
WATER CONTENT (%) _____
DRY DENSITY (PCF) _____
SPECIFIC GRAVITY _____
HYDRAULIC CONDUCTIVITY (cm/sec - 20C) _____
TEST PROCEDURES: ASTM D422.

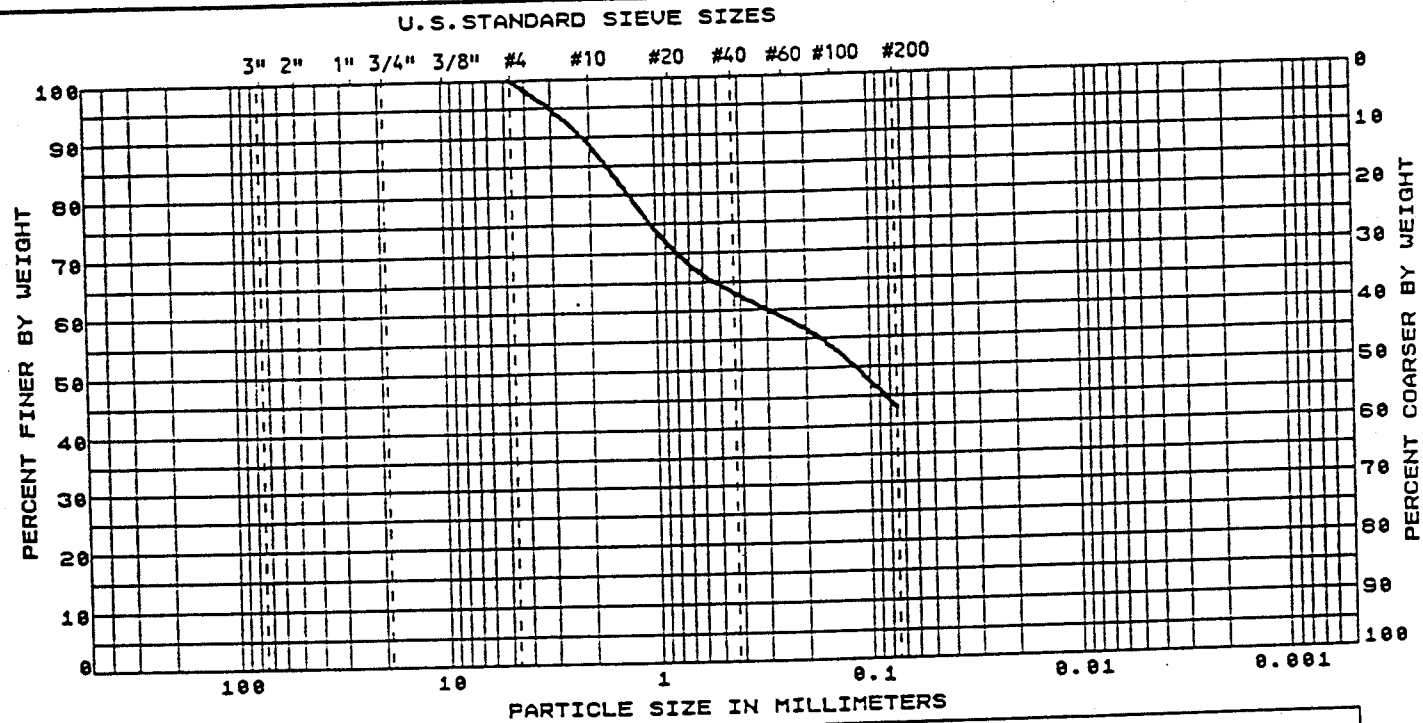
LAW ENVIRONMENTAL, INC.
M.A. O'Kelly

LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Law Engineering, Inc.
396 Plasters Avenue
Atlanta, Georgia 30324

JOB NO. 41-8902.05 DATE April 10, 1990
LAB NO. 9843 PAGE 4
PROJECT Haywood Co.Law Engr.#1130014201
SAMPLE ID B-113 5.0'



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

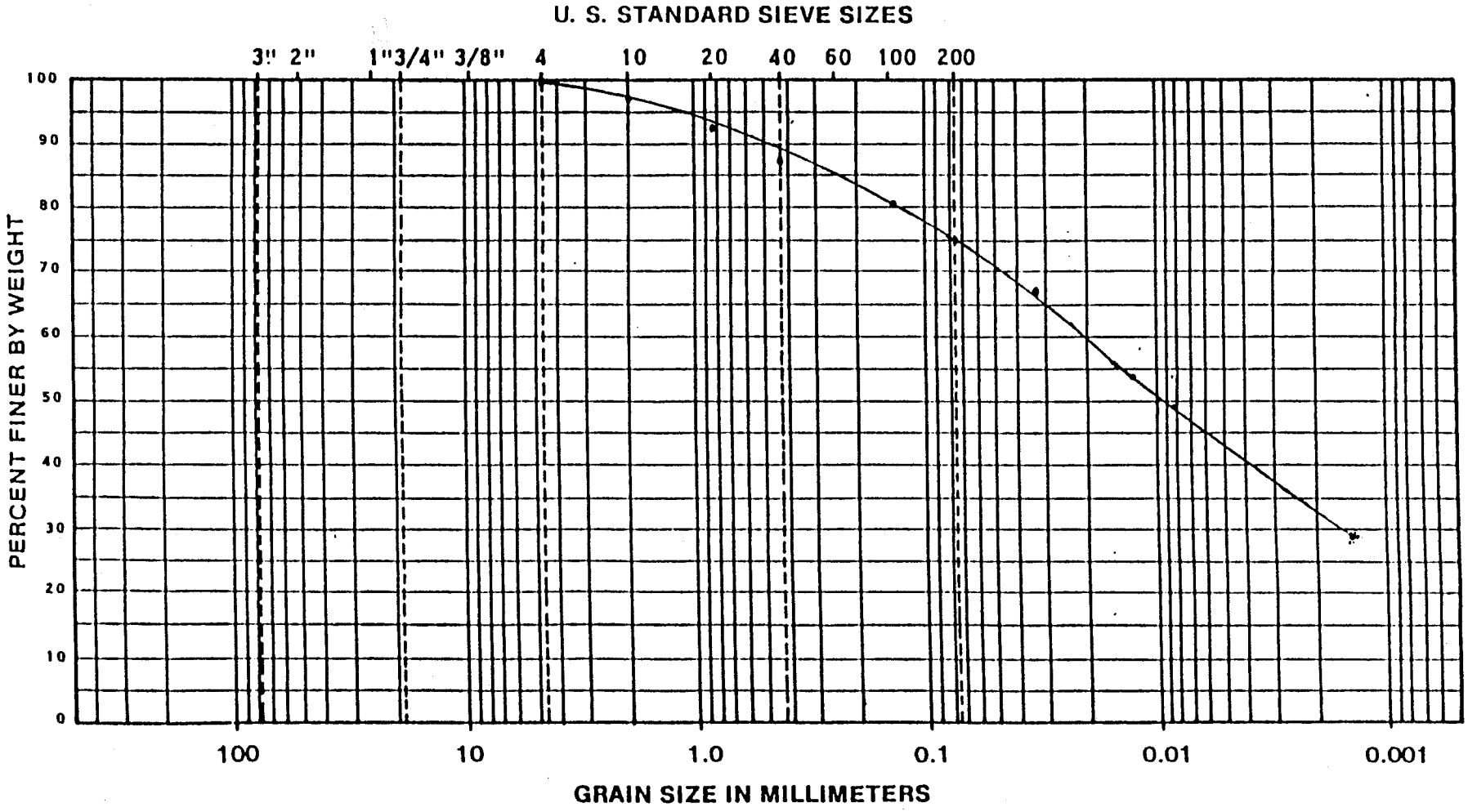
U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75			0.050
2"	50			0.020
1-1/2"	37.5			0.005
1"	25			0.002
3/4"	19			0.001
1/2"	12.5			
3/8"	9.5			
#4	4.75	100.0		
#10	2.00	88.7		
#20	0.850	71.0		
#40	0.425	63.0		
#60	0.250	58.6		
#100	0.150	53.5		
#200	0.075	42.9		

POROSITY (%) _____
EFFECTIVE SIZE (mm) _____
COEFFICIENT OF UNIFORMITY _____
COEFFICIENT OF CURVATURE _____
LIQUID LIMIT _____
PLASTIC LIMIT _____
PLASTICITY INDEX _____
CLASSIFICATION ( )

WATER CONTENT (%) _____
DRY DENSITY (PCF) _____
SPECIFIC GRAVITY _____
HYDRAULIC CONDUCTIVITY (cm/sec - 20C) _____
TEST PROCEDURES: ASTM D422.

LAW ENVIRONMENTAL, INC.
M.A O'Kelley

BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES



Law Engineering

Grain Size Distribution

BORING NO.	DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-105	4 TO 5.5	29.2	55	32	23	BROWN MEDIUM TO FINE SANDY CLAYEY SILT (MH)
JOB NO. 11-300 142.01						

LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

COMPACTION TEST

CLIENT Law Engineering, Inc.
396 Plasters Avenue
Atlanta, Georgia 30324

JOB NO. 41-8902.05
LAB NO. 9845
BORING NO. B-112
SAMPLE NO.

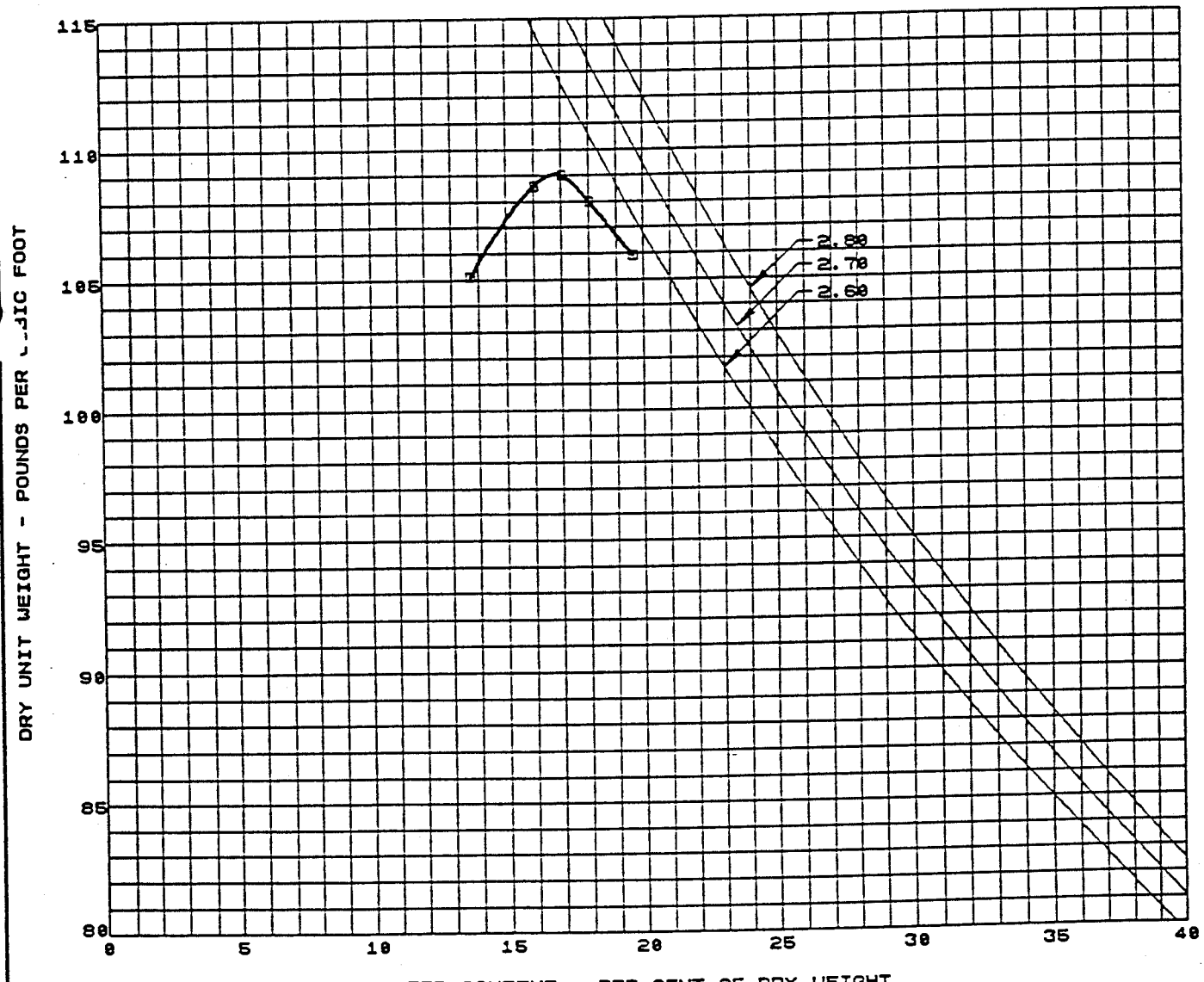
DATE April 10, 1990
PAGE 1

PROJECT Haywood Co.Law Engr.#1130014201 DEPTH 0.0'- 15.0'
LOCATION
METHOD OF TEST ASTM D698

SOIL DESCRIPTION Brown SlCl Si Sa
TESTED BY JTM, MAO

MAXIMUM DENSITY (PCF) 109.0

OPTIMUM MOISTURE CONTENT (%) 17.0



LAW ENVIRONMENTAL, INC.
M. A. O'Kelley

LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

COMPACTION TEST

CLIENT Law Engineering, Inc.
396 Plasters Avenue
Atlanta, Georgia 30324

JOB NO. 41-8902.05
LAB NO. 9844
BORING NO. B-111
SAMPLE NO.
DEPTH 0.0'- 10.0'

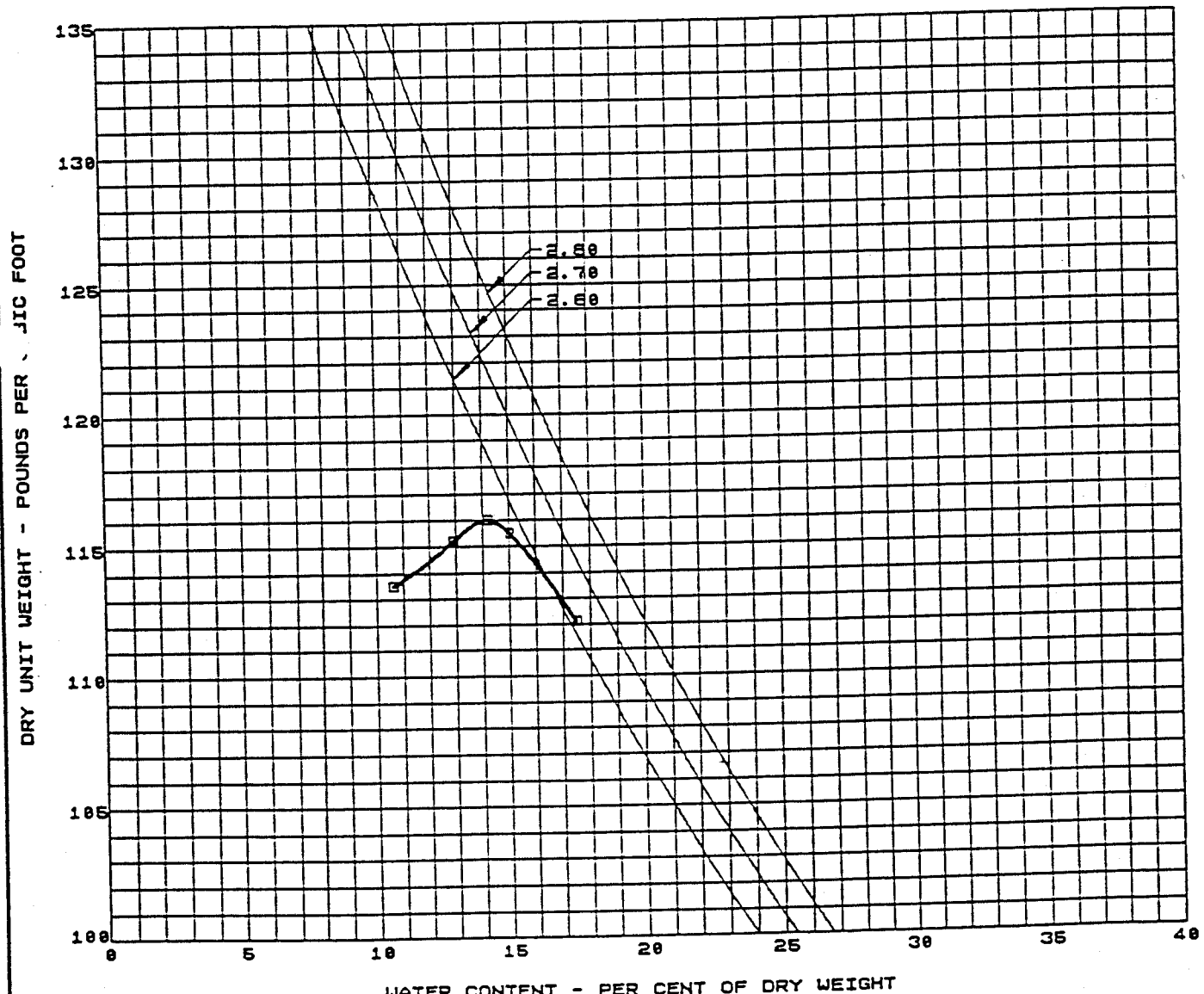
DATE April 10, 1990
PAGE 1

PROJECT Haywood Co.Law Engr.#1130014201
LOCATION
METHOD OF TEST ASTM D698-A

SOIL DESCRIPTION Brown SlCl Si Sa
TESTED BY JTM, MAO

MAXIMUM DENSITY (PCF) 116.0

OPTIMUM MOISTURE CONTENT (%) 14.2



LAW ENVIRONMENTAL, INC.

M.A. O'Kelley

SECTION 5

INVENTORY OF LOCAL WATER SUPPLIES

ROBERT D. HATCHER GEOLOGICAL SUMMARY

FROEHLING & ROBERTSON, INC. REPORT

Johanna Wood and
Mary Henigbaum

SURVEY OF WHITE OAK RESIDENTS

October 9, 1989

1. White house with gate on Steven's Creek (last house in 2 mile radius). Did not leave info. Neighbors said no one living there

2. Brown house with plastic steer in yard. Left info.

3. Trailer at church. Left info.

4. Tommie Conard, Rt. 4, Box 214, Waynesville 28786
Rowe (sp?) Ledford owned property. Bill Davis bought it.
Community will have another meeting about the landfill.
Leatherwood property at entrance.
White Oak Road a problem in winter.
Water - spring
No cattle.

5. Betty McMahan, Rt. 4, Box 204E
Water - well
No cattle

6. ~~Brick house south of McMahan's~~
~~Left info.~~

6½. Charles Teague, Rt. 4, Box 204C
Wonders if site is best one for landfill.
Raised here and know property.
Crabtree site already approved.
Will have to haul dirt, there are rocks at site.
Would not mind if it's the best spot.
Water - well
No cattle

7½. William Lee Teague, Rt. 4, Box 204B
Brick house.
Brother of Charles.
Left info.
Water - well
Has horse that drinks from stream.

8½. Georgia E. Teague, Rt. 4, Box 204A
Mother of Charles & William
Left info with Charles
Water - spring
No cattle

Oct. 9 (cont.)

9 ~~10~~. George Michal, Rt. 4, Box 203A
Water - spring
No cattle

10 ~~11~~. Joyce Jaynes, Rt. 4, Box 203
Hikes all over, and knows Bill Davis property.
Says beautiful country, lots of deer and wild flowers.
Asked if found unusual wild flowers and she mentioned yellow lady slippers.
Wanted to know if will leave trees around landfill.
Will it be visible from I-40?
Mentioned ugly clearcutting on Dick's Trail.
Water - spring
No cattle

11 ~~12~~. House down by creek with the elaborate turnaround.
Rt. 4, Box 201
Left info

12 ~~13~~. House by pond, up drive without mail boxes.
Left info

13 ~~14~~. Second house on same drive as above
Did not leave info

14 ~~15~~. Richard Woody, Rt. 4, Box 200A
Water - well
Has chickens, no cattle

15 ~~16~~. Odie Fish, Rt. 4, Box 200
Rowe (sp?) Ledford owned property.
Thinks cannot have entrance road at site as planned.
The government owns to the guardrail.
Thinks the government will not give access.
Suggestion: condemn enough property in each township to have a landfill for each.
Mr. Fish used to work for ASCS.
He says the government holds 2000 foot access to the Park Road.
He says there is a lot of rock at site.
Water - spring
No cattle

Oct. 9 (cont.)

16 ~~17~~. Brian E. Bennett, Rt. 4, Box 200AA
Left info

17 ~~18~~. Henry A. Davis, Rt. 4,
Mobile home #1918
Left info

18 ~~19~~. Raphael Strivelli, Rt. 4, Box 196 (?)
Rainbow Builders 627-8460
Did not leave info
House occupied?

19 ~~20~~. H. E. Sler, Rt. 4, Box 197
WHITE OAK STUDIO
Left info

~~20~~ ~~21~~. Wayne Bramlett, Rt. 4. Box 196 (?)
Mr. Bramlett is 85.
Small house without electricity or water.
He carries water from spring 1/4 mile down road which is present entrance to Bill Davis property.
He also uses rain water.
We found him working on his wood pile.
He did not voice any concerns about the landfill, but did comment on the Champion-Tennessee problem and the hurricane.
His neighbor, Mrs. Thomas, said people bring him wood and food.

~~21~~ ~~22~~. Mrs. I. E. Thomas, Rt. 4, Box 193
Mrs. Thomas (and Mrs. Mitchell Phillips) are organizing the community to protest the landfill site.
She said the county has no permission to build the entrance road as planned.
Concerned about noise, odor, rats and mosquitoes.
Concerned about where the money will come from to carry out all the measures that must be taken.
Bramletts own a lot of property in area.
For the Park Road, the government tore down Bramlett's house.
The county should not take property.
The county should use what people offer - like Redmond's.

Oct. 9 (cont)

Mrs. Thomas (cont.)

Messer permit? (Property in Crabtree approved)
Leatherwood property is solid rock, according to Larry Jones in the White Oak Development.
Why add seepage to the Pigeon?
People will be able to see the landfill from the interstate.
It will be bad for visitors from Tennessee.
She has stood at the top of the Davis property and can see the interstate.
Trucks that cannot get into the landfill will dump on the White Oak road.
If the gate is closed and there is no guard, they will just dump.
She is concerned about Wayne Bramlett's spring being contaminated.
Water - well
No cattle

October 10, 1989

22. Tim Gann, Rt. 4, Box 191
Concerns - rats in winter, White Oak Road not adequate.
Would prefer that the county require recycling or have a high temperature incinerator.
Water - spring
Has pony that drinks from pond.
Has pond and eat fish from pond.

23. First log house after Gann
Left info.

24. Small house on spit of land
Left info

25. Jack R. Martin
Telephone wire down
Left info.

26. Catherine Gardner, Rt. 4, Box 190A
Solid rock at entrance site.
Concerned about cost of transfer and covering trash.
Two creeks through property.
Not enough soil, area soil is shallow to rock.
Most people in subdivision are on wells.
Davis bought land on purpose to sell as landfill.
Water - well.
No cattle.

27. Sue Justice, Rt. 4, Box 193
Water - spring
Chickens drink spring water

28. Andy Presnell, Rt. 4, Box 194
Last house on road by river.
Old home place on rock outcrop.
Husband in accident.
Water - well
Cattle are watered from well

OCTOBER 11, 1989

29. Hugh Williams, Rt. 4, Box 186A
Aware of community meetings.
Sees no problem with landfill.
Water - well
No cattle

30. Kelly Williams, Rt. 4, Box 186B
Left info
Water - spring
Cattle drink from spring

Oct. 11 (cont.)

31. Mrs. W. T. Williams, Rt. 4, Box 186
Left info
Water - spring
No cattle

32. Doris Audrey Ringer, Rt. 4, Box 186C
Left info with mother, Gladys Daly
Water - well
No cattle

33. Gladys Daly, Rt. 4, Box 186D
Double wide mobile home on Ringer property
Share well with daughter above.

34. R. W. Miner, Rt. 4, Box 187A
Left info

35. Tetrault, Rt. 4, Box 187
Remodeled large house with gate.
Left info
Lance said owners from NY.
Old Rob Davis house.

Oct. 11 (cont.)

36. Johnnie Lee, Jr. and
Nellie Lance, Rt. 4, Box 189
Lots of rock on site.
Solid rock going in.
Site will be seen from I-40.
Panther Creek better place.
Lance looked after cattle on Ledford's and Bramlett's property.
Site has yellow lady slippers, showy orchis and red and white trillium.
PLEASE LET PEOPLE COME IN AND GET WILD FLOWERS TO TRANSPLANT BEFORE SITE IS DISTURBED.
Site has red and gray foxes, coon and deer which come across river from Wilkins Creek.
There are three branches on the site.
Steep pasture.
Hope to keep trees around the site.
The government did not allow Bramlett to cross the right of way for the Park Road.
SUGGESTION: (Mary's) SHARE BIO SURVEY WITH COMMUNITY.
Aware of meeting on Oct. 13 with county officials.
Concerned that it is a long way to haul trash.
Mentioned a property owner with 119 acres and a house in the center the community calls "Rambo".

Johanna Wood

SURVEY OF WHITE OAK RESIDENTS

October 12, 1989

1. Lee. J. Ferguson, Rt. 3 Clyde, NC
   Water - spring
   Bernard Ferguson has cattle on this property that are watered by a stream.

2. Log house. Left info. in door.

3. Log house on hill above the last house. Left info in door.

4. Edward T. Rathbone, Rt. 3 Box 230-B, Clyde.
   Water - well.

5. Rock house with beige siding. Appeared to be empty, but I left info in door.

6. Mrs. David Nolan, Rt. 3 box 215, Clyde.
   Action should have been taken sooner.
   Water - well.
   Cattle (they operate a dairy) - well.

7. White two-story house across from the dairy. Left info. in door.

8. Mr. Billy McElroy, Rt. 3 Box 212, Clyde.
   David Nolan has cattle in pasture on hill behind the McElroy home.
   Water - well.

9. White house with black shudders. Left info. in door. Two mailboxes with Forbes and Bobby G. Rathbone

10. Mr. Weaver E. Ledford, Rt. 3 Box 206, Clyde
    Water - spring.

11. Ernest Russell, Rt. 3 Box 204, Clyde
    Water - well.

12. White house with Russell on the house. Left info. in door. Had talked with their daughter-in-law at the last house. The two families use the same well as their water source.

13. Louise Hubbard, Rt. 3 Box 205, Clyde.
    Water - spring.

14. Dennis Rathbone, Rt. 3 Box 194, Clyde.
    Water - well.

15. Green and white trailer on the hill. Left info in door.

16. Brown trailer. Left info. in door.

17. Brown double wide trailer. Left info in door.

18. Jim & Bobby Greene, Rt. 3 Box 192, Clyde.
    Water - well.

* For 15 - 18. There were four mailboxes at the road leading into the area where I found the last four homes. The names on the mailboxes

were: R. D. Summey Box 193-B; Tom, Sandy, Brian Beasley Box 193-C;James Greene; the fourth mailbox did not have a name on it.

19. Earl Henson, 15 Valley St. Canton
This gentleman was camping along Fines Creek Road.
He gets his water from Jack Ferguson.
He felt the White Oak site was a better site for the landfill than the Panther Creek site.

October 13, 1989

1. Log house with rock entrance. The first road to the left after going into Shelton Laurel. Left info in the gate.

2. Log house. Left info.

3. John Snipes, Rt. 3 Box 224, Clyde.
Will waste going into the landfill be just from Haywood County or will waste be brought in from other counties and other states?
Water - well.
His well is tested every yar and is always good. He doesn't want anyone bothering his well. He said he came home one day and found a man pulling insulation off his well and starting to drop some kind of pills down into his well. When I asked him about whether or not he had cattle he said he would not answer any more durn questions until he had looked at the information I gave him.

4. White trailer - green sticker #3510. Sign at the driveway entrance that said Jim Henry's. Left info in door.

5. White trailer with old truck. 1989 Mobile Home Sticker #220. Left infor in the door.

6. White house at the mission. Left info in the door.

7. Blue house at the mission. Left info in door.

8. Grey house behind the mission to the left of the cemetery. Left info in the door.

* Names on mailboxes at the mission: James P. Henry; James F. Doyle; J. L. Frese & S. G. Wilburn

9. Glen Inman, Rt. 3 Box 227-A, Clyde.
Water - well.
Has horses that are watered by stream in the pasture.

10. Wilbur Teague, Rt. 3 Clyde.
How many years can the landfill operate at the White Oak location?
Water - well.
Cattle - watered by a branch.

11. Hugh Rogers' house. Left info in the door.

12. Mike Mehaffey, Rt. 3 Box 222, Clyde
Water - well.
Cattle - watered by a branch.

13. Bertha Moody, Rt. 3 Box 221, Clyde
Water - well.

14. Log house with Gratton's on the house. Left info in the door.

15. Jack Redmond, Rt. 3 Box 218, Clyde
Is property for landfill being condemned?
Water - well & spring.
Sheep - water from branch.

16. Jerry Trivette, Rt. 3 Box 219-B, Clyde
Water - spring.

17. Beige trailer to the left of Trivette. Box 192. Left info in the door.

18. Albert Beasley, Rt. 3 Box 220, Clyde
Water - spring.

19. Fannie Ledford, Rt. 3 Box 219, Clyde
Water - well. She shares with Wilburn Sutton. I gave Mrs. Ledford my last information, so I asked her to share it with other family members living close to her. She gave me information about the water source for family members I did not talk with. Milas Ledford has a well. Lizzie Sutton has a well.

October 16, 1989

1. Irene Norton, Rt. 3 Box 234, Clyde
Will the Panther Creek Road be used for hauling waste to the landfill?
Water - spring.

2. Francis E. Morton, Rt. 3 Box 235-A, Clyde
Blue and white moble home. I left info in the door. I got his name and mailing address from his sister-in-law who lived at the next house I visited.

3. Mr. & Mrs. Water Morton, Rt. 3 Box 235-A, Clyde (Panther Creek Rd.)
Will the landfill be visible from the house? Mrs. Morton took me to the upper deck of the house to try to see if the landfill would be visible from their upper deck. I could not tell much at that time. The bridge crossing the Pigeon going into White Oak is visible from the upper deck. I suggested Mrs. Morton take the map to the proposed sight for the landfill, pick out a landmark and go back to their deck to try to determine if the landfill would be visible from their house.
Other questions: She wanted to know about smell from the landfill. She is also concerned about traffic to the landfill, she is concerned about school buses and the large hauling trucks being on the road together, particularly in bad weather.
Water - well. No cattle.

4. James A. Morton, Rt. 3 Box 235-A, Clyde.
This is the son of Mrs. Morton whose remarks are listed in #3. James Morton was not at home, so I left the information for him with his mother.
Water - well. No cattle.

5. Green house on main road to the left of the road to the Morton's. Left info in the door.

6. House to the right of road to the Morton's. Mailbox had John Rathbone. Left info in door.

7. Brown house sitting back off the main road. Left info in the door.

8. Mobile home with mailbox that had the Greene's on it. Did not leave information.

9. House up behind mobile home. Mailbox with John Russell Box 236. Left info in the door.

10. Geraldine Parking Rt. 3 Box 239, Clyde
Water - spring.
Cattle - (The Parkins' have a dairy.) watered by a spring and some from a branch.

11. Cathy Parkins, Rt. 3 June Rd., Clyde
Will the landfill affect the water? Mrs. Parkins had heard that the landfill could cause the spread of diseases through the water. She was concerned about this.
Water - well.

12. Brown house above the Parkins dairy. The sign said "Walnut Grove Farm". I left info in the door.

13. Brick house with James W. Parkins on the mailbox. I left info in the door.

14. Rev. Bill Turner, Rt. 3 Box 240-A, Clyde.
Water - well.

15. Mobile home located next door to the home of James Parkins. Moble home 1989 license #2762. Left info in the door.

16. House with Box 245. Did not leave material. Met dog in the yard acting very aggressive and dragging the chain he had been chained with.

17. House with Parkins Box 244 on the mailbox. House appeared vacant so I did not leave info. Another neighbor told me this house was vacant.

18. Earl Bradley, Rt. 3 Box 243, Clyde
Water - well. No cattle.

19. Brickhouse up above Earl Bradley. Did not leave info.

*There were several houses located on down the dirt road past the home of Earl Bradley, I was not sure about whether or not I should go to these houses, so I did not go at that time. If these houses should be surveyed, please let me know.

SUMMARY OF GEOLOGIC OBSERVATIONS AT THE PROPOSED WHITE OAK LANDFILL SITE HAYWOOD COUNTY, NORTH CAROLINA

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Prepared December 10-11, 1989

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Introduction

The proposed White Oak landfill site is located some 2000 ft southwest of the Fines Creek exit on the south side of Interstate Highway 40 in Haywood County, North Carolina. The site and nearby exposures were visited by Dr. Hatcher and Dr. John R. Tabor, Post-Doctoral Research Associate in structural geology (working with Professor Hatcher), on December 6, 1989, at the request of local resident Mrs. Nancy Hoffman. Approximately 5 hours were spent in the proposed site area, with the majority of the time (3.5 to 4 hours) spent walking over the proposed site, making observations and recording measurements of geologic structures and the character of the bedrock exposed in the proposed site. The goal of spending this time here was to make observations of bedrock and surficial geology that might bear on the quality of the proposed site as a long-term (20 to 30 year) site for disposal of municipal (mostly household) solid waste.

It is assumed that the landfill, if constructed, will be built and maintained at least cost and will meet the minimum standards defined by county, state, and EPA regulations. It is also assumed that regardless of whatever care will be exercised in construction and day-to-day operation and maintenance of the landfill, total isolation of the waste materials placed in the landfill will not be accomplished, and that there will be some leakage into the impounded Pigeon River (Walters Reservoir). It is therefore assumed that the landfill will contribute leachate to Walters Lake and the ground water system in the area.

Nontechnical Summary

The bedrock unit underlying the proposed landfill consists of coarse- to very coarse-grained foliated granitic gneiss (metamorphosed granite) cut by veins of pegmatite and quartz. Some fault rock (mylonitic gneiss formed by ductile faulting – clearly premetamorphic) was observed at one locality. These observations of bedrock type in the proposed site reconfirm the high quality of geologic mapping of Hadley and Goldsmith (1963) in this area.

Rocks exposed within the proposed site generally contain relatively few joints (average spacing one to five feet or more), except locally. Rocks along the principal flowing stream in the proposed site are more intensely fractured (spacing of one to two inches) and the drainage of this stream, like most in the crystalline southern Appalachians, appears to be controlled by the bedrock fracture system. The NW-SE orientation of the valleys in the proposed site area is parallel to one of the major regional fracture sets in the southern Appalachian region. Fresh bedrock exposures are most likely to be present because the rock mass contains fewer fracutures and weathers more slowly. Consequently, a trenching and drilling program would be needed to properly assess the spacing and intensity of fractures present in the proposed site.

The ground water system in this region (entire crystalline southern Appalachians – the Blue Ridge and Piedmont – along with the Valley and Ridge of Alabama, Georgia, Tennessee, and Virginia) is located in fractures in bedrock, except locally where it may occur in surficial deposits (floodplain alluvium, soils, and colluvium). Despite opinions to the contrary, there are no "underground streams" in the crystalline rocks, except very locally where limestone or dolomite (or metamorphic equivalent marbles) may occur. Limestone and dolomite are rare in the Blue Ridge and Piedmont. Ground water in the Blue Ridge and Piedmont does not travel for great distances (generally less than one mile) once it enters the ground water reservoir. Open fractures (commonly joints but also brittle faults) that permit surface water to carry contaminants into the ground water system will create problems within a relatively short distance of the point of entry of the contaminant into the ground water.

Geologic Observations

The area that will be directly affected by the proposed landfill ranges in elevation from ~ 2300 ft on Walters Reservoir to >2680 ft along the crests of the divides in the proposed site (Fig. 1; TVA/USGS, 1967). Slopes here range from gentle to steep, and the proposed site is drained by several small intermittent to permanent streams that

Slopes are mostly covered by residual soils, and small amounts of alluvium occur in the valleys. Soil thickness ranges from 0 to an estimated 50 to 70 feet, based on observed depth of westhering in nearby road and stream cuts. Exposures of fresh bedrock are sparse, but sufficient, along with several exposures of saprolite, to confirm the nature of bedrock in the proposed landfill.

The bedrock unit underlying the proposed landfill consists of coarse- to very coarse-grained strongly foliated and lineated to moderately foliated granitic orthogneiss composed of feldspar-quartz-biotite gneiss cut by veins of pegmatite and quartz. Some amphibole-bearing gneiss was observed at one locality (#7 along Walters Lake, Fig. 1), and mylonitic orthogneiss (clearly premetamorphic mylonite) was observed at one locality (#6, Fig. 1). These observations of bedrock type in the proposed site reconfirm the high quality of geologic mapping of Hadley and Goldsmith (1963) in this area.

Rocks within the proposed site generally contain relatively few joints (average spacing one to five feet or more), except locally. Rocks along the principal flowing stream in the proposed site are more intensely fractured (spacing of one to two inches) and the drainage of this stream, like most in the crystalline southern Appalachians, appears to be controlled by the bedrock fracture system. The NW-SE orientation of the valleys in the proposed site area is parallel to one of the major regional fracture sets in the southern Appalachian region. Fresh bedrock exposures are most likely to be present because the rock mass contains fewer fracutures and weathers more slowly. Consequently, a trenching and drilling program would be needed to properly assess the spacing and intensity of fractures present in the proposed site.

The dominant foliation here is defined by the parallel orientation of platy minerals, principally biotite, with quartz and feldspars flattened into the foliation. It has a somewhat variable orientation, and numerous folds were observed in some exposures within the proposed site in which axial surfaces are parallel to the dominant foliation. As the bedrock weathers, the foliation may open and become a fracture surface along which ground water may flow.

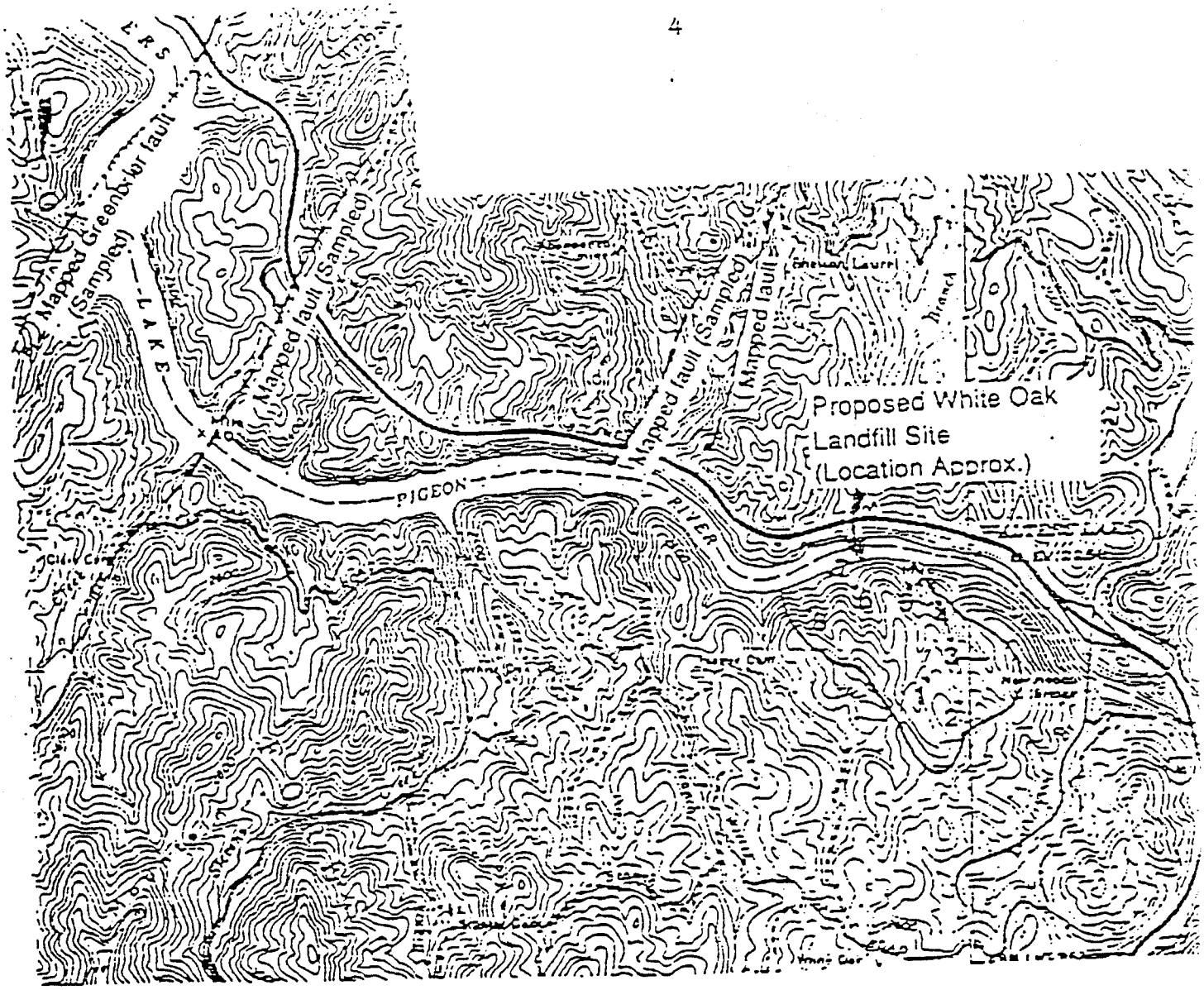

Figure 1. Topographic map of the proposed White Oak landfill site (from TVA/USGS, 1967) showing the locations of measurements and observations of bedrock exposures, along with measurements of geologic structures at numbered points. 1 – Strongly foliated feldspar-quartz-biotite gneiss. Rocks are strongly isoclinally folded with fold axial surfaces parallel to the dominant foliation. Foliation N11E/36SE. Unfilled joints N68W/69SW, N67E/75NW. Fracture density is low (2-3 ft spacing) 2 – Massive, coarse grained feldspar-quartz-biotite orthogneiss. Foliation N59E/32SE. Unfilled joint N61E/32NW. 3 – Massive, exfoliated coarse-grained feldspar-quartz-biotite orthogneiss. Garnet and orthopyroxene metacrysts up to 0.5 cm in some parts of exposure, oriented parallel to compositional banding. Almost no fractures. Joint spacing 20-30 ft. Unfilled joints N32E/79NW, N56W/77SW. 4 – Strongly foliated and lineated feldspar-quartz-biotite orthogneiss. Foliation N9E/32SE. Unfilled joints (spacing 0.5-1 ft) N45E/76NW, N70E/80SE. 5 – Strongly fractured feldspar-quartz-biotite orthogneiss. Foliation N67E/32SE. Dominant closely spaced (1 in to 3 in) fracture set (N38W/77NW) approximately parallel to valley orientation. 6 – Medium-grained annealed mylonite derived from feldspar-quartz-biotite orthogneiss. No measurements taken because is a large block, probably locally derived (within <100 ft of present location), but appears out of place. 7 – Strongly foliated feldspar-quartz-amphibole gneiss along Walters Lake. Foliation N66E/22SE. Unfilled joint N40W/69W. 8 – Large cliff exposure of coarse-grained feldspar-quartz-biotite orthogneiss. Rock mass is moderately fractured, with a zone of intense fracturing (spacing <1-2 in) in part of the exposure. Foliation N33E/24SE. Unfilled joints N33W/86NE,* N41W/81NE, N47W/68SW, N23E/vertical, N43E/vertical.

Medium-grained mylonitic orthogneiss occurs in a block that is probably a few feet out of place at one locality (#6, Fig. 1). This mylonite is clearly premetamorphic, but indicates the presence of a ductile shear zone or premetamorphic fault of unknown dimensions, geometry, or extent in the proposed site. This fault rock was not sampled and sectioned for microscopic study, but consists of massive, strongly foliated, annealed mylonite, easily determined from field observations. There is no indication of any reactivation along this fault from the limited exposure available.

Samples were collected from other mapped fault zones located along I-40 3000, 8000, and 11,000 feet respectively northwest of the western edge of the proposed site. All of these faults would cross Walters Lake on the Pigeon River, and microscopic examination of samples from all three of these faults reveals that all are postmetamorphic faults, but all contain mylonite; no brittle fault rocks (gouge, breccia, other cataclasites) were observed.. Ironically, the fault crossing I-40 some 11,000 feet NW of the proposed site is the Greenbrier fault, almost universally recognized by all who have studied it and related faults nearby like the Hayesville (Hadley and Goldsmith, 1963; King, 1964; Hatcher, 1978, 1987) as the type premetamorphic fault in the southern Appalahcians. At this locality, the trace of the Greenbrier fault was mapped by Hadley and Goldsmith (1963) and correctly located during our brief time in the field. The fault here was locally reactivated forming a retrograde assemblage of muscovite, chlorite, and other minerals, and sulfides (principally pyrrhotite) were deposited in the fault zone. This fault zone is very easy to locate because of the occurrence of iron-oxide stain on the road cut. The other fault zones to the southeast are easy to recognize because of the strong contrast between the character of bedrock and mylonite in the fault zones. The mylonite contains abundant shear-sense indicators (rotated porphyroclasts, S-C fabrics, mica fish) and new retrograde minerals (muscovite, chlorite) that, together with microtextures, are indicative of a postmetamorphic movement history.

fracture porosity/permeability, except for that occurring in surficial materials (soils, alluvium, colluvium). Fractures generally are closed below depths of approximately 200 ft. except for a few isolated throughgoing fractures that may propagate ground water to much greater depth. Generally speaking, most ground water in wells is derived from within 200 ft of the surface and involves surface (meteoric) recharge of the fracture system over periods of a few weeks to months to several years, depending on the interconnected nature of the fracture system and how well it is connected to the surface. Faults can play a major or minor role in ground water distribution because they are isolated fracture planes that may either impede flow or serve as conduits. They may also create additional fracture porosity near the fault plane. Because of the limited time available, no attempt was made to ascertain if the faults observed (except for the Greenbrier) are aquicludes or conduits for ground water flow. The Greenbrier fault is obviously locally a conduit for flow where exposed in I-40.

In conclusion, while I was not informed of the criteria for siting this landfill, I would not have chosen this site because leakage and leachate will accumulate in a nearby standing body of water, thereby increasing the chances of contamination of the local ground water.

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December 8, 1980

Haywood County Board of Commissioners
c/o Jensen Engineering
Post Office Box 1818
Asheville, North Carolina 28814

Attention: Mr. George Jensen, P.E.

Re: Preliminary Subsurface Exploration
Proposed Haywood County Landfill
White Oak Township
Haywood County, North Carolina
F&R File No. P-70-613
Report No. 1

Gentlemen:

Froehling and Robertson, Inc has performed the preliminary subsurface exploration for the referenced project as authorized verbally by Mr. Ralph Owens of Jensen Engineering and we are submitting our findings herein. The exploration was performed to evaluate subsurface conditions as they pertain to site evaluation and the design and construction of the proposed landfill facilities. This report presents a brief description of our understanding of the project, the information obtained in the subsurface exploration and our conclusions and recommendations.

PROJECT DESCRIPTION

We have discussed the project with the Mr. George Jensen of Jensen Engineering and have been furnished site boundary plan showing the survey locations prepared by Gibson Land Surveying. We understand that the project is in the conceptual stages and specific details regarding site design have not been completed.

SUBSURFACE EXPLORATION

The subsurface exploration included the performance of eight soil test borings and eleven auger probe borings at locations selected by representatives of Jensen Engineering. The boring locations were established in the field by a representative of Jensen Engineering and the approximate boring locations are presented on a plan in the Appendix. The Appendix also contains Test Boring Records presenting the information obtained in the subsurface exploration, a key to the terms used in the Test Boring Records, and a brief description of the boring procedures used. The borings were drilled with a CME 55 truck mounted drill rig and were advanced using a 6-inch hollow stem auger. Soil specimens were obtained by standard split spoon and by bulk methods.

LABORATORY TESTS

Laboratory test included the performance of classification test (ASTM D-4318, D-421, D-2487), Standard Proctor moisture-density (ASTM D-698), and permeability of remolded specimens. The tests were performed on four separate bulk soils specimens obtained in the field from the auger spoils as directed by personnel from

Jensen Engineering. Results of the laboratory tests and descriptions of the test procedures are presented in the appendix of this report.

SITE DESCRIPTION AND SUBSURFACE CONDITIONS

The site of the proposed landfill is located near Hepco in White Oak Township in Haywood County, North Carolina. The site covers an area of approximately 108.9 acres south of Waterville Lake. At the time the soil test borings were made, the site was open pasture land bordered by forest. The site consists of gently rolling hills and shallow hollows. The site lies within the Blue Ridge Belt of the Blue Ridge Physiographic Province of North Carolina. The rocks underlying this area are of sedimentary and igneous origin but have been profoundly altered by the high heat and pressure associated with deep burial and tectonic movements which have affected them since their formation in late Precambrian time. The rocks most commonly encountered in the local area are mapped as metasediments of the Ocoee Supergroup. Chemical weathering of the rocks has produced soils which normally consist of silt with variable amounts of fine sand, and minor amounts of clay and fine mica.

Weathering of the bedrock may be accelerated by the presence of joints, fractures, or zones of easily weathered minerals in the rock. For this reason, the upper surface of the rock may be irregular and isolated boulders, pinnacles, and ledges composed of the more resistant materials may be encountered above the general soil/rock contact.

In some areas, the natural surface soils may consist of alluvium which has been formed by the deposition of water borne sediments on flood plains or in stream channels. The alluvial soils may consist of organic material, boulders, gravel, sand, clay, or

silt, either singly or in any combination. Because these materials have been deposited from either flowing or quiet waters, alluvial soils may vary greatly in consistency, composition, and character in both the horizontal and vertical directions.

Moderate to very high consistency residual soils were encountered from the surface to the total depth explored in each boring. The residual soils have been formed by means of chemical weathering of the metasedimentary rocks of the Ocoee Supergroup which forms the bedrock in this portion of the Blue Ridge Physiographic Province of North Carolina. The residual soils consisted of mottled reddish brown, purple, and grey SILT which contained variable amounts of sand and traces of fine mica and of silty SAND which contained traces of fine mica. The lines on the boring logs denote color or textural changes in the residuum. However, the residual soils are laterally discontinuous with textural changes expected with short distances. The penetration resistances ("N" values) ranged from 8 blows per foot to 50 blows per 6 inches.

Laboratory classification tests performed indicated that the residual soils are relatively fine grained with 100 to 98 percent of the material fine than the U.S. No. 4 sieve and 46.5 to 83.0 percent of the material consisted of silts and clays finer than the U.S. No. 200 sieve. The liquid limits ranged from 29 to 49 and the fines are nonplastic. The soils were classified as either a ML (low plasticity silt), or a SM (silty sand) by the Unified Soil Classification System. Maximum dry density as determined by a standard Proctor ranged from 101.5 to 110.2 pounds per cubic foot with the optimum moisture contents ranging from 15.8 to 20.0 percent. Natural moisture contents ranged from 13.5 to 20 percent. Permeability tests performed on remolded specimens compacted to densities ranging from 94.9 to 101.4 percent of the individual soil specimens respective Standard Proctor maximum dry density provided averaged permeability values ranging from 2.9×10^{-7} to 5.1×10^{-7} centimeters per second. The permeabilities were determined by an average of three tests on each remolded specimen.

ROCK - Weathered bedrock was encountered in borings B-1, B-3, and B-8 and depths of 35, 26, and 35 feet, respectively. The penetration resistances ("N" values) ranged from 50 blows per six inches to 50 blow per 1 inch penetration. Unweathered rock, as defined by rock which can not be drilled with auger drilling equipment, was encountered at boring B-3 at a depth of 37 feet.

Ground Water - Ground water was not encountered at the time the soils test borings were performed and no long term ground water observations were performed.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices for the exclusive use of Haywood County Board of Commissioners and their agents in the design of the proposed Haywood County Landfill to be constructed on the south side of Waterville Lake in the White Oak Township in Haywood County, North Carolina. No other warranty, expressed or implied. is made. Our conclusions and recommendations are based upon design information furnished to us, the information obtained in the previously described subsurface exploration, and our previous experience. These conclusions and recommendations do not reflect variations in subsurface conditions which may exist between boring locations or in unexplored portions of the site. Should such variations become apparent during construction, it will be necessary to reevaluate our findings based upon on-site observation of the conditions.

In the event that changes are made in the design or location of the proposed landfill site, the recommendations presented in this report shall not be considered valid unless the changes are reviewed by our firm and the conclusions of this report modified or verified in writing. We should also be given the opportunity

to review the design, grading plans, and applicable portions of the project specifications when the design is finalized.

We recommend that this report, in its entirety, should be made available to the prospective contractors for informational purposes. The Test Boring Records should not be separated from this report.

ACKNOWLEDGMENT

Froehling and Robertson, Inc. appreciates the opportunity to work with you on this project. If there are any questions regarding the information presented in this report, please do not hesitate to contact us.

Respectfully submitted,

FROEHLING AND ROBERTSON, INC.

Richard O. Ricks, E.I.T.
Geotechnical Staff

William H. Duhling, Jr., P. E.
Geotechnical Engineer

NORTH CAROLINA REGISTERED PROFESSIONAL ENGINEER 1858 WILLIAM H. DUHLING, JR.

Appendix

A P P E N D I X

Laboratory Test Results

Site Plan

Test Boring Records

Proctor Test Reports

Graphs

Descriptive Terms

Procedures

F&R File No. P-70-613
Report No. 1

LABORATORY TEST RESULTS

CLASSIFICATION TESTING

Sample No.	Depth ft.	Nat. W%	Limits LL	Limits PI	Sieve #4	Sieve #10	(% finer) #40	(% finer) #200	Classification
B-5	9-14	17.6	34	NP	99.0	95.6	74.4	55.1	ML
B-6	1.5-10	14.3	34	NP	99.7	94.7	76.9	46.5	SM
B-7A	0-10	13.5	29	NP	98.0	94.3	74.4	48.7	SM
B-7B	15-25	20.0	49	NP	100.0	98.5	94.9	83.0	ML

PERMEABILITY RESULTS

SAMPLE NO. Boring B-5, 9-14' TYPE OF TEST: Constant Head

AREA (cm^2): 81.07 DIA. (cm): 10.16 LENGTH ($cm^)$: 11.63

VOL. (cm^3): 942.88 WT. OF SAMPLE (gm): 1900.5

Moist.: 20.6% DRY DENSITY (pcf): 104.3 COMP.: 98.2

TEST No.	C^O	ELAPSE TIME (sec)	FLOW (cc)	HEAD (psi)	K (cm/sec)
1	21	10,440	5.5	3.0	$3.6 * 10^{-7}$
2	21	4,500	4.1	5.0	$3.7 * 10^{-7}$
3	21	3,720	3.5	5.0	$3.8 * 10^{-7}$
				k (ave)=	$3.7 * 10^{-7}$

F&R File No. P-70-613
Report No. 1

PERMEABILITY RESULTS (Cont.)

SAMPLE NO. Boring B-6, 9-14' TYPE OF TEST: Constant Head

AREA (cm^2): 81.07 DIA. (cm): 10.16 LENGTH (cm): 11.63

VOL. (cm^3): 942.88 WT. OF SAMPLE (gm): 1896.0

Moist.: 19.9% DRY DENSITY (pcf): 104.6 COMP.: 94.9%

TEST No.	C^O	ELAPSE TIME (sec)	FLOW (cc)	HEAD (psi)	K (cm/sec)
1	21	28,140	13.2	3.0	$3.2 * 10^{-7}$
2	20	5,700	2.2	3.0	$2.6 * 10^{-7}$
3	20	52,920	21.6	5.0	$2.8 * 10^{-7}$
				k (ave)=	$2.9 * 10^{-7}$

SAMPLE NO. Boring B-7A, 0-10' TYPE OF TEST: Constant Head

AREA (cm^2): 81.07 DIA. (cm): 10.16 LENGTH (cm): 11.63

VOL. (cm^3): 942.88 WT. OF SAMPLE (gm): 1918.7

Moist.: 20.7% DRY DENSITY (pcf): 105.4 COMP.: 100.5%

TEST No.	C^O	ELAPSE TIME (sec)	FLOW (cc)	HEAD (psi)	K (cm/sec)
1	21	10,380	7.7	3.0	$5.0 * 10^{-7}$
2	21	1,481	1.8	5.0	$5.0 * 10^{-7}$
3	21	3,240	4.2	5.0	$5.3 * 10^{-7}$
				k (ave)=	$5.1 * 10^{-7}$

F&R File No. P-70-613
Report No. 1

PERMEABILITY RESULTS (Cont.)

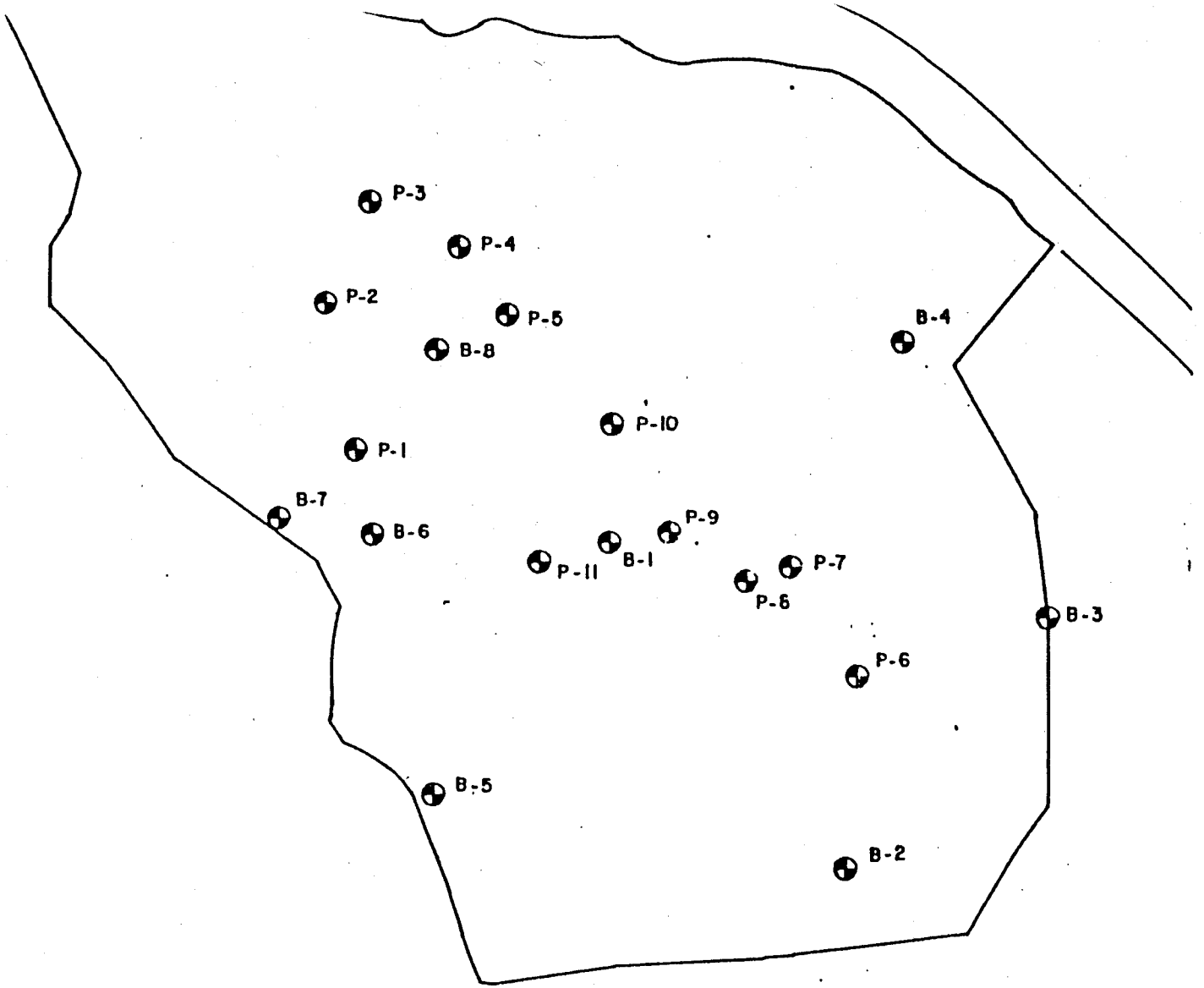
SAMPLE NO. Boring B-7B, 15-25' TYPE OF TEST: Constant Head

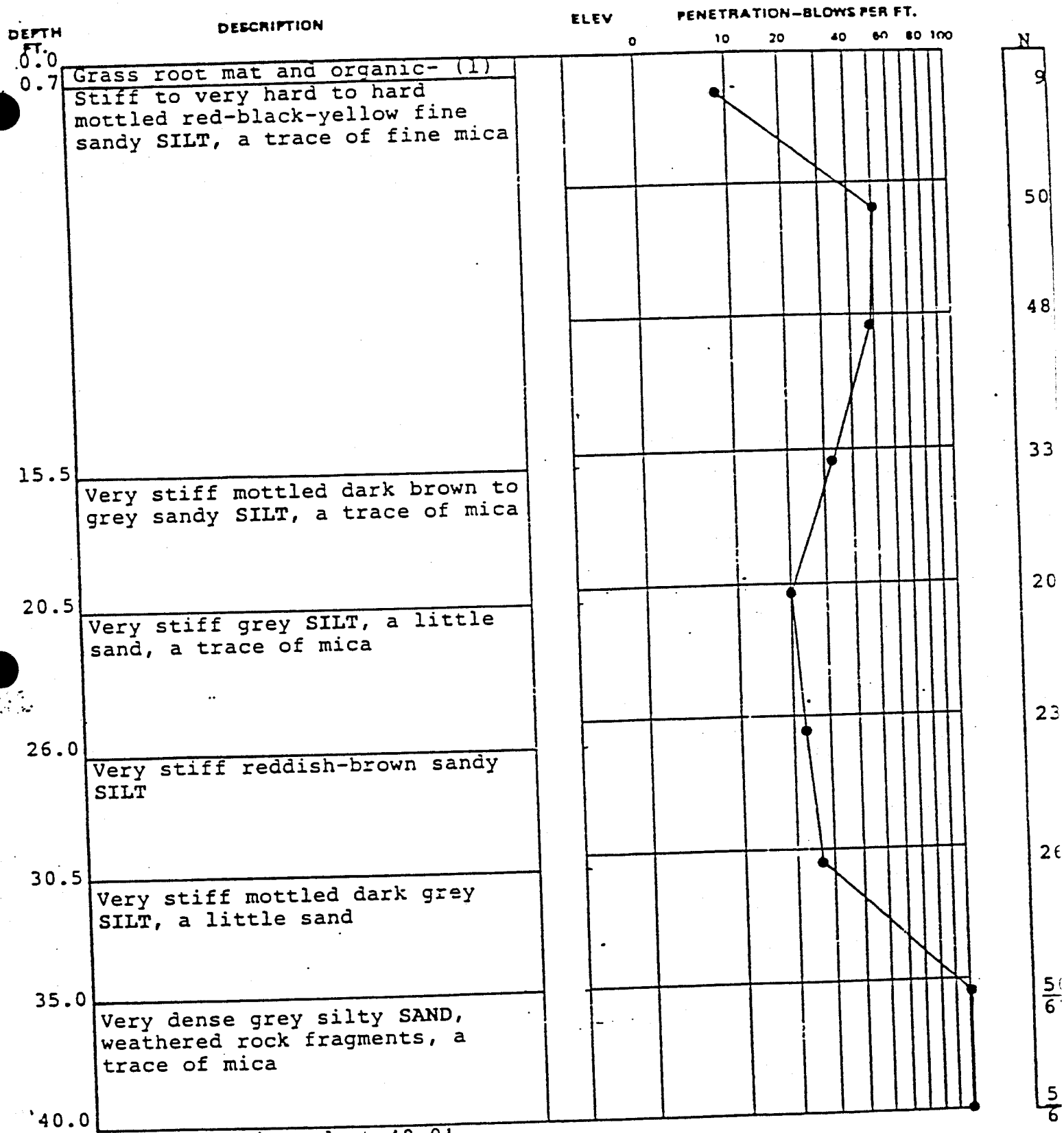
AREA (cm^2): 81.07 DIA. (cm): 10.16 LENGTH ($cm^)$: 11.63

VOL. (cm^3): 942.88 WT. OF SAMPLE (gm): 1859.7

Moist.: 23.8% DRY DENSITY (pcf): 99.4 COMP.: 97.9%

TEST No.	C^O	ELAPSE TIME (sec)	FLOW (cc)	HEAD (psi)	K (cm/sec)
1	21	22,260	15.6	3.0	$3.8 * 10^{-7}$
2	20	5,820	3.3	3.0	$3.9 * 10^{-7}$
3	20	53,040	27.4	3.0	$3.5 * 10^{-7}$
				k (ave)=	$3.7 * 10^{-7}$


P-3
P-4
P-2
P-5
B-8
B-4
P-10
P-1
B-7
B-6
P-9
B-1
P-11
P-7
P-8
B-3
P-6
B-5
B-2



Boring Terminated at 40.0'
Weathered rock at 35'
No water at completion

(1)- laden soil

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-1
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

(1)- laden soil

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

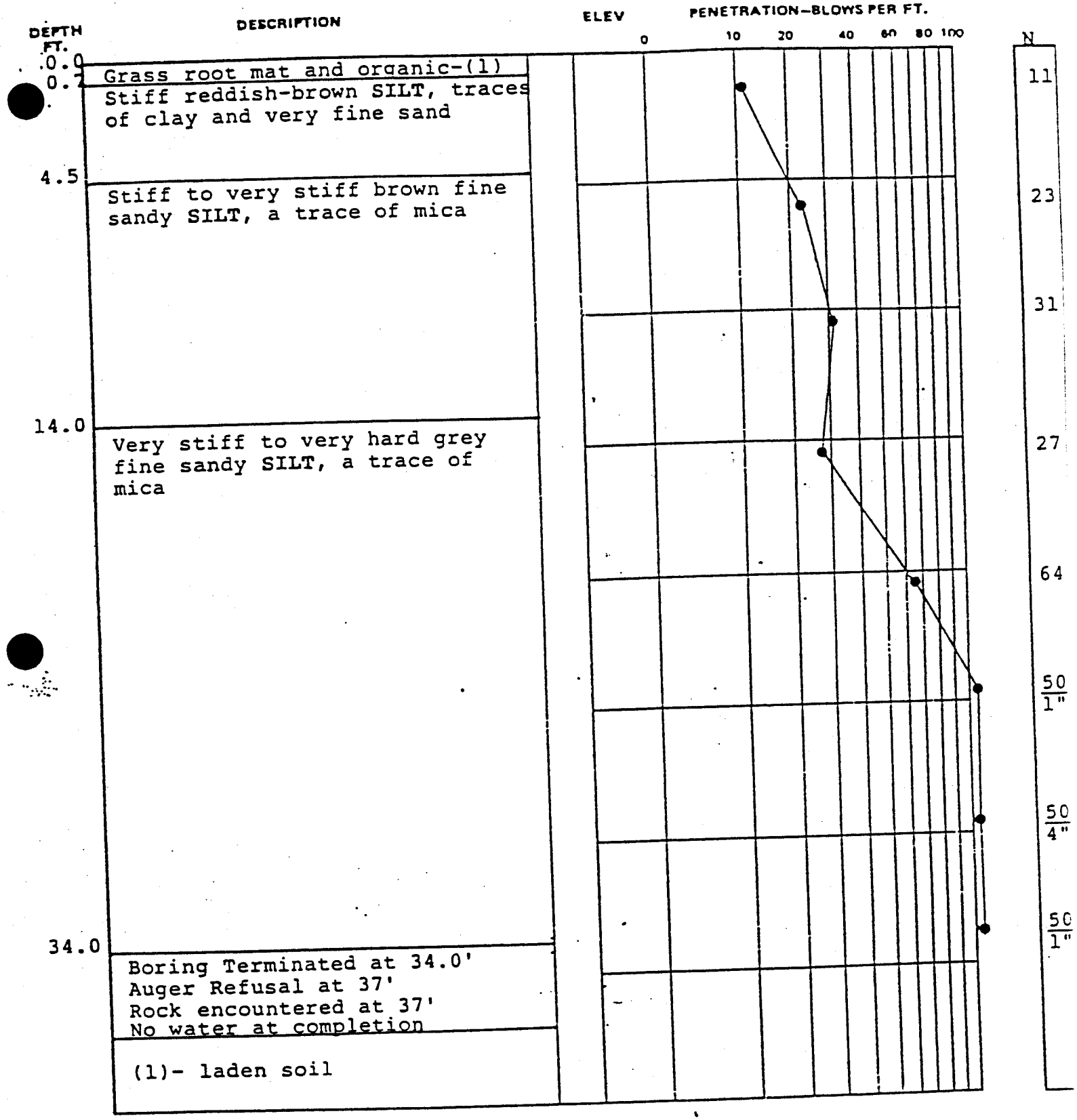
TEST BORING RECORD

BORING NO. B-2

DATE DRILLED 11-4-88

LAB NO.

JOB NO. P-70-561



FROEHLING & ROBERTSON, INC.

TEST BORING RECORD

BORING NO. B-3
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

ORING AND SAMPLING MEETS ASTM D-1586
ORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

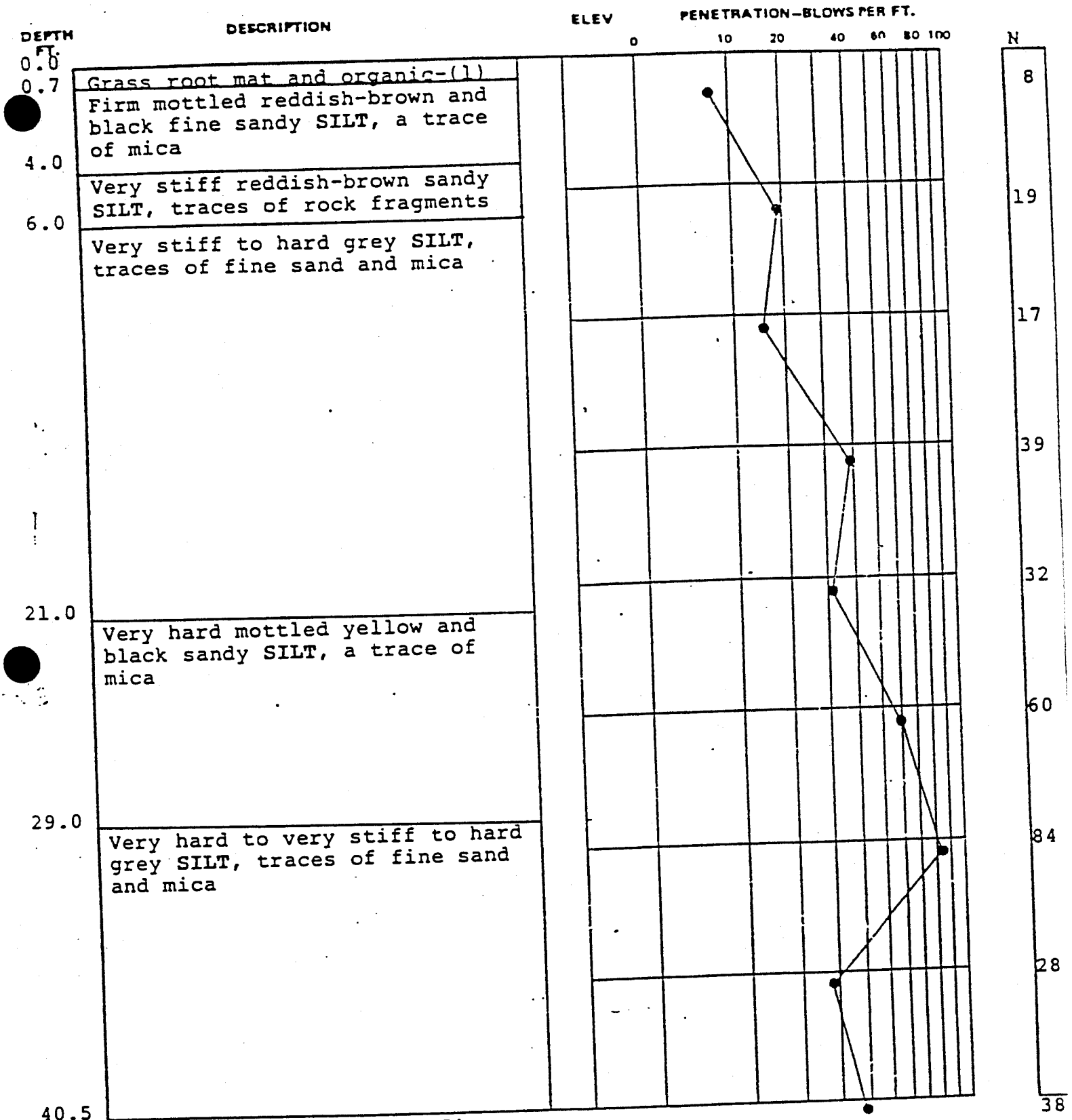
UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER



Boring Terminated at 40.5'
No rock fragments
No water at completion
(1)- laden soil

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 60 | % ROCK CORE RECOVERY

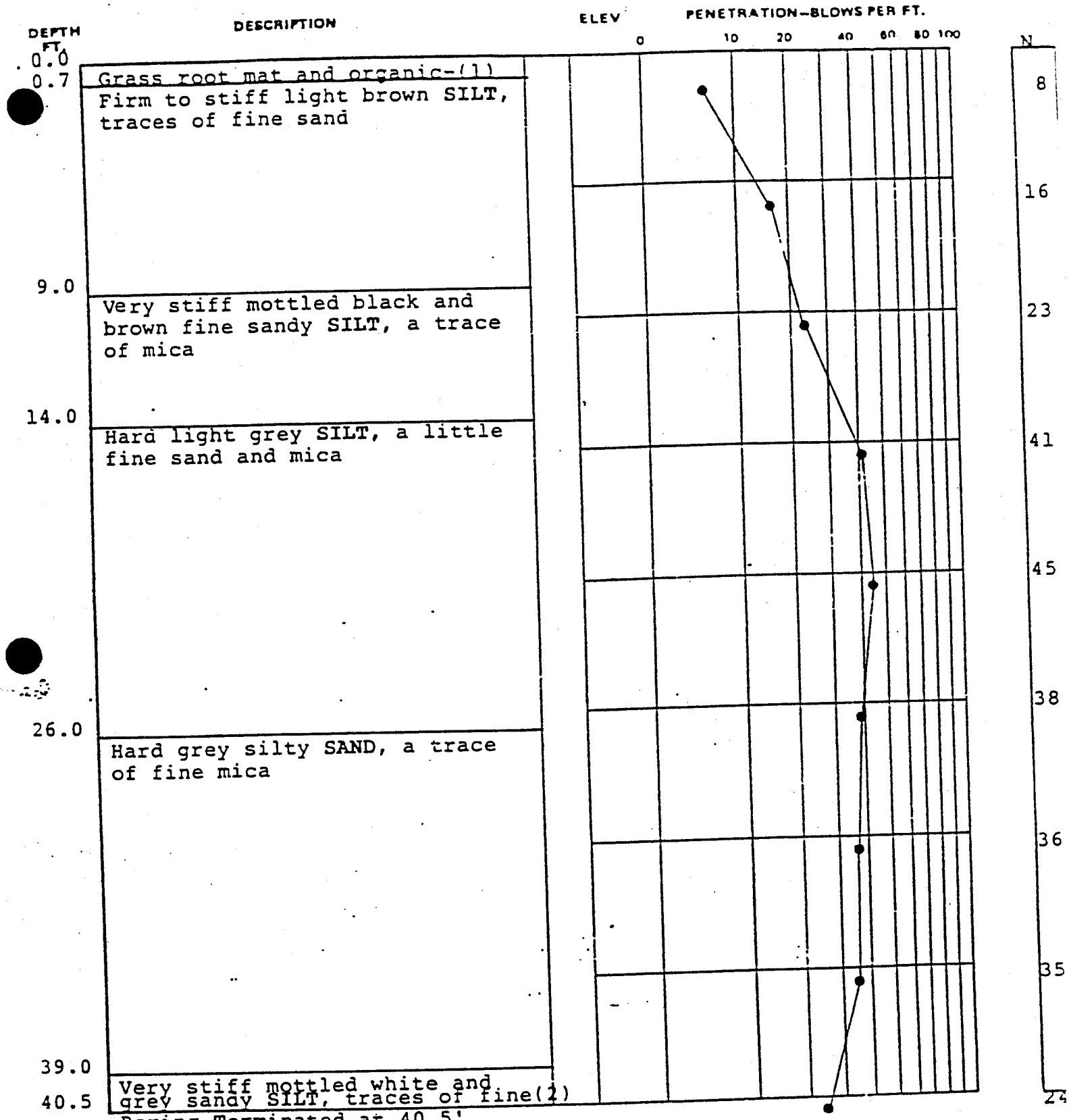
WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-4
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561



FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

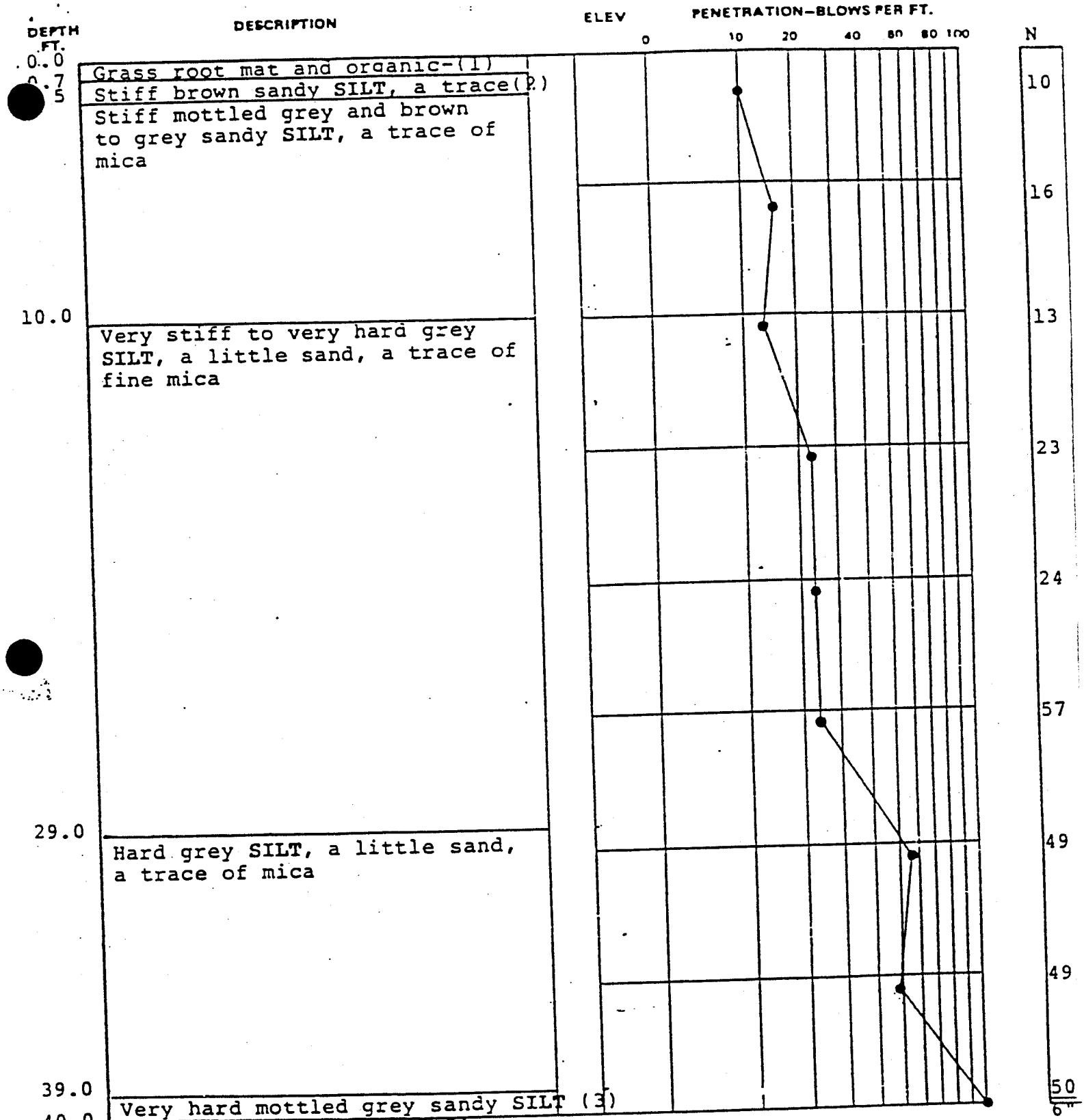
TEST BORING RECORD

BORING NO. B-5

DATE DRILLED 11-7-88

LAB NO.

JOB NO. P-70-561



FROEHLING & ROBERTSON, INC.

ORING AND SAMPLING MEETS ASTM D-1586
ORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

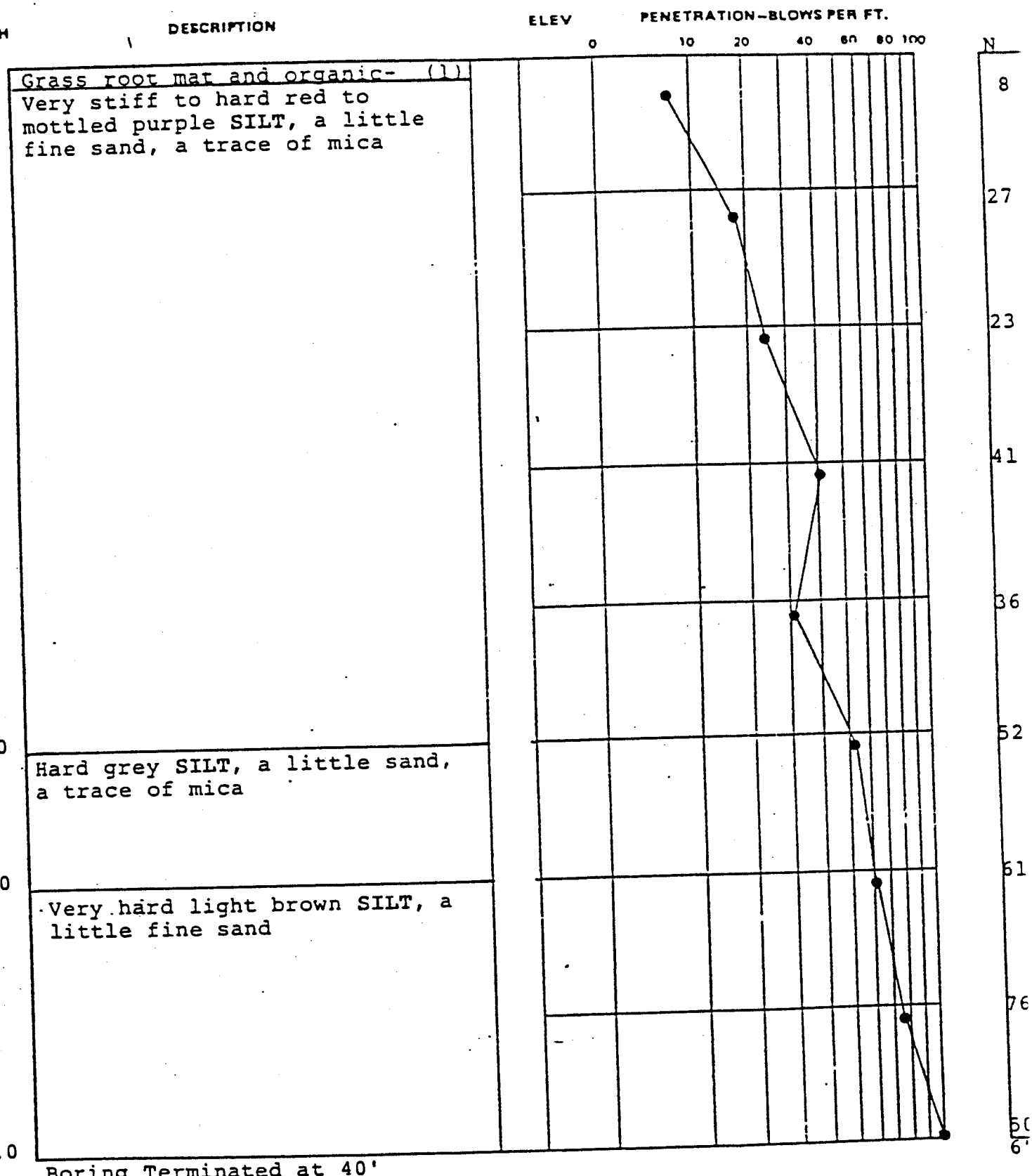
TEST BORING RECORD

BORING NO. B-6

DATE DRILLED 11-5-88

LAB NO.

JOB NO. P-70-561



FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 60 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

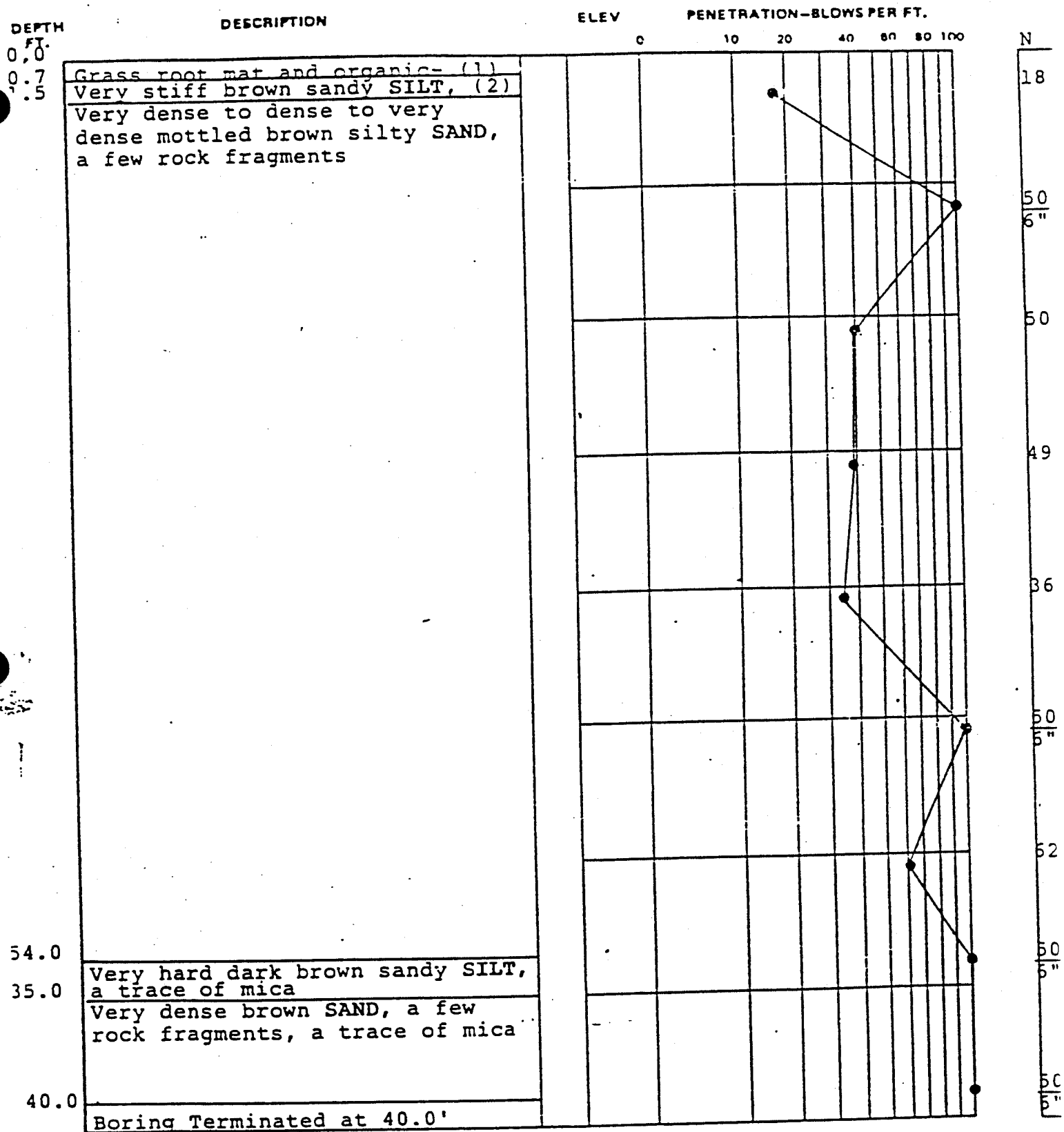
TEST BORING RECORD

BORING NO. B-7

DATE DRILLED 11-5-88

LAB NO.

JOB NO. P-70-561



(1)- laden soil
(2)- a trace of mica

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-8
DATE DRILLED 11-4-88
LAB NO.
JOB NO. P-70-561

DEPTH FT.	DESCRIPTION	ELEV	PENETRATION–BLOWS PER FT. 0 10 20 40 60 80 100
0.0			
10.0	Boring Terminated at 10.0' No rock encountered No water at completion		

FROEHLING & ROBERTSON, INC.

ORING AND SAMPLING MEETS ASTM D-1586
ORE DRILLING MEETS ASTM D-2113

ENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-1
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

DEPTH FT	DESCRIPTION	ELEV	PENETRATION–BLOWS PER FT. 0 10 20 40 60 80 100
0.0	Small rock fragments from 5 to 10'		
10.0	Boring Terminated at 10.0' No water at completion		

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
RE DRILLING MEETS ASTM D-2113

NETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-2
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

DEPTH FT.	DESCRIPTION	ELEV	PENETRATION—BLOWS PER FT. 0 10 20 40 60 80 100
0.0			
10.0	Boring Terminated at 10.0' No rock encountered No water at completion		

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
ORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 60 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

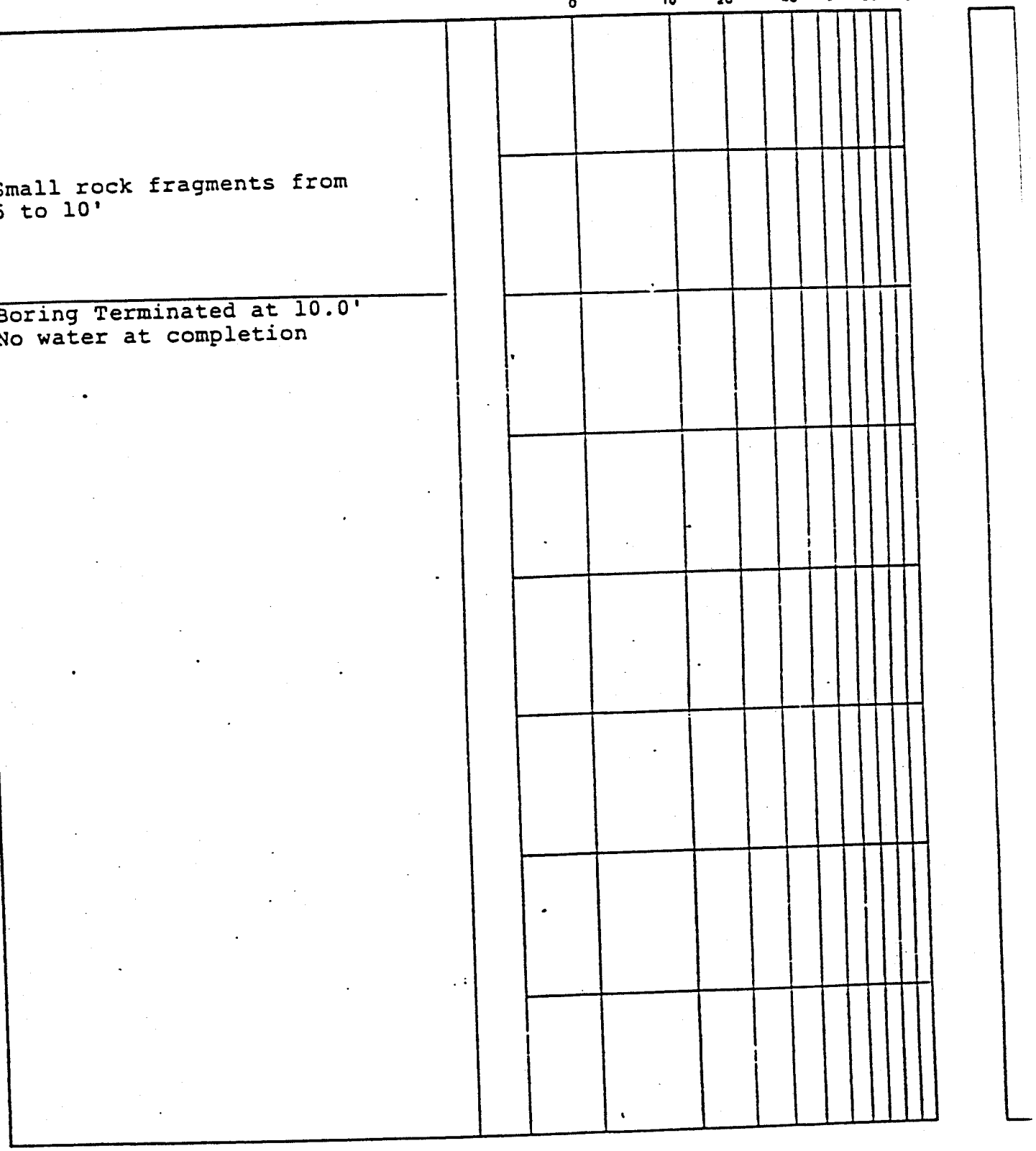
WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-3
DATE DRILLED 11-7-88
LAB NO. _____
JOB NO. P-70-561

DEPTH FT.	DESCRIPTION	ELEV	PENETRATION–BLOWS PER FT. 0 10 20 40 60 80 100
0			
	Small rock fragments from 5 to 10'		
10.0	Boring Terminated at 10.0' No water at completion		



FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. P-4
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

DEPTH	DESCRIPTION	ELEV	PENETRATION—BLOWS PER FT. 0 10 20 40 60 80 100
0.0	Rock fragments from 5 to 10'		
10.0	Boring Terminated at 10.0' No water at completion		

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
RE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 60 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-5
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

DEPTH FT	DESCRIPTION:	ELEV	PENETRATION–BLOWS PER FT. 0 10 20 40 60 80 100
0.0	Small rock fragments from the surface to a depth of 10'		
10.0	Boring Terminated at 10.0' No water at completion		

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-6
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

DEPTH FT.	DESCRIPTION	ELEV	PENETRATION—BLOWS PER FT. 0 10 20 40 60 80 100
0.0			
10.0	Boring Terminated at 10.0' No rock encountered No water at completion		

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
RE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-7

DATE DRILLED 11-7-88

LAB NO.

JOB NO. P-70-561

DEPTH FT.	DESCRIPTION	ELEV	PENETRATION–BLOWS PER FT. 0 10 20 40 60 80 100
0.0			
10.0	Boring Terminated at 10.0' No rock encountered No water at completion		

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 60 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-8
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

DEPTH FT.	DESCRIPTION	ELEV	PENETRATION—BLOWS PER FT. 0 10 20 40 60 80 100
0.0	Small rock fragments from 5 to 10 feet		
10.0	Boring Terminated at 10.0' No water at completion		

FROEHLING & ROBERTSON, INC.

BORING AND SAMPLING MEETS ASTM D-1586
ORE DRILLING MEETS ASTM D-2113

. ENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-9

DATE DRILLED 11-7-88

LAB NO.

JOB NO. P-70-561

DEPTH	DESCRIPTION	ELEV	PENETRATION–BLOWS PER FT. 0 10 20 40 60 80 100
0.0 FT			
10.0	Boring Terminated at 10.0' No rock encountered No water at completion		

FROEHLING & ROBERTSON, INC.

"ORING AND SAMPLING MEETS ASTM D-1586
)RE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-10
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

DEPTH FT	DESCRIPTION	ELEV	PENETRATION–BLOWS PER FT. 0 10 20 40 60 80 100
0.0			
10.0	Boring Terminated at 10.0' No rock encountered No water at completion		

FROEHLING & ROBERTSON, INC.

...ING AND SAMPLING MEETS ASTM D-1586
...E DRILLING MEETS ASTM D-2113

...ENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

| 50 | % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, ? HR.

◀ LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. P-11-
DATE DRILLED 11-7-88
LAB NO.
JOB NO. P-70-561

APPENDIX II

Historical Groundwater Meas

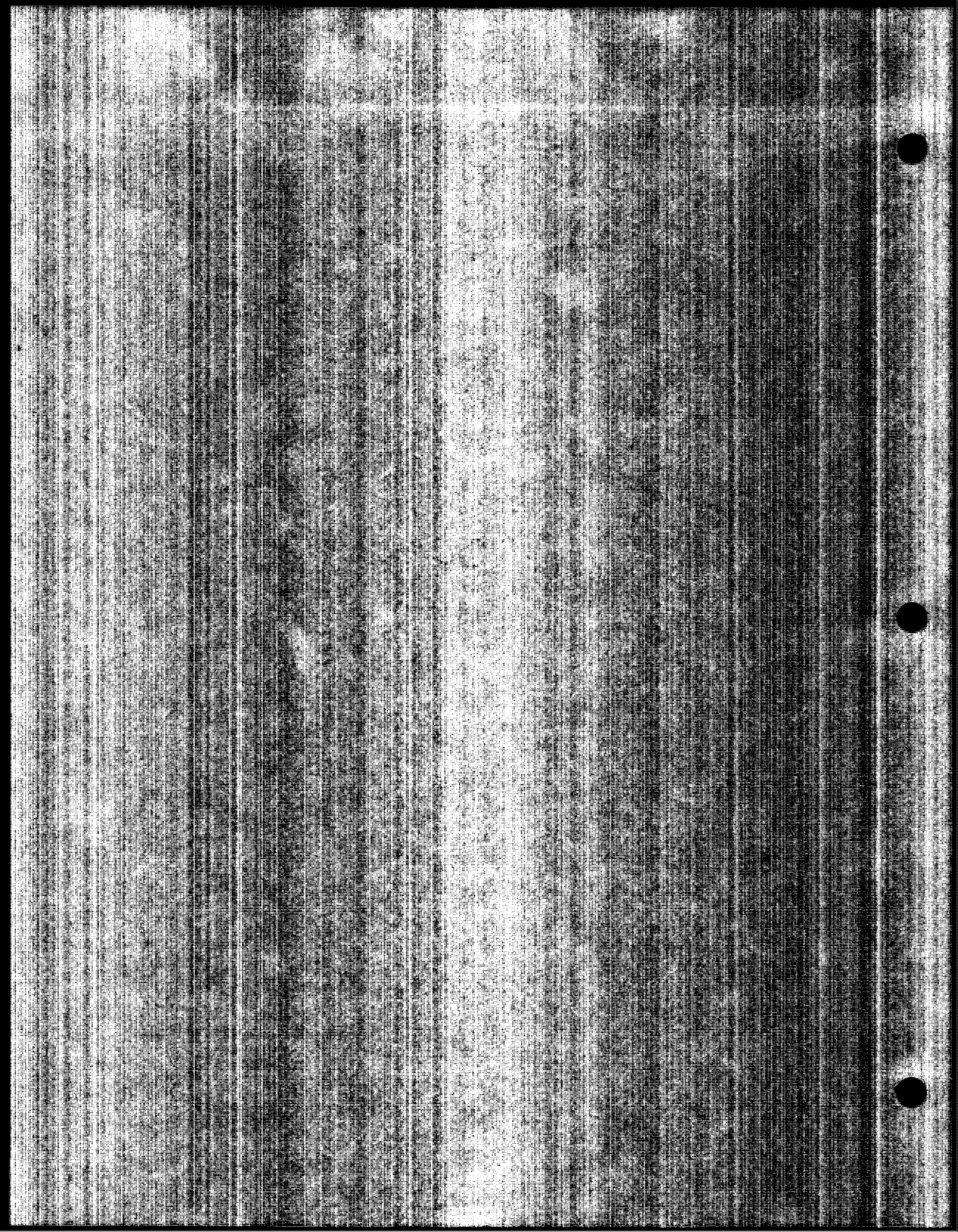
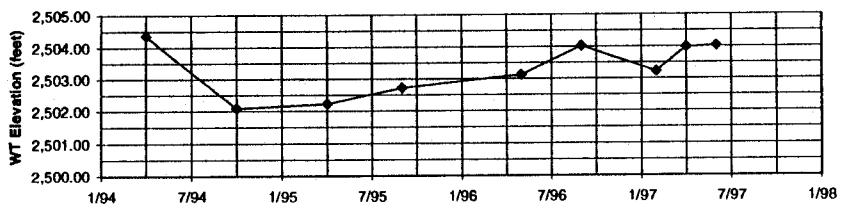


TABLE OF HISTORICAL GROUNDWATER ELEVATIONS

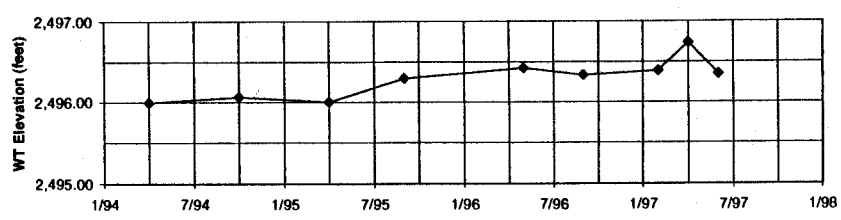
Well ID	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)	GW Elevation (Feet/MSL)
	MAXIMUM	6/19/97	4/29/97	2/13/97	9/24/96	5/1/96	9/14/95	4/13/95	10/26/94	4/25/94
MW-1	2,504.37	2,504.02	2,503.99	2,503.21	2504.02	2503.11	2502.72	2502.22	2,502.07	2,504.37
MW-2	2,468.64	2,467.75	2,467.73	2,467.12	2466.43	2467.73	2465.56	2467.44	2,466.92	2,468.64
MW-2D	2,469.87	2,468.13	2,468.71	2,468.10	2467.42	2468.71	2467.57	2468.42	2,467.92	2,469.87
MW-3	2,428.81	2,427.36	2,428.81	2,427.15	2426.35	2427.3	2427.34	2428.1	2,426.53	2,427.00
MW-3D	2,422.52	2,420.63	2,420.95	2,420.22	2420.1	2420.31	2422.19	2422.52	2,421.41	2,422.10
MW-4	2,463.66	2,457.88	2,461.16	2,456.81	2460.76	2459.51	2459.93	2458.32	2,458.10	2,463.66
MW-5	2,498.00	2,497.01	2,498.00	2,497.43	2496.79	2497.13	2496.58	2496.36	2,496.38	2,496.38
MW-5D	2,496.74	2,496.35	2,496.74	2,496.39	2496.33	2496.42	2496.29	2496	2,496.06	2,495.99
MW-6	2,523.47	2,523.00	2,522.09	2,523.34	2522.34	2523.47	2521.69	2522.65	2,522.56	2,522.59
MW-7	2,579.58	2,579.58	2,579.55	2,578.32	2578.67	2578.63	2578.17	2578.87	2,579.14	2,578.87
MW-7D	2,579.61	2,579.55	2,579.61	2,578.29	2578.59	2578.68	2578.09	2578.84	2,579.13	2,578.89
MW-8	2,447.01	2,446.57	2,447.01	2,446.26	ND	ND	ND	ND	ND	ND
MW-9	2,428.16	2,427.75	2,428.16	2,427.70	ND	ND	ND	ND	ND	ND

* *NOTE: ND = NO DATA*

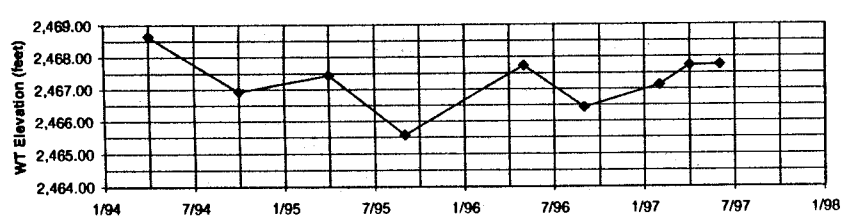
MW-1



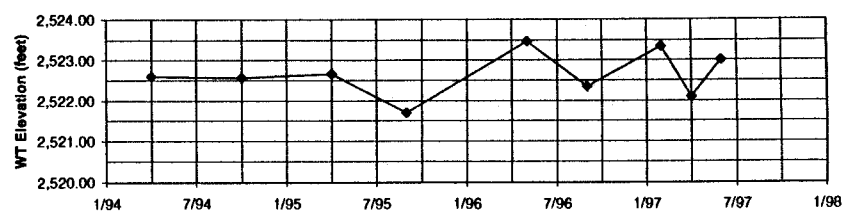
MW-5D



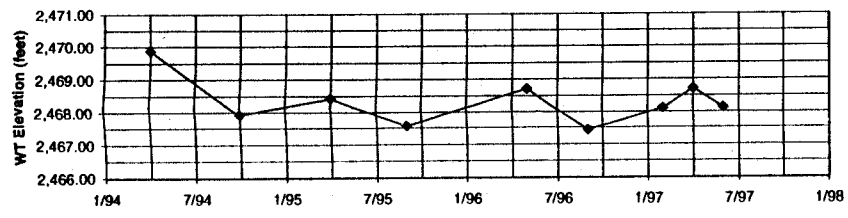
MW-2



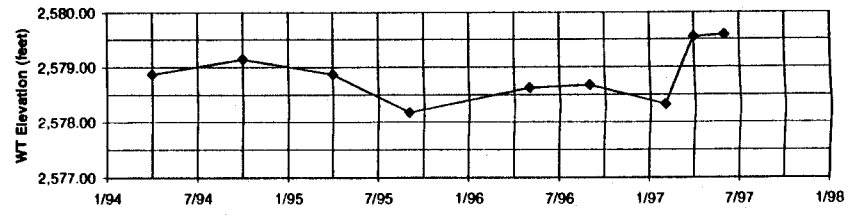
MW-6



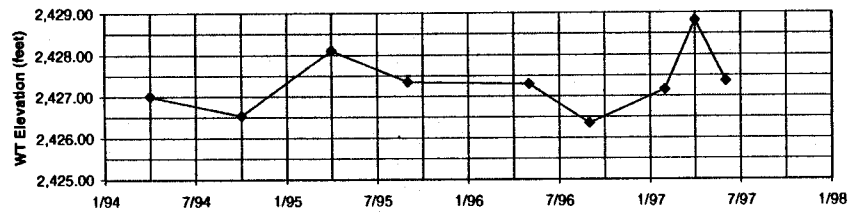
MW-2D



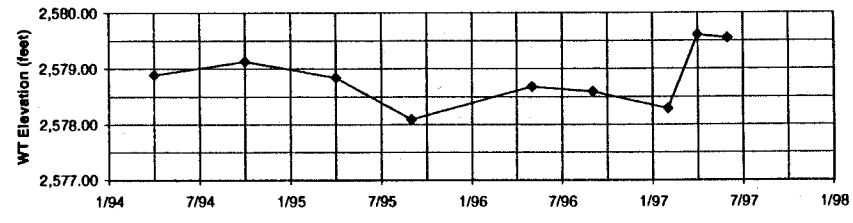
MW-7



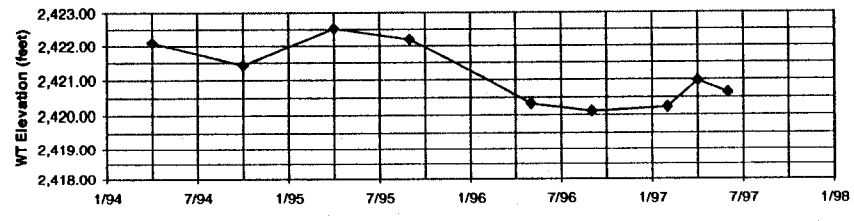
MW-3



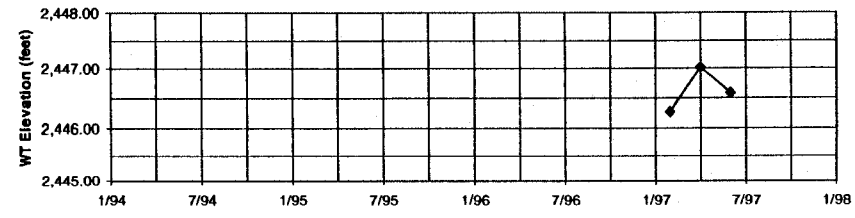
MW-7D



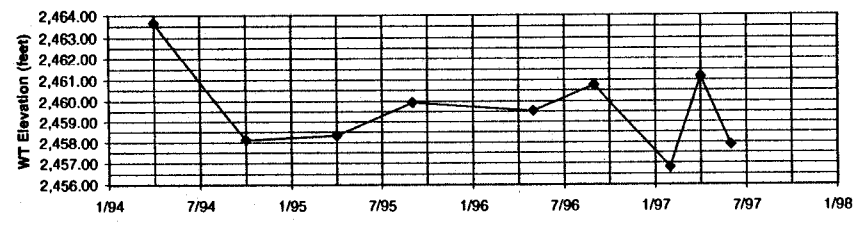
MW-3D



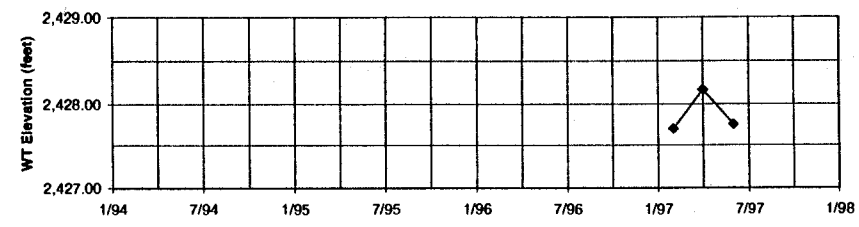
MW-8



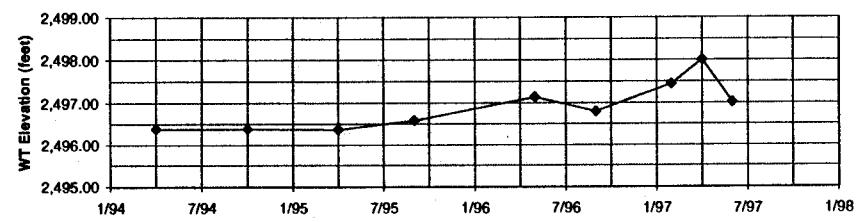
MW-4



MW-9

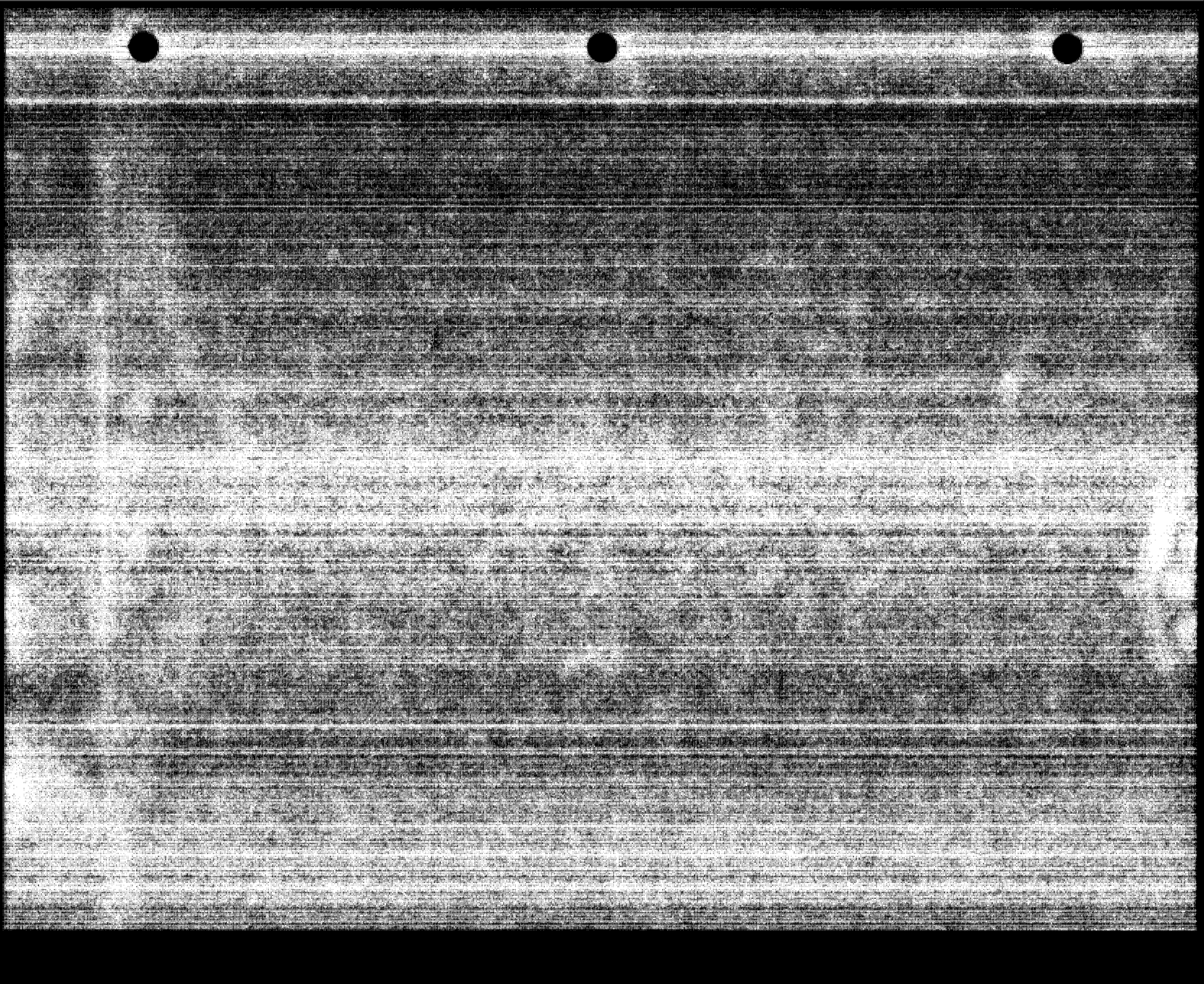


MW-5



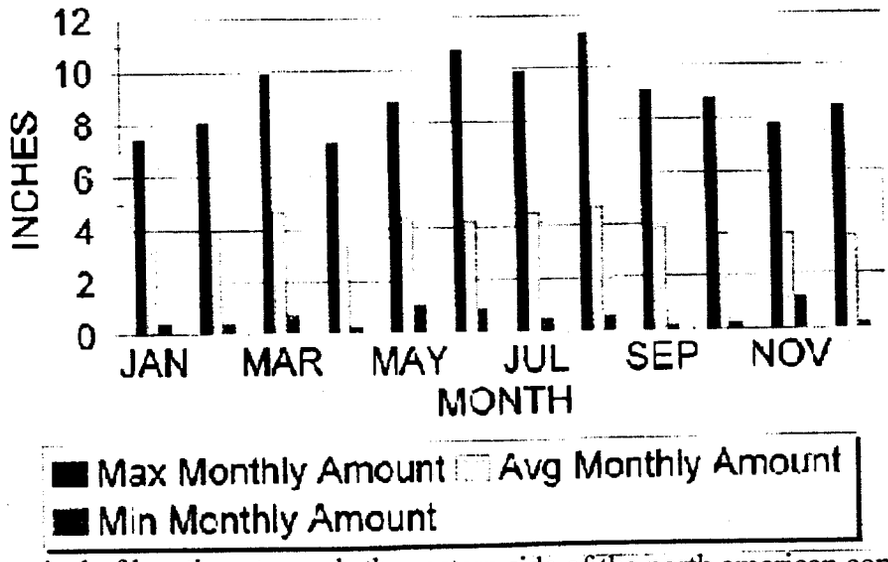
APPENDIX III

Climatological Information



PRECIPITATION CLIMATE

ASHEVILLE, NORTH CAROLINA



Asheville is typical of locations towards the eastern side of the north american continent in that precipitation is evenly distributed throughout the year. As seen on the graph, Asheville averages about 3 to 5 inches a month. But, the graph also shows Asheville is subject to extreme amounts of monthly precipitation, as well as drought conditions. Notice the 11 inch total recorded in August of 1967, and the very dry 0.16 inches received for the month of September, 1984.

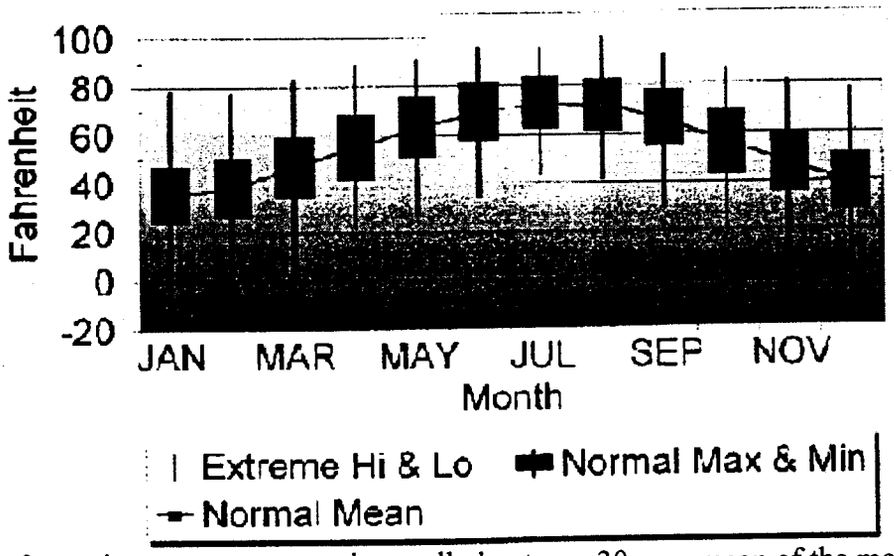
Return to the Atmospheric Sciences home page.

Go to UNCA home page.

CLIMATOLOGY OF ASHEVILLE

Temperature Distribution

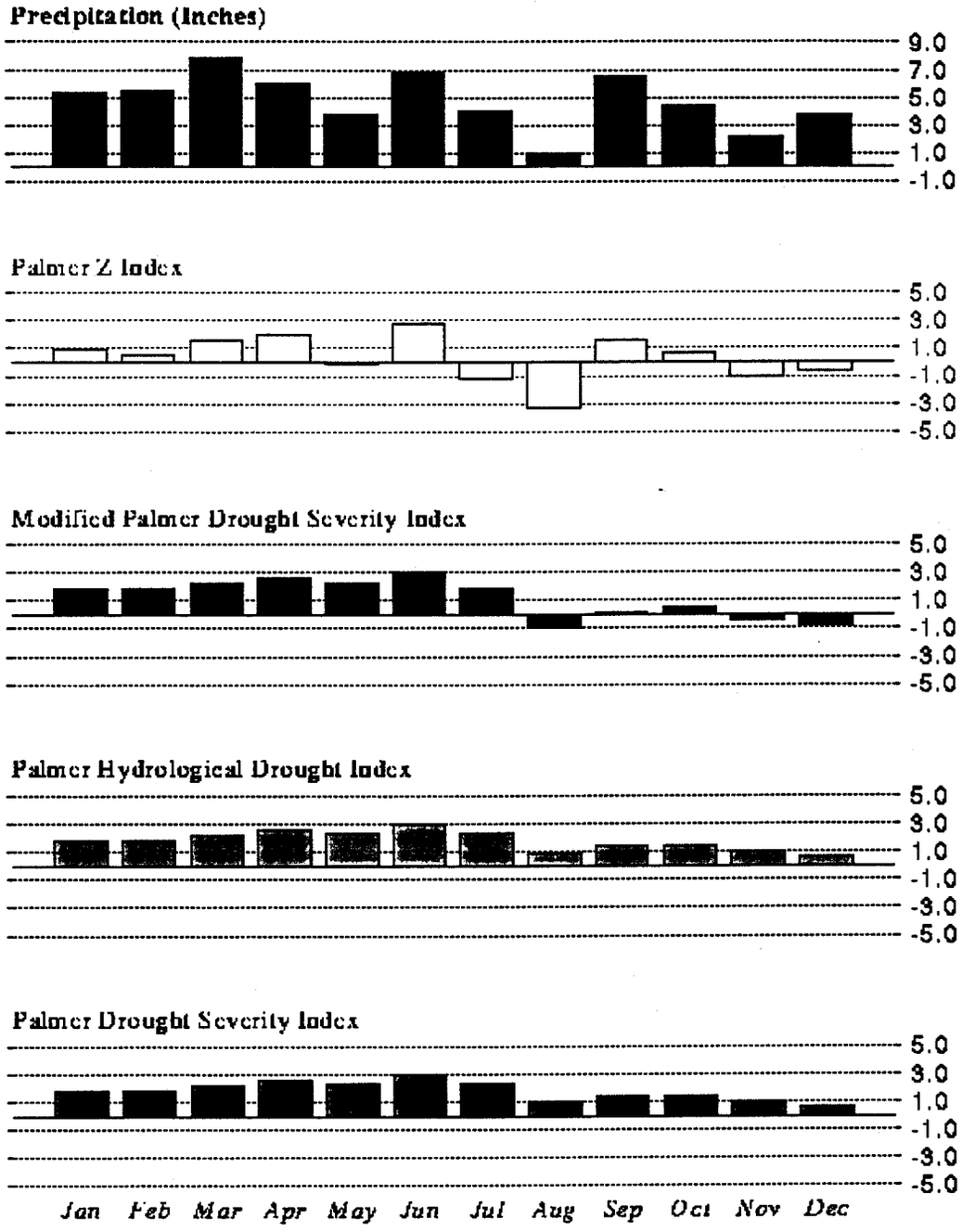
of Asheville, NC



Climatological information on temperature is usually kept as a 30 year mean of the monthly maximum and minimum. This means on average the normal high temperature of any given day in a particular month will not exceed the Normal Max. Likewise, the normal daily temperature should not drop below the Normal Min. This is illustrated on the graph, above, which shows that for a typical day in January, Asheville will have a high temperature of about 45 degrees fahrenheit, and a low of about 23 deg F.

When looking at climatological information, it is always important to also be aware of extremes. Looking at the graph above it is tempting to conclude that Asheville has a very moderate climate, one that never gets below 20 deg F in the winter, or above 80 deg F in July. By looking at the extremes, we can see Asheville can get as low as minus 16 deg F in the winter, and as hot as 100 deg F inthe summer!

Palmer Drought Data



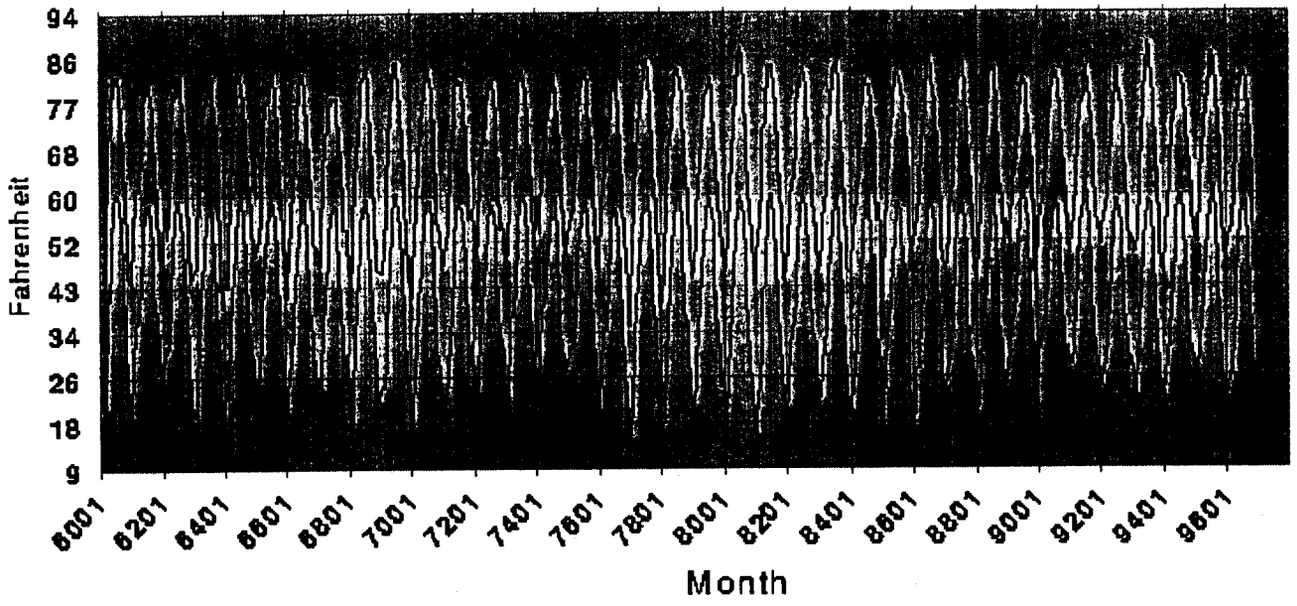
North Carolina-Division 01: 1997 (Monthly Averages)

To Download the Data File Click Here!

To Download the Graph (GIF file), Click Anywhere On the Graph with the Mouse

WAYNESVILLE 1E, NORTH CAROLINA

Temperature January 1960 to December 1997



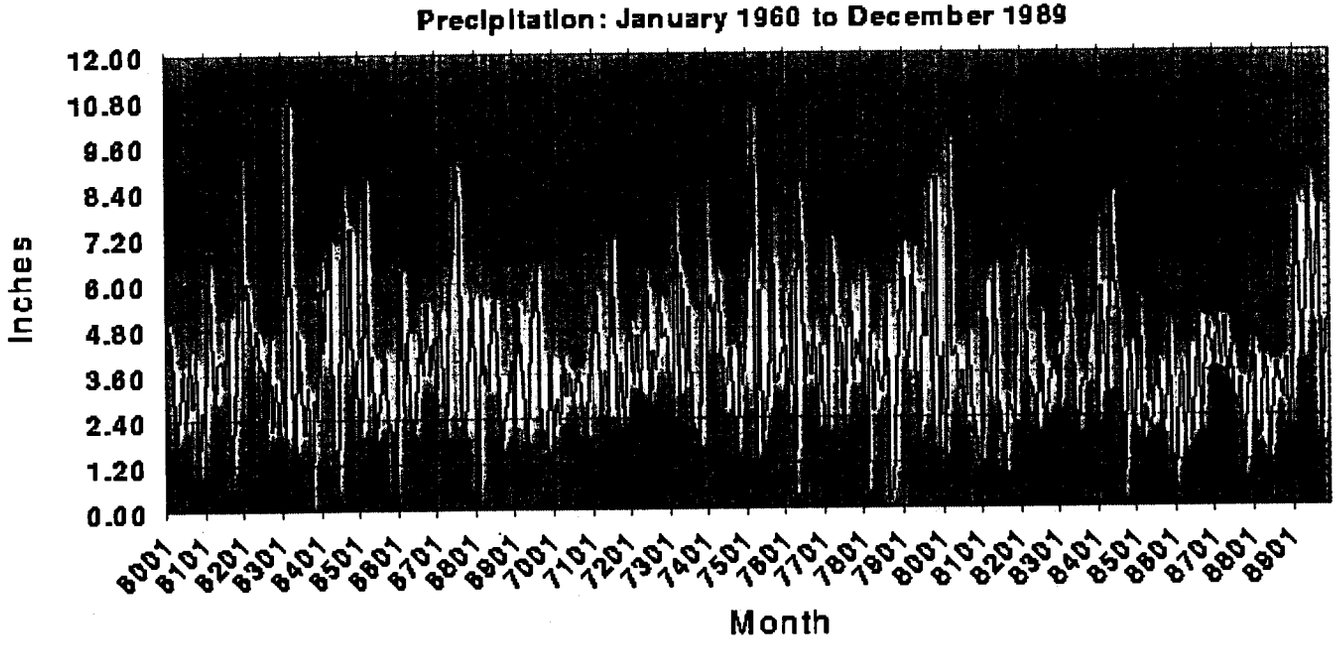
Maximum: 0.2% missing
Minimum: 0.2% missing

Location: 35.48N 82.97W

Note This graph, and the datasets associated with it, are not for commercial distribution.

Created: Thu Jul 2 10:17:46 1998

WAYNESVILLE 1E, NORTH CAROLINA



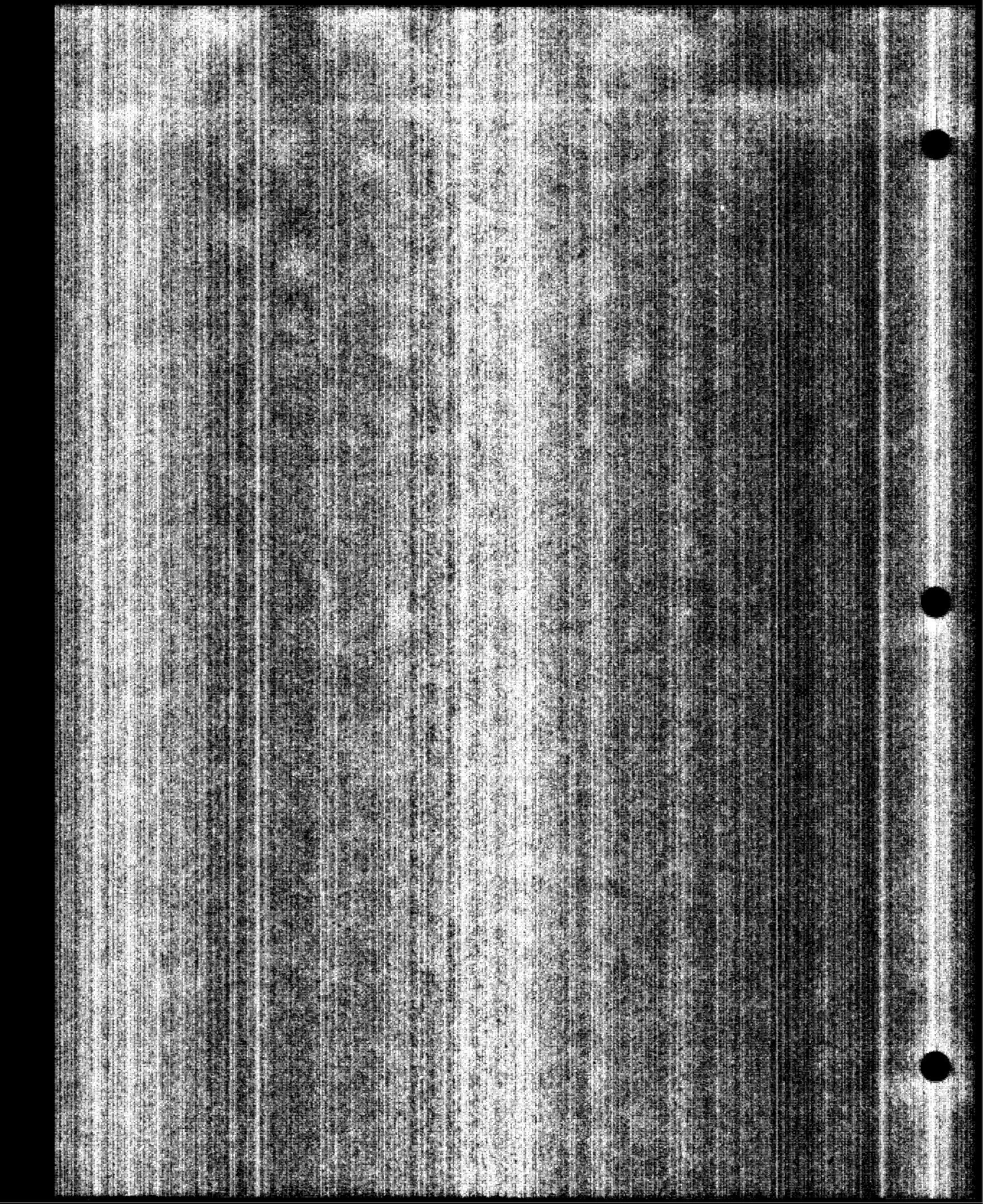
0.0 percent missing

Location: 35.48N 82.97W

Created:

APPENDIX IV

Cell Specific Investigations



VAN DER HORST

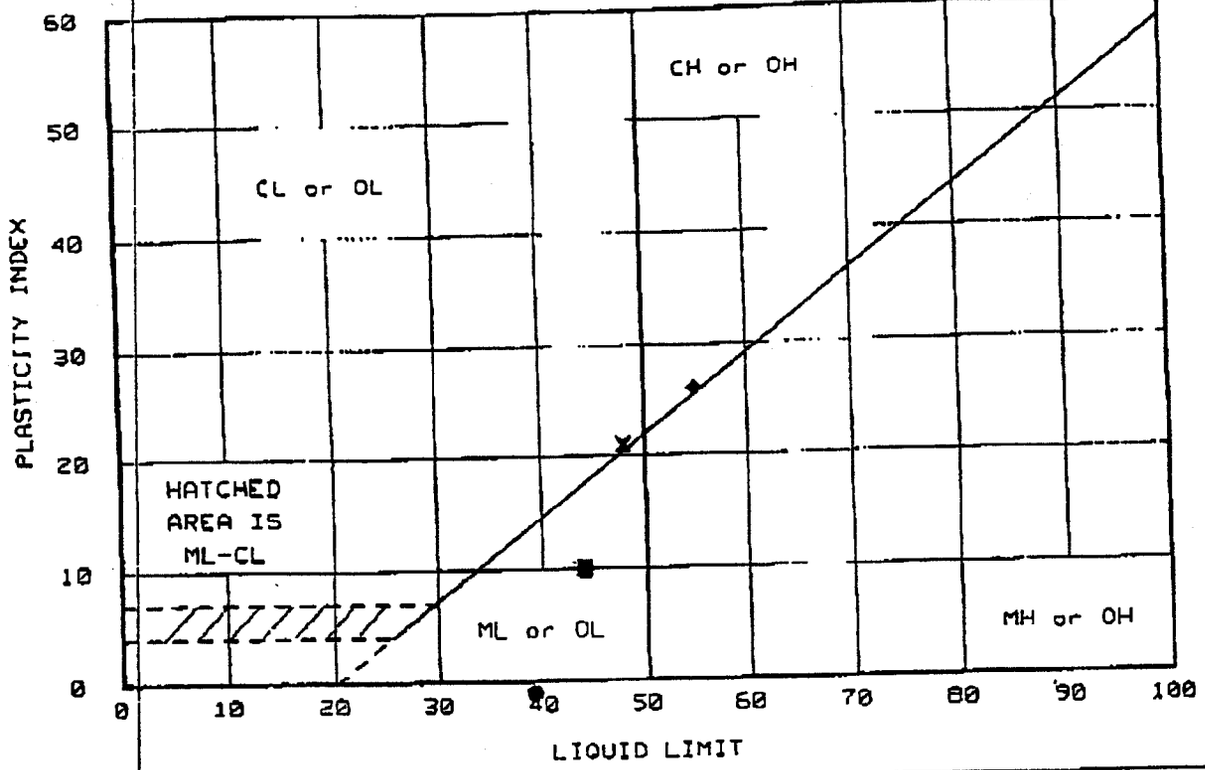
HAYWOOD COUNTY LANDFILL
VNC-98-018.001

Laboratory Testing Summary

Test Method	98-173 (P2-1@ 10-12')	98-174 (P2-1@ 21-23')	98-175 (P2-2@ 3-4')	98-176 (P2-1@ 1-5')	98-177 (P2-1@ 6-10')
Natural Moisture Content (ASTM D-2216)	22.1%	30.4%	21.5%	24.0%	22.9%
Atterberg Limits (ASTM D-4318)					
LL	39	37	44	55	48
PL	40	NP	34	29	27
PI	NP	--	10	26	21
Grain-size Analysis (ASTM D-442)					
% Gravel	1.6	0.3	8.4	2.4	3.5
% Sand	57.0	39.5	47.6	43.5	45.1
% Silt	23.5	36.2	28.2	26.4	24.6
% Clay	17.9	24.0	15.8	27.7	26.8
Specific Gravity (ASTM D-854)	2.71	2.72	2.75	2.71	2.69
USCS Soil Classification	SM	ML	SM	CH	CL
Shelby Tube Permeability (ASTM D-5084)					
Dry Density (pcf)	90.4	84.6	95.9	--	--
Moisture (%)	31.6	30.4	26.6	--	--
Permeability (cm/sec)	2.2×10^{-6}	1.3×10^{-5}	2.0×10^{-7}	--	--

Note: The atterberg for sample 98-174 was prepared using the dry method all other atterberg samples were prepared using the wet method. The bottom of the shelby tube for sample 98-174 contained 16 to 18 inches of weak weathered rock.

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location +	Description	LL	PL	PI	-200	ASTM D 2487-90
●	98-173	SHELBY TUBE P2-1 @ 10-12'	39	40	-1	41.4	SM, Silty sand
▲	98-174	SHELBY TUBE P2-1 @ 21-23'	37	NP	None	60.3	ML, Sandy silt
■	98-175	SHELBY TUBE P2-2 @ 3-4'	44	34	10	44.0	SM, Silty sand
◆	98-176	DRILL CUTTINGS P2-1 @1-5'	55	29	26	54.1	CH, Sandy fat clay
×	98-177	DRILL CUTTINGS P2-1 @ 6-10'	48	27	21	51.4	CL, Sandy lean clay

NP - Non-Plastic

Project No.: VNC-98-018
Project: HAYWOOD COUNTY LANDFILL

Client: MUNICIPAL ENGINEERING
Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

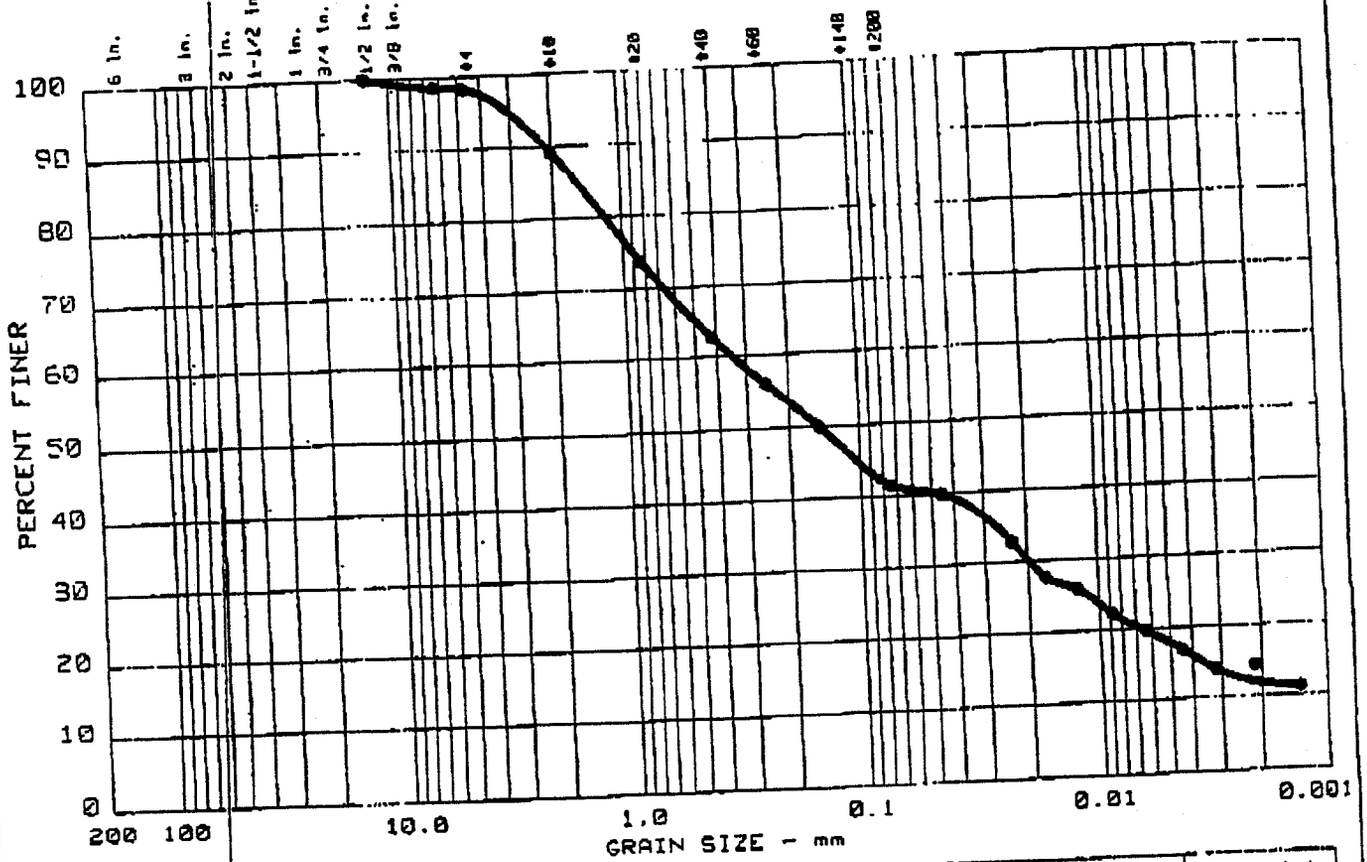
Remarks:
SAMPLES TAKEN FROM SHELBY TUBES AND DRILL CUTTINGS DELIVERED TO VANDERHORST ON 05/04/98.

LIQUID AND PLASTIC LIMITS TEST REPORT

VAN DER HORST ENGINEERING

Fig. No. 173

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	1.6	57.0	23.5	17.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	39	NP	1.57	0.34	0.15	0.020	0.0035			

	MATERIAL DESCRIPTION	USCS	AASHTO
●	OLIVE BROWN TO BROWN SILTY SAND LITTLE CLAY.	SM	

Project No.: VNC-98-018 /98-173
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

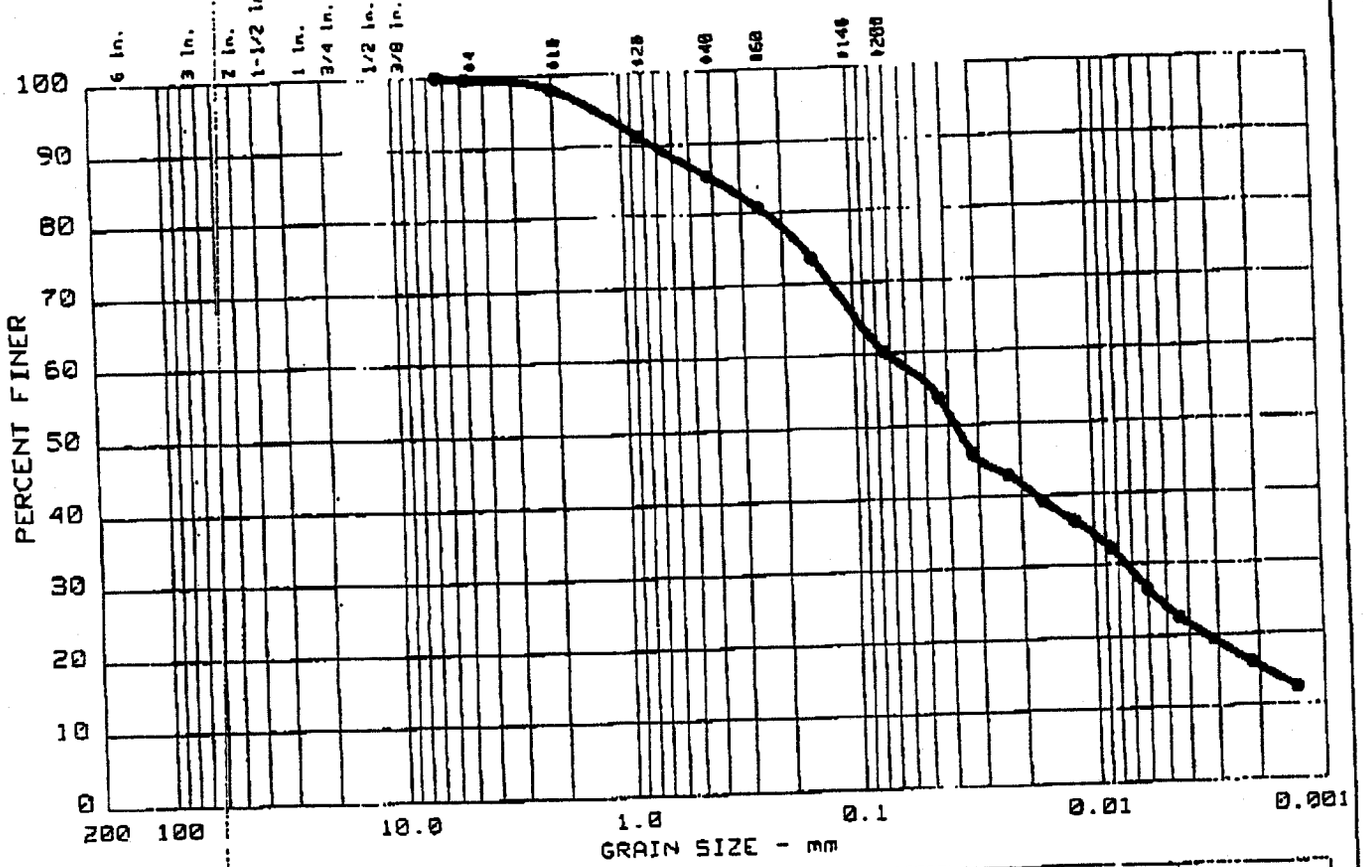
GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Remarks:
SHELBY TUBE SAMPLE
P2-1 @ 10-12', DELIVERED TO VANDERHORST ON 05/04/98.

Figure No. 173

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	0.3	39.5	36.2	24.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	37	NP	0.39		0.04	0.007	0.0019			

MATERIAL DESCRIPTION	USCS	AASHTO
● OLIVE BROWN TO BROWN SANDY SILT SOME CLAY.	ML	

Project No.: VNC-98-018 /98-174
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

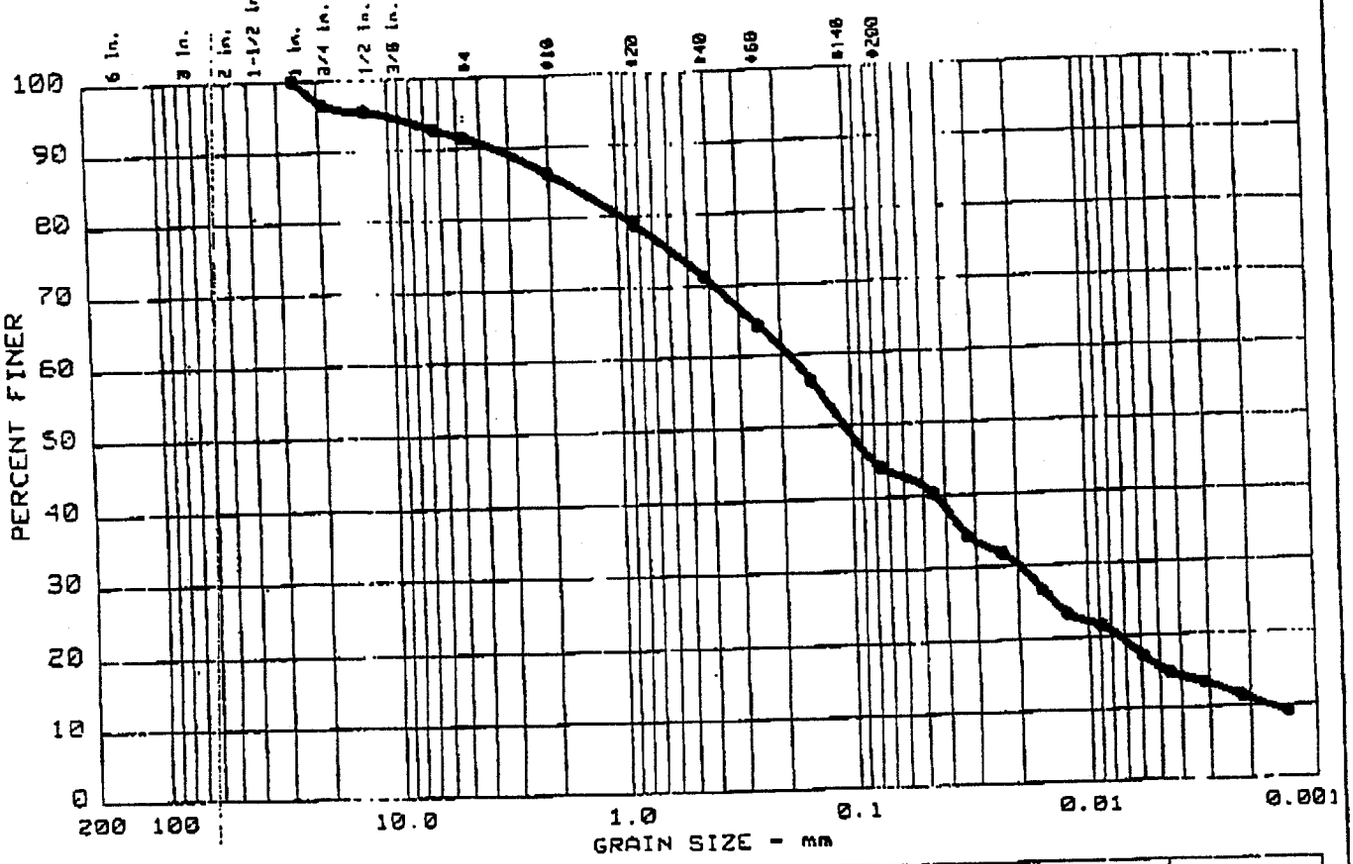
GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Remarks:
SHELBY TUBE SAMPLE
P2-1 @ 21-23', DELIVERED TO VANDERHORST ON 05/04/98.

Figure No. 174

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	B	0.0	8.4	47.6	28.2	15.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	44	10	1.70	0.18	0.11	0.019	0.0045	0.0015	1.35	117.8

MATERIAL DESCRIPTION	USCS	AASHTO
● OLIVE BROWN TO BROWN SILTY SAND LITTLE CLAY.	SM	

Project No.: VNC-98-018 /98-175
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

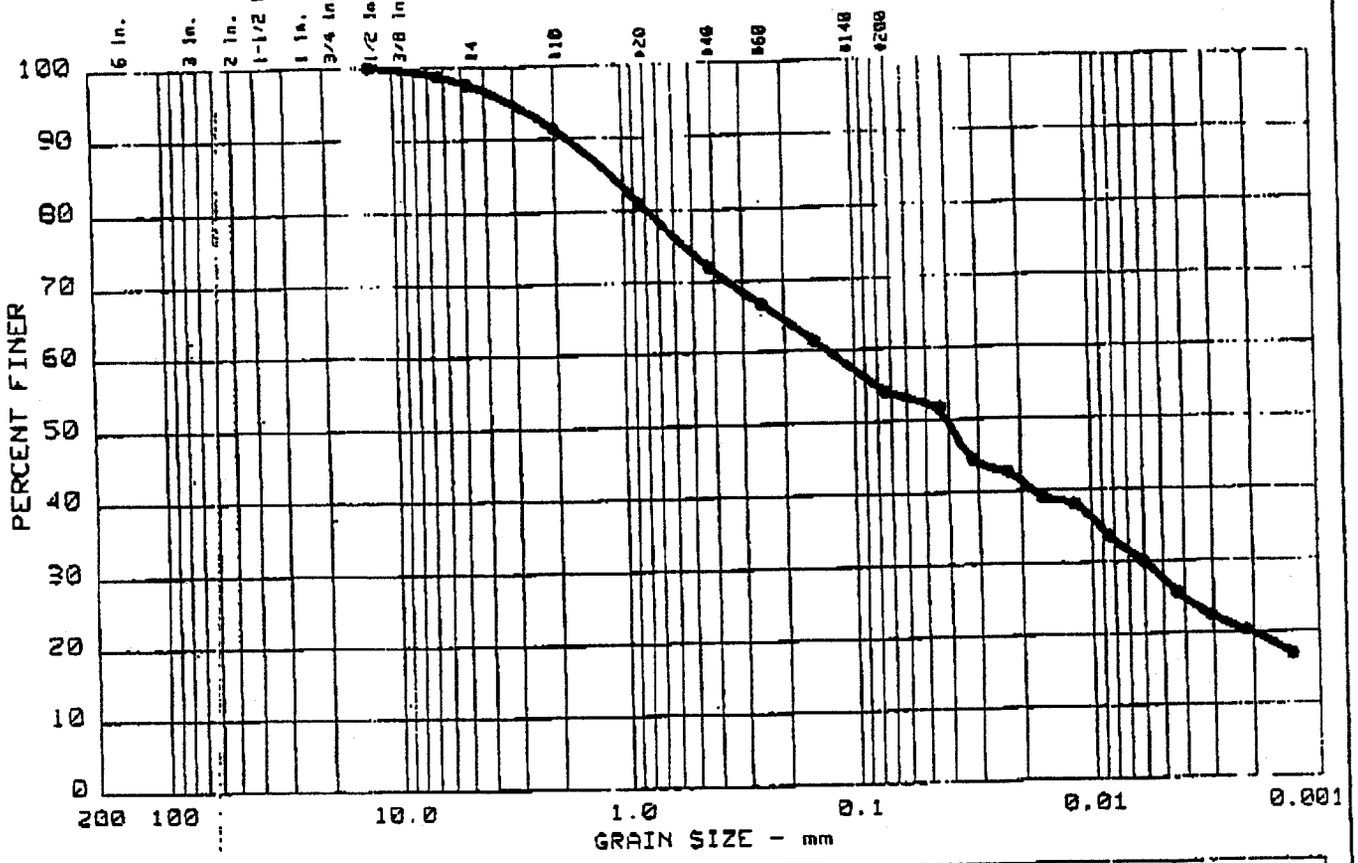
GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Remarks:
SHELBY TUBE SAMPLE
P2-2 @ 3-4', DELIVERED
TO VANDERHORST ON
05/04/98.

Figure No. 175

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	2.4	43.5	26.4	27.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	55	26	1.15	0.13	0.04	0.006				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN TO DARK BROWN SILTY SAND SOME CLAY.	CH	

Project No.: VNC-98-018 /98-176
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

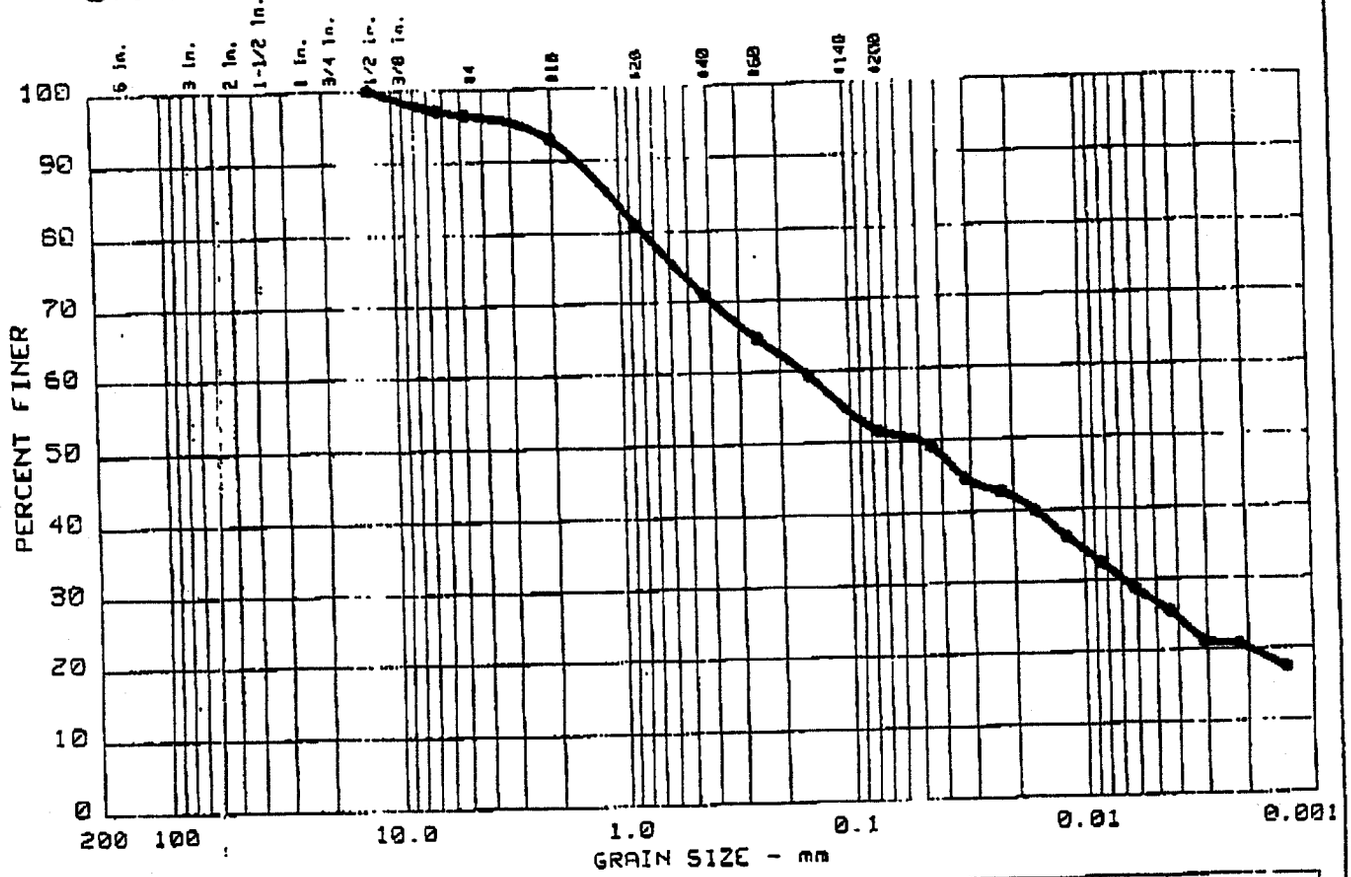
GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Remarks:
DRILL CUTTINGS SAMPLE P2-1 @ 1-5', DELIVERED TO VANDERHORST ON 05/04/98.

Figure No. 176

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	S	0.0	3.5	45.1	24.6	26.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	48	21	1.08	0.16	0.05	0.007				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN SILTY SAND SOME CLAY.	CL	

Project No.: VNC-98-018 /98-177
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Remarks:
DRILL CUTTINGS SAMPLE PZ-1 @ 6-10', DELIVERED TO VANDERHORST ON 05/04/98.

Figure No. 177

LOG OF BORING: P2-1

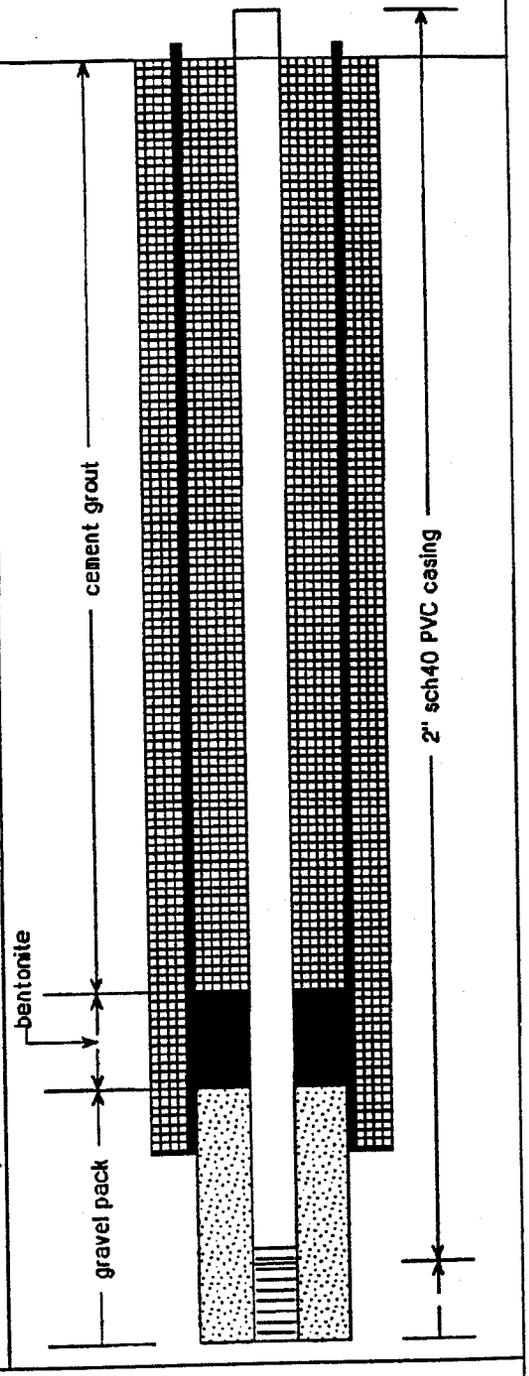
Project: Haywood County
Project No. 6980105
Type: HSA SS NQ AH

Drilling Contractor: Graham G Currie
Registration Number: 537

Surface Elevation: ft
Top of Casing: ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	6			SILTY SAND (SM); brown to dark brown, some clay, root debris
5	7			-brown, with medium grained sand, some mica and trace clay, some root debris
	11			-grades stiff, with medium to coarse grained sand and mica
10				
15	24			-red to brown, very stiff, grades with more coarse grained sand, relict foliations, zones of clayey sand
20	26			-grades with less sand, trace clay
				SANDY SILT (ML); olive brown to brown, some clay
25	39			SILTY SAND (SM); salt and pepper color, dense, medium to coarse grained, some gravel, near vertical clay-filled fracture, saprolite
30	57			-grades very dense, rock fragments, gneissic structure, grades to orange weathered rock, quartz grains with sand and silt, biotite layer
				-Auger Refusal at 34.0 feet
35				GNEISS; quartz, plagioclase, and mafic minerals, faint banding fractures at 30 degrees, REC=92%, RQD=79%
				-highly weathered, REC=59%, RQD=0%
40				

WELL DIAGRAM



Completion Depth: 52.5ft
DATE: 5/21/98

Depth to Water: 37 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P2-1

Project: Haywood County
Project No. G98010.5
Type: HSA SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: ft
Top of Casing: ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	WELL DIAGRAM
45				-weathered, REC=85%, RQD=52% -slightly weathered, fractures parallel to banding at 30 degrees REC=100%, RQD=92%	gravel pack; 2" sch40 PVC .010 slotted screen
50				End of Boring at 52.5 feet	
55					
60					
65					
70					
75					
80					

Completion Depth: 52.5ft
DATE: 5/21/98

Depth to Water: 37 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

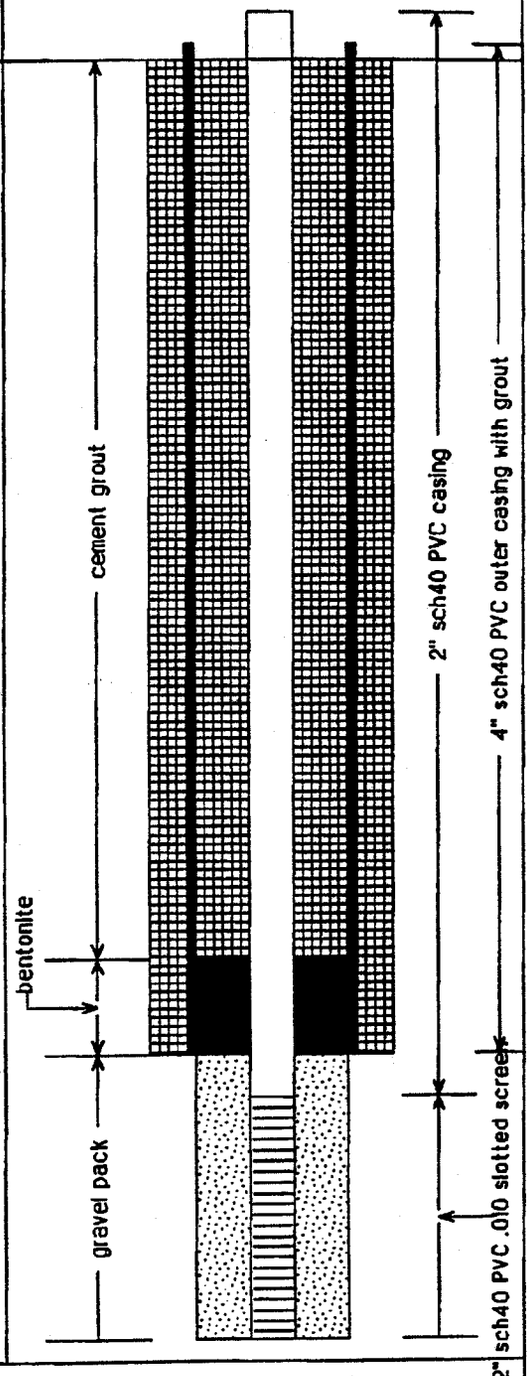
LOG OF BORING: P2-2

Project: Haywood County
Project No. G98010.5
Type: HSA SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: ft
Top of Casing: ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	5			SILT (ML): tan to brown, firm, with medium to coarse grained sand, root debris
5				SILTY SAND (SM): olive brown to brown, little clay
	10			SAND (SP): black/white, medium dense, fine to coarse grained; rock fragments, relict foliation, with quartz and biotite; iron stains
10				
15	24			SANDY SILT (ML): tan-orange, medium dense, fine sand with some coarse grains, relict foliation, vertical fracture with iron mineralization, micaceous
20	20			SILTY SAND (SM): dark brown and black, medium dense, rust staining, highly weathered quartz grains, relict foliatioin at 45 degrees with iron staining
25	29			-grades black and white with yellow stains, coarse quartz grains, micaceous iron staining, relict foliation
	50/5			SAND (SP): white-yellow, very dense, medium to coarse grained, with gravel, relict foliation Auger Refusal at 31.0 feet
30				GNEISS
35				
40				



Completion Depth: 47.3ft
DATE: 5/21/98

Depth to Water: 33 ft MD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P2-2

Project: Haywood County
Project No. G98010.5
Type: HSA SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: ft
Top of Casing: ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	WELL DIAGRAM
45					gravel pack; 2" sch40 PVC .010 slotted screen
50				End of Boring at 47.3 feet	
55					
60					
65					
70					
75					
80					

Completion Depth: 47.3ft
DATE: 5/21/98

Depth to Water: 33 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

P2-1

LOG OF BORING NO. P2-1

PROJECT Haywood JOB NO.

TYPE 4¼ HSA, SS DRILLING COMPANY Graham and Cunie

DEPTH (FT)	BLOWS PER FT	SAMPLES #	SAMPLES BEG. DEPTH	SAMPLES Retr.	DESCRIPTION OF MATERIAL	COMMENTS
					SURFACE ELEVATION	
	1·2·4·6				Med brown silt; trace clay; some coarse grains, rock frags @ ~1.5' metastalline; root debris; zones of yellow white fine sand	
					Brown, faint fabric; abundant coarse grains and frags	
5	3·4·3·5				upper spoon micaceous tan/green; trace clay	
					lower spoon brown/green w/ pebbles and frags; zones of Fe/rust	
	8·7·4·5				cl si/si l w/ coarse grains; micaceous	
					little recovery; brown/orange	
10	—		ST		SHELBY TUBE 10-12'	
					Saprolite, relict fabric; Fe stained mottles, fine sand w/ silt	
15	10·11·13·17				dark zones of Fe staining and rust; small zones of red/brown clay in grain "interstices; upper spoon light w/ coarse qtz grains	
					brown; fine grained relict fabric; micaceous, Silt w/ fine sand,	
20	11·14·12·10		Silt		trace clay; ~20.5 change Si Cl; gray, good structure	
			Si Cl		dark bands and red-brown bands	
					int clay zone	
		4/24			Tried ST from 21-23; push only 1.25' 500 lbs	
					Rock frags; metastalline small near vert seam of red-brown clay	
25	40·21·18·41				SISa; 'coarse to med grain' salt + pepper appearance	
					good relict rock fabric, saprolite; rocky layer at bottom of spoon	
					little recovery; large rock frag; gneissic texture;	
30	8·12·45·50/3"				grades to orange weathered rock (micro xtalline) qtz vein w/	
					orange fine sand and silt in interstices; black mica layers	
					grades less orange toward bottom of spoon	
					Auger Refusal @ 34'	
35						
40						

COMPLETION DEPTH

DATE 4/25/98 FIELD AGENT J. Skinner

DEPTH TO WATER IN BORING

LOCATION top of slope; in line of MW6 & Vent

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

P2-2

LOG OF BORING NO. P2-2

PROJECT Haywood JOB NO.

TYPE HSA 4¼, SS DRILLING COMPANY Graham ; Cunie

DEPTH (FT)	BLOWS PER FT	SAMPLES #	SAMPLES BEG. DEPTH	SAMPLES Rel.	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)	COMMENTS
	WH-2-3-3				CLSi ; faint fabric ; root debris; coarse grains; tan - brown grade to red-brown	
	3.0-4.0'		ST		SHELBY TUBE ; pushed ~1' 3-4' ; 500 lb pressure.	
5						
	5-5-5-5				Sand - very little recovery fine to coarse grain ; rock frags ; layered texture ; black/white ; qtz, biotite, minor Fe stains	
10						
	5-10-14-12				Tan-orange ; SaSilt : fine sand, some coarse ; faint relict fabric 14.5 grades tan - gray, less coarse grain ; fine to med sand + silt relict vertical frac ori Fe mineralization, micaceous layers	
15						
	10-8-12-11				SiSa/SaSi : dark brown, black ; areas of orange silt and rust staining ; saprolite, PWR ; qtz grains highly weathered ; layering @ ~45° w heavy Fe staining, Hmm subst	
20						
	23-18-11-11				SiSa black-white w/ yellow stain ; coarse grain of qtz ; micaceous layers and Fe staining @ 25' grades to fine to med stained SaSi relict fabric Phyllonitic ; xtals apparent	
25						
	20-46-50/5.5"		Sa SiSa		white - yellow sand, coarse grain w/ frags ; grades fine grain SiSa dark salt/pepper color ; good fabric	
30					AR@ 31'	
35						
40						

COMPLETION DEPTH DEPTH TO WATER IN BORING

DATE 4/26/98 FIELD AGENT Skinner LOCATION 30' upS from P2-1

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

SURVEY DATA*

Location:	White Oak Landfill, Haywood County, NC
Project:	83507
Date:	10/9/97
Personnel:	B.D. Klauk
	S.V. MacQueen
2578.87	Top of 4x4 Control Marker
2575.87	Bottom of 4x4 Control Marker

				LIP	PIT BOTTOM		
	BS	HI	FS	ELEV	PIT DEPTH	ELEV	
BM	8.92	2584.79					BS to Control Bottom
TP1			2.83	2581.96	7.00	2574.96	
TP2			9.00	2575.79	8.60	2567.19	
TP3			5.92	2578.87	9.10	2569.77	
TP4			6.79	2578.00	9.20	2568.80	
TP5			6.08	2578.71	9.20	2569.51	
TP6			4.96	2579.83	7.20	2572.63	
TP7			5.67	2579.12	6.10	2573.02	
POG			0.83	2583.96			FS to Point on Ground
TP@B114	6.67	2590.63					BS to Point on Ground For Turning Point Elev.
TP8			0.83	2589.80	9.60	2580.20	
TP9			4.90	2585.73	8.30	2577.43	

*All elevations are in feet above mean sea level

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	FILL, consists of stiff to very stiff moist brown fine sandy micaceous silt (ML).		23
			14
12.0	Firm moist red-brown silty micaceous fine to coarse SAND (SM).		18
15.0	Stiff moist brown and orange-brown fine sandy micaceous SILT (ML).		13
			11
26.0	PARTIALLY WEATHERED ROCK (PWR), sampled as dry yellow, gray, and orange-brown silty micaceous fine to coarse sand, with trace rock fragments.		50/4"
			50/2"
37.2	Auger refusal encountered at 37.2 feet. Boring terminated.		50/0"

REMARKS:

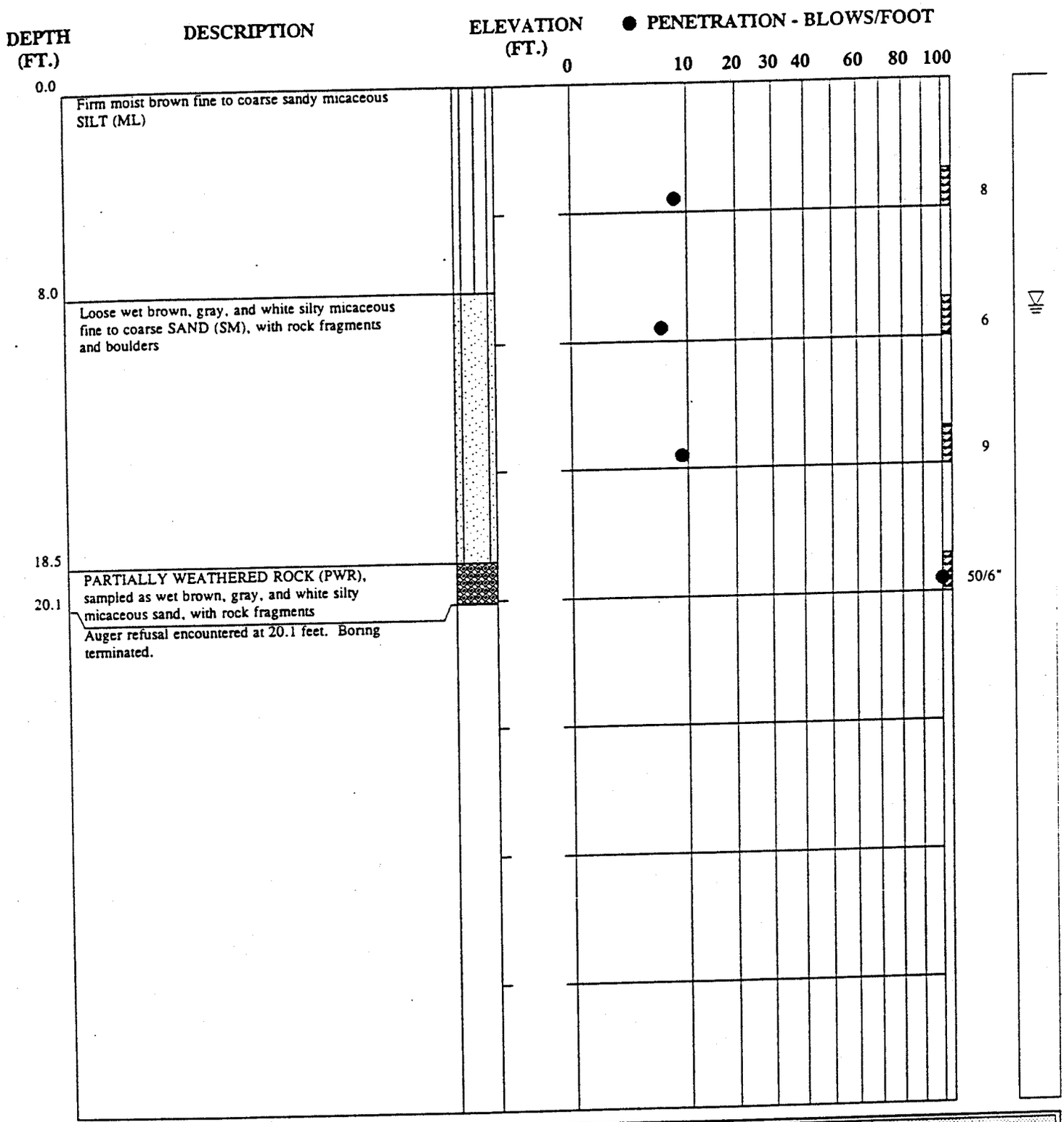
Borehole dry at completion of drilling. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-5
DATE DRILLED	September 15, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

Groundwater encountered at 9.0 feet. Type II Monitoring Well Installed. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

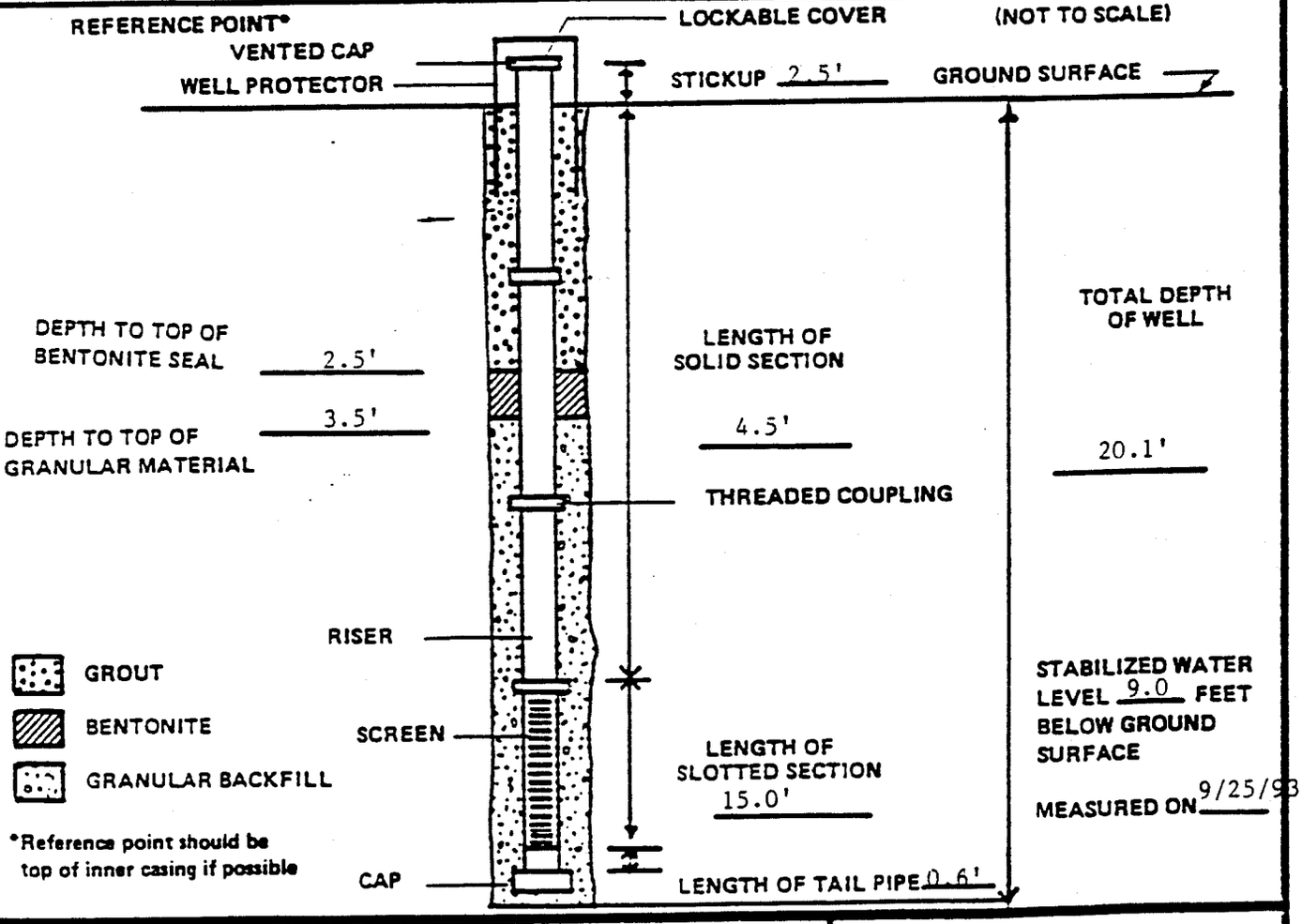
TEST BORING RECORD

BORING NUMBER	GWM-5A
DATE DRILLED	September 25, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME: White Oak Landfill
JOB NUMBER: 472-07913-03
WELL NUMBER: GWM-5A
INSTALLATION DATE: 09/25/93
LOCATION: West Drainage Feature (See Record Drawings)
GROUND SURFACE ELEVATION:
REFERENCE POINT ELEVATION:
GRANULAR BACKFILL MATERIAL: NC #2 sand
SLOT SIZE: 0.010"
SCREEN MATERIAL: PVC
SCREEN DIAMETER: 2"
RISER MATERIAL: PVC
RISER DIAMETER: 2"
DRILLING TECHNIQUE: HSA
DRILLING CONTRACTOR: Law Engineering
BOREHOLE DIAMETER: 8"
LAW ENGINEERING FIELD REPRESENTATIVE: Hoda Kablawi
LOCK BRAND: Master
SIZE/MODEL: #3
KEY CODE/COMBINATION: 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-6083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc ____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR Law Engineering
DRILLER REGISTRATION NUMBER 332
GWM-5A
LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: White Oak, North Carolina
(Road, Community, or Subdivision and Lot No.)
County: Haywood

2. OWNER Haywood County, North Carolina
ADDRESS 420 N. Main Street (Street or Route No.)
Waynesville (City or Town) NC (State) 28786 (Zip Code)

3. DATE DRILLED 9/25/93 USE OF WELL Monitoring
4. TOTAL DEPTH 20.1' CUTTINGS COLLECTED ☒ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
6. STATIC WATER LEVEL: 11.5' FT. ☐ above ☒ below TOP OF CASING,
TOP OF CASING IS 2.5' FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST N/A
8. WATER ZONES (depth): _____
9. CHLORINATION: Type N/A Amount N/A

DRILLING LOG

Depth From	Depth To	Formation Description
0	8'	Sandy SILT
8'	18.5'	Silty sand
18.5'	20.1'	Partially weathered rock

If additional space is needed use back of form.

10. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	4.5 Ft.	2"		PVC
		Ft.			
		Ft.			

11. GROUT:

	Depth From	Depth To	Material	Method
	0	2.5 Ft.	Cem-Bent	Tremie
		Ft.		

12. SCREEN:

	Depth From	Depth To	Diameter	Slot Size	Material
	4.5	19.5 Ft.	2" in.	0.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

13. GRAVEL PACK:

	Depth From	Depth To	Size	Material
	3.5'	20.1 Ft.		NC#2 sand
		Ft.		

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

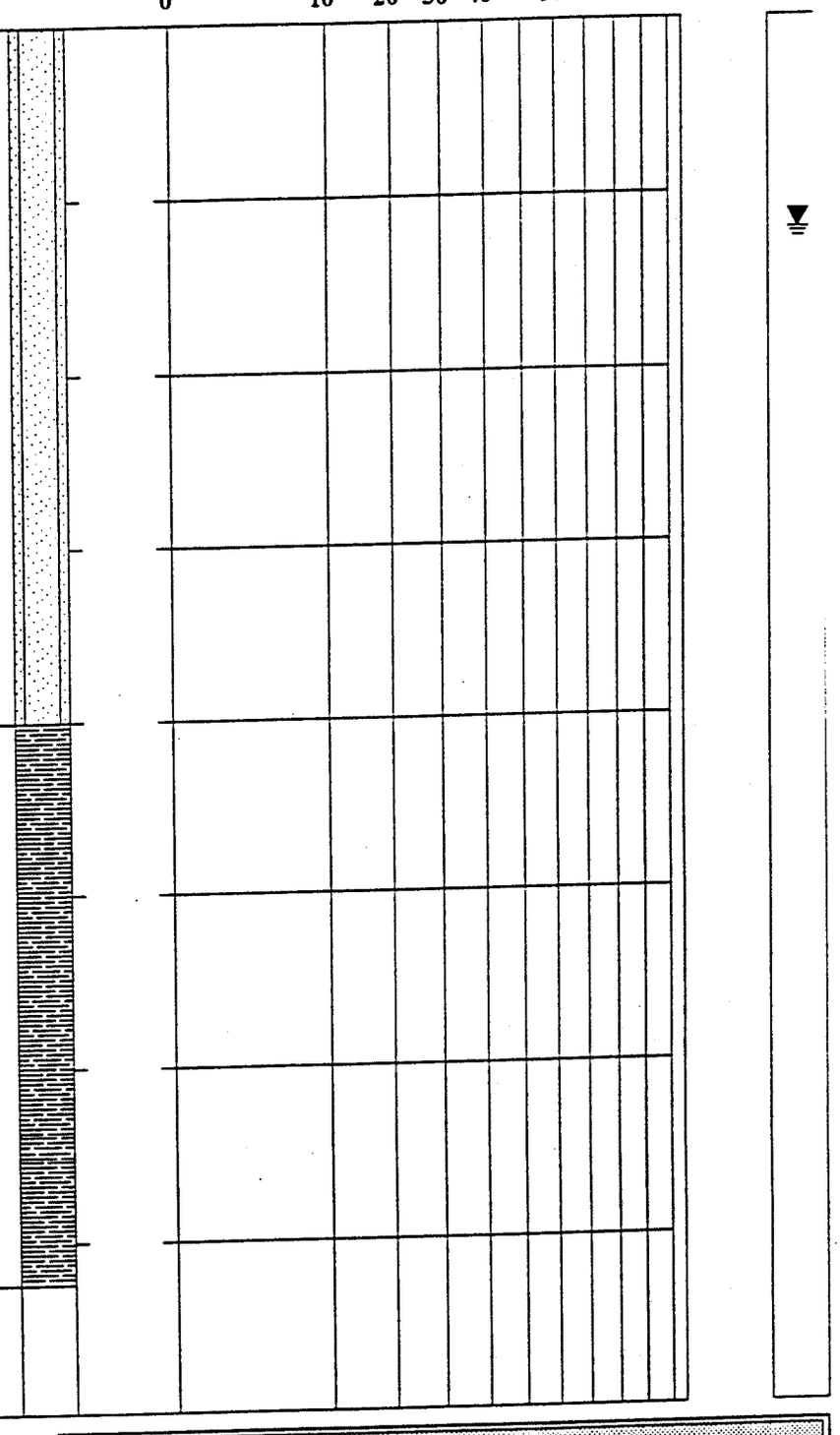
REMARKS: Bentonite 2.5' to 3.5'

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Thomas M. Schuppert 10/1/93
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/84
Submit original to Division of Environmental Management and copy to well owner

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
0.0	Overburden Soils (Brown silty sand) See Boring GWM-5A for detailed soil descriptions		
20.0	Hard Rock (Brown)		
36.2	Boring terminated at 36.2 feet		



REMARKS:

Groundwater measured at 6.1 feet after stabilization. Type II Monitoring Well Installed. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-5D
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME White Oak Landfill — JOB NUMBER 472-07913-03

WELL NUMBER GWM-5D — INSTALLATION DATE 9/29/93 & 9/30/93

LOCATION West Drainage Feature (See Record Drawings)

GROUND SURFACE ELEVATION _____ — REFERENCE POINT ELEVATION _____

GRANULAR BACKFILL MATERIAL NC #2 Sand — SLOT SIZE 0.010"

SCREEN MATERIAL PVC — SCREEN DIAMETER 2"

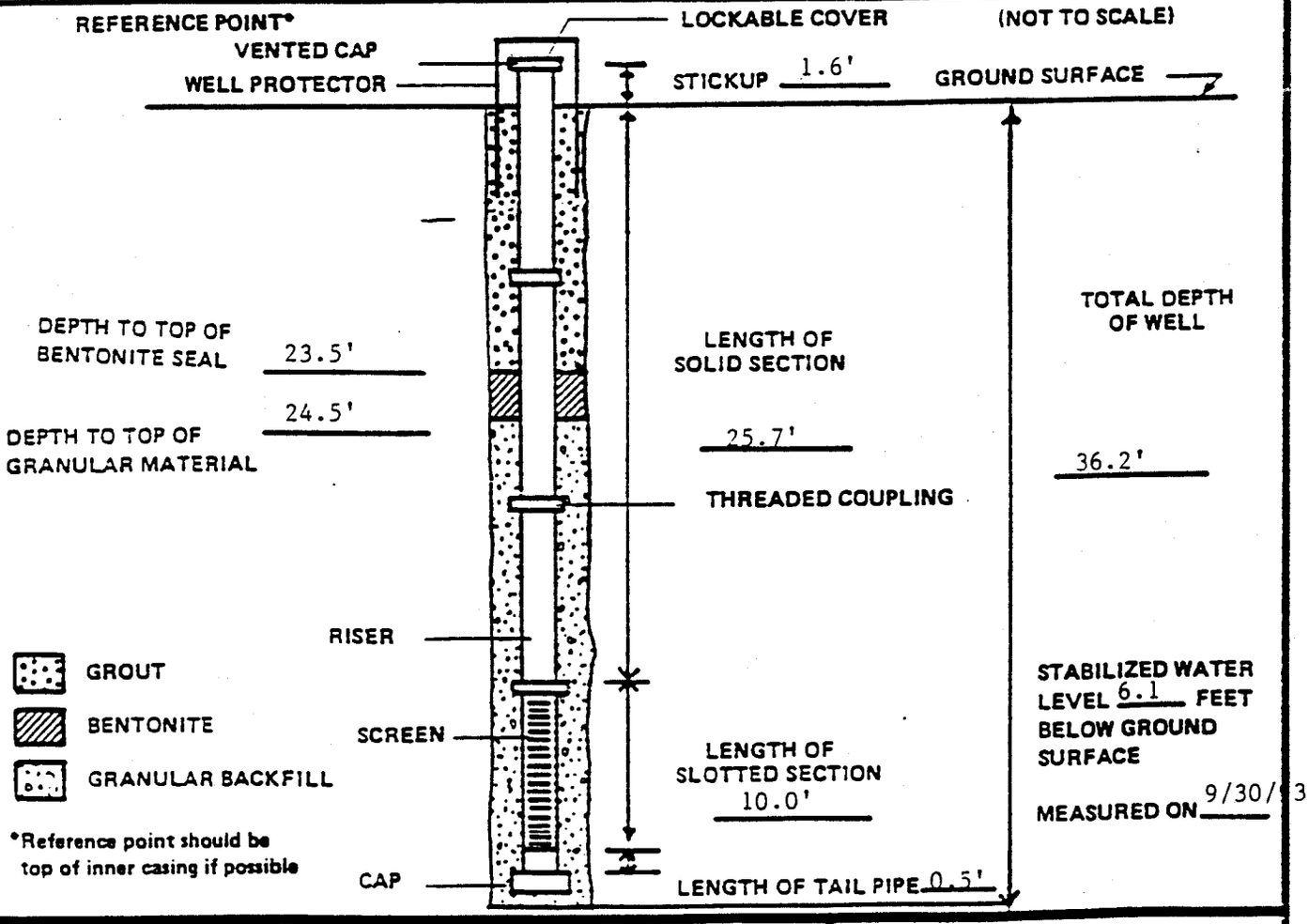
RISER MATERIAL PVC — RISER DIAMETER 2"

DRILLING TECHNIQUE Air-Rotary — DRILLING CONTRACTOR Caldwell

BOREHOLE DIAMETER 6 1/4" — LAW ENGINEERING FIELD REPRESENTATIVE T. Schipporeit

LOCK BRAND Master — SIZE/MODEL #3

KEY CODE/COMBINATION 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat. _____ Long. _____ Pc ____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent.

WELL CONSTRUCTION RECORD

GWM-5D

DRILLING CONTRACTOR: Caldwell

LANDFILL . CONSTRUCTION

DRILLER REGISTRATION NUMBER: 99 PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: White Oak County: Haywood
   (Road, Community, or Subdivision and Lot No.)
2. OWNER Haywood County, North Carolina
   ADDRESS 420 N. Main Street
   (Street or Route No.)
   Waynesville NC 28786
   City or Town State Zip Code
3. DATE DRILLED 9/29/93 USE OF WELL Monitoring
4. TOTAL DEPTH 36.2'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 7.7 FT.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 1.6 FT. Above Land Surface*

* Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118

9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): _____
11. CHLORINATION: Type N/A Amount N/A
12. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 25.7	Ft.	2"		PVC
From	To	Ft.			
From	To	Ft.			

13. GROUT:

	Depth		Material	Method
From 0	To 23.5	Ft.	Cement-Bent.	Tremie
From	To	Ft.		

14. SCREEN:

	Depth		Diameter	Slot Size	Material
From 25.7	To 35.7	Ft	2 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

15. SAND/GRAVEL PACK:

	Depth		Size	Material
From 24.5	To 36.2	Ft.		NC #2 Sand
From	To	Ft.		

16. REMARKS: Bentonite 23.5' to 24.5'

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0'	20'	Silty sand
20'	36.2'	Hard Rock

If additional space is needed use back of form

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Thomas M. Shuffstall 10-4-93

SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 REV. 5/91

Submit original to Division of Environmental Management and copy to well owner.

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	FILL, consists of very stiff moist brown fine sandy micaceous silt (ML), with gravel and cobbles.		28
6.0	Firm moist brown and red-brown silty micaceous fine to coarse SAND (SM)		19
			26
18.5	Very stiff moist brown fine sandy micaceous SILT (ML).		28
24.5	PARTIALLY WEATHERED ROCK (PWR), sampled as dry to moist silty sand, with trace rock fragments		50/5"
			50/3"
			50/3"
38.5	Very dense moist brown micaceous fine to medium SAND (SP), with trace rock fragments		80

REMARKS:

Groundwater encountered at 42.5 feet. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-6
DATE DRILLED	September 14, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
	Very dense moist brown micaceous fine to medium SAND (SP), with trace rock fragments.	
43.5	Auger refusal encountered at 43.5 feet. Boring terminated.	

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100

50/0"

REMARKS:

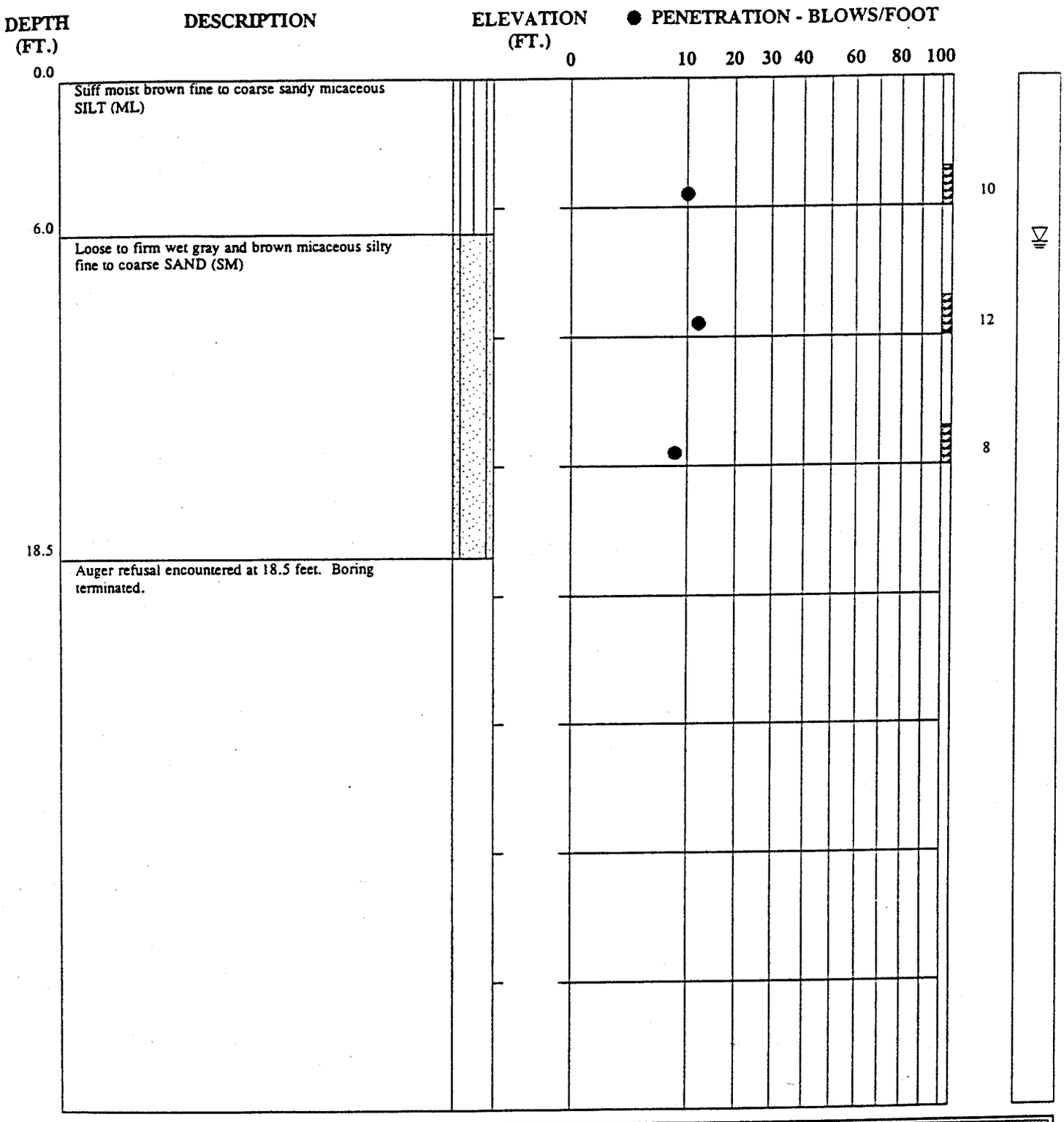
Groundwater encountered at 42.5 feet. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-6
DATE DRILLED	September 14, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 2	

LAW ENGINEERING



REMARKS:

Groundwater encountered at 6.5 feet. Type II Monitoring Well Installed. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

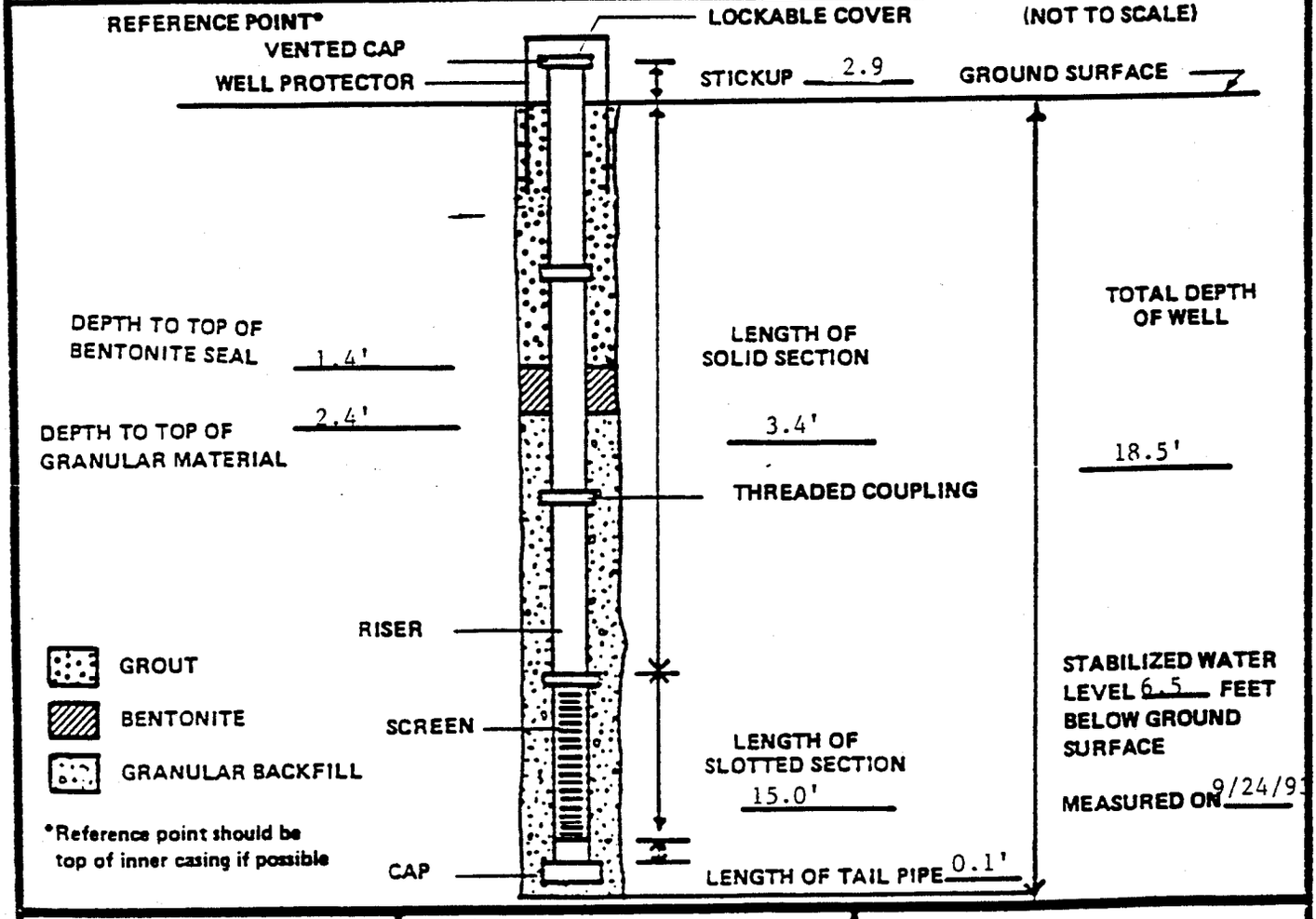
TEST BORING RECORD

BORING NUMBER	GWM-6A
DATE DRILLED	September 24, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME: White Oak Landfill
JOB NUMBER: 472-07913-03
WELL NUMBER: GWM-6A
INSTALLATION DATE: 09/24/93
LOCATION: West Drainage Feature (See Record Drawings)
GROUND SURFACE ELEVATION:
REFERENCE POINT ELEVATION:
GRANULAR BACKFILL MATERIAL: NC #2 sand
SLOT SIZE: 0.010"
SCREEN MATERIAL: PVC
SCREEN DIAMETER: 2"
RISER MATERIAL: PVC
RISER DIAMETER: 2"
DRILLING TECHNIQUE: HSA
DRILLING CONTRACTOR: Law Engineering
BOREHOLE DIAMETER: 8"
LAW ENGINEERING FIELD REPRESENTATIVE: Hoda Kablawi
LOCK BRAND: Master
SIZE/MODEL: #3
KEY CODE/COMBINATION: 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY

Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR Law Engineering GWM-6A

DRILLER REGISTRATION NUMBER 332

LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: White Oak, North Carolina
   (Road, Community, or Subdivision and Lot No.)
   County: Haywood
2. OWNER Haywood County, North Carolina
   ADDRESS 420 N. Main Street (Street or Route No.)
   Waynesville (City or Town) NC (State) 28786 (Zip Code)
3. DATE DRILLED 9/24/93 USE OF WELL Monitoring
4. TOTAL DEPTH 18.5' CUTTINGS COLLECTED ☒ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
6. STATIC WATER LEVEL: 9.4 FT. ☐ above ☒ below TOP OF CASING.
   TOP OF CASING IS 2.9 FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST N/A
8. WATER ZONES (depth): _____
9. CHLORINATION: Type N/A Amount N/A
10. CASING:

	Depth From	To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
	0	3.4		2"		PVC

11. GROUT:

	Depth From	To	Ft.	Material	Method
	0	1.4		Cem-Bent	Tremie

12. SCREEN:

	Depth From	To	Ft.	Diameter	Slot Size	Material
	3.4	18.4		2" in.	in.	PVC
				in.	in.	
				in.	in.	

13. GRAVEL PACK:

	Depth From	To	Ft.	Size	Material
	2.4	18.5			NC#2 sand

14. REMARKS: Bentonite 1.4' to 2.4'

DRILLING LOG

Depth From	To	Formation Description
0'	6'	Sandy SILT
6'	18.5'	Silty sand

If additional space is needed use back of form.

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

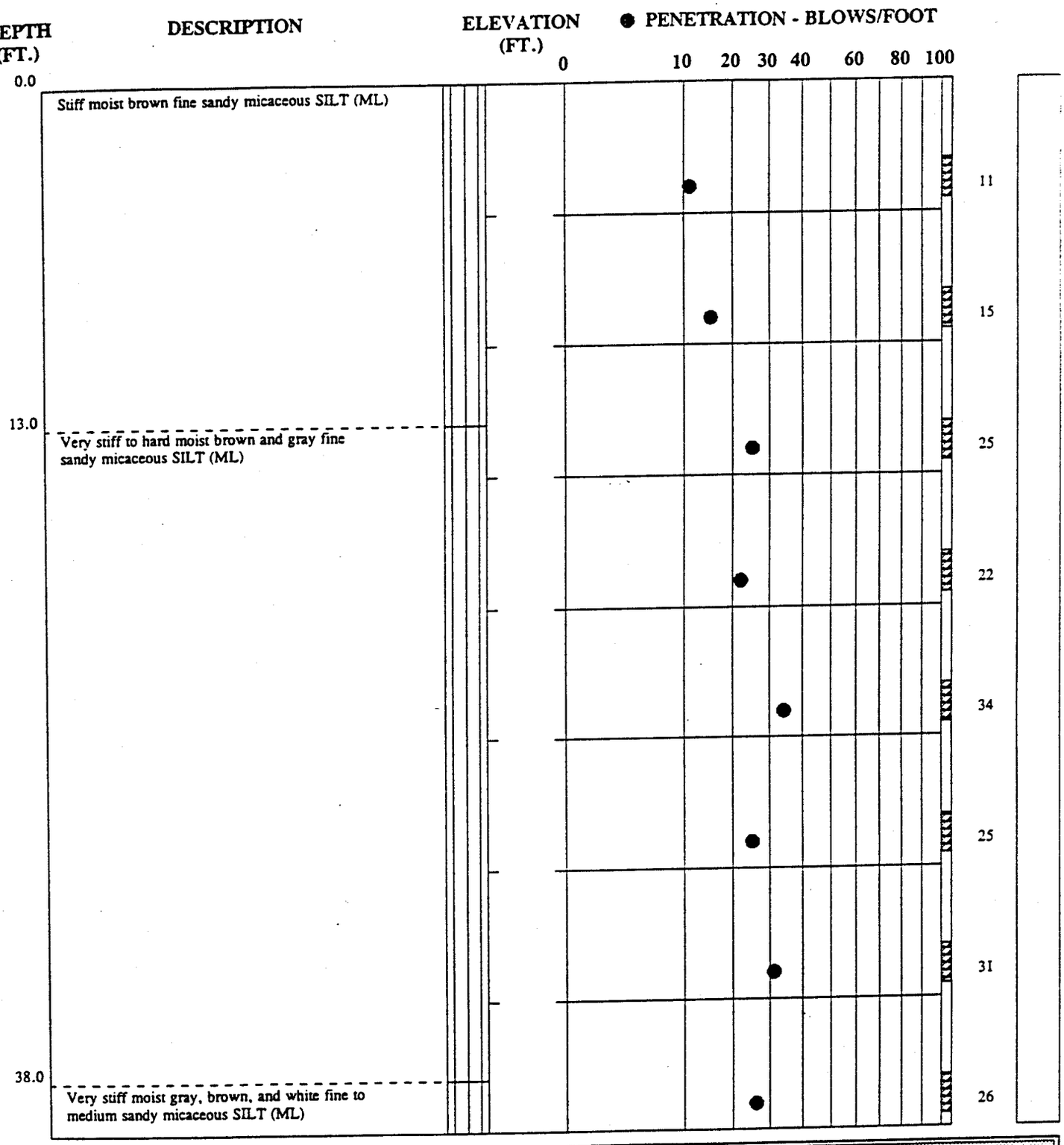
I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Thomas M. Shippout 10/1/93

SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to well owner

GW-1 Revised 11/84



REMARKS:

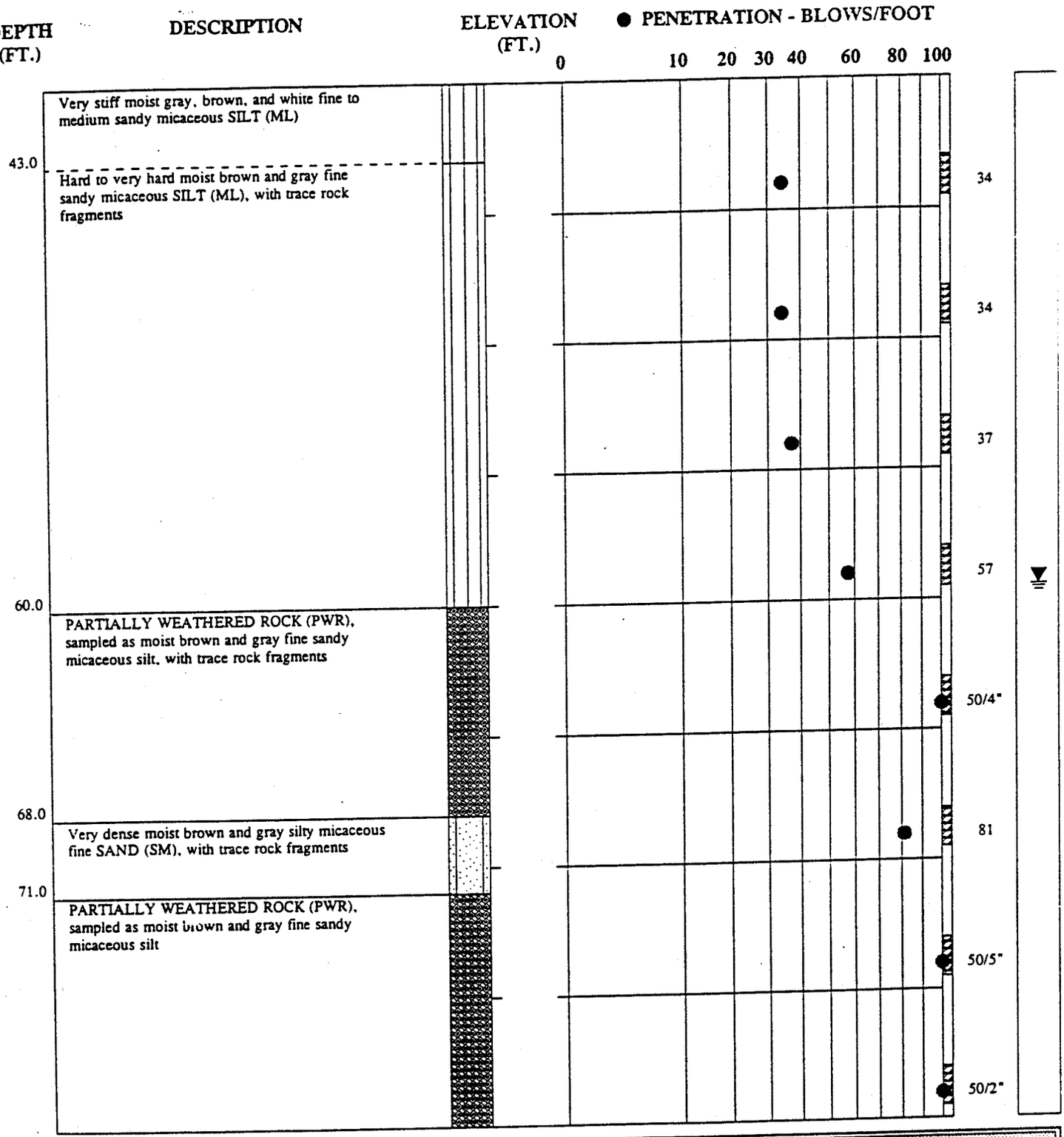
Type III Monitoring Well installed 07-14-93. Drillers: W.Whichard and C.Coumbes. Drill Rig: CME 550 ATV. Boring Type: Open-hole wash using 6" tri-cone bit.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7
DATE DRILLED	July 12, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 3	

LAW ENGINEERING



REMARKS:

Type III Monitoring Well installed 07-14-93. Drillers: W.Whichard and C.Coumbes. Drill Rig: CME 550 ATV. Boring Type: Open-hole wash using 6" tri-cone bit.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

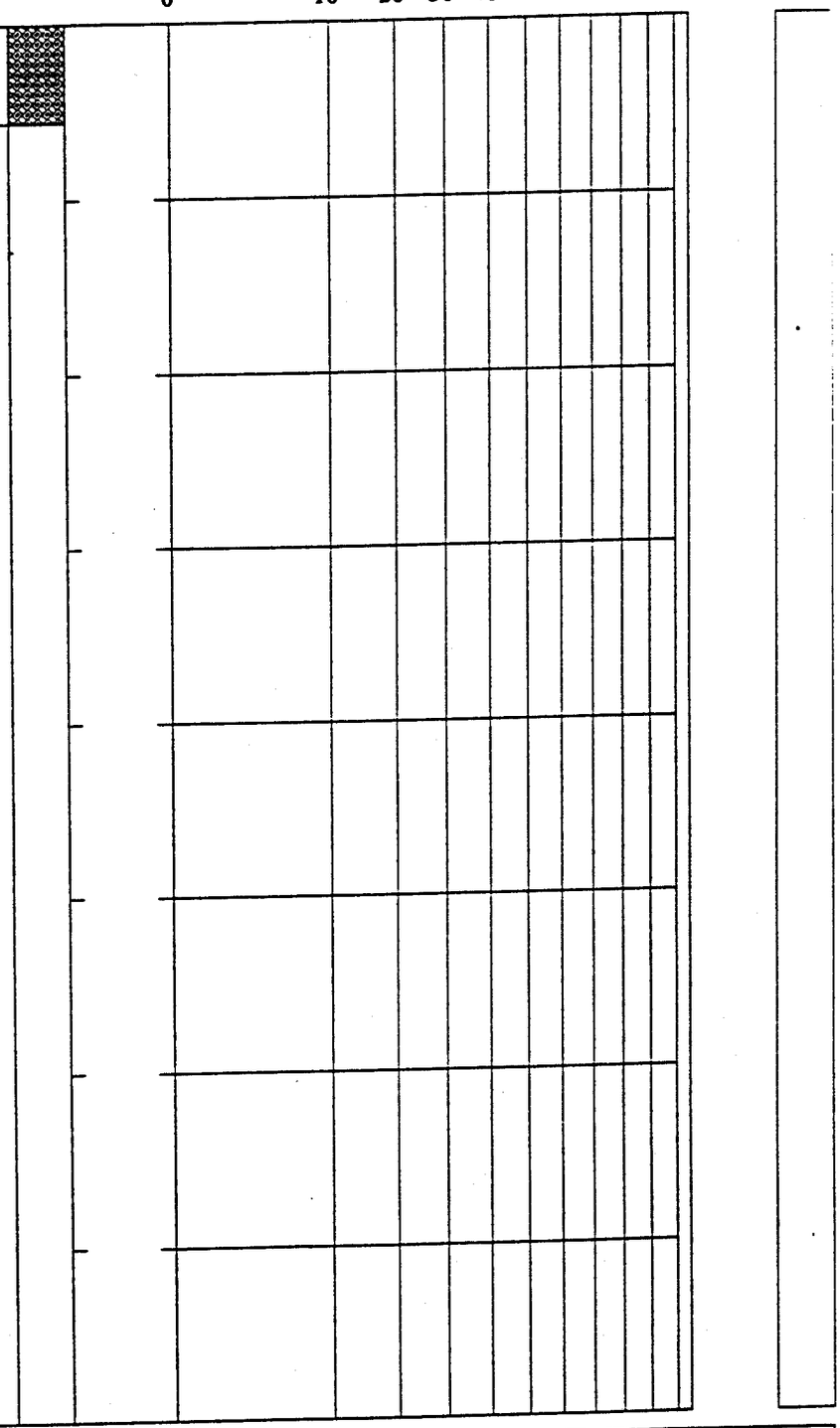
BORING NUMBER	GWM-7
DATE DRILLED	July 12, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
	PARTIALLY WEATHERED ROCK (PWR), sampled as moist brown and gray fine sandy micaceous silt	
82.8	Tri-cone bit refusal encountered at 82.8 feet on 07-13-93. Boring terminated.	

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100



REMARKS:

Type III Monitoring Well installed 07-14-93. Drillers: W.Whichard and C.Coumbes. Drill Rig: CME 550 ATV. Boring Type: Open-hole wash using 6" tri-cone bit.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7
DATE DRILLED	July 12, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 3 OF 3	

LAW ENGINEERING

TYPE III MONITORING WELL INSTALLATION RECORD - Part A

JOB NAME White Oak Sanitary Landfill JOB NUMBER 472-07913-03

WELL NUMBER GWM-7 INSTALLATION DATE 7-12 through 7-14-93

LOCATION Haywood County, North Carolina

GROUND SURFACE ELEVATION

CASING MATERIAL PVC CASING DIAMETER 4"

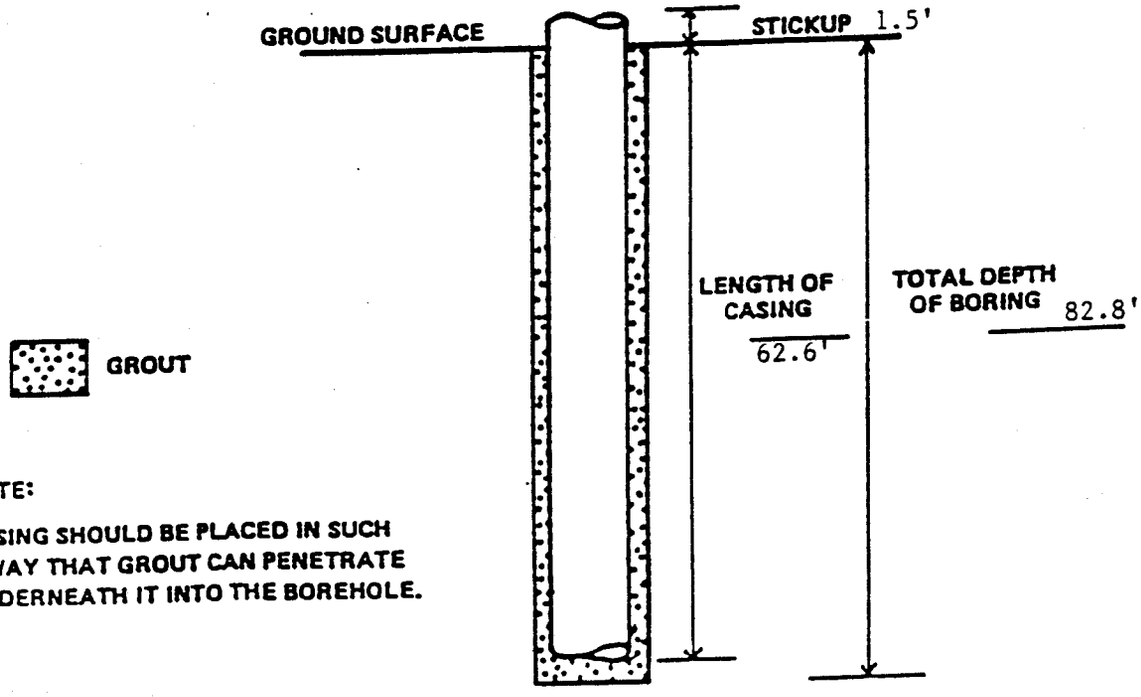
BOREHOLE DIAMETER 6"

DRILLING TECHNIQUE Open-hole wash with tri-cone bit

DRILLING CONTRACTOR Law Engineering (332)

LAW ENGINEERING FIELD REPRESENTIVE T. Schipporeit

(NOT TO SCALE)



NOTE:

CASING SHOULD BE PLACED IN SUCH A WAY THAT GROUT CAN PENETRATE UNDERNEATH IT INTO THE BOREHOLE.

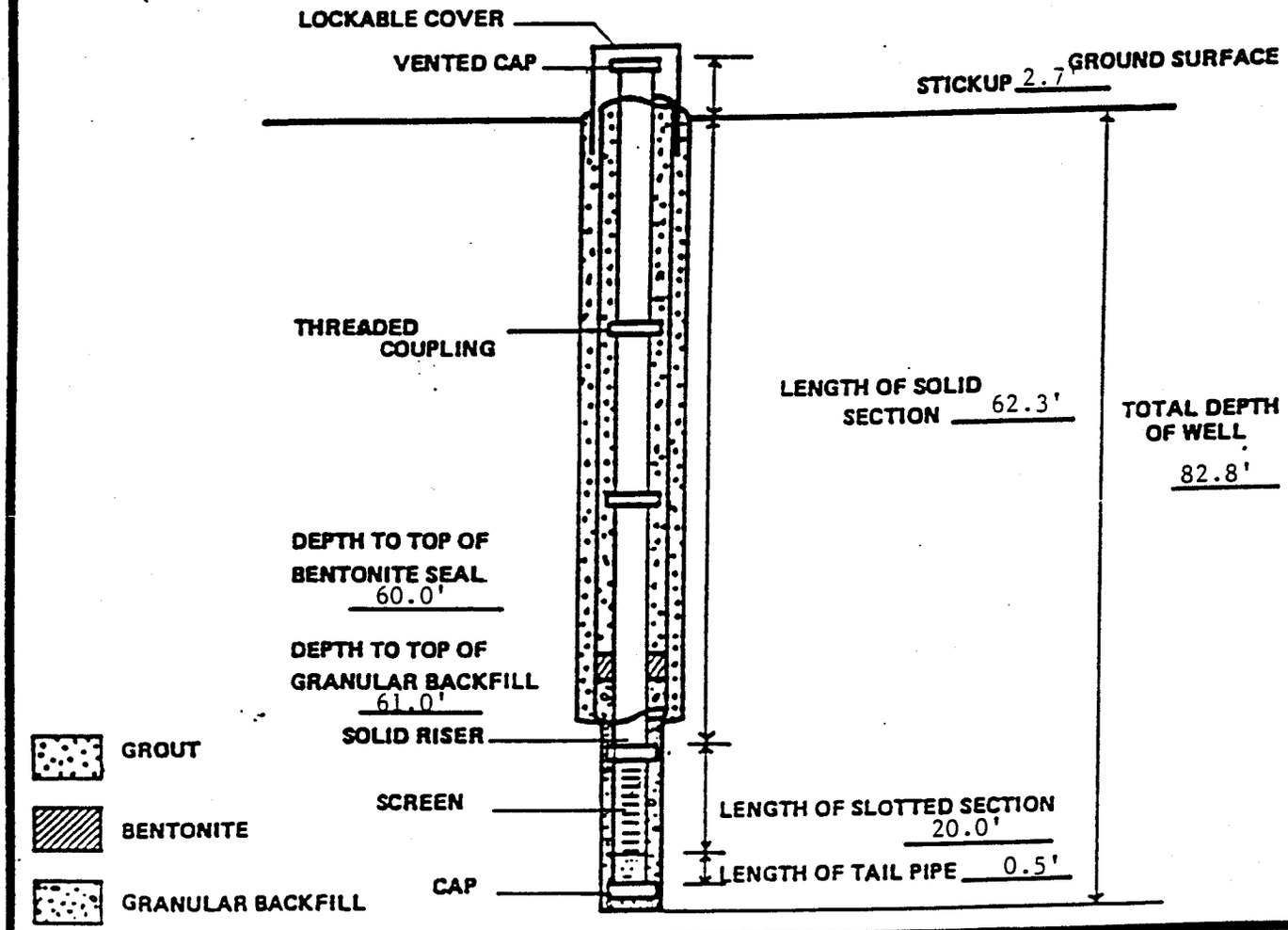
LAW ENGINEERING TESTING COMPANY

FIGURE 3 A

TYPE III MONITORING WELL INSTALLATION RECORD - Part B

JOB NAME White Oak Sanitary Landfill
JOB NUMBER 472-07913-03
WELL NUMBER GWM-7
INSTALLATION DATE 7-12 through 7-14-93
LOCATION Haywood County, North Carolina
GROUND SURFACE ELEVATION
REFERENCE POINT ELEVATION
GRANULAR BACKFILL NC #2 , Sand
SLOT SIZE 0.010"
SCREEN MATERIAL PVC
SCREEN DIAMETER 2"
RISER MATERIAL PVC
RISER DIAMETER 2"
BOREHOLE DIAMETER 6"
LAW ENGINEERING FIELD REP. T. Schipporeit
DRILLING TECHNIQUE Open-hole wash
DRILLING CONTRACTOR Law Engineering
LOCK: BRAND Master SIZE/MODEL #3
KEYCODE/COMBINATION 0536
STABILIZED WATER LEVEL 59.5 FEET BELOW GROUND SURFACE, MEASURED ON 7-15-93

(NOT TO SCALE)



LAW ENGINEERING TESTING COMPANY

FIGURE 3 8

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

GWM-7

DRILLING CONTRACTOR Law Engineering

DRILLER REGISTRATION NUMBER 332

LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: White Oak, North Carolina
(Road, Community, or Subdivision and Lot No.)

County: Haywood

2. OWNER Haywood County, North Carolina
ADDRESS 420 N. Main Street (Street or Route No.)
Waynesville (City or Town) NC (State) 28786 (Zip Code)

3. DATE DRILLED 7-12/7-13-92 USE OF WELL Monitoring

4. TOTAL DEPTH 82.8' CUTTINGS COLLECTED ☒ Yes ☐ No

5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No

6. STATIC WATER LEVEL: 62.2 FT. ☐ above ☒ below TOP OF CASING,
TOP OF CASING IS 2.7 FT. ABOVE LAND SURFACE.

7. YIELD (gpm): N/A METHOD OF TEST N/A

8. WATER ZONES (depth):

9. CHLORINATION: Type N/A Amount N/A

10. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 62.6	Ft.	4 in		PVC
From 0	To 62.3	Ft.	2 in		PVC
From	To	Ft.			

11. GROUT:

	Depth		Material	Method
From 0	To 60.0	Ft.	Cem.-Bent.	Tremie
From	To	Ft.		

12. SCREEN:

	Depth		Diameter	Slot Size	Material
From 62.3	To 82.3	Ft.	2 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

13. GRAVEL PACK:

	Depth		Size	Material
From 61.0'	To 82.8	Ft.		NC #2 Sand
From	To	Ft.		

14. REMARKS: Bentonite 60.0' to 61.0'

DRILLING LOG

From	To	Formation Description
0'	60'	Sandy silt
60'	82.8'	Partially weathered rock

If additional space is needed use back of form.

LOCATION SKETCH
(Show direction and distance from at least two State Road or other map reference points)

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Thomas M. Schuyler 10/1/93
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/84

Submit original to Division of Environmental Management and copy to well owner.

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
0.0	Overburden Soils (Brown sandy silt and silty sand) See Boring GWM-7 for detailed soil descriptions		

REMARKS:

Groundwater measured at 64.6 feet after stabilization. Type II Monitoring Well Installed. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

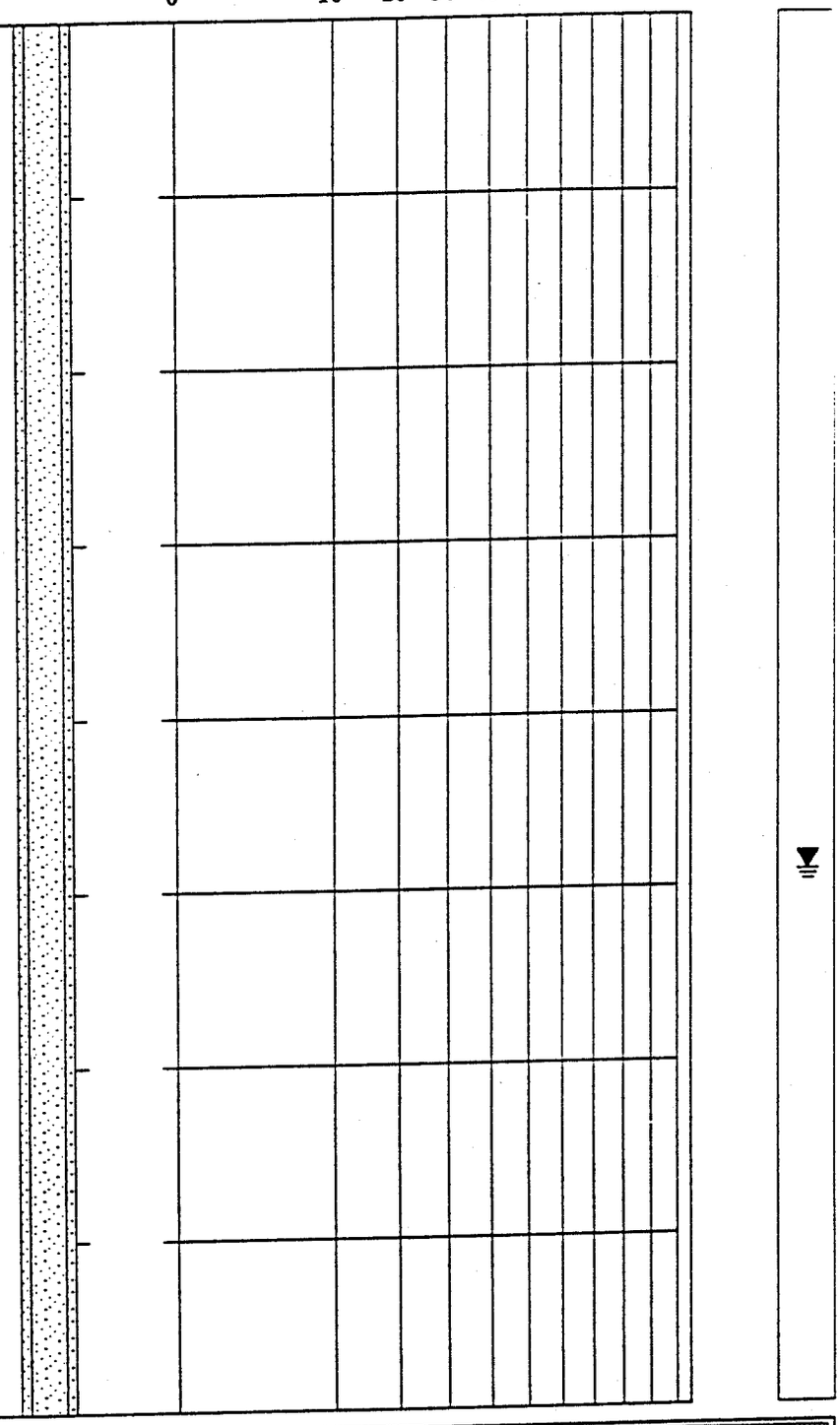
SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7D
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	Overburden Soils (Brown sandy silt and silty sand) See Boring GWM-7 for detailed soil descriptions		



REMARKS:

Groundwater measured at 64.6 feet after stabilization. Type II Monitoring Well Installed. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7D
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	Overburden Soils (Brown sandy silt and silty sand) See Boring GWM-7 for detailed soil descriptions		
85.0	Hard Rock (Brown)		
103.2	Boring terminated at 103.2 feet		

REMARKS:

Groundwater measured at 64.6 feet after stabilization. Type II Monitoring Well Installed. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

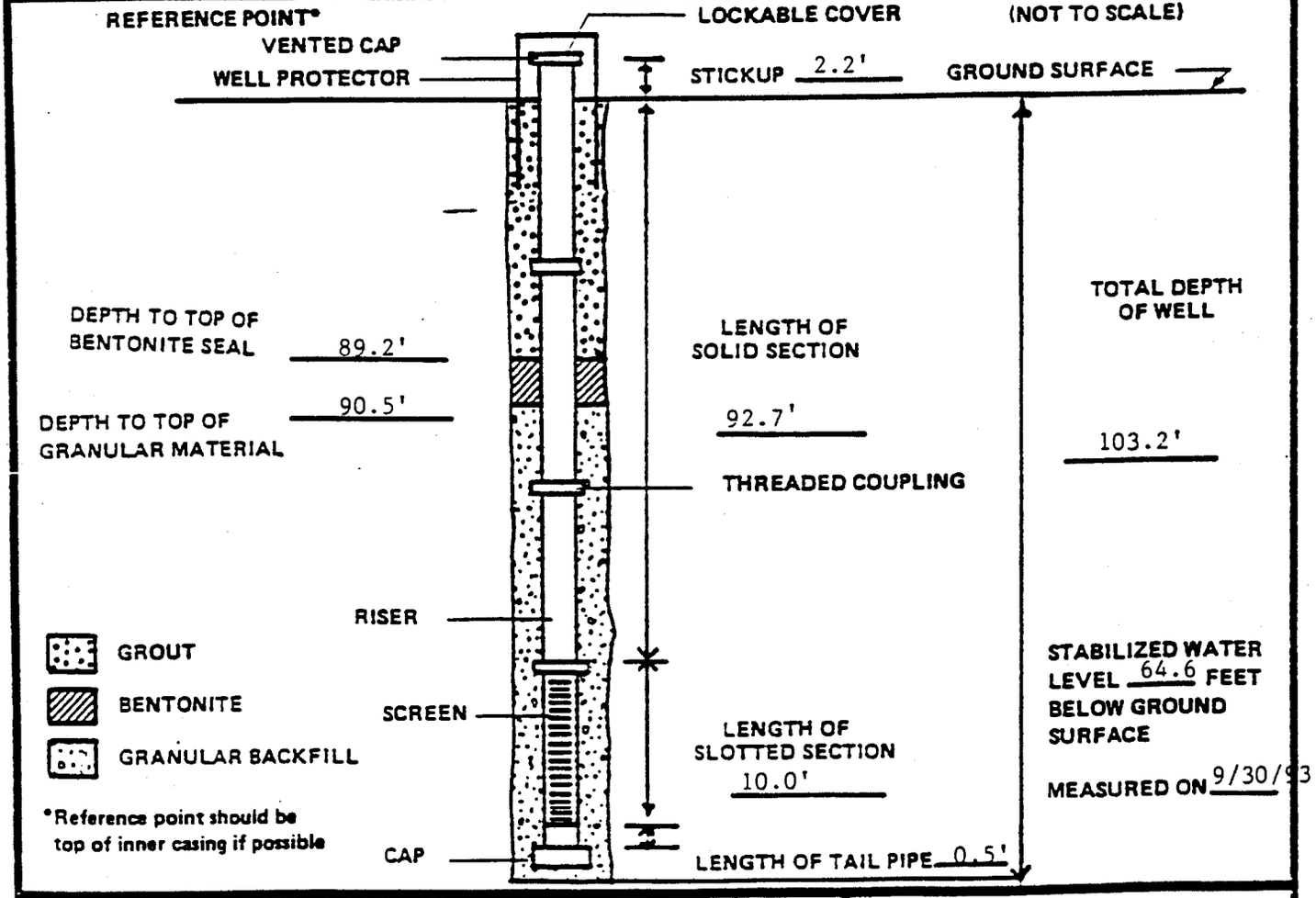
TEST BORING RECORD

BORING NUMBER	GWM-7D
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 3 OF 3	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME: White Oak Landfill
JOB NUMBER: 472-07913-03
WELL NUMBER: GWM-7D
INSTALLATION DATE: 9/29 - 9/30/93
LOCATION: South End (See Record Drawings)
GROUND SURFACE ELEVATION:
REFERENCE POINT ELEVATION:
GRANULAR BACKFILL MATERIAL: NC #2 Sand
SLOT SIZE: 0.010"
SCREEN MATERIAL: PVC
SCREEN DIAMETER: 2"
RISER MATERIAL: PVC
RISER DIAMETER: 2"
DRILLING TECHNIQUE: Air-Rotary
DRILLING CONTRACTOR: Caldwell
BOREHOLE DIAMETER: 6 1/4"
LAW ENGINEERING FIELD REPRESENTATIVE: T. Schipporeit
LOCK BRAND: Master
SIZE/MODEL: #3
KEY CODE/COMBINATION: 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent.

WELL CONSTRUCTION RECORD

GWM-7D

DRILLING CONTRACTOR: Caldwell

DRILLER REGISTRATION NUMBER: 99

LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: White Oak County: Haywood
   (Road, Community, or Subdivision and Lot No.)
2. OWNER Haywood County, North Carolina
   ADDRESS 420 N. Main Street (Street or Route No.)
   Waynesville (City or Town) NC (State) 28786 (Zip Code)
3. DATE DRILLED 9/29/93 USE OF WELL Monitoring
4. TOTAL DEPTH 103.2'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 66.8 FT.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.2 FT. Above Land Surface*

* Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118

9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): _____
11. CHLORINATION: Type N/A Amount N/A
12. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 92.7	Ft.	2"		PVC
From _____	To _____	Ft.			
From _____	To _____	Ft.			

13. GROUT:

	Depth		Material	Method
From 0	To 89.2	Ft.	Cement-Bent.	PVC
From _____	To _____	Ft.		

14. SCREEN:

	Depth		Diameter		Slot Size		Material
From 92.7	To 102.7	Ft	2	in.	0.010	in.	PVC
From _____	To _____	Ft.		in.		in.	
From _____	To _____	Ft.		in.		in.	

15. SAND/GRAVEL PACK:

	Depth		Size	Material
From 90.5	To 103.2	Ft.		NC #2 Sand
From _____	To _____	Ft.		

16. REMARKS: Bentonite 89.2' to 90.5'

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0'	85'	Sandy silt/silty sand
85'	103.2'	Hard rock

If additional space is needed use back of form

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Thomas M. Shuffstuit 10-4-93

SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 REV. 5/91

Submit original to Division of Environmental Management and copy to well owner.

STEFFEN ROBERTSON & KIRSTEN (US)
CONSULTING ENGINEERS & SCIENTISTS

JOB NO.: 83504
LOCATION: Haywood County
WELL NUMBER: GMW-8

SHEET 1 OF 1

DRILL SUMMARY

DATE: 1-28-97	
DRILLED BY: Craig Bender	
LOGGED BY: Larry Matilla	
DRILLING METHOD: 4.25 ID Hollow Stem Auger	

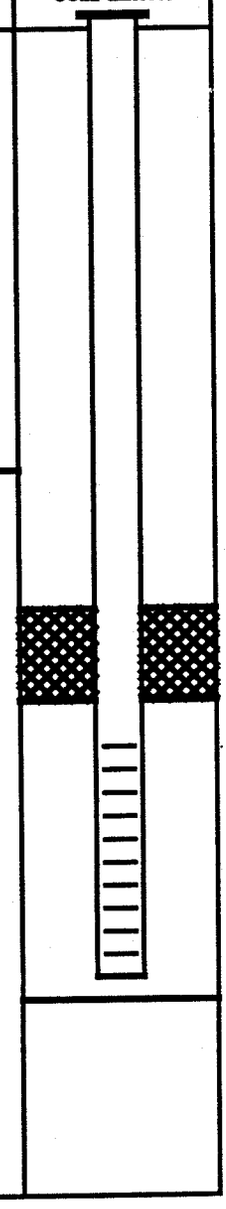
SURVEY INFORMATION

CASING HEIGHT: 2.5 ft. AGS	
LAND SURFACE ELEVATION:	
STATIC WATER LEVEL: 31 Ft @ drilling	
LATITUDE: LONGITUDE:	

WELL SPECIFICATIONS

GROUT: 0' – 27'	SEAL: Bentonite, 27' – 29'	GRAVEL PACK: 20' – 30' Silica, 29' – 42'	
CASING TYPE: Pvc 40	DIAMETER: 2 in.	DEPTH: 0 – 31'	HOLE DIA.: 8 in.
SCREEN TYPE: PVC 40	SLOT: 0.010 DIAMETER: 2 in.	DEPTH: 31' – 41'	TOTAL DEPTH: 42'

O V A	PEN. RES.	DEPTH (FT)	LITHOLOGY	LITHOLOGIC TEXTURE / REMARKS	WELL COMPLETION
	1, 2 4, 10	0		Fill. Rock at 3' moving 2' south (auger refusal).	
		10	GM	Fill. silt mixed with partially weathered rock. Yellowish brown. Trace of rock to 16 ft.	
				Auger refusal at 17 ft. Move 12 ft east (install solid head auger).	
		20	ML	Silt. Yellowish brown.	
		30	ML	Saturated at 31 ft. Silt with trace of rock (partially weathered rock).	
		40		Silt. Yellowish brown. Total depthe = 42 ft.	



STEFFEN ROBERTSON & KIRSTEN (US)
CONSULTING ENGINEERS & SCIENTISTS

JOB NO.: 83504
LOCATION: Haywood County
WELL NUMBER: GMW-9

SHEET 1 OF 1

DRILL SUMMARY

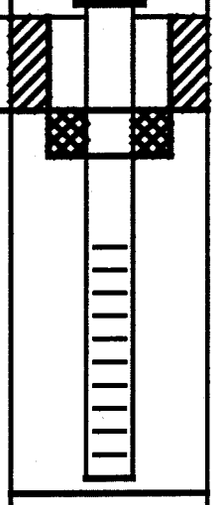
DATE: 1-28-97	
DRILLED BY: Craig Bender	
LOGGED BY: Larry Mattila	
DRILLING METHOD: Completion	

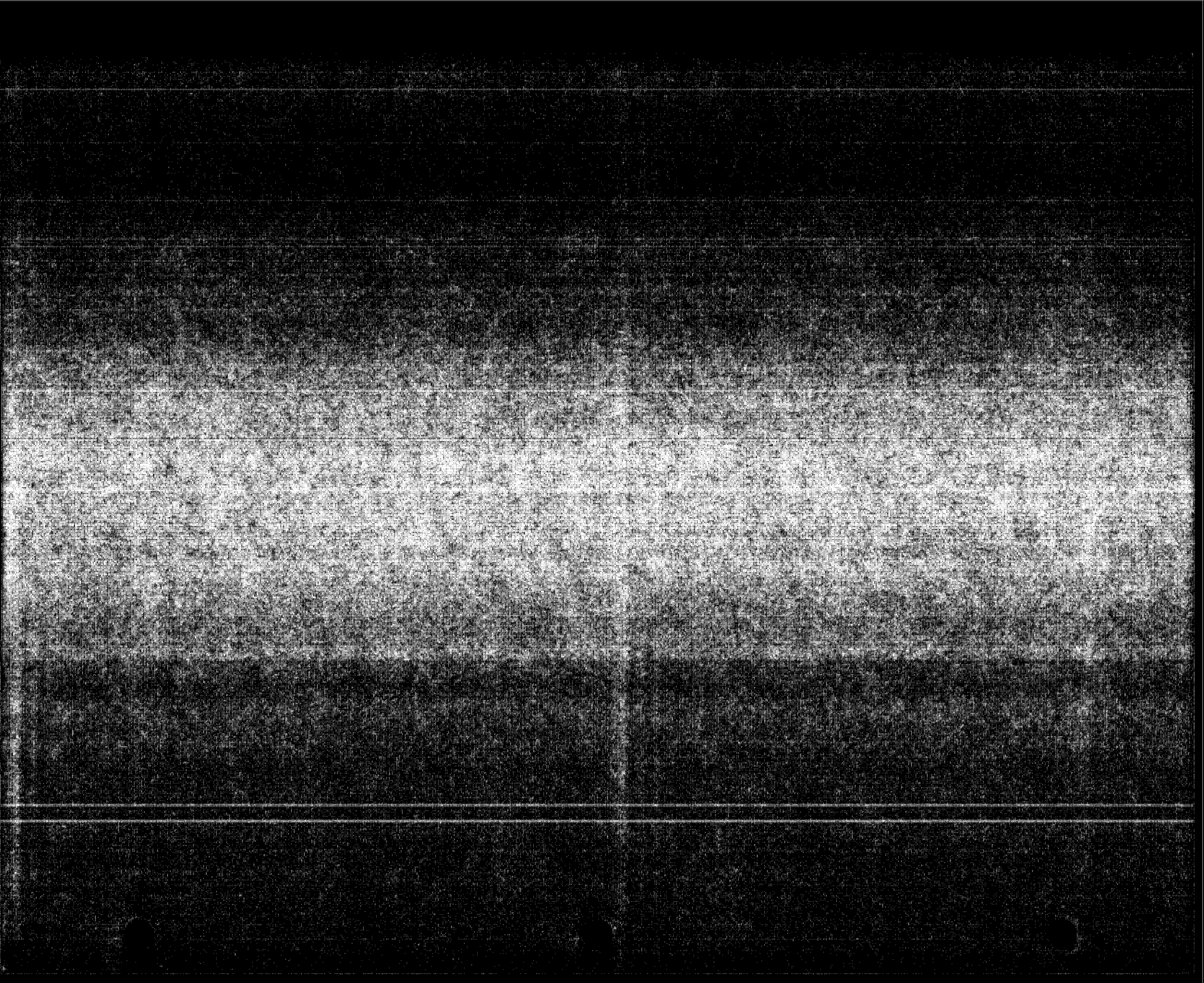
SURVEY INFORMATION

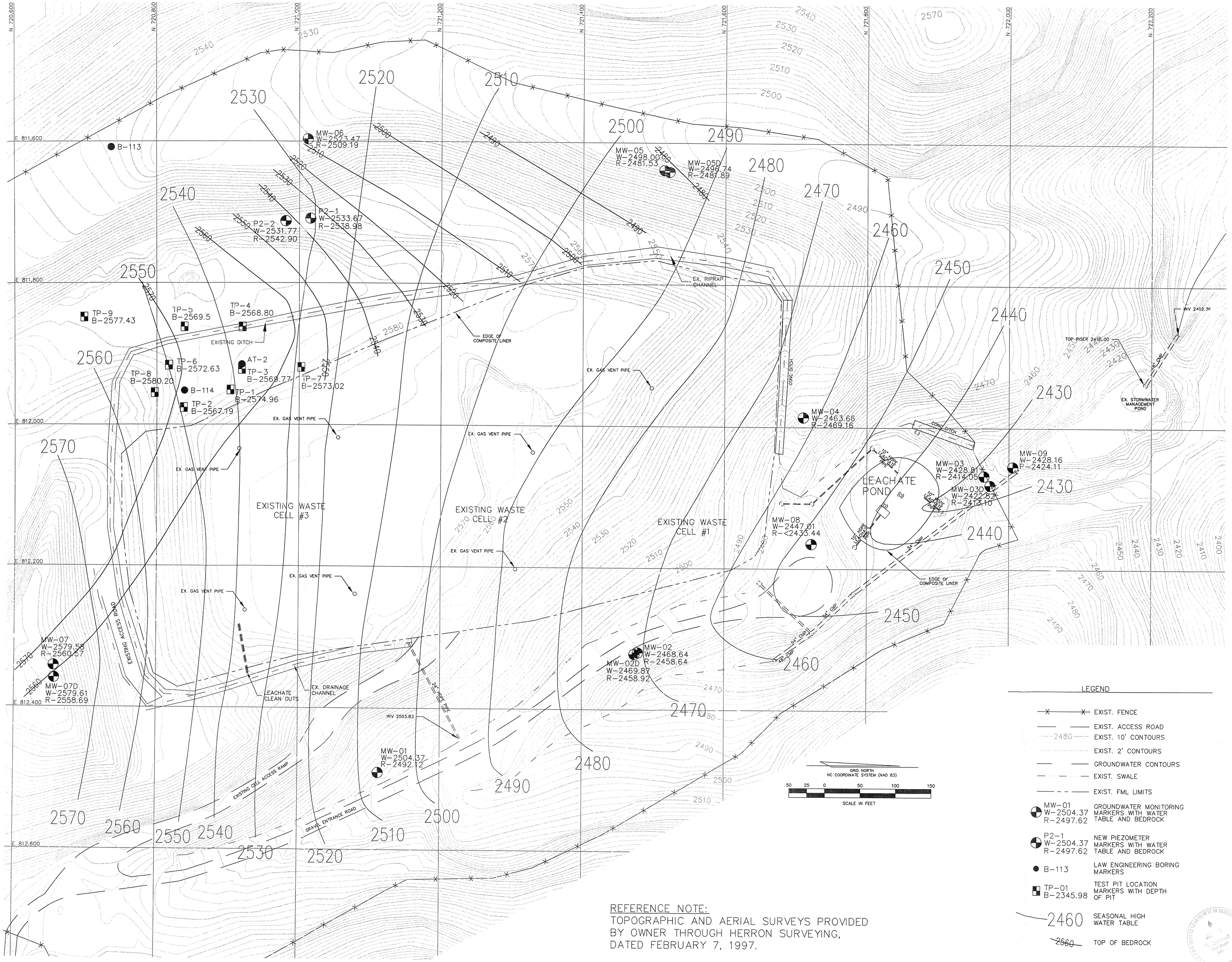
CASING HEIGHT: 2 ft. AGS	
LAND SURFACE ELEVATION:	
STATIC WATER LEVEL: Dry at installation	
LATITUDE: •	
LONGITUDE: •	

WELL SPECIFICATIONS

GROUT: Portland, 0' – 2'	SEAL: Bentonite, 2' – 4'	GRAVEL PACK: FX-50, 4' – 11'	
CASING TYPE: Pvc 40	DIAMETER: 6 in. & 2 in.	DEPTH: 0 – 6' & 0' – 6'	HOLE DIA.: 6 in.
SCREEN TYPE: PVC 40	SLOT: 0.010	DIAMETER: 6 in. & 2 in. DEPTH: 6'-11' & 6'-11'	TOTAL DEPTH: 11'

O V A	SAMPLE RECOVERY	DEPTH (FT)	LITHOLOGY	LITHOLOGIC TEXTURE / REMARKS	WELL COMPLETION
		0	GM	(0' – 2') Compacted fill.	
		5	GP	(2' – 11') Crushed rock fill.	
		10			
		11		(11') Bedrock.	





REFERENCE NOTE:
TOPOGRAPHIC AND AERIAL SURVEYS PROVIDED BY OWNER THROUGH HERRON SURVEYING, DATED FEBRUARY 7, 1997.

LEGEND

- EXIST. FENCE
- EXIST. ACCESS ROAD
- EXIST. 10' CONTOURS
- EXIST. 2' CONTOURS
- GROUNDWATER CONTOURS
- EXIST. SWALE
- EXIST. FML LIMITS
- MW-01 W-2504.37 R-2497.62 — GROUNDWATER MONITORING MARKERS WITH WATER TABLE AND BEDROCK
- P2-1 W-2504.37 R-2497.62 — NEW PIEZOMETER MARKERS WITH WATER TABLE AND BEDROCK
- B-113 — LAW ENGINEERING BORING MARKERS
- TP-01 B-2345.98 — TEST PIT LOCATION MARKERS WITH DEPTH OF PIT
- 2460 — SEASONAL HIGH WATER TABLE
- 2560 — TOP OF BEDROCK

STEFFEN ROBERTSON & KIRSTEN (NC), INC.
CONSULTING ENGINEERS & SCIENTISTS
5641 PIPER DRIVE
FUQUAY, NORTH CAROLINA, 27526, USA
(919) 557-0444

GEOLOGIST

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WASTE CELL 4
DESIGN HYDROGEOLOGIC REPORT
WHITE OAK LANDFILL
HAYWOOD COUNTY BOARD OF COMMISSIONERS
WAYNESVILLE, HAYWOOD COUNTY, NC

SEASONAL HIGH WATER TABLE

REVISIONS

NO.	DESCRIPTION	BY	DATE
1	SUBMITTAL TO DENR, DIV. OF SOLID WASTE MANAGEMENT, RALEIGH, NC	SWALLBB	9/97
2	SUBMITTAL TO DENR, DIV. OF SOLID WASTE MANAGEMENT, RALEIGH, NC	SWALLBB	7/98

REFERENCES

SITE SURVEY AND TOPO. MAP BY HERRON LAND SURVEYING, INC. POTENTIOMETRIC SURFACE BASED ON WELL ELEVATIONS MEASURED 2/13/97
DSWM APPROVED PERMIT APPLICATION DATED OCTOBER 8, 1993, PERMIT NO. 44-07

PROJECT NO.: 83507

FIGURE 1

SCALE: 1"=50'

DESIGNED	LHM	7/98
DRAWN	JHMB	7/98
CHECKED	SVM	7/98
APPROVED	LBB	7/98

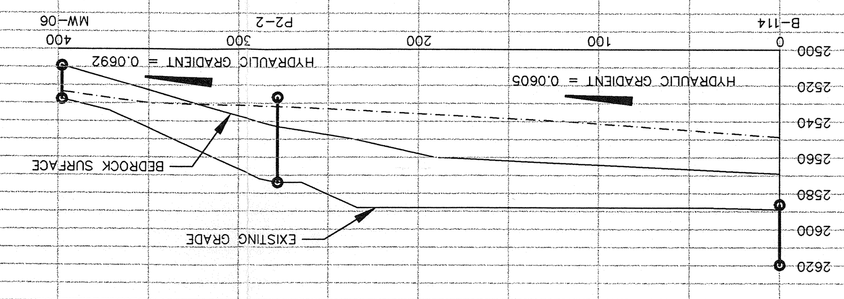
DWG: \\JAMES-HUGH\C-DRIVE\JAMES HUGH\AUTOCAD\FIGURE1.DWG, PLOTTED 7/15/98

DWG: \\JAMES-HUGH\C-DRIVE\JAMES HUGH\AUTOCAD\CROSS.DWG, PLOTTED 7/15/97

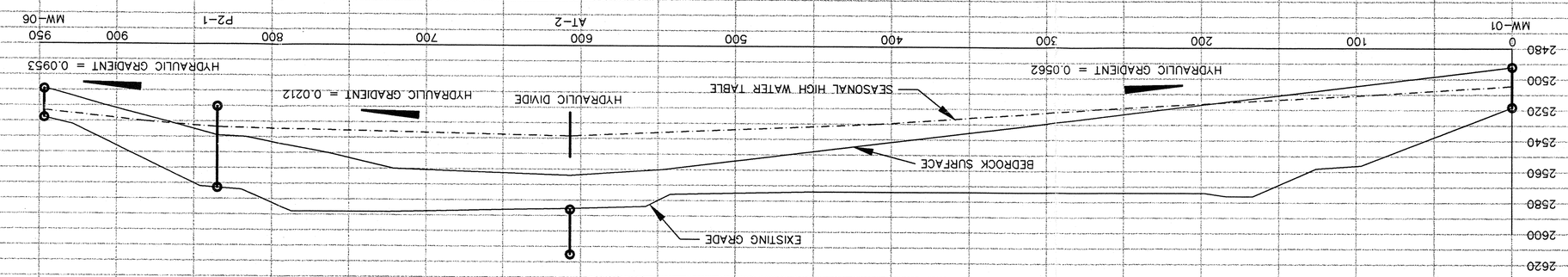
NOTES:

1. THE WATER TABLE SURFACES SHOWN ARE THE SEASONAL HIGH WATER TABLE SURFACES.
2. BEDROCK ELEVATION FROM B-114 HAS BEED IGNORED BECAUSE OF THE PRESENCE OF A LARGE BOULDER THAT INDICATED A FALSE BEDROCK SURFACE DURING INITIAL INVESTIGATIONS.
3. THE BEDROCK ELEVATIONS SHOWN ARE THE HIGHEST POSSIBLE ELEVATIONS AS DETERMINED BY THE SERIES OF TEST PITS CONDUCTED IN THE AREA OF INVESTIGATION.
4. SURVEY FOR TOPOGRAPHIC MAP WAS PERFORMED BY HERRON SURVEYING, DATED FEBRUARY 7, 1997. AS SUCH, GROUND ELEVATIONS FOR SOME INITIAL INVESTIGATION BORINGS ARE NO LONGER VALID. THIS INCLUDES B-114 AND AT-2.

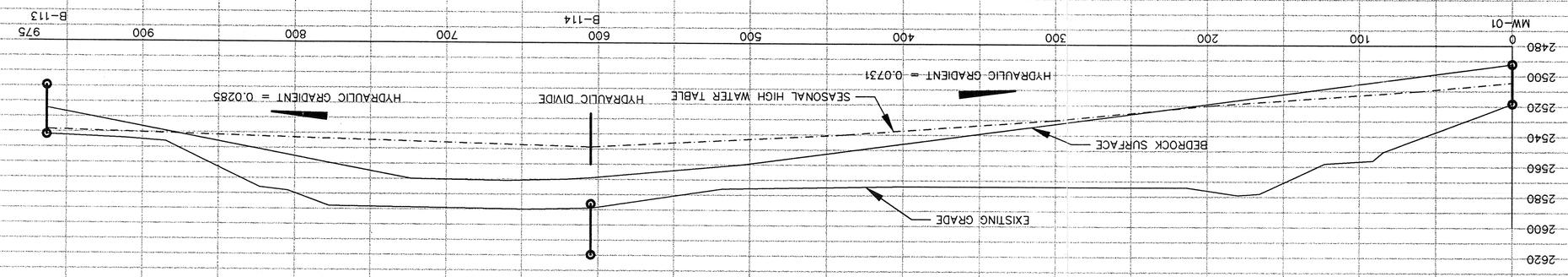
B-114 TO P2-2 TO MW-06



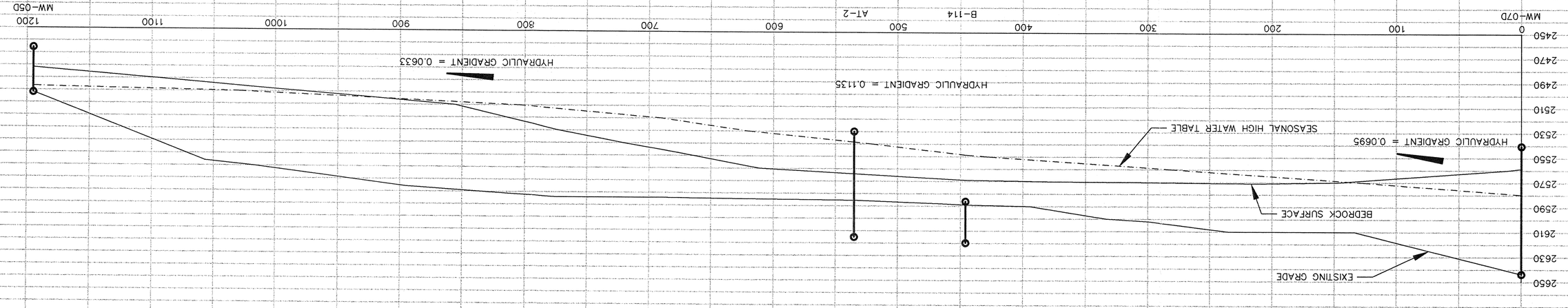
MW-01 TO AT-2 TO P2-1 TO MW-06



MW-01 TO B-114 TO B-113



MW-07D TO B-114 TO AT-2 TO MW-05D



REVISIONS

NO.	DESCRIPTION	BY	DATE
0	SUBMITTAL TO DENR, DIV. OF SOLID WASTE MANAGEMENT, RALEIGH, NC	NED	6/97
1	SUBMITTAL TO DENR, DIV. OF SOLID WASTE MANAGEMENT, RALEIGH, NC	SVM,LBB	7/98

REFERENCES

SITE SURVEY AND TOPO. MAP BY HERRON LAND SURVEYING, INC.
POTENTIOMETRIC SURFACE BASED ON WELL ELEVATIONS MEASURED 2/13/97
DSWM APPROVED PERMIT APPLICATION DATED OCTOBER 8, 1993, PERMIT NO. 44-07

WASTE CELL 4
VARIOUS
PROFILES

DESIGN HYDROGEOLOGIC REPORT
WHITE OAK LANDFILL
HAYWOOD COUNTY BOARD OF COMMISSIONERS
WAYNESVILLE, HAYWOOD COUNTY, NC

STEFFEN ROBERTSON AND KIRSTEN (NC), INC. (ALL RIGHTS RESERVED)

GEOLOGIST

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SRK

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JUL 1998
Received
Solid Waste
Section

DESIGNED JHMB 7/98
DRAWN JHMB 7/98
CHECKED SVM 7/98
APPROVED LBB 7/98

FIGURE 2
SCALE: 1"=50'
PROJECT NO.: 83507