Carmencita Johnson

Fac/Perm/Co ID #	Date	Doc ID#
43-02	6/25/13	DIN

43-02

SUBTITLE D LANDFILL SITE APPLICATION REPORT

FOR

PROPOSED EXPANSION OF THE DUNN/ERWIN LANDFILL

HARNETT COUNTY, NORTH CAROLINA

M&C Project No. 304/10.OR

State Contact

Mr. Jim Coffey
Division of Solid Waste Management
NCDEHNR
P.O. Box 27687
Raleigh, North Carolina
Phone: 919-733-0692

Prepared by

McKim & Creed Engineers, P.A.
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Phone: 919-233-8091

NORTH CAROLINA PROFESSIONAL SEAL 8955 ENGINEER CLARENCE TYRUS CLAYTON

Carmencita Johnson

Fac/Perm/Co ID #	Date	Doc ID#
43-02	6/25/13	DIN

SUBTITLE D LANDFILL SITE APPLICATION REPORT

FOR

PROPOSED EXPANSION OF THE DUNN/ERWIN LANDFILL

HARNETT COUNTY, NORTH CAROLINA

M&C Project No. 304-0010.OR

State Contact

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Division of Solid Waste Management
NCDEHNR
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OCT 1995
Received
Solid Waste
Section

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ATTACHMENTS

Attachment 1: Geologic and Hydrologic Report (Prepared by S&ME, Inc.)
Attachment 2: Archaeological Survey (Prepared by Archaeological Resource Consultants, Inc.)

SECTION I

INTRODUCTION

SECTION I: INTRODUCTION

A. Applicable Regulations and Site Background

This report has been prepared for Harnett County in accordance with the landfill siting requirements contained within the *15A NCAC 13B. 1600* regulations. The information provided herein together with the enclosed drawings is submitted for siting approval of a Subtitle D municipal solid waste (MSW) landfill at the Dunn/Erwin Landfill Facility. This site has previously been approved and permitted under the *15A NCAC 13B.0503* regulations. The permit number is 43-02.

Currently, there is one active MSW unlined landfill unit and two closed MSW unlined landfill units ,which stopped receiving waste before October 9, 1993 at the landfill site. As stated in the Harnett County Dunn\Erwin Landfill Transition Plan submitted to the North Carolina Department Of Environmental Health and Natural Resources (NCDEHNR) in April 1994, it is anticipated that the current MSW landfill will reach capacity in 1997.

This site application discusses and describes the next landfill phase, which is to be designated as Phase IV. The phase number designation was selected in order to continue the numbering system used for the existing site which contains Phases I through III, as previously designated.

SECTION II

REGIONAL AND LOCAL CHARACTERIZATION STUDY

SECTION II: REGIONAL AND LOCAL CHARACTERIZATION STUDY

A. Introduction

The regional and local characterization studies were completed in accordance with the requirements set forth in the *15A NCAC 13.B1618(c)(1 and 2)* regulations. Any features listed in the regulations that must be identified on the regional and local maps, have been shown if they are within the specified distance from the landfill boundary.

B. Regional Study

The Regional Characterization Map (Sheet C-1), is a topographic map adapted from the Dunn, Coats, Benson, and Erwin, North Carolina quadrangle (7.5 Minute Series) prepared by the United States Geological Survey (USGS). A two mile perimeter line was superimposed on these maps to delineate features within the required area.

Summary.

The existing Dunn/Erwin Landfill has been in the same location since opening in 1978. It is located just north of NCSR 1725 in an area surrounded by farmland, forest, wetlands and scattered houses and farms. The closest town to its boundary is the Town of Erwin, approximately two miles south of the landfill. The proposed lined landfill is within the currently-permitted landfill boundary.

Public Water Supply Wells.

There are no public water supply wells within the two mile perimeter of the landfill. All public water is supplied by a county wide water system maintained by Harnett County. The main water line originates in the Town of Lillington, NC.

According to the Harnett County Health Department, there may be individual water wells within the two mile study boundary but well permits are not required and therefore the location of the wells is unknown.

There are no surface water intakes within the two mile perimeter of the landfill.

Residential Subdivisions.

The residential subdivisions within the two mile radius of the landfill (see Sheet C-1) are limited mainly to trailer parks and numerous homes scattered throughout this portion of the County. The two mile radius also takes in a portion of the Town of Erwin. A field reconnaissance was made of the homes lying close to the landfill boundary. Homes were not counted within the city limits of Erwin.

The trailer parks within the two mile radius and number of residences were:

Park Name	No. of Residences
Green Acres Mobile Home Park	9
Avery's Trailer Park	25
Village Rentals Mobile Home Park	35
Park Island Mobile Home Rentals	41

There are approximately 700 single family homes in the two mile perimeter area. This does not include the unknown number of homes within the Town of Erwin. Visual observations in the area indicated that only three (3) of the thirty five (35) residences had bored wells. It was unknown whether these wells were in use. The remaining residents are connected to the Harnett County water supply system.

Waste Transportation Routes.

The major waste transportation routes in the area are shown on Sheet C-1. These include North Carolina State Routes 1725, 1722, 1703, 1723,1726,2009,2011, and highway 55.

Public Use Airports and Runways.

The nearest public airport is the Harnett County Airport. The airport lies due west of the Dunn/Erwin Landfill. The north end of the runway is located 23,195 ft. from the western landfill boundary.

As required by *15A NCAC 13B.1622(1)(b)*, both the Federal Aviation Agency (FAA) and the Harnett County Airport have been informed of the proposed modification to the Dunn/Erwin Landfill. Please refer to Section IV of this document for correspondence to these agencies.

C. Local Study

The Local Characterization Map (Sheet C-2) was taken from the same USGS map(s) mentioned previously in this document. This document shows the required information within a 2,000 ft. perimeter of the landfill facility property. In addition, an aerial photo (Sheet C-4) shows the ground features at a scale of 1"=400'. The date of this photo was March 1995.

Sheet C-4 outlines the approximate location of the proposed lined landfill. Also depicted on this photo is a 200 foot wide, high-tension power line easement. which is the only easement that runs through the property.

Summary.

As summarized in the Regional Characterization Study section above, the area in the immediate vicinity of the landfill is generally characterized as rural. The area surrounding the existing landfill has historically been used as farmland. Scattered developments and mobile home parks are mingled between farms and forested areas. The area designated for the Subtitle D landfill is only several hundred feet west of the existing MSW landfill site. This land is zoned RA-30, which means that the minimum lot size must be 30,000 square feet for agricultural or residential use. A portion of the area is within the 100 year floodplain and other portions of the area have been designated as wetlands.

The existing landfill boundary encompasses 225 acres. Within that area, the Subtitle D landfill will cover 26 acres. The remaining area is dedicated to the existing

MSW landfill, closed out landfill operations, yard waste storage areas, tire storage areas, borrow areas, and other facilities associated with landfill operations.

Existing Land Use and Zoning.

Land use in the vicinity of the Dunn\Erwin Landfill Facility and proposed site primarily involves farming, and scattered residential areas. According to staff at the Harnett County Planning Department, the majority of this area is zoned RA-30. This zoning designation requires a minimum lot size of 30,000 square feet for residential or agricultural purposes.

In addition to the existing landfill facility and proposed landfill area, Harnett County also owns the tract of land on the northeast side of the entrance road to the landfill. This land is to serve as both a borrow area and additional buffer between the landfill facility and neighboring land.

Private Residences and Schools.

There are about 35 occupied residences within the 2,000 feet perimeter of the Dunn/Erwin landfill property line. Visual observations in the area indicated that only three (3) of the thirty five (35) residences had bored wells. It was unknown whether these wells were in use. The remaining residents are connected to the Harnett County water supply system.

The closest school to the Dunn/Erwin landfill is Triton High School. The school is located approximately one mile southwest of the landfill property and therefore not shown on the Local Area Map. The Schools' water is supplied by the Town of Erwin.

Commercial/Industrial Buildings and Other Potential Sources Of Contamination.

There is only one commercial or industrial business that has been identified within the 2,000 feet perimeter of the landfill. The company is a bottled gas company located along the Durham and Southern railroad line approximately 1,700 feet west of the north west property line of the landfill.

There are no other sources of potential contamination within the 2,000 feet perimeter of the landfill except the landfill itself. Water samples collected from monitoring wells surrounding the existing, unlined cells have exhibited high levels of volatile organic compounds (VOC's) and metals. A detailed assessment of the extent and nature of the groundwater contamination at the Dunn/Erwin landfill is currently being conducted. Once the extent of the problem is determined, a remediation plan will be implemented upon approval by NCDEHNR.

Potable Wells and Well Documentation.

The Harnett County Department of Health does not require well permits for the installation of private water wells. Therefore, specific information regarding private wells within the 2,000 feet perimeter of the property is limited. Local well drillers in the area were contacted regarding general information pertaining to well installation in the

area. The wells that have been installed in the general area have been bored and are in the range of 20 inches to 24 inches diameter. Total depth of the wells were in the 40 feet to 50 feet range. The yield has been in the range of 5 to 20 gallons per minute. No information exists on the depth or yield of smaller diameter drilled wells.

Historic Sites.

An archaeological survey was conducted in June 1991. This area included the area slated for the Subtitle D landfill site. Although the survey recorded three prehistoric sites, no historic sites were noted in the study area. The survey is included as Attachment II to this report. See Section IV, Location Restriction Demonstration, for further detail regarding correspondence with the North Carolina Department of Cultural Resources and the archaeological survey performed at the proposed landfill site.

Existing Topography and Other Features.

The Local Characterization Map shows the existing topography within the 2,000 foot perimeter of the site. This map was generated by using USGS Quadrangle Maps for Dunn and Coats, North Carolina. It shows the general surface water drainage patterns and watersheds, perennial and intermittent streams. There are no rivers or lakes within the 2,000 foot perimeter of the landfill boundary. The 100-year floodplain shown on Sheet C-3 was not mapped by the Corp of Engineers. According to the Corp, the 100 year floodplain for this area ranges from 5 ½ feet for the upstream section to

seven feet for the down stream section. Sheet C-3 shows a conservative approximation of the 100-year floodplain for this area. See Section II, Appendix A for correspondence relating to the determination of the floodplain.

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1890
WILMINGTON, NORTH CAROLINA 28402-1890

REPLY TO
ATTENTION OF

March 13, 1995

RECEIVED
MAR 16 1995
Ans'd.....

Plan Formulation and
Economic Section

Mr. Tom Wainwright
McKim and Creed Engineers
5625 Dillard Road, Suite 117
Cary, North Carolina 27511

Dear Mr. Wainwright:

This is in response to your March 6, 1995, facsimile and subsequent check dated March 9, 1995, for $105, regarding the request for flood hazard information for a proposed landfill extension near Stewart's Creek, just upstream of the CSX Railroad, Harnett County, North Carolina. The site, as shown on the map in your facsimile, is located about two miles northeast of Erwin, North Carolina.

We do not have detailed flood elevation information at this site. Stewart's Creek, which borders the westerly edge of the site, and an unnamed tributary stream of Stewart's Creek, which flows through the site from northeast to southwest, are mapped approximately as special flood hazard areas, as shown on Panel 37085C0112 D of the April 16, 1990, Harnett County Flood Insurance Rate Map. However, based on an approximate method developed by the United States Geological Survey for determining depth of flooding, we estimate that the 100-year flood height for the downstream (southerly) end of this property is about seven feet above the normal streamflow level of Stewart's Creek. This elevation varies to about 6-1/2 feet above normal streamflow along Stewart's Creek at the upstream (northerly) end of the site and to about 5-1/2 feet above normal streamflow level along the tributary where it crosses the upstream (northeasterly) border of the site.

You also requested available information on benchmarks near the site. Enclosed is a copy of elevation reference mark (RM) data from the Harnett County, North Carolina, Flood Insurance Study, dated April 16, 1990, and a copy of a portion of Panel 112. It appears that RM8 is nearest to the site. Its location is highlighted on the attached copy of Panel 112.

If we can be of further assistance in this or any other flood plain matter, please do not hesitate to contact us.

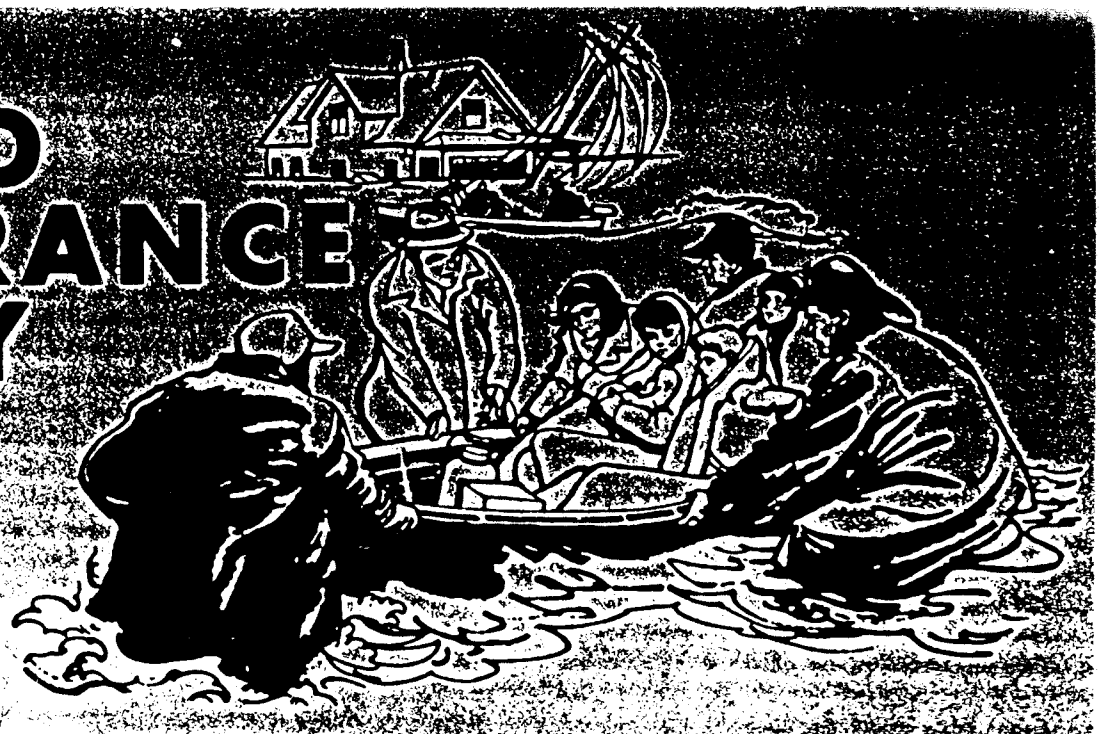
Sincerely,

William R. Dawson, P.E.
Chief, Engineering and
Planning Division

Enclosures

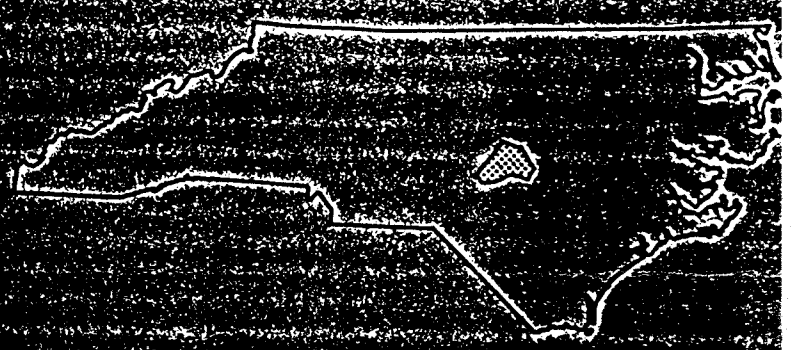
Printed on Recycled Paper

FLOOD INSURANCE STUDY



HARNETT COUNTY, NORTH CAROLINA AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
DUNN, CITY OF	370264
ERWIN, TOWN OF	370456
LILLINGTON, TOWN OF	370381
UNINCORPORATED AREAS	370328



APRIL 16, 1990

Federal Emergency Management Agency

ELEVATION REFERENCE MARKS

REFERENCE MARK	FLOOD INSURANCE RATE MAP PANEL	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
1	0085	190.07	PK nail in southeast abutment of SR 1516 bridge over Buies Creek
2	0085	184.42	North Carolina Geodetic Survey disk flush with ground located 800 feet east of intersection of SR 1519 and U.S. Route 421, about 84.7 feet north of centerline of U.S. Route 421, on 15-foot embankment
3	0085	128.92	chiseled cross in northwest end of metal rail of SR 1519 bridge over Buies Creek
4	0085	158.08	PK nail in edge of pavement on upstream side of U.S. Route 421 at centerline of culvert under road
5	0112	187.93	PK nail in north edge of pavement at centerline of SR 2009 bridge over Juniper Creek
6	0112	128.57	PK nail in north edge of pavement at centerline of U.S. Route 421 bridge over Juniper Creek
7	0112	128.42	PK nail in southeast end of rail on Homestead Road bridge over Stewarts Creek, in mobile home park
8	0112	163.39	PK nail in southeast wingwall of SR 1725 bridge over Stewarts Creek
9	0113	112.66	PK nail in northeast post of access road bridge over Juniper Creek, west of filtration plant
10	0113	108.15	PK nail in southeast wingwall of SR 1769 bridge over Juniper Creek
11	0114	149.24	chiseled cross in northeast end of headwall of SR 1726 bridge over Stewarts Creek

res.

aries of the floodways were computed at cross sections and interpolated
n cross sections. The floodways were based on hydraulic considerations
gard to requirements of the Federal Emergency Management Agency.

ay widths in some areas may be too narrow to show to scale. Refer to
ay Data Table where floodway width is shown at 1/20 inch.

l base flood elevations apply only landward of the shoreline.

ap incorporates approximate boundaries of coastal barriers established
the Coastal Barrier Resources Act (PL 97-348).

on reference marks are described in the Flood Insurance Study Report.

ate limits shown are current as of the date of this map. The user should
t appropriate community officials to determine if corporate limits have
d subsequent to the issuance of this map.

mmunity panel revision history prior to countywide mapping, refer to
unity Map History in the Flood Insurance Study Report.

joining panels, see separately printed Map Index.

MAP REPOSITORY

to Repository Listing on Map Index.

EFFECTIVE DATE OF COUNTY-WIDE
FLOOD INSURANCE RATE MAP:

APRIL 16, 1990

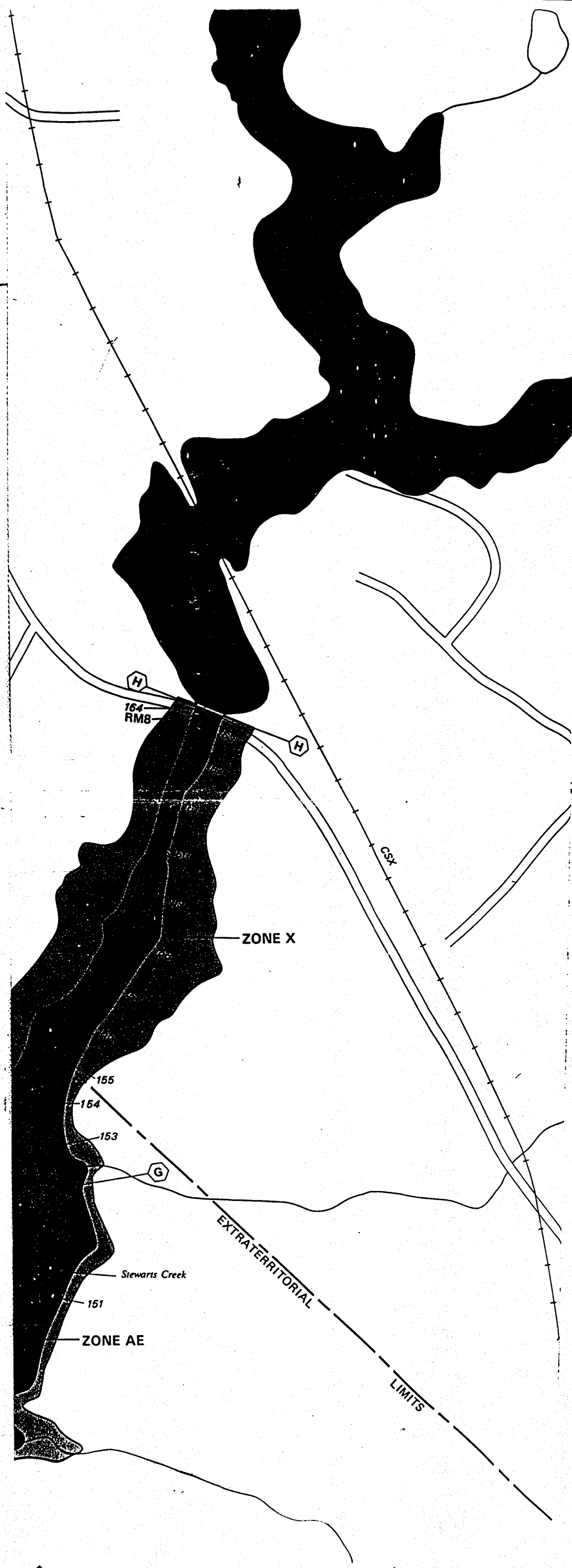
EFFECTIVE DATE(S) OF REVISIONS TO THIS PANEL:

termine if flood insurance is available, contact an insurance agent or call
ational Flood Insurance Program at (800) 638-6620.

N

APPROXIMATE SCALE IN FEET

500 0 500



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

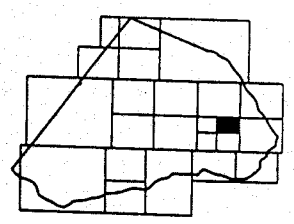
HARNETT COUNTY,
NORTH CAROLINA AND
INCORPORATED AREAS

PANEL 112 OF 185

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ERWIN, TOWN OF	370456	0112	D
UNINCORPORATED AREAS	370328	0112	D

PANEL LOCATION



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37085C0112 D
EFFECTIVE DATE:
APRIL 16, 1990

Federal Emergency Management Agency

SECTION III

HYDROGEOLOGICAL REPORT

SECTION III GEOLOGIC AND HYDROGEOLOGIC REPORT

A. Geologic and Hydrogeologic Report

The site Geologic and Hydrogeologic Report as required by rule *15A NCAC 13B.1618(3)* can be found in Attachment 1. The study was prepared in accordance with the requirements set forth in Rule *15A NCAC 13B .1623*. The report consists of three components, as follows:

- A report entitled: "SUBSURFACE EXPLORATION DUNN-ERWIN LANDFILL, HARNETT COUNTY, NORTH CAROLINA," by Froehling & Robertson, Inc., (F&R) September 1986 sealed by a professional engineer (PE),
- A report entitled: "GEOLOGIC AND HYDROGEOLOGIC STUDY FOR DUNN-ERWIN LANDFILL EXPANSION, " by Westinghouse Environmental and Geotechnical Services, Inc. , (WR) July 1991 sealed by a PE and a professional geologist (PG),
- A Supplemental Geologic and Hydrogeologic Evaluation (SGHE) provided by McKim & Creed.

The F&R report primarily contains soil boring information. The WR report contains additional soil boring data, physiography and regional hydrogeology, subsurface conditions, and conclusions. In the SGHE, McKim & Creed has provided addition information on groundwater levels, subsurface characterization, and location restriction requirements. Table 1 of the SGHE shows the summary of all applicable

regulations regarding the geological and hydrogeological site study, and their respective references.

SECTION IV

LOCATION RESTRICTION DEMONSTRATION

SECTION IV: LOCATION RESTRICTION DEMONSTRATION

A. Introduction

The following section has been prepared in accordance with *15A NCAC 13B.1622* regulations. Issues related to airport safety, floodplain, wetlands, State Nature and Historic Preserve, water supply watersheds, and endangered and threatened species are discussed below. Geotechnical considerations such as the potential presence of unstable areas, faults, and seismically active areas are also discussed below.

An archaeological survey was performed by Archaeological Research Consultants, Inc. in accordance with North Carolina Office of State Archaeology standards. The report summarizing the results of the archaeological survey and the potential impact of the proposed landfill on cultural resources is presented in Attachment II of this report.

B. Airport Safety

The closest airport to the Dunn/Erwin landfill is the Harnett County Airport located between NCSR 27 and the Cape Fear River northwest of Erwin. The Harnett County airport runway is approximately four and one-third miles (23,195 ft.) west northwest of the Dunn/Erwin landfill. Consequently, the landfill facility is outside of the 10,000-foot buffer required between a landfill and an airport serviced by turbine-powered aircraft.

However, the proposed site will be within a five mile radius from the airport. Therefore, the Harnett County Airport and the Federal Aviation Administration, will be notified of the proposed lined landfill, as specified in *15A NCAC 13B.1622(b).* Section IV, Appendix A contains a copy of the notification letters sent to the Harnett County Airport and the Federal Aviation Administration (FAA). A copy of a letter sent to the FAA requesting verification of airport locations in the vicinity of the landfill and a copy of the FAA response letter are also included in Section IV, Appendix A. Any responses from the FAA will be included as part ot the Site Application Report.

C. Floodplain

Neither the existing vertical expansion unit nor the proposed lined landfill are within the 100-year floodplain based on research of floodway maps. See Sheet C-3 for location of the estimated 100-year floodplain boundary. The 100-year floodplain shown on Sheet C-3 was mapped per the Corp of Engineers instructions in their March 13, 1995 letter to Mr. Tom Wainwright of McKim and Creed. According to the Corp, the 100-year floodplain for this area ranges from 5 ½ feet for the upstream section to seven feet for the downstream section. Sheet C-3 shows a conservative approximation of the 100-year floodplain for this area. Please refer to Section II, Appendix B for a copy of the Corp correspondence regarding floodplain determination in this area.

D. Wetlands

A wetland delineation was performed and subsequently approved by the U.S. Army Corps of Engineers on April 10, 1991. Approval was requested in December 1994 for modification to the wetlands under Sections 14 and 26 of the Nationwide permit. Approval was subsequently granted as shown in the letters from Department of Enviromental Management (DEM) and the Corp. Section IV, Appendix B contains a copies of the wetlands approval letters regarding this issue. Sheet C-3 shows the approved wetlands boundary. As shown on this sheet, the proposed landfill lies outside the wetlands and therefore will not impact these areas.

E. Fault Areas

Based on our review of available literature (USGS Geologic Map of North Carolina), no evidence can be found of any known or suspected faults that have had displacement in Holocene time within 200 feet of the site. The closest major fault is the Nutbush fault. This fault is located approximately 30 miles northwest of the site.

F. Seismic Impact Zones.

North Carolina Solid Waste Management defines a seismic impact zone as an area with a ten percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percent of the earth's gravitational field(g), will exceed 0.10 g (0.10 times the acceleration due to gravity) in 250 years. Based on our review of available literature, the proposed site is not located in a seismic impact

area. This region of the Coastal Plain Province is considered to be inactive relative to potential seismic and tectonic activity. Figure 1 in Appendix C of this section shows the major earthquake zones of the Eastern United States. Figure 2 in Appendix C of this section shows a reproduced portion of the U.S. Geological Survey Map MF2120 (Map C) from "*Probabilistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico*", by Algermissen et al, 1990. The proposed landfill is located within an area where the peak acceleration will not exceed 0.10 g in 250 years according to that document. Additional discussion of the model used to make this prediction is included in Appendix C of this section.

G. Unstable Areas

The preliminary boring information and a reconnaissance of the site do not suggest the presence of any widespread weak or unstable areas to be present. Soil conditions were encountered in the borings that ranged from very dense to very loose relative densities. Variations in soil strength and settlement characteristics of the soils within individual landfill cells will be evaluated in greater detail during the design phase.

H. Cultural Resources.

As stated in a March 20, 1991 letter from David Brook, Deputy State Historic Preservation Officer with the North Carolina Department of Cultural Resources, to Mr. Charlie Musser, McKim & Creed Engineers, there are no structures of historical or

archaeological importance located within the proposed landfill planning area. Mr. Brook's comments were made in accord with G.S. 121-12(a) and Executive Order XVI.

In addition, Mr. Brook recommended that a comprehensive survey be conducted by an experienced archaeologist to identify the presence and significance of archaeological remains that may be damaged or destroyed by the proposed landfill. This survey was performed by Mr. Thomas Hargrove of Archaeological Research Consultants, Inc. and is included in Attachment II to this report. A copy of this report was submitted to Mr. Brook for review and comment. A copy of Mr. Brook's comments is included in Appendix C of this section.

I. State Nature and Historic Preserve

According to Mr. Ken Huband, NCDEHNR Division of Parks and Recreation, the only state park within Harnett County is Raven Rock State Park. The landfill is not located within Raven Rock State Park and therefore, the proposed landfill would not impact any land designated as State Nature and/or Historic Preserve.

J. Water Supply Watersheds

According to Ms. Suzanne Hover, NCDEHNR Water Quality Section, all of the existing and proposed Dunn\Erwin Landfill Facility drains to Stewart Creek and its unnamed tributaries. These streams are all designated as Class C Nutrient Sensitive Waters (NSW). Class C is a general classification for all waters that are neither used for recreational purposes nor for water supply.

K. Endangered and Threatened Species

Correspondence to and from the U.S. Fish and Wildlife Service Ecological Services is documented in Appendix E of this Section. The latest correspondence from Candice Marino (Acting Endangered Species Coordinator), dated September 12, 1995, states that " Based on information provided, it appears that your project site does not contain suitable habitat for any Federally-listed endangered or threatened species known to occur in the area".

No additional work is contemplated based on this response.

County of Harnett

Transportation
Procurement
Solid Waste Management

JERRY T. BLANCHARD
Director
(919) 893-7536

October 6, 1995

Mr. Walter Bauer
Federal Aviation Administration
Atlanta Airport District Office
1680 Phoenix Parkway, Suite 101
Atlanta, Georgia 30349

RE: Notice of Proposed Landfill Site in Proximity to the Harnett County Airport
Dunn/Erwin Landfill
Harnett County, North Carolina

Dear Mr. Bauer :

In compliance with 15A *North Carolina Administrative Code* 13B.1622 (1) (b), this letter is to notify you that Harnett County is submitting a site application to the North Carolina Department of Environmental Health and Natural Resources (NCDEHNR) for a Subtitle D municipal solid waste landfill. The proposed landfill site is adjacent to the currently permitted and active Dunn/Erwin Landfill Facility and is approximately four miles east southeast of the nearest Harnett County Airport runway. Please note that a similar notification letter has also been sent to the Federal Aviation Administration (Atlanta Airport District Office.)

The coordinates that approximately border the entire existing and proposed landfill property boundaries are shown below:

Approx. Boundary	Latitude	Longitude
Northeast	35° 22' 04"	78° 39' 25"
Northwest	35° 22' 04"	78° 38' 42"
Southeast	35° 21' 08"	78° 39' 08"
Southwest	35° 21' 08"	78° 38' 42"

P.O. Box 940 • Lillington, North Carolina 27546

If you have any questions regarding the proposed landfill site, please contact me at (910) 893-7536 or C. T. Clayton, McKim & Creed Engineers, at (919) 233-8091.

Sincerely,

Jerry Blanchard
Solid Waste Management Director

cc: C. T. Clayton, McKim & Creed Engineers, P.A.

County of Harnett

Transportation
Procurement
Solid Waste Management

JERRY T. BLANCHARD
Director
(919) 893-7536

October 6, 1995

Mr. Walter Bauer
Federal Aviation Administration
Atlanta Airport District Office
1680 Phoenix Parkway, Suite 101
Atlanta, Georgia 30349

RE: Notice of Proposed Landfill Site in Proximity to the Harnett County Airport
Dunn/Erwin Landfill
Harnett County, North Carolina

Dear Mr. Bauer :

In compliance with 15A *North Carolina Administrative Code* 13B.1622 (1) (b), this letter is to notify you that Harnett County is submitting a site application to the North Carolina Department of Environmental Health and Natural Resources (NCDEHNR) for a Subtitle D municipal solid waste landfill. The proposed landfill site is adjacent to the currently permitted and active Dunn/Erwin Landfill Facility and is approximately four miles east southeast of the nearest Harnett County Airport runway. Please note that a similar notification letter has also been sent to the Federal Aviation Administration (Atlanta Airport District Office.)

The coordinates that approximately border the entire existing and proposed landfill property boundaries are shown below:

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Northwest	35° 22' 04"	78° 38' 42"
Southeast	35° 21' 08"	78° 39' 08"
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P.O. Box 940 • Lillington, North Carolina 27546

If you have any questions regarding the proposed landfill site, please contact me at (910) 893-7536 or C. T. Clayton, McKim & Creed Engineers, at (919) 233-8091.

Sincerely,

Jerry Blanchard
Solid Waste Management Director

cc: C. T. Clayton, McKim & Creed Engineers, P.A.

McKIM&CREED

June 28, 1994

M&C 0006-L009.9E (13)

ENGINEERS

SURVEYORS

ARCHITECTS

PLANNERS

Mr. Walter Bauer
Federal Aviation Administration
Atlanta Airport District Office
1680 Phoenix Parkway, Suite 101
Atlanta, Georgia 30349

RE: Airport Location Request for Landfill Transition Plans for Landfills in Harnett County, Johnston County, and Union County, North Carolina

Dear Mr. Bauer:

The purpose of this letter is to request your assistance in obtaining information regarding airport locations in North Carolina so as to address a North Carolina Department of Environmental Health and Natural Resources (NC DEHNR) requirement governing municipal solid waste (MSW) landfill and airport proximity restrictions. In April 1994, McKim & Creed Engineers submitted three landfill transition plans to the NC DEHNR for Harnett County, Johnston County, and Union County, North Carolina. In general, the purpose of the transition plans was to have North Carolina MSW landfill owners and operators demonstrate to NC DEHNR that the necessary measures were being taken to ensure that the existing MSW landfills would eventually meet the requirements of the federally-mandated Subtitle D landfill regulations.

After an initial review of the MSW landfill transition plans, NC DEHNR recently requested that we provide evidence from the Federal Aviation Administration that confirms the location of the public-use airports closest to these landfills. In order to satisfactorily address the NC DEHNR's transition plan comments, we are especially interested in learning the locations of the following:

a. runways at public-use airports that are used by only piston-powered aircraft and that are within 5,000 feet from any of the landfills referenced above, and

b. runways at public-use airports that are used by turbine-powered aircraft and that are within 10,000 feet from any of the landfills referenced above.

SUITE 117

BUILDING I

5625 DILLARD ROAD

CARY, NC 27511

PHONE 919/233-8091

FAX 919/233-8031

The latitudinal and longitudinal coordinates that approximately border the three landfills' property boundaries are given below:

Harnett County (Dunn-Erwin) Landfill

Approx. Boundary	Latitude	Longitude
Northeast	35° 22' 04"	78° 39' 25"
Northwest	35° 22' 04"	78° 38' 42"
Southeast	35° 21' 08"	78° 39' 08"
Southwest	35° 21' 08"	78° 38' 42"

Johnston County Landfill

Approx. Boundary	Latitude	Longitude
Northeast	35° 31' 23"	78° 25' 23"
Northwest	35° 31' 46"	78° 26' 11"
Southeast	35° 30' 34"	78° 25' 30"
Southwest	35° 30' 41"	78° 26' 22"

Union County Landfill

Approx. Boundary	Latitude	Longitude
Northeast	35° 02' 19"	80° 27' 30"
Northwest	35° 02' 34"	80° 28' 06"
Southeast	35° 01' 55"	80° 27' 46"
Southwest	35° 01' 55"	80° 27' 57"

We appreciate your assistance in this matter. Please call me if you need any further information in processing this request.

Respectfully,

McKIM & CREED ENGINEERS, P.A

Michael J.E. Sanchez, EIT
Project Engineer

/mjes

cc: C.T. Clayton, P.E.

\304\61009.93\13\faa.let

McKIM&CREED

U.S. Department
of Transportation
**Federal Aviation
Administration**

Atlanta Airports District Office
1680 Phoenix Parkway, Suite 101
Atlanta, Georgia 30349-5421

JUL 20 1994

RECEIVED
JUL 25 1994
Ans'd.....

Mr. Michael J. E. Sanchez
McKim & Creed-Engineers, Surveyors, Architects, and Planners
Dillard Road, Suite 117, Building 1
Cary, North Carolina 27511

Dear Mr. Sanchez:

Your letter of June 28, 1994, regarding public-use airports, requests the name, other information and the distance to three landfill areas. Based on the coordinates provided, in a 6-mile search around the given points, our database shows no existing public-use airports within 10,000 feet. Enclosed is a copy of each print-out.

We would like to call your attention to the fact that the Federal Aviation Administration (FAA) recommends that operators proposing new or expanded landfill sites within 5 statutory miles (26,400 feet) of a runway end notify the airport owner and FAA. Please notice that all the airports identified by our computer circle search are within that distance from the points given in your letter.

Please call if we may be of further assistance.

Sincerely,

Walter Bauer
Program Manager

Enclosures

cc:
Mr. Richard W. Barkes, Div. of Aviation, NC DOT, w/o Enc.

The latitudinal and longitudinal coordinates that approximately border the three landfills' property boundaries are given below:

Harnett County (Dunn-Erwin) Landfill – CLOSEST LANDING AREA IS HARNETT COUNTY AIRPORT, ERWIN, N

(1)

Approx. Boundary	Latitude	Longitude	DISTANCE TO ARP (FEET)
(a) Northeast	35° 22' 04"	78° 39' 25"	23,195.19
(b) Northwest	35° 22' 04"	78° 38' 42"	26,711.36
(c) Southeast	35° 21' 08"	78° 39' 08"	26,099.55
(d) Southwest	35° 21' 08"	78° 38' 42"	28,113.04

Johnston County Landfill – CLOSEST LANDING AREA IS JOHNSTON COUNTY AIRPORT, SMITHFIELD, N

(2)

Approx. Boundary	Latitude	Longitude	DISTANCE TO ARP (FEET)
(a) Northeast	35° 31' 23"	78° 25' 23"	12,319.80
(b) Northwest	35° 31' 46"	78° 26' 11"	14,832.50
(c) Southeast	35° 30' 34"	78° 25' 30"	16,077.28
(d) Southwest	35° 30' 41"	78° 26' 22"	18,763.99

Union County Landfill – THE CLOSEST LANDING AREA IS U.S. HELIPORT, WINGATE, NC

(3)

Approx. Boundary	Latitude	Longitude	DISTANCE TO ARP (FEET)
(a) Northeast	35° 02' 19"	80° 27' 30"	22,607.14
(b) Northwest	35° 02' 34"	80° 28' 06"	25,463.73
(c) Southeast	35° 01' 55"	80° 27' 46"	21,272.74
(d) Southwest	35° 01' 55"	80° 27' 57"	21,818.42

ARP = AIRPORT REFERECE POINT

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 1.a LATITUDE: 35-22-04.0 ; AND LONGITUDE: 78-39-25.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE	DIST. (FEET)	LATITUDE	LONGITUDE
NC	DUNN	BETSY JOHNSON MEM HOS	16676.51	H	PR		35-18-48	78-38-09
NC	DUNN	NATIONAL ESTATES INC	16676.5	A	PR		35-16-13	78-34-25
NC	ERWIN	HARNETT COUNTY	16707.1	A	PU	23,195.19	35-22-43	78-44-01

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 1.b LATITUDE: 35-22-04.0 ; AND LONGITUDE: 78-38-42.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE		LATITUDE	LONGITUDE
NC	DUNN	BETSY JOHNSON MEM HOS	16676.51	H	PR		35-18-48	78-38-09
NC	DUNN	NATIONAL ESTATES INC	16676.5	A	PR		35-16-13	78-34-25
NC	ERWIN	HARNETT COUNTY	16707.1	A	PU	26,711	35-22-43	78-44-01

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 1.d LATITUDE: 35-21-08.0 ; AND LONGITUDE: 78-38-42.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE	LATITUDE	LONGITUDE
NC	DUNN	BETSY JOHNSON MEM HOS	16676.51	H	PR	35-18-48	78-38-09
NC	DUNN	NATIONAL ESTATES INC	16676.5	A	PR	35-16-13	78-34-25
NC	ERWIN	HARNETT COUNTY	16707.1	A	PU 28,113'	35-22-43	78-44-01
NC	LINDEN	SURLES	16866.5	A	PR	35-15-01	78-44-59

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 1.c LATITUDE: 35-21-08.0 ; AND LONGITUDE: 78-39-08.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE	LATITUDE	LONGITUDE
NC	DUNN	BETSY JOHNSON MEM HOS	16676.51	H	PR	35-18-48	78-38-09
NC	DUNN	NATIONAL ESTATES INC	16676.5	A	PR	35-16-13	78-34-25
NC	ERWIN	HARNETT COUNTY	16707.1	A	PU 29,100'	35-22-43	78-44-01
NC	LINDEN	SURLES	16866.5	A	PR	35-15-01	78-44-59

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 2.a LATITUDE: 35-31-23.0 ; AND LONGITUDE: 78-25-23.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE		LATITUDE	LONGITUDE
NC	SMITHFIELD	HOLT'S LAKE	17101.2	A	PR		35-27-51	78-22-52
NC	SMITHFIELD	JOHNSTON COUNTY	17101.	A	PU	13,319.8	35-32-33	78-23-21

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 2.b LATITUDE: 35-31-46.0 ; AND LONGITUDE: 78-26-11.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE		LATITUDE	LONGITUDE
NC	SMITHFIELD	HOLT'S LAKE	17101.2	A	PR		35-27-51	78-22-52
NC	SMITHFIELD	JOHNSTON COUNTY	17101.	A	PU	14,832.50	35-32-33	78-23-21

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 2.C LATITUDE: 35-30-34.0 ; AND LONGITUDE: 78-25-30.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE		LATITUDE	LONGITUDE
NC	SMITHFIELD	HOLT'S LAKE	17101.2	A	PR		35-27-51	78-22-52
NC	SMITHFIELD	JOHNSTON COUNTY	17101.	A	PU	16,077.28	35-32-33	78-23-21

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 2.d LATITUDE: 35-30-41.0 ; AND LONGITUDE: 78-26-22.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE		LATITUDE	LONGITUDE
NC	SMITHFIELD	HOLT'S LAKE	17101.2	A	PR		35-27-51	78-22-52
NC	SMITHFIELD	JOHNSTON COUNTY	17101.	A	PU	18,763.99	35-32-33	78-23-21

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 3.a LATITUDE: 35-02-19.0 ; AND LONGITUDE: 80-27-30.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE	LATITUDE	LONGITUDE
NC	MONROE	UNION MEM HOS HELI	16926.1	H	PR	34-58-04	80-31-25
NC	WINGATE	ARANT	17217.7	A	PR	35-03-22	80-27-00
NC	WINGATE	U.S.HELIPORT	17217.71	H	PU 22,607.14	34-59-04	80-25-17
NC	WINSTON SALEM	UNNAMED	00000.00	H	PR	35-05-28	80-22-24

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 3.b LATITUDE: 35-02-34.0 ; AND LONGITUDE: 80-28-06.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE	LATITUDE	LONGITUDE
NC	MONROE	EDWARDS FARM AIRPORT	00000.000	A	PR	35-04-16	80-34-59
NC	MONROE	UNION MEM HOS HELI	16926.1	H	PR	34-58-04	80-31-25
NC	WEST MONROE	SIMMONS	00000.000	H	PR	35-00-12	80-34-21
NC	WINGATE	ARANT	17217.7	A	PR	35-03-22	80-27-00
NC	WINGATE	U.S.HELIPORT	17217.71	H	PU 25,463.73	34-59-04	80-25-17
NC	WINSTON SALEM	UNNAMED	00000.00	H	PR	35-05-28	80-22-24

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 3.d LATITUDE: 35-01-55.0 ; AND LONGITUDE: 80-27-57.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE	LATITUDE	LONGITUI
NC	MONROE	UNION MEM HOS HELI	16926.1	H	PR	34-58-04	80-31-2
NC	WINGATE	ARANT	17217.7	A	PR	35-03-22	80-27-0
NC	WINGATE	U.S.HELIPORT	17217.71	H	PU 21,8,8,61	34-59-04	80-25-1
NC	WINSTON SALEM	UNNAMED	00000.00	H	PR	35-05-28	80-22-2

SUBJECT: AIRPORT/HELIPORT SEARCH,
POINT 3.c LATITUDE: 35-01-55.0 ; AND LONGITUDE: 80-27-46.0
MILES SEARCHED = 6

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LANDING AREA FACILITIES IN STATE

ST	CITY	AIRPORT NAME	SITE NO.	TYPE	USE	LATITUDE	LONGITU
NC	MONROE	UNION MEM HOS HELI	16926.1	H	PR	34-58-04	80-31-2
NC	WINGATE	ARANT	17217.7	A	PR	35-03-22	80-27-0
NC	WINGATE	U.S.HELIPORT	17217.71	H	PU 21,27,74	34-59-04	80-25-1
NC	WINSTON SALEM	UNNAMED	00000.00	H	PR	35-05-28	80-22-2

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Environmental Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
A. Preston Howard, Jr., P.E., Director

DEHNR

March 10, 1995
Harnett County
DEM Project # 95103

APPROVAL of 401 Water Quality Certification and ADDITIONAL CONDITIONS

Mr. Neil Emory, County Manger
County of Harnett
P.O. Box 759
Lillington, N.C. 27546

FILE CO

Dear Mr. Emory:

You have our approval to place fill material in 2.18 acres of wetlands or waters for the purpose of land fill expansion at Harnett County land fill on SR 1724, as you described in your application dated 30 January 1995. After reviewing your application, we have decided that this fill is covered by General Water Quality Certification Numbers 2671 and 2732. These certifications allow you to use Nationwide Permit Numbers 26 and 14 when they are issued by the Corps of Engineers.

This approval is only valid for the purpose and design that you described in your application. If you change your project, you must notify us and you may be required to send us a new application. For this approval to be valid, you must follow the conditions listed in the attached certification. Waste disposal areas shall be no closer than 300 feet to Stewart's Creek. In addition, you should get any other federal, state or local permits before you go ahead with your project.

If you do not accept any of the conditions of this certification, you may ask for an adjudicatory hearing. You must act within 30 days of the date that you receive this letter. To ask for a hearing, send a written petition which conforms to Chapter 150B of the North Carolina General Statutes to the Office of Administrative Hearings, P.O. Box 27447, Raleigh, N.C. 27611-7447. This certification and its conditions are final and binding unless you ask for a hearing.

This letter completes the review of the Division of Environmental Management under Section 401 of the Clean Water Act. If you have any questions, please telephone John Dorney at 919-733-1786.

Sincerely,

John R Dorney

A. Preston Howard, Jr. P.E.

Attachment
cc: Wilmington District Corps of Engineers
Corps of Engineers Wilmington Field Office
Fayetteville DEM Regional Office
Mr. John Dorney
Central Files
Mark Ashness; McKim and Creed

95103.ltr

GENERAL CERTIFICATION FOR PROJECTS ELIGIBLE FOR CORPS OF ENGINEERS NATIONWIDE PERMIT NUMBER 14 (ROAD CROSSINGS)

This General Certification is issued in conformity with the requirements of Section 401, Public Laws 92-500 and 95-217 of the United States and subject to the North Carolina Division of Environmental Management Regulations in 15A NCAC 2H, Section .0500 and 15A NCAC 2B .0109 and .0201 for the discharge of fill material to waters and wetland areas as described in 33 CFR 330 Appendix A (B) (14) of the Corps of Engineers regulations (i.e., Nationwide Permit No. 14). The category of activities shall include any fill activity for road crossing and is limited to fill less than one-third of an acre. This Certification replaces Water Quality Certification Number 2177 issued on November 5, 1987 and Water Quality Certification Number 2666 issued on January 21, 1992.

The State of North Carolina certifies that the specified category of activity will not violate Sections 301, 302, 303, 306 and 307 of the Public Laws 92-500 and 95-217 if conducted in accordance with the conditions hereinafter set forth.

Conditions of Certification:

1. Proposed fill or substantial modification of wetlands under this General Certification requires written concurrence from the Division of Environmental Management. Projects which impact waters only do not require written concurrence.
2. If written concurrence is not issued by the Division of Environmental Management within 45 days from receipt of a complete application by the Division's 401 Certification Office in Raleigh, then 401 Certification is deemed to be issued as long as the applicant follows all other conditions of this General Certification unless additional information is requested in writing by the Director or his designee;
3. The width of the fill is limited to the minimum needed for the actual crossing;
4. That the roadway width shall be minimized as much as practicable and that no practicable alternative exists;
5. That established sediment and erosion control practices are utilized to prevent violations of the appropriate turbidity water quality standard (50 NTUs in streams and rivers not designated as trout waters by DEM; 25 NTUs in all saltwater classes, and all lakes and reservoirs; and 10 NTUs in trout waters);
6. Measures shall be taken to prevent live or fresh concrete from coming into contact with waters of the state until the concrete has hardened;
7. That additional site-specific conditions may be added to

projects proposed under this Certification in order to ensure compliance with all applicable water quality and effluent standards;

8. Concurrence from DEM that this Certification applies to an individual project shall expire three years from the date of the cover letter from DEM.

Non-compliance with or violation of the conditions herein set forth by a specific fill project shall result in revocation of this Certification for the project.

The Director of the North Carolina Division of Environmental Management may require submission of a formal application for individual certification for any project in this category of activity, if it is determined that the project is likely to have a significant adverse effect upon water quality or degrade the waters so that existing uses of the wetland or downstream waters are precluded.

Public hearings may be held for specific applications or group of applications prior to a Certification decision if deemed in the public's best interest by the Director of the North Carolina Division of Environmental Management.

This is the 1st day of May, 1992

DIVISION OF ENVIRONMENTAL MANAGEMENT

By George T. Everett

George T. Everett, Director

gencert.14a
jrd/gc

WQC #2732

GENERAL CERTIFICATION FOR PROJECTS ELIGIBLE FOR CORPS OF ENGINEERS NATIONWIDE PERMIT NUMBER 26 (HEADWATERS AND ISOLATED WETLANDS)

This General Certification is issued in conformity with the requirements of Section 401, Public Laws 92-500 and 95-217 of the United States and subject to the North Carolina Division of Environmental Management Regulations in 15A NCAC 2H, Section .0500 and 15A NCAC 2B .0109 and .0201 for the discharge of fill material to navigable waters and adjacent wetland areas which are above the headwaters or to wetland areas that are not a part of the surface tributary system to interstate waters or navigable waters of the United States (i.e., isolated wetlands) as described in 33 CFR 330 Appendix A (B) (26) of the Corps of Engineers regulations (i.e., Nationwide Permit No. 26). The category of activities shall include any fill activity in these headwaters and isolated wetland and water areas where the activity results in the loss or substantial modification of not more than 10 acres of waters of the United States, including wetlands. This Certification replaces Water Quality Certification Number 2176 issued on November 5, 1987.

The State of North Carolina certifies that the specified category of activity will not violate Sections 301, 302, 303, 306 and 307 of the Public Laws 92-500 and 95-217 if conducted in accordance with the conditions hereinafter set forth.

Conditions of Certification:

1. Proposed fill or substantial modification of greater than one-third of an acre of such waters, including wetlands, requires a written concurrence from the Division of Environmental Management.
2. Proposed fill or substantial modification of equal to or less than one-third of an acre of such waters, including wetlands, does not require written concurrence from the Division of Environmental Management.
3. Proposed fill of greater than one acre in SA, trout, HQW, ORW, WS-I and WS-II watersheds requires public notice and an individual 401 Certification from the Division of Environmental Management;
4. That established sediment and erosion control practices are utilized to prevent violations of the appropriate turbidity water quality standard (50 NTUs in streams and rivers not designated as trout waters by DEM; 25 NTUs in all saltwater classes, and all lakes and reservoirs; 10 NTUs in trout waters);
5. That additional site-specific conditions may be added to projects with greater than one-third of an acre impact which are proposed under this Certification in order to ensure compliance with all applicable water quality and effluent standards;
6. Measures shall be taken to prevent live or fresh concrete from coming into contact with waters of the state until the concrete has hardened.
7. Concurrence from DEM this Certification applies to an individual project shall expire three years from the date

of the cover letter from DEM.

Non-compliance with or violation of the conditions herein set forth by a specific fill project shall result in revocation of this Certification for the project.

The Director of the North Carolina Division of Environmental Management may require submission of a formal application for individual certification for any project in this category of activity, if it is determined that the project is likely to have a significant adverse effect upon water quality or degrade the waters so that existing uses of the wetland or downstream waters are precluded.

Public hearings may be held for specific applications or group of applications prior to a Certification decision if deemed in the public's best interest by the Director of the North Carolina Division of Environmental Management.

This is the 21st day of January, 1992

DIVISION OF ENVIRONMENTAL MANAGEMENT

By George T. Everett

George T. Everett, Director

gencert.26
jrd/gc

WQC# 2671

May 4, 1995

Regulatory Branch

Action ID No. 199502198 Nationwide Permit No. 14 (Road Crossing) and Nationwide Permit No. 26 (Headwaters and Isolated Waters)

County of Harnett
ATTN: Mr. Neil Emory
Post Office Box 759
Lillington, North Carolina 27546

Dear Mr. Emory:

Please reference your application dated January 11, 1995, in which you requested Department of the Army (DA) authorization to discharge fill material into 0.25 acre of jurisdictional wetlands located above the headwaters of Stewart Creek, under Nationwide Permit #14 and 1.93 acre of the same wetland system under Nationwide Permit #26. All proposed fill will be used to create road crossings in association with the land fill expansion in Harnett County on State Road 1724, near Erwin, North Carolina.

For the purposes of the Corps of Engineers' Regulatory Program, Title 33, Code of Federal Regulations (CFR), Part 330.6, published in the Federal Register on November 22, 1991, lists nationwide permits. Authorization was provided, pursuant to Section 404 of the Clean Water Act, for discharges of dredged or fill material into headwaters and isolated waters. Also, authorization pursuant to Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act, was provided for fills for roads crossing waters of the United States (including wetlands and other special aquatic sites). Your 0.25 acre of fill is authorized under Nationwide Permit #14 provided:

a. The width of the fill is limited to the minimum necessary for the actual crossing;

b. The fill placed in waters of the United States is limited to a filled area of no more than one-third acre. Furthermore, no more than a total of 200 linear feet of the fill for the roadway can occur in special aquatic sites, including wetlands;

c. The crossing is culverted, bridged or otherwise designed to prevent the restriction of, and to withstand, expected highflows and the movement of aquatic organisms;

d. The crossing, including all attendant features, both temporary and permanent, is part of a single and complete project for crossing of a water of the United States; and

e. For fills in special aquatic sites, including wetlands, the permittee notifies the District Engineer (DE) in accordance with the "Notification" general condition.

Authorization was provided, pursuant to Section 404 of the Clean Water Act, for discharges of dredged or fill material into headwaters and isolated waters. The remaining 1.93 acres of fill is authorized under Nationwide Permit #26. Your work is authorized by these nationwide permits provided it is accomplished in strict accordance with your submitted plans, the enclosed conditions, and provided you receive a Section 401 water quality certification from the North Carolina Division of Environmental Management (NCDEM). You should contact Mr. John Dorney, telephone (919) 733-1786, regarding water quality certification. This nationwide permit does not relieve you of the responsibility to obtain other required State or local approval.

These verifications will be valid for two years from the date of this letter unless the nationwide authorization is modified, reissued or revoked. These verifications will remain valid for the two years if, during that period, the nationwide permit authorization is reissued without modification or the activity complies with any subsequent modification. If during the two years, the nationwide permit authorization expires or is suspended or revoked, or is modified, such that the activities would no longer comply with the terms and conditions of the nationwide permit, activities which have commenced or are under contract to commence, in reliance upon the nationwide permit, will remain authorized. This is provided the activities are completed within twelve months of the date of the nationwide permit's expiration, modification or revocation.

Questions or comments may be addressed to Mr. Scott McLendon, Wilmington Field Office, Regulatory Branch, telephone (910) 251-4725.

Sincerely,

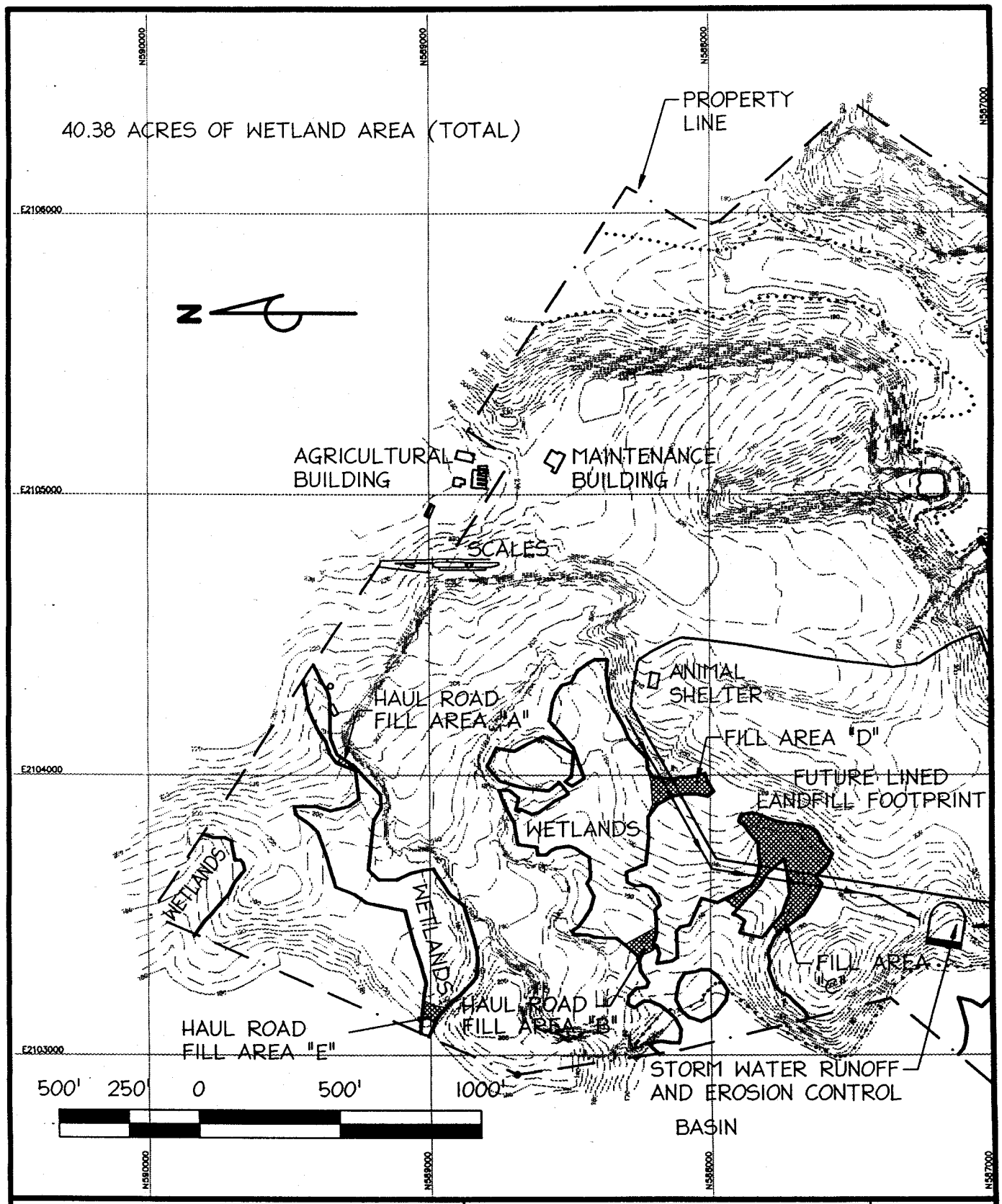
FILENAME:43emory.5
CESAW-CO-E1/sm/m
CESAW-CO-E/WINEGARDNER
CESAW-CO-E/WRIGHT/s
MAIL 5 ·9
CESAW-CO-E/FILES

G. Wayne Wright
Chief, Regulatory Branch

Enclosure

Copy Furnished (without enclosure):

Mr. John Dorney
Division of Environmental Management
North Carolina Department of
Environment, Health and
Natural Resources
Post Office Box 29535
Raleigh, North Carolina 27626-0535



DUNN - ERWIN LANDFILL
HARNETT COUNTY, N.C.

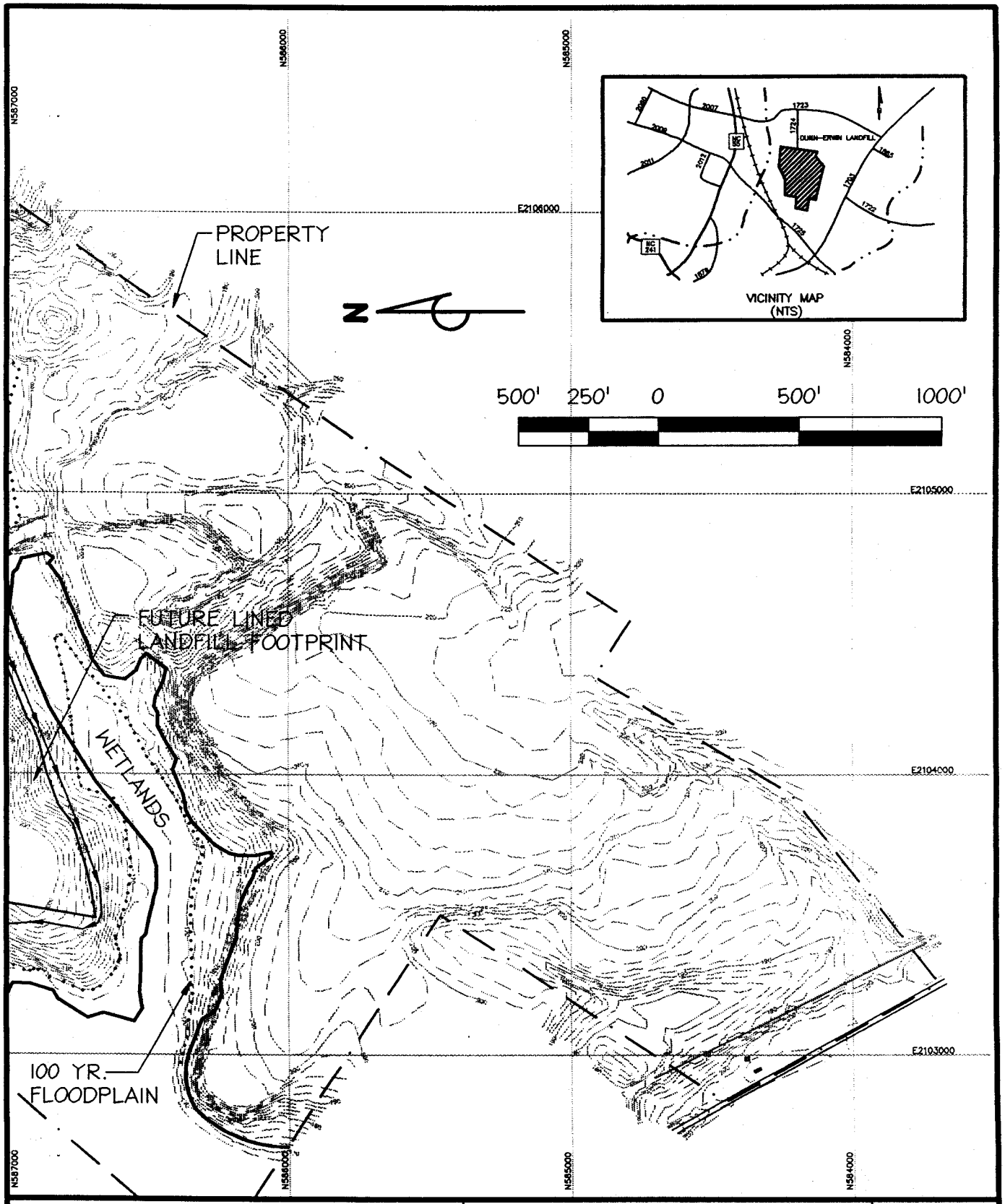
OVERALL SITE PLAN - SHEET 1 OF 2

McKIM & CREED

ENGINEERS • PLANNERS • SURVEYORS
WILMINGTON, NORTH CAROLINA RALEIGH, NORTH CAROLINA
SMITHFIELD, NORTH CAROLINA

FIG. NO.

1



DUNN - ERWIN LANDFILL
HARNETT COUNTY, N.C.

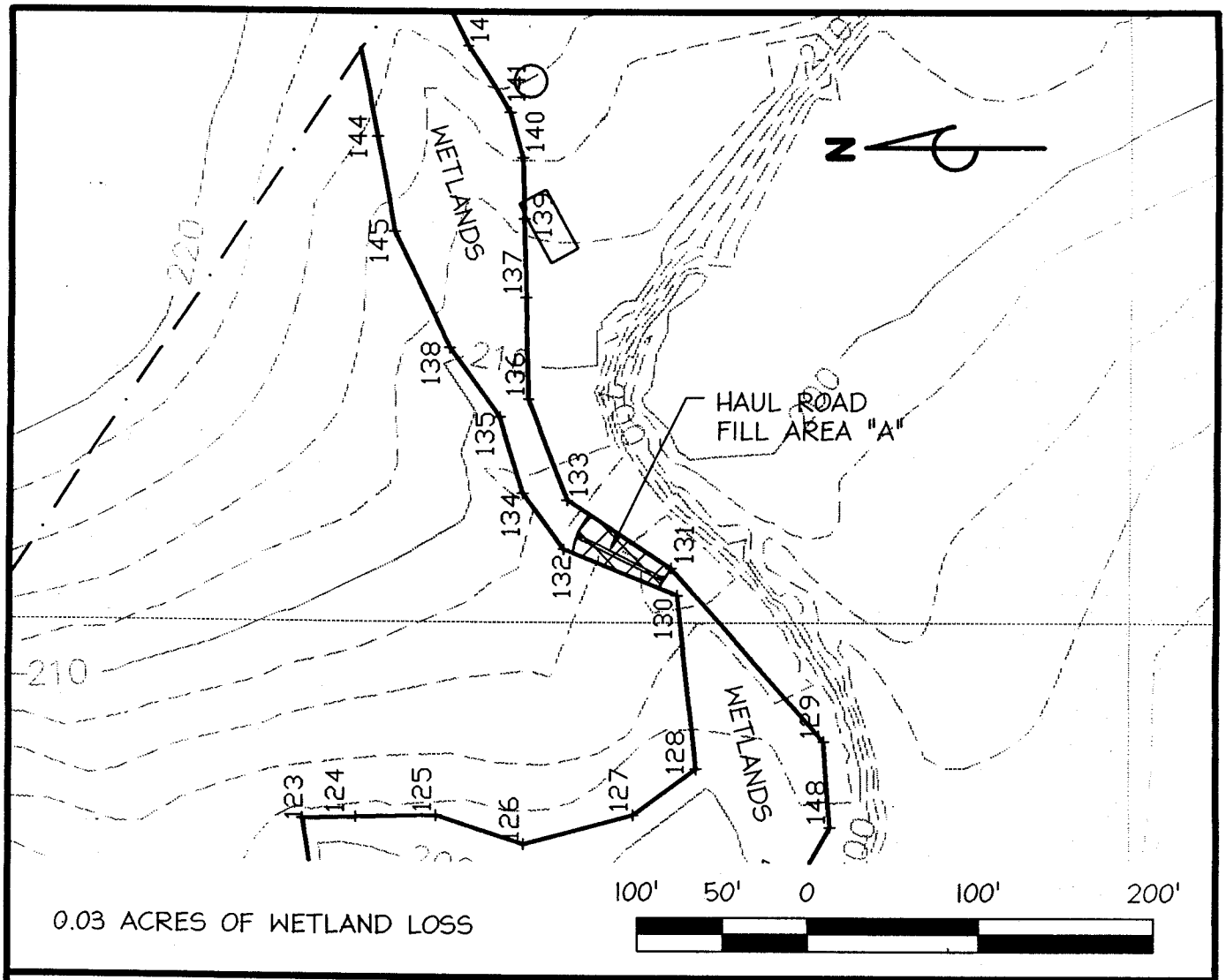
OVERALL SITE PLAN - SHEET 2 OF 2

McKIM&CREED

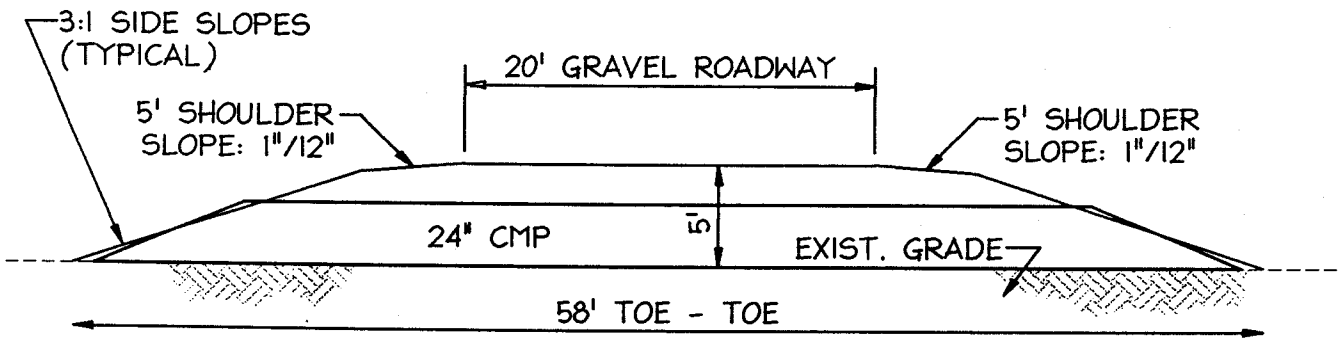
ENGINEERS • PLANNERS • SURVEYORS
WILMINGTON, NORTH CAROLINA RALEIGH, NORTH CAROLINA
SMITHFIELD, NORTH CAROLINA

FIG. NO.

2



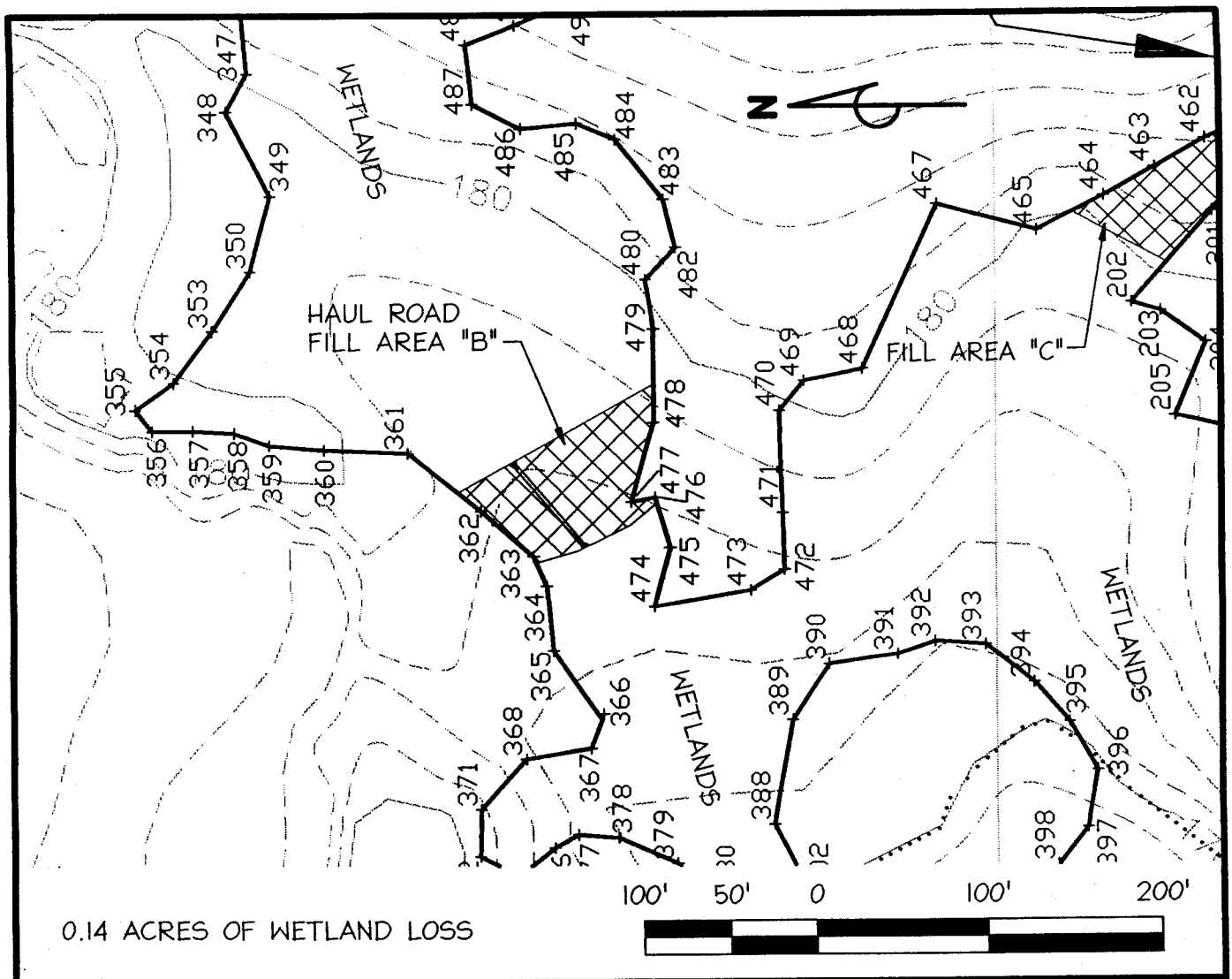
0.03 ACRES OF WETLAND LOSS



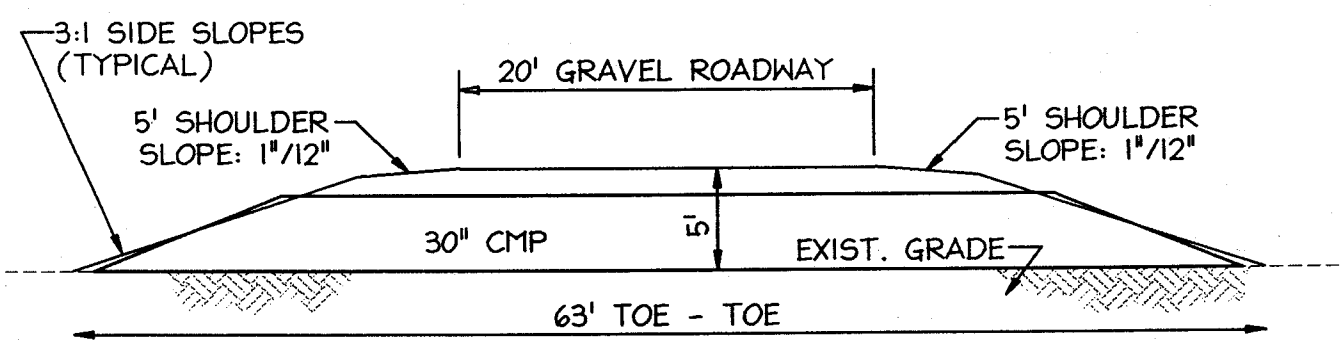
TYPICAL SECTION THROUGH
HAUL ROAD "A"

NTS

DUNN - ERWIN LANDFILL HARNETT COUNTY, N.C.	McKIM&CREED ENGINEERS • PLANNERS • SURVEYORS WILMINGTON, NORTH CAROLINA RALEIGH, NORTH CAROLINA SMITHFIELD, NORTH CAROLINA	FIG. NO.
HAUL ROAD "A" - PLAN & SECTION		3



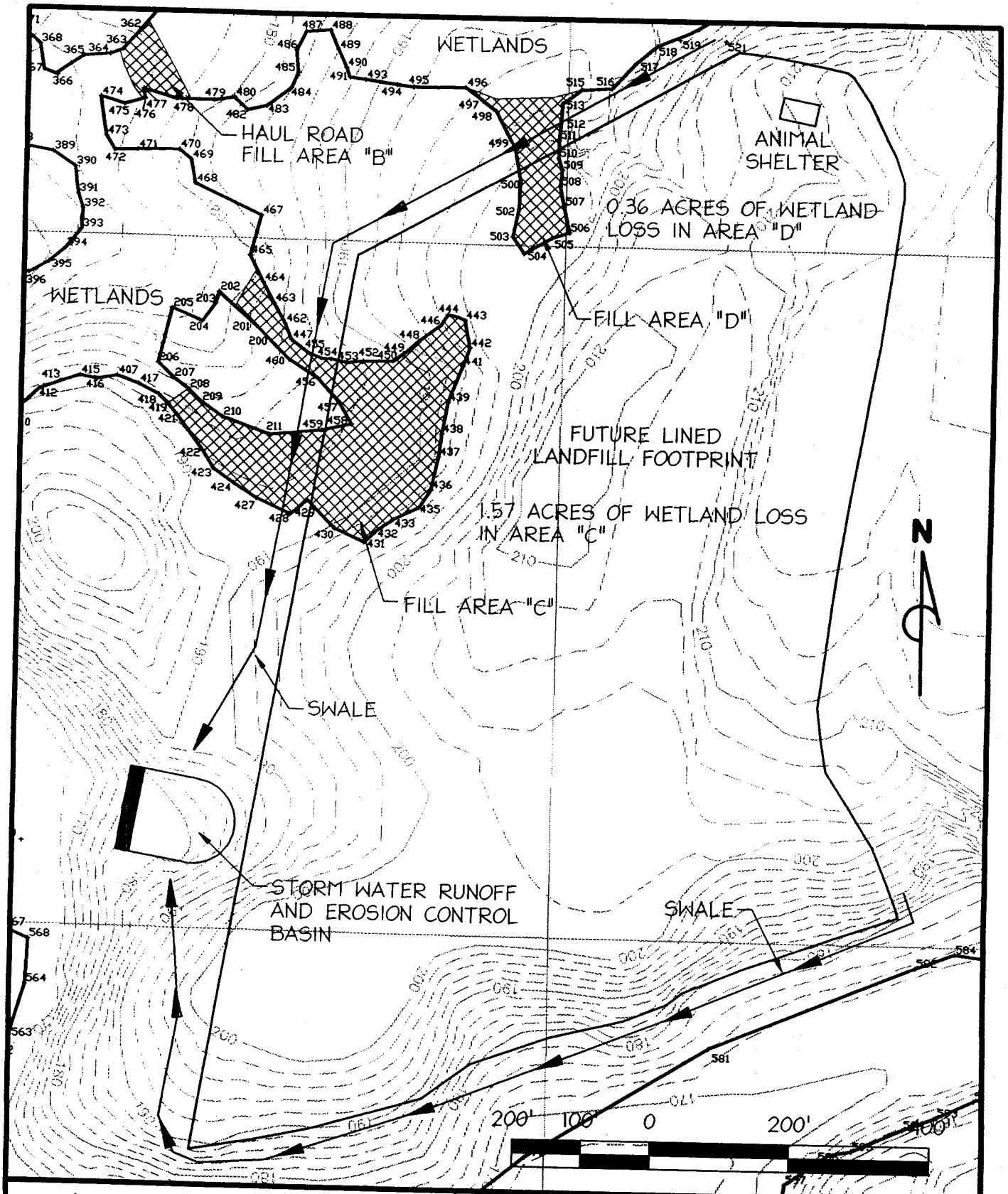
0.14 ACRES OF WETLAND LOSS



TYPICAL SECTION THROUGH
HAUL ROAD "B"

NTS

DUNN - ERWIN LANDFILL HARNETT COUNTY, N.C.	McKIM&CREED ENGINEERS • PLANNERS • SURVEYORS WILMINGTON, NORTH CAROLINA RALEIGH, NORTH CAROLINA SMITHFIELD, NORTH CAROLINA	FIG. NO.
HAUL ROAD "B" - PLAN & SECTION		4



DUNN - ERWIN LANDFILL
HARNETT COUNTY, N.C.

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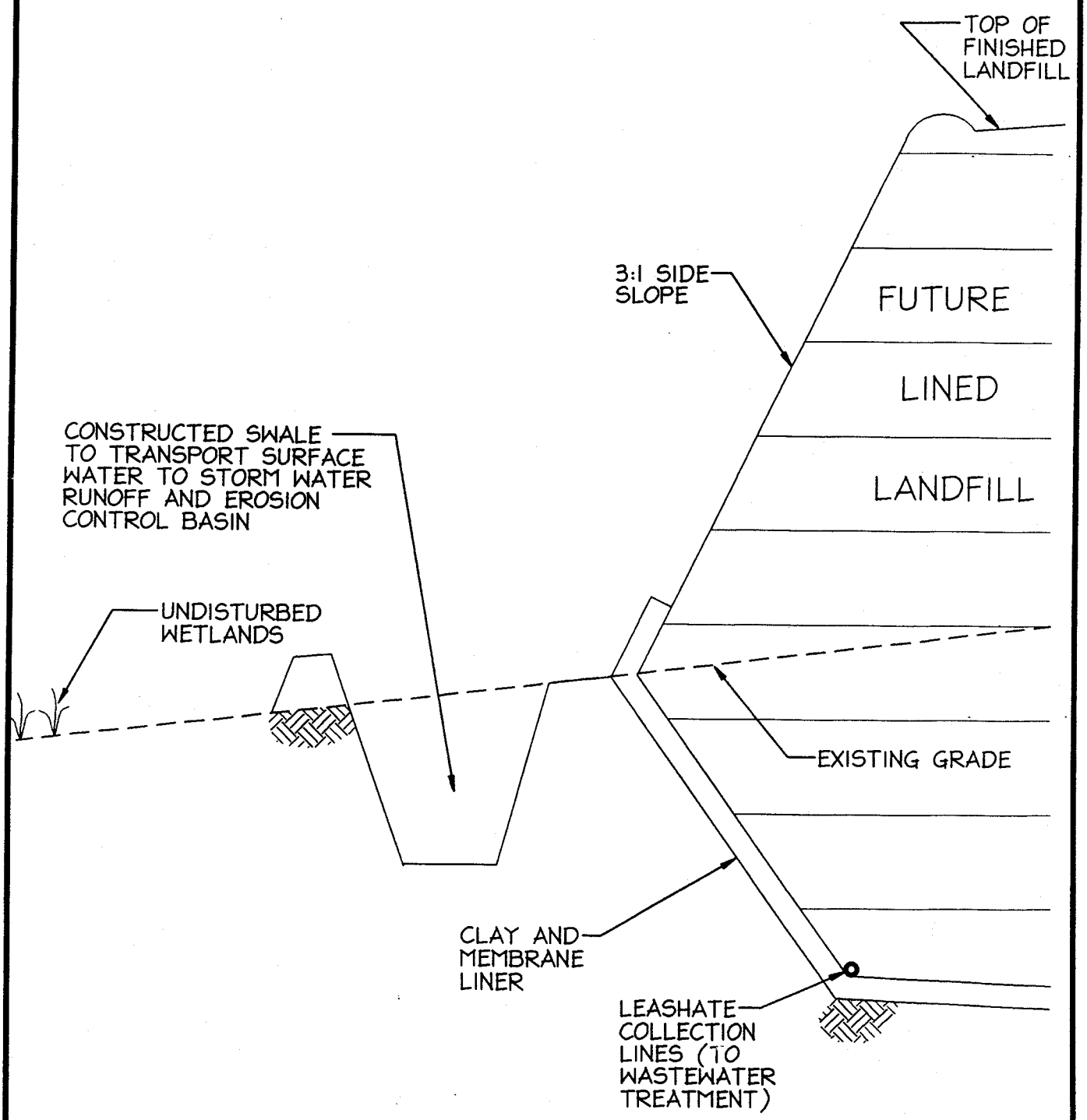
WILMINGTON, NORTH CAROLINA RALEIGH, NORTH CAROLINA
SMITHFIELD, NORTH CAROLINA

FIG. NO.

FILL AREA "C" & "D" PLAN

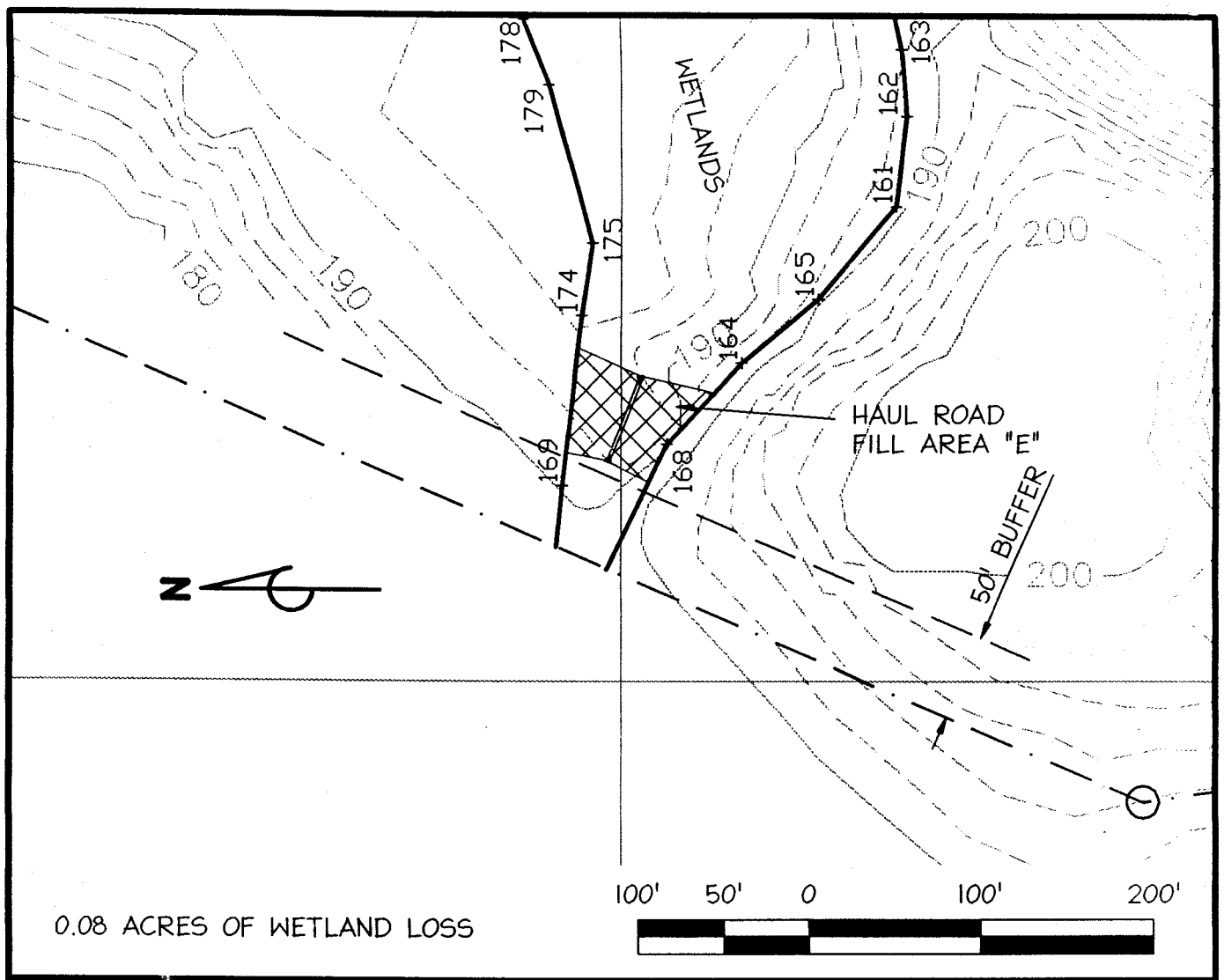
5



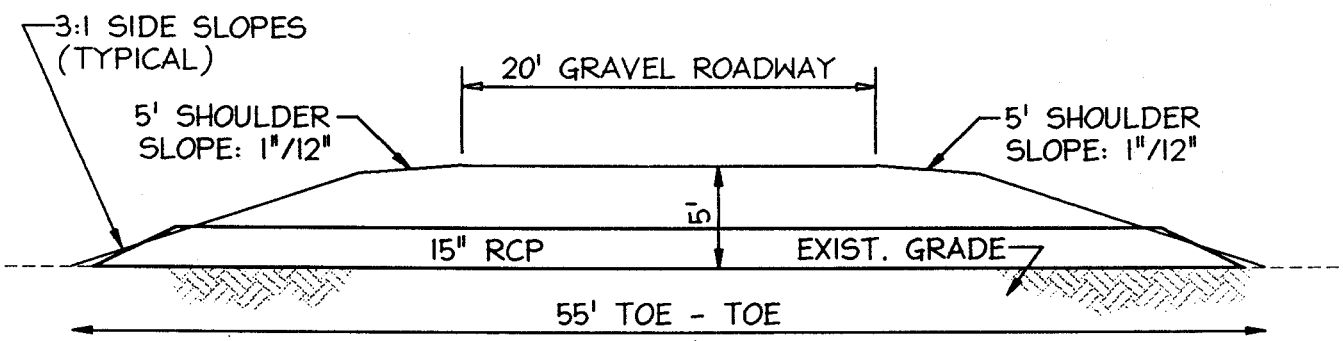
TYPICAL SECTION
AREAS "C" & "D"

NTS

DUNN - ERWIN LANDFILL HARNETT COUNTY, N.C.	McKIM&CREED ENGINEERS • PLANNERS • SURVEYORS WILMINGTON, NORTH CAROLINA RALEIGH, NORTH CAROLINA SMITHFIELD, NORTH CAROLINA	FIG. NO.
FILL AREA "C" & "D" SECTION		6



0.08 ACRES OF WETLAND LOSS

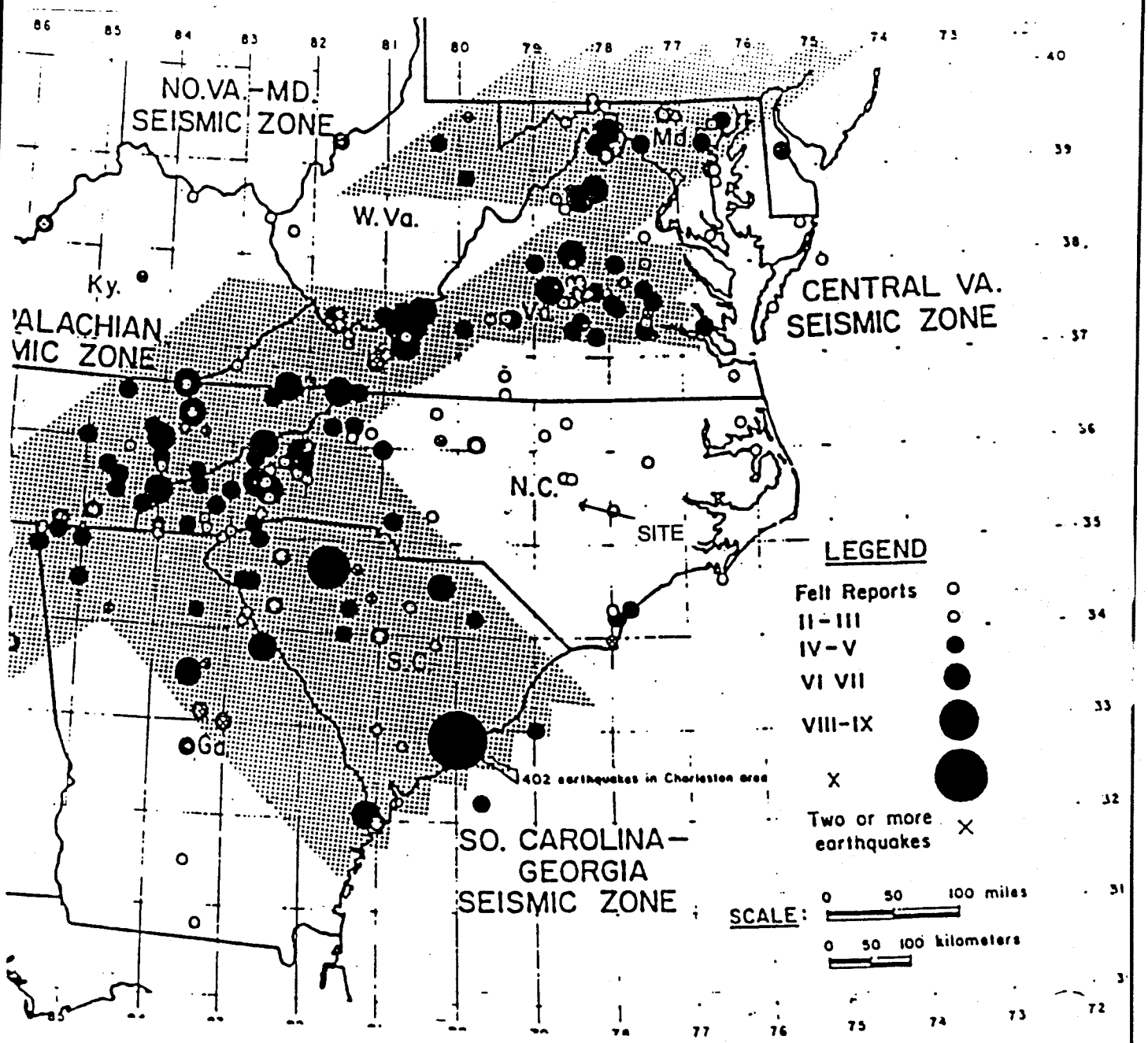


TYPICAL SECTION THROUGH
HAUL ROAD "E"

NTS

DUNN - ERWIN LANDFILL HARNETT COUNTY, N.C.	McKIM&CREED ENGINEERS • PLANNERS • SURVEYORS WILMINGTON, NORTH CAROLINA RALEIGH, NORTH CAROLINA SMITHFIELD, NORTH CAROLINA	FIG. NO.
HAUL ROAD "E" - PLAN & SECTION		7

SOURCE: Bollinger, G.W., Seismic Zones, Bull. of the Seismological Society of America, 1973, pp. 1785–1808

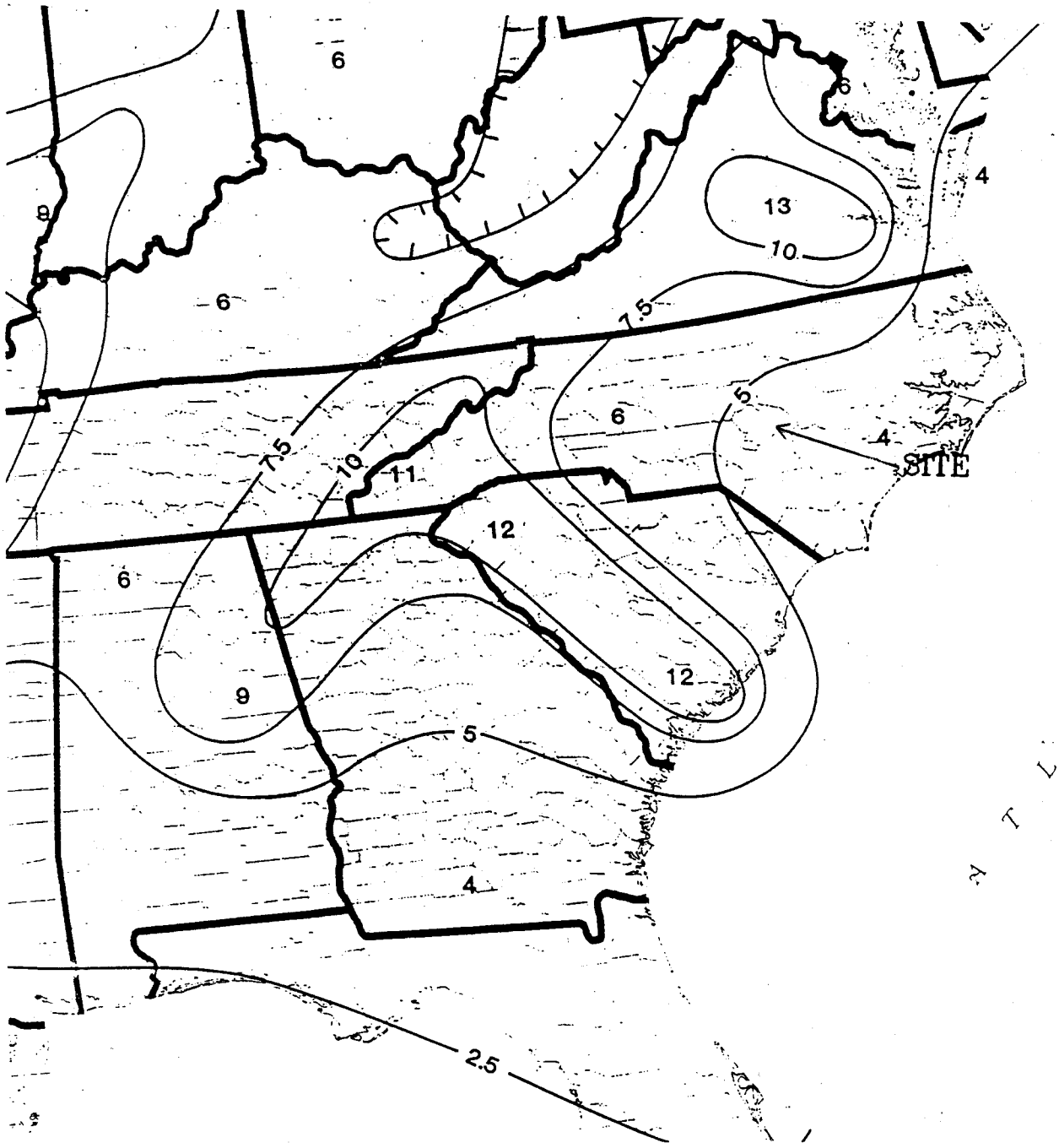


HARNETT COUNTY LANDFILL
SEISMICITY (1754-1971)
OF THE S.E. UNITED STATES

McKIM&CREED
ENGINEERS • PLANNERS • SURVEYORS

APPROVED BY:	
DRAWN BY:	
SCALE:	
JOB No:	Appendix C
FIGURE:	Figure 1
DATE:	

SOURCE: Algermissen, S. T. et al, Probabilistic Earthquake Acceleration for the United States and Puerto Rico: U.S. Geological Survey Map MF2120 (Map C)



HORIZONTAL ACCELERATION (90 PERCENT PROBABILITY OF NOT BEING EXCEEDED IN 250 YEARS)

EXPLANATION

——5—— Contour – Horizontal acceleration expressed as percent of gravity. Some areas show acceleration values without contours. Hachures indicate closed area of lower acceleration. No data available for Hawaii and Puerto Rico.

HARNETT COUNTY LANDFILL SEISMIC HAZARD MAP	McKIM&CREED ENGINEERS • PLANNERS • SURVEYORS	APPROVED BY: DRAWN BY: SCALE: JOB No: FIGURE: DATE: Appendix C Figure 2

Text for Probabilistic Map shown in Figure 9. Source: Algermissen, S.T. et al, 1990, Probabilistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico: U. S. Geological Survey Miscellaneous Field Studies Map MF-2120, Map C

MISCELLANEOUS FIELD STUDIES
MAP MF-2120
SHEET 1 OF 2

INTRODUCTION

The ground-motion maps presented here (maps A-D) show the expected seismic-induced or earthquake-caused maximum horizontal acceleration and velocity in rock in the contiguous United States, Alaska, Hawaii, and Puerto Rico. There is a 90 percent probability that the maximum horizontal acceleration and velocity shown on the maps will not be exceeded in the time periods of 50 and 250 years (average return period for the expected ground motions of 474 and 2,372 years). Rock is taken here to mean material having a shear-wave velocity of between 0.75 and 0.90 kilometers per second. (Algermissen and Perkins, 1976). Mapped values shown here for the contiguous United States are modified from those of Algermissen and others (1982) by accounting for statistical uncertainty in the ground-motion attenuation relations and in the magnitude-fault rupture length relation, as described in the following discussion. Algermissen and others (1982) provide details and background information concerning the development of the ground-motion hazard maps that are only generally described herein.

HAZARD MODEL

The calculation of the ground motions is based on the assumptions that earthquakes are exponentially distributed with regard to magnitude and interoccurrence time and uniformly distributed in space with regard to source zones and source faults. The exponential magnitude distribution is an assumption based on empirical observation. The assumption of an exponential interoccurrence time is that of a uniform distribution in time (the Poisson process) and is consistent with historical earthquake occurrence insofar as it affects the probabilistic hazard calculation. Large earthquakes closely approximate a Poisson process, but small shocks may depart significantly from a Poisson process. The ground motions associated with small earthquakes are of only marginal interest in engineering applications and consequently the Poisson assumption serves as a useful and simple model. The usefulness of the Poisson process in the engineering analysis of earthquake ground motion has been known for a long time (see, for example, Lomnitz, 1974; a recent treatment of the problem justifying the use of the Poisson process even where large earthquakes may be quasi-periodic is given by Cornell and Winterstein, 1988). In general, use of the Poisson process provides appropriately conservative values of ground motion for engineering purposes if sites of interest are affected by more than two sources of earthquakes.

Spatially, in the model used here, seismicity is grouped into discrete areas termed seismic source zones or seismic source faults. The ideal characteristics of a seismic source zone or fault is that it have seismicity and should represent a reasonable seismotectonic or seismogenic structure or zone. A seismotectonic structure or zone is taken here to mean a specific geologic feature or group of features that are known to be associated with the occurrence of earthquakes. A seismogenic structure or zone is defined as a geologic feature or group of features throughout which a style of deformation and tectonic setting are similar and for which a relationship between this deformation and historic earthquake activity can be reasonably inferred. If a seismotectonic or seismogenic structure or zone cannot be identified, the seismic source zone is based on historical seismicity. In source zones, earthquakes are modeled as either point ruptures or linear ruptures of finite length. Earthquakes modeled as linear ruptures of finite length are approximations or generalizations of real (known) faults or of hypothetical (inferred) faults. Strikes of inferred faults are modeled parallel to regional structural trends.

Development of probabilistic ground-motion maps using the concepts outlined above involves three principal steps: (1) delineation of seismic sources; (2) analysis of the magnitude distribution of historical earthquakes or paleoseismicity in each seismic source; and (3) calculation and mapping of the extreme cumulative probability, $F_{max,t}(a)$, of ground motion, a, for some time, t.

Once the sources have been delineated and the distribution of earthquakes likely to occur in each source zone or along a fault is decided upon, the effect at each site due to the occurrence of earthquakes in each source zone or for each fault can be computed using suitable ground-motion attenuation curves.

From the cumulative distribution of ground motion, F(a), at each site, the expected number of times a particular amplitude of ground motion is likely to occur in a given period of years at the site is calculated, and, consequently, the maximum amplitude of ground motion in a given number of years corresponding to any level of probability may be obtained. The probability, $F_{max,t}(a)$, of not exceeding some amplitude, a, during a particular exposure time, t, is given by:

$$F_{max,t}(a) = e^{-\Phi t[1-F(a)]},$$

where Φ is the mean rate of occurrence of earthquakes used to generate F(a).

TREATMENTS OF UNCERTAINTY

The probabilistic model, seismic source zones, and data used in the computation of the present maps are, with some exceptions noted below, from Algermissen and others (1982). The principal change from the Algermissen and others (1982) maps is that uncertainty in attenuation and fault rupture length have been included in the calculation. We briefly recapitulate the assumptions used here.

The fault rupture length relationship used for the maps is that of Mark (1977). The acceleration attenuation for the western United States is from Schnabel and Seed (1973), modified for the eastern United States by Algermissen and others (1982). The velocity attenuation used in the preparation of the maps was developed by Perkins and others (unpublished data, 1989) using a data set and methods of analysis similar to that of Schnabel and Seed (1973). The estimates of uncertainty for fault rupture length and attenuation are taken from McGuire and Shedlock (1981). McGuire and Shedlock (1981) give a standard deviation for Mark's (1977) fault rupture relationship of $\log_{10}$ (rupture length) = 0.52 for a given magnitude and a standard deviation for the Schnabel and Seed (1973) attenuation relationship of $\ln_e$ (acceleration) = 0.62. The same standard deviation, $\ln_e$ (velocity) = 0.62, was assumed for the velocity attenuation curves developed by Perkins and others (unpublished data, 1989) because they were developed in a manner similar to the Schnabel and Seed (1973) acceleration curves and show comparable variability. For computational purposes, the probability of a value greater than 6σ was set to zero.

MODIFICATIONS IN SOURCE MODELS AND MINIMUM MAGNITUDE

The changes from the Algermissen and others (1982) source model involve the removal of modeled faults (linear ruptures) in seismic source zones 104, 107, and 115 (see Algermissen and others, 1982) in the eastern United States and an increase in the modeled minimum magnitude earthquake from 4.0 to 4.6 M_L. Source zone 104 encompasses the Ramapo fault zone; zone 107, the eastern Massachusetts thrust province; and zone 115, the Clarendon-Linden lineament. Earthquakes from these sources, as well as other earthquakes in the eastern United States, were modeled as point sources in preparing the present maps because of continuing uncertainty in relating seismicity to the Ramapo fault (compare Aggarwal and Sykes, 1978, with Ratcliffe, 1981, 1982) and an apparent growing consensus that the rupture lengths for earthquakes in the eastern United States are relatively short (Electric Power Research Institute, 1987). Eastern U.S. sources in general, therefore, are adequately modeled by point sources at the scale of the national maps. Finite ruptures were retained in the New Madrid, Missouri, area (zone 87), where very large earthquakes may occur.

Minimum magnitudes of interest to ground-motion hazard models become particularly important in regions of low-to-moderate earthquake activity when attenuation variability is modeled (Bender and Campbell, 1989). There are relatively few large earthquakes in the eastern United States; small and moderate earthquakes therefore dominate the ground-motion hazard. Attenuation variability allows these small earthquakes to produce some high peak ground motions. Because the maps represent a fixed nonexceedance probability (10 percent in the given exposure times), these high amplitudes from small earthquakes dominate the ground-motion estimates even though these amplitudes are of short duration and generally do not cause significant damage to engineered structures. For that reason, we have raised the minimum magnitude of earthquakes of concern from 4.0 (Algermissen and others, 1982) to 4.6 herein. Considerably more research is needed before this issue can be resolved entirely satisfactorily. One statistical approach that might merit use in future hazard mapping efforts uses a tapered distribution of low-magnitude earthquakes wherein some, but not all, small earthquakes generate high-amplitude ground motions of engineering significance (Bender and Campbell, 1989). Nonetheless, the parameters of such a distribution remain to be defined by empirical earthquake damage data.

Although raising the minimum magnitude has lowered the probabilistic ground motion at some places in the eastern United States, the principal effect of incorporating attenuation uncertainty in the calculations has been to raise the map values. The higher the ground-motion values on the maps of Algermissen and others (1982), the greater is the increase in those values when attenuation uncertainty is taken into account. For the most active faults in California, the increase in ground motion may be as much as a factor of two on the 250-yr exposure time map. Along the San Andreas fault system, including the San Jacinto and Elsinore faults and the southern extension of the Newport-Inglewood faults, levels of acceleration exceed 80 percent of the acceleration of gravity, and velocities exceed 80 centimeters per second. These areas are delineated by contours marked >80 (either percent of gravity or centimeters per second) and are principally on the 250 year exposure time maps. For long exposure times, the ground-motion maps are influenced greatly by the parameter variabilities assumed for attenuation and velocity, resulting in peak values of acceleration and velocity that are very large along highly active faults. Special studies are required in these areas of high expected ground motion to more accurately constrain sources of uncertainty in estimating near-field ground motions to be considered in seismic design.

AREAS OUTSIDE THE CONTIGUOUS UNITED STATES

Using the data and the probabilistic model of Thenhaus and others (1982), the ground-motion maps for Alaska were recomputed to include fault rupture length and attenuation variability. The same standard deviations for fault rupture length and attenuation as used for the contiguous United States were used in the recomputation of the Alaska ground-motion maps.

The ground-motion maps for Hawaii and Puerto Rico are provided here for completeness and are taken directly from the "NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings, Part 2, Commentary" (Federal Emergency Management Agency, 1985). The only modification of the maps is the conversion of the velocity contours from inches per second to centimeters per second to conform with units used on the other maps. The ground-motion values shown for Hawaii and Puerto Rico do not represent the results of a particular probabilistic ground-motion calculation but are weighted averages of the ground-motion estimates available at the time of the Applied Technology Council (1978) study. However, the mapped values are reasonable and in general agreement with our preliminary studies of probabilistic ground motion in these areas.

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Algermissen, S.T., and Perkins, D.M., 1976, A probabilistic estimate of maximum acceleration in rock in the contiguous United States: U.S. Geological Survey Open-File Report 76-416, 44 p., 2 pls.

Algermissen, S.T., Perkins, D.M., Thenhaus, P.C., Hanson, S.L., and Bender, B.L., 1982, Probabilistic estimates of maximum acceleration and velocity in rock in the contiguous United States: U.S. Geological Survey Open-File Report 82-1033.

Applied Technology Council, 1978, Tentative provisions for the development of seismic regulations for buildings, ATC 3-06: National Science Foundation Publication 78-8, 505 p.

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Lomnitz, Cinna, 1974, Global tectonics and earthquake risk: Developments in Geotectonics 5, Elsevier Scientific Publishing Co., 320 p.

Mark, R.K., 1977, Application of linear statistical models of earthquake magnitude versus fault length in estimating maximum expectable earthquakes: Geology, v. 5, p. 464-466.

McGuire, R.K., and Shedlock, K.M., 1981, Statistical uncertainties in seismic hazard evaluations in the United States: Bulletin of Seismological Society of America, v. 71, no. 4, p. 1287-1308.

Ratcliffe, N.M., 1981, Reassessment of the Ramapo fault system as control for current seismicity in the Ramapo seismic zone and the New York recess: Geological Society of America Abstracts with Programs, v. 13, no. 3, p. 171.

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Schnabel, P., and Seed, H.B., 1973, Acceleration in rocks for earthquakes in the western United States: Bulletin of Seismological Society of America, v. 63, p. 501-516.

Thenhaus, P.C., Ziony, J.I., Diment, W.H., Hopper, M.G., Perkins, D.M., Hanson, S.L., and Algermissen, S.T., 1982, Probabilistic estimates of maximum seismic horizontal ground acceleration on rock in Alaska and the adjacent continental shelf: Earthquake Spectra, v. 1, no. 2, p. 286-306.

Manuscript approved for publication, January 9, 1990

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1990

For sale by U.S. Geological Survey Map Distribution, Box 25286, Federal Center, Denver, CO 80225

RECEIVED
MAR 25 1991
Ans'd.....

North Carolina Department of Cultural Resources

James G. Martin, Governor
Patric Dorsey, Secretary

Division of Archives and History
William S. Price, Jr., Director

March 20, 1991

Mr. Charlie Musser
Manager of Environmental Services
McKim & Creed Engineers, P.A.
5580 Centerview Drive, Suite 100
Raleigh, N.C. 27606

Re: Harnett County Landfill Project
ER 91-7896

Dear Mr. Musser:

Thank you for your letter of March 5, 1991, concerning the above project.

We have conducted a search of our files and are aware of no structures of historical or architectural importance located within the planning area.

There are no known recorded archaeological sites within the project boundaries. However, the project area has never been systematically surveyed to determine the location or significance of archaeological resources. It is likely that Archaic period sites are located within the project area and will be affected by landfill construction.

We recommend that a comprehensive survey be conducted by an experienced archaeologist to identify the presence and significance of archaeological remains that may be damaged or destroyed by the proposed project. Potential effects on unknown resources should be assessed prior to the initiation of construction activities.

Enclosed is a list of archaeological consultants who have conducted or expressed an interest in conducting contract work in North Carolina. Individual files providing additional information on the consultants may be examined at the State Historic Preservation Office's Office of State Archaeology, 421 North Blount Street, Raleigh. If additional names are desired, you may consult the current listing of the members of the Society of Professional Archeologists, or contact the society's current secretary/treasurer, J. Barto Arnold, III, P.O. Box 13265, Austin, Texas 78711-3265. Any of the above persons, or any other experienced archaeologist, may be contacted to conduct the recommended investigation.

These comments are made in accord with G.S. 121-12(a) and Executive Order XVI. If you have any questions regarding them, please contact Ms. Renee Gledhill-Earley, environmental review coordinator, at 733-4763.

Sincerely,

David Brook

David Brook
Deputy State Historic Preservation Officer

DB:slw

Enclosure

North Carolina Department of Cultural Resources

James G. Martin, Governor
Patric Dorsey, Secretary

Division of Archives and History
William S. Price, Jr., Director

August 9, 1991

Mr. Charlie Musser
Manager of Environmental Services
McKim & Creed
5580 Centerview Drive, Suite 100
Raleigh, N.C. 27606

Re: Dunn-Erwin Landfill, Harnett County
ER 91-7896, ER 92-7014

Dear Mr. Musser:

We have reviewed the archaeological survey report by Thomas H. Hargrove and offer our comments.

For purposes of compliance with Section 106 of the National Historic Preservation Act, we concur that the following properties were determined not eligible for listing in the National Register of Historic Places:

31HT176, 31HT177, 31HT178

In general the report meets our office's guidelines and those of the Secretary of the Interior.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act of 1966 and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106, codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919/733-4763.

Sincerely,

David Brook

David Brook
Deputy State Historic Preservation Officer

DB:slw

cc: T. Hargrove

109 East Jones Street • Raleigh, North Carolina 27601-2807

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE
Ecological Services
Post Office Box 33726
Raleigh, North Carolina 27636-3726

TO: TOM WAINWRIGHT P.E. - Project Engineer
McKIM & CREED ENGINEERS
5625 DILLARD ROAD - BUILDING I / SUITE 117
CARY, NC 27511

Thank you for your letter requesting information or recommendations from the U.S. Fish and Wildlife Service. This form provides the Service's response pursuant to Section 7 of the Endangered Species Act, as amended (16 U.S.C. 1531-1543), and the Fish and Wildlife Coordination Act (16 U.S.C. 661-667d).

Re: DUNN/ERWIN LANDFILL - HARNETT COUNTY
Project Name/Location/County

August 24, 1995
Date of Incoming Letter

1848
Log Number

____ The attached page(s) list(s) the Federally-listed species which may occur within the project impact area.

✓ Based on the information provided, it appears that your project site does not contain suitable habitat for any Federally-listed endangered or threatened species known to occur in the area.

____ Due to staffing limitations, we are unable to conduct a field visit or make site-specific comments; therefore, we take "no action" on this project. If further information becomes available which affects our position, we will forward additional comments to you. This response should not be construed as a "no effect" or "no objection" conclusion to potential project impacts.

____ If the proposed project will be removing pines greater than or equal to 30 years of age in pine or pine/hardwood habitat, surveys should be conducted for active red-cockaded woodpecker cavity trees in appropriate habitat within a 1/2 mile radius of project boundaries. If red-cockaded woodpeckers are observed within the project area or active cavity trees found, the project has the potential to adversely affect the red-cockaded woodpecker, and you should contact this office for further information.

Biologist — Date

Candace Martino — 9/12/95

Acting Endangered Species Coordinator — Date

SECTION V

LOCAL GOVERNMENT APPROVALS

SECTION V: LOCAL GOVERNMENT APPROVAL

A: Local Government Approval: *15A NCAC 13B.1618(c)(5)*

According to rule *15A NCAC 13B.1618(c)(6)(d)(1) and (2)* an existing facility proposed for designation as a new facility is exempt from the requirements of Subparagraph(c)(5) if the site study meets the following criteria: (1) The facility boundary delineated in accordance with Subparagraph (c)(6) of rule .1618 is the same boundary described in the boundary described in the current permit; and (2) the areal limits of the proposed MSWLF unit is within the approved disposal area approved by the current permit. The proposed lined landfill meets both of these requirement and therefore this rule applies and the facility is exempt from the requirements of Subparagraph (c)(5).

SECTION VI

FACILITY PLAN

SECTION VI: FACILITY PLAN

A. Introduction

This subsection of the proposed facility plan was prepared in accordance with *15A NCAC 13B.1619(e)1* as required under *15A NCAC 13B.1618(c)(6)* as part of a municipal solid waste (MSW) landfill facility site application. The following discussion addresses each of the requirements for a site application specified under the subsection shown in bolded italics below.

B. Type of Wastes Specified For Disposal

The proposed landfill phase covered under this site application is referred to on the Facility Plan drawing C-3 as Phase IV. The proposed unit will receive the same type of wastes that are currently being disposed of in the current landfill, which is primarily MSW. In addition, asbestos containing materials (ACM) will be received at the proposed landfill and managed in accordance with 40 CFR 61 requirements. Asbestos disposal will be in a designated area separate from other waste materials. Other materials such as yard waste, scrap tires, white goods, and recyclables will be handled and disposed of as performed at the currently permitted landfill facility,however, these waste **will not** be disposed of in the proposed landfill units.

C. Average Monthly Disposal Rates and Estimated Variance

The proposed Phase IV landfill will begin to receive waste upon closure of the existing active landfill unit, which is expected to occur at the end of 1997. Therefore, the proposed lined landfill will be designed to accommodate five full years of waste disposal beginning January 1, 1998.

As shown on the waste volume computations spreadsheets included in Section VI, Appendix A , the estimated daily waste weight is projected to increase steadily through the year 2002 at the same rate as the expected population growth. The following table summarizes the estimated daily waste weight and monthly disposal rates (in tons and cubic yards) for each one year period from 1997 through 2002.

YEAR	ESTIMATED DAILY WASTE WEIGHT (tons)	ESTIMATED MONTHLY DISPOSAL RATE (tons)	ESTIMATED MONTHLY DISPOSAL RATE (cubic yards)
1998	224	5824	14,560
1999	227	5902	14,755
2000	229	5954	14,885
2001	231	6006	15,015
2002	233	6058	15,145

Although the anticipated waste disposal rates are projections based on measured waste tonnages received at the Harnett County landfill, various assumptions were

incorporated in converting the measured values into expected future waste disposal rates. These assumptions include the following:

1. The estimated daily waste weight in 1997 is equal to 222 tpd, as derived in the Harnett County Transition Plan for the existing permitted facility.
2. The percent increase in the estimated daily waste weight for the years 1998through 2002 is equal to the percent increase in population projected for these same years.

Population projections were obtained from the Harnett County Planning Department, which received the projection from the State Data Center.

Consequently, because of the number of variables involved in establishing the projected waste disposal rates, the actual waste disposal rates that will occur are likely within ± 25 percent of the anticipated values.

D. Area to be Served by the Proposed Facility

Similar to the existing permitted landfill facility, the proposed landfill unit will receive all of the Harnett County's MSW.

E. Segregated Management Procedures at On-Site Facilities

The following waste management procedures are currently practiced at the existing permitted facility and will be applied to the proposed landfill unit, as well.

Operation of the Landfill

The following summarizes the proposed daily operation of the Dunn\Erwin facility, as required under *.1625(b)(2)* and as presented in the operation drawings referenced below.

1. All solid waste will enter the facility by way of NCSR 1724 and will be weighed. Only solid waste, as defined by *15A NCAC 13(B)* will be accepted. See Sheet C-3 for location of entrance road and scales.

2. Municipal solid waste will be directed to the disposal area located on the west side of the access road past the weigh scales. Daily operation of the vertical expansion area is detailed below:

   a) Waste is dumped by the hauler onto the working face either from the top of the fill slope down onto the face or from the bottom of the working face and pushed up onto the face. Either way, the waste is pushed into the cell by the equipment operator. This process generally keeps operating activity working in the dry.

   b) At the start of a new layer on the top surface of the landfill, berms will be made at the perimeter of the layer and the waste will be placed at the toe of the berms by the hauler.

   c) Once placed onto the working face, all waste will be compacted to an appropriate density using a Trash Master Compactor.

   d) The horizontal surface of the municipal solid waste landfill unit will be covered with one foot of soil cover at the end of each operating day.

   e) Fabrisoil, a synthetic cover material, will be used to cover the working (vertical) face every Monday through Friday that the landfill is in operation. One end of the Fabrisoil will be anchored down at the bottom of the working face. The cover material will be moved by attaching the other end of the material to landfill operating equipment and pulling the sheet to cover or uncover the working face. Adequate tie downs will be provided along the edges to prevent the Fabrisoil from blowing off the

working face. The material will extend a minimum of ten feet beyond the working face and will be replaced, as necessary, when no longer serviceable.

f) At the end of each Saturday, a minimum of six inches of cover soil will be placed on the working face and the unit will remain covered until the end of operation on Monday or the next operating day.

g) After filling one layer with waste completely, but prior to commencing to add waste to the next vertical layer, the one foot of daily soil cover added to the horizontal working area will be removed, as needed. In this way, waste can be added directly on top of previously placed waste. This offers two distinct advantages: less landfill volume is used and a homogeneous fill volume is achieved which will facilitate future methane gas extraction.

3. Construction and demolition waste will continue to be directed temporarily to the vertical expansion disposal area along with the municipal solid waste. Upon closure of the existing landfill C&D waste will be disposed of in a permitted C&D landfill at either the Dunn\Erwin or Anderson Creek landfill. The proposed Dunn/Erwin construction and demolition (C&D) landfill will be located within the existing borrow area west of the access road immediately past the weigh scales (see sheet C-3). Drawings for the permit application for the proposed C&D landfill will be submitted at a future date. Currently, C&D materials are being handled in the same manner as the municipal solid waste, and therefore, a separate operation plan is not included for the C&D materials. A detailed operation plan for the C&D landfill will be submitted with the permit application for that landfill.

4. Presently, the Dunn\Erwin landfill receives approximately 6,000 cubic yards per year of yard waste. The yard waste processing will be relocated from its existing location south of the vertical expansion area to a location along the north boundary of the facility, immediately west of the access road. The yard waste storage area will generally stay in the existing area (see sheet C-3). The yard waste processing area and borrow area application are included in the Transition Plan for the Dunn\Erwin Landfill, Harnett County North Carolina, Section XIII. A detailed description of the operation of the proposed yard waste storage is included in that Section. Until the proposed yard waste processing and storage area is ready to receive waste, the current daily operation of the yard waste area will continue to be limited to the following:

a) Yard waste will enter the landfill facility and will be weighed by scales similar to any other waste that enters the facility.

b) Once weighed, the yard waste will be directed to the yard waste processing area, south of the vertical expansion area.

c) The yard waste will then be unloaded and segregated into leaves, and grass clippings; limbs and stumps less than six inches in diameter, and the remaining yard waste that does not fall into either of the first two categories. Material received at the yard waste will be limited to separated organic wood leaves and grass.

d) A Norkot Slabgrinder or similar equipment will be used to reduce waste material size to a uniform size. Screen sizes of 1" to 4" will be utilized. Wood waste will be stockpiled and leaves and grass clippings added to the chipped wood and made available for the local community to use as mulch.

e) Monitoring and reporting requirements will be submitted to NCDEHNR. These requirements include:

i. Sources, type, quantity, by weight or volume, of waste received at the facility.

ii. The quantity, by weight or volume, of mulch produced.

iii. The quantity, by weight or volume, of mulch removed from the facility.

iv. A description of the end product and distribution or method of disposal.

5. An asbestos monofill is currently in operation at the Dunn\Erwin landfill facility and is located approximately 900 feet south (See Sheet C-3) of the vertical expansion municipal solid waste disposal area and on the west side of the access road. This asbestos disposal area is separated from all other disposal areas and is clearly designated as an asbestos disposal area. Therefore, the asbestos disposal area complies with *.1626(1)(d)(ii).* Asbestos shipments are handled in accordance with 40 CFR 51 regulations as described in the Asbestos Management Plan included as Appendix C of this section. The asbestos waste is covered immediately with soil in a manner that does not cause airborne conditions. Appendix B includes an NCDEHNR approval letter of the asbestos monofill and other activities.

6. Scrap tires are received at the Dunn\Erwin landfill but are currently disposed of off-site at a permitted, private scrap tire monofill, Womble Tire Monofill in western Harnett County. However, a scrap tire monofill has been permitted for the Dunn\Erwin facility at a site approximately 1,200 feet south of the municipal solid waste vertical expansion area and on the east side of the access road. Appendix

D contains a copy of the NCDEHNR approval letter for the tire monofill and other activities. At this time, no scrap tires are being placed in the permitted Dunn\Erwin tire monofill.

7. White goods will be collected, stored, and disposed of in a safe, environmentally sound manner meeting State-mandated regulations. There will be collection sites at the Dunn\Erwin landfill and Anderson Creek Transfer Station. Operating hours for each site will be from 8:00 a.m. to 4:30 p.m. on Monday through Saturday, except for some holidays. Staff will be available at each site to provide information and to help off-load white goods. In addition, white goods not containing chlorofluorocarbons (CFCs) will be recycled through a scrap metal dealer. Management of motors and capacitors will be done by the same dealer. White goods containing CFCs will also be processed through the same dealer if the dealer provides verification that CFCs are managed properly and if it is cost effective for Harnett County to do so. If the need arises, Harnett County will purchase equipment and train personnel to extract and manage CFCs, motors, and capacitors. No fee will be collected for disposal of white goods.

F. Equipment Requirements for Operation of the Landfill- *15A NCAC 13B.1619(e)(1)(E)*

The following equipment is owned by Harnett County and operated at the existing Dunn\Erwin Landfill:

- 615C CAT Scraper

- Two 613B CAT Scraper
- International E-200 Pan
- Two 355B Trash Master Compactor
- John Deere 850 Dozer
- International 250 Loader
- Rubber Tire Loader
- Two John Deere Tractors
- Fuel Truck
- Trackhoe with tree attachment
- Galleon 118 Grader

Operation of the proposed landfill unit will be similar to that currently practiced at the existing permitted facility. Therefore, no additional equipment is required beyond that already owned and operated by the Dunn\Erwin Landfill Facility.

Subsection II- Landfill Capacity Information

This subsection of the proposed facility plan report was prepared in accordance with *15A NCAC 13B.1619(e)2* as required under *15A NCAC 13B.1618 (c)(6)* as part of a municipal solid waste (MSW) landfill facility site application.

Summary

Construction of the proposed landfill facility will begin with Phase IV. In general, construction will begin with excavation (and/or filling) to the proposed cut elevations, which are based on maintaining a minimum four foot separation between the subgrade

and seasonally high groundwater levels. Soils accumulated during excavation will be stockpiled in the proposed stockpile area on the Facility Plan, Sheet C-3.

A. Total Operating Capacity

As shown on the waste volume spreadsheet in Section VI, Appendix A, the operating capacity of the proposed Phase IV will be approximately 1,004,577 cubic yards. As previously mentioned, these volumes are based on historical records of waste received and projected population growth for Harnett County. These volumes include both the expected waste volume and weekly soil cover volume anticipated to accumulate over the life of the proposed landfill. The total operating capacity expected does not include the volume to be used for the final cover upon landfill closure.

B. Operating Capacity for Each Phase of Development

The operating capacity for the only phase of development is discussed above.

C. In-place Ratio of Waste to Soil

The amount of soil to be used during operations will be significantly reduced by the use of an artificial cover for daily cover. Artificial cover material made from high density woven polyethylene coated fabric, is proposed for covering the working (vertical) face every Monday through Friday that the landfill

is in operation. At the beginning of the work day, the cover material will be moved by attaching the top end of the material to landfill operating equipment and the sheet will be rolled over itself to uncover the working face. At the end of the work day, the same end of the artificial cover that was attached to the operating equipment in the morning, will be reattached to the operating equipment and rolled back over itself to cover the waste. The material will extend a minimum of ten feet beyond the working face and will be replaced, as necessary, when no longer serviceable. If high wind conditions exist, used tires may be placed around the border of the artificial cover to anchor down the material. However, under calm weather conditions, previous experience with an artificial cover has proven that no such anchor is necessary in order for the cover to remain in place. At the end of each Saturday, a minimum of six inches of cover soil will be placed on the working face and the unit will remain covered until the beginning of operation on Monday or the next operating day. Just prior to the further addition of waste, approximately four of the six inches of soil on the vertical face will be removed. Appendix C of this section contains the NCDEHNR letter approving the use of synthetic daily cover at the Dunn\Erwin facility.

The nearly horizontal surface formed at the top of each ten-foot waste lift will be covered with one foot of soil cover at the end of each operating day. After filling one layer with waste completely, but prior to commencing to add waste to the next vertical layer, the one foot of daily soil cover added to the horizontal working area will be removed, as needed. In this way, waste can be added

directly on top of previously placed waste. This results in less waste of valuable landfill space on clean soil and a more homogenous fill volume, which will facilitate future potential landfill gas extraction.

Although the waste to soil ratio is approximately 4:1 under standard operating practices in which six inches of soil is used for daily cover on the working face, this ratio is unrealistically low when using an artificial cover for daily cover as proposed for the new landfill. In addition, approximately 75% of the one-foot intermediate soil cover, which will be placed on the horizontal surface at the top of each ten-foot lift, will be removed prior to addition of waste to the next ten -foot lift. Consequently, this will serve to further increase the waste to soil ratio. Therefore, for the purpose of estimating the total landfill volume required for a five-year period, a conservative waste to soil ratio estimate of 8:1 will be assumed.

D. Available Soil Resources from On-Site Sources and Required Soil Quantities

Construction of the proposed landfill facility will begin with Phase IV. In general, construction will begin with excavation to the proposed cut elevations, which are based on maintaining a minimum four foot separation between the lowest landfill subgrade and seasonally high groundwater levels. Phase IV will be constructed all at once. The soil volume to be excavated during Phase IV construction in order to reach the proposed cut elevations shown on C-6, is

estimated to be approximately 210,700 cubic yards (cy). This soil will be used for fill material and to construct the perimeter berm surrounding the landfill perimeter. There will be approximately 84,000 CY of material remaining after construction which will be stockpiled for use as daily cover or operational cover.

Additional soil needs include: approximately 81,000 cy of clay for construction of the composite liner; 81,000 CY of soil; 126,000 CY of weekly cover soil; and 141,000 cy of final cover soil. These materials, which total 429,000 cy, will be obtained from on site and off site sources.

In summary, the total borrow soil needed for construction of the proposed landfill phase is approximately 429,000 cy while the borrow available on site is about 243,000 cy. Therefore, a net soil volume of 177,000 cy will need to be obtained from off-site sources. Potential off-site borrow sources will be researched during Permit to Construct Application Preparation.

E. Estimated Operating Life of the Proposed Landfill

The proposed Phase IV landfill is expected to begin receiving waste on January 1, 1998 once the existing landfill reaches capacity. In accordance with *15A NCAC 13B.1619(c)(1)*, Phase IV is designed to contain an estimated five years of waste and cover soil. This would result in Phase IV reaching capacity in 2002. The waste initial and final contours shown on Sheet C-6 and C-8, respectively, have been conceptually designed to provide sufficient capacity to accommodate the waste volumes presented in Section VI, Appendix A, Table 1.

Consequently, it appears at this time that the proposed landfill site will ultimately be capable of providing five years of operating life to Harnett County. However, because a conservative approach was used in the conceptual design of the proposed landfill phase, it is possible that the phase could potentially accommodate larger volumes. During the construction design phase, the detailed design of the future phase will be adjusted in accordance with the additional design hydrogeological investigation to be completed to provide only five years of capacity. If land is still available after Phases IV has been designed, a decision will be made as to whether sufficient land remains to begin an additional phase within the area granted the site suitability permit.

Subsection III - Containment and Environmental Control Systems

This subsection of the proposed facility plan report was prepared in accordance with *15A NCAC 13B.1619(e)3* as required under *15A NCAC 13B.1618 (c)(6)* as part of a municipal solid waste (MSW) landfill facility site application. The following discussion provides a brief description of the basic design concepts that will be incorporated into the proposed landfill phase so as to prevent contamination of the surrounding areas and groundwater by providing containment of the waste and to facilitate landfill operations.

A. Base Liner System

The bottom of the base liner system will be at a minimum elevation four feet above the seasonally high groundwater table elevation. The clay liner will consist of 24-inch thick compacted clay with a permeability of no more than 1 x 10^{-7} cm/sec. Immediately on top of the clay liner, a geomembrane liner with a water vapor transmission rate less than or equal to 0.03 gm/m^2 - day will be installed.

B. Leachate Management System

The leachate management system will consist of leachate collection, pretreatment, and disposal. The following discussion provides a brief overview of the proposed components of this system.

Leachate Collection System.

A leachate collection system will be constructed directly above the composite liner and will effectively collect and remove leachate from the landfill while maintaining a minimum 24-inches of separation between the waste and the base liner system. The leachate collection system will include a drainage layer, a pipe network with cleanouts, and the necessary filters designed to prevent physical clogging and promote leachate collection and removal from the landfill. As shown on Sheet C-7, the collection system will discharge to a sump outside

the perimeter berm and from there will be pumped to the proposed pretreatment unit located within the existing borrow area at the north end of the landfill.

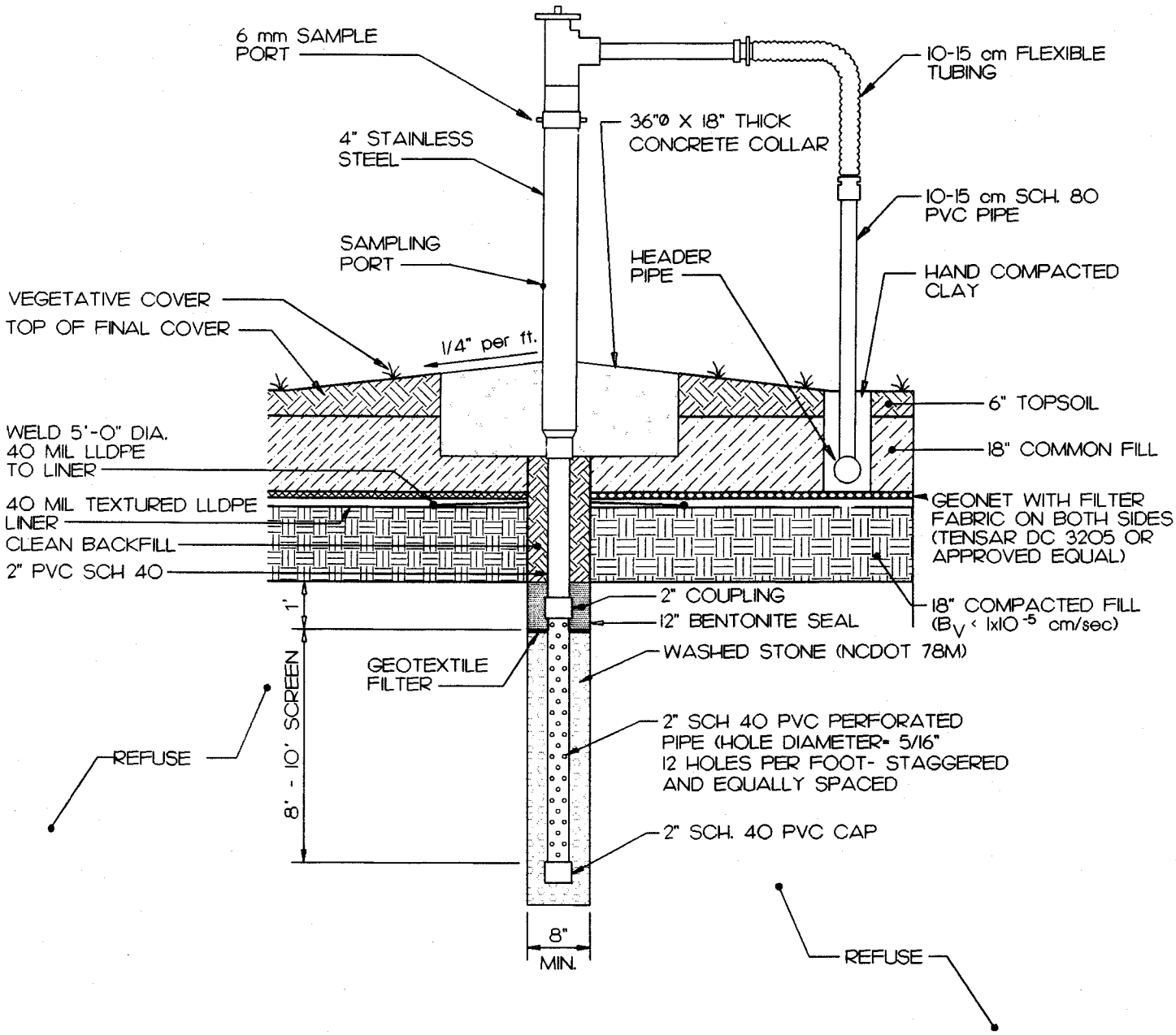
Pretreatment Unit.

The leachate pretreatment unit will be located just northwest of the currently permitted landfill, within the current borrow area. The groundwater remediation system will likely be incorporated into the leachate management system in order to provide pretreatment of the collected leachate. This remediation system will be designed in accordance with the findings of the groundwater assessment currently being performed at the existing facility. The pretreatment unit will consist of an aerated lagoon and ancillary units needed to reduce the Biological Oxygen Demand (BOD), volatile organic compound, and metals concentrations potentially exhibited by the leachate. In addition, this lagoon will serve as a temporary storage facility prior to disposal of the treated leachate. Sludge removed from the lagoon will be tested and subsequently incorporated into the landfill.

On-Site Disposal.

After being treated at the pre-treatment plant, leachate will then be pumped to the northwest corner of the site to be used in a proposed constructed wetlands.

An application for the constructed wetlands will be submitted to the appropriate agencies.



NOT TO SCALE

McKIM&CREED
ENGINEERS • ARCHITECTS • SURVEYORS

FIGURE 1

TYPICAL FINAL GAS CAP SYSTEM WITH GAS COLLECTION DETAIL

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C. Final Cap System

In accordance with *15A NCAC 13B.1627(c)(1)*, the final cap will have a permeability less than or equal to that established for the base liner system. This will consist of 18-inches of compacted clay that has a permeability of no more than 1×10^{-5} cm/sec and a geomembrane to prevent infiltration into the closed landfill. In addition, a minimum six-inch soil layer capable of sustaining vegetative growth will be placed on top of the low permeability layer in order to prevent sedimentation and erosion. A gas venting system will be incorporated into the final cap so as to minimize gas pressure which could potentially develop as a by-product of the waste degradation. A typical final cap system is shown on the preceding page.

D. Erosion and Sediment Control

The proposed landfill will be developed in five to ten foot lifts sloped to promote drainage away from the working area. As the landfill is filled, but before exceeding the surrounding grade elevation, temporary berms will be used to prevent stormwater from flowing into the landfill and temporary slope drains will be used to divert stormwater that enters the landfill away from the working area. Once the fill elevation exceeds the surrounding grade elevation, temporary slope drains will be lain from the top of the landfill down along the side slopes to a channel around the toe of the landfill. In addition, as filling activities occur at the landfill and the landfill sides are raised, berms will be constructed at regular

intervals along the side slopes to collect and divert stormwater landing on the side slopes. Stormwater drainage will be achieved on the top of the landfill by maintaining an adequate top surface slope ($\geq$ 5%) so as to convey stormwater away from the working face. These berms will prevent stormwater from flowing long distances down the side slopes, which could potentially result in erosion problems. The drainage channel around the toe of the landfill will convey accumulated stormwater to a sedimentation basin near the toe of the landfill as shown on the Proposed Facility Plan. The proposed sedimentation basins will be designed for the 25-year, 24-hour storm event, in order to comply with *15A NCAC 13B.1625(b)(3)(B)*.

It should be noted that by filling the landfill in lifts and by progressively constructing the stormwater drainage system as described above, the site may be easily closed out at any time during the facility life with minimal effort needed to control stormwater runoff.

E. Drainage Control and Water Protection Requirements

In addition to the slope drain and channel system described above, the facility will be monitored daily to prevent any solid from being disposed of into ponded water resulting from heavy rains. The landfill operator will also reserve areas close to the access road to deposit waste during inclement weather.

Landfill operations will be conducted in a manner that will avoid discharge of pollutants into wetlands, and will therefore, prevent violation of Clean Water

Act discharge regulations or North Carolina water quality management plan requirements.

F. Gas Monitoring

Outdoor gas monitoring stations will consist of a gas monitoring well that will be constructed so that the well screen is positioned within the geologic stratum that is most likely to allow for methane gas migration. Indoor gas monitoring stations will be located in the lowest part of the buildings being monitored and will involve collection of ambient methane gas measurements. Monitoring will be conducted on a quarterly basis, at a minimum, or more often, as necessary.

HARNETT COUNTY
DUNN-ERWIN SUBTITLE D PHASE IV LANDFILL SITE APPLICATION
WASTE VOLUME COMPUTATIONS

Year	Month	Number of Operating Days	Estimated Daily Waste Weight (tons)	Estimated Waste Weight (tons)	Estimated Waste Volume (cubic yards)	Estimated Soil Volume (cubic yards)	Estimated Total Volume (cubic yards)	Estimated Accumulated Volume (cubic yards)
1998	Jan. thru Jun.	156	224	35,018	87,545	10,943	98,488	98,488
1998	Jul. thru Dec.	156	224	35,018	87,545	10,943	98,488	196,975
Cumulative Totals		**312**	**N/A**	**70,036**	**175,089**	**21,886**	**196,975**	**196,975**
1999	Jan. thru Jun.	156	227	35,394	88,484	11,061	99,545	296,520
1999	Jul. thru Dec.	156	227	35,394	88,484	11,061	99,545	396,065
Cumulative Totals		**624**	**N/A**	**140,823**	**352,057**	**44,007**	**396,065**	**396,065**
2000	Jan. thru Jun.	156	229	35,675	89,188	11,149	100,337	496,401
2000	Jul. thru Dec.	156	229	35,675	89,188	11,149	100,337	596,738
Cumulative Totals		**936**	**N/A**	**212,174**	**530,434**	**66,304**	**596,738**	**596,738**
2001	Jan. thru Jun.	156	231	36,088	90,219	11,277	101,497	698,235
2001	Jul. thru Dec.	156	231	36,088	90,219	11,277	101,497	799,732
Cumulative Totals		**1,248**	**N/A**	**284,349**	**710,873**	**88,859**	**799,732**	**799,732**
2002	Jan. thru Jun.	156	233	36,417	91,042	11,380	102,422	902,154
2002	Jul. thru Dec.	156	233	36,417	91,042	11,380	102,422	1,004,577
Cumulative Totals		**1,560**	**N/A**	**357,183**	**892,957**	**111,620**	**1,004,577**	**1,004,577**

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ASBESTOS MANAGEMENT

A. General Description

1. The referenced landfill will receive properly packaged asbestos and dispose of the asbestos in the monofill as shown on the plans.

2. The design storage capacity of the asbestos monofill is 27,400 cubic yards an expected life of 20 years.

B. Regulatory Requirements

The disposal site for asbestos waste will be owned and operated in accordance to N.C. Regulations. Material delivered to the sanitary landfill must be sealed in a leak-proof container with an OSHA specified label that includes the name of the waste generator. Upon delivery and prior to disposal of the asbestos into the landfill, the following information must be provided to the operator:

1. Name, address and telephone number of the generator

2. Name, address, and telephone number of the transporter

3. Name, address and telephone number of the North Carolina Asbestos Branch.

4. Quantity of waste

5. Date material was transported to disposal facility

The above will be provided on Form-1 as shown in Appendix II of this report and herein referred to as a Waste Shipment Record.

Upon provision of the above, the operator of the yard waste facility will insure that the form has been properly executed and certify by signature that the waste is properly described, labeled and packaged.

Within 30 days of execution of the waste shipment record, the disposal operator must return one copy of the shipment record fully executed and signed by the generator, unless a discrepancy is noted. If a discrepancy is noted, the disposal operator will inform

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Solid Waste Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
William L. Meyer, Director

DEHNR

December 21, 1993

Mr. Jerry Blanchard,Director
Harnett County Transportation/Procurement
P.O. Box 940
Lillington, North Carolina 27546

Subject: *Harnett County(Dunn-Erwin Landfill)*
Yard Waste Facility
Tire Monofill
Asbestos Monofill

Dear Mr. Blanchard:

The Solid Waste Section has received the completeness review information, submitted to the Section, by McKim & Creed Engineers, P.A., on your behalf. The information presented in this submittal is consistent with the requirements for the above referenced facilities and hereby informs Harnett County to proceed with activities associated with these facilities. Please note, that the above mentioned activities are allowed under the existing permit for the Dunn-Erwin Sanitary landfill, and will need to be referenced in the "transition plan" to be submitted prior to April 9, 1994. Operational practices for the referenced facilities shall be in accordance with Solid Waste Management Rules, 15 NCAC 13B.

If you have any questions about this approval letter, please contact the undersigned at (910) 486-1191 or James C. Coffey at (919) 733-06

Sincerely,

Jim Barber
Eastern Area Engineer
Solid Waste Section

James C. Coffey, Supervisor
Permitting Branch
Solid Waste Section

cc: *Terry Dover-Eastern Area Supervisor*
Mark Fry-Waste Management Specialist
Neil Emory-County Manager
C.T. Clayton, P.E.-McKim & Creed
Fayetteville Regional Office
Raleigh Central Office

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Solid Waste Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
William L. Meyer, Director

DEHNR

December 22, 1993

Mr. Thomas J. Ellis, P.E.
Project Engineer, McKim & Creed
Suite 117, Building 1
5625 Dillard Road
Cary, North Carolina 27511

RE: Request for use of Fabrisoil from Phillips Fibers Corporation for daily cover.
Harnett County (Dunn-Erwin) Landfill, Permit #43-02
Harnett County (Anderson Creek) Landfill Permit #43-03

Dear Mr. Ellis:

The Solid Waste Section has reviewed your request to use Phillips Fibers Corporation Fabrisoil as an alternative to daily soil cover. Your proposal is hereby approved with the following conditions:

1. Within 30 days of receipt of this letter develop and submit for Section approval an operational plan to include all methods, procedures and practices involved. Mail the operational plan to me at Fayetteville Regional Office, Solid Waste Section, 225 Green Street, Suite 601, Fayetteville, North Carolina 28301.

2. Approval is granted for use at Harnett County Landfills #43-02 and #43-03 only as daily cover for units receiving household waste i.e., approval does not apply to any approved Land Clearing-Inert Debris (LCID) or Construction and Demolition (C&D) Landfill units at these facilities.

3. Approval is granted for Harnett County Landfill #43-02 until the Transition Plan for this facility is approved by the Section and becomes a condition of the permit.

This approval is subject to immediate revocation if the use of this synthetic daily cover results in a threat to the public health or environment.

If you have any questions concerning this matter, please contact me at (910) 486-1191.

Sincerely,

Mark S. Fry

Mark S. Fry
Waste Management Specialist
Solid Waste Section

MSF:cft

cc: Terry Dover
Jim Barber
Jim Coffey
Jerry Blanchard
Central Files - Harnett County - #43-02 P

SUPPLEMENTAL GEOLOGIC AND HYDROGEOLOGIC REPORT

Prepared by McKim & Creed Engineers, PA

September 1995

Introduction

The Supplemental Geologic and Hydrogeologic Evaluation (SGHE) is intended to consolidate and supplement the geologic and hydrogeologic data already available for the site in the Froehling & Robertson, Inc.(F&R) and Westinghouse Environmental and Geotechnical Services (WR) reports. The SGHE was prepared by McKim & Creed in general accordance with the parts of Rule *15A NCAC 13B .1623* that were either not specifically or adequately addressed in the WR or the F&R reports, as shown in Table 1.

15A NCAC 13B.1623(a)(3)

There is a total of 31 borings, piezometers, and monitoring wells within the 26-acre footprint and surrounding area of the proposed lined landfill as shown in Table 2. In addition, ten test pits were excavated by McKim and Creed in surrounding areas of the lined landfill. Sheet C-5 of this Site Application Plan shows the locations of the borings, piezometers, monitoring wells, and test pits. The boring logs and well construction records can be found in the F&R report and WR, in Attachment 1, Appendices A and B, respectively.

15A NCAC 13B.1623(a)(5)

In August 1995, ten test pits were excavated by McKim and Creed in the areas proposed for the construction and demolition (C&D) landfill, leachate storage pond, and a designated borrow area. Test pit logs are shown in Attachment 1, Appendix C of this supplemental. The additional information obtained from these test pits is described as follows:

1. Test Pit Data

A total of ten test pits were excavated to depth ranging from 9 to 21 feet. Four test pits were located in the area planned for the leachate storage pond and C&D area, and six test pits in the designated new borrow area, numbered TP-1 through TP-4, and TP-5 Through TP-10, respectively. Approximate test pit locations are shown on Sheet C-5 of the application drawings. Groundwater level measurements were performed about five hours after the test pits were excavated. Soil conditions in the specific test pit logs are discussed below. Conclusions regarding the suitability of the area for future placement of the leachate storage basin and C&D landfill, and the suitability of the proposed borrow area are also presented below. Test pit logs are shown Attachment 1, Appendix C attached herein. USCS soil classifications of test pit soils are estimated based on visual field classification of these soils (no laboratory tests were performed). Test pit depths and water levels in the test pits were measured with respect to ground surface elevation using a tape measure. Therefore, all depths and elevations in this report are approximate. Table 3 provides a summary of approximate water table elevations observed in the test pits between three to five hours after they were excavated.

2. Area Planned for Leachate Storage Basin and C&D Landfill

As shown on Sheet C-5, test pits TP-1 through TP-4 were excavated

in the area proposed for the leachate storage basin and C&D landfill. These test pits were terminated in a hard clay layer when the excavation became difficult. The average depth to the hard clay layer was four, six, one, and seven feet, for TP-1 through TP-4, respectively. The test pits were left open for about five hours (with the exception of TP-4) to observe water levels. Water was observed only in TP-3 at a depth of about 8.5 feet (approximate elevation of 172.5 feet), just slightly below the apparent top of the hard clay layer. Soils in these test pits vary from tan silty coarse sands (SM or SC) near the surface to the deeper greyish stiff to hard clay layer that appear to be continuous (CL or CH). Water flow was observed in both drainage trenches that border the area. The flow appeared to be marginal and was not measured. However, it is estimated that at the downstream end of each of these trenches (west side of the area), the flow was less than one gallon per minute (gpm), similar to a garden hose flow.

The source of this flow may indicate intermittent drainage of limited quantities of perched water through sandy lenses in the top six to ten feet of the natural surrounding terrain through the cut slopes of the existing borrow area. Based on these observations, it appears that the existing ground surface elevations may provide adequate vertical separation for the proposed leachate basin and construction and demolition landfills as outlined in the conceptual facility plan of this application for the proposed Subtitle D landfill. The apparent continuous clay layer may provide a good

natural containment barrier for the proposed facilities. The field investigation program for the Permit to Construct Application will include an adequatc number of borings and piezometer installations to provide better characterization of the hydrogeology in this area.

3. Proposed Borrow Area

As seen on Sheet C-5, the proposed borrow area topography trends to the west with the exception of the small peak in the center of this area. The east-west relief is from approximate ground elevations of 220 to 200 feet near the centrally located peak with slopes of up to about five percent. East of the peak the relief towards the wetlands in the west is steeper (up to about ten percent) from approximate ground elevations of 200 to 180 feet. Most of the area is cleared with the exception of the trees on the ridge of the small peak in the central area. Based on field observations and the test pit logs in Appendix C of this supplemental, the proposed borrow area is covered with top soil six-inches to two-feet deep consisting of greyish to tan silty sands (SM) with apparent organic matter and roots. The top soil is underlain by tan to grey silty sands (SM) and tan sandy silts (ML). In TP-8 and TP-10 the silty sands are reddish yellow with coarse sand particles. Generally, these silty soils occur in one to eight-foot thick layers and tend to transition into the underlaying clayey soils. The clayey soils are generally stiff to hard greyish silty or sandy clays (CL or CH) and start at depths that vary between

1.5 foot (TP-6) to 17 feet (TP-8). These clayey soils contain sandy lenses, which appear in relative quantities that vary between 20% within the clay layer to 50% near the transition to the overlaying sandy and silty soils. No clay was encountered in TP-10, where the reddish yellowish clayey coarse sand (SC) extended to a depth of 17 feet. In TP-8 the grey clayey sand occurred to a depth of about 17 feet. Generally, there appeared to be little lateral continuity between the various soil types observed in the test pits. These test pits were left open for about five hours to observe water tables. Water was observed in all test pits. As shown in Table 3, approximate depths to water in the test pits were measured and appeared to vary between 13 to 16 feet below ground surface representing approximate elevations ranging form 194.8 at the western most test pit TP-5 to 178.8 feet at the eastern most test pit TP-9. The water appears to represent a surficial aquifer or perched water that dripped or seeped through sandy lenses within the clayey soils into the open test pits. An approximate seep depth of ten feet was observed in TP-8. In TP-6 and TP-9 water was dripping from an approximate depth of 12 feet. Based on these observations, the proposed borrow area appears suitable for excavation to an average depth of about ten feet in order to stay above the apparent surficial groundwater. The potential borrow soils appear to vary with little lateral continuity. These soils include silty sands (SM), clayey sands (SC), sandy clays (CL-CH), and sandy silts (SM).

15A NCAC 13B.1623(a)(6)

Figures 1, 2, and 3 of this supplemental show the three stratigraphic cross-sections (A-A', B-B', C-C') in the site area. The locations of these cross-sections are shown on Sheet C-5. Cross-section A-A' and B-B' are also shown in the WR (Figures 4a and 4b, respectively). Cross-section C-C' was prepared by McKim & Creed. The groundwater elevations shown on the cross-section are dated July 7, 1995 with the noted exceptions.

15A NCAC 13B.1623(a)(7)(A)

The WR contains groundwater elevations measured at the time of drilling, 24 hours after drilling, and stabilization of the piezometers PZ-40 through PZ-48 and PB-9. The F&R report contains groundwater elevations measured for borings B16 through B33. No records are available for borings B-1 through B-15 and the monitoring wells MW-1, and MW-6.

15A NCAC 13B.1623(a)(7)(B)

Groundwater elevations have been monitored at the site over the last few years and the recorded elevations were tabulated in order to develop an understanding of their seasonal fluctuations as shown in Tables 4, 5, and 6. The data within these tables represent a combination of data obtained from the WR, F&R report and McKim & Creed. McKim & Creed has been monitoring groundwater elevations in the piezometers and monitoring wells within the proposed footprint and surrounding area of the proposed Subtitle D landfill, on a monthly basis since March 1995. Monthly monitoring will continue

throughout the application process to more accurately evaluate seasonally high groundwater levels for the area.

15A NCAC 13B.1623(a)(7)(C)

Groundwater elevations measured within the area of the landfill show fluctuations that range from less than one foot to a maximum of about six feet. The average groundwater elevation fluctuation appears to be about three feet, considered to be within the normal seasonal variation in the landfill area due to fluctuations in precipitation, and evapo-transpiration. Additional measurements are necessary to better evaluate seasonal fluctuations. McKim & Creed will continue to measure groundwater elevations on a monthly basis throughout the application process.

15A NCAC 13B.1623(a)(7)(D)

Human activities, which may have the potential for causing groundwater table fluctuations, will include construction of final cover on the existing landfill and construction of the proposed lined landfill. These construction activities eliminate or substantially reduce the recharge areas beneath the cover. Therefore, lower groundwater levels and reduced gradients may result in the immediate vicinity of the covered area. However, these construction activities are not expected to significantly impact groundwater levels and overall gradients in the general area of the landfill.

There are no high capacity wells or injection wells in the vicinity of the site. The nearest water supply well is located near the entrance as shown on sheet C-2. This well

is used for landfill office and maintenance facilities. Due to its small yield and the distance from the proposed construction areas, this well is not expected to affect either groundwater levels or groundwater flow at the site.

If not properly designed, borrow activities may influence groundwater levels in their immediate vicinity. All borrow activities will be conducted in a manner that will minimize drainage of superficial perched water aquifers. The borrow areas will be terminated above the water table. They will be graded to affect positive drainage. By eliminating or minimizing localized areas of concentrated infiltration or dewatering, the proposed borrow area will not significantly impact groundwater.

Major storm events are viewed as the only natural occurrences that have the potential for causing significant groundwater level fluctuation, excluding seasonal changes in precipitation and evapo-transpiration. The site is located outside of any tidal influences. The flow of Stewart Creek and its tributaries is not modified by any impoundments or reservoirs. Groundwater changes resulting from river stage changes will likely be limited to the floodplain of Stewart Creek and it tributaries. The proposed construction will be located outside the floodplain. Therefore, major storm events will only result in subdued water table changes through infiltration of precipitation. Construction-related topographic changes in ground surface adjacent to the floodplain may influence groundwater levels in the floodplain vicinity. Due to the slopes of the constructed landfill, small changes to groundwater levels within the floodplain would not extend appreciably beyond the floodplain.

15A NCAC 13B.1623(a)(8)

Groundwater flows from areas of higher potential to areas of lower potential. Groundwater flow is perpendicular to potentiometric contours as surface water flow would be to topographic contours. The general direction of flow for the proposed area of the lined landfill is southwest toward the wetlands. Potentiometric contours are shown on Sheet C-5. Groundwater gradients and flow rates are calculated and discussed in the WR.

15A NCAC 13B.1623(a)(9)&(10)

Groundwater contours and boring location are shown on Sheet C-5.

15A NCAC 13B.1623(a)(13)(B)

Groundwater flows from areas of higher hydraulic head to areas of lower hydraulic head discharging into surface water-bodies such as lakes, streams, and rivers and within the subsurface, into water supply wells. With the exception of groundwater discharge features, potential groundwater receptors are limited to water supply wells. At the landfill site, groundwater receptors are limited to the unnamed tributaries of Stewart Creek. There are no known downgradient water supply wells located on-site or within 500 feet of the landfill property boundary. There is one upgradient water supply well on-site. The well is used only for landfill office and maintenance facilities on-site.

15A NCAC 13B.1623(a)(13)(D)

Final design of the landfill in the Permit to Construct Application shall incorporate a groundwater and surface water monitoring plan to be sealed by a Professional Geologist. Site topography, drainage and groundwater characteristics of this site should allow adequate monitoring of this site.

Surface water monitoring is being performed at three points along the unnamed tributary of Stewart Creek for the existing MSW landfill. These points would continue to be utilized for the proposed landfill. In the area of the proposed lined landfill, groundwater flow is generally to the southwest. Groundwater monitoring would utilize the existing downgradient monitoring well MW-23 and additional downgradient wells could be installed. Monitoring wells MW-6, MW-7B and MW-8 could be used as upgradient wells for the proposed lined landfill, and as downgradient wells for the existing landfill (as they are currently used). An additional background (upgradient) well will be added as needed and its location will be determined by a professional geologist in the groundwater monitoring plan of the Permit To Construct Application.

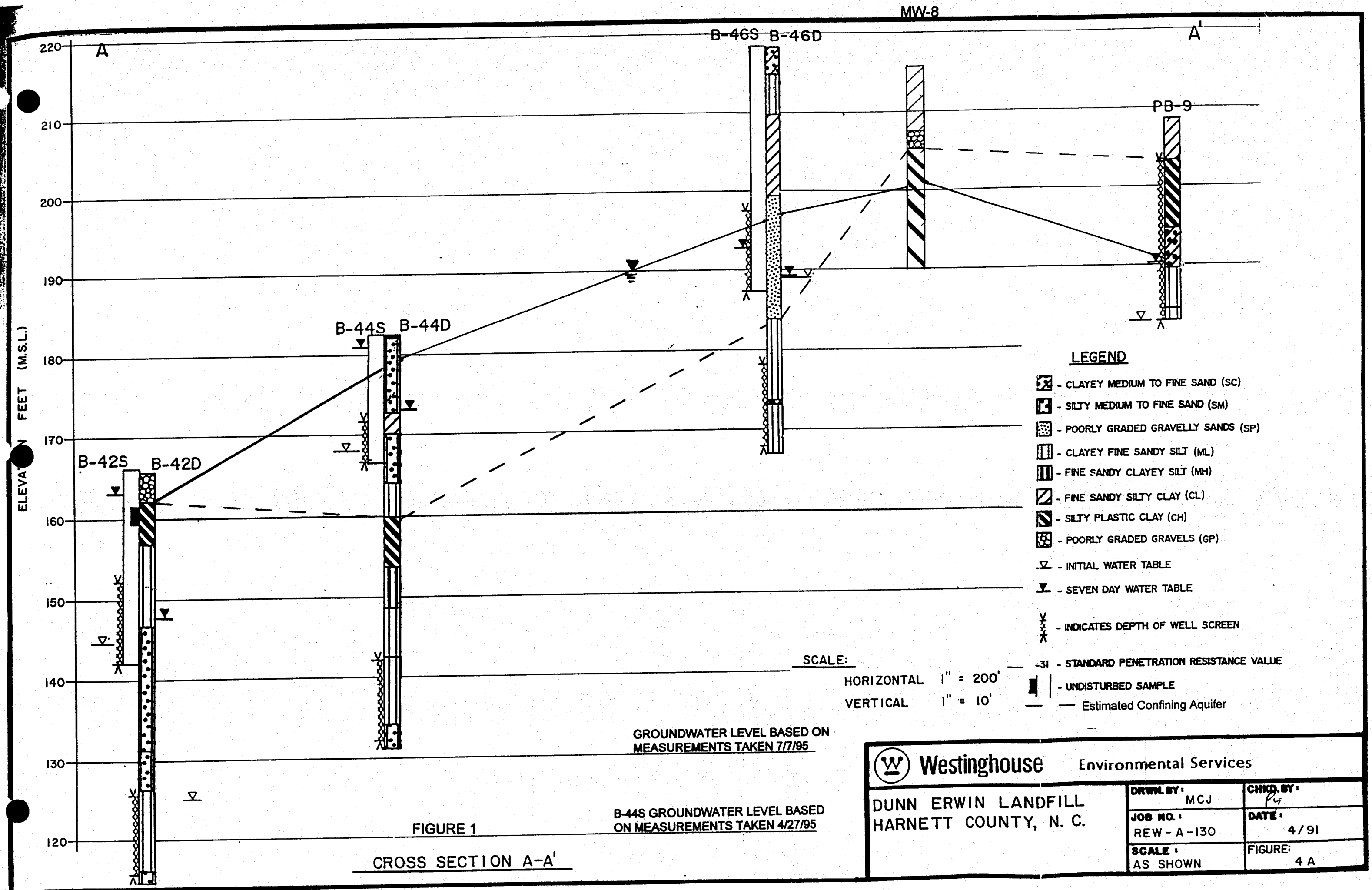
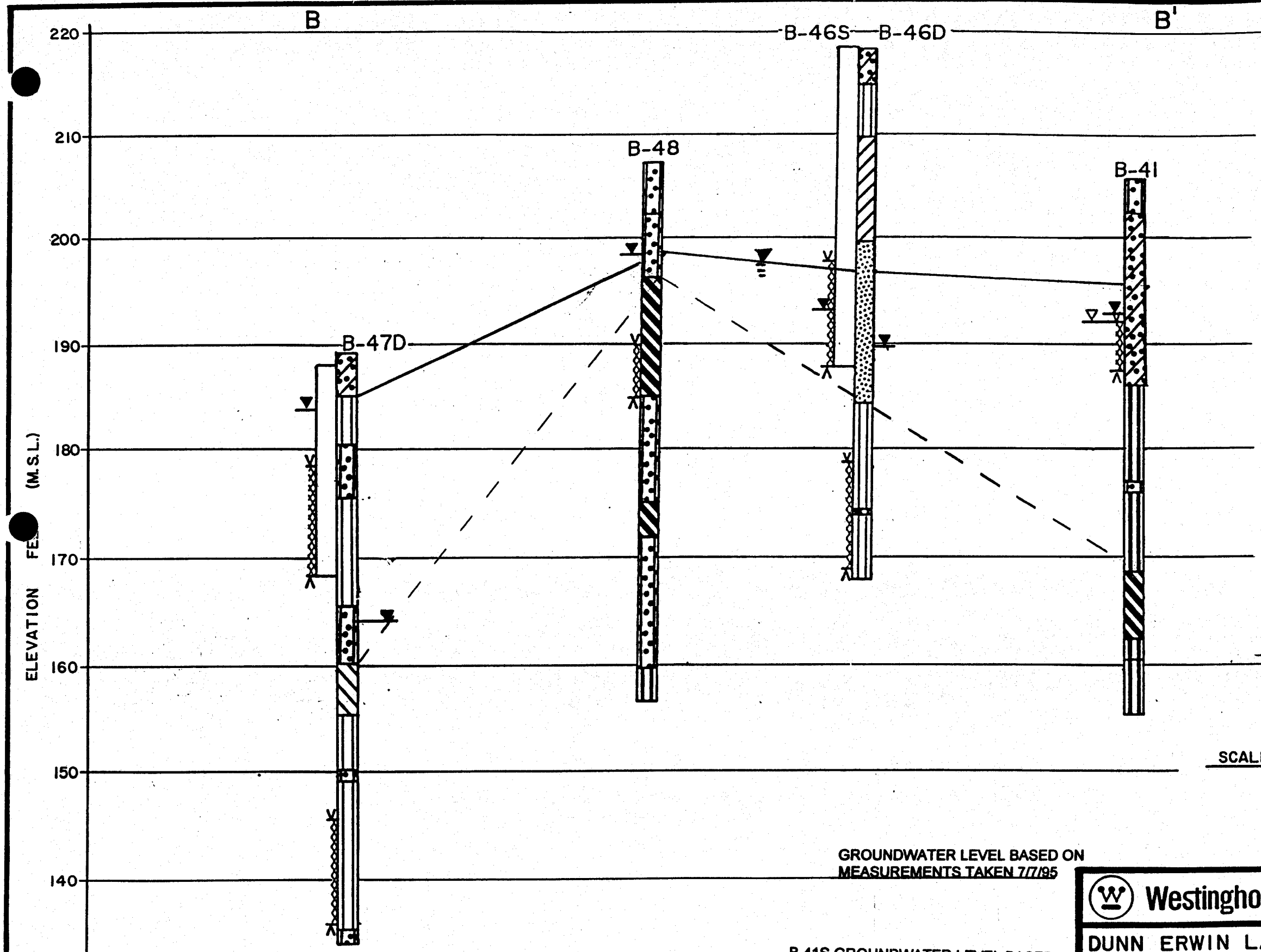


FIGURE 1

CROSS SECTION A-A'



LEGEND

- CLAYEY MEDIUM TO FINE SAND (SC)
- SILTY MEDIUM TO FINE SAND (SM)
- POORLY GRADED GRAVELLY SANDS (SP)
- CLAYEY FINE SANDY SILT (ML)
- FINE SANDY CLAYEY SILT (MH)
- FINE SANDY SILTY CLAY (CL)
- SILTY PLASTIC CLAY (CH)
- POORLY GRADED GRAVELS (GP)
- INITIAL WATER TABLE
- SEVEN DAY WATER TABLE
- INDICATES DEPTH OF WELL SCREEN
- -31 - STANDARD PENETRATION RESISTANCE VALUE
- UNDISTURBED SAMPLE
- Estimated Confining Aquifer

SCALE:

HORIZONTAL 1" = 200'

VERTICAL 1" = 10'

GROUNDWATER LEVEL BASED ON MEASUREMENTS TAKEN 7/7/95

B-41S GROUNDWATER LEVEL BASED ON MEASUREMENTS TAKEN 3/28/95

FIGURE 2

CROSS SECTION B-B'

Westinghouse Environmental Services

DUNN ERWIN LANDFILL
HARNETT COUNTY, N. C.

DRWN. BY: MCJ	CHKD. BY: PG
JOB NO.: REW-A-130	DATE: 4/91
SCALE: AS SHOWN	FIGURE: 4B

DUNCAN-PARNELL, INC., RALEIGH 888 919-833-4677

CALCULATION

McKIM&CREED

PROJECT NO.
DATE 7/28/95
DES. BY BS
CK. BY

1/1

PROJECT DUNN-ERWIN SITE APP
CLIENT HARNETT COUNTY
SUBJECT CROSS-SECTION C-C

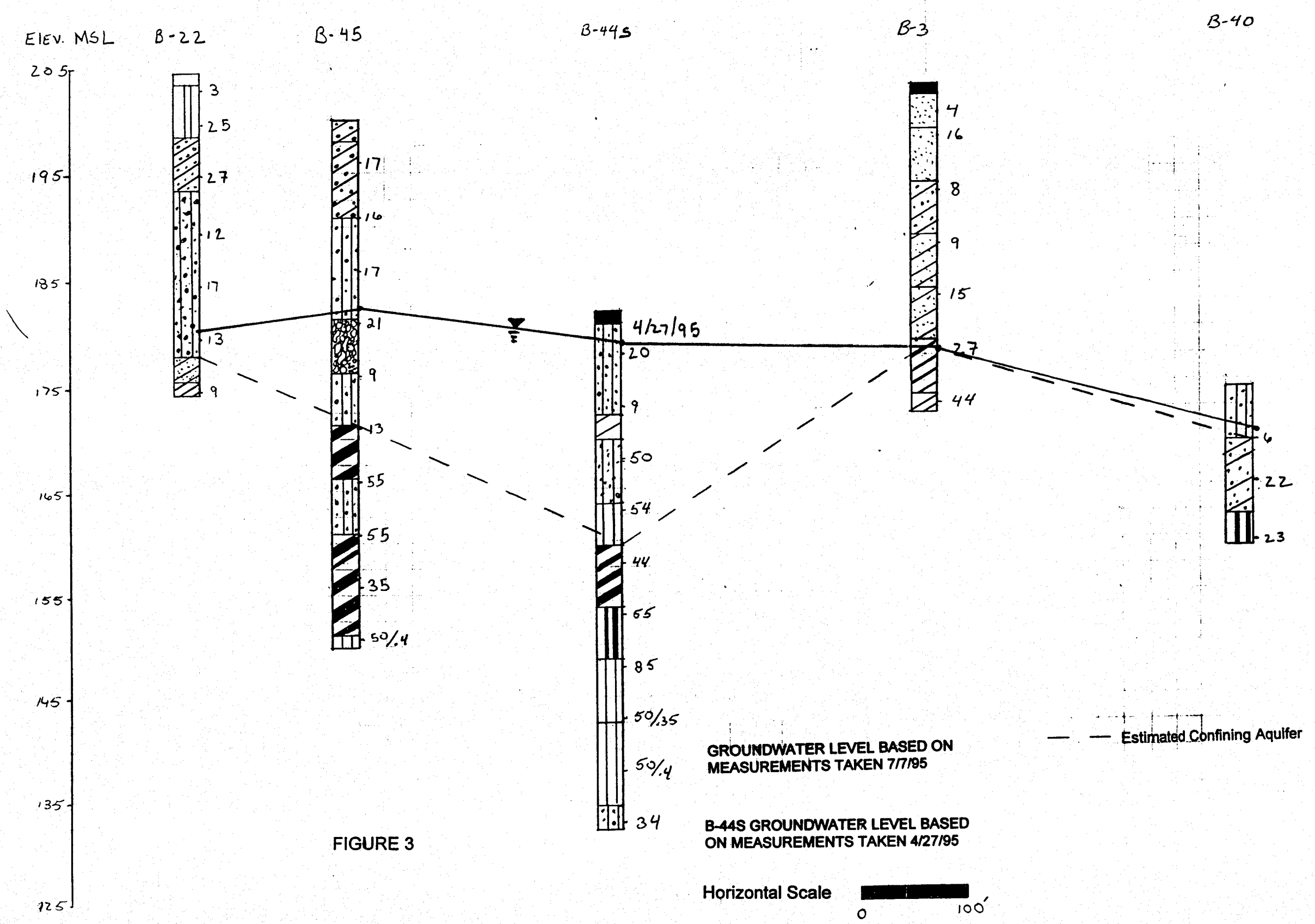


FIGURE 3

ATTACHMENT 1

APPENDIX A

SUBSURFACE EXPLORATION DUNN-ERWIN LANDFILL

HARNETT COUNTY, NORTH CAROLINA

by Froehling & Robertson, Inc.

September 1986

SUBSURFACE EXPLORATION

DUNN-ERWIN LANDFILL

HARNETT COUNTY, NORTH CAROLINA

Subsurface Exploration

Dunn-Erwin Landfill

Harnett County, North Carolina

Made For

County of Harnett

c/o Ragsdale Engineers, P.A.

Lillington, North Carolina

Made By

Froehling and Robertson, Inc.

Raleigh, North Carolina

RN66-263

September 1986

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III. **Appendix B - Field Exploration**

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(2) Key to Soil Classification

(3) Boring Logs

(4) Schematic and Well Logs

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERS & CHEMISTS
"OVER ONE HUNDRED YEARS OF SERVICE"

P. O. Box 2551, Raleigh, NC 27602
Telephone: (919) 828-3441

September 22, 1986

County of Harnett
c/o Ragsdale Consultants, P.A.
P. O. Box 757
Lillington, NC 27546

Attention: Mr. Jose' Velazquez, P.E.

Re: Geotechnical Exploration and Monitoring Wells - Proposed Dunn-Erwin Landfill
Harnett County, North Carolina

Gentlemen:

Froehling and Robertson, Inc. (F&R) has performed the referenced geotechnical exploration and installation of the monitoring wells in accordance with our Geotechnical Contract Agreement with Harnett County. This work was authorized by Mr. Dallas H. Pope, County Manager.

The purpose of these geotechnical services was to determine the soil stratification, static groundwater levels, coefficient of permeability of the confining soil layers and to construct groundwater monitoring wells.

FIELD EXPLORATION

Test Borings: Prior to this exploration, F&R had drilled fifteen test borings at the proposed site. Eighteen additional test borings were drilled, borings B-16 through B-33. These additional test borings were located by Ragsdale Consultants and elevations of each test location were furnished our office. The test locations, for the most part, were positioned in areas densely wooded having a rolling topography. The borings were accessed with a CME-750 rig mounted on an All-Terrain-Vehicle. Some clearing was provided by the County using a dozer.

Boring depths ranged from 20 to 50 feet depending upon the subsoil conditions encountered. The borings were drilled in accordance with procedures outlined in ASTM D-1586. The soil samples obtained from the Standard Penetration Tests (SPT) were sealed in 8-ounce glass jars, labeled and transported to our laboratory. Each soil sample was examined and visually classified by a geotechnical engineer.

In order to accurately monitor the groundwater levels, 1-1/2 inch PVC pipe was installed in each boring. The bottom 10-foot section was slotted and a sand pack was placed around each screen to a depth of two feet above the top of the screen. The annular space extending from the sand pack to the ground surface was

backfilled with auger cuttings and tamped. The elevation of the ground surface and top of pipe was recorded by Ragsdale Consultants and furnished our office.

In addition to the test borings, a field permeability test was performed in borings B-18 and B-25. Also groundwater monitoring wells were constructed in borings B-16, B-23, B-31, B-32 and B-33. Borings B-32 and B-33 were located at the existing landfill site. Details of the field permeability tests and monitoring well construction are discussed later in this report.

GEOLOGY AND SOIL PROFILE

The project site lies in the Coastal Plain geologic formation. Soils of the Tuscaloosa formation were encountered in the test borings drilled at the site. The Tuscaloosa formation appears as a series of beds of tan to reddish-brown sandy clay with loose sand near the surface. Beneath the weathered beds, the Tuscaloosa formation is predominantly a light gray to bluish-gray clay. The Tuscaloosa formation is mainly a massive clay containing interbedded layers of sand. In the upper layers the coarser materials are intimately mixed.

The soil profile encountered at the boring locations is illustrated on Drawings A1a, A1b and A1c. These drawings also include elevations, groundwater levels, soil stratification and SPT values. A detailed description of each boring is presented on the boring logs in the Appendix of this report.

A stratum of very stiff to hard silty clay was encountered in the lower portions of most of the borings. The exceptions occur in borings B-18 and B-22. These two borings were terminated at elevation 180 and 174 respectively. With the exception of B-17, which was terminated at elevation 199, all other borings extended below elevation 174.

Groundwater: Slotted 1-1/2 inch PVC pipe was installed in each boring except the monitoring well borings (B-16, B-23, B-31, B-32 and B-33) in order to monitor the fluctuation in the groundwater levels. The recorded groundwater levels are as follows:

Boring	Ground Elev.	Elev. Top of PVC Pipe	Depth to Groundwater, Ft. (Elev.) IAD	Elev.	Elapsed Time	Depth	Elev.
B-16	194.24	195.58	20.0	174.2	22 days	6.0	188.2
B-17	224.05	226.26	none	-	15 days	23.6	200.5
B-18	205.10	209.15	21.0	184.1	13 days	13.0	192.1
B-19	172.82	174.58	9.0	163.8	8 days	3.6	169.2
B-20	175.86	178.13	12.5	163.4	8 days	5.9	170.0
B-21	180.93	185.88	none	-	18 days	5.0	175.9
B-22	204.30	206.79	27.0	177.3	14 days	27.2	177.1
B-23	168.37	169.96	19.0	149.4	22 days	5.4	163.0
B-24	177.41	179.95	none	-	8 days	4.3	173.1
B-25	195.24	197.03	none	-	-	-	-
B-26	175.57	176.88	none	-	14 days	2.8	172.8
B-27	187.04	188.54	none	-	14 days	9.2	177.8
B-28	194.30	195.70	21.0	173.3	15 days	6.1	188.2
B-29	215.10	216.76	46.0	169.1	19 days	15.3	199.8
B-30	207.73	208.78	none	-	18 days	3.8	203.9
B-31	231.90	233.25	37.0	194.9	24 days	19.9	212.0
B-32	182.17	183.81	none	-	20 days	6.6	175.6
B-33	170.90	173.85	19.0	151.9	16 days	6.7	164.2

Field Permeability Tests: Field permeability tests were performed at the location of borings B-18 and B-25. A 3-inch I.D. PVC pipe was installed in offset borings to depths of 12.6 ft. and 14.2 ft. in borings B-18 and B-25 respectively. A 12-inch thick bentonite seal was placed at the bottom of each pipe and the annular area between the pipe and the bore hole was sealed with cement grout. An initial reading point was established approximately 2-1/2 to 3 inches from the top of each PVC pipe with black permanent ink. The pipes were filled with water to the zero mark and the drop in water level was recorded over a period of 24 and 15 days respectively in borings B-18 and B-25. The coefficient of permeability was computed based on the elapsed time, flow of water and pressure head.

At the B-18 location, the test was performed in a red clayey silt (ML) at a depth of 12.6 feet below the ground surface (elevation = 192.50). The computed coefficient of permeability, k, is 8.75×10^{-8} cm/sec.

At the B-25 location, the test was performed in a yellowish-brown and gray fine sandy silty clay with mica. The test depth was 14.2 feet (elevation = 181.0). The computed coefficient of permeability, k, is 4.65×10^{-8} cm/sec.

Monitoring Wells: Two-inch Schedule 40 PVC groundwater monitoring wells were constructed in borings B-16, B-23, B-31, B-32 and B-33. Borings B-32 and B-33 were located at the existing landfill site. The wells were constructed in accordance with the guidelines submitted by Mr. Michael L. Babuin of the N. C. Solid and Hazardous Waste Management Branch. The boring logs, N. C. Well Completion Records and a schematic of each well is submitted in the Appendix of this report.

Acknowledgement: Froehling and Robertson, Inc. appreciates the opportunity to work with you on this project. Should there be any questions regarding this report, please do not hesitate to contact us.

Sincerely,

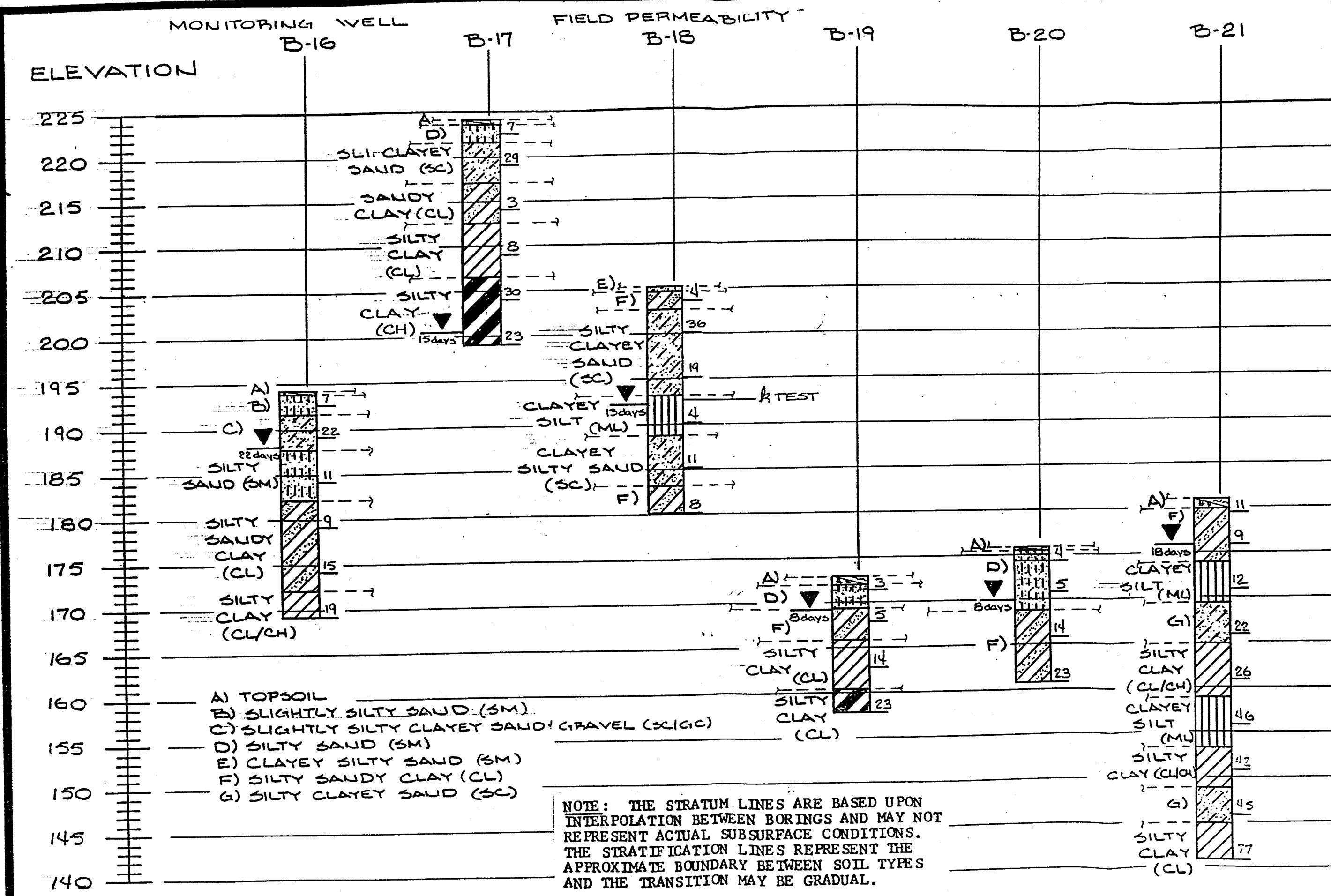
FROEHLING & ROBERTSON, INC.

Ray T. Whitaker

Ray T. Whitaker, P.E., Manager
Raleigh Branch Office

APPENDIX A

DRAWINGS



DATE: 18 SEPT '86
SCALE: V: 1" = 10', H: NONE
DRWN: MJO
DWG. NO. A-1a

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MATERIALS TESTING & INSPECTION - ENGINEERS & CHEMISTS
CABLE ADDRESS - "FROEHLING"
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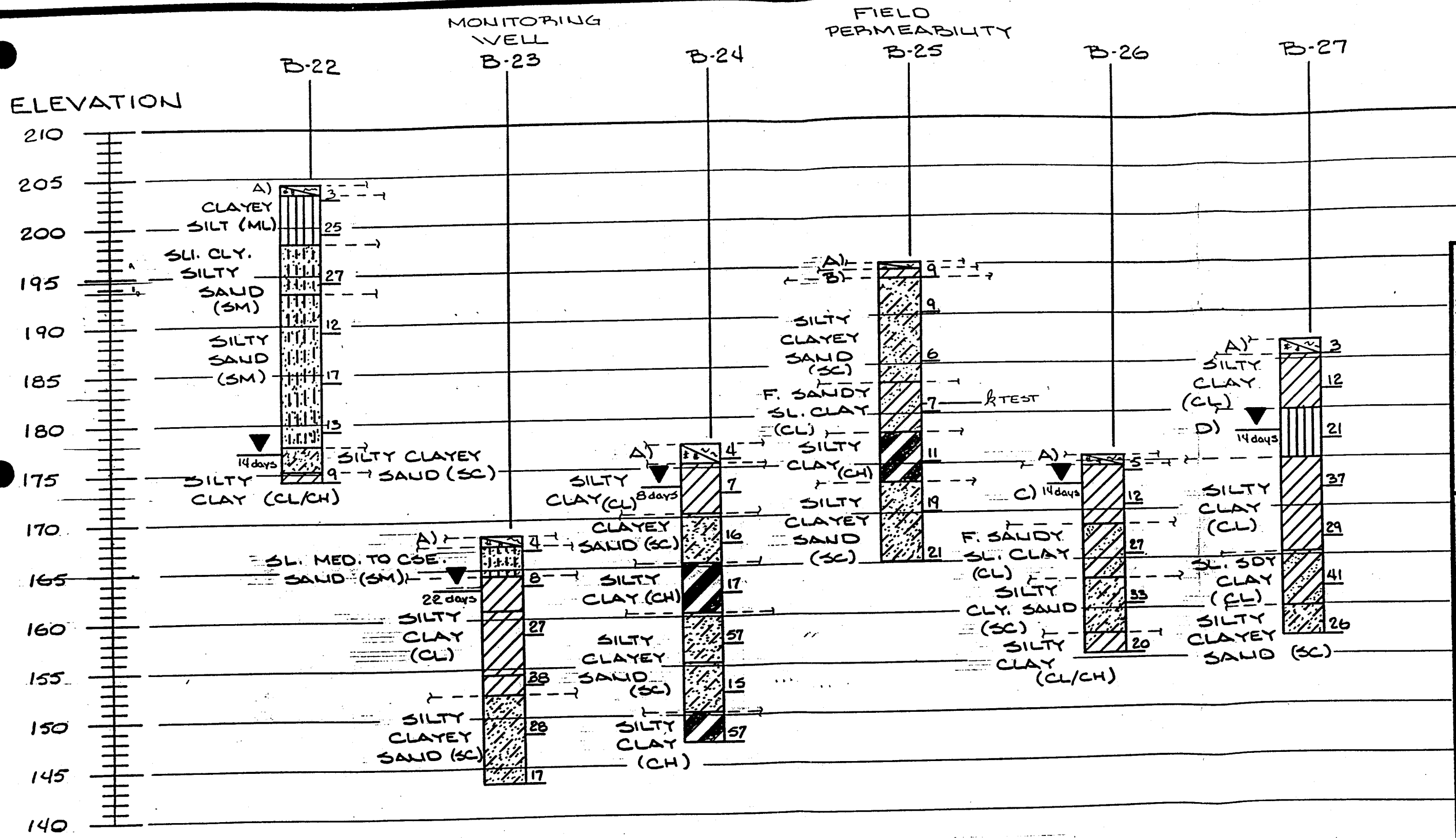
SOIL BORING PROFILE
DUNN - ERWIN LANDFILL
HARNETT CO. NC



A) TOPSOIL
B) SILTY CLAY (CL)
C) SILTY CLAY / CLAYEY SILT (CL/ML)
D) SLIGHTLY CLAYEY SILT (ML)

NOTE: THE STRATUM LINES ARE BASED UPON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS. THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

DATE: 18 SEPT '86
SCALE: V: 1" = 10' H: NONE
DRWN: MJO
DWG. NO. A-16

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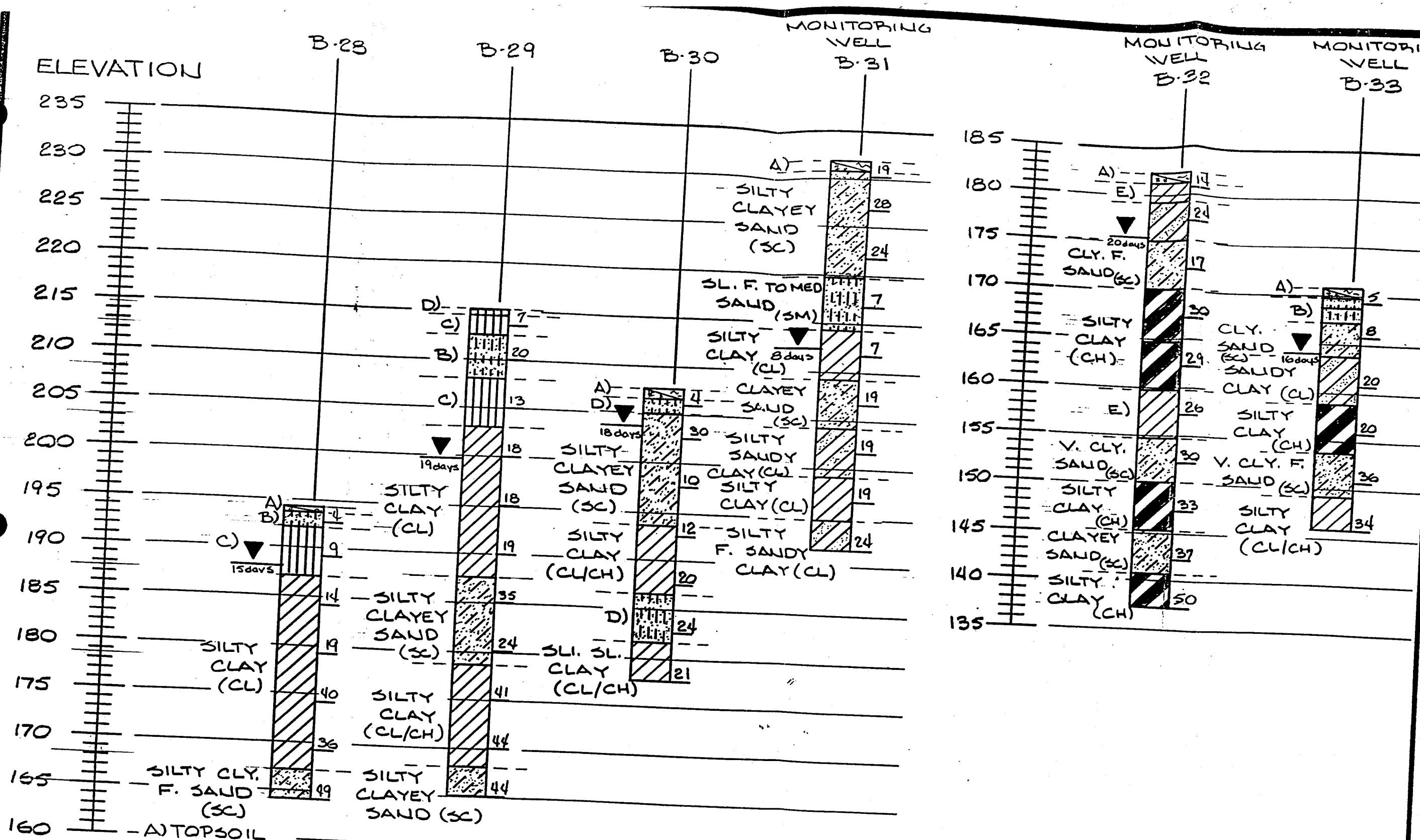
MATERIALS TESTING & INSPECTION - ENGINEERS & CHEMISTS
CABLE ADDRESS - "FROEHLING"
SINCE 1881

SOIL BORING PROFILE
DUNN-ERWIN LANDFILL
HARNETT CO., NC



A) TOPSOIL
B) SILTY FINE SAND (SM)
C) CLAYEY SILT (ML)
D) SLIGHTLY CLAYEY SILTY SAND (SM)
E) SILTY CLAY (CL)
F) SILTY FINE SANDY CLAY (CL)

NOTE: THE STRATUM LINES ARE BASED UPON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS. THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

FROEHLING & ROBERTSON, INC.
MATERIALS TESTING & INSPECTION -- ENGINEERS & CHEMISTS
CABLE ADDRESS -- "FROEHLING"
SINCE 1881

SOIL BORING PROFILE
DUNN ERWIN LANDFILL
HARNETT CO. NC

DATE: 18 SEPT '86
SCALE: V: 1" = 10' H: NONE
DRWN: MJO
DWG. NO. A-1c

Division of Health Services

WELL COMPLETION RECORD

OMPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N.C
EPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANCH
. O. BOX 2091, RALEIGH, N.C. 27602

AME OF SITE: *Existing Dunn-Erwin Landfill*	PERMIT NO.:
DDRESS: *Harnett County, North Carolina*	OWNER (print): *County of Harnett*
RILLING CONTRACTOR: *Froehling & Robertson, Inc.*	REGISTRATION NO.: *421*

asing Type:	PVC Sch. 40	dia.	2	in.	Grout Depth:	from	0	to	10	ft. - dia.	8 in
asing Depth:	from 0	to	14	ft. - dia.	2	in.	Bentonite Seal:	from	10	to	12	ft. - dia.	8 in
creen Type:	PVC 0.01" Slot	dia.	2	in.	Sand/Gravel PK:	from	12	to	25	ft. - dia.	8 in
creen Depth:	from 14	to	24	ft. - dia.	2	in.	Total Well Depth:	from	0	to	24	ft. - dia.	8 in

atic Water Level: 9.7 feet from top of casing — Date Measured 9 / 18 / 86

ield (gpm): N/A Method of Testing: N/A — Casing is 2.95 feet above land surfac
PVC

DRILLING LOG B-33

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0'	1.0'	Light brown silty clayey sandy topsoil.
1.0'	2.0'	Loose, tan silty SAND with gravel. (SM)
2.0'	3.5'	Loose, black silty SAND with gravel. (SM)
3.5'	7.0'	Loose, light to dark gray clayey SAND (damp). (SC)
7.0'	12.0'	Very stiff, pale brown sandy CLAY. (CL)
12.0'	17.0'	Very stiff, gray silty CLAY with some fine sand. (CH)
17.0'	21.5'	Dense, gray very clayey fine SAND. (SC)
21.5'	25.0'	Hard, dark gray silty CLAY. (CL/CH)

(Boring terminated at 25.0 feet.)

LOCATION SKETCH

(show distance to numbered roads, or other map reference points)

See Location Drawing prepared by Ragsdale Consultants, Inc.

EMARKS: Log of boring presented in Appendix. Monitoring well constructed in 3.25 inch I.D. hollow stem auger (8" O.D.).

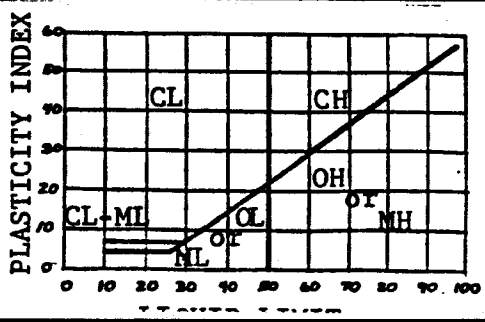
ATE: Sept. 18, 1986 SIGNATURE:

IS 3342 (6/85)
lid & Hazardous Waste Management Branch

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More Than 50% Larger Than No. 200 Sieve)	GRAVELS More than 50% of coarse fraction larger than No. 4 Sieve	CLEAN GRAVELS (little or no fines)	GW	Well graded gravels
			GP	Poorly graded gravels
		GRAVELS (with fines)	GM	Silty gravels
			GC	Clayey gravels
	SANDS More than 50% of coarse fraction smaller than No. 4 Sieve	CLEAN SANDS (little or no fines)	SW	Well graded sands
			SP	Poorly graded sands
		SANDS (with fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS (More Than 50% Smaller Than No. 200 Sieve)	SILTS AND CLAYS (Liquid Limit ⩽ 50)		ML	Silts - sandy or clayey silts with slight plasticity
			ML	Micaceous silts with slight plasticity
			CL	Silty clays with low plasticity
			CL	Sandy clays with low plasticity
	SILTS AND CLAYS (Liquid Limit ⩾ 50)		MH	Silts or clayey silts with high plasticity.
			CH	Clays, silty clays with high plasticity
HIGHLY ORGANIC SOILS			PT	Peat or other highly organic soils.

PLASTICITY CHART



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INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS

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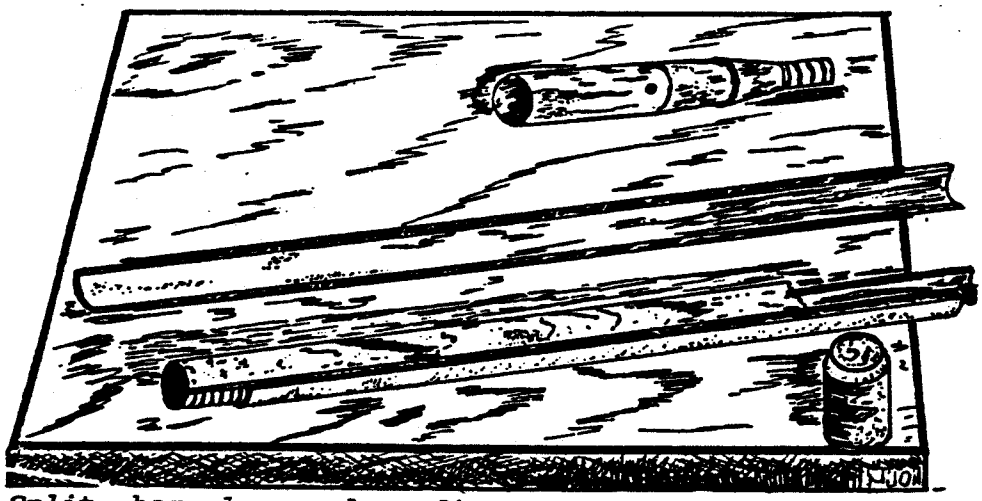
APPENDIX B

FIELD EXPLORATION

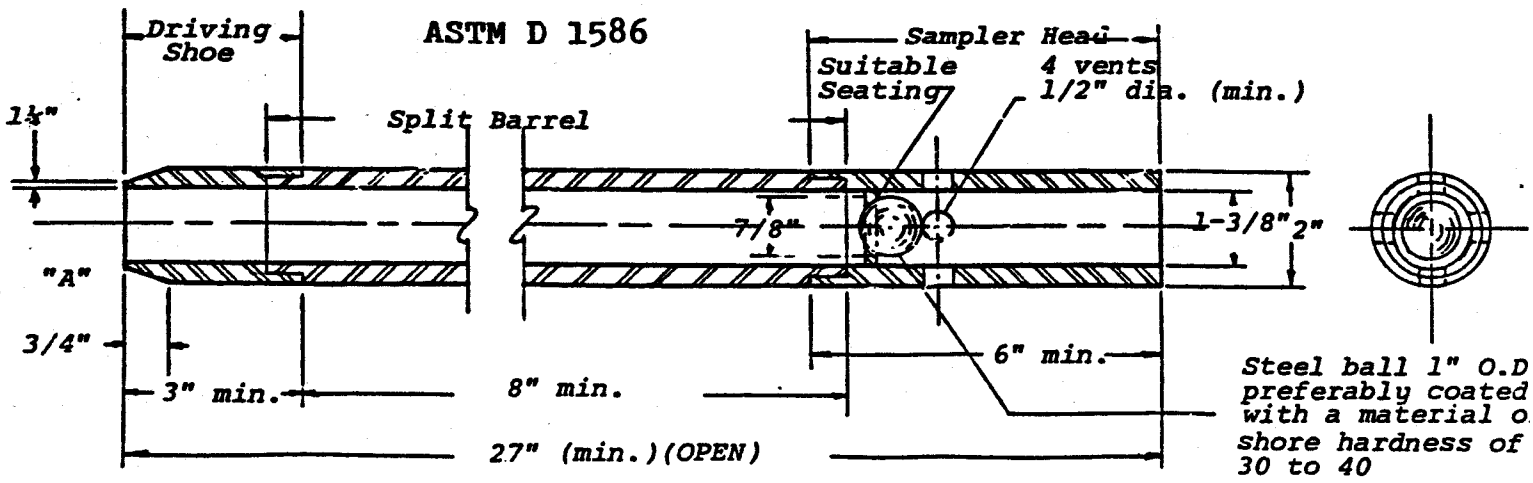
SPLIT SPOON SAMPLING

The borings were made in accordance with ASTM Specification D-1586. The borings were advanced using either hollow stem augers or the rotary drill method using a bentonite slurry. The drill method employed depends upon the subsurface conditions and our experience in the general area. After cleaning all loose cuttings from the boring, the soil is sampled with a split barrel sampler (see illustration below). The sampler is driven to a depth of 18 inches or to a blow count of 100 blows with a 140-pound hammer falling 30 inches. The number of blows required for driving each 6-inch increment is recorded. The first 6-inch increment is required to seat the sampler below the disturbed zone, the second and third increments are added to yield blows per foot. This value is the standard penetration resistance, N. This is recorded on the attached logs of borings per each 6-inch increment of penetration. The "N" value, when properly evaluated, is an index to the in-place density strength and foundation support capacity.

Representative portions of each soil sample, obtained from the split tube sampler, were placed in glass jars, sealed and transported in accordance with ASTM D-2488, "Visual-Manual Classification of Soils for Engineering Purposes, based on the Unified System. The Unified Group Symbol is shown on the logs for each distinct stratum and is described briefly on the attached chart.



Split barrel sampler disassembled after driving, showing soil in one half of the tube (in the foreground), soil in the cutting shoe on the right, and the check valve head and drill rod connector at the right rear.



KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistance with Relative Density and Consistency

Sands and Gravels

No. of Blows, N	Relative Density
0 - 4	Very loose
4 - 10	Loose
10 - 30	Medium dense
30 - 50	Dense
Over 50	Very dense

Silts and Clays

No. of Blows, N	Relative Density
0 - 2	Very soft
2 - 4	Soft
4 - 8	Firm
8 - 15	Stiff
15 - 30	Very stiff
30 - 50	Hard
Over 50	Very Hard

Particle Size Identification (Unified Classification System)

Boulders:	Diameter exceeds 8 inches
Cobbles:	3 to 8 inches diameter
Gravel:	Coarse - 3/4 to 3 inches diameter Fine - 4.76 mm to 3/4 inch diameter
Sand:	Coarse - 2.0 mm to 4.76 mm diameter Medium - 0.42 mm to 2.0 mm diameter Fine - 0.074 mm to 0.42 mm diameter
Silt and Clay:	Less than 0.07 mm (particles cannot be seen with naked eye)

Modifiers

The modifiers provide our estimate of the amount of fines (silt or clay size particles) in the soil sample.

Approximate Fines Content	Modifiers
5% Fines 12%	Slightly silty or slightly clayey
12% Fines 30%	Silty or clayey
30% Fines 50%	Very silty or very clayey

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMICA
"ONE HUNDRED YEARS OF SERVICE"

Report No. RN66-263 DATE 8-27-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-16 | Total Depth: 25.0 ft. | Elevation: 194.24 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-27-86 | Completed: 8-27-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	N	Sample No.	REMARKS
194.2	0.0'						
~~193.9~~	~~0.3~~	~~Tan and black silty sandy topsoil.~~					
		Loose, light tan slightly silty SAND with rock fragments and some small roots. (SM)	2 3 4	1.5	7	S-1	GROUNDWATER DATA
191.7	2.5'						20.0 ft. immediatel after drilling.
		Medium dense, light tan and red slightly silty clayey SAND and GRAVEL (quartz fragments). (SC/GC)	7 10 12	3.5 5.0	22	S-2	6.0 ft. at 22 days.
187.7	6.5'						
		Loose to medium dense, light tan silty SAND (damp). (SM)	5 6 5	8.5 10.0	11	S-3	
182.0	12.0'						
		Stiff, tan and gray silty sandy CLAY with mica. (CL)	3 4 5	13.5 15.0	9	S-4	
			6 8 7	18.5 20.0	15	S-5	
172.0	22.0'						
		Very stiff, gray silty CLAY. (CL/CH)	6 8 11	23.5 25.0	19	S-6	
169.2	25.0'						
		Boring terminated at 25.0 feet.					
		Installed 2" I.D. PVC monitoring well with 10 ft. of well screen - see schematic in Appendix.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

BORING LOG

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMICA
"ONE HUNDRED YEARS OF SERVICE"
1881

Report No. RN66-263 DATE 9-3-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-17 | Total Depth: 25.0 ft. | Elevation: 224.05 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 9-3-86 | Completed: 9-3-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	N	Sample No.	REMARKS
224.1	0.0'	~~Dark brown silty sand - topsoil.~~					
223.6	0.5'	Loose, tan silty SAND with gravel and small roots. (SM)	3 3 4	1.5	7	S-1	GROUNDWATER DATA
221.6	2.5'	Medium dense, yellowish-brown slightly clayey SAND with quartz fragments. (SC)	9 13 16	3.5 5.0	29	S-2	No water encountered at completion of drilling. 23.6 ft. at 15 days
217.1	7.0'	Soft, yellow and gray sandy CLAY. (CL)	2 1 2	8.5 10.0	3	S-3	
212.6	11.5'	Firm, yellowish-brown silty CLAY with trace of fine sand. (CL)	4 4 4	13.5 15.0	8	S-4	
206.6	17.5'	Very stiff, gray silty CLAY with some mica. (CH)	9 13 12	18.5 20.0	30	S-5	
199.1	25.0'		8 10 13	23.5 25.0	23	S-6	
		Boring terminated at 25.0 feet.					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor ground-water level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

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FULL SERVICE LABORATORIES • ENGINEERS & CHEM
"OVER ONE HUNDRED YEARS OF SERVICE"
1881

Report No. RN66-263 DATE 8-20-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-18 | Total Depth: 25.0 ft. | Elevation: 205.10 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-20-86 | Completed: 8-20-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
205.1	0.0'						
204.6	0.5'	* Soft to firm, reddish-brown silty sandy CLAY with quartz fragments and small roots. (CL)	2 2 2	1.5	4	S-1	GROUNDWATER DATA
202.6	2.5'			3.5			Groundwater encountered at a depth of 21.0 feet immediately after drilling.
		Medium dense to dense, light brown silty clayey SAND with quartz rock fragments. (SC)	16 17 19	5.0	36	S-2	13.0 ft. at 13 day
				8.5			
			9 10 9	10.0	19	S-3	
193.1	12.0'						
		Soft, red clayey SILT. (ML)		13.5			
			1 2 2	15.0	4	S-4	
188.6	16.5						
		Medium dense, yellowish-tan clayey silty SAND. (SC)		18.5			
			7 6 5	20.0	11	S-5	
183.1	22.0'						
		Firm to stiff, gray silty sandy CLAY. (CL)		23.5			
180.1	25.0'		3 3 5	25.0	8	S-6	
		Boring terminated at 25.0 feet.					
		* Very loose to loose, light brown clayey silty SAND with small rock fragments and trace of small roots. (SM)					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

BORING LOG

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Report No. RN66-263 DATE 8-25-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-19 | Total Depth: 15.0 ft. | Elevation: 172.82 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-25-86 | Completed: 8-25-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
172.8	0.0'						
171.8	1.0'	Brown and black silty sandy topsoil.	1 2 1	1.5	3	S-1	GROUNDWATER DATA
169.3	3.5'	Very loose, tan clayey silty SAND (damp). (SM)		3.5			9.0 ft. immediately after drilling.
165.8	7.0'	Soft to firm, red, tan and gray sandy silty CLAY. (CL)	3 2 3	5.0	5	S-2	3.6 ft. at 8 days.
160.3	12.5'	Stiff, maroon and gray silty CLAY with fine sand and mica. (CL)	4 6 8	8.5 10.0	14	S-3	
157.8	15.0'	Very stiff, maroon and dark gray silty CLAY. (CH)	6 10 13	13.5 15.0	23	S-4	

Boring terminated at 15.0 feet.

Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.

No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

No. 500

BORING LOG

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FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMICA
"ONE HUNDRED YEARS OF SERVICE"

Report No. RN66-263 DATE 8-25-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-20 | Total Depth: 15.0 ft. | Elevation: 175.86 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-25-86 | Completed: 8-25-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
175.9	0.0'						
175.6	0.3'	Tan and black silty sandy topsoil.					
174.4	1.5'	*	1 2 2	1.5	4	S-1	GROUNDWATER DATA
		Loose, black silty SAND with quartz fragments. (SM)		3.5			12.5 ft. immediately after drilling.
			2 2 3	5.0	5	S-2	5.9 ft. at 8 days
168.9	7.0'						
				8.5			
		Stiff to very stiff, gray and tan silty sandy CLAY with mica. (CL)	5 7 7	10.0	14	S-3	
				13.5			
160.9	15.0'		7 11 12	15.0	23	S-4	
		Boring terminated at 15.0 feet.					
		* Very loose, tan silty SAND with fine roots. (SM)					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

Form No. 500

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Report No. RN66-263 DATE 8-15-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-21 | Total Depth: 40.0 ft. | Elevation: 180.93 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-15-86 | Completed: 8-15-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	N	Sample No.	REMARKS
180.9	0.0'						
179.9	1.0'	*	3 5 6	1.5	11	S-1	GROUNDWATER DATA
		Stiff, light tan and gray silty sandy CLAY. (CL)	3 4 5	3.5 5.0	9	S-2	No groundwater encountered immediately after drilling. 5.0 ft. at 18 days.
173.9	7.0'						* Topsoil - dark brown clayey sand SILT with rock fr ments and some small roots.
		Stiff, maroon, gray and tan clayey SILT with mica. (ML)	4 5 7	8.5 10.0	12	S-3	
169.4	11.5'						
		Medium dense, light tan silty clayey SAND. (SC)	10 9 13	13.5 15.0	22	S-4	Installed 1-1/2" I. PVC pipe with slotted end section to monitor ground-water level.
164.9	16.0'						
		Very stiff, gray silty CLAY with some mica. (CL/CH)	10 11 15	18.5 20.0	26	S-5	
158.9	22.0'						
		Hard, dark maroon and gray clayey SILT. (ML)	15 19 27	23.5 25.0	46	S-6	
153.4	27.5'						
		Hard, gray silty CLAY with some fine sand. (CL/CH)	10 16 26	28.5 30.0	42	S-7	
148.9	32.0'						
		Dense, gray silty clayey SAND. (SC)	18 19 26	33.5 35.0	45	S-8	
144.9	36.0'						
		Very hard, gray clayey SILT. (ML)	26 34 43	38.5 40.0	77	S-9	
140.9	40.0'	(Boring terminated at 40.0 feet.)					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

Form No. 500

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Report No. RN66-263 DATE 8-19-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-22 | Total Depth: 30.0 ft. | Elevation: 204.30 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-19-86 | Completed: 8-19-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
204.3	0.0'						
203.3	1.0'	Topsoil - dark brown sandy SILT with roots and leaves.	1 2 1	1.5	3	S-1	GROUNDWATER DATA
		Very stiff, yellowish light tan clayey SILT with some fine sand. (ML)	7 11 14	3.5 5.0	25	S-2	Groundwater encountered at a depth of 27.0 feet immediately after drilling.
198.3	6.0'						27.2 ft. at 14 days
		Medium dense, reddish-brown slightly clayey silty SAND with quartz fragments. (SM)	12 13 14	8.5 10.0	27	S-3	
193.3	11.0'						
		Medium dense, yellowish-tan silty SAND with quartz fragments. (SM)	5 6 6	13.5 15.0	12	S-4	
			8 9 8	18.5 20.0	17	S-5	
			6 6 7	23.5 25.0	13	S-6	
177.8	26.5'						
175.3	29.0'	Loose, yellowish-tan and gray silty clayey SAND with quartz fragments. (SC)	3 4 5	28.5 30.0	9	S-7	
174.3	30.0'	*					
		Boring terminated at 30.0 feet.					
		* Soft to firm, gray to light tan silty CLAY with fine sand. (CL/CH)					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

Form No. 500

BORING LOG

SINCE 1881

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FULL SERVICE LABORATORIES • ENGINEERING/CHEMIC
"ONE HUNDRED YEARS OF SERVICE"

Report No. RN66-263 DATE 8-27-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-23 | Total Depth: 25.0 ft. | Elevation: 168.37 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-27-86 | Completed: 8-27-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	N	Sample No.	REMARKS
168.4	0.0'						
167.4	1.0'	Tan silty SAND - topsoil with wood fragments.	3 2 2	1.5	4	S-1	GROUNDWATER DATA
164.4	4.0'	Loose, light tan silty medium to coarse SAND with some gravel (damp). (SM)	4 3 5	3.5 5.0	8	S-2	19.0 ft. immediately after drilling. 5.4 ft. at 22 days.
160.9	7.5'	Soft, red, tan and gray silty CLAY with rock fragments. (CL)	7 12 15	8.5 10.0	27	S-3	
154.4	14.0'	Very stiff, red, tan and dark gray silty CLAY with some fine sand. (CL)	9 13 25	13.5 15.0	38	S-4	
152.4	16.0'	Very stiff, light gray silty CLAY with fine sand, claystone. (CL)	12 13 15	18.5 20.0	28	S-5	
143.4	25.0'	Medium Dense, light gray silty clayey SAND. (SC)	7 8 9	23.5 25.0	17	S-6	

Boring terminated at 25.0 feet.

Installed 2" I.D. PVC monitoring well with 10 ft. of well screen - see schematic in Appendix.

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

m No. 500

ORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMIC
"ONE HUNDRED YEARS OF SERVICE"

port No. RN66-263 DATE 8-25-86

ent: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

roject: Dunn-Erwin Landfill, Harnett County, NC

oring No.: B-24 | Total Depth: 30.0 ft. | Elevation: 177.41 ft. | Location:

ype of Boring: 3.25" I.D. H.S.A. | Started: 8-25-86 | Completed: 8-25-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
177.4	0.0'						
175.4	2.0'	Dark brown silty sandy topsoil.	2 2 2	1.5	4	S-1	GROUNDWATER DATA
		Firm, tan and gray silty CLAY with fine sand and mica. (CL)	3 3 4	3.5 5.0	7	S-2	No water was encountered immediately after drilling. 4.3 ft. at 8 days.
170.4	7.0'						
		Medium dense, gray clayey SAND with some mica. (SC)	7 8 8	8.5 10.0	16	S-3	
165.4	12.0'						
		Very stiff, dark gray silty CLAY with some mica. (CH)	7 7 10	13.5 15.0	17	S-4	
160.4	17.0'						
		Very dense, gray silty clayey SAND. (SC)	23 26 31	18.5 20.0	57	S-5	
155.4	22.0'						
		Medium dense, gray silty clayey SAND. (SC)	10 7 8	23.5 25.0	15	S-6	
150.4	27.0'						
147.4	30.0'	Very hard, red, tan and gray silty CLAY. (CH)	14 27 30	28.5 30.0	57	S-7	
		Boring terminated at 30.0 feet.					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

o. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6

Scale 1"=5' unless otherwise not

¬ No. 500

ORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
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"ONE HUNDRED YEARS OF SERVICE"

eport No. RN66-263 DATE 8-26-86

ient: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

roject: Dunn-Erwin Landfill, Harnett County, NC

oring No.: B-25 | Total Depth: 30.0 ft. | Elevation: 195.24 ft. | Location:

ype of Boring: 3.25" I.D. H.S.A. | Started: 8-26-86 | Completed: 8-26-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
195.2	0.0'						
194.6	0.6'	Tan and brown silty sandy topsoil.					
193.7	1.5'	*	1 3 6	1.5	9	S-1	GROUNDWATER DATA
		Loose, red and yellow silty clayey SAND (wet). (SC)	4 4 5	3.5 5.0	9	S-2	No water was encountered at completion of drilling.
			2 3 3	8.5 10.0	6	S-3	
183.2	12.0'						
		Firm, yellowish-brown and gray fine sandy silty CLAY with mica. (CL)	2 3 4	13.5 15.0	7	S-4	
178.2	17.0'						
		Stiff, dark gray silty CLAY with mica. (CH)	4 5 6	18.5 20.0	11	S-5	
173.2	22.0'						
		Medium dense, gray and light tan silty clayey SAND with mica. (SC)	7 8 11	23.5 25.0	19	S-6	
165.2	30.0'		7 8 13		21	S-7	
		Boring terminated at 30.0 feet.					
		* Stiff, reddish-yellow silty CLAY with some small roots. (CL)					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

o. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 increments. The sum of the last two increments of penetration is listed in the

Scale 1"=5' unless otherwise note

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERS & CHEM
"OVER ONE HUNDRED YEARS OF SERVICE"

Report No. RN66-263 DATE 8-19-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-26 | Total Depth: 20.0 ft. | Elevation: 175.57 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-19-86 | Completed: 8-19-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
175.6	0.0'						
174.6	1.0'	*	2 2 3	1.5	5	S-1	GROUNDWATER DATA
		Firm, gray silty CLAY/clayey SILT with fine sand. (CL/ML)	4 6 6	3.5 5.0	12	S-2	No groundwater encountered immediately after drilling.
168.6	7.0'						2.8 ft. at 14 days
		Very stiff, gray and tan fine sandy silty CLAY with mica. (CL)	6 12 15	8.5 10.0	27	S-3	
163.1	12.5'						
		Dense, gray silty clayey SAND. (SC)	11 16 17	13.5 15.0	33	S-4	
157.6	18.0'						
155.6	20.0'	Stiff, bluish-gray clayey SILT with trace of mica. (ML)	9 10 10	18.5 20.0	20	S-5	
		Boring terminated at 20.0 feet.					
		* Very dark gray fine sandy silty topsoil with wood fragments.					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance. N.

Scale 1"=5' unless otherwise note

Form No. 500

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Report No. RN66-263 DATE 8-19-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-27 | Total Depth: 30.0 ft. | Elevation: 187.04 | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-19-86 | Completed: 8-19-86 | Driller: Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	N	Sample No.	REMARKS
187.0	0.0'						
185.5	1.5'	Dark brown sandy silty topsoil with rock fragments and root matter.	2 1 2	1.5	3	S-1	GROUNDWATER DATA
		Stiff, gray and tan silty CLAY with fine sand and trace of mica. (CL)	4 5 7	3.5 5.0	12	S-2	No groundwater encountered immediately after drilling. 9.2 ft. at 14 days
180.0	7.0'						
		Very stiff, gray slightly clayey SILT. (ML)	6 10 11	8.5 10.0	21	S-3	
175.0	12.0'						
		Hard to very stiff, gray to light tan silty CLAY with some fine sand. (CL)	9 14 23	13.5 15.0	37	S-4	
			13 14 15	18.5 20.0	29	S-5	
165.5	21.5'						
		Hard, gray silty sandy CLAY. (CL)	14 17 24	23.5 25.0	41	S-6	
160.0	27.0'						
157.0	30.0'	Medium dense, gray and tan silty clayey SAND with some mica. (SC)	11 12 14	28.5 30.0	26	S-7	
		Boring terminated at 30.0 feet.					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

Form No. 500

BORING LOG

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Report No. RN66-263 DATE 8-18-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-28 | Total Depth: 30.0 ft. | Elevation: 194.30 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-18-86 | Completed: 8-18-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
194.3	0.0'						
193.8	0.5'	*					
		Very loose, light brown silty fine SAND. (SM)	1 2 2	1.5	4	S-1	GROUNDWATER DATA
192.3	2.0'						
		Stiff, yellowish-brown clayey SILT with fine sand. (ML)	4 5 4	3.5 5.0	9	S-2	Groundwater encountered at a depth of 21.0 feet immediately after drilling. 6.1 ft. at 15 day.
187.3	7.0'						
		Stiff, gray silty CLAY with some mica and some fine sand. (CL)	5 7 7	8.5 10.0	14	S-3	
			8 9 10	13.5 15.0	19	S-4	
			10 17 23	18.5 20.0	40	S-5	
			8 14 22	23.5 25.0	36	S-6	
167.3	27.0'						
		Dense, gray silty clayey fine SAND. (SC)	19 23 26	28.5 30.0	49	S-7	
164.3	30.0'						
		Boring terminated at 30.0 feet.					
		* Dark brown sandy silty topsoil with rock fragments and root matter.					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

Form No. 500

BORING LOG

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Report No. RN66-263 DATE 8-14-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-29 | Total Depth: 50.0 ft. | Elevation: 215.10 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-14-86 | Completed: 8-14-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
215.1	0.0'						
214.6	0.5'	* Firm, brown, light tan and gray clayey SILT with fine sand and roots. (ML)	2 3 4	1.5	7	S-1	GROUNDWATER DATA
212.6	2.5'	Medium dense, white and red silty SAND. (SM)	6 10 10	3.5 5.0	20	S-2	Groundwater encountered at a depth of 46.0 feet immediately after drilling. 15.3 ft. at 19 days
208.1	7.0'	Stiff, red clayey SILT with fine sand. (ML)	5 6 7	8.5 10.0	13	S-3	* Dark brown clayey sandy SILT with r matter. (ML)
203.1	12.0'	Very stiff, light tan and gray silty CLAY with some fine sand. (CL)	7 8 10	13.5 15.0	18	S-4	SHEET 1 OF 2
			7 8 10	18.5 20.0	18	S-5	
			9 9 10	23.5 25.0	19	S-6	
187.6	27.5'	Dense, gray silty clayey SAND with mica. (SC)	14 16 19	28.5 30.0	35	S-7	
			10 12 12	33.5 35.0	24	S-8	
178.6	36.5'	Hard, gray silty CLAY with fine sand and mica. (CL)	14 17 24	38.5 40.0	41	S-9	

(Continued on Sheet 2 of 2)

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

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Report No. RN66-263 DATE 8-14-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-29 CONT | Total Depth: | Elevation: | Location:

Type of Boring: | Started: | Completed: | Driller:

Elevation 175.1	Depth 40.0'	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
							GROUNDWATER DATA
		(Continued from Sheet 1 of 2)	14 18 26	43.5 45.0	44	S-10	SHEET 2 OF 2
168.1	47.0'	Dense, gray silty clayey SAND with mica. (SC)	16 19 25	48.5 50.0	44	S-11	
165.1	50.0'	Boring terminated at 50.0 feet.					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

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Report No. RN66-263 DATE 8-15-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-30 | Total Depth: 30.0 ft. | Elevation: 207.73 | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-15-86 | Completed: 8-15-86 | Driller: Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
207.7	0.0'						
206.7	1.0'	Dark brown silty sandy topsoil with some roots.	2 2 2	1.5	4	S-1	GROUNDWATER DATA
205.2	2.5'	Very loose, dary gray slightly clayey silty SAND with trace of small roots. (SM)		3.5			No groundwater encountered immediately after drilling.
			8 11 19	5.0	30	S-2	3.8 ft. at 18 days.
		Medium dense, tan and gray silty clayey SAND with some mica. (SC)		8.5			
			5 5 5	10.0	10	S-3	
193.7	14.0'			13.5			
			4 5 7	15.0	12	S-4	
		Stiff to very stiff, light tan and gray clayey SILT with mica and traces of fine sand. (ML)		18.5			
			8 9 11	20.0	20	S-5	
186.7	21.0'						
		Medium dense, light gray slightly clayey silty fine SAND with mica. (SM)		23.5			
			10 9 15	25.0	24	S-6	
181.7	26.0'						
		Very stiff, gray slightly silty CLAY with mica. (CL)		28.5			
177.7	30.0'		8 9 12	30.0	21	S-7	
		Boring terminated at 30.0 feet.					
		Installed 1-1/2" I.D. PVC pipe with slotted end section to monitor groundwater level.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

Form No. 500

BORING LOG

SINCE 1881

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Report No. RN66-263 DATE 8-26-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-31 | Total Depth: 40.0 ft. | Elevation: 231.90 ft. | Location:

Type of Boring: 3.25" I.D. HSA | Started: 8-25-86 | Completed: 8-26-86 | Driller: Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	N	Sample No.	REMARKS
231.9	0.0'						
230.9	1.0'	Light brown sandy silty clayey topsoil.	7 9 10	1.5	19	S-1	GROUNDWATER DATA
		Medium dense, gray, tan and red silty clayey SAND with rock fragments. (SC)	9 13 15	3.5 5.0	28	S-2	37.0 ft. immediately after drilling. 19.0 ft. at 24 hour. 19.9 ft. at 24 days
			10 3 4	8.5 10.0	24	S-3	
219.9	12.0'						
		Loose, yellowish-tan silty coarse to medium SAND with quartz fragments. (SM)	2 3 4	13.5 15.0	7	S-4	Installed 2" I.D. PVC monitoring well with 10 ft. of well screen - see schematic in Appendix.
214.4	17.5'						
		Firm, light tan and gray silty CLAY with some fine sand and mica. (CL)	2 3 4	18.5 20.0	7	S-5	
209.4	22.5'						
		Medium dense, light tan to light gray clayey SAND with some mica. (SC)	6 8 11	23.5 25.0	19	S-6	
204.4	27.5'						
		Very stiff, gray and yellowish-tan silty sandy CLAY with mica. (CL)	5 7 12	28.5 30.0	19	S-7	
199.4	32.5'						
		Very stiff, gray and yellowish-tan silty CLAY with some fine sand and mica. (CL)	7 8 11	33.5 35.0	19	S-8	(Boring terminated at 40.0 feet.)
194.9	37.0'						
		Very stiff, dark gray silty fine sandy CLAY with mica. (CL/CH)	11 11 13	38.5 40.0	24	S-9	
191.9	40.0'						

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise note

Form No. 500

BORING LOG

SINCE 1881

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"ONE HUNDRED YEARS OF SERVICE"

Report No. RN66-263 DATE 8-29-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-32 | Total Depth: 45.0 ft. | Elevation: 182.17 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 8-29-86 | Completed: 8-29-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	N	Sample No.	REMARKS
182.2	0.0'						
181.2	1.0'	Tan silty sandy clayey topsoil.	5 6 8	1.5	14	S-1	GROUNDWATER DATA
179.2	3.0'	Stiff, yellowish-tan silty CLAY with trace of fine sand. (CL)		3.5			No water was encountered at completion of drilling.
175.2	7.0'	Very stiff, gray and tan silty fine sandy CLAY with mica. (CL)	7 11 13	5.0	24	S-2	6.6 ft. at 20 days.
170.2	12.0'	Medium dense, light gray clayey fine SAND. (SC)	6 7 10	8.5 10.0	17	S-3	SHEET 1 OF 2
164.7	17.5'	Very stiff to hard, dark gray silty CLAY. (CH)	8 13 17	13.5 15.0	30	S-4	
159.7	22.5'	Very stiff to hard, red, tan and dark gray silty CLAY. (CH)	13 13 16	18.5 20.0	29	S-5	
155.2	27.0'	Very stiff, gray and olive brown silty CLAY with trace of fine sand. (CL)	10 12 14	23.5 25.0	26	S-6	
150.2	32.0'	Medium dense to dense, very clayey SAND with mica. (SC)	12 14 16	28.5 30.0	30	S-7	
145.2	37.0	Hard, dark gray silty CLAY. (CH)	14 15 18	33.5 35.0	33	S-8	
		Dense, gray clayey SAND. (SC)	12 17 20	38.5 40.0	37	S-9	

(Continued on Sheet 2 of 2)

No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6

Scale 1"=5' unless otherwise

Form No. 500

BORING LOG

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Report No. RN66-263 DATE 9-2-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-33 | Total Depth: 25.0 ft. | Elevation: 170.90 ft. | Location:

Type of Boring: 3.25" I.D. H.S.A. | Started: 9-2-86 | Completed: 9-2-86 | Driller: W. Dew

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	N	Sample No.	REMARKS
170.9	0.0'						
169.9	1.0'	* ~~Loose, tan silty SAND with~~ gravel. (SM)	1 2 3	1.5	5	S-1	GROUNDWATER DATA
168.9	2.0'	Loose, black silty SAND with gravel. (SM)		3.5			19.0 ft. immediately after drilling.
167.4	3.5'	Loose, light to dark gray clayey SAND (damp). (SC)	2 4 4	5.0	8	S-2	6.7 ft. at 16 days.
163.9	7.0'	Very stiff, pale brown sandy CLAY. (CL)	8 8 12	8.5 10.0	20	S-3	
158.9	12.0'	Very stiff, gray silty CLAY with some fine sand. (CH)	5 8 12	13.5 15.0	20	S-4	
153.9	17.0'	Dense, gray very clayey fine SAND. (SC)	10 15 21	18.5 20.0	36	S-5	
149.4	21.5'	Hard, dark gray silty CLAY. (CL/CH)	10 15 19	23.5 25.0	34	S-6	
145.9	25.0'	Boring terminated at 25.0 feet.					

* Light brown silty clayey sandy topsoil.

Installed 2" I.D. PVC monitoring well with 10 ft. of well screen - see schematic in Appendix.

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

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Report No. RN66-263 DATE 8-29-86

Client: County of Harnett, c/o Ragsdale Consultants, P.A., Lillington, NC

Project: Dunn-Erwin Landfill, Harnett County, NC

Boring No.: B-32 CONT. | Total Depth: | Elevation: | Location:

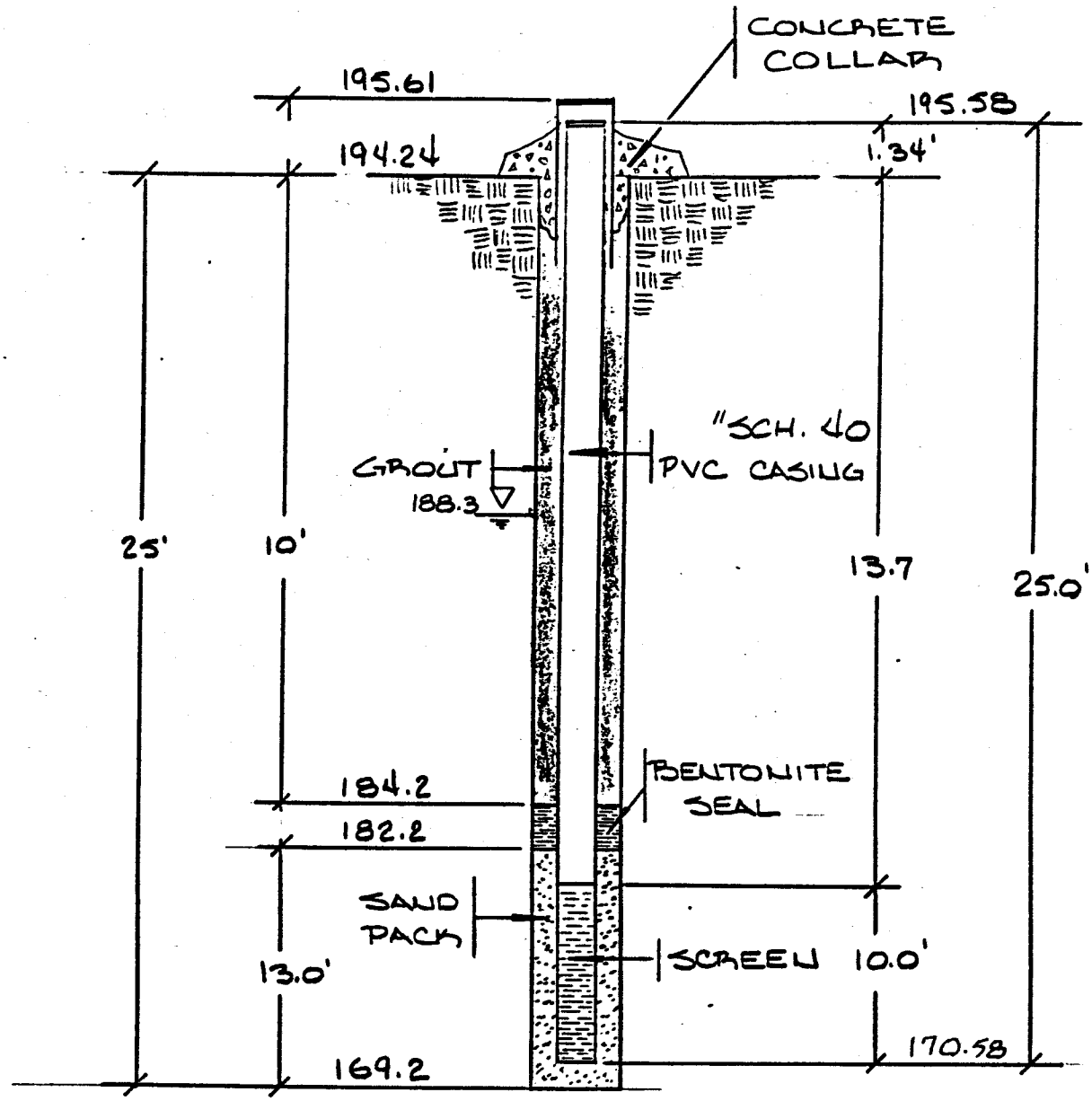
Type of Boring: | Started: | Completed: | Driller:

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	N	Sample No.	REMARKS
142.2	40.0'						
140.7	41.5'	(Continued from Sheet 1 of 2)					GROUNDWATER DATA
		Hard to very hard, dark gray silty CLAY with trace of fine sand. (CH)	21 24 26	43.5 45.0	50	S-10	SHEET 2 OF 2
137.2	45.0'						
		Boring terminated at 45.0 feet.					
		Installed 2" I.D. PVC monitoring well with 10 ft. of well screen - see schematic in Appendix.					

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

WELL NO. 16



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MATERIALS TESTING & INSPECTION – ENGINEERS & CHEMISTS
CABLE ADDRESS – "FROEHLING"

DATE: 27 AUG. '86
SCALE: AS SHOWN
DRWN: MJO

SCHEMATIC OF WELL CONSTRUCTION

DWG. NO. A-

N. C. Department of Human Resources
Division of Health Services

WELL COMPLETION RECORD

OMPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N. EPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANC . O. BOX 2091, RALEIGH, N.C. 27602

AME OF SITE: *Proposed Dunn-Erwin Landfill*

PERMIT NO.:

DDRESS: *Harnett County, North Carolina*

OWNER (print): *County of Harnett*

RILLING CONTRACTOR: *Froehling and Robertson, Inc.*

REGISTRATION NO.: *421*

asing Type: *PVC Sch. 40* dia. *2* in. Grout Depth: from *0* to *10* ft. - dia. *8* i
asing Depth: from *0* to *13.7* ft. - dia. *2* in. Bentonite Seal: from *10* to *12* ft. - dia. *8* i
creen Type: *PVC 0.01" Slot* dia. *2* in. Sand/Gravel PK: from *12* to *25* ft. - dia. *8* i
creen Depth: from *13.7* to *23.7* ft. - dia. *2* in. Total Well Depth: from *0* to *23.7* ft. - dia. *8* i

tatic Water Level: *7.3* feet from top of casing Date Measured *9* / *18* / *8*

ield (gpm): *N/A* Method of Testing: *N/A* Casing is *1.34* feet above land surfa *PVC*

DRILLING LOG *B-16*

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0'	0.3'	Tan and black silty sandy topsoil.
0.3'	2.5'	Loose, light tan slightly silty SAND with rock frag. & some small roots. (SM)
2.5'	6.5'	Medium dense, light tan & red slightly silty clayey SAND & GRAVEL (quartz fragments. (SC/GC)
6.5'	12.0'	Loose to medium dense, light tan silty SAND (damp). (SM)
12.0'	22.0'	Stiff, tan & gray silty sandy CLAY with mica. (CL)
22.0'	25.0'	Very stiff, gray silty CLAY. (CL/CH)

Boring terminated at 25.0 feet.

LOCATION SKETCH

(show distance to numbered roads, or other map reference points

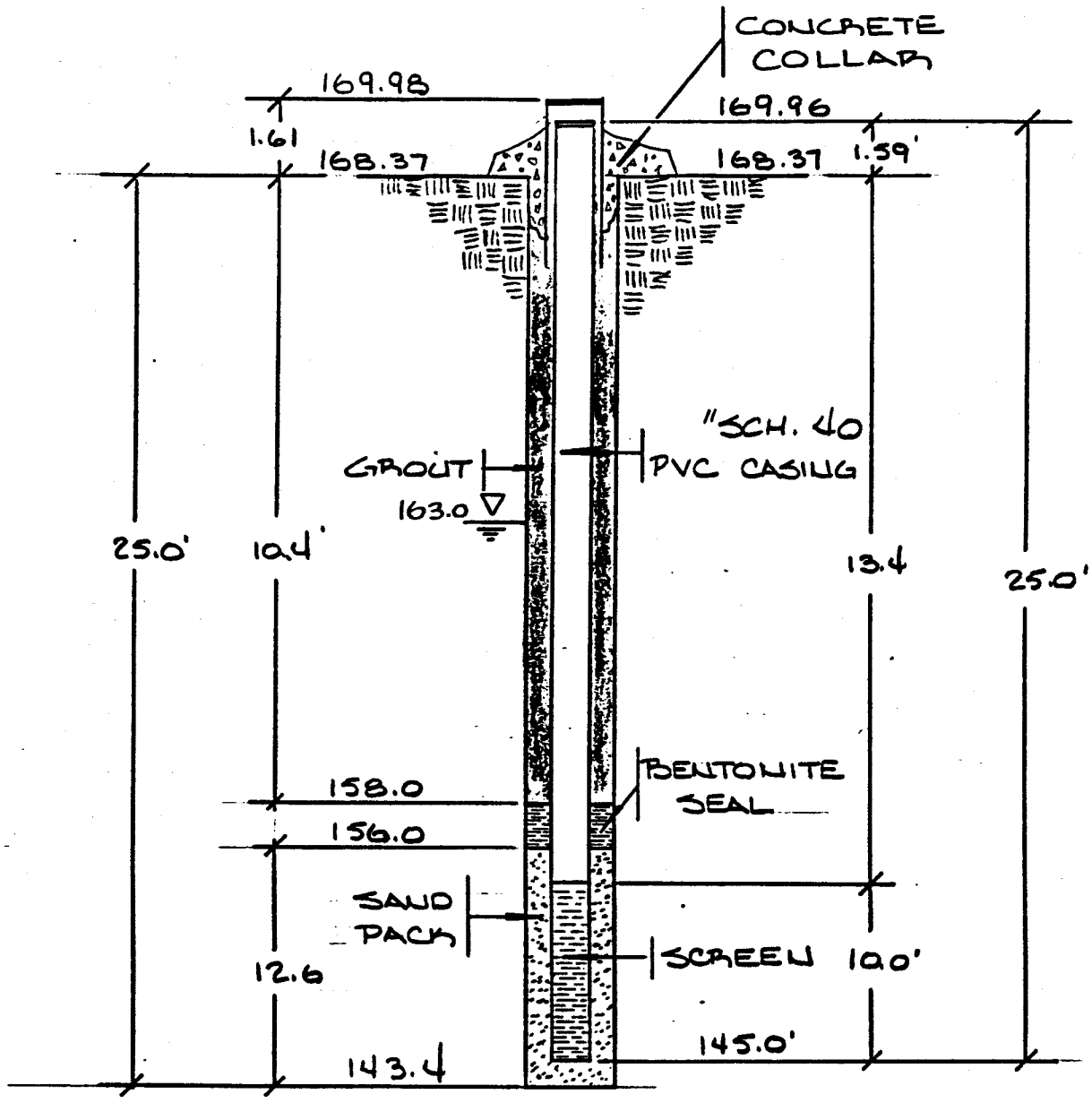
See Location Drawing prepared by Ragsdale Consultants, Inc.

EMARKS: *Log of boring presented in Appendix. Monitoring well constructed in 3.25 inch I.D. hollow stem auger (8" O.D.).*

ATE: *Sept. 18, 1986* SIGNATURE:

IS 3342 (6/85)
id & Hazardous Waste Management Branch

WELL NO. 23



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DRWN: MJO

SCHEMATIC OF WELL CONSTRUCTION

DWG. NO. A-

N. C. Department of Human Resources
Division of Health Services

WELL COMPLETION RECORD

OMPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N. EPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANC O. BOX 2091, RALEIGH, N.C. 27602

AME OF SITE: *Proposed Dunn-Erwin Landfill*

PERMIT NO.:

DDRESS: *Harnett County, North Carolina*

OWNER (print): *County of Harnett*

RILLING CONTRACTOR: *Froehling and Robertson, Inc.*

REGISTRATION NO.: *421*

sing Type: *PVC Sch. 40* dia. *2* in.
sing Depth: from *0* to *12.4* ft. - dia. *2* in.
reen Type: *PVC 0.01" Slot* dia. *2* in.
reen Depth: from *13.4* to *23.4* ft. - dia. *2* in.

Grout Depth: from *0* to *10.4* ft. - dia. *8* i
Bentonite Seal: from *10.4* to *12.4* ft. - dia. *8* i
Sand/Gravel PK: from *12.4* to *25.0* ft. - dia. *8* i
Total Well Depth: from *0* to *23.4* ft. - dia. *8* i

atic Water Level: *7.0* feet from top of casing

Date Measured *9* / *18* / *8*

eld (gpm): *N/A* Method of Testing: *N/A*

Casing is *1.6* feet above land surfac *PVC*

DRILLING LOG B-23

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0'	1.0'	Tan silty SAND - topsoil with wood fragments.
1.0'	4.0'	Loose, light tan silty med. to coarse SAND with some gravel (damp). (SM)
4.0'	7.5'	Soft, red, tan & gray silty CLAY with rock fragments. (CL)
7.5'	14.0'	Very stiff, red, tan & dark gray silty CLAY with some fine sand. (CL)
14.0'	16.0'	Very stiff, light gray silty CLAY with fine sand - claystone. (CL)
16.0'	25.0'	Medium dense, light gray silty clayey SAND. (SC)

(Boring terminated at 25.0 feet.)

LOCATION SKETCH

(show distance to numbered roads, or other map reference points)

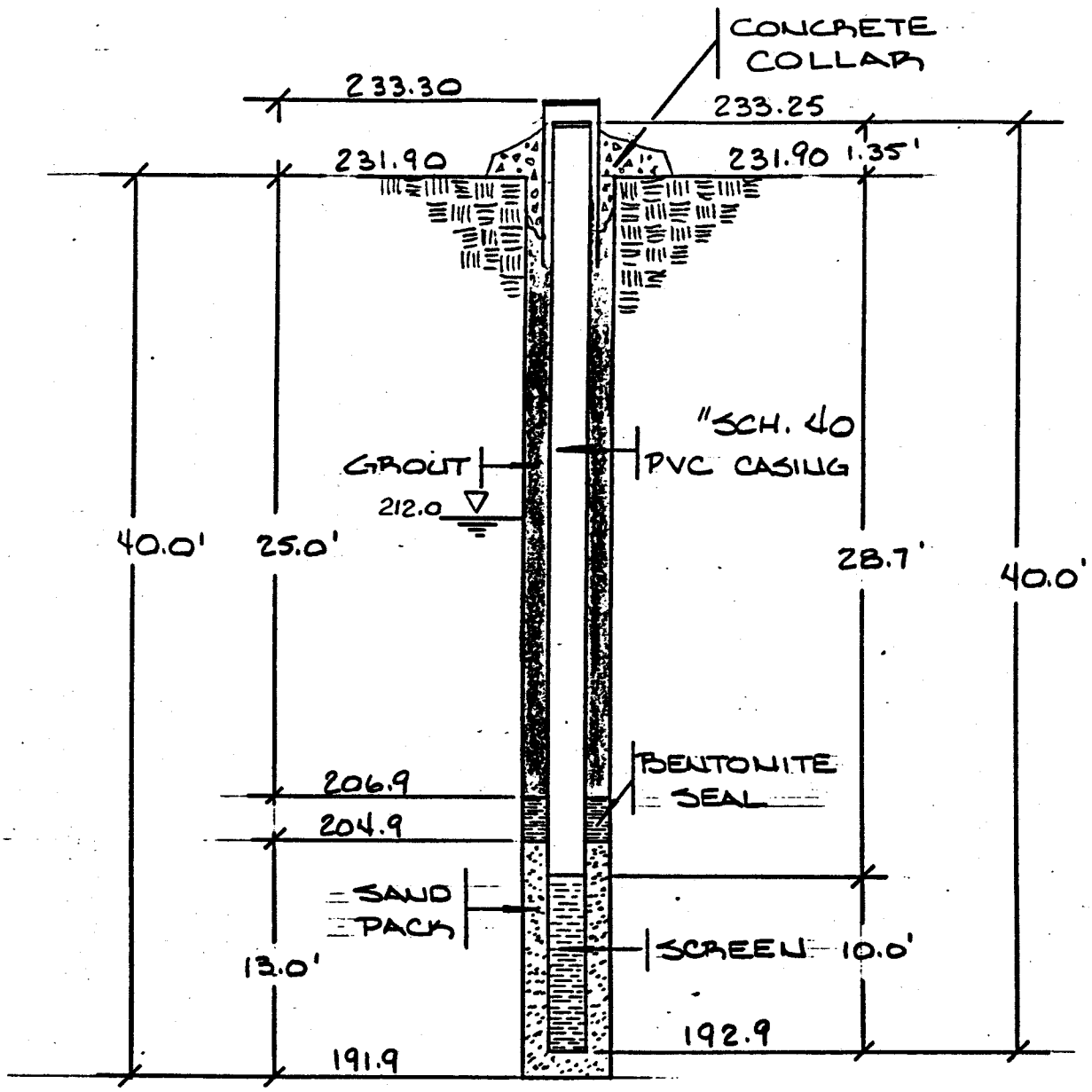
See Location Drawing prepared by Ragsdale Consultants, Inc.

MARKS: Log of boring presented in Appendix. Monitoring well constructed in 3.25 inch I.D. hollow stem auger (8" O.D.).

TE: Sept. 18, 1986 SIGNATURE:

3342 (6/85)
& Hazardous Waste Management Branch

WELL NO. 31



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DRWN: MJO

SCHEMATIC OF WELL CONSTRUCTION

DWG. NO. A

Division of Health Services

WELL COMPLETION RECORD

OMPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N. EPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANC O. BOX 2091, RALEIGH, N.C. 27602

AME OF SITE: *Proposed Dunn-Erwin Landfill*

PERMIT NO.:

DDRESS: *Harnett County, North Carolina*

OWNER (print): *County of Harnett*

RILLING CONTRACTOR: *Froehling and Robertson, Inc.*

REGISTRATION NO.: *421*

sing Type:	PVC Sch. 40	dia. 2 in.		Grout Depth:	from 0	to 25	ft. - dia. 8		
sing Depth:	from 0	to 29	ft. - dia. 2 in.	Bentonite Seal:	from 25	to 27	ft. - dia. 8		
reen Type:	PVC 0.01" Slot	dia. 2 in.		Sand/Gravel PK:	from 27	to 40	ft. - dia. 8		
reen Depth:	from 29	to 39	ft. - dia. 2 in.	Total Well Depth:	from 0	to 40	ft. - dia. 8		

atic Water Level: 21.3 feet from top of casing — Date Measured 9 / 2 / 86

eld (gpm): N/A Method of Testing: N/A Casing is 1.35 feet above land surfa PVC

DRILLING LOG B-31

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0'	1.0'	Light brown sandy silty clayey topsoil.
1.0'	12.0'	Medium dense, gray, tan & red silty clayey SAND with rock fragments. (SC)
12.0'	17.5'	Loose, yellow.-tan silty coarse to med. SAND with quartz fragments. (SM)
17.5'	22.5'	Firm, light tan & gray silty CLAY w/fine sand & mica. (CL)
22.5'	27.5'	Med. dense, light tan to light gray clayey SAND w/some mica. (CL)
27.5'	32.5'	Very stiff, gray & yellow.-tan silty sandy CLAY w/mica. (CL)
32.5'	37.0'	Very stiff, gray & yellow-tan silty CLAY w/some fine sand & mica. (CL)
37.0'	40.0'	Very stiff, dark gray silty fine sandy CLAY with mica. (CL/CH)

(Boring terminated at 40.0 feet.)

LOCATION SKETCH

(show distance to numbered roads, or other map reference points

See Location Drawing prepared by Ragsdale Consultants, Inc.

EMARKS: Log of boring presented in Appendix. Monitoring well constructed in 3.25 inch I.D. hollow stem auger (8" O.D.)

ATE: Sept. 18, 1986 SIGNATURE:

S 3342 (6/85)
d & Hazardous Waste Management Branch

Division of Health Services

WELL COMPLETION RECORD

OMPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N. EPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANC O. BOX 2091, RALEIGH, N.C. 27602

AME OF SITE: *Existing Dunn-Erwin Landfill*

PERMIT NO.:

DDRESS: *Harnett County, North Carolina*

OWNER (print): *County of Harnett*

RILLING CONTRACTOR: *Froehling and Robertson, Inc.*

REGISTRATION NO.: *421*

asing Type:	PVC Sch. 40 dia. 2 in.		Grout Depth:	from 0 to 29.4 ft. - dia. 8	
asing Depth:	from 0 to 33.4 ft. - dia. 2 in.		Bentonite Seal:	from 29.4 to 31.4 ft. - dia. 8	
reen Type:	PVC 0.01" Slot dia. 2 in.		Sand/Gravel PK:	from 31.4 to 45.0 ft. - dia. 8	
reen Depth:	from 33.4 to 44.4 ft. - dia. 2 in.		Total Well Depth:	from 0 to 43.4 ft. - dia. 8	

atic Water Level: 10.8 feet from top of casing — Date Measured 9 / 18 /

eld (gpm): N/A — Method of Testing: N/A — Casing is 1.6 feet above land surfa PVC

DRILLING LOG B-32

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0'	1.0'	Tan silty sandy clayey topsoil.
1.0'	3.0'	Stiff, yellow.-tan silty CLAY with trace of fine sand. (CL)
3.0'	7.0'	Very stiff, gray & tan silty fine sandy CLAY with mica. (CL)
7.0'	12.0'	Medium dense, light gray clayey fine SAND. (SC)
12.0'	17.5'	Very stiff to hard, dark gray silty CLAY. (CH)
17.5'	22.5'	Very stiff to hard, red, tan & dark gray silty CLAY. (CH)
22.5'	27.0'	V. stiff, gray & olive brown silty CLAY/trace fine sand. (CL)
27.0'	32.0'	M. dense to dense, very clayey SAND with mica. (SC)
32.0'	37.0'	Hard, dark gray silty CLAY. (CH)
37.0'	41.5'	Dense, gray clayey SAND (SC)
41.5'	45.0'	Hard to very hard, dark gray silty CLAY/trace of fine sand. (CH)

(Boring terminated at 45.0 feet.)

LOCATION SKETCH

(show distance to numbered roads, or other map reference point

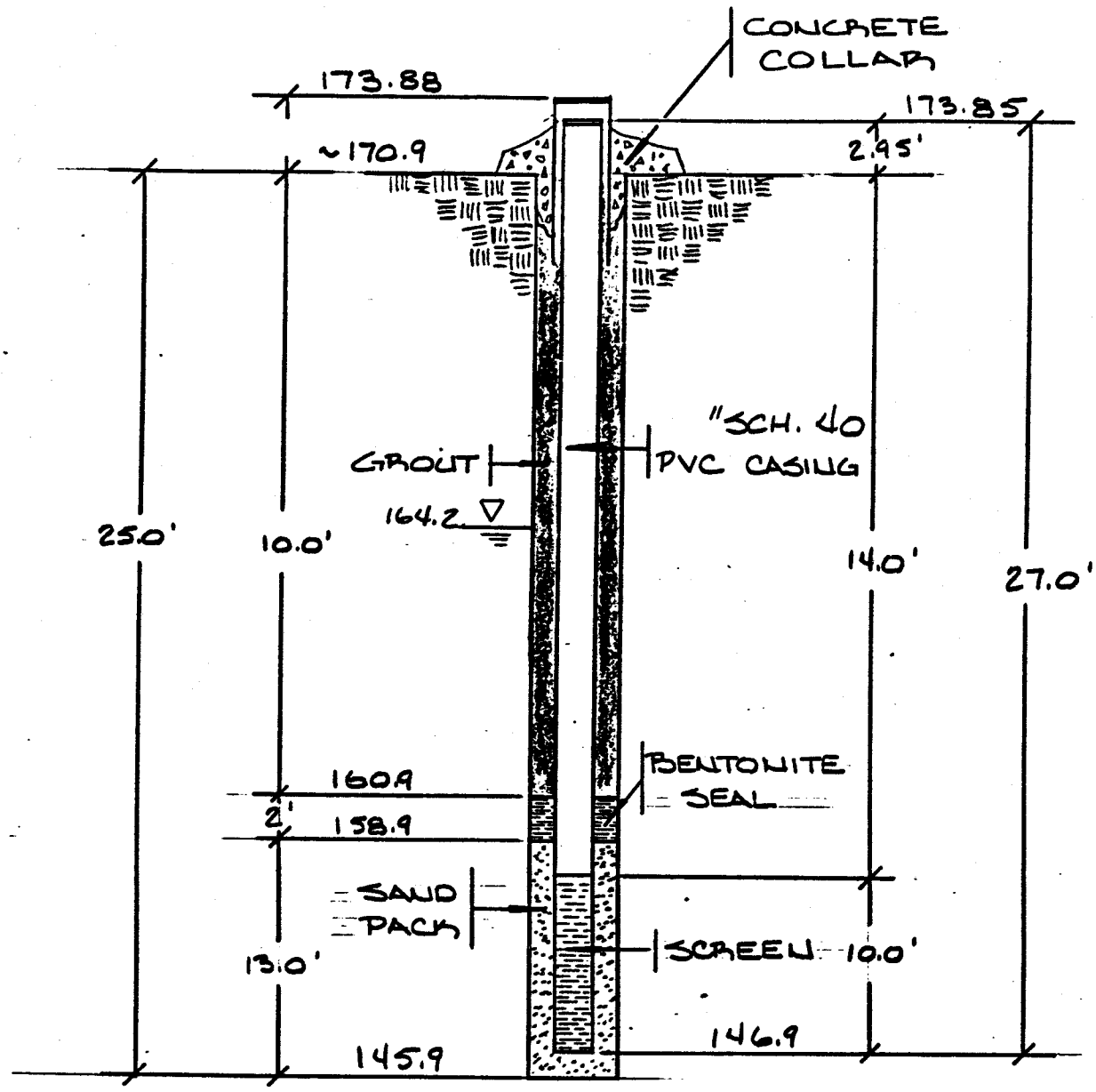
See Location Drawing prepared by Ragsdale Consultants, Inc.

EMARKS: Log of boring presented in Appendix. Monitoring well constructed in 3.25 inch I.D. hollow stem auger (8" O.D.).

ATE: Sept. 18, 1986 SIGNATURE:

S 3342 (6/85)
d & Hazardous Waste Management Branch

WELL NO. 33



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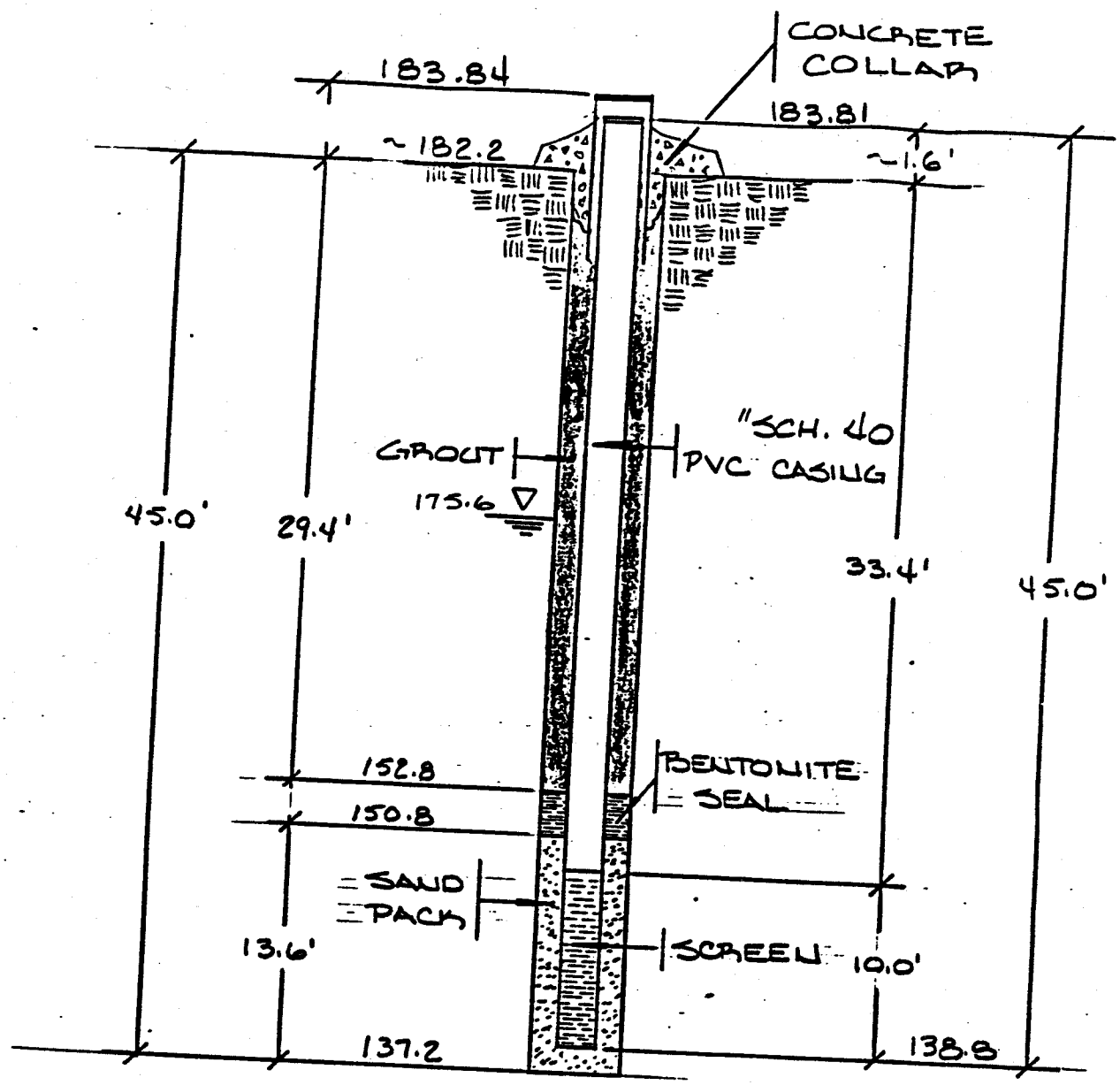
SCHEMATIC OF WELL CONSTRUCTION

DWG. NO. A

WELL NO. 32



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DATE:
SCALE: AS SHOWN
DRWN: MJO

SCHEMATIC OF WELL CONSTRUCTION

DWG. NO. A

ATTACHMENT 1

APPENDIX B

GEOLOGIC AND HYDROGEOLOGIC STUDY

FOR DUNN-ERWIN LANDFILL EXPANSION

by

Westinghouse Environmental and Geotechnical Services, Inc.

July 1991

GEOLOGIC AND HYDROGEOLOGIC STUDY
FOR
DUNN-ERWIN
LANDFILL EXPANSION
HARNETT COUNTY, NORTH CAROLINA
WESTINGHOUSE PROJECT No. REW-A-130

Prepared For:

McKim and Creed
5580 Centerview Drive
Raleigh, North Carolina 27606

Prepared By:

Westinghouse Environmental and Geotechnical Services, Inc.
3100 Spring Forest Road (27604)
Post Office Box 58069
Raleigh, North Carolina 27658-8069

July, 1991

Westinghouse Environmental and Geotechnical Services, Inc.

3100 Spring Forest Road (27604)
P.O. Box 58069
Raleigh, North Carolina 27658-8069
(919) 872-2660
Fax (919) 790-9827

July 9, 1991

McKim and Creed
5580 Centerview Drive
Suite 100
Raleigh, North Carolina 27606

Attention: Mr. Charles A. Musser

Reference: Geologic and Hydrogeologic Study for
Dunn-Erwin
Landfill Expansion
Harnett County, North Carolina
Westinghouse Project No. REW-A-130

Dear Mr. Musser:

This report presents the appropriate geologic and hydrogeologic information required for the permit application for the Dunn-Erwin Landfill Expansion, Phase IV, in Harnett County, North Carolina. Enclosed are the maps, profiles, charts and reports as they pertain to ground water and geology to substantiate site application as required in Section .0504 "Application Requirements for Sanitary Landfills" of the North Carolina Solid Waste Management Rules as amended March, 1988. At your request, we have also submitted an evaluation of a proposed borrow area for soils to be used as liner and cover materials. Preliminary recommendations concerning liner considerations and slope stability are also included in this report.

We look forward to your positive response after you have had time to review the enclosed information such that the Geologic and Hydrogeologic Report may be finalized in the near future and forwarded for your approval.

If you should have any questions regarding the enclosed information, or if we may be of any further assistance to you, please feel free to contact us at your convenience.

Very truly yours,

WESTINGHOUSE ENVIRONMENTAL AND GEOTECHNICAL SERVICES, INC.

Abner F. Riggs, Jr., P.E.
NC Registration No. 14155

Ann M. Borden, P.G.
Senior Project Manager

AFR/AMB/als/R91A130A

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SECTION 1

INTRODUCTION

1.1 SITE DESCRIPTION

A geologic and hydrogeologic assessment of the proposed Dunn-Erwin Landfill expansion site and adjacent borrow area has been completed. The proposed site is located adjacent to the existing Dunn-Erwin Landfill in Harnett County, North Carolina. The Dunn-Erwin Landfill is located to the east of NC Highway 55 between State Roads (SR) 1723 and 1725 approximately 3 miles northeast of Erwin and 4 miles northwest of Dunn, North Carolina (see Figure 1). The expansion site and borrow area encompass approximately 30 acres each. The sites presently are predominately undeveloped woodland with open uncultivated farmland, fenced pasture land, identified wetlands and a pond. The only structures currently standing on the proposed sites are the Harnett County Dog Pound, a silo, and a farm shed. The southern portion of the site is to be developed as a landfill cell and the northern portion, separated by a designated wetland area, is to be utilized as a borrow site.

Topographically, the project site is gently sloping with several knolls dissected by shallow drainage features. Ground surface elevations range from 162 feet along the southwest corner of the site to 230 feet along the northeast corner of the site.

1.2 PURPOSE

An exploration program was performed to explore the general subsurface conditions in the proposed landfill area and to obtain the necessary geologic and hydrogeologic information required by the North Carolina Solid Waste Management rules for the site permit application. The primary focus of this study was to characterize the geologic stratigraphy and hydrogeologic conditions of both the proposed expansion cell and the area immediately downgradient. Additionally, the soils of the borrow area to the north were evaluated as a source of liner and cover material for the proposed landfill expansion cell. The results of our field and laboratory tests are attached in the Appendices to this report.

SECTION 2
EXPLORATION PROCEDURES

2.1 SUBSURFACE INVESTIGATION

Subsurface conditions at the site were investigated with fourteen soil test borings and five test pits performed within the proposed expansion area at the approximate locations as shown on the attached Boring Location Plan (Figure 2). The boring locations and ground surface elevations were surveyed in the field. The borings were advanced to termination depths of 15 to 55 feet beneath existing site grade with a CME-45 drill rig mounted on an all-terrain vehicle (ATV) utilizing wash boring and hollow stem auger techniques to advance the borings. Standard penetration test procedures (ASTM D-1586) were performed at selected intervals to evaluate the consistency and relative density of the in-situ soils. The test pits were excavated with a rubber-tired backhoe to depths of 10 to 10.5 feet beneath existing site grade and were observed by a geotechnical engineer. Additionally, one 25 foot soil test boring (PB-9) and two test pits (TP-9 and TP-29) excavated to depths of 10 and 8 feet, respectively, were performed as requested to better characterize subsurface conditions within the present landfill cell located to the east of the proposed expansion site. Split-spoon samples obtained from the standard penetration tests were visually classified by a geologist in the field in accordance with the Unified Soil Classification System guidelines. Laboratory grain size analyses, natural moisture contents, specific gravities and Atterberg limits testing were performed on selected split-spoon samples to verify visual classifications. A summary of the field and laboratory methods is presented in Appendix A.

Additionally, four bulk soil samples were obtained to perform standard Proctor compaction tests (ASTM D-698) and remolded falling head permeability tests to evaluate the suitability of the borrow soils as liner and cover materials. In addition, one relatively undisturbed soil sample was obtained to determine the permeability characteristics of the in-situ soils. A summary of the laboratory tests conducted and test data are presented on Tables I, II, and III attached to this report.

A generalized subsurface profile prepared from the test boring and test pit data is attached to this report as Figures 3 A and B to graphically illustrate subsurface conditions encountered at this site. More detailed descriptions of the conditions encountered at the individual test boring locations have been presented on the attached Test Boring Records (Appendix C). Additionally, a summary of the Test Pit Data is attached to this report as Table IV.

2.2 PIEZOMETER INSTALLATION

A total of nine of the soil test borings were used in the construction of temporary piezometers with the purpose of evaluating the potentiometric surface and hydrogeologic characteristics of the proposed expansion site and downgradient areas. Four additional borings were offset 5 to 10 feet from deep piezometers for the installation of shallow piezometers. The piezometers were installed with the hollow stem augers in the ground. The screens and risers used in the piezometer construction were made of 1.25 inch O.D. schedule 40 PVC pipe. The piezometers have either 5 or 10 foot screen sections with 0.010 inch pre-cut slots. After the piezometer was placed in the ground, a sand pack was placed to roughly 2 feet above the top of the screen. A bentonite seal was placed above the sand pack to hydraulically isolate the screened interval. The remainder of the bore-hole was then sealed with cement grout. The piezometer construction data is summarized on Table V.

Four of the piezometers were installed at a depth of approximately 50 feet. The remaining nine piezometers are shallower and vary in depth from 15 to 30 feet. The piezometers were arranged as four nests (one deep and one shallow) and five isolated piezometers (see Figure 2).

2.3 GROUND WATER

The water level in the bore-holes were measured relative to the ground surface elevation using a weighted tape. Water levels in bore-holes were measured at the time of boring termination and after 24 hours from completion of boring in some of the borings. If the bore-hole remained open, the water level was remeasured approximately two weeks after completion (March 19, 1991).

Heavy intermittent rains did not permit recording accurate water levels prior to this date. The water level data collected on March 19 were preceded by four consecutive non-rain days. The levels recorded on this day are assumed to represent equilibrium conditions. The water level for each bore-hole is noted on Figures 3 A and B.

Ground water levels in piezometers were recorded using an electric water level probe. The probe was used to measure the distance from the top of the piezometer casing to the water level in the piezometer. The ground water elevation was then calculated using the surveyed elevation at the top of the casing. If possible, the water level was recorded at the time of boring and 24 hours after the installation of the piezometer. Equilibrium water levels were then recorded on March 19, March 26, April 12 and again on June 27, 1991. Ground water elevations during this period showed only minor fluctuations. Piezometer ground water elevation data is listed in Table VI and discussed in Section 3.4.

2.4 FIELD PERMEABILITY TESTS

Falling-head slug tests using a "THOR" pressure transponder system were conducted to determine typical permeabilities of the in-situ soils. The static height of the water level in each piezometer was measured by the pressure transponder prior to the addition of the slug. The rise in head in the piezometer was accomplished using 1 gallon of distilled water as a slug. The height of the water column in the piezometer during the recovery phase was recorded at preprogrammed intervals by the "THOR" system. The raw data from the slug tests, as well as the permeability calculations can be found in Appendix B. The results of the field permeability tests are discussed in Section 4.3.

2.5 LABORATORY

A geologist visually examined each split-spoon sample to estimate grain size distribution, plasticity, organic content, moisture condition, color, presence of lenses or seams, and apparent geological origin. Soils were classified in accordance with the Unified Soil Classification System (USCS). Soil descriptions, USCS classifications, and field results are presented on the individual Test Boring Records included in Appendix C.

Representative soil samples obtained during field exploration were tested in our laboratory. Classification tests included natural moisture content, grain size distribution (with sieve and hydrometer), Atterberg limits, and specific gravity. In addition, standard Proctor compaction tests and laboratory falling head permeability tests were performed on selected bulk and relatively undisturbed samples. A summary of the number of tests performed along with the applicable procedure used is provided in Table I.

2.6 LABORATORY PERMEABILITY

The permeability of the on-site soils was evaluated by performing laboratory permeability tests on 4 bulk samples of prospective cover and liner material obtained from test pits. Laboratory permeability tests were performed on remolded samples compacted to 94.6 to 99.0 percent of the standard Proctor (ASTM D-698) maximum dry density. Additionally, two laboratory permeability tests were conducted on relatively undisturbed samples to determine the hydraulic conductivity of the in-situ soils. These tests were performed in a triaxial type permeability cell. Tests continued until steady state flow was achieved and relatively constant values of hydraulic conductivity were obtained. Results of the permeability tests are provided on the Summary of Laboratory Falling Head Permeability Test Data in Table III and on Data sheets included in Appendix D.

SECTION 3
PHYSIOGRAPHY AND REGIONAL HYDROGEOLOGY

3.1 PHYSIOGRAPHY

North Carolina is divided into three physiographic provinces: the Blue Ridge, Piedmont, and Coastal Plain. Harnett County is located in the western portion of the Coastal Plain Province of North Carolina. The Coastal Plain Geologic Region has been formed during past transgressive and regressive movements of the oceans in North Carolina. The Coastal Plain Province is characterized by subdued topographic features and relatively flat, low-lying terrain.

According to the Erwin 7.5 Minute Topographic Quadrangle Map (USGS, 1981) and a site specific contour map, the subject property is located within a generally southwest flowing drainage sub-basin of Stewart Creek. Surface drainage within the proposed expansion cell is to the southwest. Site elevations range from a high of 230 feet along the northeast corner of the site to a low of 162 feet along a small drainage feature at the southwest corner of the site.

3.2 REGIONAL CHARACTERISTICS

The proposed landfill expansion site is located in the eastern portion of Harnett County in the western portion of the Coastal Plain Province of North Carolina. Stratigraphically, the Coastal Plain consists of Cretaceous and younger sediments unconformably deposited above the older Paleozoic crystalline rocks of the Piedmont. Sediments of the Coastal Plain are typically undeformed and include both unconsolidated sediments and lithified units. Data from well logs in the towns of Dunn and Coats suggest that Cretaceous sediments in the area are underlain by slate bedrock at a depth of 120 to 200 feet (Geology and Ground Water Resources of the Fayetteville Area, 1961). The depth to crystalline bedrock and the thickness of the sediments of the Coastal Plain increase to the east. The Coastal Plain generally has gentle topography and is dissected by east flowing rivers. Ground water in Harnett County is found in and recovered from both the unconsolidated Mesozoic and younger sediments and the Paleozoic metamorphic basement (Geology and Ground Water Resources of the Fayetteville Area, 1961).

Average annual rainfall in this portion of North Carolina averages 41.76 inches (National Weather Service 45 year average for the RDU Station). Rainfall in the 86-90 period averaged 41.67 inches. The total rainfall for 1990 was slightly below average at 37.50 inches, but the total rainfall for the previous year was well above average at 54.15 inches. The North Carolina Climate Office reports that rainfall for the first three months of 1991 was close to average and totaled 9.4 inches.

3.3 SITE GEOLOGY

The site is underlain by sands, silts, and clays of the Cretaceous Middendorf formation (Geologic Map of North Carolina, 1985). The Middendorf Formation includes grey to reddish grey sands, silts and clays. The Middendorf Formation tends to have laterally discontinuous beds. The stratigraphy of the Middendorf Formation is therefore comprised of lenses of sand, clay, and silt. The Middendorf Formation is underlain by the Cape Fear Formation. The Cape Fear Formation consists of grey to blue-grey silty and clayey sands, silts and clays. Beds in the Cape Fear Formation are laterally more continuous than those of the Middendorf Formation. These two sedimentary units combined have also been referred to as the Tuscaloosa Formation. No lithified sediments or crystalline rocks were encountered on the site within the 55 feet depth of exploration.

Although it is difficult to differentiate between the Middendorf and Cape Fear Formations from the available boring data, field evidence suggests that clays and silts from the Cape Fear Formation are exposed or exist at a relatively shallow depth in the lower elevations of the site. The Generalized Subsurface Profile (Figures 3, A and B) indicate that site stratigraphy is highly discontinuous above an elevation of about 160 feet. At an elevation of approximately 160 feet, the clay and clayey silt units appear to be more continuous. This more continuous unit may be the upper boundary of the Cape Fear Formation. The 160 foot elevation coincides with a nearby wetland area near boring B-42 which appears to be lying on this clay stratum. The boring profiles along two cross-sections (A-A′ and B-B′) are shown in Figures 4 A and B. Due to the complexity of the Middendorf sediments, a simplified cross-section sketch was constructed to depict the site geology and hydrogeology (Figure 5).

3.4 SITE HYDROGEOLOGY

As stated previously, sediments of the Middendorf Formation include laterally discontinuous clay layers. These clay layers are relatively impervious and higher perched conditions may occur during periods of wet weather due to perching of surface water on the soils. As indicated on Figures 3A and 3B, piezometer B-48S was installed above a clay layer and had an anomalously high apparent ground water elevation. The water level in B-46S is 5 feet lower, but is at a higher topographic elevation than B-48S and did not encounter a clay layer. A similar condition as B-48S exists in B-41S, which also has a piezometer installed above an apparently discontinuous clayey silt layer. The water level in B-41S, which may also be perched, is higher than expected from topography and ground water elevation data from two nearby piezometers. The relatively continuous layer of clays and clayey silts of the Cape Fear Formation would be expected to form a leaky aquitard to sediments below these beds. Piezometer nests B-47 and B-44 had screens both above and below this horizon. In these nests, the ground water elevation of the deeper piezometer was between 12 to 20 feet lower than that of the shallow piezometer (see Table VI). This data implies that these beds locally separate ground water in the sediments of the Middendorf Formation from those of the deeper Cape Fear Formation, and that the vertical hydraulic gradient is downward.

A hydrogeologic cross-section (Figure 6) was constructed from the logs of piezometers B-42S, B-42D, B-44S, B-44D, B-47S, and B-47D in the southwestern portion of the site to study the relationships between geology and ground water levels. The ground water levels shown in the shallow piezometers are all close to the ground surface and contrast sharply with the deeper ground water levels found in the deep piezometers. The logs of the deeper piezometers indicate the presence of clay layers at elevations above 155 feet. These contrasting ground water levels and the presence of clay layers support the concept of shallow perched ground water near the ground surface and a hydraulically continuous ground water zone at greater depth. The relatively high potentiometric elevation of the deep ground water zone presented in piezometer B-44D is attributed to the hillside location of this piezometer.

Piezometers B-42S and B-42D are located near the edge of a wetland area in the southwest portion of the property. The respective ground water elevations in these two borings indicate a significant potentiometric contrast and tend to support the concept of a perched wetland area, rather than a universal ground water discharge area, to the southwest.

Based on ground water elevation data collected from "non-perched" piezometers, a ground water contour map was constructed. The ground water contours calculated from piezometers installed below the top of the Cape Fear Formation are illustrated on the Ground Water Contour Map, (Figure 7). The water level in B-48S is believed to be perched on a clay layer and the data from this boring was not used in this evaluation.

The Hydrogeological Supervisor, Mr. James Bales, of the Fayetteville Regional Office of the Ground Water Section of the Department of Environmental Management was contacted regarding the seasonal variation of ground water levels in Harnett County. Mr. Bales stated that he knew of no such data compilation for Harnett County; however, he said that ground water levels are usually highest in the period from December to April and lowest from August to October in this area of the Coastal Plain. He also noted that the annual fluctuation in the county can range from 5 to 8 feet.

Monthly ground water level elevations were recorded from borings previously installed at the site (Location Map 8). These elevations were taken from May 1985 through April 1986. The mean seasonal fluctuation of the groundwater table at the site was approximately 2.8 feet (See Table VII). Since rainfall for the last 5 years has been very close to the average precipitation and groundwater levels are usually highest from December to April, the ground water data presented in Table VI, as well as the ground water contour map constructed from this data (Figure 7) probably approximate seasonal high annual ground water levels for this site.

Based on ground water elevation data, the average hydraulic gradient between B-46S and B-40S is 0.023 (vertical foot/horizontal foot) and 0.19 between B-46S and B-42S. However, as expected, areas of steep topography have much higher gradients. In the proximity of B-40S the gradient appears to be as high as 0.67.

Due to the extreme geologic heterogeneity of the site, it is very difficult to estimate a ground water velocity for the site. However, assuming preferential flow along units with higher conductivities (roughly 1×10^{-4} cm/sec), the measured hydraulic gradient of approximately 0.02 and with an estimated effective porosity of 30 percent, a rough estimate of ground water velocity can be made. This estimate is based on the following relationship - $Ks = (KxI)/N$, where Ks is the ground water velocity, K is the hydraulic conductivity, I is the hydraulic gradient and N is the effective porosity. Using the estimated values for the required parameters, the equation yields a value of 6.7×10^{-6} cm/sec. This means that "perched" ground water flowing under the proposed expansion site would travel on the order of 2 meters per year.

3.5 SITE SOILS

The site area has been mapped by the Soil Conservation Service (SCS) to identity near surface soil series. This information is presented in the published manual for Harnett County, and the site is shown on sheets P-5, P-6 and Q-4 of that publication. The soil survey of Harnett County shows six soil series that exist on this site. The soil series encountered consist of the Bibb, Blaney, Gilead, Marboro, Norfolk, and Wagram. These soils are comprised mostly of loamy sand and sandy loam which are well to moderately well drained with the exception of the Bibb series which is poorly drained and generally is associated with wetlands. These soil series commonly exist in areas with slopes ranging from 0 to 15 percent. High water tables within these type soil series generally range from perched and apparent conditions at depths of 0.5 to 6.0 feet to ground water tables of greater than 6 feet beneath the surface. Organic contents vary from 0.5 to 2.0 percent to depths of up to 24 inches beneath the surface. These soil characteristics generally apply to soils encountered within the upper 60 to 75 inches from the surface and may not be valid at depths below this level. Selected SCS soil characteristics useful for planning and development such as, sanitary landfill area, daily cover for landfill, shallow excavations, embankments dike and levees, are listed in Table VIII.

SECTION 4
SUBSURFACE CONDITIONS

Figures 3 A and B graphically illustrate subsurface conditions at this site. The profiles have been generalized and may not depict actual subsurface conditions at boring locations. The actual subsurface profile transitions between material types, gradational and not abrupt as indicated in the profiles. Detailed descriptions of the conditions encountered at the individual test boring locations are presented on the attached Test Boring Records (Appendix C) Summary of Test Pit Data Table IV.

4.1 TOPSOIL

A relatively thin 3.5 to 6 inch veneer of topsoil with rootmat and organics was encountered at most of the boring locations. An exception to this exists at boring B-45 which encountered dark brown clayey silty sand with organics to a depth of 24 inches beneath the surface.

4.2 SEDIMENTS

The underlying Coastal Plain sediments consist of interbedded relatively clean to silty and clayey fine sands (SP, SM, SC) with occasional gravel zones (GP), with layers of fine sandy to silty clays (CL, CH) and fine sandy to clayey silts (ML,MH) that often vary abruptly both horizontally and vertically. Sands predominate in most places, with clays scattered throughout the subsurface profile; clays and silts predominate in other areas with sands scattered throughout. Standard penetration resistance values in the sands range from 3 to greater than 100 blows per foot (bpf) with typical values on the order of 20 to 30 bpf exhibiting very loose to very dense relative densities. Standard penetration resistances in the clays and silts range from 3 to greater than 100 bpf, with typical values on the order of 15 to 25 bpf, exhibiting soft to hard consistencies. At depths of greater than 30 to 40 feet beneath the existing ground surface, the consistencies and relative densities become harder and more dense with standard penetration resistances on the order of 50 bpf to 50 blow per

0.2 feet of penetration. Although these materials exhibit consistencies of partially weathered rock materials, they are classified as overconsolidated sedimentary soils typical of this geologic formation.

4.3 FIELD AND LABORATORY PERMEABILITY

Soil permeability values were calculated from both field and laboratory tests. The results of the field test indicate hydraulic conductivities that range from 1×10^{-3} to 1×10^{-6} cm/sec, whereas laboratory tests yielded values in the 5×10^{-5} to 5×10^{-7} cm/sec range.

Field permeability tests were performed to evaluate the need for a lined landfill to impede leachate from easily entering the underlying ground water. A rate of recovery plot (see Appendix B) was created using these data. The recovery data was obtained and a hydraulic conductivity for each piezometer was calculated using the Rice-Bouwer equations for an unconfined aquifer (H. Bouwer, 1989). A brief explanation of the Rice-Bouwer technique, piezometer recovery plots and parameters used in solving the Rice-Bouwer equations can also be found in Appendix B. The hydraulic permeability calculated for each piezometer and the soil type in which the test was performed are summarized in Table III.

Laboratory permeability testing was performed on relatively undisturbed (shelby tube) and remolded (bulk bag) samples obtained from test borings and test pits at depths between 2 and 10.5 feet beneath the existing ground surface. The remolded samples were compacted in accordance with ASTM D-698 at moisture contents within $\pm$ 2 percent of optimum. This moisture range was selected to simulate the soil moisture content likely to be utilized for liner construction.

The remolded and undisturbed samples were encapsulated in a rubber membrane and placed in a triaxial type permeability cell. An effective confining stress of 2 psi was used to establish a tight fit between the membrane and the sample. Test specimens were saturated under a back pressure of 100 psi prior to running the falling head permeability test. The permeability tests were performed with an effective confining pressure of 2 pounds per square inch (psi) and hydraulic heads of about 40 centimeters (cm) of water across typical sample lengths of 7.59

to 8.10 cm. Inflow and outflow during each test was monitored and the hydraulic conductivity was calculated from each recorded increment. The soil samples collected were the potentially low permeability materials planned for use as liner and top cover material in the development of the proposed landfill.

Following completion of the falling head permeability tests, representative samples were subjected to specific gravity, Atterberg Limits, and grain size analyses to further characterize the on-site soils. Results of the permeability testing performed on undisturbed and remolded samples, including hydraulic conductivity, porosity, molding conditions, and the classification based on the Unified Soil Classification System are included in Table III.

The laboratory test results indicate that the on-site (SC and CL) soils recompacted should provide hydraulic conductivity values on the order of 5×10^{-5} to 1×10^{-6} cm/sec, provided that the in-place dry densities are at least 95 percent of the standard Proctor maximum. Increasing the degree of compaction of these soils to at least 98 percent of the standard Proctor maximum dry density will decrease the hydraulic conductivities to values on the order of 1×10^{-5} to 5×10^{-7} cm/sec. Based on our past experience with similar subsurface conditions, hydraulic conductivity values on compacted samples under controlled laboratory conditions may be as much as a half of an order of magnitude higher than that obtained in the field. Therefore, hydraulic conductivity values of these soils compacted to approximately 98 percent of the maximum dry density in the field may only provide values on the order of 5×10^{-5} to 1×10^{-6} cm/sec. It should be noted that there do exist (CH) soils on-site that were not obtained for laboratory testing and that these soils are anticipated to provide hydraulic conductivity values in the range of 5×10^{-7} to 1×10^{-7} cm/sec when recompacted in the field. However, this should be verified by further laboratory testing and in the field prior to the start of construction with a test strip section.

SECTION 5
CONCLUSIONS AND PRELIMINARY RECOMMENDATIONS

5.1 EXCAVATION CHARACTERISTICS

The sedimentary soils at the site can generally be excavated using conventional equipment such as pans, scrapers, backhoes, and dozers. Based on our past experience with similar materials, the hard to very dense materials exhibiting standard penetration resistances as hard as 50 blows per 3 inches of penetration to 100 bpf will require preloosening by ripping during general site grading to expedite excavation procedures. This can be performed using conventional methods by first loosening the materials with a single-toothed ripper attached to a suitable sized dozer such as a Caterpillar D8 or D9.

5.2 LINER

Based on the results of laboratory permeability tests conducted on bulk samples (2 feet to 10.5 feet) at selected test pits, from within the borrow area, a composite liner system may be necessary to control leachate seepage from the proposed landfill. This system would require the installation of a minimum 60 mil high-density polyethylene, liner overlying low permeability soils. It is our understanding that the state requires a minimum 18 inch thick layer of recompacted low permeable soil such as those sporadically encountered at the site to be used as a liner material beneath the synthetic liner. The presence of occasional quartz rock fragments and gravel may eliminate portions of the low permeable soils on-site to be used as liner materials.

The permeabilities of the in-place recompacted materials to be used as liner material should be at least 5×10^{-7} cm/sec, however, this would be confirmed by the State. It is our opinion that the silty clay (CH) materials encountered at this site, recompacted to at least 98 to 100 percent of the standard Proctor maximum dry density, will provide hydraulic conductivity values in the field on the order of 5×10^{-7} cm/sec to 1×10^{-7} cm/sec. However, this should be verified in the field prior to construction by a test strip. Because of the limited amount of availability of these materials at the site, it may be necessary to obtain soils from off-site. The quantity of material needed for development of the proposed landfill cell has not been determined at this time.

Additive enrichment of on-site materials is an alternative to obtaining off-site soils for use as liner materials in subsequent cells. If additive enriched soils are used, hydraulic conductivity values on the order of 1×10^{-7} cm/sec can be obtained. This would enable the use of a larger quantity of the on-site materials to be used and reduce or eliminate the use of off-site materials. The additive enriched material should be placed in no greater than 6 to 8 inch lifts, compacted to at least 95 percent of standard Proctor maximum dry density.

We recommend that the synthetic liner be placed at least 6 feet above the March 19, 1991, ground water levels presented in Table VI. These correspond to the water levels utilized in constructing the Ground Water Contour Map (Figure 7). This recommendation is provided for two purposes: 1) to allow ease in construction of the soil liner below the synthetic liner, and 2) to provide the minimum 4 foot separation as required by the North Carolina Administrative Code, Subchapter G, by allowing for potential variations in seasonal high water table across the site.

We do not recommend excavating below 4 feet above the anticipated high water table due to capillary rise and softening of the base of the excavation by construction equipment. It is our opinion that should the excavations proceed below the 4 foot level rutting and pumping would likely occur which may deteriorate the base of the landfill.

5.3 SLOPES

Interior slopes of the landfill cell constructed of adequately compacted on-site soils and placed at 1 on 3 slopes should provide adequate stability against shear failure. The final slope design should consider slope heights, duration of exposure to erosion, and type of backfill used as cover material. Further laboratory tests will be warranted in the final design to confirm the shear strength and frictional characteristics of the proposed cover material on these slopes. Due to the shear strength of the liner materials and soil to liner materials, side slopes at 1 on 4 may be necessary or a textured liner used.

5.4 SOIL LINER PLACEMENT

Clayey silts, such as those encountered on site, will sometimes rut and pump beneath heavy construction equipment, especially if the moisture content is on the wet side of optimum. Rutting and pumping may also occur in a properly compacted soil due to the low shear strength of the soil. For this reason, we recommend that a separation of 4 feet be maintained between the high water table and heavy construction equipment. Rounded tooth sheepsfoot rollers should be utilized for compaction of the clayey silt liner. Vibratory steel drum or pneumatic tired rollers should not be used to compact soil lifts. The final surface of the soil liner should, however, be smoothed with a smooth drum roller, but vibration of the roller should not be permitted. We recommend that soils be placed and compacted in layers no greater than 6 to 8 inches.

Due to the characteristics of the on-site soil, moisture control will be necessary during spreading and compaction. We recommend that the soil liner material be compacted from 0 to plus 4 percent of optimum moisture content. The soil liner will not be conducive to wet weather grading, thus, it will be advantageous to place the liner during dry weather. It is anticipated that in-place moisture content of the on-site soils will vary according to topography and existing drainage on the site. Ground water conditions were encountered within the borrow area at depths of 6.5 to 9.5 feet beneath the surface. However, it is anticipated that these shallow ground water conditions are perched and that the true ground water level is lower. Therefore, some drying of the borrow soils will be required before they can be adequately compacted. It is anticipated that these perched ground water conditions can be controlled by positive surface drainage.

Proper selection and construction of liner material will be an important aspect for successful utilization of the liner. If on-site soils are used, selection and separation of these materials in the field should be based upon classification testing and evaluation by an experienced soils technician working directly under the supervision of a geotechnical engineer. Liner soils should contain no more than 40 percent of materials coarser than a No. 200 sieve with less than 5 percent retained on a No. 4 sieve and have a Plasticity Index greater than 10 percent with associated Liquid Limits of at least 25 percent. It is our opinion that these soils can be found within the proposed excavation depths in

the proposed borrow area. The contractor should separate liner material from general fill and not include rock fragments, cobbles, or organic materials with potential liner soils.

5.5 GENERAL EMBANKMENT CONSTRUCTION CONSIDERATIONS

Prior to placement of fill for the perimeter embankment, the subgrade should be thoroughly stripped of all topsoil and organics, including removal of old stumps and roots. The exposed subgrade should be proofrolled with a loaded dump truck to identify any areas of soft surface soils. Areas that rut or pump after successive passes of the roller should be undercut to suitable soils and replaced with compacted backfill. For preliminary design, the cut or fill slopes should be constructed no steeper than 1 on 3.

SECTION 6

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TABLES

TABLE I SUMMARY OF LABORATORY TESTS CONDUCTED		
TYPE OF TEST	PROCEDURE	TEST NUMBER
Natural Moisture Content	ASTM D-2216-80	28
Grain Size Distribution - Hydrometer and Sieve	ASTM D-422-72	10
Atterberg Limits	ASTM D-4318-83	10
Specific Gravity	ASTM D-854-83	10
Standard Proctor Compaction	ASTM D-698	4
Falling Head Permeability	ASTM D-1110-2-1906	9

TABLE II
SUMMARY OF LABORATORY TEST DATA
DUNN-ERWIN LANDFILL

LOCATION	DEPTH	NATURAL MOISTURE CONTENT %	PERCENT PASSING NO. 200 SERIES	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIFIED SOILS CLASSIFICATION
PB-9	8.5-10.0	31.6	--	--	--	--	--
PB-9	23.5-25.0	21.1	--	--	--	--	--
B-41	33.5-35.0	28.8	--	--	--	--	--
B-41	38.5-40.0	26.7	--	--	--	--	--
B-41	48.5-50.0	25.8	--	--	--	--	--
B-42	3.5-5.0	26.7	--	--	--	--	--
B-42	4.0-5.0	32.5	94.0	60	29	31	CH
B-42	5.0-6.0	30.1	83.0	53	26	27	CH
B-42	8.5-10.0	28.5	--	--	--	--	--
B-42	43.5-45.0	21.1	--	--	--	--	--
B-42	48.5-50.0	21.1	--	--	--	--	--
B-44	8.5-10.0	21.4	42.0	64	18	46	SC
B-44	23.5-25.0	22.6	--	--	--	--	--
B-44	28.5-30.0	25.1	--	--	--	--	--
B-44	33.5-35.0	24.0	--	--	--	--	--
B-45	33.5-35.0	17.8	--	--	--	--	--
B-45	43.5-45.0	23.6	--	--	--	--	--

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TABLE II (CONTINUED)
SUMMARY OF LABORATORY TEST DATA
DUNN-ERWIN LANDFILL

LOCATION	DEPTH	NATURAL MOISTURE CONTENT %	PERCENT PASSING NO. 200 SERIES	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIFIED SOILS CLASSIFICATION
B-45	48.5-50.0	19.8	--	--	--	--	--
B-46	13.5-15.0	20.5	69.0	46	16	30	CL
B-47	23.5-25.0	19.8	--	--	--	--	--
B-47	28.5-30.0	18.0	--	--	--	--	--
B-47	33.5-35.0	23.3	--	--	--	--	--
B-48	13.5-15.0	29.2	92.0	55	29	26	CH
TP-49	7.0-8.0	19.0	58.9	33	15	18	CL
TP-50	2.0-6.0	19.5	31.0	54	25	29	SC
TP-52	7.0-10.5	19.0	41.0	43	18	25	SC
TP-54	3.5-10.0	25.8	24.0	33	24	9	SC-SM
TP-56	8.0-10.5	22.6	66.0	35	22	13	CL

TABLE III
SUMMARY OF LABORATORY FALLING HEAD PERMEABILITY TEST DATA
DUNN-ERWIN LANDFILL

LOCATION	DEPTH	MAXIMUM DRY DENSITY	STANDARD PROCTOR OPTIMUM MOISTURE CONTENT %	COMPACTION MOISTURE (%)	PERCENT COMPACTION	PERMEABILITY AVE (K) CM/SEC	POROSITY (%)	UNIFIED SOILS CLASSIFICATION
B-42	4'-5'	--	--	--	Undisturbed	3.73×10^{-6}	49.7	CH
B-42	5'-6'	--	--	--	Undisturbed	1.36×10^{-6}	48.2	CH
TP-49	7'-10'	117.8	12.8	14.8	96.6	1.43×10^{-6}	30.4	CL
TP-49	7'-10'	117.8	12.8	14.7	98.1	2.60×10^{-7}	29.3	CL
TP-50	2'-6'	107.8	16.6	19.0	95.4	6.88×10^{-6}	37.1	SC
TP-50	2'-6'	107.8	16.6	18.5	99.0	7.76×10^{-7}	34.7	SC
TP-52	7'-10.5'	112.6	14.5	16.6	95.3	2.07×10^{-6}	35.1	SC
TP-52	7'-10.5'	112.6	14.5	16.6	97.9	7.80×10^{-7}	33.4	SC
TP-54	3.5'-10.0'	113.5	14.8	17.3	94.6	6.73×10^{-5}	34.8	SM-SC

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TABLE IV
SUMMARY OF TEST PIT DATA
DUNN-ERWIN LANDFILL

TEST PIT	DEPTH (FT.)	DESCRIPTION
TP-9	0.0-4.0	Brown Tan Fine Sandy Silty CLAY (CL)
	4.0-10.0	Dark Gray Silty CLAY (CH)
		No Ground Water Encountered at Completion
TP-29	0.0-8.0	Dark Gray Tan Mottled Slightly Fine Sandy Silty CLAY (CH)
		No Ground Water Encountered at Completion
TP-49	0.0-2.5	Brown Gray Silty Fine SAND with Roots (SM)
	2.5-7.0	Gray and Orange Clayey Fine SAND (SC-CL)
	7.0-10.0	Light Gray Fine Sandy Silty CLAY (CL)
		Ground Water Level at 6.5 Feet at Completion
TP-50	0.0-2.0	Tan Gray Clayey Silty Fine SAND (SC)
	2.0-6.0	Gray Tan Mottled Slightly Silty Clayey Fine SAND (SC)
	6.0-10.0	Tan and Gray Mottled Fine Sandy Silty CLAY (CL)
		Ground Water Level at 8.0 Feet at Completion
TP-52	0.0-1.3	Tan and Gray Silty Fine SAND (SM)
	1.3-7.0	Red-Orange Clayey Silty Fine SAND (SC) With Gravel At Bottom
	7.0-10.5	Gray Tan Mottled Silty Clayey Fine SAND (SC)

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TABLE IV (CONTINUED) SUMMARY OF TEST PIT DATA DUNN-ERWIN LANDFILL		
TEST PIT	**DEPTH (FT.)**	**DESCRIPTION**
Ground Water Level at 9.0 Feet at Completion		
TP-54	0.0-2.0	Brown Gray Slightly Silty Fine SAND (SP-SM)
	2.0-3.5	Tan Silty Fine SAND (SM)
	3.5-10.0	Yellow Tan and Light Gray Mottled Slightly Silty Clayey Fine SAND (SM-SC) with Gravel at Bottom
	10.0-10.5	Light Gray Fine Sandy Silty CLAY (CL)
Ground Water Level at 9.0 Feet at Completion		
TP-56	0.0-0.3	Brown Silty Fine SAND (SM)
	0.3-8.0	Tan Orange Slightly Silty Fine SAND (SP-SM)
	8.0-10.5	Gray, Brown and Red Mottled Fine Sandy Silty CLAY (CL)
	10.5-11.0	Light Gray Silty CLAY (CH)
Ground Water Level at 9.5 Feet at Completion		

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TABLE V
PIEZOMETER CONSTRUCTION DATA
DUNN-ERWIN LANDFILL
ELEVATION TO TOP OF

PIEZOMETER	SCREEN INTERVAL	SAND	BENTONITE	CASING
40-S	158.8-163.7	164.90	166.40	176.17
41-S	187.4-192.4	193.90	195.40	208.58
42-D	116.7-126.6	129.40	131.30	167.96
42-S	142.5-152.4	153.10	156.60	168.05
44-D	133.5-143.4	146.20	148.50	184.48
44-S	167.1-172.0	173.30	176.00	184.20
45-S	178.9-183.9	185.20	187.00	202.71
46-D	169.2-179.2	180.70	183.00	221.38
46-S	187.7-197.7	199.70	201.70	220.77
47-D	135.2-145.2	147.30	149.30	190.10
47-S	168.6-178.6	182.20	183.90	189.89
48-S	185.1-195.1	199.00	201.50	208.27
PB-9	183.6-203.6	204.50	208.80	211.24

TOC - Top of Cap

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TABLE VI PIEZOMETER GROUND WATER ELEVATIONS						
	GROUND WATER ELEVATION AT					
PIEZOMETER	T.O.B.	24 HOUR	3/19/91	3/26/91	4/12/91	6/27/91
40-S	ND	ND	171.68	171.44	171.38	170.61
41-S	192.1	ND	192.83	192.85	192.89	192.21
42-D	127.1	140.0	148.23	148.08	148.07	147.68
42-S	145.0	160.7	163.03	162.81	162.32	162.63
44-D	ND	ND	173.13	171.86	171.17	170.30
44-S	169.1	ND	180.86	180.79	179.20	180.46
45-S	181.4	ND	181.26	181.16	181.82	180.54
46-D	174.4	ND	190.04	189.87	191.61	192.70
46-S	ND	ND	193.17	194.14	193.23	193.76
47-D	ND	ND	163.39	161.38	161.13	161.03
47-S	ND	ND	184.25	183.81	183.46	181.83
48-S	DRY	195.2	197.22	197.01	196.85	196.41
PB-9	DRY	188.4	190.82	190.40	190.07	189.93

ND - No Data
T.O.B. - Time of Boring
(All elevations in feet.)

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TABLE VII
DUNN ERWIN LANDFILL
WATER LEVEL RECORDINGS

BORE ID NUMBER	GROUND WATER ELEVATION	WATER TABLE ELEVATION (FEET)												
		MAY 1, 1985	MAY 30, 1985	JULY 8, 1985	JULY 30,1985	SEPT 5, 1985	OCT 4, 1985	Nov 1, 1985	DEC 86	JAN 86	FEB 86	MAR 86	APRIL 86	**CHANGE in GW ELEVATION (FT)
1	234.6	GONE	219.0	220.0	221.6	219.1	220.8	219.0	218.4	218.7	---	218.9	218.7	3.2
2	204.1	187.6	187.1	187.0	187.2	186.9	187.1	187.0	185.9	185.9	183.5	186.2	185.9	4.1
3	203.7	183.7	183.7	184.1	184.7	184.6	184.6	184.1	183.1	183.0	183.8	182.8	183.20	1.9
4	207.6	196.9	196.4	197.1	197.0	196.5	196.1	195.9	193.4	194.0	194.0	193.8	193.00	4.1
5	214.3	197.7	197.9	198.8	199.4	198.8	199.0	198.3	195.3	195.7	196.4	195.5	195.6	4.1
6	203.1	187.9	187.8	188.6	188.4	188.2	187.8	187.9	186.9	187.7	187.4	187.2	186.9	1.7
7	217.1	208.1	207.2	GONE	*214.5	209.9	207.3	208.9	204.1	209.4	205.8	203.3	203.1	*11.2
8	200.3	189.8	190.1	191.1	190.7	190.4	190.5	190.4	191.2	189.9	190.3	190.6	190.0	1.4
9	230.4	212.1	211.8	212.4	212.3	211.9	211.1	211.3	210.3	210.8	211.40	210.9	210.7	2.1
10	193.2	181.4	181.6	182.4	183.3	182.6	184.9	185.0	184.1	184.3	183.8	182.4	183.4	3.6
11	210.0	192.5	192.7	192.5	192.4	192.8	192.6	192.2	191.3	191.3	191.6	191.7	191.3	1.5
12	214.8	192.1	191.8	191.6	191.8	191.6	191.4	191.3	189.3	186.4	188.7	186.7	186.1	6.0
13	202.2	183.3	183.3	183.2	183.2	183.1	183.1	182.9	181.9	181.7	182.4	182.0	182.3	1.6
14	207.6	190.5	190.1	190.6	190.8	190.6	190.6	189.4	189.2	189.7	189.4	189.6	189.7	1.6
15	200.3	192.1	191.9	192.4	192.7	192.3	192.2	192.0	191.0	191.5	191.8	191.5	191.2	1.7

*Well repaired - anomalous data

**Groundwater table mean seasonal fluctuation-2.8 feet

T91A382.VOB

TABLE VIII
SELECTED SCS SOIL CHARACTERISTICS
DUNN-ERWIN LANDFILL

SOIL SERIES	RANGE IN SLOPE %	SANITARY LANDFILL AREA	DAILY COVER FOR LANDFILL	SHALLOW EXCAVATIONS	EMBANKMENTS DIKES AND LEVEES
Bibb	0	Severe-Flooding, Wetness	Poor-Wetness	Severe-Wetness	Severe-Piping, Wetness
Blaney	8-15	Severe-Slope, Seepage	Fair-Slope	Severe-Cutbanks Cave	Severe-Piping
Gilead	2-8	Moderate-Wetness	Fair-Too Clayey, Wetness	Severe-Wetness	Moderate-Wetness
Marboro	2-6	Slight	Fair-Too Clayey	Moderate-Too Clayey	Severe-Piping
Norfolk	0-2 2-6 6-10	Slight Slight Slight	Slight Slight Fair-Slope	Moderate-Wetness Moderate-Wetness Moderate-Wetness, Slope	Slight Slight Slight
Wagram	0-6	Slight	Good	Slight	Slight

Good, Slight - Means that the soil properties are generally favorable for the specified use and that any limitations are minor and easily overcome.

Fair, Moderate - Means that some soil properties are unfavorable but can be overcome or modified by special planning and design.

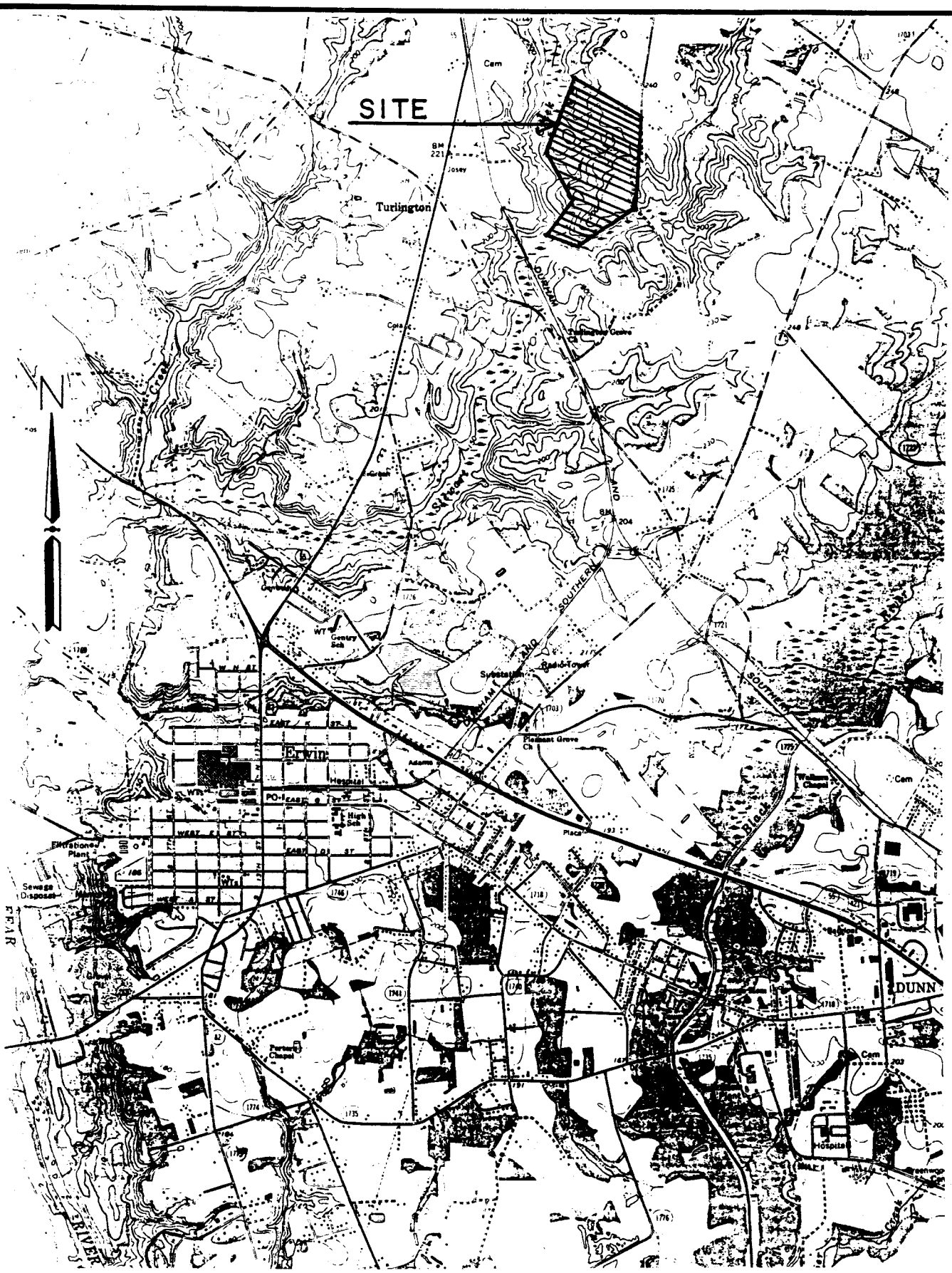
Poor, Severe - Means that the soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance.

Ratings apply only to a depth of about 60-75 inches and therefore may not be valid if excavations are much deeper.

R91A130A/als

TABLE IX SUMMARY OF FIELD PERMEABILITY TEST RESULTS				
PIEZOMETER No.	SCREEN INTERVAL ELEVATION (ft)		SOIL TYPE	HYDRAULIC CONDUCTIVITY k (cm/sec)
	FROM	TO		
40S	158.8	163.7	MH and SC	2.9×10^{-5}
41S	187.4	192.4	SM/SC	1.3×10^{-3}
44S	167.1	172.0	SM and CL	1.8×10^{-5}
46D	169.2	179.2	ML	1.0×10^{-6}
47S	168.6	178.6	ML and SM	7.6×10^{-6}

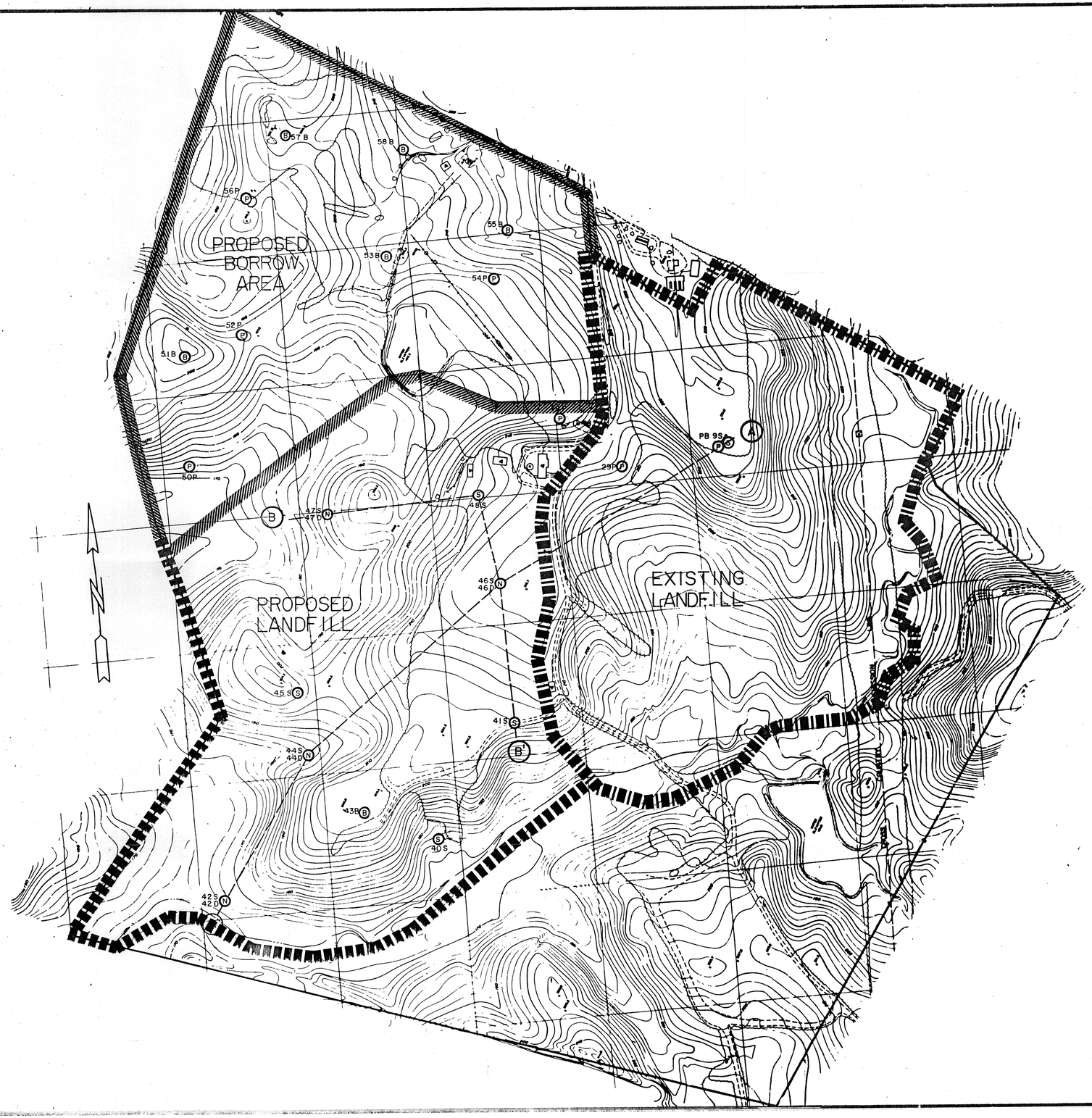
FIGURES



VICINITY MAP

PROJECT		
DUNN ERWIN LANDFILL	Westinghouse	SCALE: 1" = 1000'
HARNETT COUNTY, N. C.		JOB NO: REW-A-130
		FIG. NO: 1

SME-4



LEGEND:

- (S) SHALLOW PIEZOMETER (ONE)
- (N) NESTED PIEZOMETER (TWO)
- (P) TEST PIT
- (B) SOIL BORING
- (A)—(A') CROSS SECTION LOCATION

REV. NO.	DESCRIPTION	DATE:

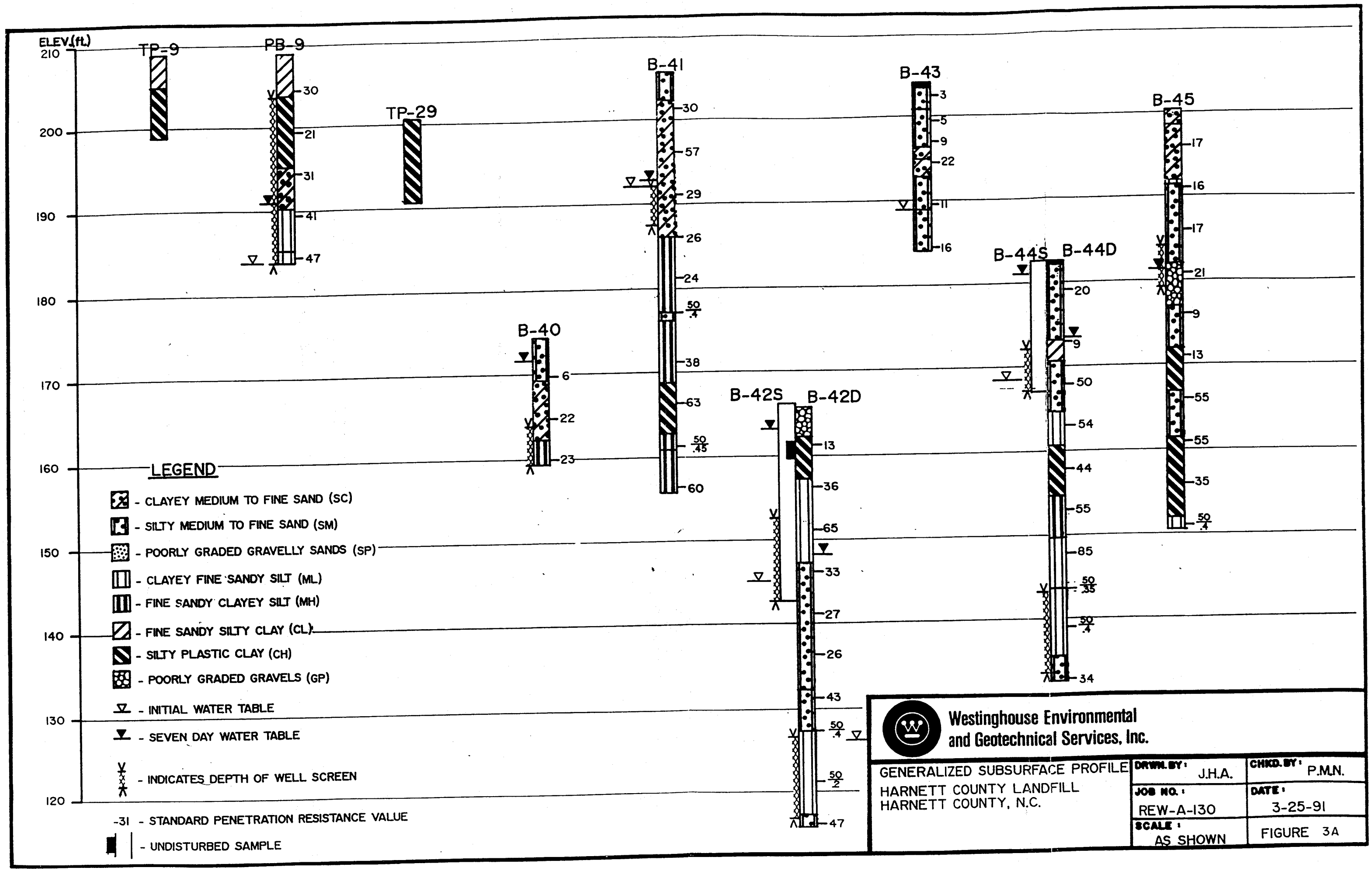
DUNN ERWIN LANDFILL
HARNETT COUNTY, N. C.

PIEZOMETER, BORING, TEST PIT AND CROSS SECTION LOCATION MAP

Westinghouse Environmental and Geotechnical Services, Inc.

FIGURE: 2

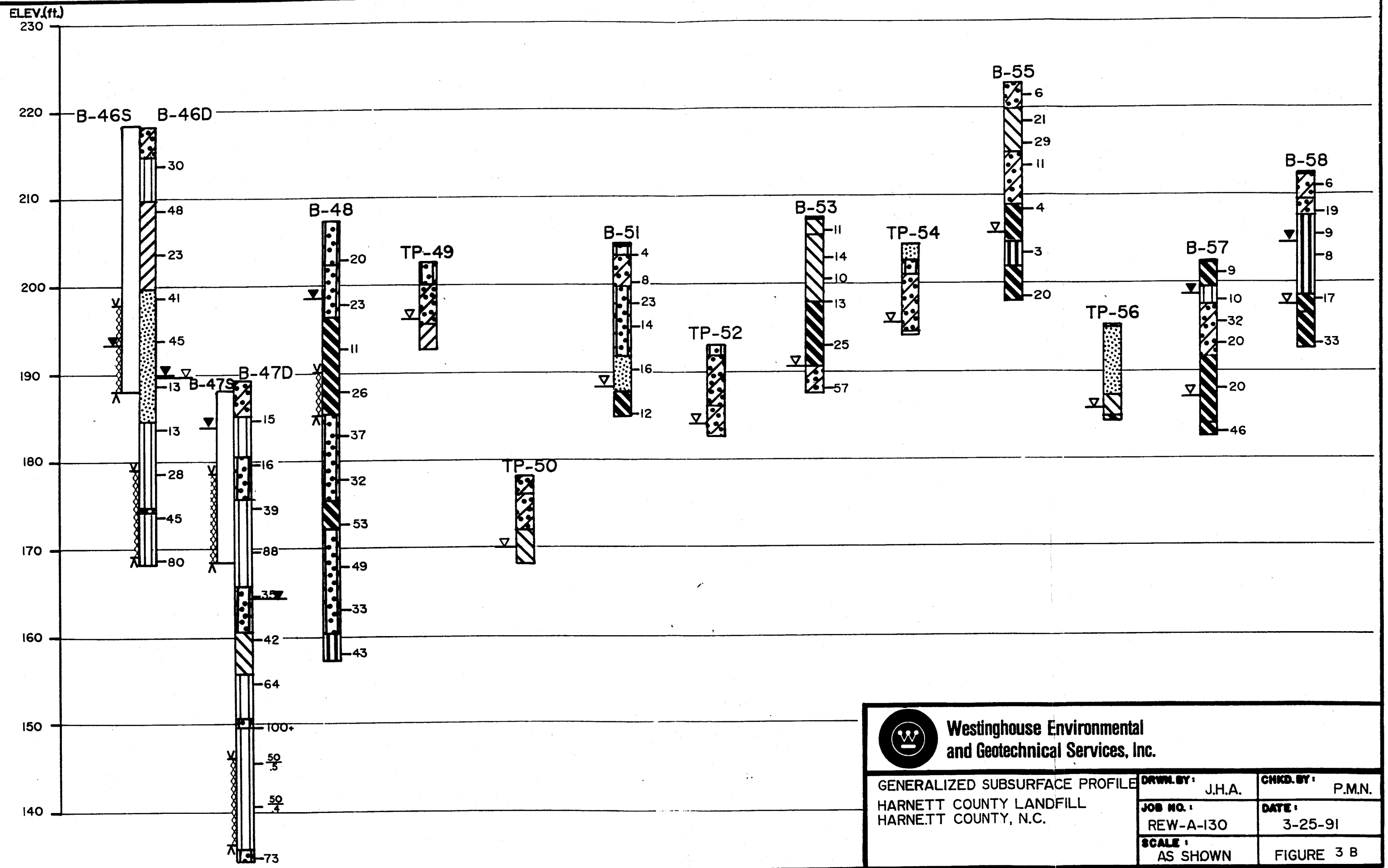
SCALE: 1" = 200'	DRAWN BY: MCJ	CHECKED BY:
JOB NO. REW-A-130	DATE: 4/10/91	SHEET OF



Westinghouse Environmental and Geotechnical Services, Inc.

GENERALIZED SUBSURFACE PROFILE
HARNETT COUNTY LANDFILL
HARNETT COUNTY, N.C.

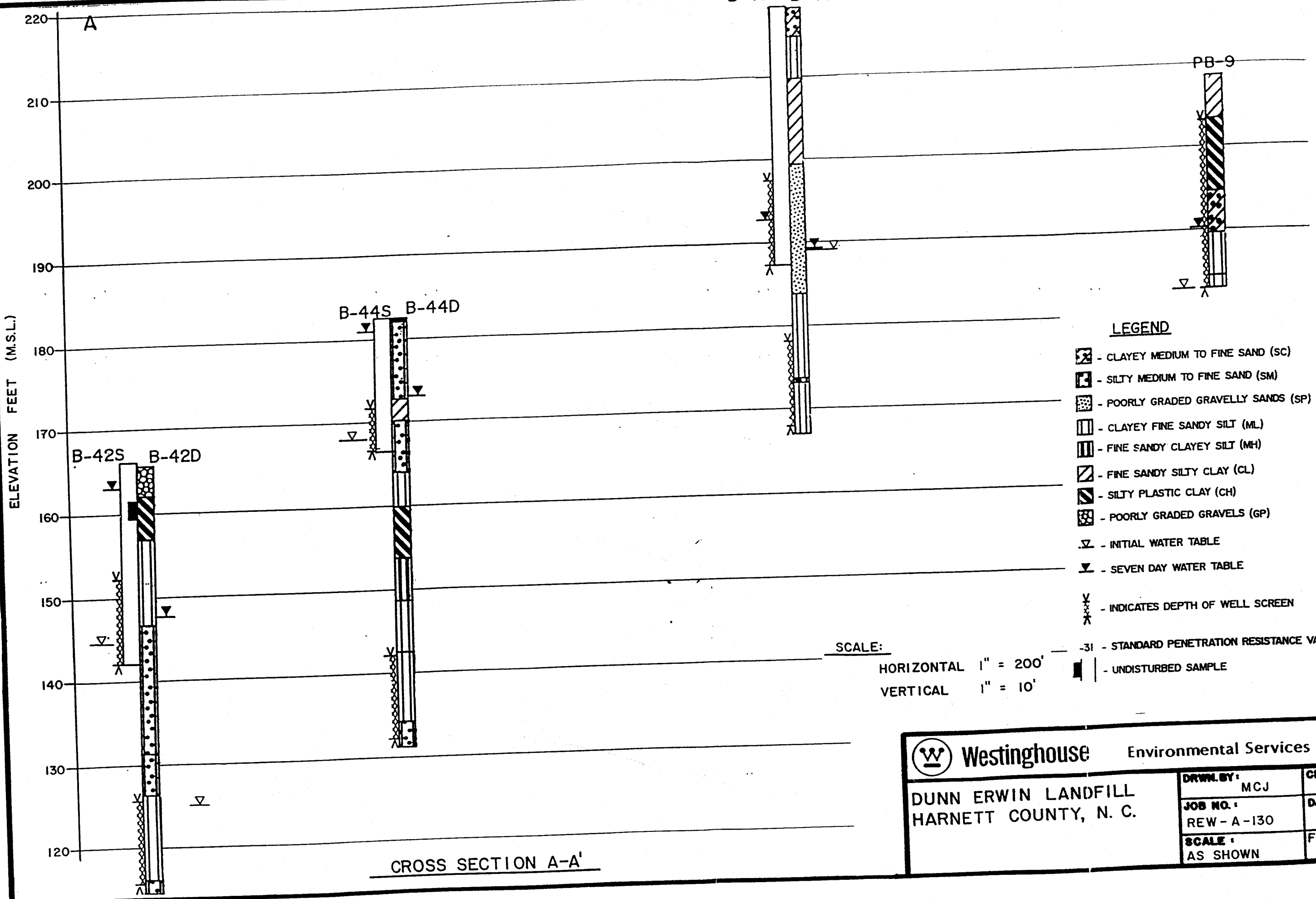
DRWN. BY: J.H.A.	CHKD. BY: P.M.N.
JOB NO.: REW-A-130	DATE: 3-25-91
SCALE: AS SHOWN	FIGURE 3A



Westinghouse Environmental and Geotechnical Services, Inc.

GENERALIZED SUBSURFACE PROFILE HARNETT COUNTY LANDFILL HARNETT COUNTY, N.C.	DRWN. BY: J.H.A.	CHKD. BY: P.M.N.
	JOB NO.: REW-A-130	DATE: 3-25-91
	SCALE: AS SHOWN	FIGURE 3 B

155A

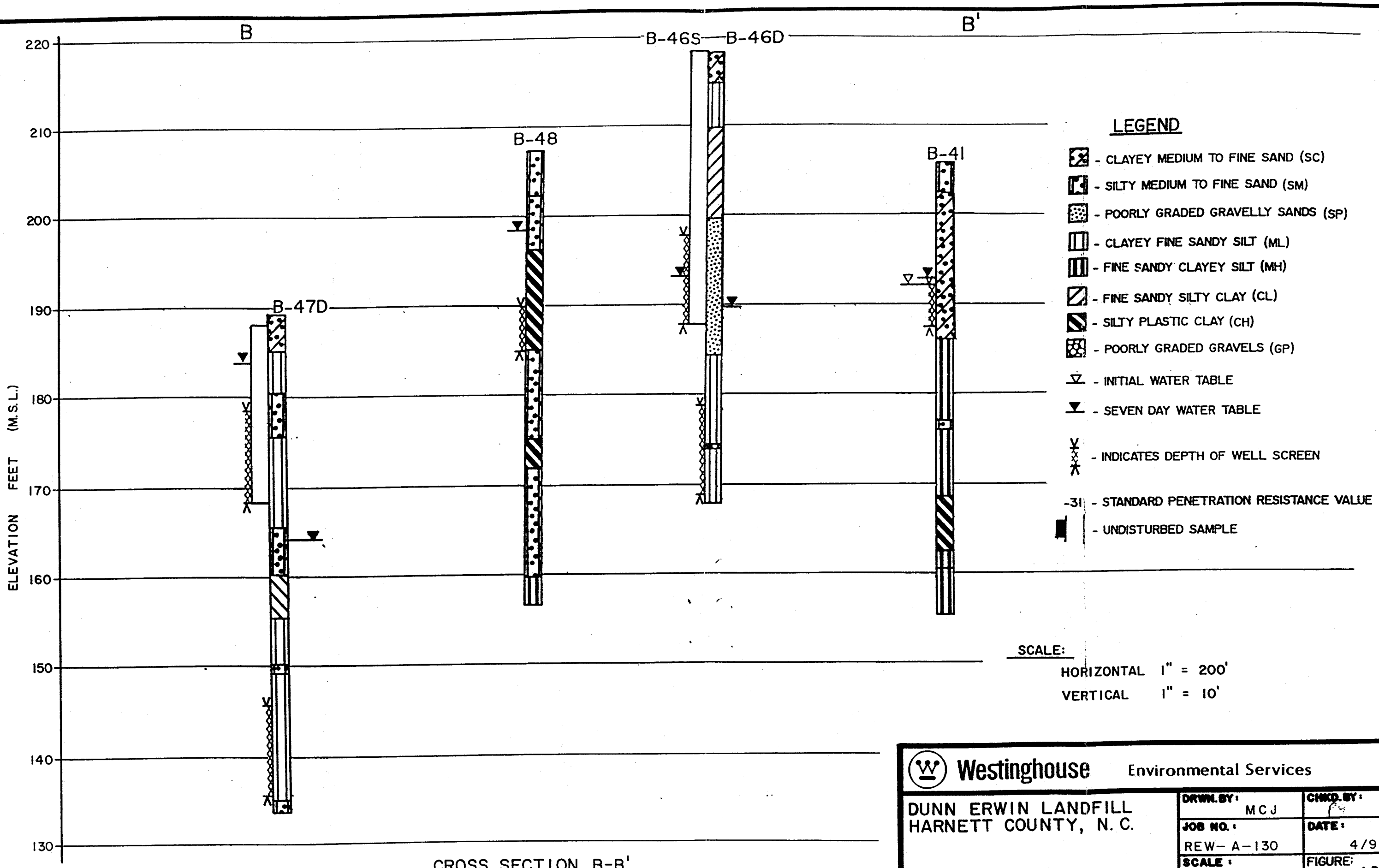


CROSS SECTION A-A'

Westinghouse Environmental Services

DUNN ERWIN LANDFILL
HARNETT COUNTY, N. C.

DRWN. BY: MCJ	CHKD. BY: PG
JOB NO.: REW-A-130	DATE: 4/91
SCALE: AS SHOWN	FIGURE: 4 A

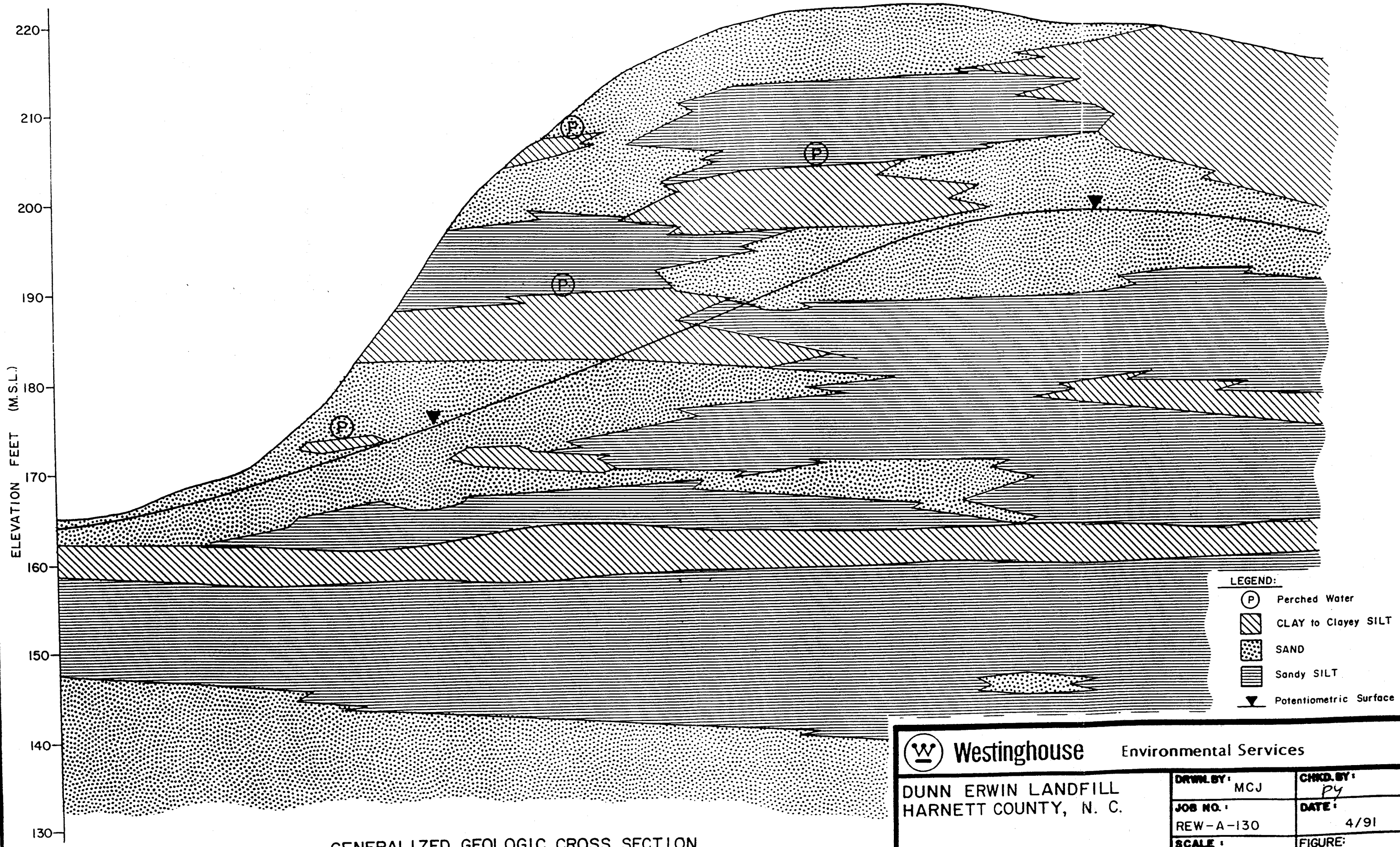


CROSS SECTION B-B'

Westinghouse Environmental Services

DUNN ERWIN LANDFILL HARNETT COUNTY, N. C.	DRWN. BY: MCJ	CHKD. BY:
	JOB NO.: REW- A-130	DATE: 4/91
	SCALE: AS SHOWN	FIGURE: 4 B

DUNCAN-PARNELL, INC., RALEIGH 866 919-833-4077

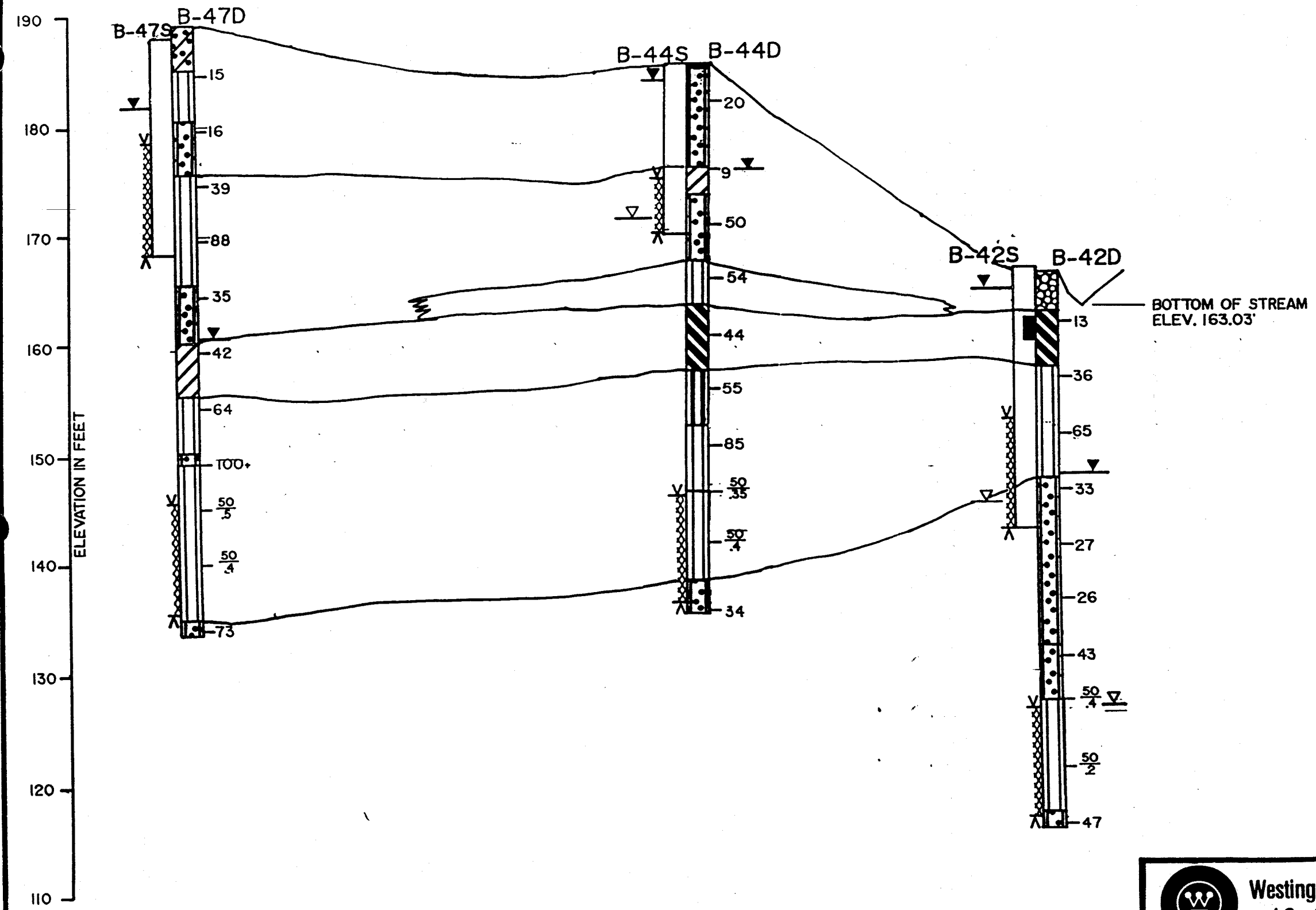


GENERALIZED GEOLOGIC CROSS SECTION

Westinghouse Environmental Services

DUNN ERWIN LANDFILL HARNETT COUNTY, N. C.	DRWN. BY: MCJ	CHKD. BY: PY
	JOB NO.: REW-A-130	DATE: 4/91
	SCALE: AS SHOWN	FIGURE: 5

DUNCAN-PARNELL, INC., RALEIGH 988 919-833-4677



LEGEND

- CLAYEY MEDIUM TO FINE SAND (SC)
- SILTY MEDIUM TO FINE SAND (SM)
- POORLY GRADED GRAVELLY SANDS (SP)
- CLAYEY FINE SANDY SILT (ML)
- FINE SANDY CLAYEY SILT (MH)
- FINE SANDY SILTY CLAY (CL)
- SILTY PLASTIC CLAY (CH)
- POORLY GRADED GRAVELS (GP)
- INITIAL WATER TABLE
- WATER TABLE 6/27/91
- INDICATES DEPTH OF WELL SCREEN
- 31 - STANDARD PENETRATION RESISTANCE VALUE
- UNDISTURBED SAMPLE

SCALE:

HORIZONTAL 1" = 200'

VERTICAL 1" = 10'

Westinghouse Environmental and Geotechnical Services, Inc.

DUNN ERWIN LANDFILL HARNETT COUNTY, NORTH CAROLINA	DRWN. BY: J.H.A.	CHKD. BY: A.M.B.
	JOB NO.: REW-A-130	DATE: 7-1-91
HYDROGEOLOGIC CROSS-SECTION	SCALE: AS SHOWN	FIGURE: 6

DUNCAN-PARNELL, INC., RALEIGH 888 919-833-4677

LEGEND

170 — GROUND WATER CONTOUR

APPROXIMATE BOUNDRIES OF WETLAND AREAS

REV. NO.	DESCRIPTION	DATE:

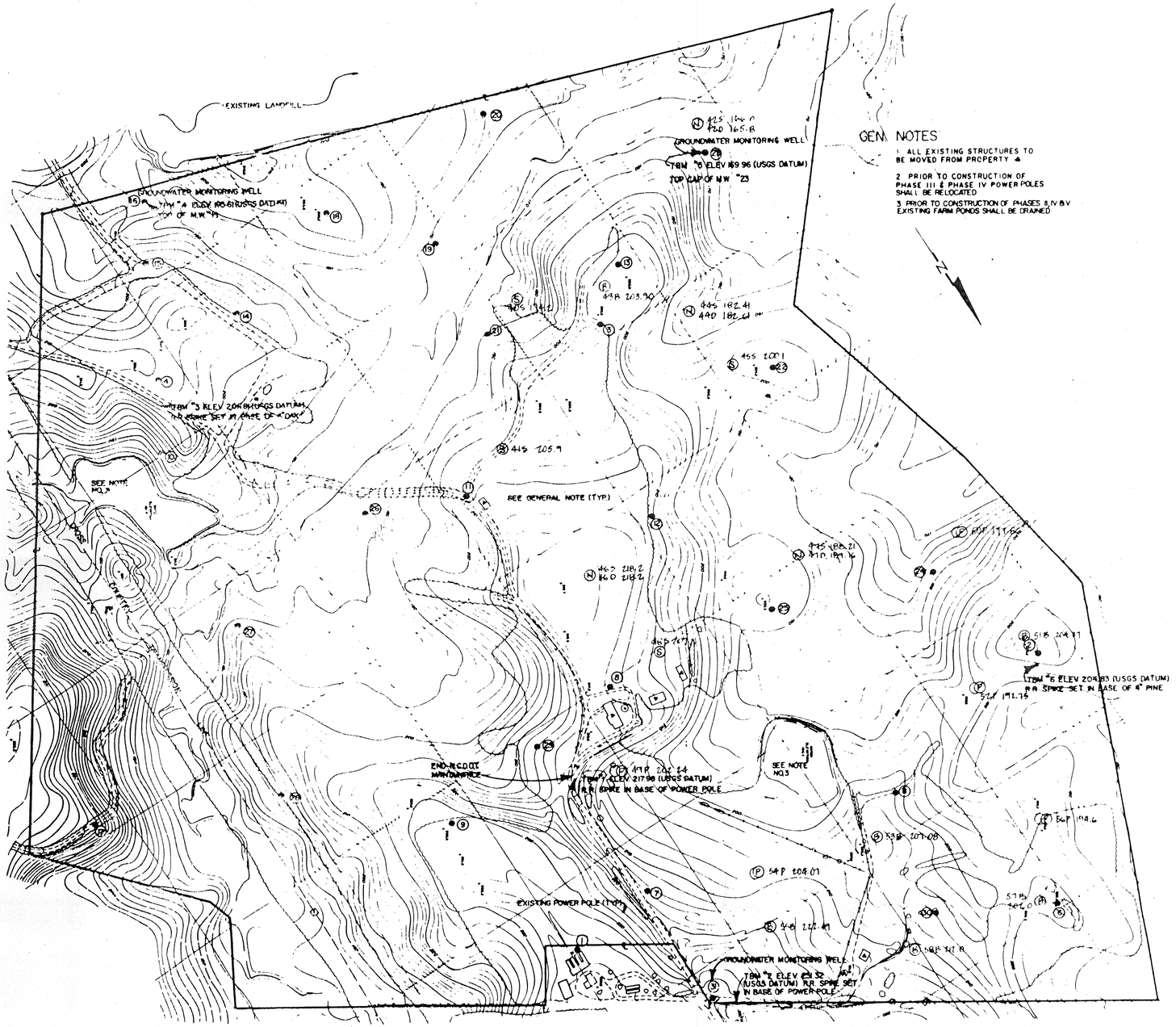
DUNN ERWIN LANDFILL
HARNETT COUNTY, NORTH CAROLINA

GROUND WATER CONTOUR MAP
C. I. = 10 FEET

Westinghouse Environmental and Geotechnical Services, Inc.

FIGURE: 7

SCALE: 1" = 200'	DRAWN BY: M.C.J. / J.H.A.	CHECKED BY: A.M.B.
JOB NO. REW-A-382	DATE: 7-2-91	SHEET OF



GEN. NOTES

1. ALL EXISTING STRUCTURES TO BE MOVED FROM PROPERTY ▲
2. PRIOR TO CONSTRUCTION OF PHASE III & PHASE IV POWER POLES SHALL BE RELOCATED
3. PRIOR TO CONSTRUCTION OF PHASES II, IV & V EXISTING FARM PONDS SHALL BE DRAINED

TOP OF PIPE ELEVATIONS

42S - 168.05
42D - 167.96
44S - 184.20
44D - 184.48
45S - 202.71

40S - 176.17
41S - 208.58
46S - 220.77
46D - 221.38
48S - 209.27

47S - 189.89
47D - 190.91

LEGEND

(B) 53B 207.08 —— WESTINGHOUSE BORING LOCATION, NUMBER & GROUND ELEV.

(S) —— SHALLOW (BORINGS - 50', PIEZOMETER - 15')
(N) —— NESTED 15' - 50'
(B) —— BORINGS 15' - 20'
(P) —— TEST PITS

LEGEND

PAVED ROAD
UNPAVED ROAD
TRAIL
BUILDING
SIDEWALK
POLE
LOCATED OBJECT
CULVERT
FENCE
BORING LOCATIONS
STREAM OR SHORE LINE
TREE LINE
SINGLE TREES
INDEX CONTOUR
INTERMEDIATE CONTOUR
APPROXIMATE CONTOUR LOCATION DUE TO GROUND COVER
SPOT ELEVATION

NO.	DATE	BY	REVISION
	5/27/71	RMC	ADDED WESTINGHOUSE BORING LOCATIONS

RAGSDALE CONSULTANTS, P.A.
ENGINEERS, PLANNERS & SURVEYORS
P.O. BOX 1749, 310 E. JOHNSTON STREET, SMITHFIELD, N.C. 27577
5005C WESTERN BOULEVARD, RALEIGH, N.C. 27606
P.O. BOX 760, 813 MAIN STREET, LILLINGTON, N.C. 27546

NORTH CAROLINA PROFESSIONAL SEAL 6865 ENGINEER CLARENCE TYRUS CLAYTON

SCALE 1" = 200'
DATE 4-7-87
DRAWN BY
CHECKED BY G.W.W.
APPROVED BY C.T.C.
PROJECT NO. 86-113E

COUNTY OF HARNETT
DUNN ERWIN LANDFILL
EXISTING TOPOGRAPHIC MAP/ PREVIOUS BORING LOCATIONS

FIGURE 8

copy provided by courtesy of rehmann

APPENDIX A

FIELD AND LABORATORY METHODS

SOIL TEST BORINGS

Borings were advanced with 3-1/4 inch hollow-stem augers and, at standard intervals, soil samples were obtained with standard 1.4-inch I.D., 2-inch O.D., split-tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows, designated as Standard Penetration Resistance, when properly evaluated is an index to soil strength and relative density.

Representative portions of each split-tube sample were placed in glass jars and classified by a geologist in our laboratory. Laboratory analyses of plasticity, grain size, and specific gravity were used to confirm visual classifications. Test Boring Records showing the soil descriptions and standard Penetration Resistances are included in Appendix C.

MOISTURE CONTENT

The moisture content of several samples was determined. The moisture content is the ratio of the weight of water in a given mass of soil to the dry weight of the solids. This test was conducted in accordance with ASTM Designation D 2216-66. Test results are presented on the attached Summary of Laboratory Data Sheet (Table II).

GRAIN SIZE TESTS

Grain size tests were performed to examine the particle size and distribution of the bulk samples tested. Grain size distribution of soils coarser than a No. 200 sieve was determined by passing the samples through a set of nested sieves. Soil particles passing the No. 200 sieve were suspended in solution and the grain size distribution determined from the rate of settlement.

The results are presented on the attached Grain Size Distribution Sheets. (Appendix D).

SOIL PLASTICITY TESTS (ATTERBERG LIMITS)

Samples were selected for Atterberg limits testing to determine the soil's plasticity characteristics. Plastic Index (PI) is representative of this characteristic and is the difference between the Liquid Limit (LL) and the Plastic Limit (PL). Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid as determined in accordance with ASTM D-423. Plastic Limit is the moisture content at which the soil begins to loose its plasticity as determined in accordance with ASTM D-424. Analytical data is presented in Table II.

SPECIFIC GRAVITY

Specific gravity is the ratio of the weight in air of a given volume of soil to the weight in air of an equal volume of water and is determined in accordance with ASTM Designation D 854-58. The results of the test are presented on the attached data sheets (Appendix D).

APPENDIX B

Well Number: _____ Drilling Method: _____

Date Started: _____ Drilling Fluids: _____

Date Finished: _____ Static Water Level: _____ Date: _____

Geologist/Engineer: P. Nelis / P. Yanez Observed By: _____

Remarks: _____

Generalized Piezometer Schematic

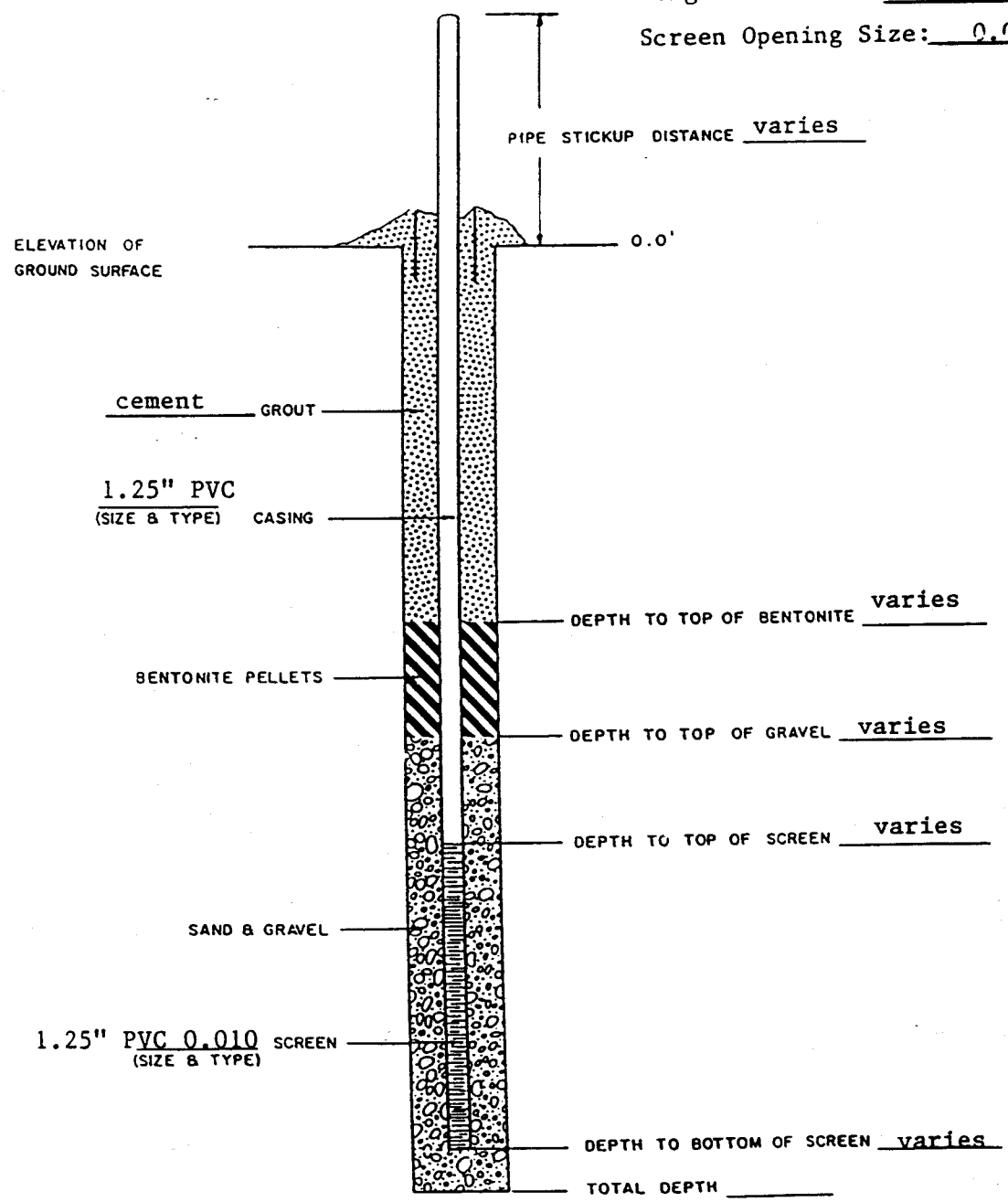
O.D. of Borehole: 6.5"

O.D. of Casing: 1.25"

Length of Screen: varies

Screen Opening Size: 0.010

ALL DEPTHS REFERENCED FROM GROUND SURFACE



PROJECT		
Dunn-Erwin Landfill	Westinghouse	SCALE: NTS JOB NO: REW-A- 130 FIG. NO:

DUNCAN-PARNELL, INC., RALEIGH 686 919-833-4677

Harnett Co. Landfill
REW A 382
4/12/91

Well 40-S - Slug Test Data

Static Water Level Reading (FT-H2O) = 11.37

Y = Water Level Reading During Test (FT-H2O)
Del Y = Y - Static Water Level at Time t
t = Time in Seconds Since Start of Test

40-S

Y	Del Y	Log Del Y	t
15.71	4.34	0.637489	6
15.67	4.3	0.633468	12
15.63	4.26	0.629409	18
15.61	4.24	0.627365	24
15.6	4.23	0.626340	30
15.59	4.22	0.625312	36
15.57	4.2	0.623249	42
15.6	4.23	0.626340	48
15.57	4.2	0.623249	54
15.56	4.19	0.622214	60
15.56	4.19	0.622214	66
15.55	4.18	0.621176	72
15.54	4.17	0.620136	78
15.45	4.08	0.610660	138
15.45	4.08	0.610660	144
15.42	4.05	0.607455	174
15.4	4.03	0.605305	204
15.28	3.91	0.592176	354
15.26	3.89	0.589949	384
14.92	3.55	0.550228	1044
14.8	3.43	0.535294	1344
14.69	3.32	0.521138	1644
14.58	3.21	0.506505	1944
14.47	3.1	0.491361	2244
14.37	3	0.477121	2544
14.26	2.89	0.460897	2844
14.18	2.81	0.448706	3144
14.08	2.71	0.432969	3444
13.99	2.62	0.418301	3744
13.91	2.54	0.404833	4044
13.83	2.46	0.390935	4344
13.68	2.31	0.363611	4944
13.53	2.16	0.334453	5544
13.41	2.04	0.309630	6144
13.3	1.93	0.285557	6744
13.2	1.83	0.262451	7344
13.06	1.69	0.227886	7944
12.93	1.56	0.193124	8844
12.81	1.44	0.158362	9744
12.69	1.32	0.120573	10644
12.55	1.18	0.071882	11544
12.46	1.09	0.037426	12444
12.34	0.97	-0.01322	13344
12.24	0.87	-0.06048	14244
12.13	0.76	-0.11918	15144
12.1	0.73	-0.13667	15744

Harnett Co. Landfill
REW A 382
4/11/91

Well 41-S - Slug Test Data

Static Water Level Reading (FT-H2O) = 4.54

Y = Water Level Reading During Test (FT-H2O)
Del Y = Y - Static Water Level at Time t
t = Time in Seconds Since Start of Test

41-S

Y	Del Y	Log Del Y	t
6.84	2.3	0.361727	6
5.7	1.16	0.064457	12
5.31	0.77	-0.11350	18
5.13	0.59	-0.22914	24
5.03	0.49	-0.30980	30
4.96	0.42	-0.37675	36
4.92	0.38	-0.42021	42
4.88	0.34	-0.46852	48
4.85	0.31	-0.50863	54
4.83	0.29	-0.53760	60
4.81	0.27	-0.56863	66
4.8	0.26	-0.58502	72
4.78	0.24	-0.61978	78
4.77	0.23	-0.63827	84
4.76	0.22	-0.65757	90
4.75	0.21	-0.67778	96
4.74	0.2	-0.69897	102
4.73	0.19	-0.72124	108
4.72	0.18	-0.74472	114
4.72	0.18	-0.74472	120
4.71	0.17	-0.76955	126
4.71	0.17	-0.76955	132
4.67	0.13	-0.88605	168
4.66	0.12	-0.92081	198
4.66	0.12	-0.92081	228
4.66	0.12	-0.92081	258
4.65	0.11	-0.95860	288
4.64	0.1	-1	318
4.64	0.1	-1	348
4.63	0.09	-1.04575	378
4.62	0.08	-1.09691	408
4.62	0.08	-1.09691	468
4.61	0.07	-1.15490	528
4.6	0.06	-1.22184	588
4.6	0.06	-1.22184	648
4.6	0.06	-1.22184	708
4.58	0.04	-1.39794	1038
4.55	0.01	-2	1338

Harnett Co. Landfill
REW A 352
4/12/91

Well 44-8 - Slug Test Data

Static Water Level Reading (FT-H2O) = 10.03

Y = Water Level Reading During Test (FT-H2O)
Del Y = Y - Static Water Level at Time t
t = Time in Seconds Since Start of Test

44-8

Y	Del Y	Log Del Y	t
12.23	2.2	0.342422	6
12.24	2.21	0.344392	12
12.23	2.2	0.342422	18
12.22	2.19	0.340444	24
12.22	2.19	0.340444	30
12.21	2.18	0.338456	40
12.2	2.17	0.336459	58
12.19	2.16	0.334453	82
12.19	2.16	0.334453	107
12.19	2.16	0.334453	137
12.17	2.14	0.330413	263
12.15	2.12	0.326335	413
12.13	2.1	0.322219	593
12.13	2.1	0.322219	713
12.09	2.06	0.313867	1042
11.98	1.95	0.290034	2242
11.89	1.86	0.269512	3742
11.8	1.77	0.247973	5242
11.69	1.66	0.220108	7042
11.59	1.56	0.193124	9442
11.5	1.47	0.167317	11542
11.4	1.37	0.136720	13642
11.31	1.28	0.107209	16342
11.25	1.22	0.086359	18142

SLUG TEST ON PIEZOMETER 46-D

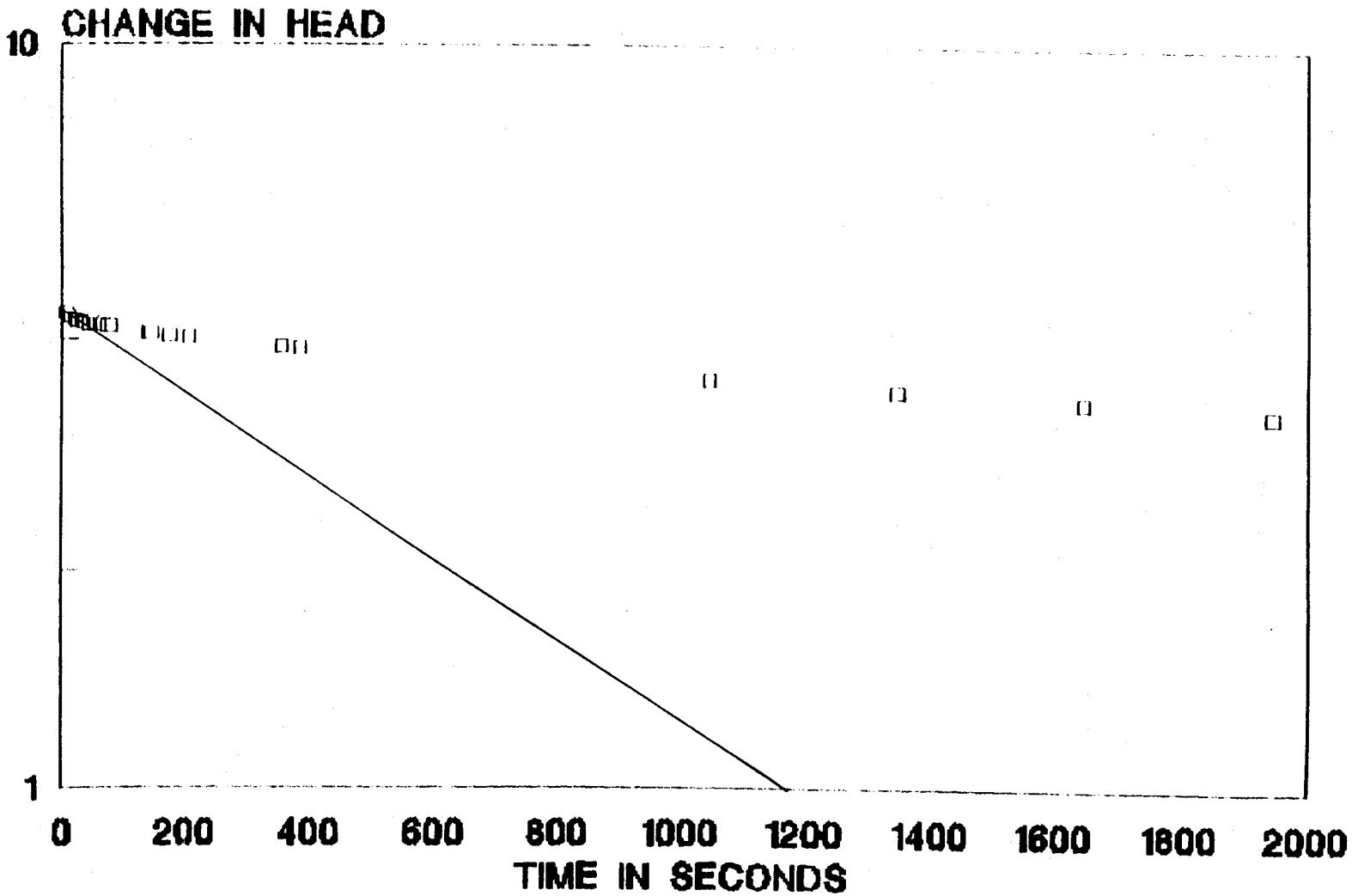
SECONDS	W HEIGHT	DELTA
10	27.19	7.64
20	27.17	7.61
30	27.16	7.61
60	27.12	7.57
90	27.11	7.56
120	27.07	7.52
150	27.06	7.51
180	27.04	7.49
210	27.01	7.46
240	27.00	7.45
270	26.99	7.44
300	26.97	7.42
330	26.96	7.41
360	26.95	7.40
390	26.95	7.40
420	26.93	7.38
450	26.92	7.37
480	26.91	7.36
510	26.91	7.36
540	26.91	7.36
570	26.91	7.36
600	26.89	7.34
630	26.89	7.34
750	26.86	7.31
870	26.83	7.28
990	26.81	7.26
1110	26.80	7.25
1230	26.78	7.23
1350	26.75	7.20
1470	26.74	7.19
1590	26.73	7.18
1710	26.72	7.17
1830	26.70	7.15
1950	26.68	7.13
2070	26.67	7.12
2190	26.66	7.11
2310	26.65	7.10
2430	26.63	7.08
2550	26.62	7.07
2670	26.61	7.06
2790	26.59	7.04
2910	26.58	7.03
3030	26.57	7.02
3150	26.57	7.02
3270	26.54	6.99
3390	26.53	6.98
3510	26.52	6.97

3630	26.51	6.96
3750	26.50	6.95
3870	26.47	6.92
3990	26.48	6.93
4110	26.26	6.70
4230	26.46	6.90
4350	26.45	6.90
4470	26.44	6.89
4590	26.42	6.87
4710	26.40	6.85

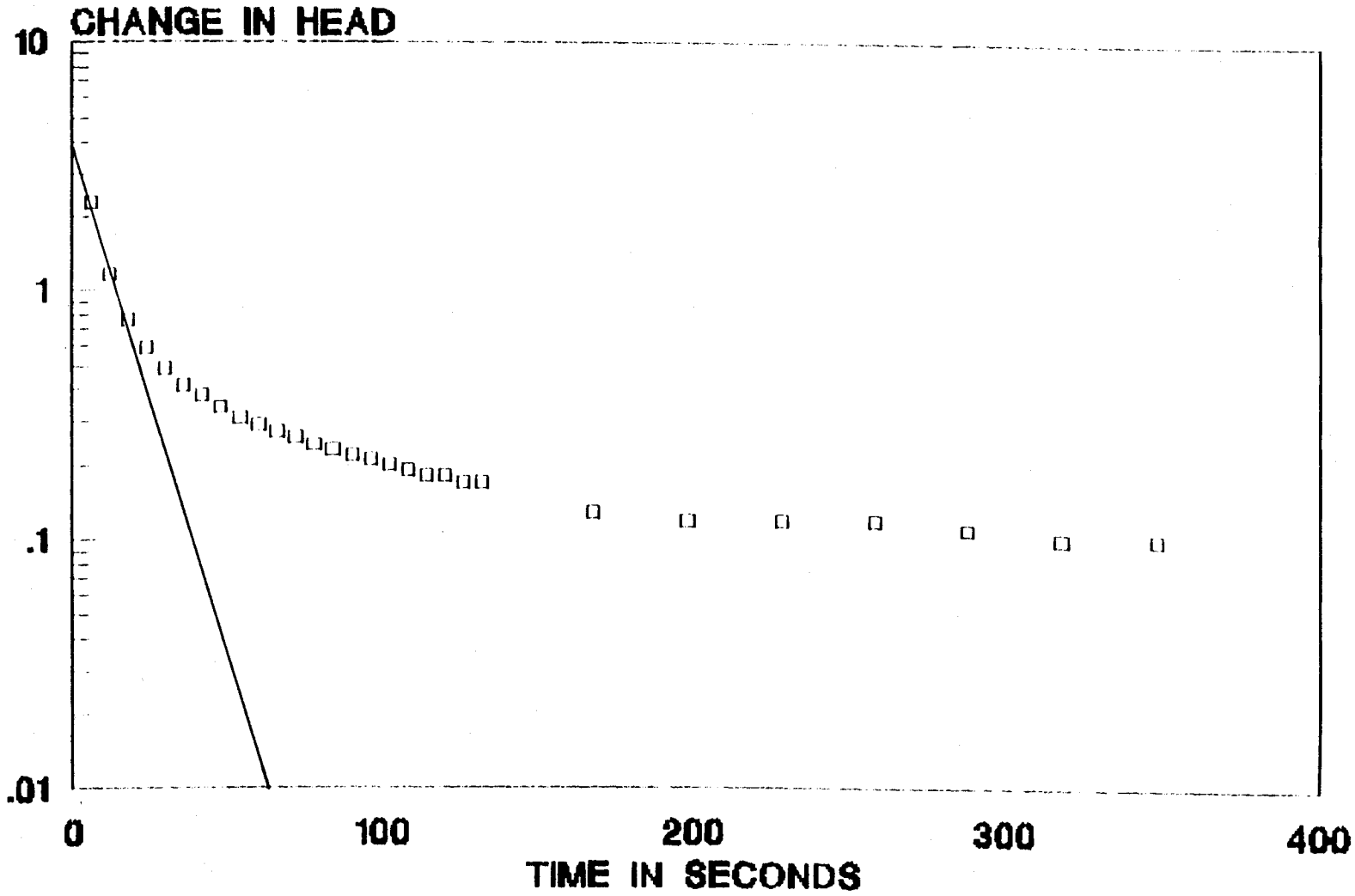
SLUG TEST ON PIEZOMETER 47-S

SECONDS	W HEIGHT	DELTA
10	18.70	5.05
20	18.68	5.03
30	18.56	4.91
40	18.51	4.86
50	18.47	4.82
60	18.45	4.80
70	18.41	4.76
80	18.39	4.74
90	18.37	4.72
100	18.34	4.69
110	18.32	4.67
120	18.29	4.64
130	18.27	4.62
140	18.24	4.59
150	18.22	4.57
160	18.19	4.54
280	17.95	4.30
400	17.75	4.10
520	17.55	3.90
640	17.38	3.73
760	17.22	3.57
880	17.09	3.44
1000	16.91	3.26
1120	16.78	3.13
1240	16.67	3.02
1360	16.56	2.91
1480	16.40	2.75
1600	16.31	2.66
1720	16.22	2.57

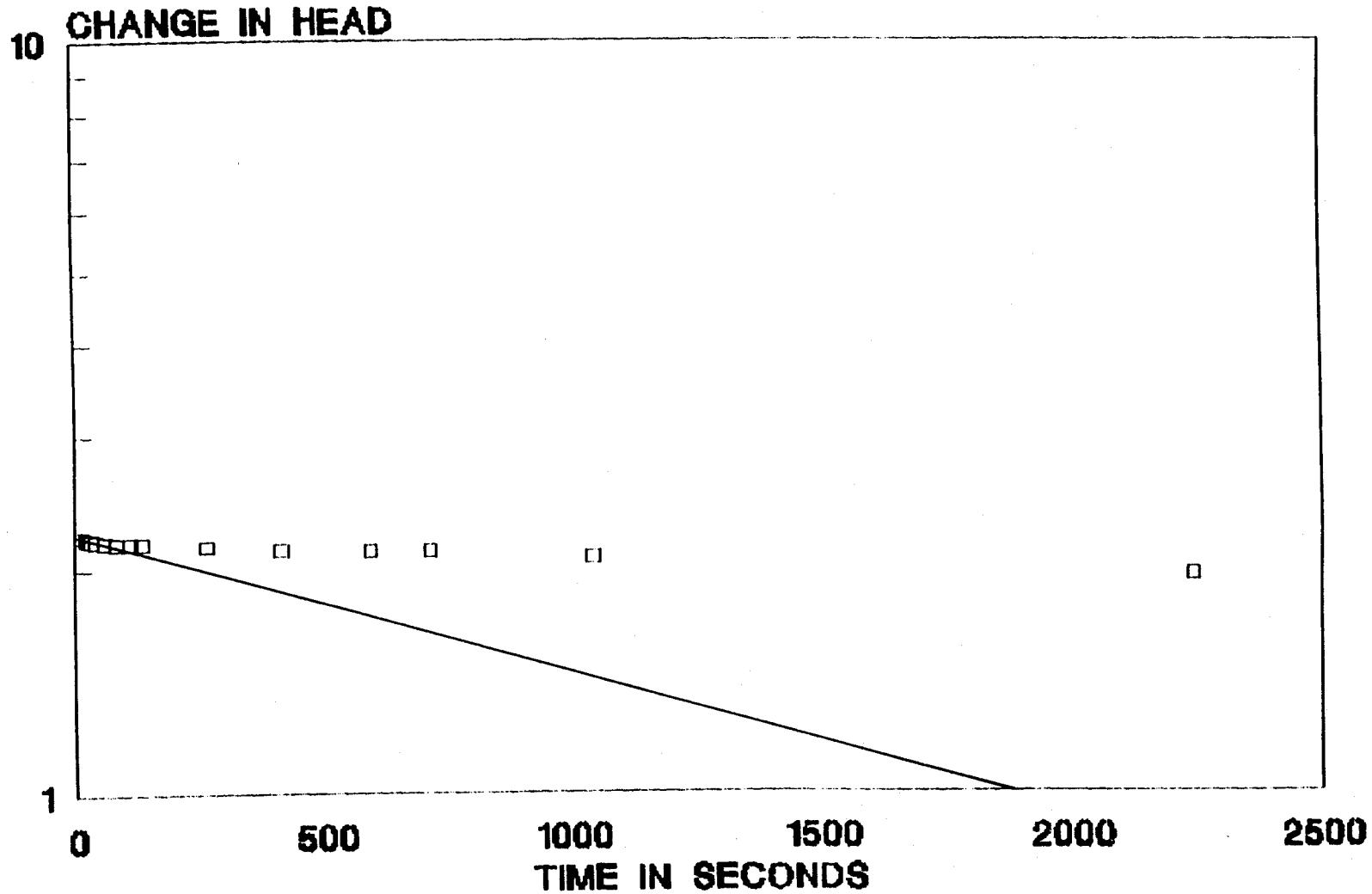
DATA FROM SLUG TEST ON 40-S



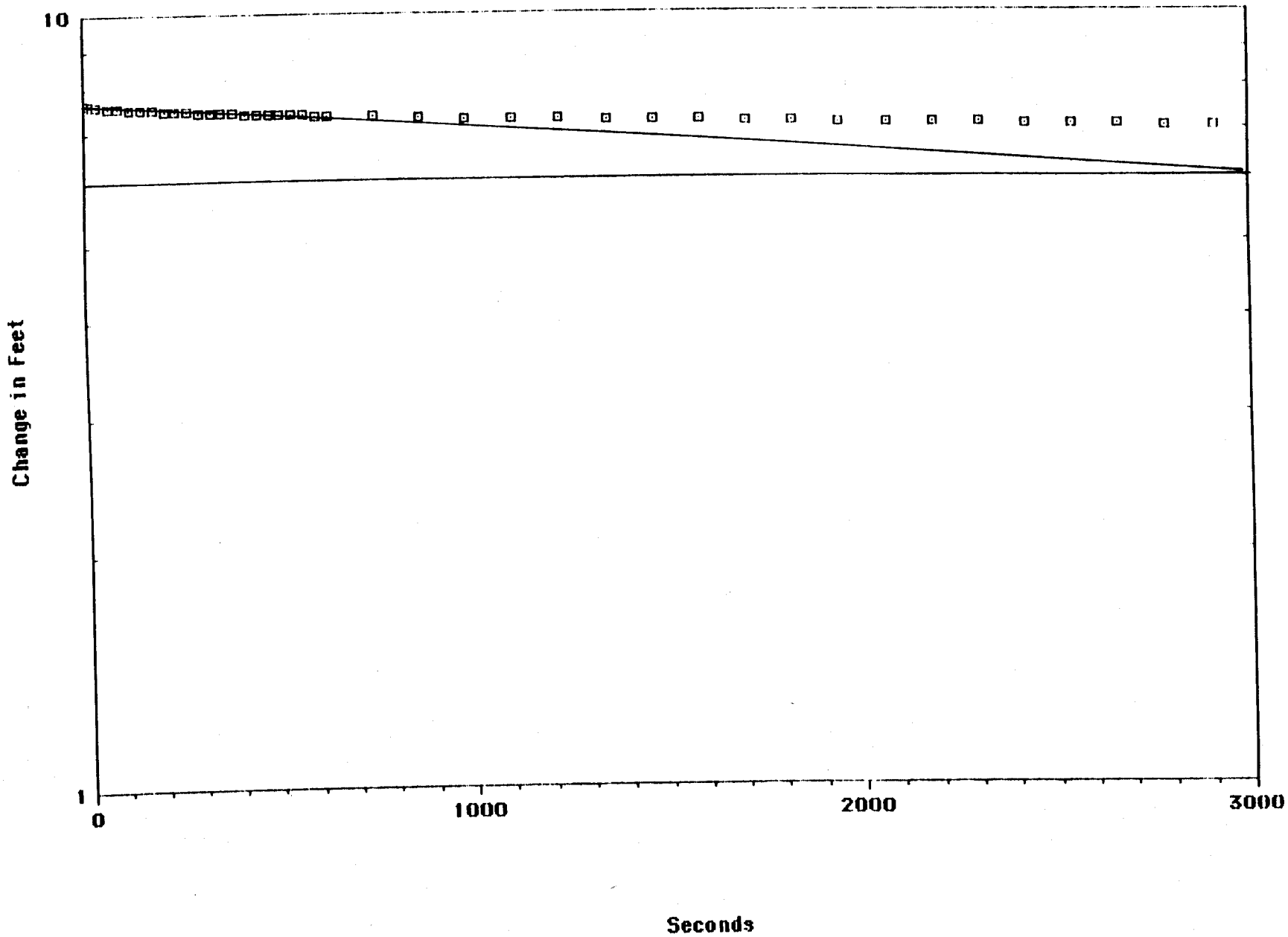
SLUG TEST ON 41-S



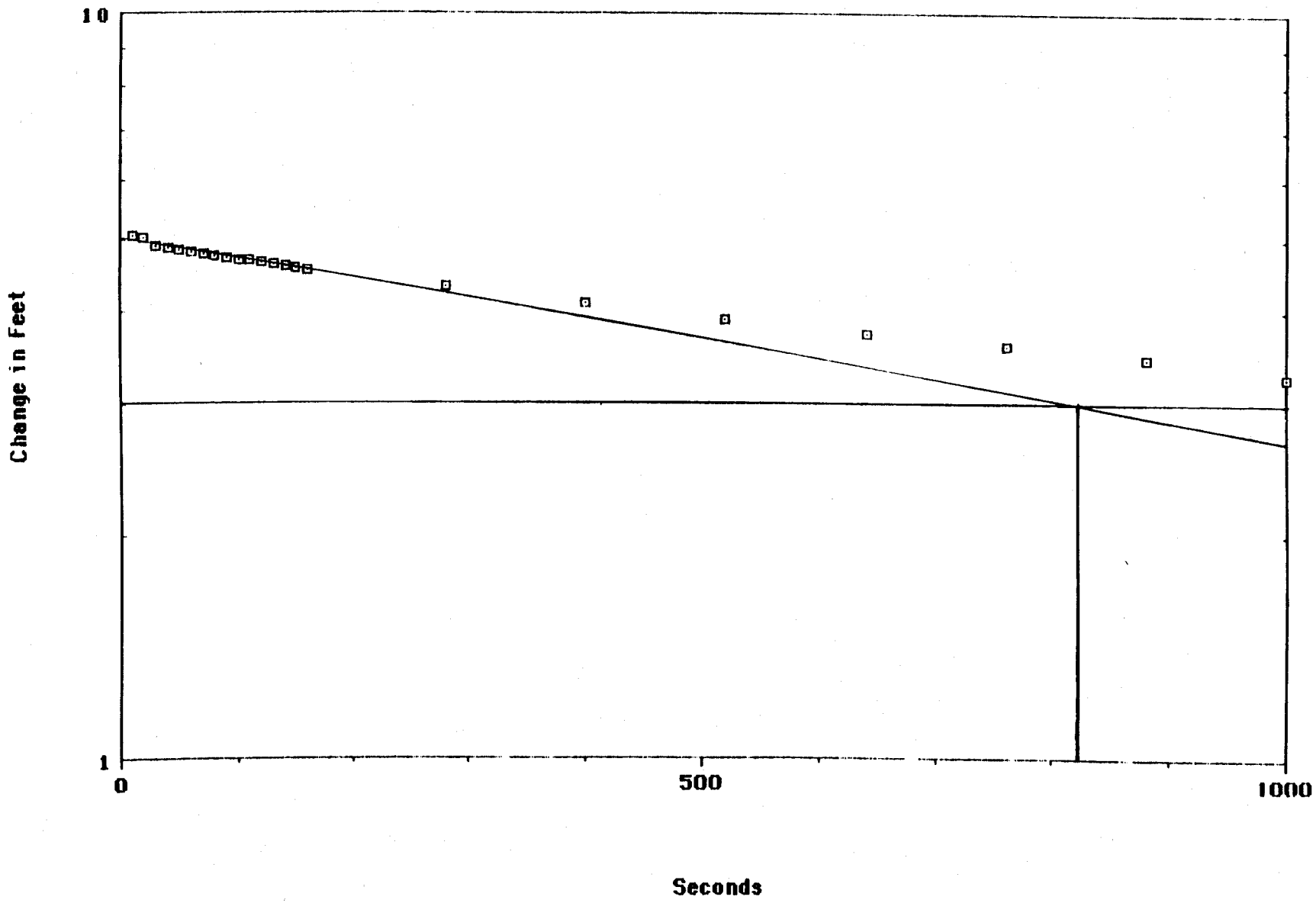
DATA FROM SLUG TEST ON 44-S



Data from "46-D Slug Test"



Data from "47-S slug Test"



PIEZOMETER	RICE-BOUWER EQUATION PARAMETERS							
	L_e	r_c	r_w	y_0	y_t	t	L_w	H
40-S	58.8	0.625	3	4.34	1.0	1,164	151.0	151.0
41-S	60.0	0.625	3	3.90	0.01	64	65.8	290.8
44-S	58.8	0.625	3	2.22	1.0	1,875	169.2	247.9
46-D	120.0	0.625	3	7.6	6.0	3,000	250.1	340.0
47-S	120.0	0.625	3	5.0	3.0	820	187.8	270.0

y_t and y_0 in feet
all other variables in inches

R91A130A/als

PROCEDURE FOR DETERMINING THE HYDRAULIC CONDUCTIVITY (K) OF AN AQUIFER FROM SLUG TEST DATA USING THE BOUWER AND RICE ANALYSIS

Reference: The Bouwer and Rice Slug Test - An Update by H. Bouwer, pp. 304-309, Ground Water, May - June 1989.

Conditions: The well can be partially penetrating and partially screened. The test may be performed by either adding or evacuating water. Consult the reference for further information.

Step 1: Determine the well dimensions required for this analysis and complete Figure 1.

Step 2: The elevational difference in feet between the static water level and the water level at time t seconds during the test is defined as (Y_t). Plot Y_t versus t on the semilog paper provided, following the example shown on Figure 3.

Step 3: Determine the natural (static) ground water elevation relative to the top of the well screen and the top of the gravel pack. If the slug test is expected to either drain or flood the gravel pack, a double straight line effect may appear in the data plot due to the relatively high K values of the gravel pack or developed zone versus the formation, as shown on Figure 4. Draw a "best fit" straight line through the "B-C" segment of the data and extrapolate this line to the log Y_t axis and the t axis, as shown in Figures 3 and 4.

Step 4: Having ascertained the values of Y_o (line intersection with Y axis), t (line intersection with t axis), and Y_t (y coordinate with t value) from the extrapolated line drawn in Step 3, calculate the value of 1/t ln (Y_o/Y_t)

Step 5: Using well construction and hydrogeologic information (Figure 1) ascertain the values of r_w, r_c, L_e, L_w, and H (saturated thickness). From the information, calculate the value of L_e/r_w.
If $L_w < H$ (Partially penetrating well), ascertain the values of A and B from Figure 2 and substitute them into the following equation to determine the value of $\ln(R_e/r_w)$. The values of L_w, r_w, H and L_e are all expressed in inches.

$$\ln (R_e/r_w) = \frac{1}{\dfrac{1.1}{\ln (L_w/r_w)} + \left(\dfrac{A + B \ln\left(\dfrac{H-L_w}{r_w}\right)}{L_e/r_w} \right)}$$

If $L_w = H$, ascertain the value of C from Figure 2 and substitute it into the following equation to determine the value of ln (R_e/r_w)

$$\ln (R_e/r_w) = \frac{1}{\dfrac{1.1}{\ln (L_w/r_w)} + \dfrac{C}{(L_e/r_w)}}$$

Step 6: Substitute the values of $(1/t \ln (Y_o/Y_t))$ and $(\ln (R_e/r_w))$, determined in Steps 4 and 5, respectively, along with r^2_c and $2L_e$ into the following equation to determine the hydraulic conductivity (K) in inches per second:

$$K = \frac{r^2_c \ln (R_e/r_w)}{2L_e} \frac{1}{t} \ln (Y_o/Y_t)$$

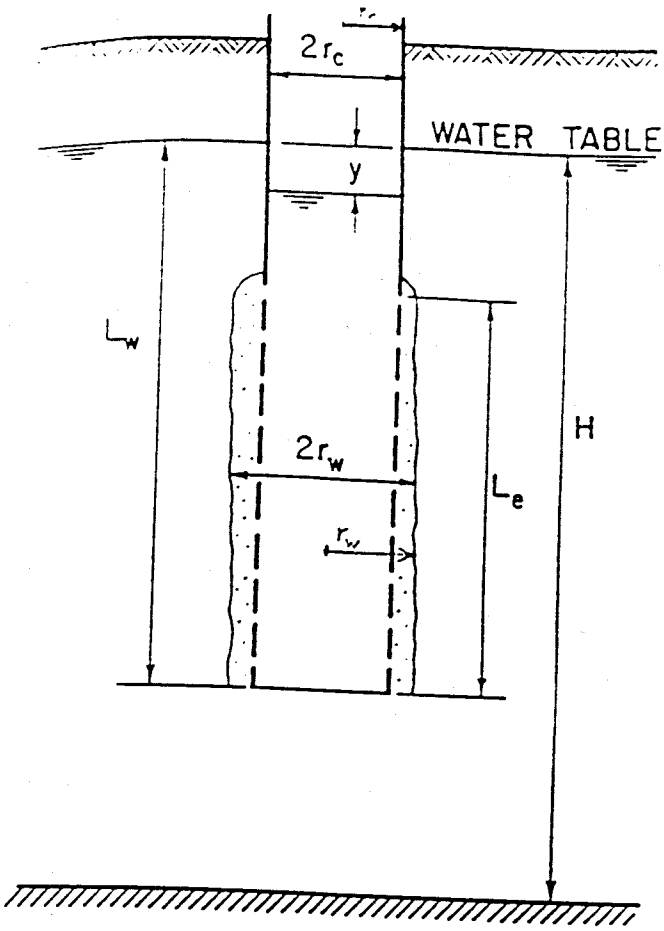
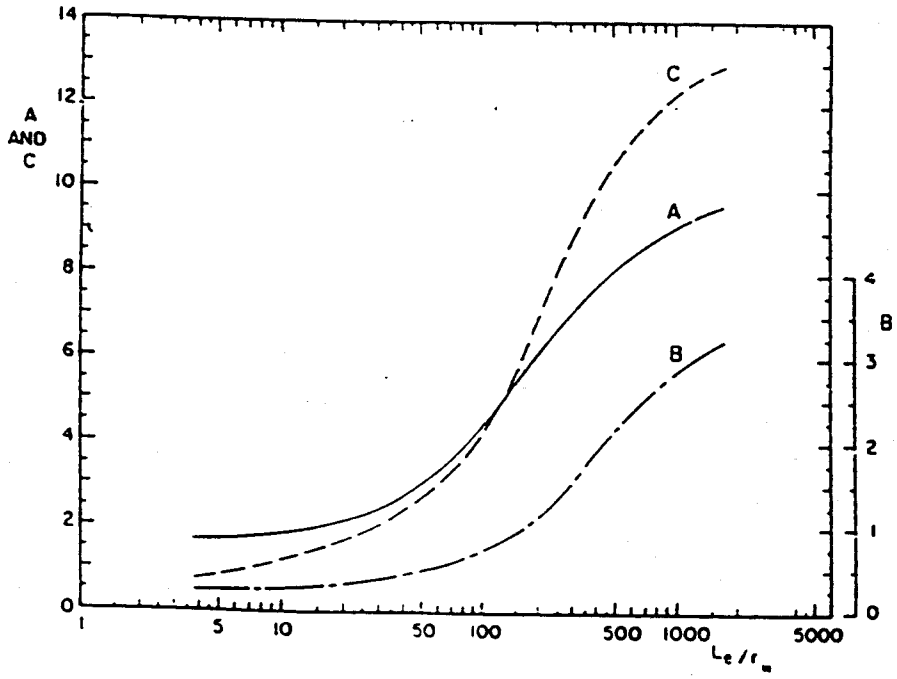


FIGURE 1



Dimensionless parameters A, B, and C as a function of L_e/r_w for calculation of $\ln(R_o/r_w)$

APPENDIX C

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Hard Reddish Brown to Gray Fine Sandy Silty CLAY	CL	208.8	8-11-19
5.0	Very Stiff Gray Silty CLAY	CH	203.8	6-9-12
			198.8	
13.5	Dense Medium Gray Clayey Silty Fine SAND	SM/SC	193.8	6-16-15
18.5	Hard Medium Gray Clayey SILT with Medium Gray Silty Fine to Medium SAND	ML/SM	188.8	8-18-23
23.5	Hard Medium Gray Clayey SILT	ML		10-20-27
25.0	Boring Terminated at 25.0'. No ground water encountered at termination of boring. Ground water encountered at 17.9' after 7 days.		183.8	

PENETRATION (BLOWS/FT.): 0 10 20 40 60 100

17.9

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER PB-9
DATE 3-4-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
0.0	Loose Gray to Brown Silty Coarse SAND	SM		2-2-4
5.0	Very Stiff Gray Very Silty Clayey Medium to Fine SAND	SM		5-8-14
12.0	Very Stiff Gray Clayey Plastic SILT	MH		6-10-13
15.0	Boring Terminated at 15.0'. No ground watet data at termination of boring. Ground water encountered at 2.4' after 7 days.			

2.4

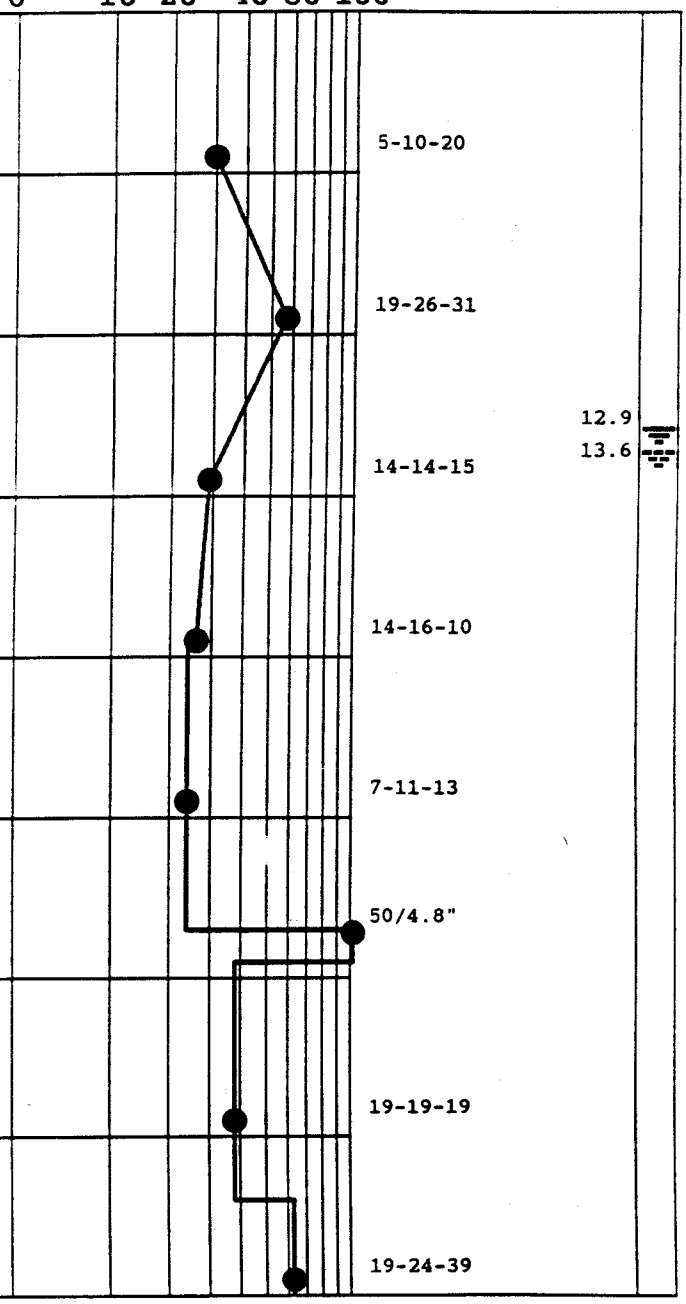
REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER 1051-91-141
BORING NUMBER B-40
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.)	BLOWS PER SIX IN.
0.0	Brown Tan Silty Medium to Coarse SAND	SM	205.7		
3.5	Medium Dense to Very Dense Light Brown-Tan Clayey Silty Medium to Coarse SAND	SM / SC	200.7		5-10-20
			195.7		19-26-31
			190.7		14-14-15
19.5	Very Stiff Gray to Tan Fine Sandy Clayey SILT	MH	185.7		14-16-10
			180.7		7-11-13
28.5	Tan Orange Silty Medium to Fine SAND with Gravel with Small Rock Fragments SM	MH	175.7		50/4.8"
29.5	Hard Gray Brown Fine Sandy Clayey SILT		170.7		19-19-19
37.0	Hard Gray Fine Sandy Silty CLAY	CH			19-24-39



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-41
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
			165.7		
43.0	Hard Gray Green Medium to Fine Sandy Clayey SILT	MH			20-27-50/4.8"
45.0	Hard Gray Green Fine Sandy Clayey SILT	MH	160.7		13-20-40
50.0	Boring Terminated at 50.0' Ground Water Encountered at 13.6' at Termination of Boring. Ground Water Encountered at 12.9' after 7 days		155.7		

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-41
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Loose Tan Brown Sandy GRAVEL	GP	165.8	
3.5	Stiff Light Gray Sandy Silty CLAY	CH	160.8	5-5-8
8.5	Hard Gray Red Mottled Clayey SILT	ML	155.8	11-14-22
			150.8	9-15-50
18.5	Medium Dense to Dense Light Gray Silty Medium to Coarse SAND	SM	145.8	3-12-21
			140.8	9-12-15
			135.8	7-12-14
33.5	Dense Light Gray Silty Medium to Medium SAND	SM	130.8	9-19-24
38.5	SEE NEXT PAGE	ML		30-50/4.8"

PENETRATION (BLOWS/FT.): 0, 10, 20, 40, 60, 100

17.6

38.7

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-42
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
	Hard Light Gray Red Mottled Clayey SILT		125.8		15-38-50/2.4"
			120.8		
48.5	Dense Light Gray Silty Fine SAND	SM			9-15-32
50.0	Boring Terminated at 50.0' Ground Water Encountered at 38.7' at Termination of Boring. Ground Water Encountered at 17.6' after 7 days.		115.8		

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-42
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Topsoil with Organics & Rootmat	SM	203.9	2-2-1
0.5	Very Loose Tan Silty Medium to Fine SAND	SM		3-2-3
3.0	Loose Orange to Brown Clayey Medium to Fine SAND		198.9	5-4-5
7.5	Loose Orange to Brown Clayey Medium to Fine SAND with Quartz Fragments	SM/SC		5-11-11
9.0	Medium Dense Orange to Brown Clayey Coarse to Medium SAND with Quartz Fragments	SM/SC	193.9	5-5-6
11.0	Medium Dense Tan Slightly Clayey Coarse to Medium SAND with Quartz Fragments	SM	188.9	5-7-9
15.0	Medium Dense Yellow Slightly Clayey Coarse to Medium SAND with Quartz Fragments	SM	183.9	
20.0	Boring Terminated at 20.0' Caved Wet at 15.0'			

PENETRATION (BLOWS/FT.): 0, 10, 20, 40, 60, 100

15.0

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-43
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0				
0.4	Topsoil with Organics and Rootmat	SC	182.2	
	Medium Dense Yellow-Orange Clayey Coarse to Medium SAND			8-9-11
			177.2	
9.5	Stiff Gray to Tan Slightly Coarse to Medium Sandy CLAY	CL		2-3-6
			172.2	
12.0	Dense Gray to Tan Silty Clayey Coarse to Medium SAND to a Coarse to Medium Sandy CLAY	SC CL		14-24-26
			167.2	
18.0	Hard Brown to Tan Medium to Fine Sandy SILT	ML		13-24-30
			162.2	
22.0	Hard Red to Gray Silty CLAY	CH		14-20-24
			157.2	
28.0	Hard Gray Clayey SILT	MH		13-22-33
			152.2	
33.0	Hard Red to Gray Medium to Fine Sandy SILT	ML		16-35-50
			147.2	
39.0				36-50/4.2"

PENETRATION (BLOWS/FT.): 0 10 20 40 60 100

9.1

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-44
DATE 3-6-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
	Hard Gray Fine Sandy SILT	ML	142.2		36-50/4.8"
47.0	Dense Light Gray Silty Coarse to Medium SAND	SM	137.2		10-12-22
50.0	Boring Terminated at 50.0' No Ground Water Data at Termination of Boring. Ground Water Encountered at 9.1' after 7 days.		132.2		

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

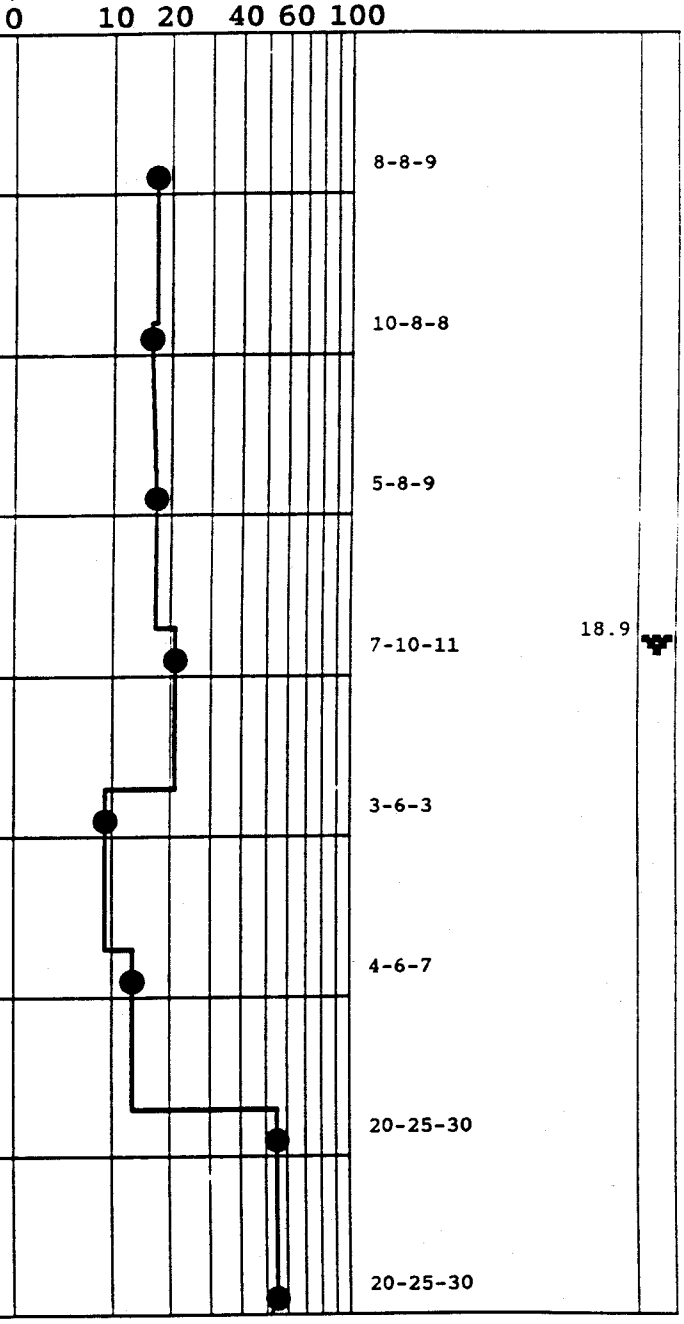
JOB NUMBER REW-A-130
BORING NUMBER B-44
DATE 3-6-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Dark Brown Clayey Silty Fine to Medium SAND with Organics SM/SC		200.2	
2.0	Medium Dense Red Clayey Silty Medium to Coarse SAND	SC		8-8-9
			195.2	
9.0	Medium Dense White Clean Medium SAND	SP		10-8-8
			190.2	5-8-9
			185.2	
18.5	Medium Dense Brown Red Silty Sandy Gravel	GP		7-10-11
			180.2	
23.5	Loose Brown White and Pink Mottled Silty Coarse SAND with Gravel	SM		3-6-3
			175.2	
28.5	Stiff Gray Silty CLAY	CH		4-6-7
			170.2	
33.5	Very Dense Brown Gray Silty Medium to Coarse SAND	SM		20-25-30
			165.2	
39.0				20-25-30

PENETRATION (BLOWS/FT.): 0 10 20 40 60 100



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-45
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
	Hard Brown Gray SILT CLAY Medium Plastic	CH	160.2		11-14-16
			155.2		
48.5	Very Dense Gray with Pink Red Mottled Clayey Sandy SILT	ML			25-35-50/4.8"
50.0			150.2		

Boring Terminated at 50.0'
Ground water encountered at 18.8' at termination of boring. Ground water encountered at 18.9' after 7 days.

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-45
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Loose Brown Clayey Silty Fine SAND	SM/SC	218.1	
3.5	Hard Brown Red Sandy Clayey SILT	ML	213.1	3-10-20
8.5	Very Stiff to Hard Red-Brown Silty Medium to Coarse Sandy CLAY	CL	208.1	16-24-24
			203.1	11-11-12
18.5	Dense to Medium Dense White with Pink Mottled Coarse SAND	SP	198.1	11-20-21
			193.1	17-21-24
			188.1	5-6-7
33.5	Stiff Gray Clayey Sandy SILT	ML	183.1	5-5-8
				11-11-17

PENETRATION (BLOWS/FT.): 0 10 20 40 60 100

28.1

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-46
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
			178.1		
43.5					
44.0	Dense Medium to Light Brown Clayey Silty SAND	SM			23-22-23
		ML	173.1		
	Hard Red-Brown to Gray Sandy Clayey SILT				20-30-50
50.0	Boring Terminated at 50.0' Ground Water Encountered at 43.7' at Termination of Boring. Ground Water Encountered at 28.1' after 7 days.		168.1		

43.7

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-46
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Brown Clayey Silty SAND with Gravel	SM/SC	188.0	
4.0	Stiff Brown Sandy Clayey SILT	ML	183.0	7-7-8
8.5	Medium Dense Brown and Light Gray Silty Fine SAND	SM	178.0	3-6-10
13.5	Hard Gray Brown Sandy Clayey SILT	ML	173.0	5-15-24
			168.0	18-40-48
22.5	Dense Gray Brown Silty Fine to Coarse SAND	SM	163.0	4-16-19
28.5	Hard Dark Gray Brown Silty CLAY	CL	158.0	19-19-23
33.5	Hard Greenish Gray Clayey SILT	ML	153.0	16-26-38
37.9	Dense to Very Dense Gray Silty Medium SAND	SM		16-18-50/4.8"

PENETRATION (BLOWS/FT.): 0, 10, 20, 40, 60, 100

24.6

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-47
DATE 3-7-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
40.0	Hard Medium Gray Fine Sandy Clayey SILT	ML	148.0		50/6.0"
			143.0		35-50/4.8"
			138.0		
53.5	Very Dense Medium Gray Silty Medium to Coarse SAND	SM			13-36-37
55.0	Boring Terminated at 55.0' No Ground Water Data at Termination of Boring. Ground Water Encountered at 24.6' after 7 days.		133.0		

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-47
DATE 3-7-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Medium Dense Gray to Tan Silty Medium to Fine SAND	SM	207.1	7-10-10
5.0	Medium Dense Orange to Yellow Slightly Clayey Coarse to Medium SAND with Quartz Fragments	SM	202.1	9-13-11
11.0	Stiff Gray to Orange Slightly Fine Sandy Silty CLAY	CH	197.1	2-3-8
			192.1	6-13-13
22.0	Dense Gray Slightly Clayey Silty Medium to Fine SAND	SM	187.1	11-16-21
			182.1	8-15-17
32.0	Hard Gray Silty Medium to Fine Sandy CLAY to a Silty Clayey Medium to Fine SAND	CH SC	177.1	8-22-31
35.0	Very Dense Silty Clayey Coarse SAND	SC	172.1	17-23-26

PENETRATION (BLOWS/FT.): 0 10 20 40 60 100

9.9

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-48
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
			167.1		10-13-20
			162.1		
47.0	Hard Gray Clayey SILT	MH			10-18-25
50.0	Boring Terminated at 50.0' No ground water encountered at termination of boring. Ground water encountered at 9.9' after 7 days.		157.1		

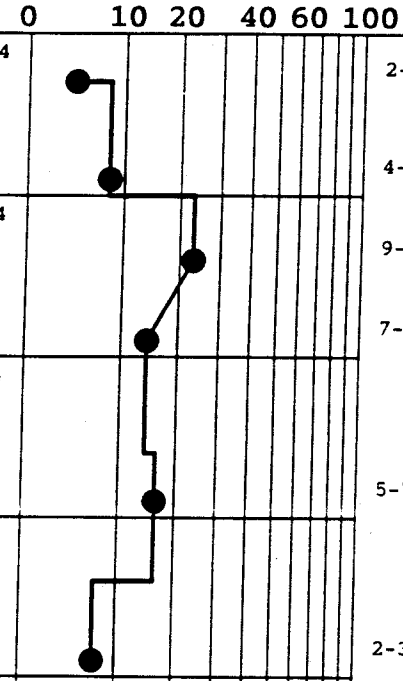
REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-48
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.)	BLOWS PER SIX IN.
0.0	Topsoil with Organics and Rootmat		204.4		2-2-2
0.5	Loose Tan to Gray Medium to Fine SAND	SM			
1.5	SM	SC			4-4-4
5.0	Loose Orange to Brown Clayey Coarse to Medium SAND	SM	199.4		9-11-12
	Medium Dense Orange to Yellow Slightly Clayey Silty Coarse to Medium SAND				7-7-7
			194.4		
13.0	Medium Dense Orange to Yellow Slightly Silty Coarse to Medium SAND	SP			5-7-9
			189.4		16.2
17.0	Medium Stiff Light Gray to Tan Silty CLAY	CH			2-3-4
20.0	Boring Terminated at 20.0' Ground Water Encountered at 16.2' at Termination of Boring		184.4		



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

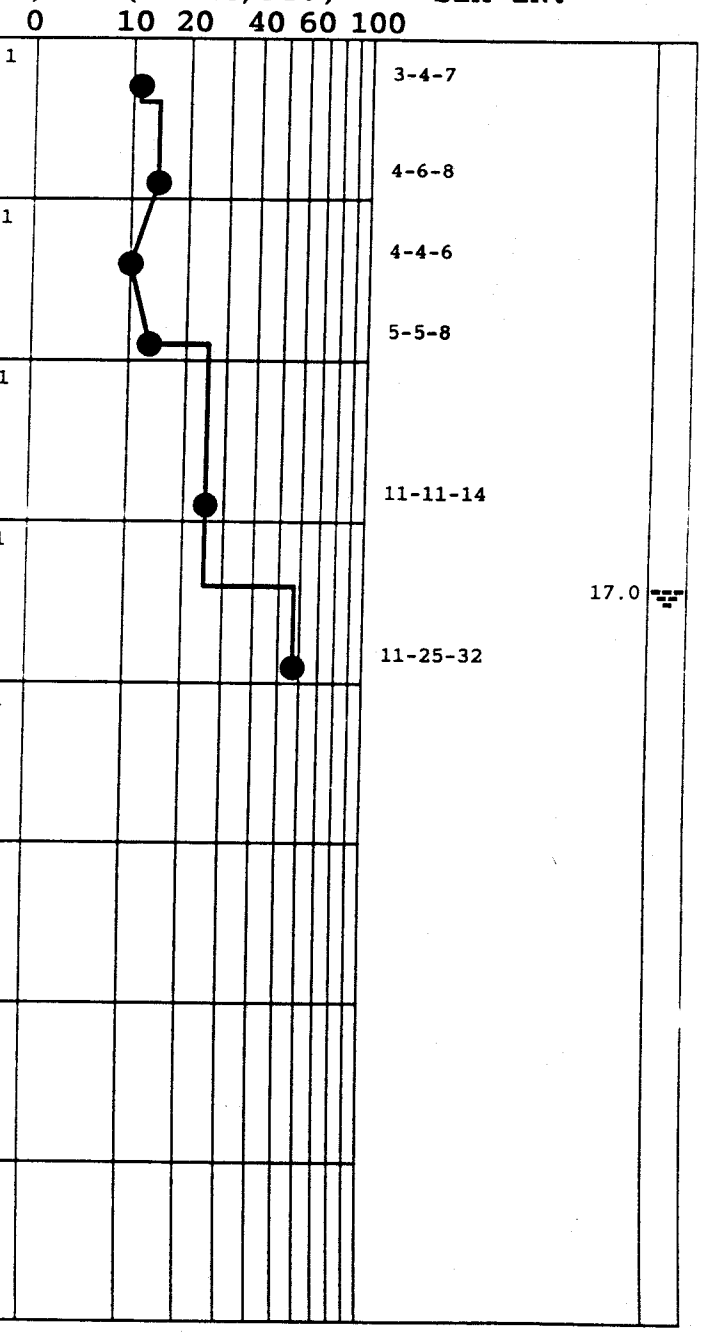
JOB NUMBER REW-A-130
BORING NUMBER B-51
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0				
0.3	TOPSOIL	CL	207.1	3-4-7
2.0	Stiff Orange to Brown Silty Medium to Fine Sandy CLAY	CL		4-6-8
	Stiff Orange Red to Yellow Fine Sandy Silty CLAY		202.1	4-4-6
9.5	Stiff Tan to Gray Silty CLAY	CH	197.1	5-5-8
				11-11-14
17.0	Very Dense Gray to Brown Silty Clayey Medium to Fine SAND	SC	192.1	11-25-32
20.0	Boring Terminated at 20.0' Ground Water Encountered at 17.0 at Termination of Boring		187.1	

PENETRATION (BLOWS/FT.)



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-53
DATE 3-4-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Loose Orange to Tan Clayey Medium to Fine SAND	SC	222.5	3-3-3
3.0	Very Stiff Orange to Red Fine Sandy Silty CLAY	CL	217.5	6-8-13
8.0	Medium Dense Orange to Brown Clayey Fine SAND	SC	212.5	8-13-16
14.0	Soft Red to Orange Silty CLAY	CH	207.5	3-4-7
18.0	Soft Red to Orange Clayey SILT	MH	202.5	2-1-3
21.0	Very Stiff Gray to Black Silty CLAY	CH	197.5	1-1-2
25.0	Boring Terminated at 25.0' Ground Water Encountered at 17.0' at Termination of Boring.			4-8-12

PENETRATION (BLOWS/FT.): 0 10 20 40 60 100

17.0

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-55
DATE 3-4-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0				
0.3	TOPSOIL	CH	202.0	
	Stiff Red Silty CLAY			3-4-5
3.0	Stiff Red Fine Sandy Clayey SILT	ML		3-4-6
5.0	Dense Red Brown Clayey Coarse to Medium SAND with Numerous Quartz Fragments	SM / SC	197.0	15-18-14
				5-10-10
11.0	Very Stiff Light Gray Silty CLAY	CH	192.0	
				4-9-11
			187.0	
18.5	Hard Light Gray to Tan Medium to Fine Sandy Silty CLAY	CH		6-17-29
20.0			182.0	

PENETRATION (BLOWS/FT.): 0, 10, 20, 40, 60, 100

3.7

15.5

Boring Terminated at 20.0'
Ground Water Encountered at 15.5' at Termination of Boring. Ground Water Encountered at 3.75' after 7 days.

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-57
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0				
0.3	TOPSOIL	SC	212.0	
	Loose Tan Clayey Medium to Fine SAND with Quartz Pebbles			2-2-4
3.0		SC		
	Medium Dense Yellow to Orange Clayey Coarse to Medium SAND			7-7-12
5.0		MH	207.0	
	Stiff Yellow Gray to Red Fine Sandy Clayey SILT			2-4-5
				3-3-5
			202.0	
14.0	Very Stiff Gray Fine Sandy Silty CLAY	CH		3-7-10
16.0		CL	197.0	
	Hard Gray Silty Medium to Fine Sandy CLAY			10-14-19
20.0	Boring Terminated at 20.0' Ground Water Encountered at 15.0' at Termination of Boring. Ground Water Encountered at 8.0' after 7 days.		192.0	

PENETRATION (BLOWS/FT.): 0 10 20 40 60 100

8.0

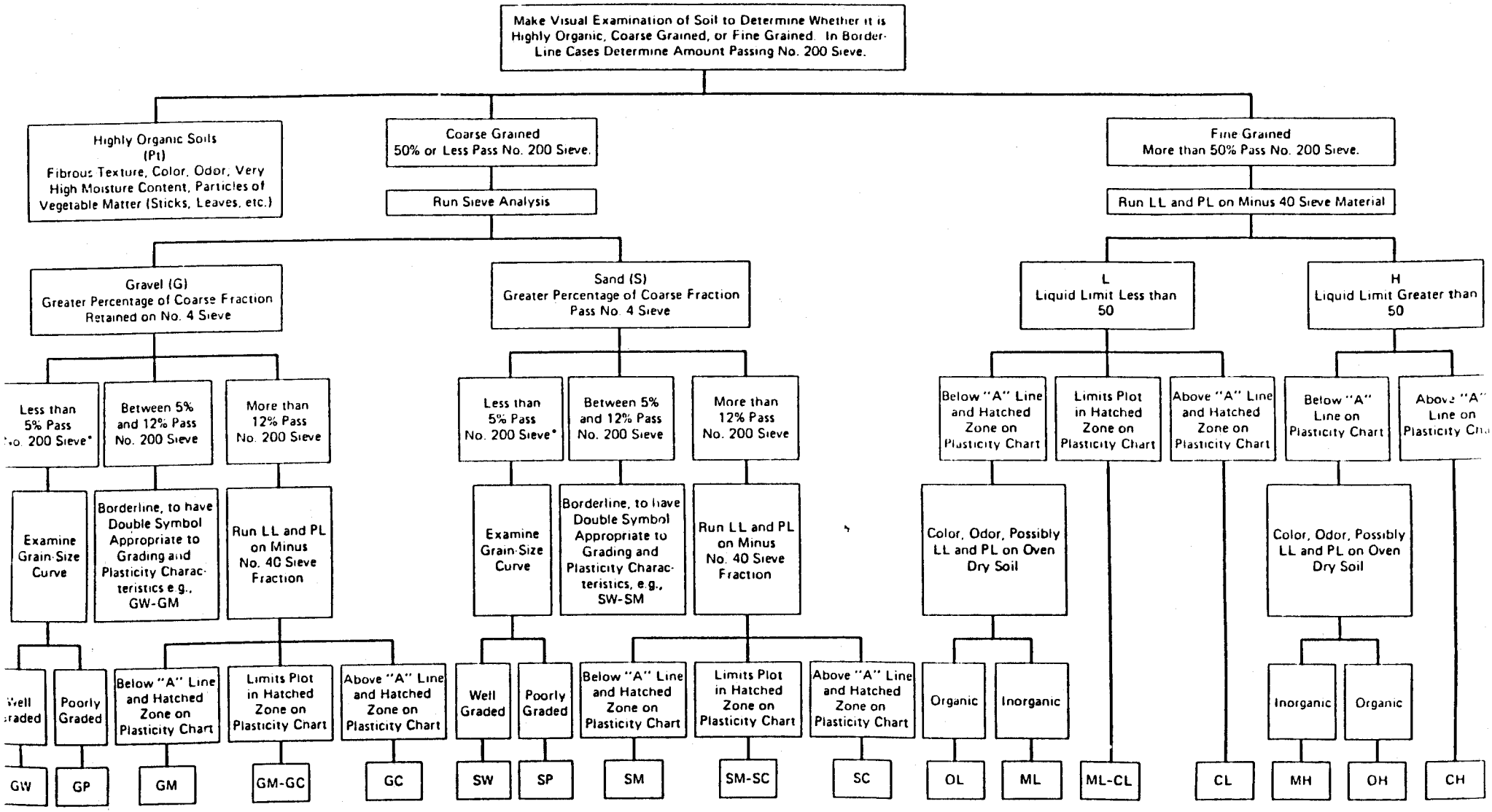
15.0

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-58
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

APPENDIX D



Note: Sieve Sizes are U.S. Standard.
*If Fines Interfere with Free-Draining Properties use Double Symbol such as GW-GM, etc.

UNIFIED SOIL CLASSIFICATION SYSTEM

WESTINGHOUSE ENVIRONMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REWICO JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: W42 DEPTH: 4 - 5 FT.

SOIL DESCRIPTION: MOTTLED SLIGHTLY SANDY SILTY CLAY

NOTES: LL = 60 / PL = 29 / PI = 31 / CH

sample from top of tube

UNDISTURBED (X) REMOLDED ( )

MAX DRY DENSITY lbs./cu.ft.

OPTIMUM MOISTURE %

% COMPACTION %

SAMPLE DATA

HEIGHT	7.75	cm.	MOISTURE CONTENT	32.5	%
DIAMETER	7.31	cm.	WET DENSITY	113.2	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	85.4	lbs/cu.ft
VOLUME	325.26	cu.cm.	INITIAL SATURATION	89.6	%
WET WEIGHT	589.97	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	445.26	grams	INITIAL VOID RATIO	0.987	
			POROSITY	0.497	
			SPECIFIC GRAVITY	2.720	apparent

1. K = 4.15E-06
2. K = 3.64E-06
3. K = 3.41E-06

AVERAGE K = 3.73E-06

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: W42 DEPTH: 4 - 6 FT.

SOIL DESCRIPTION: MOTTLED SANDY SILTY CLAY

NOTES: LL =53 / PL = 26 / PI = 27 / CH

---

sample from bottom of tube

UNDISTURBED (X) REMOLDED ( )

MAX DRY DENSITY lbs./cu.ft.

OPTIMUM MOISTURE %

% COMPACTION %

SAMPLE DATA

HEIGHT	8.10	cm.	MOISTURE CONTENT	30.1	%
DIAMETER	7.31	cm.	WET DENSITY	113.6	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	87.3	lbs/cu.ft
VOLUME	339.95	cu.cm.	INITIAL SATURATION	87.4	%
WET WEIGHT	618.90	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	475.71	grams	INITIAL VOID RATIO	0.929	
			POROSITY	0.482	
			SPECIFIC GRAVITY	2.700	apparent

1. K = 1.41E-06
2. K = 1.31E-06
3. K = 1.37E-06

AVERAGE K = 1.36E-06

WESTINGHOUSE ENVIRONMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: FEW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP49 DEPTH: 2 - 8 FT.

SOIL DESCRIPTION: GRAYISH BROWN SANDY CLAYEY SILT w/ MICA

NOTES: LL = 33 , PL = 15 , PI = 18

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	117.8 lbs./cu.ft.
OPTIMUM MOISTURE	12.8 %
% COMPACTION	96.6 %

SAMPLE DATA

HEIGHT	7.80	cm.	MOISTURE CONTENT	14.8 %
DIAMETER	7.31	cm.	WET DENSITY	130.6 lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	113.8 lbs/cu.ft
VOLUME	327.36	cu.cm.	INITIAL SATURATION	88.7 %
WET WEIGHT	685.12	grams	FINAL SATURATION	100.0 %
DRY WEIGHT	596.79	grams	INITIAL VOID RATIO	0.437
			POROSITY	0.304
			SPECIFIC GRAVITY	2.620 apparent

1. K = 1.60E-06
2. K = 1.29E-06
3. K = 1.40E-06

AVERAGE K = 1.43E-06

WESTINGHOUSE ENVIRONMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: APRIL 91 SAMPLE #: TP49 DEPTH: 2 - 8 FT.

SOIL DESCRIPTION: GRAYISH BROWN SANDY CLAYEY SILT w/ MICA

NOTES: LL = 33 / PL = 15 / PI = 18

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	117.8 lbs./cu.ft.
OPTIMUM MOISTURE	12.8 %
% COMPACTION	98.1 %

SAMPLE DATA

HEIGHT	7.80	cm.	MOISTURE CONTENT	14.7 %
DIAMETER	7.31	cm.	WET DENSITY	132.5 lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	115.6 lbs/cu.ft
VOLUME	327.36	cu.cm.	INITIAL SATURATION	92.8 %
WET WEIGHT	695.15	grams	FINAL SATURATION	100.0 %
DRY WEIGHT	606.06	grams	INITIAL VOID RATIO	0.415
			POROSITY	0.293
			SPECIFIC GRAVITY	2.620 apparent

1. K = 2.18E-07
2. K = 2.40E-07
3. K = 3.22E-07

AVERAGE K = 2.60E-07

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW100 JOB NAME: HARLETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP50 DEPTH: 2 - 6 FT.

SOIL DESCRIPTION: OLIVE YELLOW SILTY CLAYEY SAND w/ MICA

NOTES: LL = 54 / PL = 25 / PI = 29 / SC

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	107.8 lbs./cu.ft.
OPTIMUM MOISTURE	16.6 %
% COMPACTION	95.4 %

SAMPLE DATA

HEIGHT	7.59	cm.	MOISTURE CONTENT	19 %
DIAMETER	7.30	cm.	WET DENSITY	122.4 lbs/cu.ft
AREA	41.89	sq.cm.	DRY DENSITY	102.9 lbs/cu.ft
VOLUME	318.02	cu.cm.	INITIAL SATURATION	84.4 %
WET WEIGHT	623.65	grams	FINAL SATURATION	100.0 %
DRY WEIGHT	524.08	grams	INITIAL VOID RATIO	0.590
			POROSITY	0.371
			SPECIFIC GRAVITY	2.620 apparent

1. K = 7.33E-06
2. K = 6.77E-06
3. K = 6.55E-06

AVERAGE K = 6.88E-06

WESTINGHOUSE ENVIRONMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW100 JOB NAME: HARNETT COUNTY LANDFILL

DATE: APRIL 91 SAMPLE #: TP50 DEPTH: 2 - 6 FT.

SOIL DESCRIPTION: OLIVE YELLOW SILTY CLAYEY SAND w/ MICA

NOTES: LL = 54 / PL = 25 / PI = 29 / SC

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY 107.8 lbs./cu.ft.

OPTIMUM MOISTURE 16.5 %

% COMPACTION 99 %

SAMPLE DATA

HEIGHT	7.80	cm.	MOISTURE CONTENT	18.5	%
DIAMETER	7.31	cm.	WET DENSITY	126.5	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	106.8	lbs/cu.ft
VOLUME	327.36	cu.cm.	INITIAL SATURATION	91.1	%
WET WEIGHT	663.47	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	559.39	grams	INITIAL VOID RATIO	0.532	
			POROSITY	0.347	
			SPECIFIC GRAVITY	2.620	apparent

1. K = 8.11E-07
2. K = 7.22E-07
3. K = 6.95E-07

AVERAGE K = 7.76E-07

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: FEW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP52 DEPTH: 7 - 10.5 FT.

SOIL DESCRIPTION: OLIVE YELLOW SILTY CLAYEY SAND w/ MICA

NOTES: LL = 43 PL = 18 / PI = 25 / SC

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	112.6 lbs./cu.ft.
OPTIMUM MOISTURE	14.5 %
% COMPACTION	95.3 %

SAMPLE DATA

HEIGHT	7.65	cm.	MOISTURE CONTENT	16.6 %
DIAMETER	7.31	cm.	WET DENSITY	125.1 lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	107.3 lbs/cu.ft
VOLUME	321.06	cu.cm.	INITIAL SATURATION	81.3 %
WET WEIGHT	643.65	grams	FINAL SATURATION	100.0 %
DRY WEIGHT	552.02	grams	INITIAL VOID RATIO	0.541
			POROSITY	0.351
			SPECIFIC GRAVITY	2.650 apparent

1. K = 2.17E-06
2. K = 2.00E-06
3. k = 2.04E-06

AVERAGE K = 2.07E-06

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP52 DEPTH: 7 - 10.5 FT.

SOIL DESCRIPTION: OLIVE YELLOW SILTY CLAYEY SAND w/ MICA

NOTES: LL = 43 / PL = 18 / PI = 25 / SC

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY 112.6 lbs./cu.ft.

OPTIMUM MOISTURE 14.5 %

% COMPACTION 97.9 %

SAMPLE DATA

HEIGHT	7.80	cm.	MOISTURE CONTENT	16.6	%
DIAMETER	7.31	cm.	WET DENSITY	128.5	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	110.2	lbs/cu.ft
VOLUME	327.36	cu.cm.	INITIAL SATURATION	87.8	%
WET WEIGHT	673.86	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	577.92	grams	INITIAL VOID RATIO	0.501	
			POROSITY	0.334	
			SPECIFIC GRAVITY	2.650	apparent

1. K = 9.03E-07
2. K = 7.15E-07
3. K = 7.22E-07

AVERAGE K = 7.80E-07

WESTINGHOUSE ENVIRONMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: PEW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP54 DEPTH: 4 - 10 FT.

SOIL DESCRIPTION: YELLOW BROWN SILTY CLAYEY SAND w/ MICA

NOTES: LL = 33 / PL = 24 / PI = 9 / SC-SM

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	113.3 lbs./cu.ft.
OPTIMUM MOISTURE	14.8 %
% COMPACTION	94.6 %

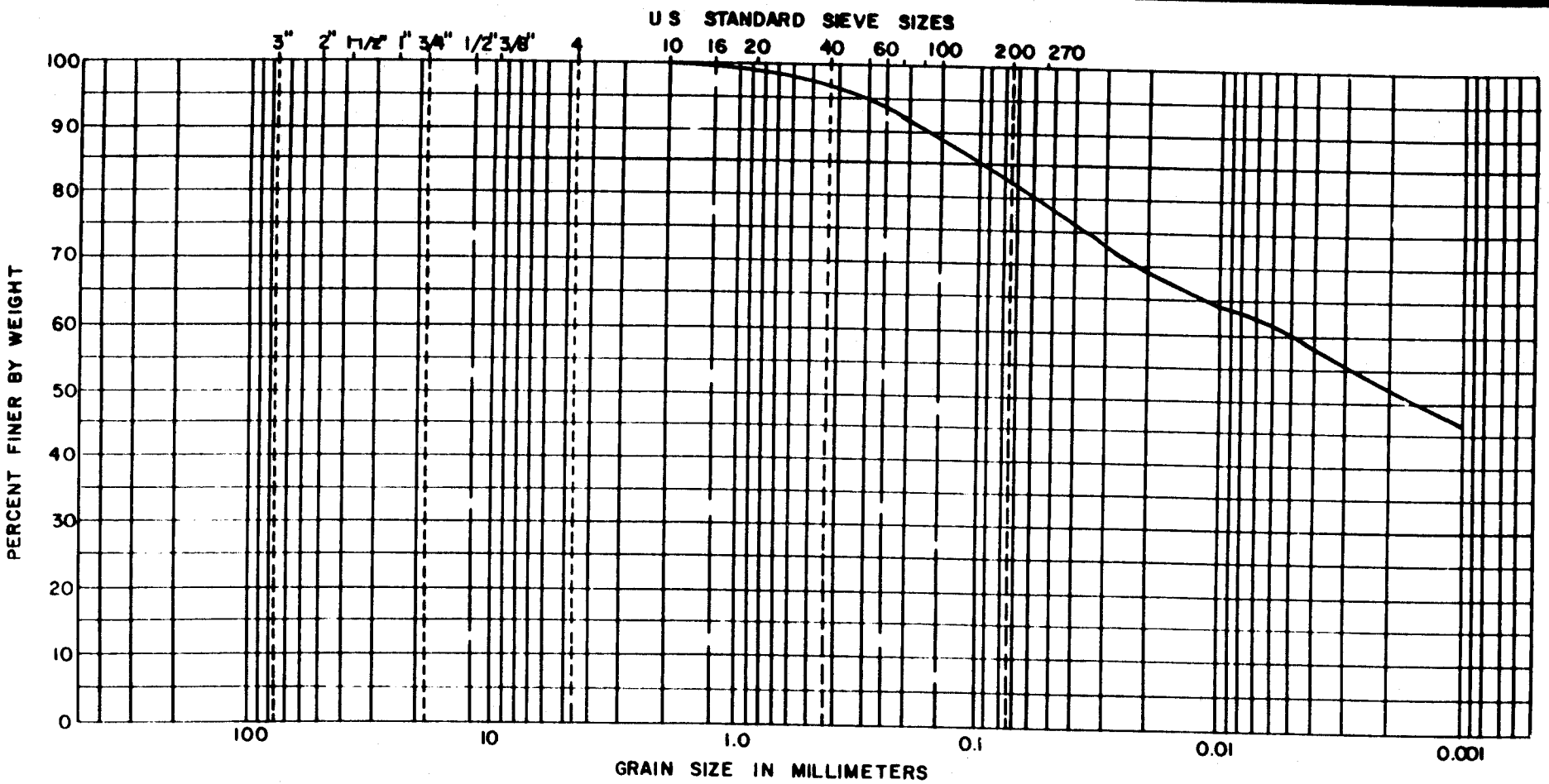
SAMPLE DATA

HEIGHT	7.80	cm.	MOISTURE CONTENT	17.3 %
DIAMETER	7.31	cm.	WET DENSITY	126.0 lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	107.4 lbs/cu.ft
VOLUME	327.36	cu.cm.	INITIAL SATURATION	85.5 %
WET WEIGHT	660.76	grams	FINAL SATURATION	100.0 %
DRY WEIGHT	563.31	grams	INITIAL VOID RATIO	0.534
			POROSITY	0.348
			SPECIFIC GRAVITY	2.640 apparent

1. K = 7.15E-05
2. K = 6.57E-05
3. K = 6.46E-05

AVERAGE K = 6.73E-05

172A



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

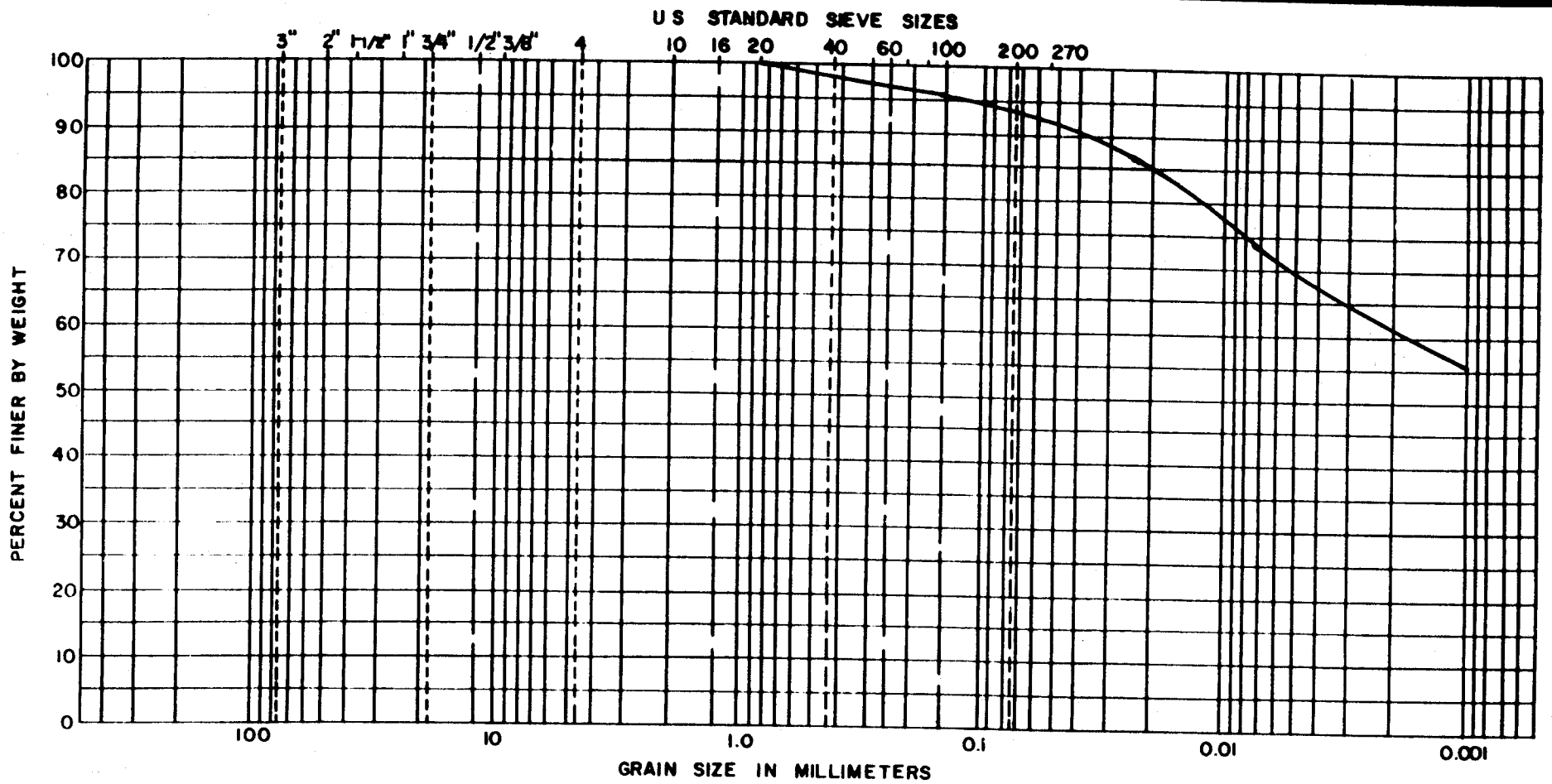
BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-42	5.0 - 6.0 BOTTOM OF TUBE	30.1	53	26	27	Light Gray Fine Sandy Silty CLAY (CH)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc

172A



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

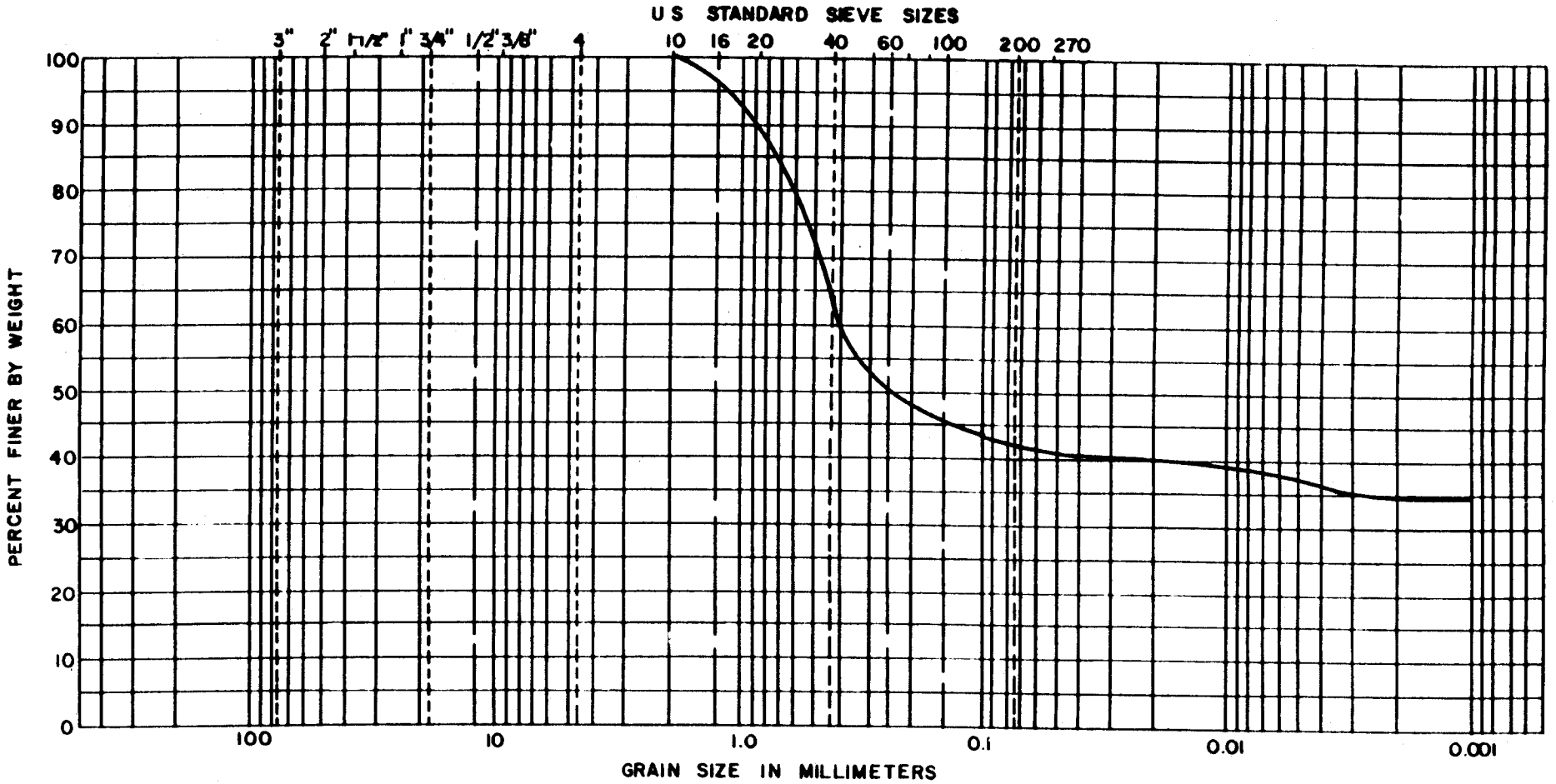
BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-42	4.0 - 5.0 TOP OF TUBE	32.5	60	29	31	Light Gray Fine Sandy Silty CLAY (CH)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.

172A



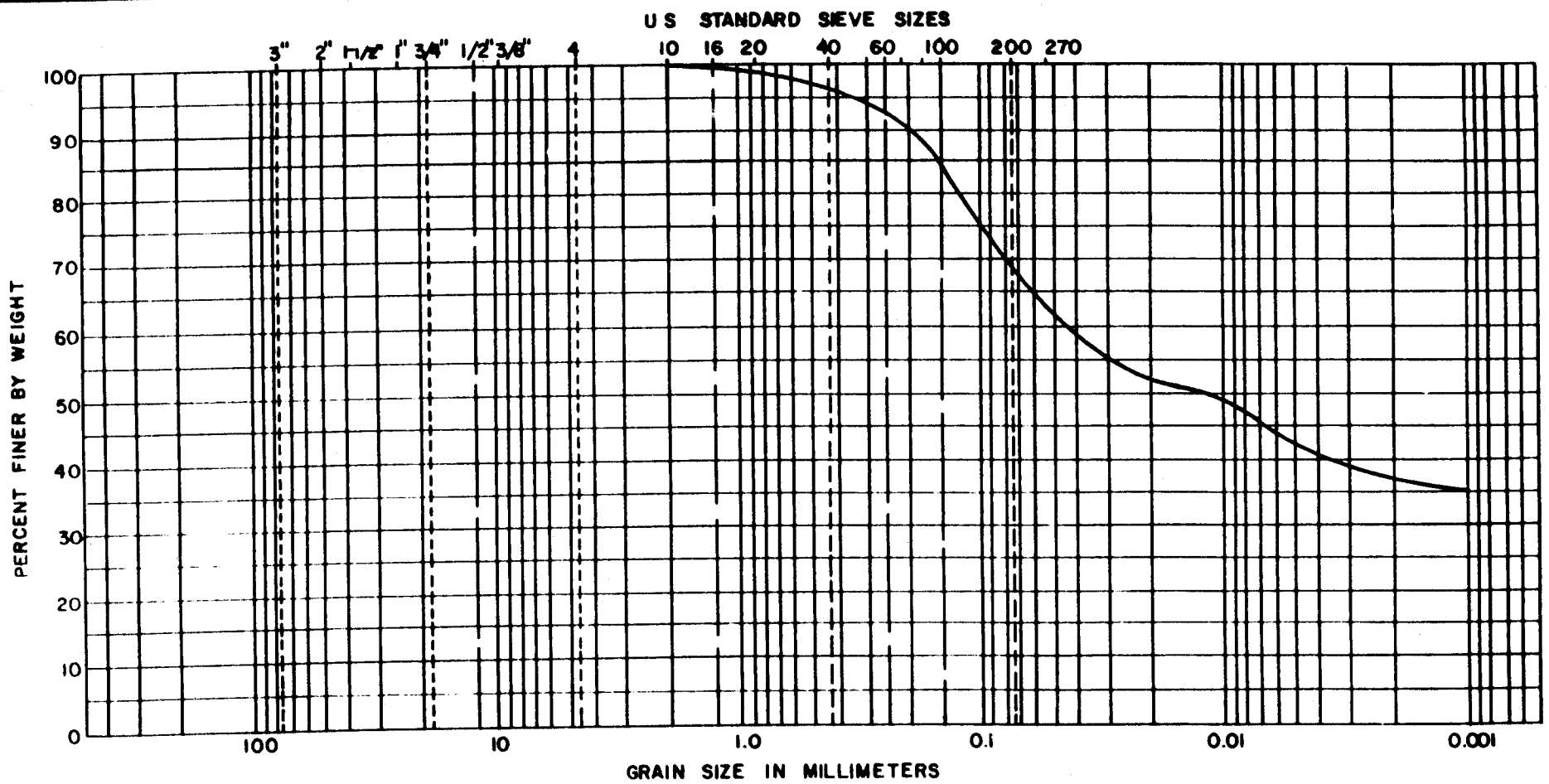
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-44	8.5-10.0	21.4	64	18	46	Yellow-Orange Clayey Course to Medium SAND (SC)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



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

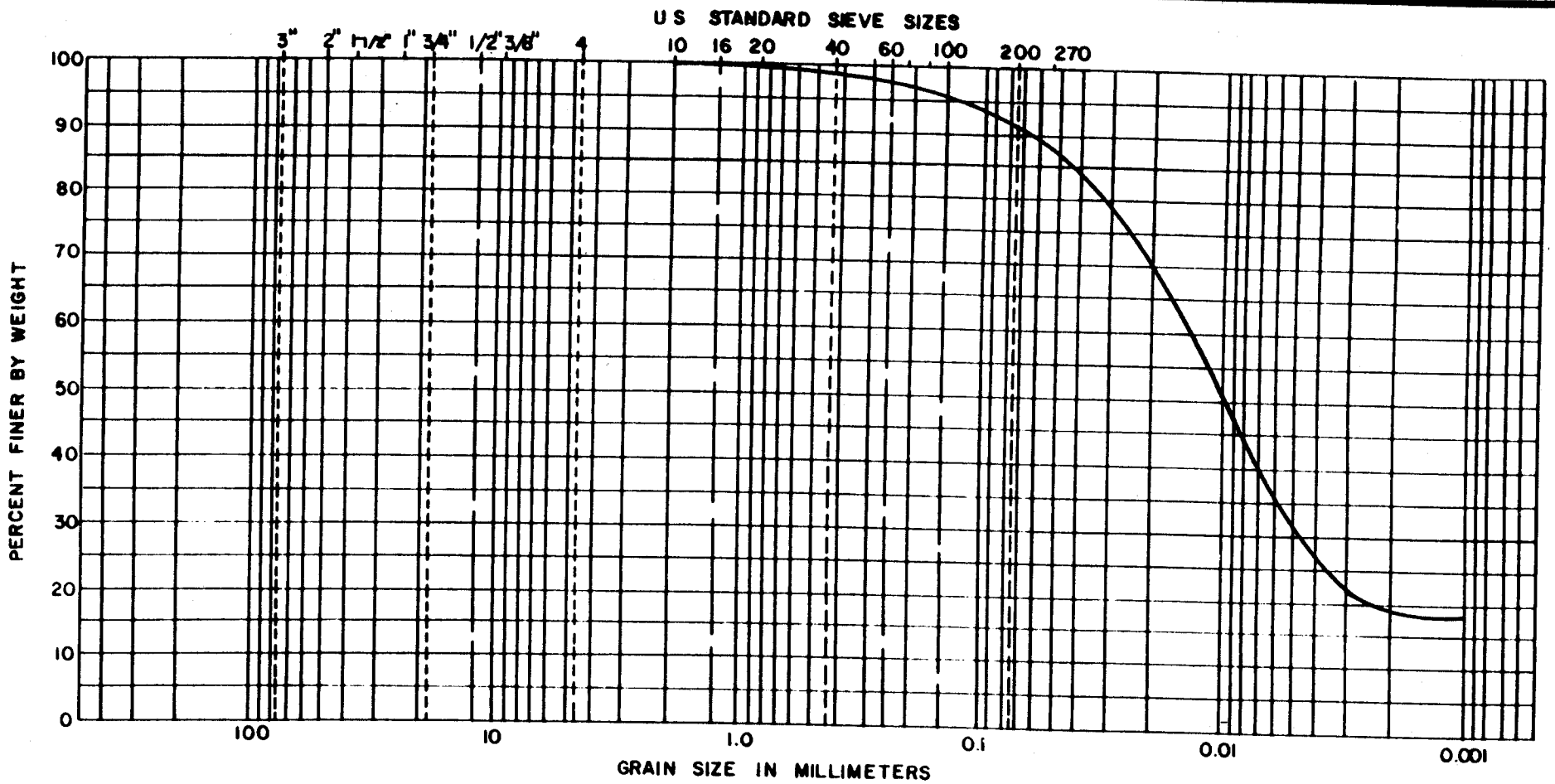
BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-46	13.5-15.0'	20.5	46	16	30	Red-Brown Silty Medium to Course Sandy CLAY (CL)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc

172A



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

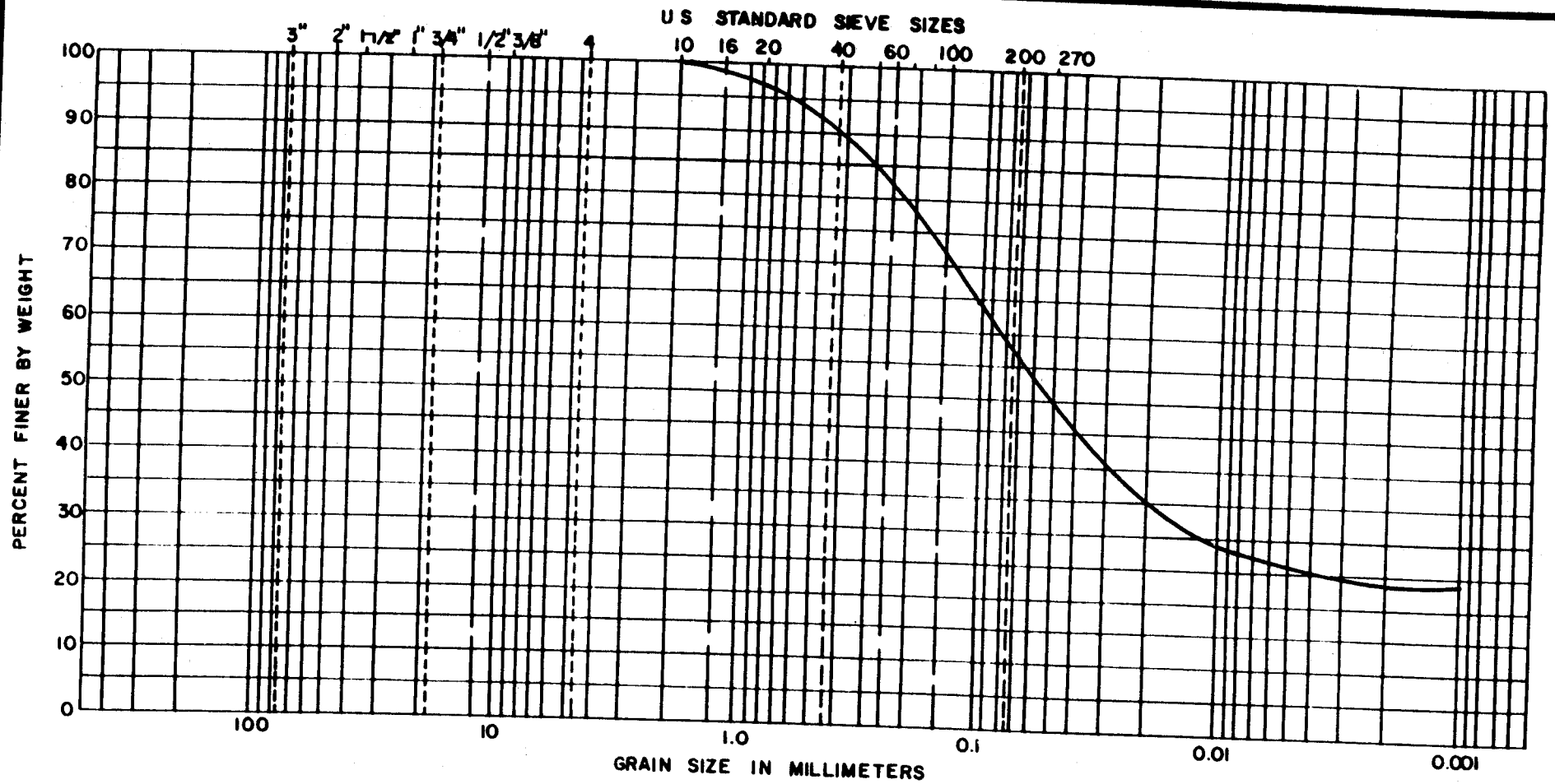
BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-48	13.5-15.0'	29.2	55	29	26	Gray to Orange Slightly Fine Sandy Silty CLAY (CH)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.

172A



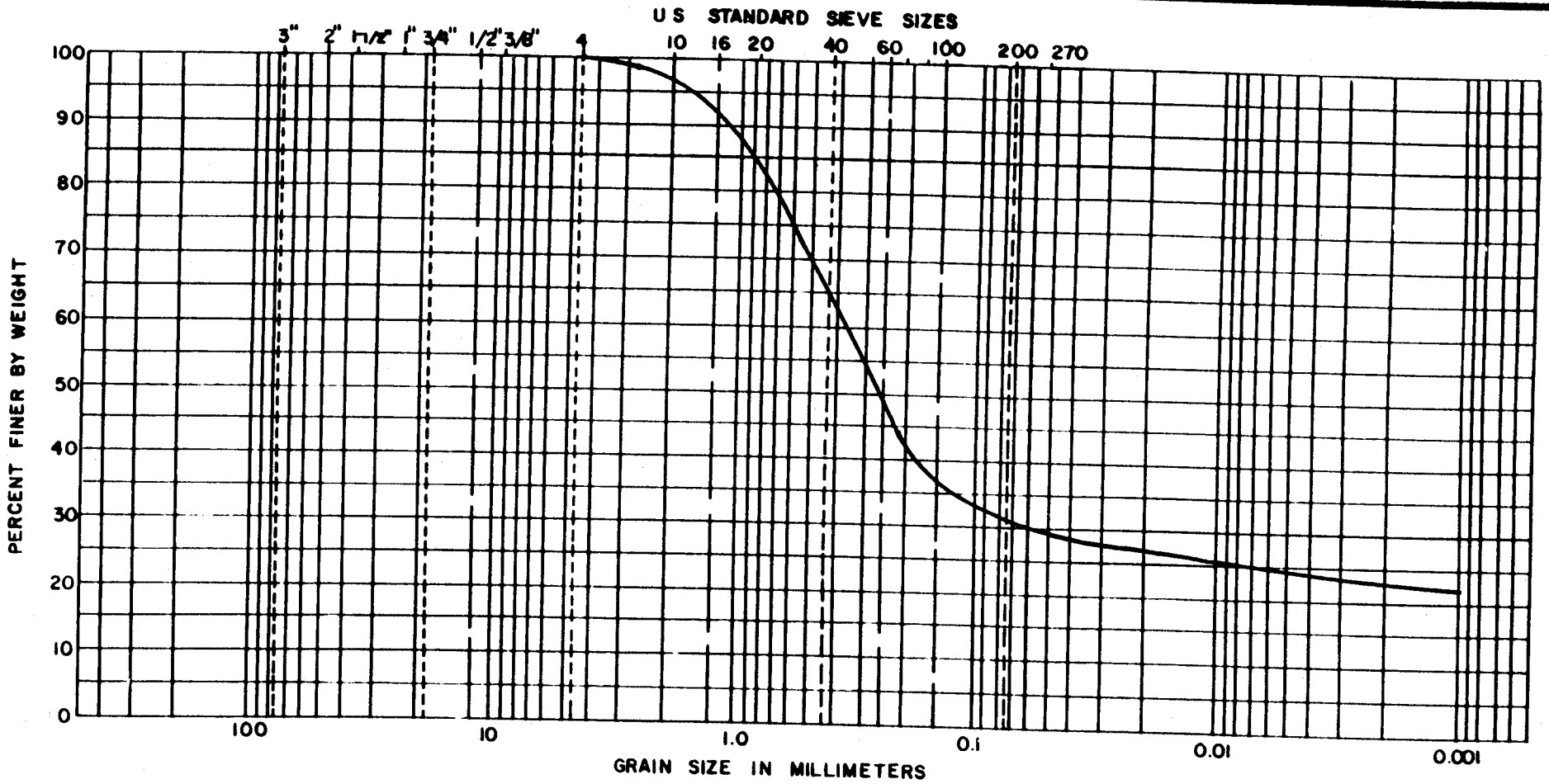
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-49	7.0 - 8.0	19.0	33	15	18	Light Gray Fine Sandy Silty CLAY (CL)

JOB NO. REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



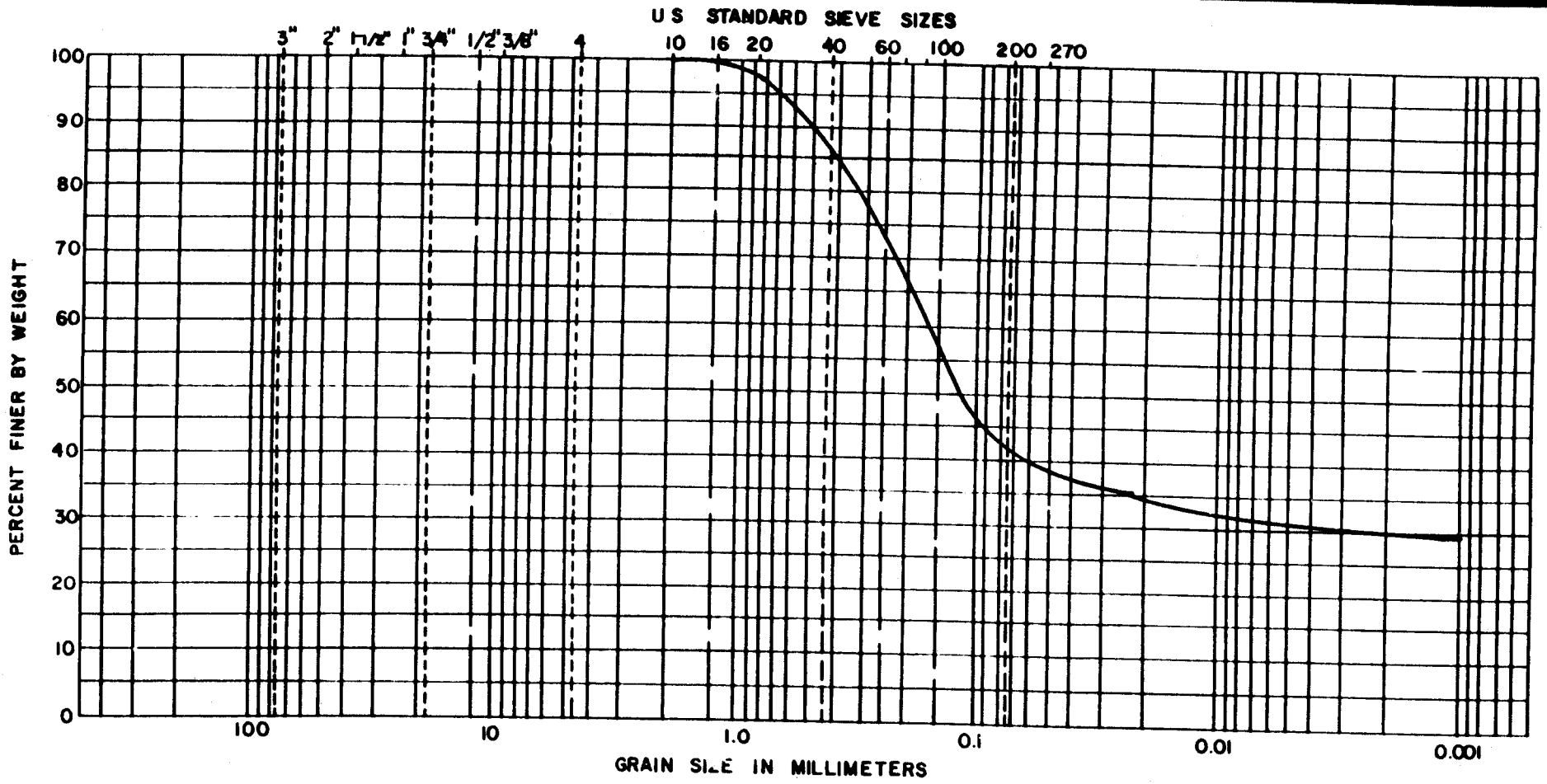
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-50	2.0 - 6.0	19.5	54	25	29	Gray -Tan Mottled Slightly Silty Clayey Fine SAND (SC)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



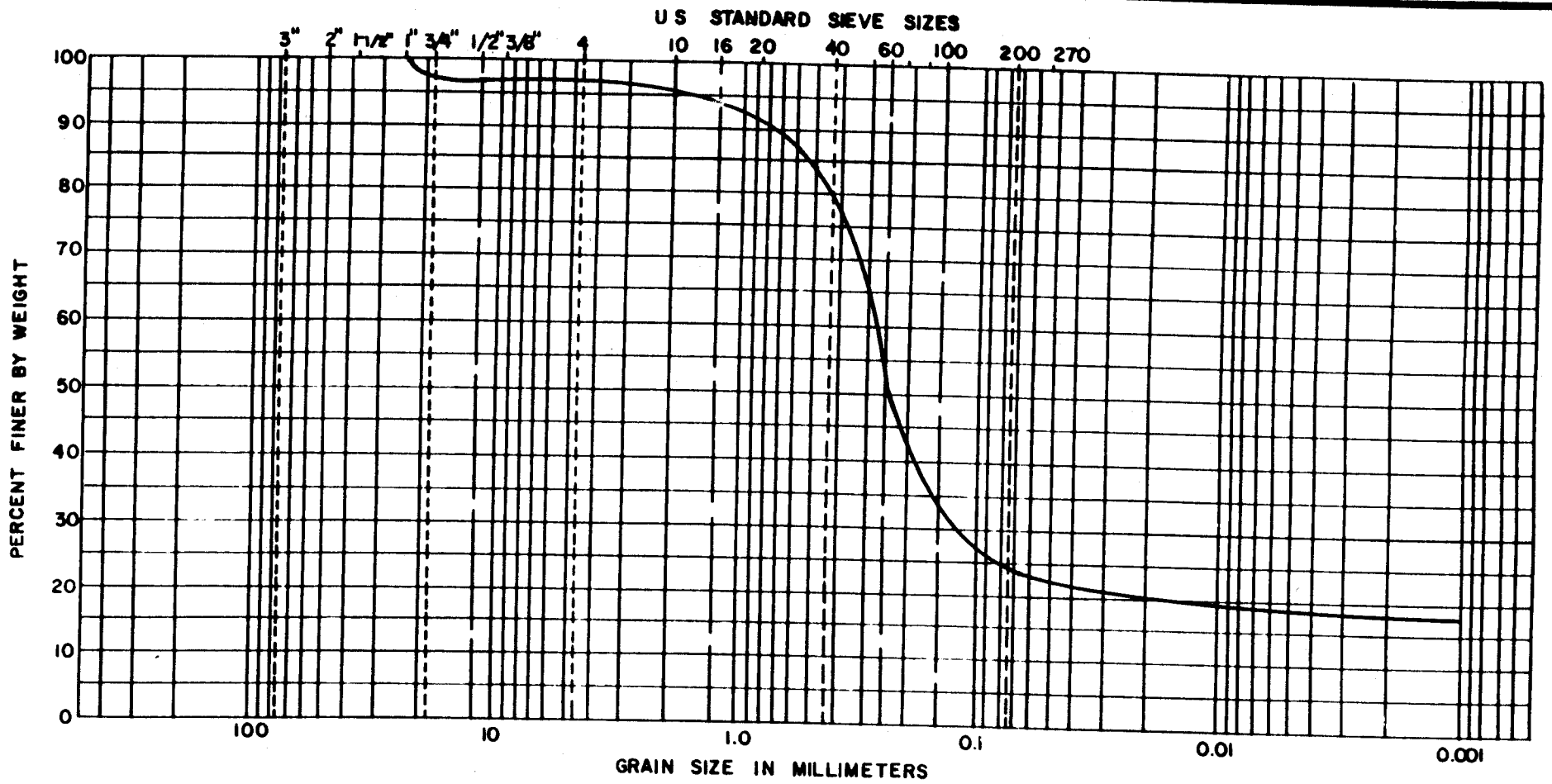
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-52	7.0 - 10.5	19.0	43	18	25	Gray -Tan Mottled Silty Clayey Fine SAND (SC)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



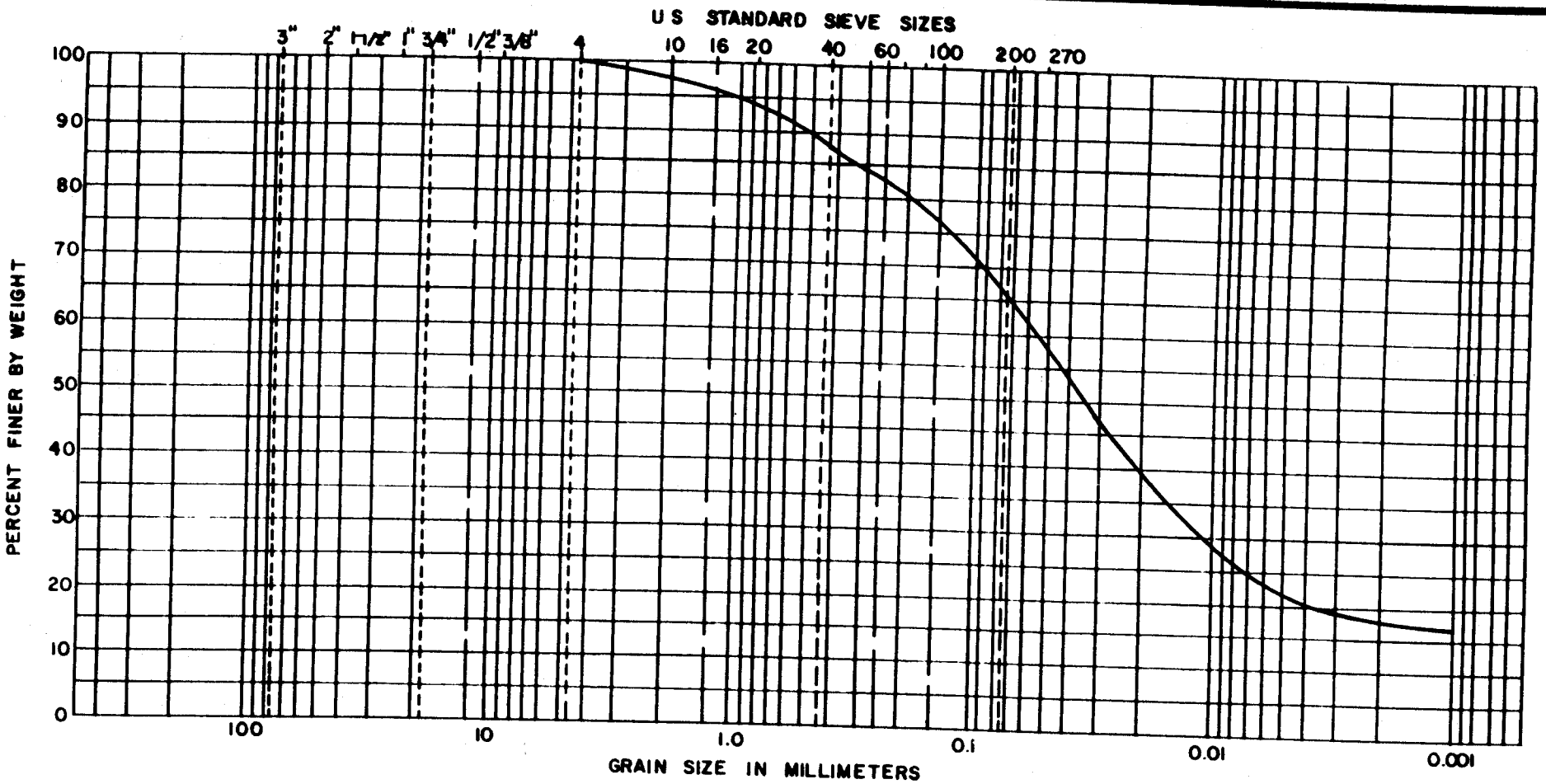
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-54	3.5 - 10.0	25.8	33	24	9	Yellow-Tan and Light Gray Mottled Slightly Silty Clayey Fine SAND (SC-SM)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



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

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-56	8.0 - 10.5	22.6	35	22	13	Gray Brown and Red Mottled Fine Sandy Silty CLAY (CL)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

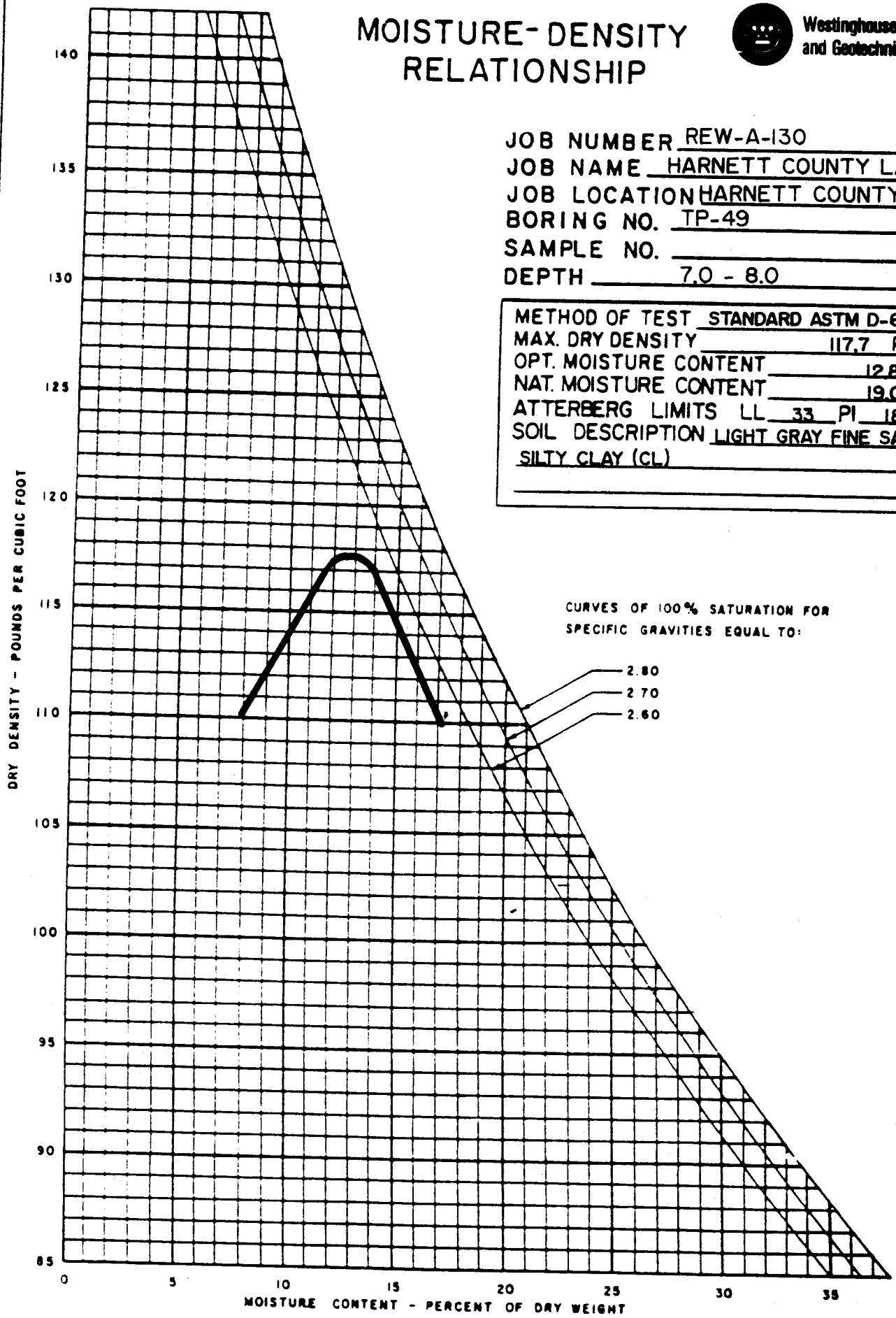
Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NUMBER REW-A-130
JOB NAME HARNETT COUNTY LANDFILL
JOB LOCATION HARNETT COUNTY, N.C.
BORING NO. TP-49
SAMPLE NO.
DEPTH 7.0 - 8.0

METHOD OF TEST STANDARD ASTM D-698
MAX. DRY DENSITY 117.7 PCF
OPT. MOISTURE CONTENT 12.8 %
NAT. MOISTURE CONTENT 19.0 %
ATTERBERG LIMITS LL 33 PI 18
SOIL DESCRIPTION LIGHT GRAY FINE SANDY SILTY CLAY (CL)



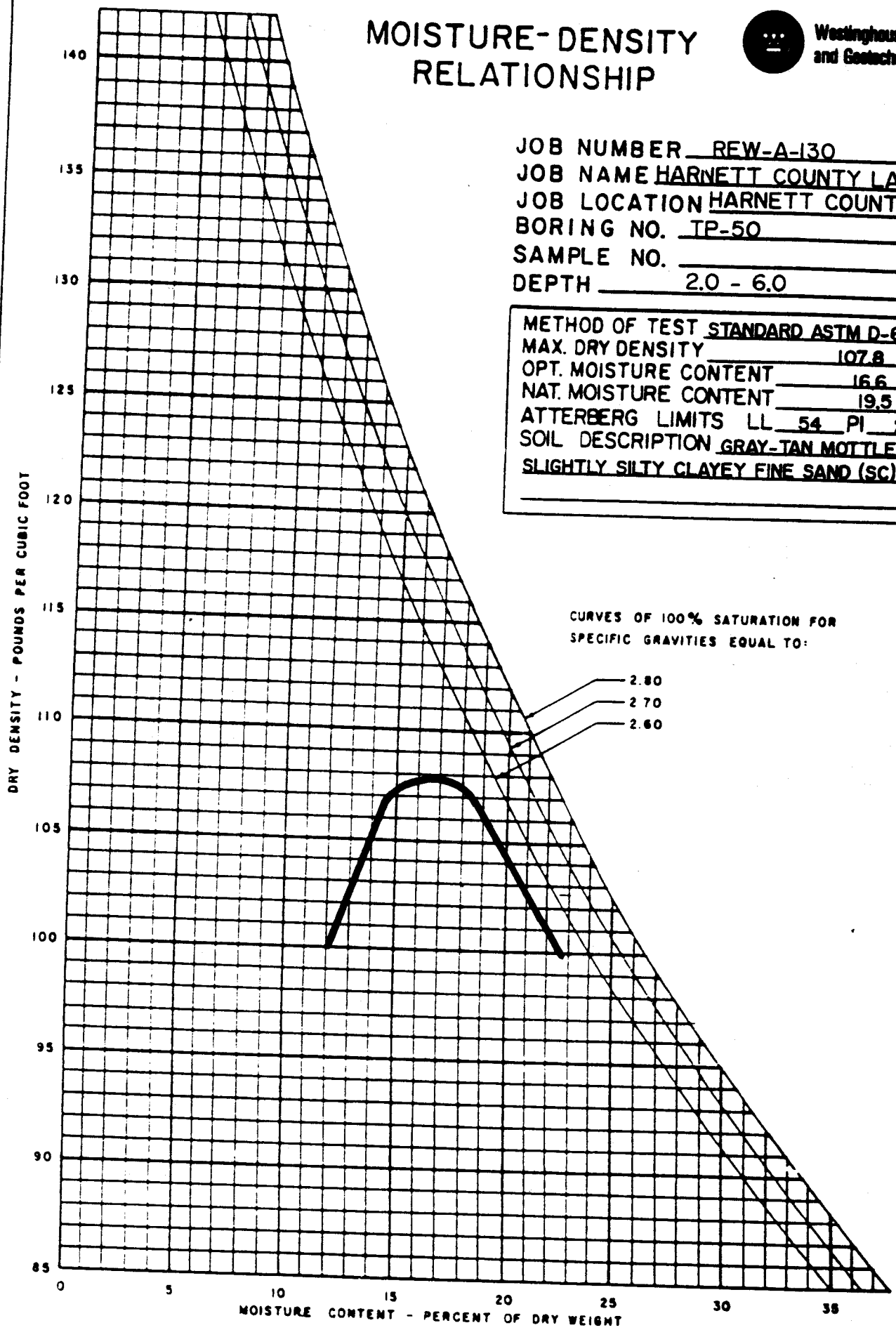
169A

MOISTURE-DENSITY RELATIONSHIP

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NUMBER REW-A-130
JOB NAME HARNETT COUNTY LANDFILL
JOB LOCATION HARNETT COUNTY, N.C.
BORING NO. TP-50
SAMPLE NO.
DEPTH 2.0 - 6.0

METHOD OF TEST STANDARD ASTM D-698
MAX. DRY DENSITY 107.8 PCF
OPT. MOISTURE CONTENT 16.6 %
NAT. MOISTURE CONTENT 19.5 %
ATTERBERG LIMITS LL 54 PI 29
SOIL DESCRIPTION GRAY-TAN MOTTLED SLIGHTLY SILTY CLAYEY FINE SAND (SC)



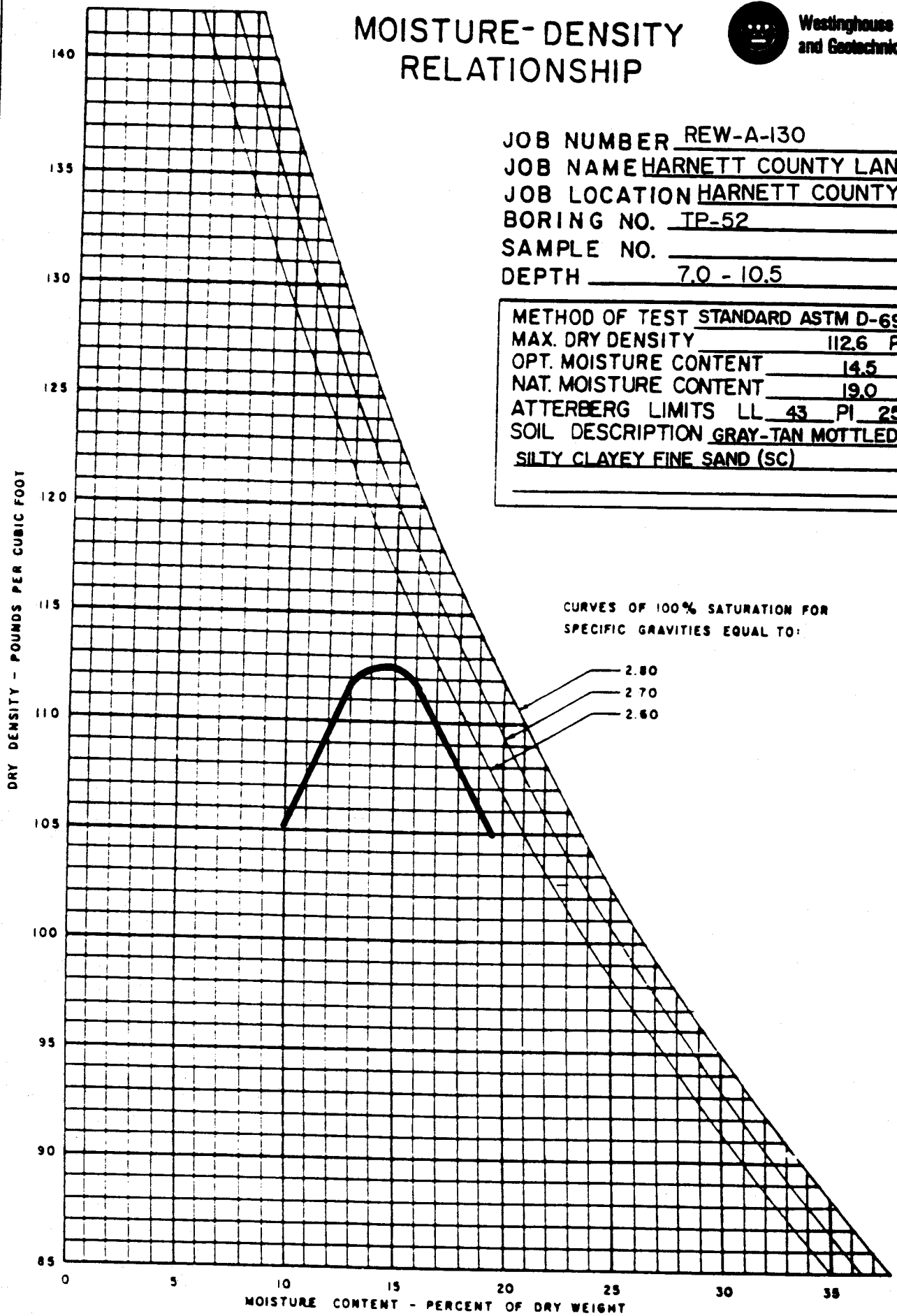
169A

MOISTURE-DENSITY RELATIONSHIP

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NUMBER REW-A-130
JOB NAME HARNETT COUNTY LANDFILL
JOB LOCATION HARNETT COUNTY, N.C.
BORING NO. TP-52
SAMPLE NO.
DEPTH 7.0 - 10.5

METHOD OF TEST STANDARD ASTM D-698
MAX. DRY DENSITY 112.6 PCF
OPT. MOISTURE CONTENT 14.5 %
NAT. MOISTURE CONTENT 19.0 %
ATTERBERG LIMITS LL 43 PI 25
SOIL DESCRIPTION GRAY-TAN MOTTLED SILTY CLAYEY FINE SAND (SC)



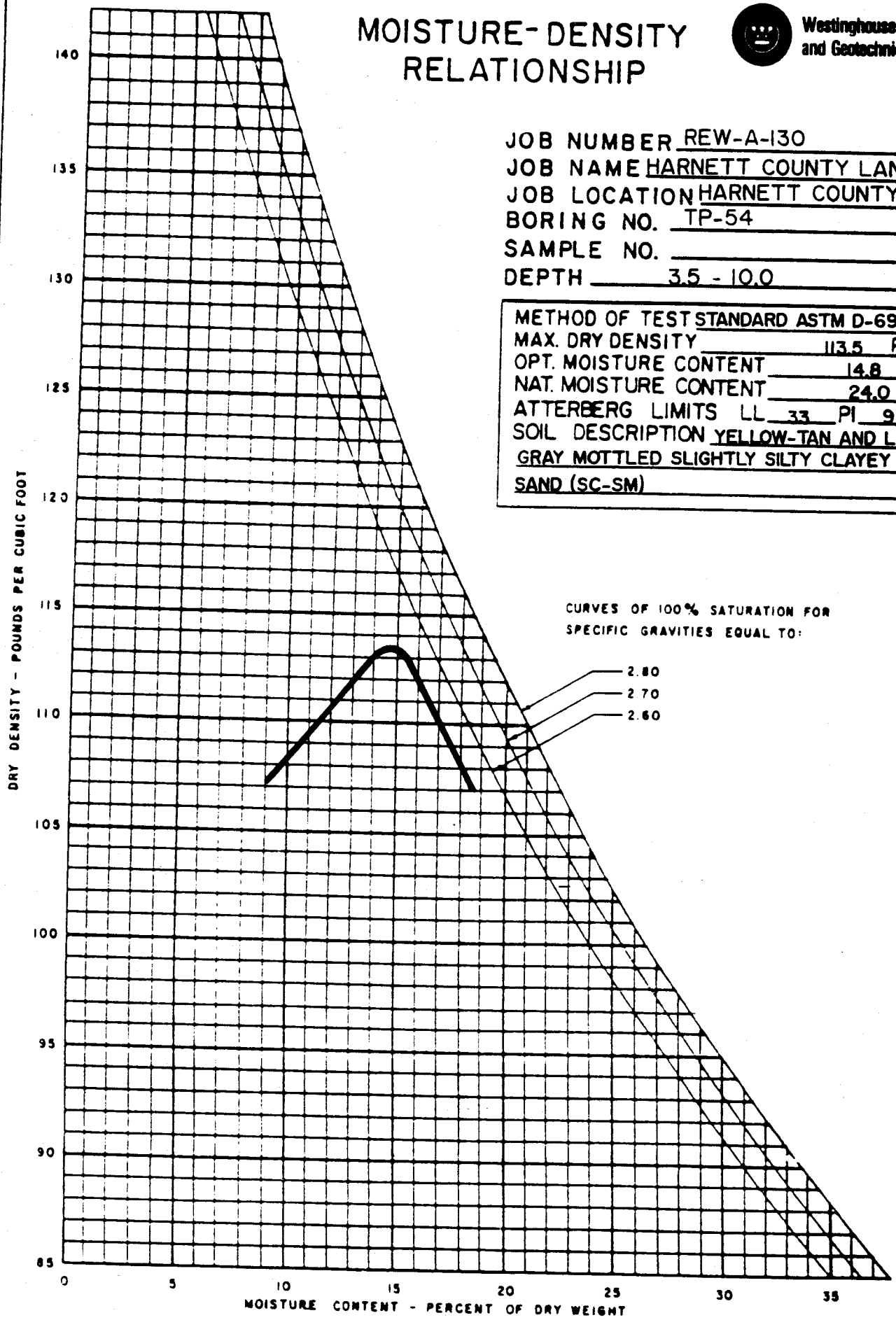
169A

MOISTURE-DENSITY RELATIONSHIP

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NUMBER REW-A-130
JOB NAME HARNETT COUNTY LANDFILL
JOB LOCATION HARNETT COUNTY, N.C.
BORING NO. TP-54
SAMPLE NO.
DEPTH 3.5 - 10.0

METHOD OF TEST STANDARD ASTM D-698
MAX. DRY DENSITY 113.5 PCF
OPT. MOISTURE CONTENT 14.8 %
NAT. MOISTURE CONTENT 24.0 %
ATTERBERG LIMITS LL 33 PI 9
SOIL DESCRIPTION YELLOW-TAN AND LIGHT GRAY MOTTLED SLIGHTLY SILTY CLAYEY FINE SAND (SC-SM)



169A

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. / RO
Minor Basin	
Basin Code	
Header Ent.	GW-1 Ent.

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: PATTERSON EXPLORATION SERVICES

DRILLER REGISTRATION NUMBER: 351

STATE WELL CONSTRUCTION PERMIT NUMBER:

MW-2

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: COATS County: HARNETT
DUNN-ERWIN LANDFILL - S.R. 1724
(Road, Community, or Subdivision and Lot No.)
2. OWNER HARNETT COUNTY
ADDRESS P.O. BOX 759
(Street or Route No.)
LILLINGTON NC 27546
City or Town State Zip Code
3. DATE DRILLED 9-23-94 USE OF WELL MONITORING
4. TOTAL DEPTH 30'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 24.5' FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 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): <1.0 METHOD OF TEST BAILING
10. WATER ZONES (depth): 22'-30'

DEPTH From	To	DRILLING LOG Formation Description
0'	3'	SANDY CLAY
3'	30'	GRAY SILTY CLAY

If additional space is needed use back of form

11. CHLORINATION: Type _____ Amount _____
12. CASING:

	Depth From	To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	15	2	SCH 40	PVC

13. GROUT:

	Depth From	To	Material	Method
	0	13	NEAT CEMENT	
	13	14	BENTONITE	

14. SCREEN:

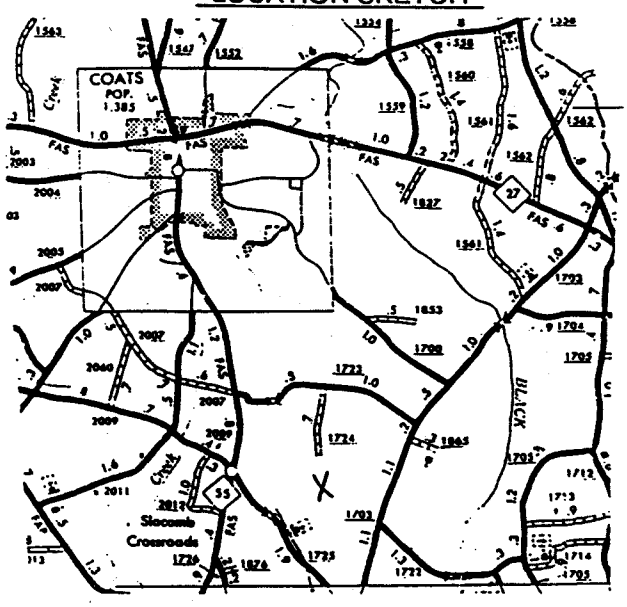
	Depth From	To	Diameter	Slot Size	Material
	15	30	2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

15. SAND/GRAVEL PACK:

	Depth From	To	Size	Material
	14	30		SAND

16. REMARKS:

LOCATION SKETCH



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.

James C Izzell 9-29-94
SIGNATURE OF CONTRACTOR OR AGENT DATE

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

GW-1 REV. 9/91

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. RO
Minor Basin	
Basin Code	
Header Ent.	GW-1 Ent.

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: PATTERSON EXPLORATION SERVICES

DRILLER REGISTRATION NUMBER: 351

STATE WELL CONSTRUCTION PERMIT NUMBER:

MW-3

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: COATS County: HARNETT
DUNN-ERWIN LANDFILL - S.R. 1724
(Road, Community, or Subdivision and Lot No.)

2. OWNER HARNETT COUNTY
ADDRESS P.O. BOX 759
(Street or Route No.)
LILLINGTON NC 27546
City or Town State Zip Code

3. DATE DRILLED 9-23-94 USE OF WELL MONITORING
4. TOTAL DEPTH 20'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 6.5 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 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): < 1.0 METHOD OF TEST BAILING
10. WATER ZONES (depth): 12' - 20'

DEPTH From	To	DRILLING LOG Formation Description
0'	5'	BROWN SILTY CLAY
5'	20'	MOTTLED CLAY

If additional space is needed use back of form

11. CHLORINATION: Type _____ Amount _____
12. CASING:

	Depth From	To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
	0	9		2"	SCH 40	PVC

13. GROUT:

	Depth From	To	Ft.	Material	Method
	0	7		NEAT CEMENT	
	7	8		BENTONITE	

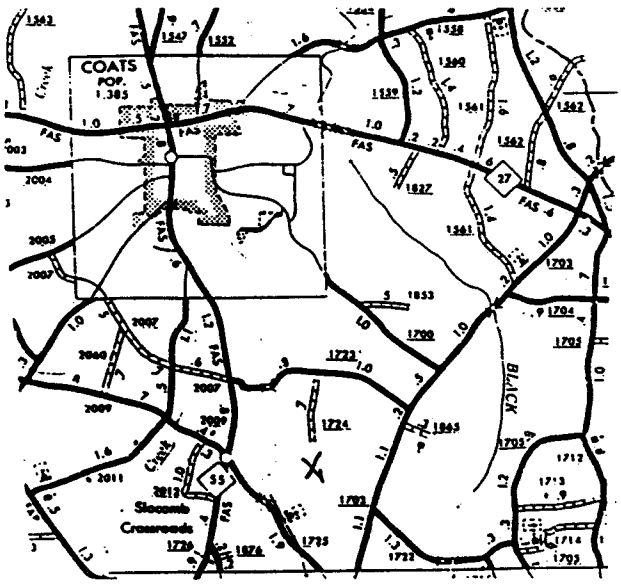
14. SCREEN:

	Depth From	To	Ft.	Diameter	in.	Slot Size	in.	Material
	9	19		2		.010		PVC

15. SAND/GRAVEL PACK:

	Depth From	To	Ft.	Size	Material
	8	20			SAND

LOCATION SKETCH



16. REMARKS:

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.

James Yazell 9-29-94
SIGNATURE OF CONTRACTOR OR AGENT DATE

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

GW-1 REV. 9/91

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. _____ RO _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: PATTERSON EXPLORATION SERVICES

DRILLER REGISTRATION NUMBER: 351

STATE WELL CONSTRUCTION PERMIT NUMBER: _____

MW-4

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: COATS County: HARNETT
DUNN-ERWIN LANDFILL - S.R. 1724
(Road, Community, or Subdivision and Lot No.)

2. OWNER HARNETT COUNTY
ADDRESS P.O. BOX 759
(Street or Route No.)
LILLINGTON NC 27546
City or Town State Zip Code

3. DATE DRILLED 9-23-94 USE OF WELL MONITORING
4. TOTAL DEPTH 20'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 4.75 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 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): <1.0 METHOD OF TEST BAILING
10. WATER ZONES (depth): 12'-20'

DEPTH From	To	DRILLING LOG Formation Description
0'	3'	SAND & GRAVEL
3'	6'	SILTY CLAY - TAN
6'	20'	SILTY CLAY - GRAY

If additional space is needed use back of form

CHLORINATION: Type _____ Amount _____

12. CASING:

	Depth From	To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
	0	9		2"	SCH 40	PVC

13. GROUT:

	Depth From	To	Ft.	Material	Method
	0	7		NEAT CEMENT	
	7	8		BENTONITE	

14. SCREEN:

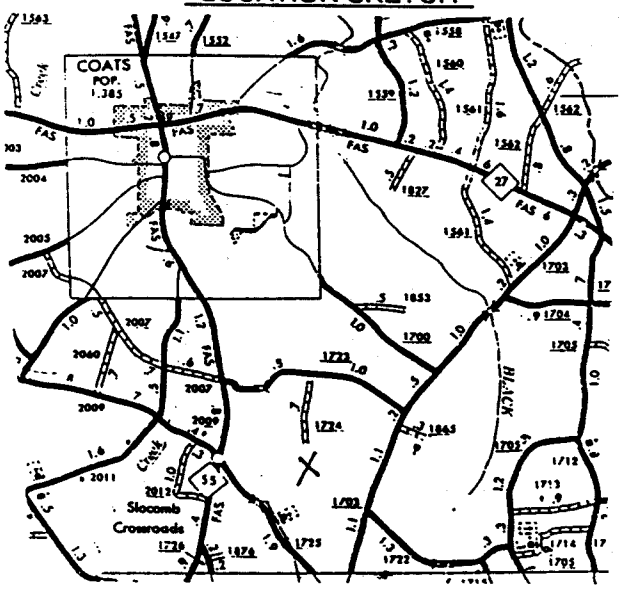
	Depth From	To	Ft	Diameter	in.	Slot Size	in.	Material
	9	19		2		.010		PVC

15. SAND/GRAVEL PACK:

	Depth From	To	Ft.	Size	Material
	8	20			SAND

16. REMARKS: _____

LOCATION SKETCH



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.

James Hall 9-29-94
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 REV. 9/91

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

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. / RO
Minor Basin	
Basin Code	
Header Ent.	GW-1 Ent.

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: PATTERSON EXPLORATION SERVICES

DRILLER REGISTRATION NUMBER: 351

STATE WELL CONSTRUCTION PERMIT NUMBER:

1. WELL LOCATION: (Show sketch of the location below) MW-5
Nearest Town: COATS County: HARNETT
DUNN-ERWIN LANDFILL - S.R. 1724
(Road, Community, or Subdivision and Lot No.)
2. OWNER HARNETT COUNTY
ADDRESS P.O. BOX 759
(Street or Route No.)
LILLINGTON NC 27546
City or Town State Zip Code
3. DATE DRILLED 9-23-94 USE OF WELL MONITORING
4. TOTAL DEPTH 35'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 15.25 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 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): <1.0 METHOD OF TEST BAILING
10. WATER ZONES (depth): 25'-35'

CHLORINATION: Type _____ Amount _____

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0'	10'	CLAY / BACKFILL
10'	35'	GRAY SILTY CLAY

If additional space is needed use back of form

12. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0'	19'	2"	SCH 40	PVC

13. GROUT:

	Depth From	Depth To	Material	Method
	0	17	NEAT CEMENT	
	17	18	BENTONITE	

14. SCREEN:

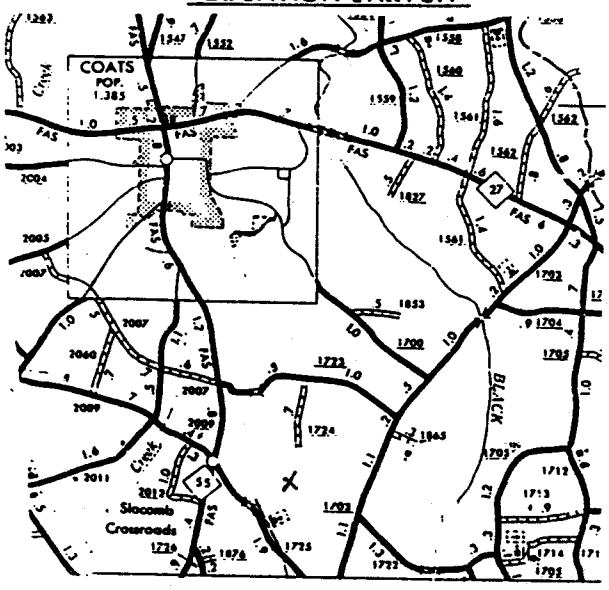
	Depth From	Depth To	Diameter	Slot Size	Material
	19'	34'	2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

15. SAND/GRAVEL PACK:

	Depth From	Depth To	Size	Material
	18'	35'		SAND

16. REMARKS:

LOCATION SKETCH



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

James Hazell 9-29-94
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 REV. 9/91

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

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. _____ RO _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: PATTERSON EXPLORATION SERVICES

DRILLER REGISTRATION NUMBER: 351

STATE WELL CONSTRUCTION PERMIT NUMBER: _____

MW-7

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: COATS County: HARNETT
DUNN-ERWIN LANDFILL - S.R. 1724
(Road, Community, or Subdivision and Lot No.)

2. OWNER HARNETT COUNTY
ADDRESS P.O. BOX 759
(Street or Route No.)
LILLINGTON NC 27546
City or Town State Zip Code

3. DATE DRILLED 9-23-94 USE OF WELL MONITORING
4. TOTAL DEPTH 25
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 22 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 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): <1.0 METHOD OF TEST BAILING
10. WATER ZONES (depth): 23' - 25'

DEPTH From	To	DRILLING LOG Formation Description
0'	18'	SANDY CLAY
18'	25'	SILTY CLAY

If additional space is needed use back of form

11. CHLORINATION: Type _____ Amount _____

12. CASING:

	Depth From	To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
	0	14		2"	SCH 40	PVC

13. GROUT:

	Depth From	To	Ft.	Material	Method
	0	~~13~~ 12		NEAT CEMENT	
	~~13~~ 12	13		BENTONITE	

14. SCREEN:

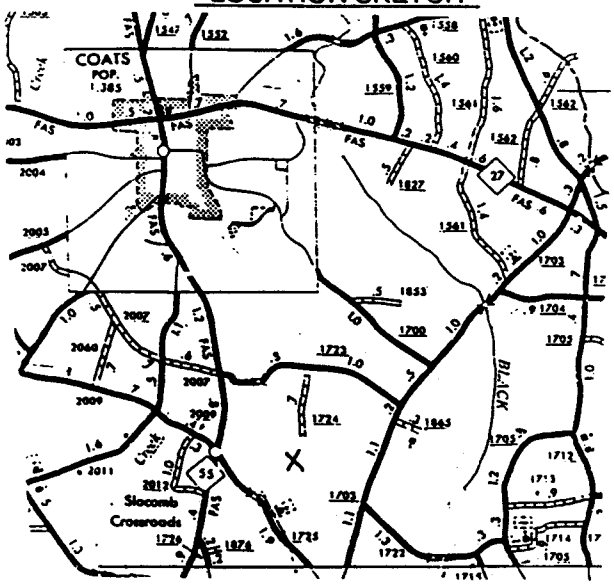
	Depth From	To	Ft	Diameter	in.	Slot Size	in.	Material
	14	24		2		.010		PVC

15. SAND/GRAVEL PACK:

	Depth From	To	Ft.	Size	Material
	13	25			SAND

16. REMARKS: _____

LOCATION SKETCH



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.

James [illegible] 9-29-94
SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to [illegible]

GW-1 REV. 9/91

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. _____ RO _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: PATTERSON EXPLORATION SERVICES

DRILLER REGISTRATION NUMBER: 351

STATE WELL CONSTRUCTION PERMIT NUMBER: _____

MW-8

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: COATS County: HARNETT
DUNN-ERWIN LANDFILL - S.R. 1724
(Road, Community, or Subdivision and Lot No.)

2. OWNER HARNETT COUNTY
ADDRESS P.O. BOX 759
(Street or Route No.)
LILLINGTON NC 27546
City or Town State Zip Code

3. DATE DRILLED 9-23-94 USE OF WELL MONITORING
4. TOTAL DEPTH 25
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 17.5' FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 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): < 1.0 METHOD OF TEST BAILING
10. WATER ZONES (depth): 18'-25'

DEPTH From	To	DRILLING LOG Formation Description
0'	8'	SANDY CLAY
8'	10'	GRAVEL
10'	25'	SILTY CLAY

If additional space is needed use back of form

CHLORINATION: Type _____ Amount _____

12. CASING:

Depth From	To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
0	9		2"	SCH 40	PVC

13. GROUT:

Depth From	To	Ft.	Material	Method
0'	7'		NEAT CEMENT	
7'	8'		BENTONITE	

14. SCREEN:

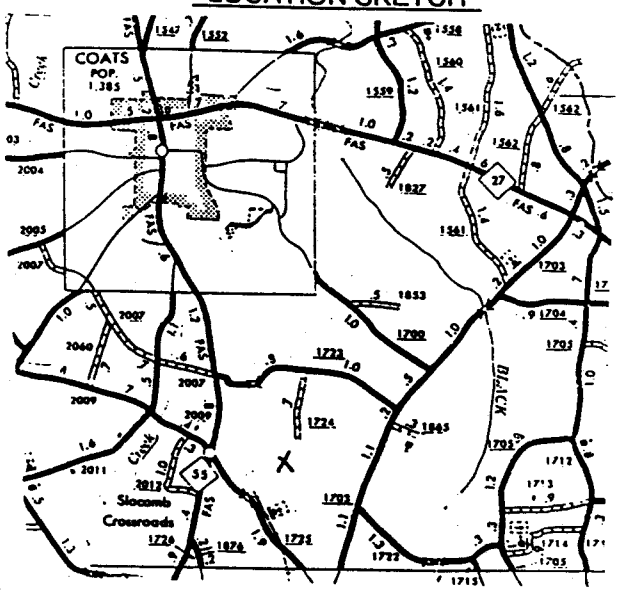
Depth From	To	Ft	Diameter in.	Slot Size in.	Material
9	24'		2	.010	PVC

15. SAND/GRAVEL PACK:

Depth From	To	Ft.	Size	Material
8'	25'			SAND

16. REMARKS: _____

LOCATION SKETCH



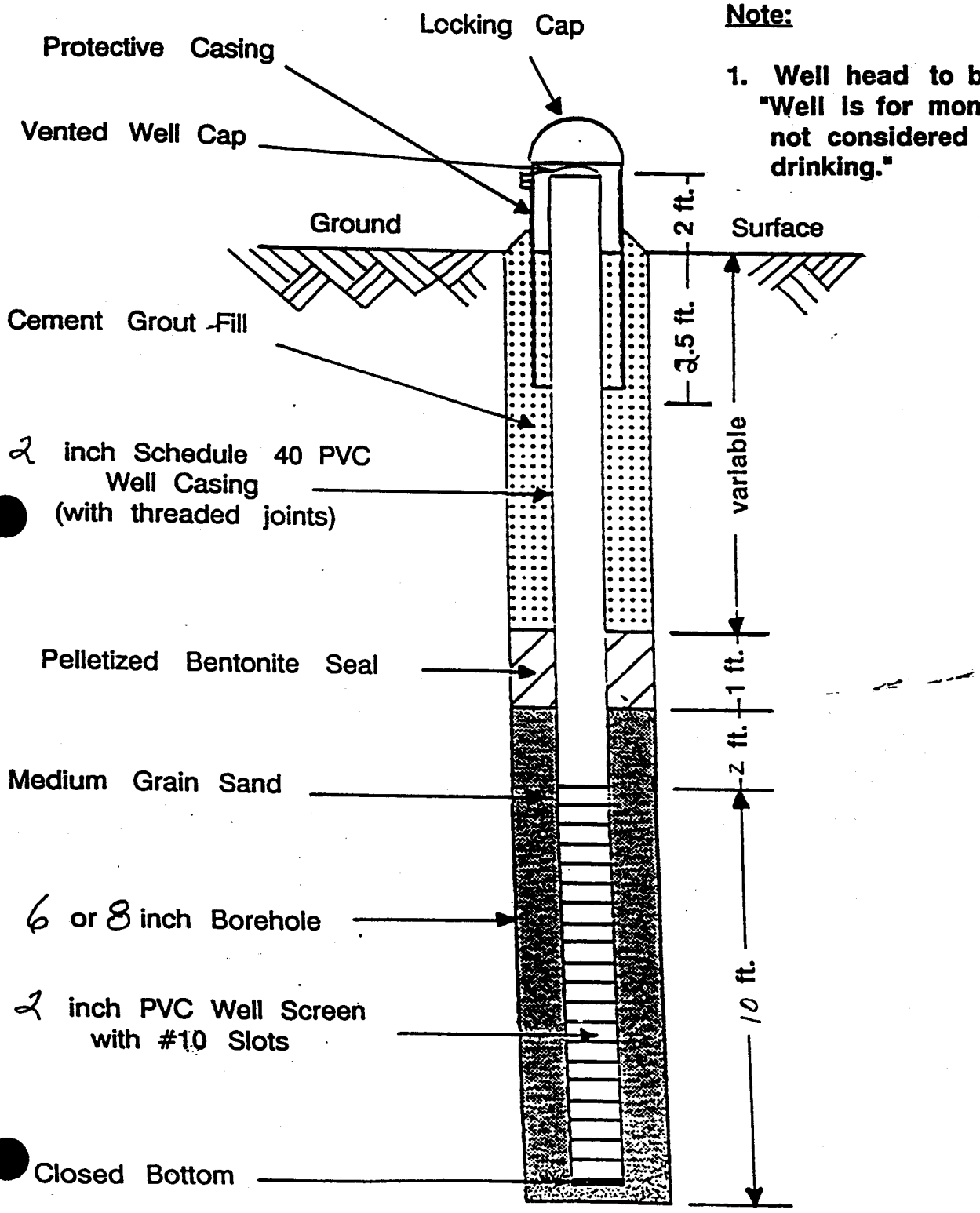
I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

James Lazell. 9-29-94
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 REV. 9/91

MONITORING WELL CONSTRUCTION

~~JOHNSTON~~ HARNETT COUNTY LANDFILL (TYP.)



Note:

1. **Well head to be labeled: "Well is for monitoring and not considered safe for drinking."**

APPENDIX C

Test Pit Logs

TEST PIT LOCATION	APPROXIMATE GROUND ELEVATION		TEST PIT LOG
Existing Borrow	197 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	No: 1

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
	193			0 to 4' : Tanish silty coarse sand with low plasticity (likely SM)
5				4 to 11' : Medium to stiff grey clay (likely CH) with high plasticity and little or no sand
10	186		Test pit was dry after 5 hours.	11': Test pit terminated in hard clay
15				
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

TEST PIT LOCATION Existing Borrow	APPROXIMATE GROUND ELEVATION: 189 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	TEST PIT LOG No: 2

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
5				0' to 6' (average depth): Tan sandy clay to grey silty(likely CL)
	183		Test pit was orientated east-west direction. Interface between layers dips about 15 degrees towards the west.	6' (average) to 11.5': Grey medium to stiff clay (likely CH)
10				
	177.5		Dry after 5 hours.	11.5': Test pit terminated, clay becomes hard
15				
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

TEST PIT LOCATION Existing Borrow	APPROXIMATE GROUND ELEVATION: 181 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	TEST PIT LOG No: 3

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
	180.5 180			0 to 6": Loose, tan Silty medium to coarse sand (likely SM) 6" to 12 ": Transition to grey clay (likely CL)
5				1 to 9': Stiff to hard grey clay (likely CH)
	172		▼ water table 172.5' after 5 hours	9 ': Test pit terminated, Clay becomes very hard
10				
15				
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

TEST PIT LOCATION Existing Borrow	APPROXIMATE GROUND ELEVATION: 178 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	TEST PIT LOG No: 4

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
	177			0 to 1': Medium dense tan silty fine sand (likely SM)
	174			1 to 3': Transition to stiff, greyish, slightly cohesive clayey sand (likely SC)
5				3 to 7': A mixed transition zone between dense tan silty sand (likely SM) to stiff grey sandy clay (likely SC)
	171			7' to 9': Stiff to hard grey clay (likely CH)
	169		Test pit was backfilled before water table was measured	9': Test pit terminated in hard grey clay
10				
15				
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

LOCATION Proposed NW Borrow	APPROXIMATE GROUND ELEVATION 208 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	TEST PIT LOG No: 5

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
	205.5			0 to 2.5': Greyish to tan silty sand (likely SM), top soil with roots
5	200.5			2.5 to 7.5': Tan to grey medium density silty clayey sand (likely SM-SC) with about 60 to 70% veins of reddish clayev sand
10	197			7.5 to 11': About 60% grey stiff clay (likely CL or CH) with lenses of about 40% tanish sand
			▼ = water table 194.8' after 5 hours	11 to 16': transition into stiff greyish clay (likely CL or CH)
15	202			16': Test pit terminated in hard clay
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

TEST PIT LOCATION Proposed NW Borrow	APPROXIMATE GROUND ELEVATION: 200 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	TEST PIT LOG No: 6

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
	199.5			0 to 6": Top soil, greyish silty sand with roots
	198.5			6" to 1.5': Medium density tanish silty sand (likely SM)
5				
	192			1.5 to 8': Grey sandy clay (likely CL)mixed with about 50% lenses of tanish silty sand (likely SM)
10				8 to 12.5': Transition to cleaner grey clay (likely CL) with about 20% on tanish silty sand (likely SM)
	187.5		Water dripping in at about 12.5' depth.	12.5 to 16': Stiff grey clay (likely CL)
15			▼ = water table 185' after 5 hours	
	184			16': Test pit terminated in hard clay
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

TEST PIT LOCATION Proposed NW Borrow	APPROXIMATE GROUND ELEVATION: 199 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	TEST PIT LOG No: 7

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
	198.5			0 to 6": Top soil, greyish silty sand with roots
				6" to 5': Tanish sandy, clayey silt (likely ML) with some reddish sandy veins
5	194			
	192			5' to 7': Tan sandy silt (likely ML) with about 50% lenses of grey clay (likely CL)
10				7' to 17': Grey clay (likely CL) with about 20% lenses of tan sand and some reddish sandy veins.
			Very moist from about 12'.	
15				
	182		▼ = water table 183.4' After 5 hours	17': Test pit terminated in hard clay
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

TEST PIT LOCATION Proposed NW Borrow	APPROXIMATE GROUND ELEVATION: 198 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	TEST PIT LOG No: 8

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
	197.5			0 to 6": Top soil, greyish silty sand with roots 6" to 2': Tanish, medium density silty fine sand (likely SM)
	196		Test pit side walls caves in 2' to 10' depth. Test pit remains open.	2' to 10': Reddish yellow to tan, loose coarse silty sand with low plasticity (likely SM).
5				
10	188		Water dripping in slowly from depth of about 10'.	10' to 17': Grey clayey sand (likely SC) with between 50% lenses of tan sand and some reddish sandy veins at 10' depth to about 20% of these sandy lenses at 17 feet.
15				
	181		▼ = water table 182.2' after 5 hours	17': Test pit is terminated. Stiffer grey clay (likely CL).
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

TEST PIT LOCATION Proposed NW Borrow	APPROXIMATE GROUND ELEVATION: 192 FEET	DATE START: August 21, 1995 DATE FINISH: August 21, 1995 EXCAVATED BY: Randy (Landfill Staff) LOGGED BY: C. J. Poran, PhD, PE	TEST PIT LOG No: 9

DEPTH (FT.)	APP. ELEV. (FT.)	SAMPLE	REMARKS	SOIL DESCRIPTION
	191.5			0 to 6": Top soil, greyish silty sand with roots 6" to 12': Medium to stiff grey clay (likely CL-CH) with about 35% lenses of tan silty sand (likely SM)
5				
10				
	180		Water dripping in slowly from depth of about 12'. ▼ = water table 178.8' after 5 hours	10' to 16': Stiff grey clay (likely CL-CH) with about 25% lenses of tan sand.
15				
	176			16':Test pit is terminated. Stiffer grey clay (likely CL).
20				
25				
30				

Notes:
BS = bulk bag samples
CS = undisturbed bulk cube samples
▼ = water table in test pit

Project No.: 0304-0010.OR
Site: Dunn-Erwin landfill
Client: McKim & Creed
Other Project Data:

ENSOL CORPORATION

An Archæological Survey of the Proposed Dunn-Erwin Landfill Expansion, Erwin Vicinity, Harnett County, North Carolina.

Thomas Hargrove

June 1991

ER 91-7896

A Report Submitted to McKim & Creed Engineers,
by
Archæological Research Consultants, Inc.,
Raleigh, North Carolina.

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Management Summary

The archæological survey of the proposed Harnett County landfill expansion covered about 100 acres adjoining the present landfill northeast of the town of Erwin in eastern Harnett County, North Carolina. The purpose of the survey was to examine the project area for prehistoric or historical archæological sites with significant remains that might be eligible for nomination to the National Register of Historic Places.

Since about three-quarters of the project area is in forest or pasture, the survey relied heavily on screened shovel tests at intervals of 30 meters (100 feet). In areas with exposed ground surfaces (plowed or upturned fields, farmroads, treefalls, etc.), the surveyors closely examined the area for prehistoric and historic artifacts.

The survey recorded three prehistoric sites. 31HT176 is a multi-component site dating to the Early Archaic, Middle Archaic, and Woodland periods. 31HT177 and 31HT178 are small lithic scatters lacking diagnostic artifacts. These sites are very low density sites, severely disturbed by farming, soil erosion, and (in two cases), by heavy earthmoving. Their potential for yielding important archæological information through excavations or controlled collections is extremely low. In addition, they resemble many other disturbed, upland prehistoric sites already recorded in Harnett County (c.f. Hargrove 1990a and 1990b), and similar sites are likely to be found in similar terrain throughout the region.

The three sites do not appear to be eligible for nomination to the National Register of Historic Places. We do not recommend additional archæological study of the landfill expansion tract, as it is now designed.

Introduction

Project title: An Archæological Survey of the Proposed Dunn-Erwin Landfill Expansion, Erwin Vicinity, Harnett County, North Carolina (ER 91-7896).

Location of the project: The 100-acre survey tract is in eastern Harnett County on the west side of the present Dunn-Erwin landfill, south of SR1723, north of SR1725, east of NC 55, and west of SR 1703. The town of Erwin is slightly over two miles to the southwest (see Figures 1, 2, and 3).

Contracting organization or individual: McKim & Creed Engineers.

Principal Investigator: Thomas H. Hargrove.

Field Crew: Jacqueline Fehon, Marilyn Barrier, Chris Murphy, Patrick Robertson.

Dates of survey: April 30 - May 1, 1991.

Scope of archæological work: See Appendix.

The following chapters follow the format of the *Guidelines for Preparation of Archæological Survey Reports Reviewed by the Archæology Branch, Division of Archives and History, North Carolina Department of Cultural Resources*. The sections include a description of the project's physical environment and its probable influences on past settlement choices and site preservation; an outline of the area's prehistoric and historic background; a description of field techniques; an inventory of sites recorded during the survey; a discussion of the archæological significance of the sites recorded; recommendations for archæological management; and a list of sources consulted for the background research, survey, and evaluation.

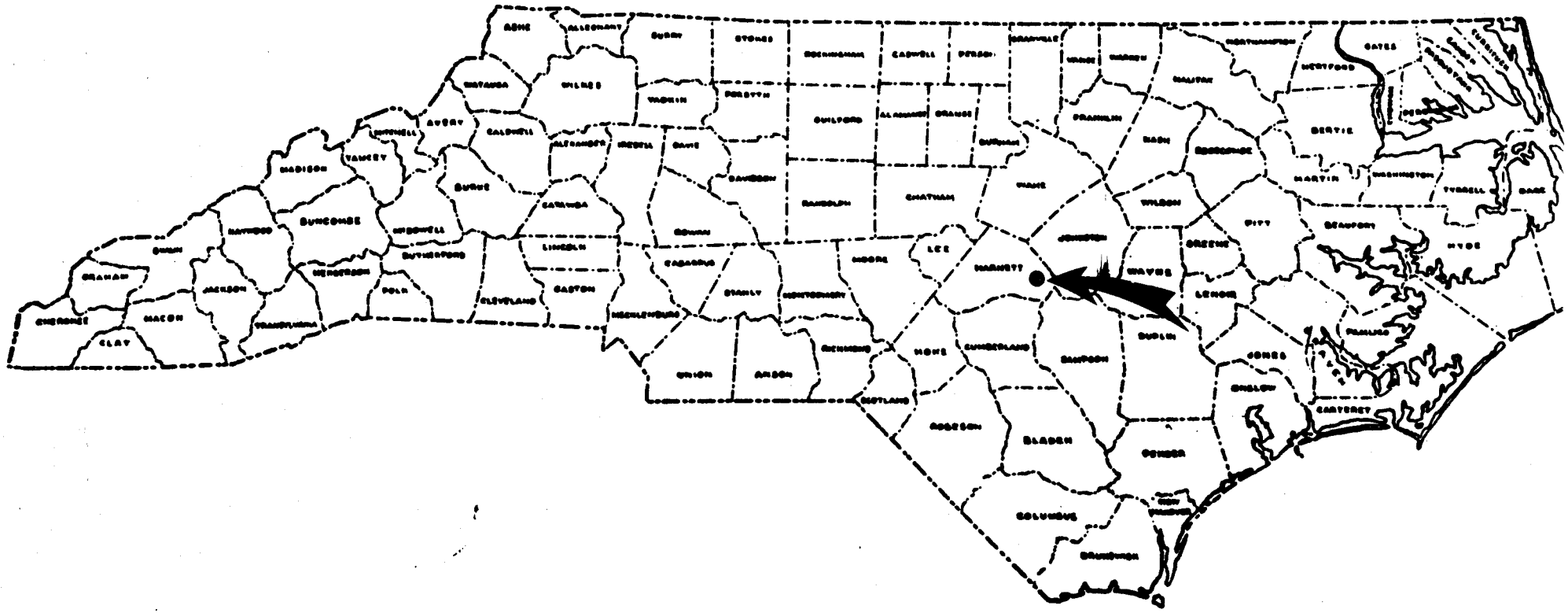


Figure 1: North Carolina and the project area (arrow).

Base map: North Carolina Division of Archives and History.

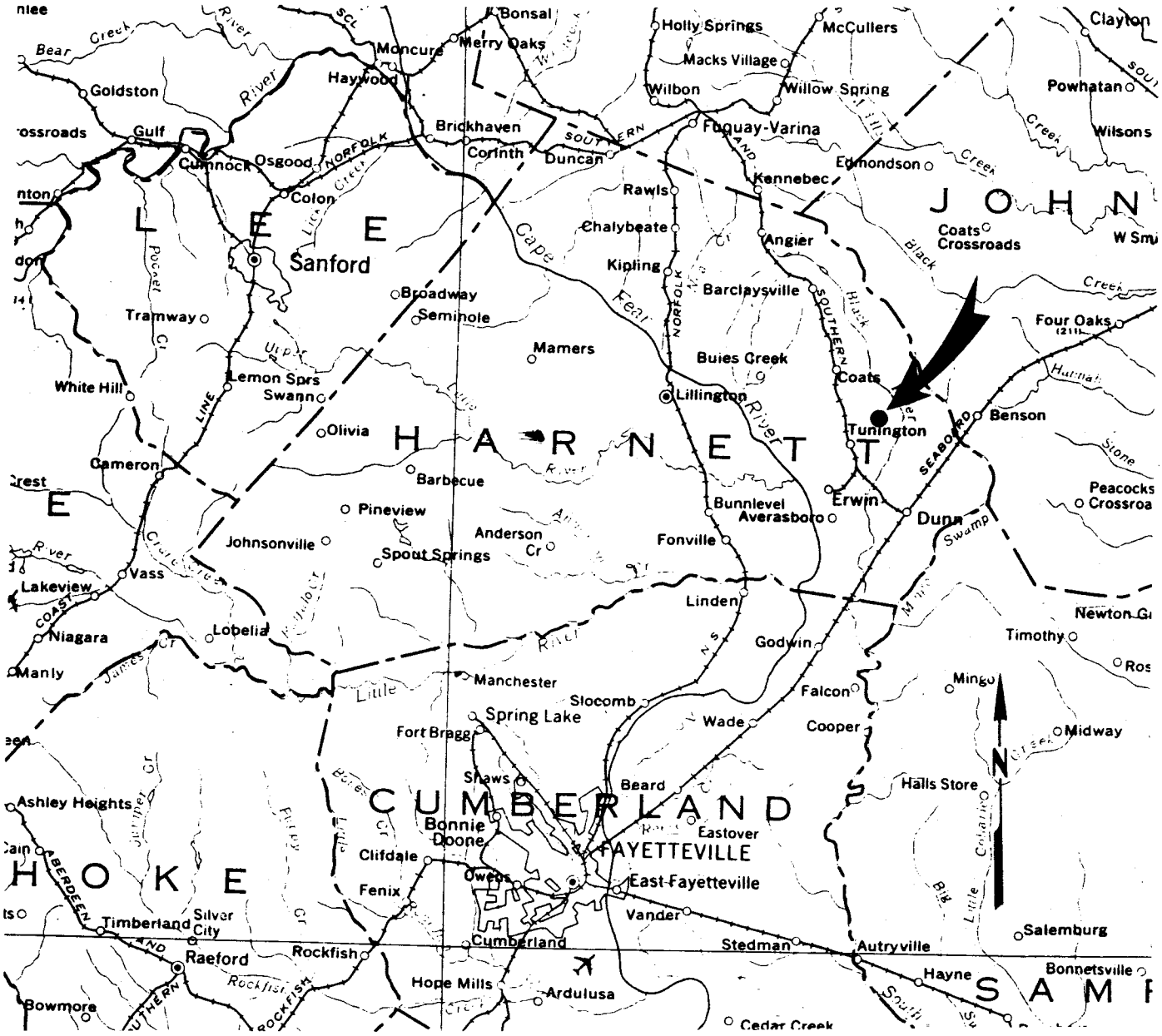


Figure 2: Harnett County and the project area (arrow).

Base map: USGS *State of North Carolina* 1985.
Scale: one inch = eight miles.

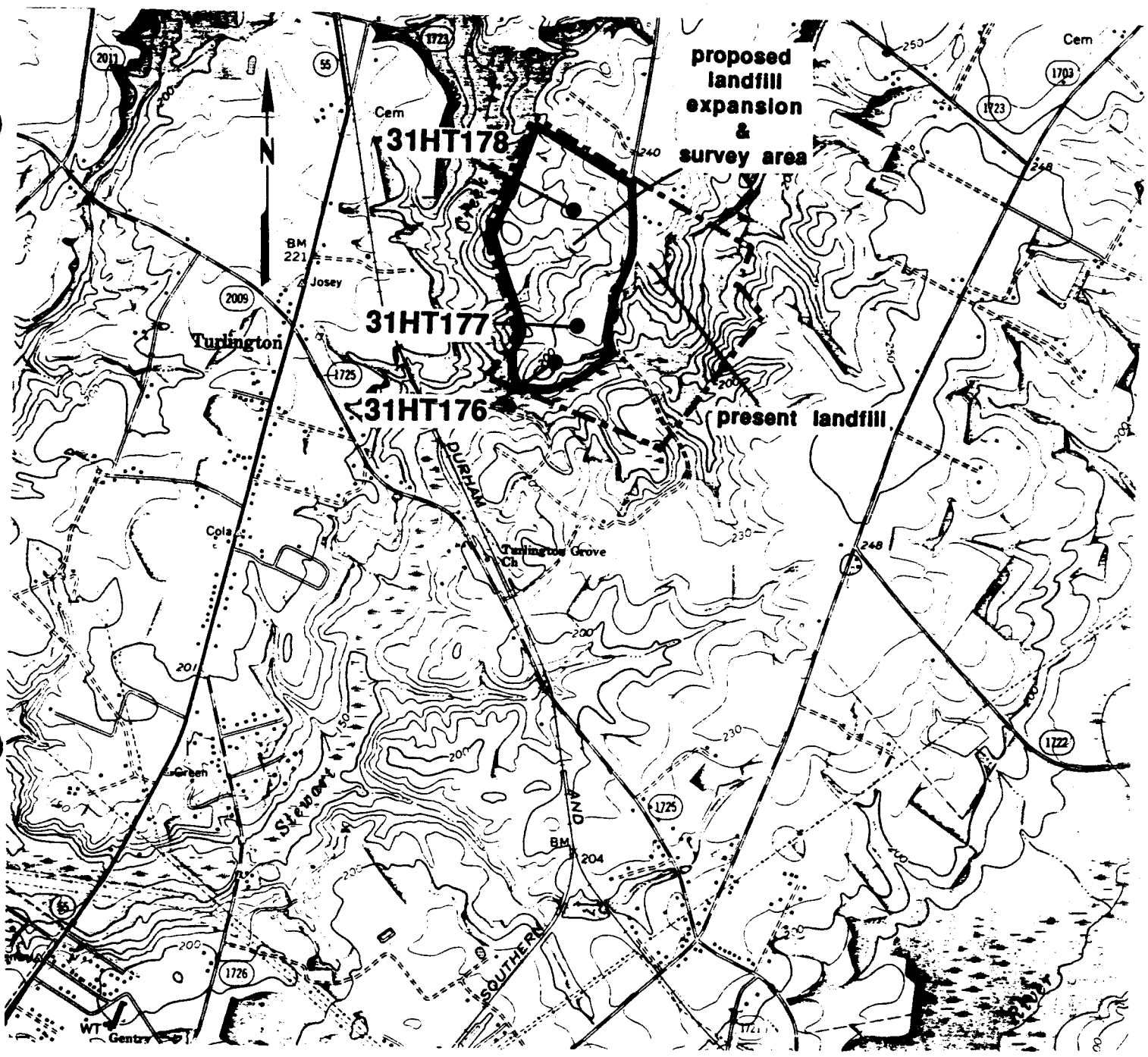
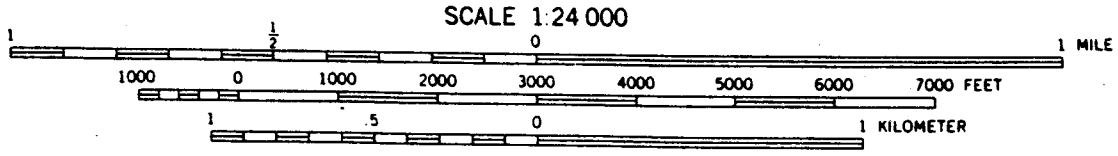


Figure 3: The project area, with archæological sites.

Base map: USGS *Erwin* quad.



Physical Environment

The project area is in a transition zone between the upper Coastal Plain and the lower Piedmont. The terrain features gently rounded uplands and steeply or gradually sloping valley sides (Daniels et al. 1984:12). Elevations range from about 166 feet above mean sea level near Stewart Creek to about 220 feet on the higher ridgetops. From a geological perspective, the area falls within the Coastal Plain's Middendorf Formation, dominated by sand, sandstone, and mudstone. Although the area probably did not provide good quality, crypto-crystalline stone for stone tools during prehistoric times, good quality felsic stone (which appears in prehistoric sites on the tract) would have been available in the Piedmont not far to the north or west (N.C. Geological Survey 1985). The area is drained by Stewart Creek, a tributary of the Cape Fear River. Most of the survey tract is in forest or pastureland. About one-quarter of the area has been exposed by farming (see Figure 4), timbering, and roads.

Prehistoric Background

Humans have lived in this part of North Carolina since at least the close of the last Ice Age, about 10,000 to 9,000 years B.C. The distinctively fluted Clovis projectile points from that period have been recorded as surface finds throughout the state, including Harnett County, where a fluted point was found near the Cape Fear River near Lillington (Perkinson 1971:6), not far to the west of our study area. As the climate warmed and the forests changed into the modern oak-hickory woodlands we see today, local cultures developed regional hunting, fishing, and wild food gathering techniques to adapt to the new forests and animal communities (Willey 1966:60; Caldwell 1958). Several of these Archaic hunting-and-gathering cultures were apparently quite stable, demonstrating little visible change over centuries or millenia. The Early Archaic period is divided into the Palmer period (about 8,000 B.C.) and the Kirk period (7,000-6,000 B.C.), both characterized by corner-notched spear or dart points (Coe 1964; Ward and Coe 1976:11-12). On the landfill expansion tract, the Early Archaic Kirk period is represented by one point at 31HT176. The Middle Archaic period is represented by the Stanly period (6,000-5,000 B.C.), the Morrow Mountain period (5,000-4,500 B.C.), the Guilford period (4,500-4,000 B.C.), and the Halifax period (about 3,500 B.C.), all typified by characteristic spear or dart points. On the landfill expansion tract, the Middle Archaic Morrow Mountain and Stanly phases are represented by points at 31HT176. The Late Archaic or Savannah River period (4,000-500 B.C.) is characterized by large, stemmed triangular blades and by large soapstone bowls (Coe 1964:119; Ward and Coe 1976:1976).

Following the nomadic, hunting-and-gathering Archaic period, the Woodland period in eastern North America was usually marked by the appearance of farming, pottery, the bow and arrow, and sometimes by the construction of burial mounds or temple mounds. In North Carolina, the first signs of the Woodland period are triangular arrow points and pottery. Significant reliance on farming and domesticated plants such as maize, beans and squash apparently came late to the North Carolina Piedmont and Coastal Plain, perhaps as late as A.D. 1000. The Woodland peoples of the region eventually became more reliant on cultivated crops and settled village life, which in turn produced distinctive regional differences such as those noted by some of the early European explorers in the late seventeenth and early eighteenth centuries (Ward 1983). Woodland-period village sites are normally found in well drained lowlands or on nearby rises or ridgetoes, although smaller, satellite camps or hamlet sites are sometimes found in the uplands. For example, the ridgetop site of 41HT176 yielded one Woodland sherd, suggesting that a small, short-term Woodland encampment followed the Archaic campsites on the same ridge.

Harnett County and other areas in the nearby Sandhills and southern Coastal Plain at one time also had a number of Indian burial mounds (possibly dating to the Middle Woodland period), but most of these mounds have apparently been destroyed by relic collectors (Phelps 1983:35). The last Indians in this area were probably members of eastern Siouan-speaking groups, but in general, very little is known about the last Indian inhabitants of Harnett County. By the time European colonists and their African slaves arrived in this section, the local Indians had been devastated by generations of foreign diseases and warfare, and the scattered remnants of many local groups had already moved to refuge areas in southeastern North Carolina, Virginia, South Carolina, or New York (Hargrove 1987).

A review of the site files in the Office of State Archæology shows that several prehistoric sites have been recorded in the project vicinity, but not on the study tract. 31HT37 is a small, Middle Archaic Guilford site in the uplands about 2500 feet southeast of the survey tract. 31HT4 is an archæological site about one mile southwest of the study area, but the state site files have no other information on the site.

Historical Background

Some local traditions maintain that a few Native Americans continued to live in the future Harnett County region into the mid-nineteenth century (Fowler 1955), but most of the area's resident Indians had probably already left when the first significant immigration of Old World settlers occurred in the mid eighteenth century. The earliest land grants in the upper Cape Fear River basin date to the late 1730's, when large tracts along the Cape Fear River itself were acquired. A great wave of immigration into the project region began in the early 1740's, when large numbers of Scottish Highlanders began taking up land. Although Scottish Lowlanders, English, Scotch-Irish, German, and Welsh settlers also settled there in significant numbers, the Highlanders made up the single largest national group, creating a major impact on the course of the region's history. The first settlers bought or were granted land on the rich floodplains of the Cape Fear River and its larger tributaries. Later arrivals moved up into the smaller rivers and creeks. By 1754, the population of the area was large enough to require the formation of a new local government, Cumberland County, created from Anson County. The population was still small and widely scattered; the 1755 tax roles for the new county listed only 302 taxables and 63 slaves. As in later years, most of the slaves were owned by a minority of the white families. For instance, about one-quarter of the Highlander families owned slaves, with four to five slaves per family, although a few wealthy families owned dozens of slaves (Fowler 1955:17-21; Meyer 1957:99,108).

The first "urban" center in the upper Cape Fear River basin was Cross Creek, a trading community that grew up near the head of navigation on the Cape Fear River, several miles downstream from our study area. That area was first settled around 1730, but the trading center of Cross Creek took shape as late as the 1750's. By that time, Cross Creek, located about one mile from the Cape Fear River, had water-powered mills, taverns, smithies, tanneries, stores, grain-buying agents from businesses in the port of Wilmington on the lower Cape Fear River, and other conveniences for the upcountry farmers. Farm products came into Cross Creek from settlements as far away as Salem, Salisbury, Hillsborough, and Charlotte. A group of businessmen in 1762 incorporated Campbellton, closer to the Cape Fear River, in an unsuccessful attempt to compete with the traders at Cross Creek. In 1778, the two settlements formally merged as Upper and Lower Campbellton. Following the Revolutionary War, the town changed its name to Fayetteville, in honor of the Marquis de Lafayette. By this time, the town was one of the state's major urban centers, numbering

several hundred inhabitants, and it served as the meeting place for the state legislature in 1786, 1788-1790, and 1793-1794 (Powell 1968:128,169; Merrens 1964:158-160).

Harnett County was created out of Cumberland County in 1855. The county seat was temporarily at Summerville. In 1859, the county residents chose a site on the south bank of the Cape Fear River, where a new county seat was laid out and named Lillington (Corbitt 1975:115-116).

In the nineteenth century, slavery continued to play a significant part in the local economy and society, with about one-third of Harnett County's population living in slavery. Harnett County's first census in 1860 listed 5,480 free whites and 2,587 slaves, with about 40 families owning over half of the slaves (Fowler 1955:9). Before the Civil War, the major cash industry was probably the production of tar, turpentine, and lumber from the then extensive longleaf pine forests. The importance of the naval stores and lumber industries continued into the late nineteenth century, when the longleaf pine forests were largely depleted. Cotton was commercially grown on a small scale after 1850. After the Civil War, commercial cotton farming became the major agricultural activity, leading to widespread clearing of the uplands, although some writers have suggested that the upland farming followed landclearing by commercial timber companies. Tobacco was introduced to the area as a cash crop in the 1880's, but it was slow to catch on, and several decades passed before tobacco acquired the significance it has today (Jurney and Perkins 1917:6,9; State Board of Agriculture 1893:124). The nearby town of Erwin was founded on the Cape Fear River about 1902, when the Erwin Cotton Mills factory was established. The name was originally Duke, but it was changed in 1925 to Erwin, in honor of William Allen Erwin, the owner of the mill (Powell 1968:164). A detailed soil map of the county in 1916 (Jurney and Perkins 1917) shows no structures or roads in the project area.

Field Methods

Since most of the project area is in forest or pasture, the survey relied heavily on screened shovel tests at intervals of 30 meters (100 feet). The shovel tests measured about 35 to 45 centimeters (14 to 18 inches) across and were excavated into the underlying clayey subsoil. The soil from the shovel tests was screened through 1/4 inch hardware cloth. In areas with exposed ground surfaces (plowed or upturned fields, bore hole pads, farmroads, treefalls, etc.), the surveyors closely examined the area for prehistoric and historic artifacts, beginning with parallel transects spaced 20 meters apart and followed by complete ground coverage in the vicinity of any finds.

We defined a prehistoric site as an area where we found at least one artifact dating to the prehistoric period (for example, a flake from manufacturing or repairing stone tools, a stone projectile point, or a potsherd). We defined an historic site as an area containing patterned evidence of settlement (house foundations or concentrations of building debris and domestic artifacts, for example) or industry (a mill or still site, for example) dating between colonial settlement in the mid-eighteenth century and 1941 (the minimum age for National Register of Historic Places eligibility is 50 years). Practically applied, we would classify, for instance, the remains of a house, a mill, a bridge, or a foundry dating before 1941 as an archæological site. An isolated fragment of whiteware or bottle glass would not be recorded as a site.

Results of the Survey

This section presents the inventory of archæological sites recorded during our survey of the project area. Under each site, we include information on the site's period of occupation (if known), the artifacts collected, the techniques used to locate and define the site, some of the relevant environmental details, indications of preservation or disturbance, potential for future research, and speculations on the effects of project construction on the sites. The site forms submitted to the Office of State Archæology list additional environmental information (elevation, distance from water, etc.). Later sections address the question of each site's significance and recommendations for each site.

The survey recorded three prehistoric sites. Figure 3 shows the location of each site. The site numbers are assigned by the Office of State Archæology under the national system of site identification, in which "31" stands for North Carolina, "HT" stands for Harnett County, and the last numbers represent the order in which the site was entered into the OSA site files for that county. The accession numbers are also assigned by the OSA, and each number is inked onto the artifacts to help in future identification after curation. Munsell color readings of soil samples are made on dry samples.

Site 31HT176 (Harnett County Landfill #1) (Accession #91-192)

Type of site: This multi-component prehistoric site is represented by a thin scatter of Archaic and Woodland artifacts, mostly flakes, from an area measuring about 600 feet from southwest to northeast (along the crest of the ridgetop) by about 200 feet from northwest to southeast (across the ridgetop).

Ceramics (Woodland)
- Plain surface, tempered with coarse sand (1/2 - 1 mm) (1)

Points
- Kirk Serrated (Early Archaic), felsic (1)
- Morrow Mountain (Middle Archaic), felsic (1)
- Stanly (Middle Archaic), quartz (1)

Other tools
- Biface fragment, quartz (1)

Flakes
- Primary flakes, felsic (1)
- Secondary flakes, felsic (6)
- Secondary flakes, quartz (7)
- Thinning flakes, felsic (24)
- Thinning flakes, quartz (19)

How recorded: During a surface inspection of a fallow field (Figure 4) and areas disturbed by earthmoving and roads for heavy equipment, the surveyors found the flakes, points, and the single sherd exposed on the surface. Surface visibility was good to excellent -- about 50 to 100%.

Environment: The site is on a well-drained, sandy ridge crest overlooking the swampy floodplains of Stewart Creek and a small tributary. The soil profile revealed an upper, plowzone level (surface to 20 cm) of gray (10YR 6/1) sandy soil over very pale brown (10YR 8/4 or 7/4) sandy clay to about 30 cm.

Signs of preservation or disturbance: Plowing, heavy earthmoving, and severe soil erosion are the major sources of disturbance.

Research potential: The low density of artifacts and the high degree of disturbance diminish the potential for additional research.

Effects of the project: The site is in the Phase IV construction area.

Figure 4: 31HT176, looking northward.

Site 31HT177 (Harnett County Landfill #2) (Accession #91-193)

Type of site: This prehistoric lithic site is represented by eight flakes, from an area measuring about 100 feet (30 meters) in diameter. The lack of diagnostic artifacts makes it impossible to assign a date to the site.

Flakes

- Primary flakes, felsic (1)
- Secondary flakes, felsic (2)
- Secondary flakes, quartz (2)
- Thinning flakes, felsic (2)
- Thinning flakes, quartz (1)

How recorded: During a surface inspection of a fallow an upturned field, the surveyors found the eight flakes exposed on the surface. Surface visibility was excellent -- about 100%.

Environment: The site is on a wide, dry, sandy ridgetop overlooking the Stewart Creek floodplain to the west.

Signs of preservation or disturbance: Plowing, heavy earthmoving, and severe soil erosion are the major sources of disturbance.

Research potential: The low density of artifacts and the high degree of disturbance diminish the potential for additional research.

Effects of the project: The site is in the Phase IV construction area.

Site 31HT178 (Harnett County Landfill #3) (Accession #91-194)

Type of site: This prehistoric lithic site is represented by two quartz primary flakes, four quartz secondary flakes, and one felsic thinning flake from an area measuring about 50 feet (15 meters) in diameter. The lack of diagnostic artifacts makes it impossible to assign a date to the site.

How recorded: During a surface inspection of a pasture, a farmroad, and large eroded areas, the surveyors found the seven flakes exposed on the surface. Surface visibility was very good -- about 90%. Shovel testing transects in the vicinity recovered no other artifacts.

Environment: The site is on a pastured ridgetop overlooking Stewart Creek to the west.

Signs of preservation or disturbance: Sheetwash and gully erosion are the major sources of disturbance.

Research potential: The low density of artifacts and the high degree of disturbance diminish the potential for additional research.

Impact of the project: The site is in the Phase V construction area.

Standards of Significance

Our evaluations of archæological significance are based on the criteria used by the National Register of Historic Places in establishing the historic significance of structures, sites, or objects that possess integrity of location, design, setting, materials, craft, feeling, and association and that:

A. are associated with events that have made a significant contribution to the broad patterns of our history; or

B. are associated with the lives of persons significant in our past; or

C. embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinctions; or

D. have yielded, or may be likely to yield, information important in prehistory or history.

(National Park Service 1986:1)

Some types of properties are usually not eligible for National Register status: properties less than 50 years in age; churches; cemeteries; commemorative items, such as public monuments; and structures moved from their original locations or substantially altered. If these types of properties are an integral part of a larger National Register district, they might qualify for National Register status (National Park Service 1986:1).

For prehistoric sites, the most relevant criterion is "D." Do these prehistoric sites have the potential to produce significant information and new insights on the region's prehistoric past? These sites are very low density sites, severely disturbed by farming, soil erosion, and (in two cases), by heavy earthmoving. Their potential for yielding important archæological information through excavations or controlled collections is extremely low. In addition, they resemble many other disturbed, upland prehistoric sites already recorded in Harnett County (c.f. Hargrove 1990a and 1990b), and similar sites are likely to be found in similar terrain throughout the area. These three sites do not appear to be eligible for nomination to the National Register of Historic Places.

Recommendations

We do not recommend additional archæological study of the landfill expansion tract, as it is now designed.

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Appendix

The Survey Proposal

An Archaeological Survey of the Proposed Dunn-Erwin Landfill Expansion, Harnett County, North Carolina.

Introduction

This proposal has been written by Archaeological Research Consultants, Inc. in response to a request from McKim & Creed for proposals to perform an archaeological survey of a 100 acre tract of land, a proposed landfill expansion between Dunn and Erwin in Harnett County, North Carolina. The purpose of the survey is to conduct an archaeological investigation to locate potentially significant prehistoric or historical archaeological sites in compliance with Federal and State regulations. For this investigation, we have designed an intensive survey, as defined by the U.S. Secretary of the Interior's standards and guidelines for identification of historic properties (Federal Register, Volume 48, Number 190), which requires both the discovery and evaluation of archaeological sites in the project area.

Background Research

The survey of the tract will begin with an archaeological and historical overview of the project area and its region. (This phase is called "Archival Research" in the Secretary of the Interior's guidelines.) The "overview" is defined by the North Carolina State Historic Preservation Officer's description of archaeological survey types:

> The purpose of an overview is basically to consolidate all of the available information about the nature, distribution, and significance of the known archaeological resources and past archaeological record in the region...The overview should result in a document which can be used by both archaeologists and non-archaeologists in developing preservation plans, land use plans, and plans for future archaeological research.
>
> In *Archaeological Surveys: Practical Advice for Grant Projects* (pages 3-4), by Mark Mathis and Dolores Hall, North Carolina Division of Archives and History.

This phase of the work will require archival research in the North Carolina State Archives, in the North Carolina Collection at U.N.C.-Chapel Hill, and in local historical sources in Harnett County. We will also interview local historians and avocational archaeologists for the locations of known or suspected sites in the area. The historical overview will also include a review of previous archaeological reports and site forms (on file with the North Carolina Division of Archives and History) from this section of the state in order to locate known sites in the vicinity and to help put the project area and its sites into a regional context, which is necessary for an evaluation of the significance of sites recorded during the survey.

Field Survey

According to the Secretary of the Interior's definition, an "intensive survey describes the distribution of properties in an area; determines the number, location, and condition of properties; determines the types of properties actually present within the area; permits classification of individual properties; and records the physical extent of specific properties." This information should be detailed enough to allow for evaluations of a site's archaeological or historical significance. On some sites with extensive remains, determining the degree of preservation, size, depth, and level of significance requires test excavations after the initial field survey (see below).

In areas with exposed ground surfaces, the surveyors will cross the exposed ground with systematic, closely spaced transects to check for prehistoric and historic artifacts on the surface. Since the ground surface visibility in most of the survey area is likely to be relatively low, the chances are small that archaeologists will find artifacts from every site exposed on the surface. In areas without ground surface visibility, the survey will have to use systematic shovel tests at intervals of 30 meters or 100 feet in parallel transects spaced 30 meters (100 feet) apart in the proposed landfill expansion. The soil from each shovel test will be screened through 1/4 inch mesh, which improves artifact recovery and cuts down on individual surveyor error. Shovel tests will not be excavated where standing water is present or where the slopes are too steep for habitation. Slopes will of course be checked for quarry sites or rockshelters. Each shovel test will measure approximately 30 centimeters on a side. Each shovel test will be backfilled after its excavation. If a surveyor finds a site within the project area, the field crew would then define the boundaries of the site by examining exposed ground surfaces or by digging and screening additional shovel tests at right angles to the transect.

In areas with surface exposure (e.g. dirt roads, plowed fields), the survey strategy will include intensive examination of the exposed areas and controlled surface collections to obtain a representative sample of artifacts (if present). The surveyors will make these controlled surface collections within two meter or four meter circles placed at regular intervals across the sites to sample the range of artifact variability and density. The use of a standard collection unit size will allow later for more meaningful comparisons of sites recorded through surface collections.

On historic sites encountered in the sample areas, the methods described above will be used, but the surveyors will also make an effort to map and photograph visible surface remains (for example, foundations, wells, chimneys, milldams). In "abandoned" cemeteries with visible markers, sinks, or other surface indications (e.g. ground-covering periwinkle), we will record inscriptions (if present) and attempt to estimate the number of graves present, as well as the size of the cemetery. The Office of State Archaeology states that an "abandoned" cemetery is one which has not been used for interment within the last 15 years.

For the purposes of this survey, we will define a prehistoric site as one that contains one or more artifacts dating to the prehistoric period (unless the artifact was obviously placed in its find spot through modern disturbances, such as the placement of fill dirt). An historic site will be defined as the remains of an occupation (a house, for instance) or an activity showing patterned, purposeful

behavior before 1941 (the cut- off date for National Register eligibility is 50 years).

Severely disturbed areas (e.g., existing road shoulders or embankments, borrow areas, etc.) and wetlands will be eliminated from the survey. These unsurveyed areas (if they cover significantly large areas) will be indicated on maps in the final report.

Some evidence of intact archaeological deposits can occasionally be found in shovel tests, but the most reliable evaluations of a site's importance, if significant deposits are suspected from survey data, usually must come from excavations of larger areas during a test phase. Before conducting the survey, it is usually impossible to predict whether significant sites requiring test excavations exist in the project area. Tests would only come later (if at all), in a second phase of work following the survey's identification of a site with evidence of intact archaeological remains. Examples of sites that might be recommended for tests would be a prehistoric village or campsite with evidence of intact cultural features, or a historic house or industrial site with structural and artifactual remains that might give us significant archaeological information about life in the region during the centuries between colonization and 1941.

Field Techniques - Test Excavations

If the initial survey phase finds evidence of intact archaeological remains in a development area, the archaeologist will notify the client and the Office of State Archaeology and outline the methods to be used in test excavations. The test excavations (if needed) will begin with attempts to define concentrations of artifacts on sites through the use of shovel tests in heavily vegetated areas or controlled surface collections in areas with exposed artifacts. On sites with some potential for subsurface features, ARC will use systematically spaced transects with one-inch diameter soil cores in order to define more exactly the locations of features within the site. The one-inch diameter soil cores will be taken at 2.5 foot intervals within sections of the sites with some potential for subsurface features. Recent fieldwork by the Research Laboratories of Anthropology at an early historic Indian site in Orange County, North Carolina has demonstrated that this soil core technique is "100% effective in locating the full range of features encountered during the ... excavations," according to the RLA's report of its fieldwork (Simpkins and Dickens 1985:19). The soil core grid, in other words, provides excellent information on the locations of subsurface archaeological features, if not of their contents.

On sites requiring test excavations, ARC will excavate a maximum of four one-meter square test units. The excavators will dig the units in natural soil levels, divided into arbitrary 10 centimeter levels in the case of the thicker strata. The soil will be screened through 1/4 inch mesh. Each excavation unit will be documented with measured drawings and photographs of the wall profiles and features (if any). In the case of features, the excavators will section each feature and remove a substantial portion of the feature fill for flotation and chemical analysis. At the conclusion of the excavations, the excavators will backfill each excavation unit.

At this time, we cannot predict whether the tract contains sites requiring test excavations. We will assume that a four unit test excavation and systematic auger tests will be sufficient to document the size, depth, and condition of most sites. At the conclusion of the survey phase of the project, we will list any sites recommended for

test excavations, with specific reasons for further work on each and provisions for changes (if any) in the test program outlined above.

Analysis

Prehistoric ceramics will be measured and classified according to attributes such as inclusions ("temper type"), surface treatments, rim forms, and thickness. Lithic and ceramic analysis will use the projectile point and ceramic types described by Coe (1964) and standard classifications of other lithic artifact types. In addition to the chronological placement of artifacts from each site, we will attempt to place each site in its environmental setting in order to develop models or describe patterns of prehistoric settlement systems and land-use. We will attempt to use the survey data and the synthesis of previous work in the area to advance our understanding of Paleo Indian, Archaic, and Woodland cultures and their use of the region.

Historic artifacts will be analyzed according to classificatory systems such as those described by South (1977), Noel Hume (1976), Munsey (1970), and Zug (1981). As far as possible, the analysis of historic artifacts and their sites will attempt to relate the remains to the documentary record and to historical questions about the area's settlement by various European and African ethnic groups and the evolution of small farms, plantations, and industries in the region.

Curation

Each artifact will be washed and then numbered in ink with accession numbers obtained from the North Carolina Division of Archives and History. ARC has facilities for short-term curation of these artifacts, but arrangements for their permanent curation as a study collection will be made with a local institution (probably the Division of Archives and History) following the conclusion of the project.

Evaluations of Significance

We will judge each prehistoric and historic site recorded during the survey according to the criteria of significance of the National Register of Historic Places. This project will include the intensive test phase needed for such definitive evaluations. The result of the fieldwork will be a body of data and recommendations in a report that will allow project managers and reviewers to make decisions about the significance and Register eligibility of each archaeological site.

Our evaluations of archaeological significance rely on the published criteria of the National Register of Historic Places for establishing historic significance for structures, sites, or objects that possess integrity of location, design, setting, materials, craft, feeling, and association and that:

A. Are associated with events that have made a significant contribution to the broad patterns of our history; or

B Are associated with the lives of persons significant in our past; or

C. Embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinctions; or

D. Have yielded, or may be likely to yield, information important in prehistory or history.

(National Park Service 1986)

Normally exempted from National Register eligibility are items less than 50 years in age, churches, cemeteries, and structures that have been moved from their original locations or substantially altered. Cemeteries are extended protection through state laws on human burials and skeletal remains, however.

Project Impacts

Each site will be analyzed with respect to the proposed landfill's impact on site preservation.

Report

Immediately after the conclusion of the fieldwork, we will submit a management summary, listing the recorded sites and the project's impact on each. The draft and final versions of the report of archaeological investigations will follow the format required by the Guidelines for the Preparation of Reports of Archaeological Surveys and Evaluations, issued by the Office of State Archaeology of the North Carolina Division of Archives and History. The final, illustrated report will have a full description of our background research and its results, our survey methods and any sites recorded, methods of artifact analysis and site interpretation, standards of site significance with documented evaluations of site potential, and statements about the relative sensitivity of various areas from an archaeological viewpoint. Any recommendations for or against further archaeological work (such as additional data recovery) or for preservation of sites will be supported with evidence from the survey and test excavations and with reference to specific, recognized areas of prehistoric and historic knowledge that would benefit from further attention to the site. Any recommendations made against further work or for specific, additional work on the sites will be subject to review by the State Historic Preservation Officer in the North Carolina Division of Archives and History. We will also provide the state with the required computerized forms describing each archaeological site located.

Personnel

The Principal Investigator will be Thomas H. Hargrove, who has a Master's degree in Anthropology from George Washington University and a Bachelor's degree in the same field from the University of New Mexico. He has been employed by ARC as an archaeologist for ten years and was previously employed as an archaeologist by the

North Carolina Division of Archives and History for over three years His archaeological experience in Harnett County includes surveys of proposed landfills near Barbecue and Johnsonville a survey of proposed alterations to NC 87 and a survey of the proposed West Buies Creek sewer line

Schedule

We estimate that the time required for the completion of background research fieldwork analysis and a preliminary report is two weeks The time needed for the completion of a draft final report and the required site forms is an additional ten days This schedule is subject to change however if the initial survey finds sites requiring test excavations

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