Carmen Johnson
Fac/Permit/Co ID 94-04 Date 4/17/12 Doc ID# DIN

FEB 1995 Received Solid Waste Section

SITE APPLICATION REPORT

FOR

PROPOSED

CONSTRUCTION AND DEMOLITION WASTE LANDFILL
AND TIRE MONOFILL

FOR

COUNTY OF WASHINGTON

APPROVED
DIVISION OF SOLID WASTE MANAGEMENT
DATE 2/17/95 BY DRB
DIEHL & PHILIPS COPY
WASHINGTON CUTT CLS
94-04

FOR REVIEW ONLY

PRINTED
JAN 31 1995
ON

NORTH CAROLINA PROFESSIONAL SEAL 13371 ENGINEER ALAN R. KEITH

10/31/94

Prepared by:

Diehl & Phillips, P.A.
Consulting Engineers
219 E. Chatham Street
Cary, NC 27511

SITE APPLICATION REPORT

FOR

PROPOSED

CONSTRUCTION AND DEMOLITION WASTE LANDFILL
AND TIRE MONOFILL

FOR

COUNTY OF WASHINGTON

NORTH CAROLINA PROFESSIONAL SEAL 13371 ENGINEER ALAN R. KEITH

10/31/94

Prepared by:

Diehl & Phillips, P.A.
Consulting Engineers
219 E. Chatham Street
Cary, NC 27511

1.0 GENERAL:

The County of Washington currently owns a 71 acre tract adjacent to the closed Washington County landfill, off NC 308 near Roper, NC. The proposed site is partially wooded and has been used as a borrow site for cover soil and a portion of the site is currently in use as a land clearing and inert debris disposal area. The County of Washington proposes to develop this site as a construction and demolition waste landfill and a tire monofill. This report and accompanying materials constitutes a site application for the proposed landfill.

2.0 LOCATION AND SURROUNDING AREA:

Accompanying this report is a plan set including details on the site, surrounding area, and special features. Sheets 1 and 2 are maps at a scale of 1-inch equals 400 feet showing the area within ¼ mile of the site boundary as required by North Carolina Solid Waste Management Rules 15A NCAC 13B (Rules) section .0504(1a).

The proposed site abuts the wetlands bordering the Roanoke River and Albemarle Sound. Only agricultural land and woodland are adjacent to the site. Washington County does not have a zoning ordinance, therefore, zoning is not shown. Existing drainage canals are shown. The 100 year flood level in the vicinity is elevation 8 MSL which will cover a portion of the site. Excerpts from Federal Emergency Management Agency maps are included in the Appendix for flood information.

Sheet 3 of the plan set is a map at a scale of 1-inch equals 1,000 feet showing the area within 2 miles of the site as required by section .0504(1b) of the Rules. Groundwater use in the vicinity is limited to residential wells and wells for corp irrigation. No surface water intakes are within 2 miles of the site. There are some swine, poultry and agricultural operations nearby. There are no residential subdivisions except development in the area called Albemarle Beach within 2 miles of the site. There are no known airports within 2 miles of the site. Also included in the Appendix is an aerial photograph at a scale of 1-inch equals 2,000 feet showing the area surrounding the site.

3.0 Geological and Hydrological Study

Included with this report is the "Geological and Hydrologic Report - Proposed Washington County C&D Debris Landfill - Washington County, NC" by S&ME, Inc. covering the requirements of Section .0504(1c) of the Rules.

4.0 Conceptual Design

The proposed facility will be constructed largely above ground. The subsurface investigation for the site indicates the water table is very near the ground surface. In order to maintain buffer distance between the waste and the water table, landfilling will occur above ground. Some minor grading to provide positive drainage from active landfilling areas is proposed.

The County utilized process silica or alum mud to construct berms in 1991 to enclose the sanitary landfill vertical expansion adjacent to the proposed site. The process silica is an industrial byproduct of alum production at a Cytec Industries plant in Plymouth, NC. Washington County has between 15,000 and 20,000 cubic yards of processed silica stockpiled on the existing landfill site.

Berms approximately 15 feet high were successfully constructed for the sanitary landfill vertical expansion which closed in October, 1994. Similar berms are proposed to enclose the C&D landfill and tire monofill. Law Engineering performed slope stability analyses for the processed silica berms which were approved by the NC Division of Solid Waste Management with the Washington County Amendment to Permit - Vertical Expansion in 1991. A copy of the slope stability analysis is included in the Appendix. Sheet 5 of the accompanying plan set illustrates the proposed berms.

The stockpiled processed silica will be utilized to construct the northern berm of the landfill. Three shorter berms will be constructed perpendicular to the north berm to separate the C&D waste from tires and to confine the waste. Landfilling will begin against the north berm proceeding across the entire face of the berm in lifts approximately 5-feet high. The first lift of waste cells will proceed to the end of the short north-south berms. Upon completion of the first lift, a second lift will start against the north berm working to the south followed by a third lift. The tire monofill will proceed similarly.

Closure of the C&D area and the tire monofill could be accomplished at any time. The working face will be sloped for drainage away from previously filled area. Final capping per State Rules would fully close the landfill.

Should permitting allow continuation of the landfill/monofill, the three north-south berms could be extended from the initially constructed berms to provide more landfill volume. Alum production continues at Cytec, therefore processed silica is currently produced. With State and County approval, additional processed silica could be used for additional berm construction. Otherwise native soils would be utilized as practical for berm construction.

Operation of the C&D area and tire monofill will require cover soils. Native soils will be used for cover material. Borrow areas east and west of the landfill/monofill will be excavated for cover material. Borrow areas are indicated on sheet 4 of the accompanying plan set. Approximate earthwork calculations are included in the Appendix. Suitable erosion control measures would be provided to control sedimentation. Monitoring wells will be provided for compliance with groundwater regulations. Existing scales will be used to track waste received by the facility. Buffers of at least 200-feet from the property line to waste areas will be maintained.

5.0 Local Government Approval

A copy of a resolution by the Washington County Commissioners is included in the Appendix illustrating their willingness to provide the proposed facility. The facility is not located in or near a municipality, therefore the County has jurisdiction. Also included is a letter stating that there is no County zoning ordinance in effect.

6.0 Siting Criteria Met

Section .0503(1) of the Solid Waste Management Rules covers criteria for siting of new landfills. As discussed in Section 2.0 the 100-year flood does cover part of the site. However, wastes will be placed outside the flood zone.

Attached in the Appendix is a copy of a report from Soil & Environmental Consultants entitled "Preliminary Endangered Species and Wetlands Surveys." This report notes that no endangered species habitats were found on the site. Bald eagles and sea turtles are federally listed species for Washington County. The site does not have shoreline access for sea turtles nor trees suitable for bald eagle nests.

Attached in the Appendix is a copy of a report by Archaeological Research Consultants, Inc. entitled "An Archaeological Survey of the Proposed Washington County Landfill". The report notes that one historic-period archaeological site with a minor prehistoric component was discovered. The site was found to be disturbed and therefore is not recommended for additional archaeological work.

There are no State Parks, recreation areas, scenic areas, nature or historic preserves in the immediate vicinity of the site. There are no airports within 10,000 feet of the site. Cover soils are available from borrow sites within the 71 acre tract. Earthwork calculations are included in the Appendix.

7.0 Landfill Data

The proposed construction and demolition waste landfill and tire monofill will serve the residents of Washington County North Carolina. Population data from the NC Department of Administration for Washington County is as follows:

YEAR	WASHINGTON COUNTY POPULATION
1970	14,038
1980	14,801
1990	13,997
2000	13,205
2010	12,408
2020	11,470

Municipal solid waste from Washington County is currently disposed of at the regional privately owned facility in Bertie County. Municipal waste will continue to be disposed of out of the County, at least for the length of the County's current contract. The existing County landfill is closed and will not receive any waste. The existing Washington County land clearing and inert debris disposal (LCID) area will continue to receive waste in the future. White goods and other recyclables are stored near the existing landfill offices until they are removed for recycling offsite. Recycling will continue in the future.

The facility proposed will dispose of wastes classified as construction and demolition wastes and used tires in separate areas. Material from building demolition, remodeling, repair, etc. are the types of material proposed for C&D disposal. Stumps and other land clearing waste would be disposed in the existing LCID area. Used tires would be disposed in the tire monofill. The County has a tire slicer to reduce the volume of the tires in the monofill.

County records collected prior to closure of the old landfill showed C&D waste receipts at approximately 50 to 75 tons per month or an annual receipt of approximately 750 tons. Since Washington County's population will not increase according to projections, it is assumed that the recorded volume would continue after the new C&D landfill is opened. Tires are currently collected and stored at the landfill for shipment to a tire recycler. Tire receipts are approximately 30,000 pounds per month at the landfill. Again this volume would be assumed to continue after opening a tire monofill.

Monthly waste volume estimates tributary to the landfill are assumed as follows:

C&D Waste:

$$750 \text{ Tons} \times \frac{2{,}000 \text{ Lbs.}}{\text{Tons}} \times \frac{\frac{1}{25} \text{ Lbs}}{\text{Cu.Ft.}} = 60{,}000 \text{ Cu.FT./Year}$$

Tires:

$$12 \text{ Months} \times \frac{30{,}000 \text{ Lbs.}}{\text{Month}} \times \frac{\frac{1}{15} \text{ Lbs}}{\text{Cu.Ft.}} = 24{,}000 \text{ Cu.FT./Year}$$

Phase 1 of the proposed landfill (initially constructed berms) would confine approximately 335,000 cubic feet in the C&D area and 140,000 cubic feet in the tire monofill area. Allowing for daily cover, waste volume available is assumed to be approximately 300,000 cubic feet for C&D and 130,000 cubic feet for tires. Life of Phase 1 C&D and tire monofill is estimated at approximately five years maximum for C&D and over five years (maximum) for tires.

Cover requirements are estimated at 4,000 cubic yards for daily cover and miscellaneous fill dirt for Phase 1 C&D and approximately 2,400 cubic yards for the tire monofill Phase 1. Should the landfill continue in operation, an additional 8,400 cubic yards for C&D cover and 5,600 cubic yards for tires would ultimately be required not counting final cap or additional berm construction. The final cap for Phase 1, assuming a 2-foot thickness would require approximately 6,000 cubic yards of material with another 12,000 cubic yards to complete the landfill cap for future phases.

The County currently has the following equipment for use at the landfill:

> One (1) Caterpillar 953 tracked loader, one (1) Caterpillar D8 bulldozer, one (1) Dragline, one (1) Tandem dump truck, one (1) Tractor with implements, and one (1) Pick-up Truck.

The County successfully operated the old landfill for nearly seven years. The landfill personnel have considerable experience in earthmoving and landfill operation.

Sheet 4 of the accompanying plan set shows the proposed monitoring well locations for the new landfill. Groundwater movement as determined in the hydrologic site study is generally south to north. One up-gradient well is proposed along with three down-gradient wells. A groundwater monitoring plan would be included in construction plans for the facility.

8.0 Conclusion

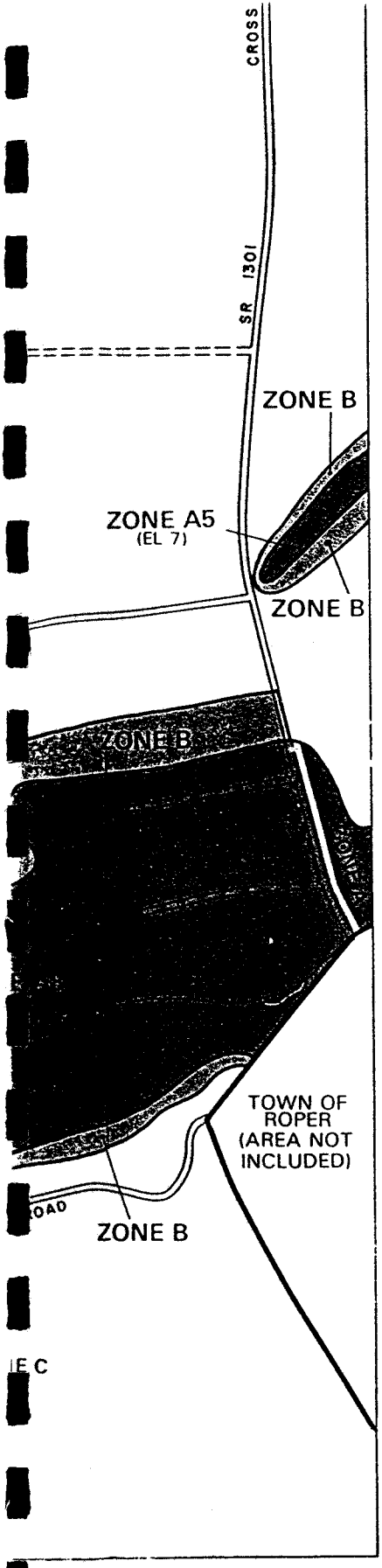
The proposed landfill is sited in a remote rural area adjacent to an existing closed landfill. Groundwater movement from the proposed site is directly toward wetlands and a large body of water. There is no existing or proposed development in the vicinity of the landfill. Large buffers (>200') can be maintained between the landfill site and the property lines which are controlled by the County. A buffer of over 1,000 feet would exist between the closed sanitary landfill and

the tire monofill. Adequate cover soil is available on site. Access to the site is controlled. The County has existing scales, office, and equipment in place to serve the proposed facility. County personnel have extensive experience in operating the type of facility proposed.

Washington County has a need for a facility to dispose of construction and demolition wastes and used tires. The County currently pays to have waste shipped out of the County. Many of the components necessary to construct and operate a C&D waste facility are already in place at the site. The site is well suited for the proposed use. Therefore, the County feels proceeding with construction of a C&D landfill and a tire monofill are warranted.

APPENDIX

Excerpts from
Federal Emergency Management Agency (FEMA) Maps
for Washington County



To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620.

APPROXIMATE SCALE

1000 0 1000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

WASHINGTON COUNTY, NORTH CAROLINA

(UNINCORPORATED AREAS)

PANEL 45 OF 350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

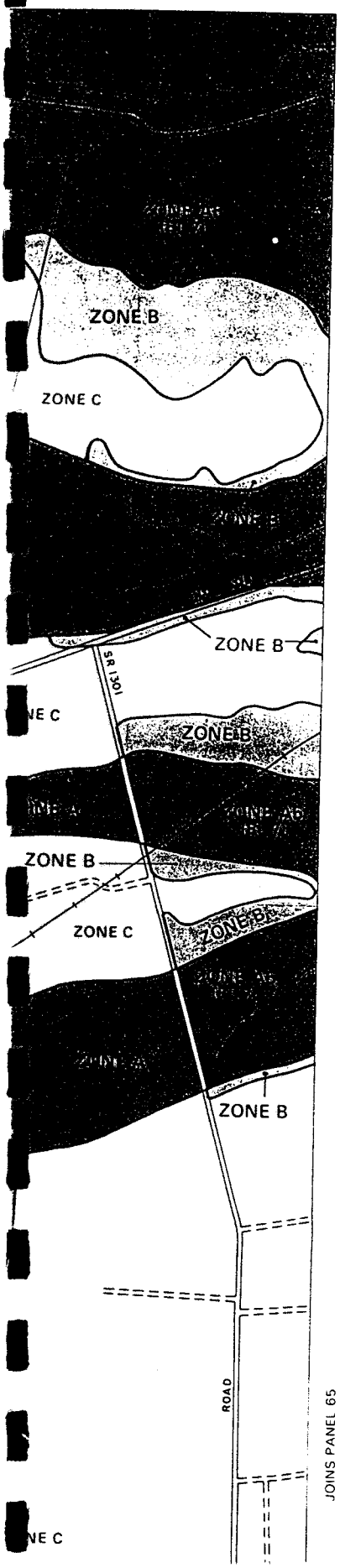
COMMUNITY-PANEL NUMBER

370247 0045 B

EFFECTIVE DATE:

AUGUST 19, 1985

Federal Emergency Management Agency



KEY TO MAP

500-Year Flood Boundary	
100-Year Flood Boundary	
Zone Designations*	ZONE B
100-Year Flood Boundary	
500-Year Flood Boundary	ZONE B
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
Zone D Boundary	
River Mile	•M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (Zones A and V) may be protected by flood control structures

This map is for flood insurance and flood plain management purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

The coastal flooding elevations shown may include the effects of wave action and may differ significantly from those developed by the National Weather Service for hurricane evacuation planning. Coastal base flood elevations apply only landward of the shoreline shown on this map.

For adjoining map panels, see separately printed Map Index

INITIAL IDENTIFICATION:

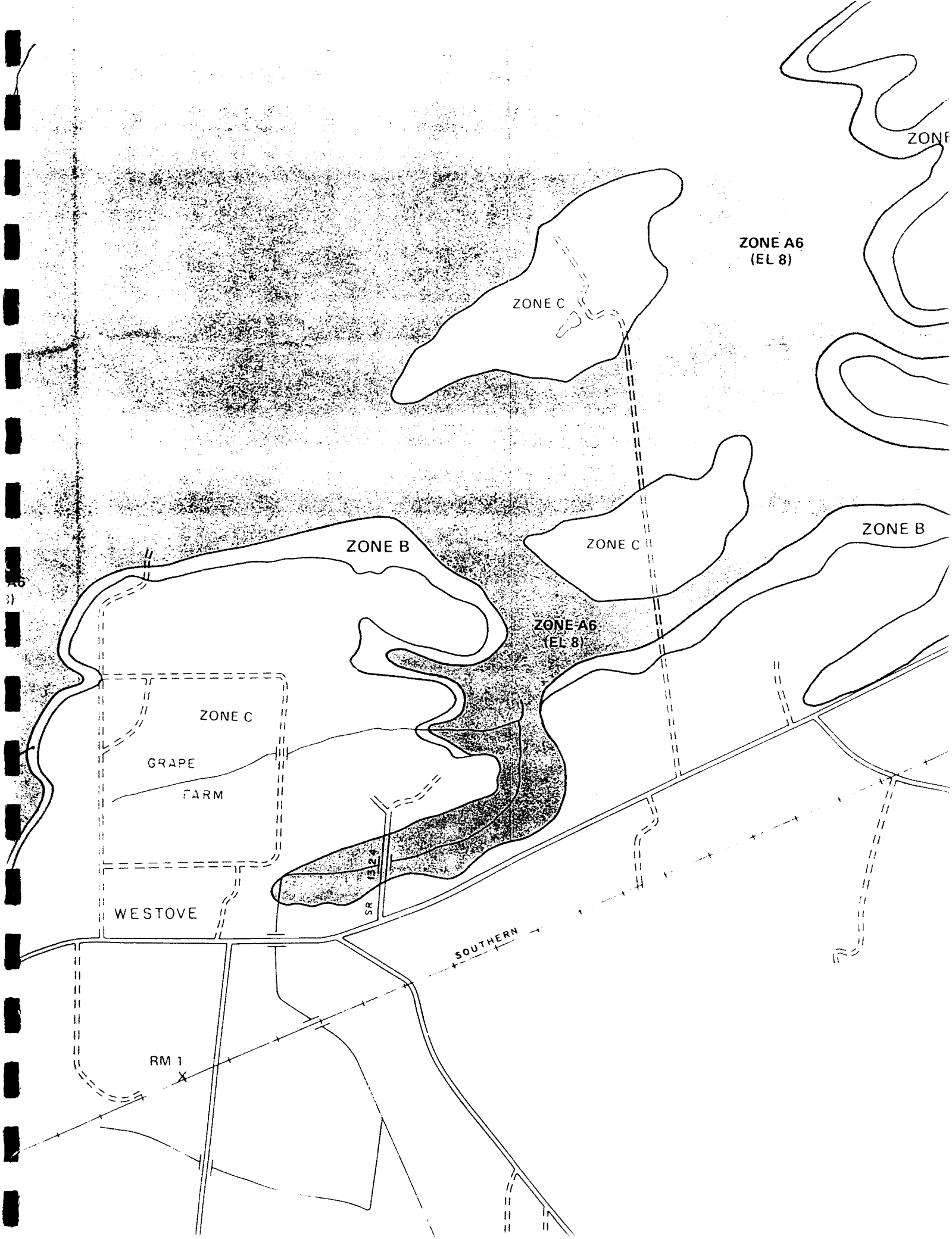
JUNE 9, 1978

FLOOD HAZARD BOUNDARY MAP REVISIONS:

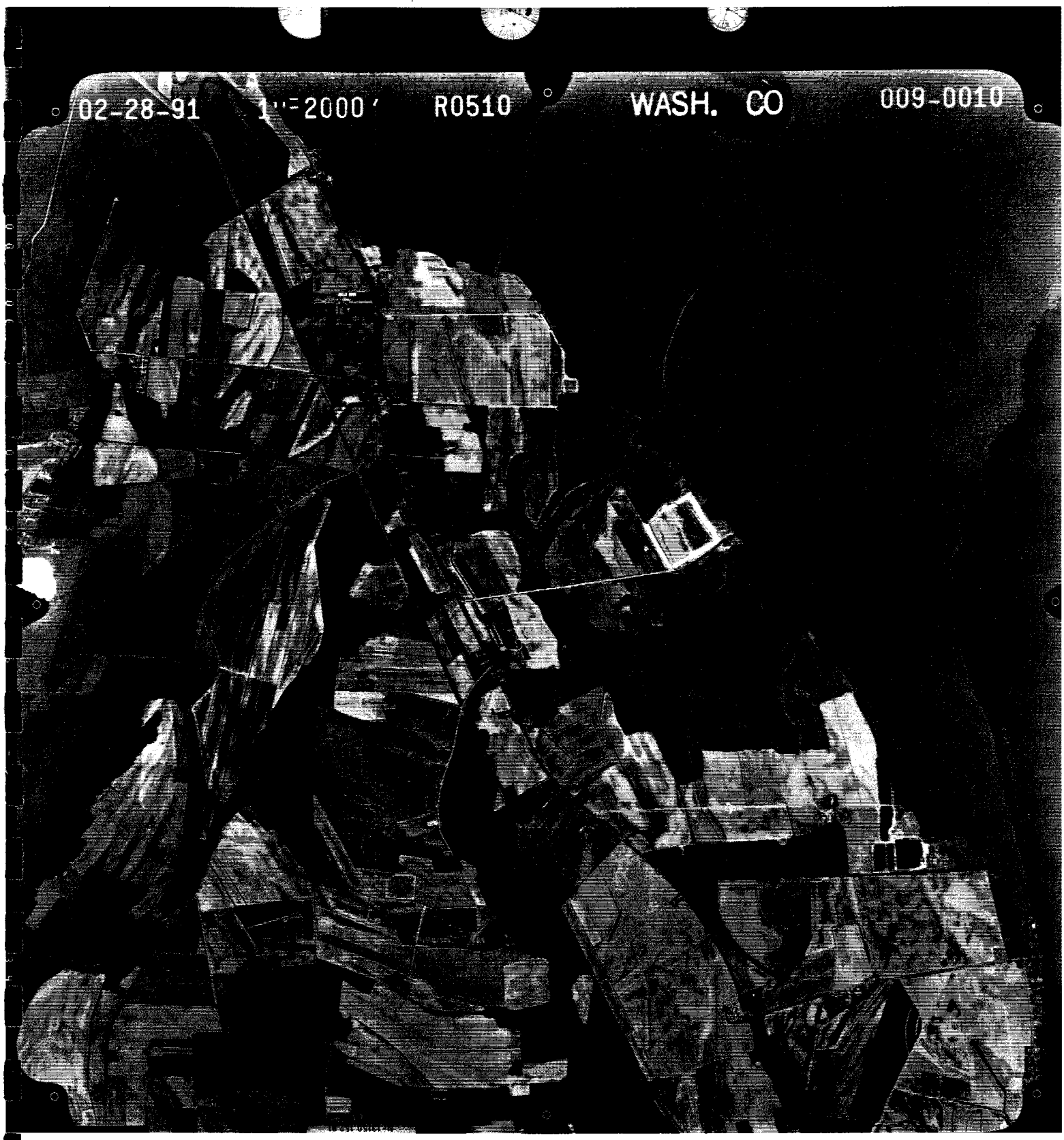
FLOOD INSURANCE RATE MAP EFFECTIVE:

AUGUST 19, 1985

FLOOD INSURANCE RATE MAP REVISIONS:


ZONE
ZONE A6
(EL 8)
ZONE C
ZONE B
ZONE C
ZONE B
ZONE A6
(EL 8)
ZONE C
GRAPE
FARM
SR 1324
WESTOVE
SOUTHERN
RM 1

Aerial Photograph
Washington County Landfill and
Surrounding Area


02-28-91
1"=2000'
R0510
WASH. CO
009-0010

GEOLOGIC AND HYDROLOGIC REPORT
PROPOSED WASHINGTON COUNTY
C&D DEBRIS LANDFILL
WASHINGTON COUNTY, N.C.

S&ME, Inc. Project No. 1054-94-119

Prepared for:

Diehl and Phillips, P. A.
Consulting Engineers
219 E. Chatham street
Cary, NC 27511

Prepared By:

S&ME, Inc.
3100 Spring Forest Road (27604)
P.O. Box 58069
Raleigh, North Carolina 27658-8069

April 1994

S&ME

April, 18, 1993

Diehl and Phillips, P.A.
Consulting Engineers
219 E. Chatham Street
Cary, N.C. 27511

Attention: Mr. Alan Keith

Reference: Geologic and Hydrologic Report
Proposed Washington County C&D Landfill
Washington County, N.C.
S&ME Inc. Project No. 1054-94-119

Dear Mr. Keith,

S&ME, Inc. has completed the geologic and hydrologic study of the 71 acre site located adjacent to the existing Washington County Landfill. Our report follows this letter. The report describes the activities performed during the study, discusses the findings of the study, and presents our preliminary recommendations.

In summary, the site appears to be favorable for construction of the proposed C&D debris landfill. The site is typical of the Coastal Plain, it is underlain by unconsolidated soil materials to a depth of greater than 50 feet. These materials consist of sands and clayey to sandy silts.

No unusual geologic conditions were observed in the vicinity of the site that would restrict siting of the landfill. A shallow groundwater table and designated wetland areas will control the actual siting. Since groundwater occurs at a relatively shallow depth across

S&ME, Inc. 3100 Spring Forest Road, Raleigh, North Carolina 27604, (919) 872-2660, Fax (919) 790-9827
Mailing address: P.O. Box 58069, Raleigh, North Carolina 27658-8069

Printed on Recycled Paper

the site, landfill cell embeddment depths will be negligible. Groundwater flow is towards the north.

Groundwater quality and water table level are influenced by the existing landfill in the extreme northwestern corner of the site. In order to adequately monitor the new landfill, it should be located as far east as practical, leaving a buffer of several hundred feet between the new construction and the existing landfill. The conceptual plans discussed during our previous meeting would appear to allow a sufficient buffer for monitoring.

The results of the borrow investigation look favorable. Based on the test pit data, the clayey soils appear to be present in sufficient quantity for use as final cover. Laboratory permeability testing performed on remolded samples indicate the material, when adequately compacted, will have sufficiently low permeability characteristics to be used for construction. Preliminary information for the borrow investigation has been forwarded to you previously. The final report will be forwarded to you shortly. Please review the attached report and call us at (919) 872-2660 if you have any questions.

S&ME appreciates the opportunity to assist Diehl and Phillips during this phase of landfill development.

Sincerely,

S&ME, Inc.

James N. Johnston
Environmental Engineer/Hydrogeologist

Walter J. Beckwith, P.G.
Senior Project Geologist

TABLE OF CONTENTS

PAGE #

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 2
- 2.1 SITE LOCATION 2
- 2.2 PROJECT BACKGROUND 2
- 2.3 CURRENT SITE USAGE 3

3.0 PURPOSE AND SCOPE 4
- 3.1 PURPOSE 4
- 3.2 SCOPE OF WORK 4

4.0 INVESTIGATIVE PROCEDURES 6
- 4.1 SUBSURFACE INVESTIGATION 6
  - 4.1.1 Soil Test Borings 6
  - 4.1.2 Soil Headspace Analysis 7
  - 4.1.3 Piezometer Installation 7
  - 4.1.4 Hand Auger Borings 8
  - 4.1.5 Site Traverse 8
- 4.2 AQUIFER TESTS 9
- 4.3 LABORATORY PROCEDURES 9

5.0 PHYSIOGRAPHY AND HYDROGEOLOGY 10
- 5.1 PHYSIOGRAPHY 10
- 5.2 GEOLOGY 10
- 5.3 HYDROGEOLOGY 11
  - 5.3.1 Stratigraphic Sequence 11
  - 5.3.2 Groundwater Occurrence 12
- 5.4 SITE TOPOGRAPHY AND SURFACE DRAINAGE 12
  - 5.4.1 Site Topography 12
  - 5.4.2 Site Drainage 12
- 5.5 SITE LITHOLOGY 13
- 5.6 SITE HYDROGEOLOGY 15
- 5.7 GROUNDWATER 15
  - 5.7.1 Shallow Water Table Aquifer 15
  - 5.7.2 Deep Potentiometric Surface 16
- 5.8 Hydraulic Conductivity of the Surficial Aquifer 16
  - 5.8.1 Upper Sands 17
  - 5.8.2 Upper Clay 17
  - 5.8.3 Underlying Silts 18
- 5.9 GROUNDWATER MOVEMENT 18

6.0 SOIL CONSERVATION SERVICE SOIL MAPPING 20

7.0 ANALYTICAL RESULTS 21
7.1 OVA ANALYSIS OF SOIL SAMPLES 21
7.2 LABORATORY DETERMINATION OF SOIL PROPERTIES 21
7.2.1 Site Soil Classification Groupings 22
7.2.2 Grain Size Determinations 22
7.2.3 Natural Moisture Content 23
7.2.4 Porosity 23
7.2.5 Laboratory Permeability 23

8.0 SITE SUITABILITY 24
8.1 SUITABILITY OF THE SITE 24
8.2 MONITORING OF SURFACE AND GROUNDWATER 24
8.2.1 Groundwater Monitoring 25
8.3 GEOLOGIC LOCATION RESTRICTIONS 25
8.3.1 Faults 26
8.3.2 Seismically Active Zones 26
8.3.3 Unstable Areas 27

REFERENCES 28

TABLES

Table 1	Piezometer & Boring Locations
Table 2	Summary of Water Level Readings
Table 3	Hydraulic Conductivity from In-situ measurements
Table 4	Hydraulic Conductivity from Grain Size
Table 5	Selected 505 Soil Characteristics
Table 6	Summary of OVA Data
Table 7	Summary of Laboratory Classification Tests

FIGURES

Figure 1	Site Map
Figure 2	Geologic Section 1
Figure 3	Geologic Section 2
Figure 4	Geologic Section 3
Figure 5	Geologic Section 4
Figure 6	Geologic Section 5
Figure 7	Shallow Potientric Map
Figure 8	Deep Potentiometric Map
Figure 9	Fault Map
Figure 10	Seismic Hazard Map

APPENDICES

Appendix I	Boring Records
Appendix II	Laboratory Test Records
Appendix III	Aquifer Test Records
Appendix IV	Other Documents

1.0 EXECUTIVE SUMMARY

S&ME, Inc. (S&ME) was authorized by Diehl and Phillips, P.A., in January 1994, to perform a hydrogeologic study of a 71 acre site proposed for construction of a Construction and Demolition (C&D) debris landfill for Washington County. Seven soil test borings were drilled on the site to classify the subsurface geology. Eleven piezometers were installed to determine the depth to groundwater. Selected soil samples were submitted for laboratory analysis for determination of their engineering properties and to confirm visual classifications.

Based on the preliminary subsurface information developed for this site, the site appears favorable for construction of the C&D debris landfill.

- Site conditions are typical of the Tidewater Region of North Carolina. Sandy soils are predominant at the ground surface. They are underlain by predominantly sandy and clayey silts.

- The depth to groundwater varies from less than 1 foot to 7 feet below the ground surface. Shallowest depths were found within portions of the site that have been previously used as a source of borrow soils. Groundwater flow is primarily to the north toward the wetland fringe of the Albemarle Sound.

- Soil permeability ranges from approximately 5×10^{-6} cm/sec in the near surface clays to approximately 1×10^{-2} cm/sec in the near surface sands. Underlying silts average approximately 2×10^{-5} cm/sec.

- No evidence of geologic location restrictions, such as faults or unstable soils, were found in the site area. The site is not located within a Seismic Impact area.

- Site conditions should allow adequate monitoring of surface and groundwater around the proposed landfill,since the existing landfill has resulted in an impact to groundwater in the vicinity of the northwest corner of the property. The new landfill should be located as far east as practical to allow adequate buffer between the two landfills for groundwater monitoring.

- The relatively shallow depth to groundwater will allow negligible cell embeddment in order to maintain acceptable separation between the waste and the seasonal high water table.

- Suitable borrow soils are available off-site for landfill cover.

2.0 INTRODUCTION

S&ME has completed the geologic and hydrologic study of the 71 acre site proposed for construction of a Construction and Demolition (C&D) debris landfill for Washington County. The study was authorized by Diehl and Phillips, P.A., who are under contract with Washington County to design the landfill.

2.1 SITE LOCATION

The existing facilities are located in northern Washington County north of N.C. highway 308 between Plymouth and Roper, North Carolina. The study area, proposed for construction of the C&D debris landfill, is located immediately east of the existing landfill. The site is bounded to the north by the wooded wetland fringe of the Albemarle Sound. It is bounded to the east and south by privately owned, wooded, undeveloped property. Access to the existing facility is provided by a 3,700 foot graveled road off of N.C. highway 308. A vicinity map showing the location of the site with respect to the Plymouth, North Carolina area is included in the application.

2.2 PROJECT BACKGROUND

Washington County is currently in the process of closing the county's existing sanitary waste landfill located adjacent to (west of) the proposed site. At the present time, the county's refuse is being landfilled outside the county. It is desirable to landfill the county's C&D waste within Washington County to reduce costs. The proposed facility would utilize the existing access road, security gate, earth moving equipment and scale house. There are no residences within 2,000 feet of the site at the present time. Surrounding property is either undeveloped or in cultivation.

2.3 CURRENT SITE USAGE

The current landfill facilities include several completed (closed) landfill cells, a soil stockpile, a processed silica stockpile, truck scales, and a scale house. Photographs showing the existing facilities are included with the application.

Approximately 25 percent of the proposed site has previously been used as a source of borrow soils, both by the landfill for cover material, and previously, by the North Carolina Department of Transportation during the improvements to US Highway 64 near Plymouth, N.C.

Most of the area used for borrow has been excavated to the water table. Standing water was observed in the west-central portion of the site. This water drains to the north through an excavated ditch. Leachate seepage was noted over a broad area west of the ditch.

Within the undisturbed portions of the site, the ground surface is elevated slightly above the surrounding land. In general, most of the land adjacent to the site boundaries is poorly drained and wooded. With the exception of the northwest corner of the site and a fringe along the existing landfill, the entire site has been timbered in the past and is now covered with a thick stand of immature hardwoods and underbrush.

3.0 PURPOSE AND SCOPE

3.1 PURPOSE

S&ME was retained by Diehl and Phillips, P.A., to determine the geologic and hydrogeologic setting of the site. The purpose of the study was to determine the general subsurface conditions within the 71 acre tract proposed for construction as required by the State of North Carolina Waste Management Rules - 15A NCAC 13B, as amended through January 4, 1994. Specifically, Section .504 (1) (c) i-iv and (g); Section .1622 (4, 5, and 6); and Section .1623 (a) (1 through 13) as they apply to general site studies for site application of a landfill construction permit. The findings, summarized in this report, will be included with the application and will be used for to provide preliminary information for design of the landfill.

3.2 SCOPE OF WORK

The scope of work consisted of the following tasks:

- Performance of a site reconnaissance to locate boring positions.
- Installation of seven soil borings. Borings not used for piezometer construction were to be abandoned by grouting at the completion of drilling in accordance with N.C. Well Abandonment Regulations.
- Installation of eleven piezometers to evaluate groundwater levels across the site and to establish aquifer characteristics through field tests.
- Determination of water levels in the wells and piezometers at intervals of 24 hours and seven (7) days following installation.
- Performance of laboratory classification testing and permeability testing on selected soil samples.

Realizing that insufficient fine grained soils exist within the site for reuse as cover material,

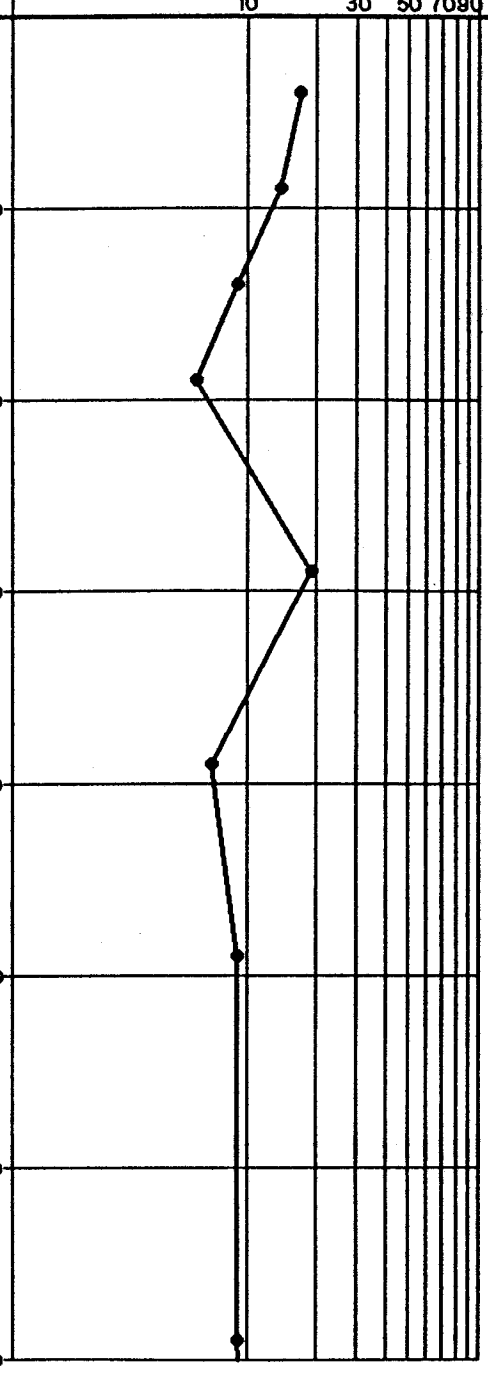
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-4

PROJECT NO.:	1054-94-119	ELEVATION:	3.1
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-28-94	WATER LEVEL:	1' - 4"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-4) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer (SP-4) installed in offset boring. Screened at 28-38 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Very Organic Topsoil (OL)					
		Loose to Medium Dense Light Gray and Light Brown Fine **SAND** (SP)					17, 14, 9
5						-1.9	
		Firm Tan and Gray Silty **CLAY**, with Trace of Roots and Organic Matter (CL)					8
10						-6.9	
		Medium Dense Brown Silty Fine **SAND**, with Some Decayed Organic Matter (SM)					19
15						-11.9	
		Loose Dark Gray Fine **SAND**, with Trace of Silt and Fine Organic Matter (SP)					7, 9
20						-16.9	
25						-21.9	
30						-26.9	
		Stiff Gray Silty **CLAY** (CL)	S2				9
35						-31.9	

Standard Penetration Test Data (Blows/ft)



S&ME
Environmental Services
Engineering * Testing

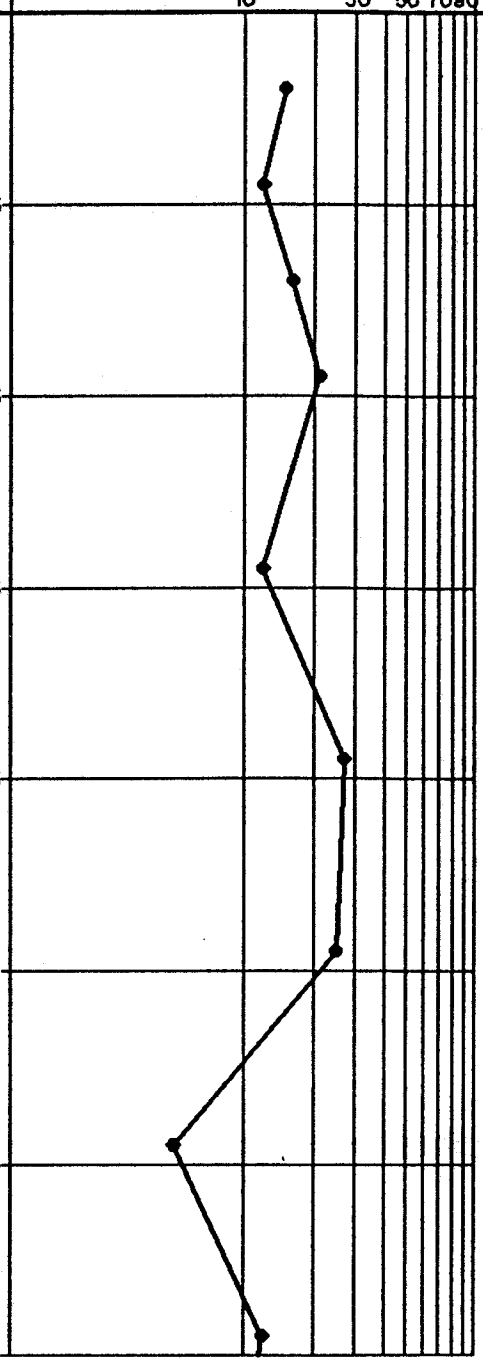
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-5

PROJECT NO.:	1054-94-119	ELEVATION:	10.5
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-28-94	WATER LEVEL:	7' - 3"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-5) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer (SP-5) installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Topsoil, Brown Silty **SAND** (SM)					
		Medium Dense Light Brown and Tan Fine to Medium **SAND** (SP)					15
5		Very Stiff Light Gray Fine Sandy Silty **CLAY** (CL)				5.5	12
							18
		Medium Dense Light Gray and Tan Medium **SAND**, with Some Coarse Sand and Pea Gravel (SP-SW)					21
10						.5	
15						-4.5	12
20						-9.5	27
25						-14.5	25
30		Firm Brown Gray Fine Sandy Clayey **SILT** with Some Fine Decayed Organic Matter (ML)				-19.5	5
35		Stiff Dark Gray Silty Sandy **CLAY**, with Trace of Organic Matter (CL)				-24.5	12

Standard Penetration Test Data (Blows/ft)



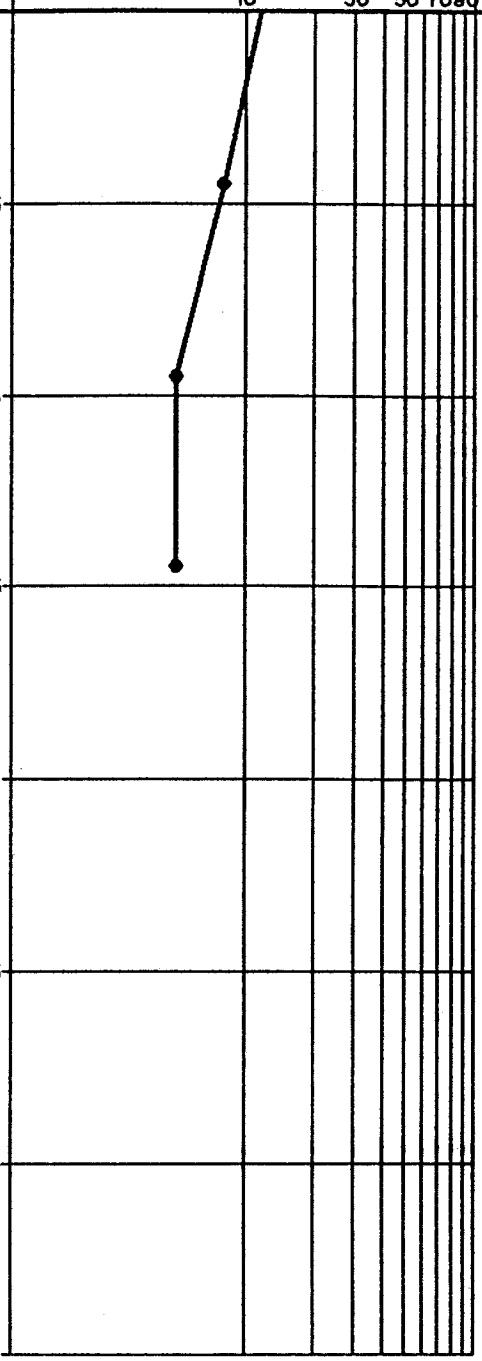
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-5
PROJECT NO.:	1054-94-119	ELEVATION:	10.5
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-28-94	WATER LEVEL:	7' - 3"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-5) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer (SP-5) installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Firm Dark Gray Clayey Fine Sandy SILT with Some Fine Organic Matter (ML)					
40						-29.5	8
45						-34.5	5
50						-39.5	5
		Boring Terminated at 50.0'					
55						-44.5	
60						-49.5	
65						-54.5	
70						-59.5	

Standard Penetration Test Data (Blows/ft)



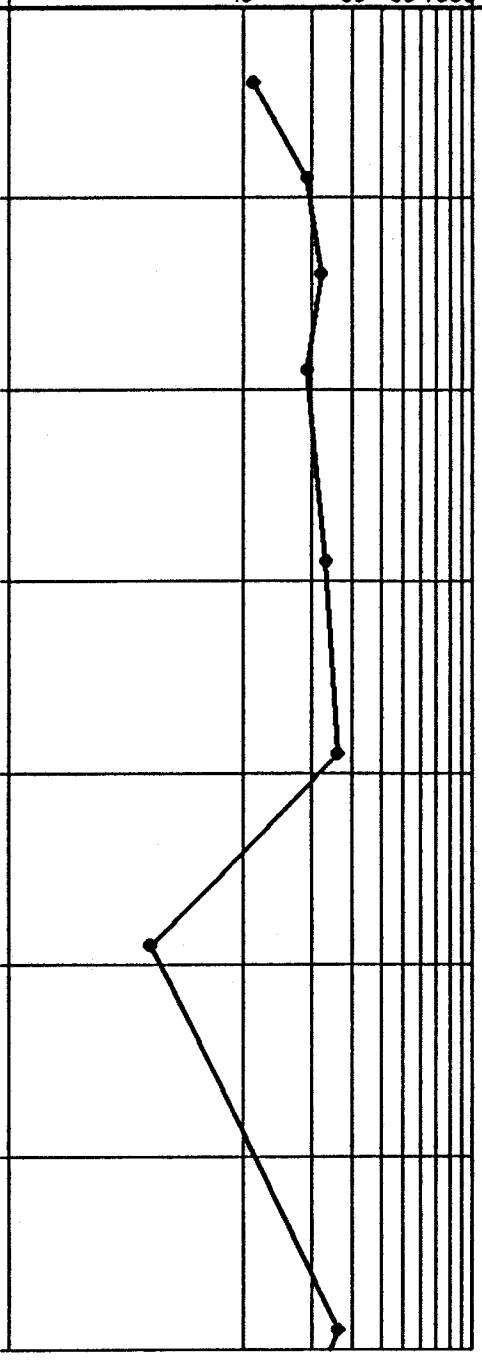
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-7
PROJECT NO.:	1054-94-119	ELEVATION:	6.3
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-4-94	WATER LEVEL:	2'-0"
DRILLING METHOD:	H.S.A./Tri-cone	DRILL RIG:	CME - 450

NOTES:
Shallow piezometer installed in adjacent borehole. Screened from 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Topsoil, Brown Silty **SAND** (SM-ML)					
		Stiff to Very Stiff Light Gray with Orange Silty **CLAY** (CL)					11, 19
5		Medium Dense Light Gray Silty Fine to Medium **SAND** (SM)				1.3	22, 19
10		Medium Dense Tan Medium **SAND** (SP)				-3.7	23
15						-8.7	
		Medium Dense Tan to Brown Coarse **SAND** with Pea Gravel (SP-GP)					26
20		Medium Dense Gray Silty Clayey Fine **SAND** (SC)				-13.7	
		Soft Gray Silty **CLAY** (CL)					
25		Very Loose Brown Tan Fine **SAND** (SP)				-18.7	4
30		Very Dense Gray Silty Fine **SAND** (SM)				-23.7	50/5
35		Very Stiff Gray Clayey **SILT**, with Some Fine Organic Matter (MH)				-28.7	26

Standard Penetration Test Data (Blows/ft)



S&ME
Environmental Services
Engineering * Testing

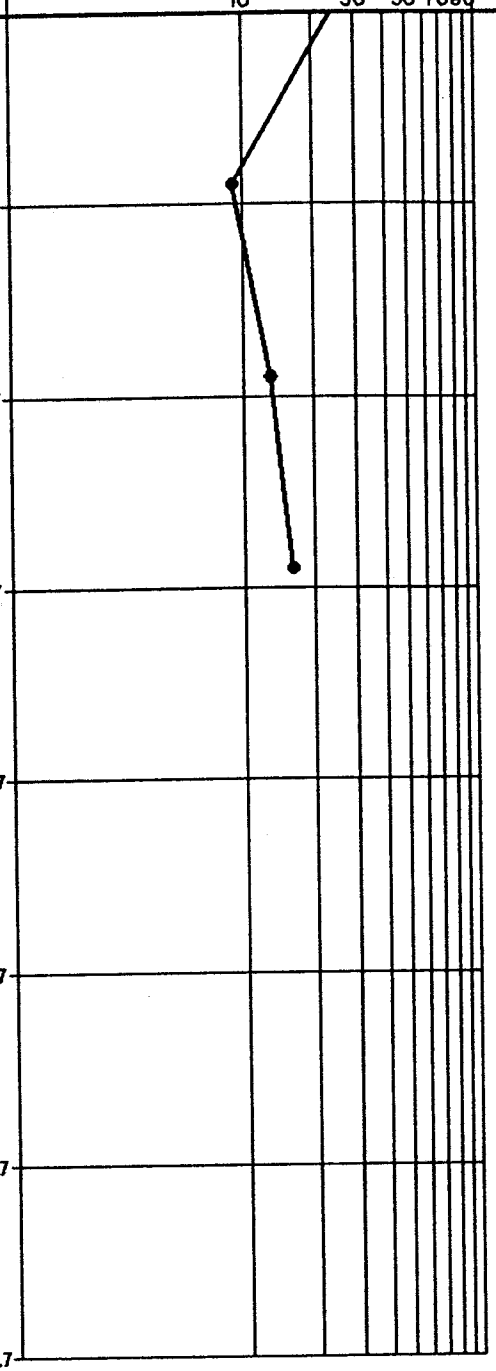
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-7

PROJECT NO.:	1054-94-119	ELEVATION:	8.3
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-4-94	WATER LEVEL:	2'-0"
DRILLING METHOD:	H.S.A./Tri-cone	DRILL RIG:	CME - 450

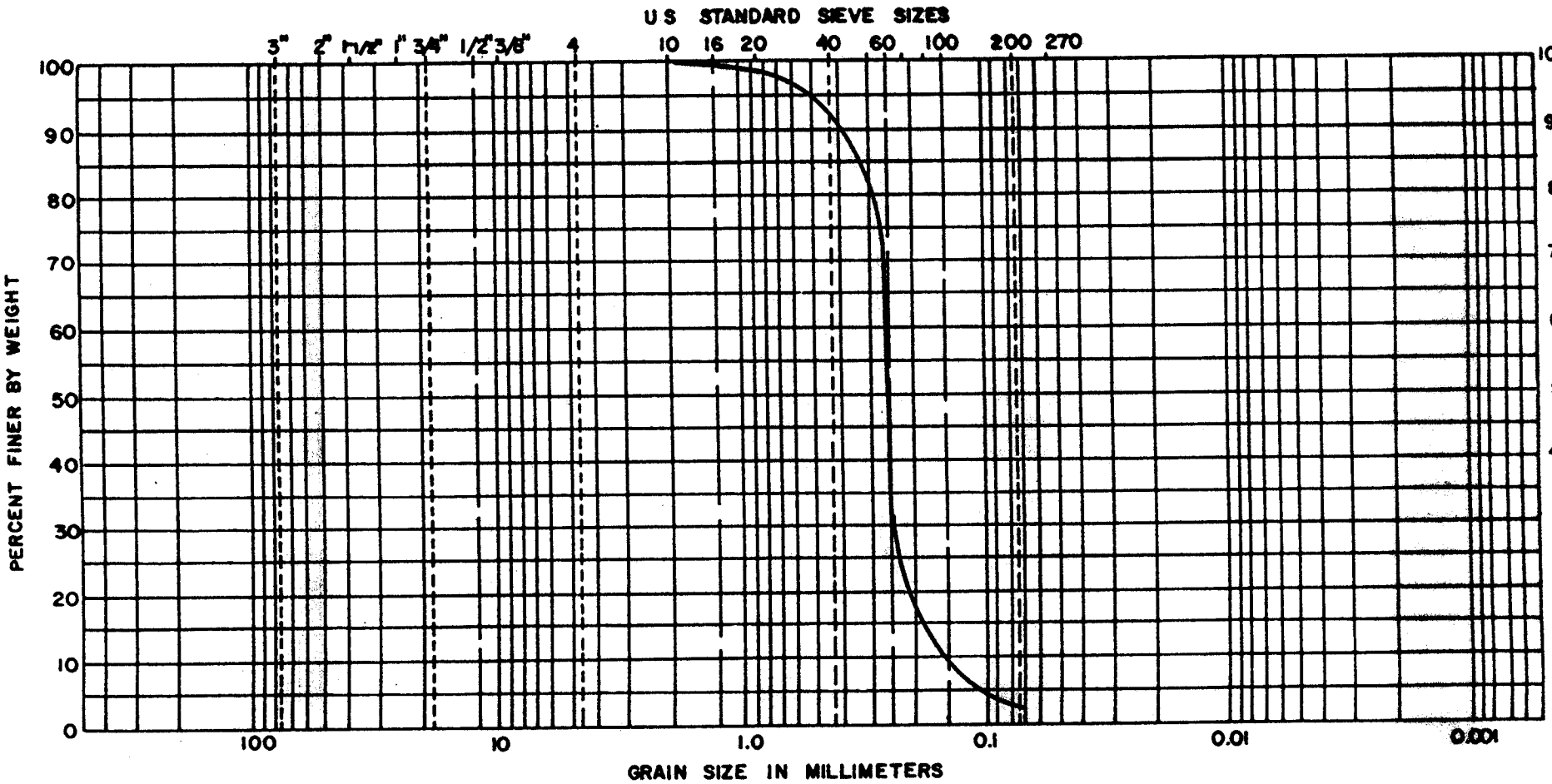
NOTES:
Shallow piezometer installed in adjacent borehole. Screened from 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Stiff Gray Clayey Sandy SILT with Fine Organic Matter (ML)					
40						-33.7	9
45						-38.7	13
50						-43.7	16
		Boring Terminated at 50.0'					
55						-48.7	
60						-53.7	
65						-58.7	
70						-63.7	

Standard Penetration Test Data (Blows/ft)



S&ME
Environmental Services
Engineering * Testing



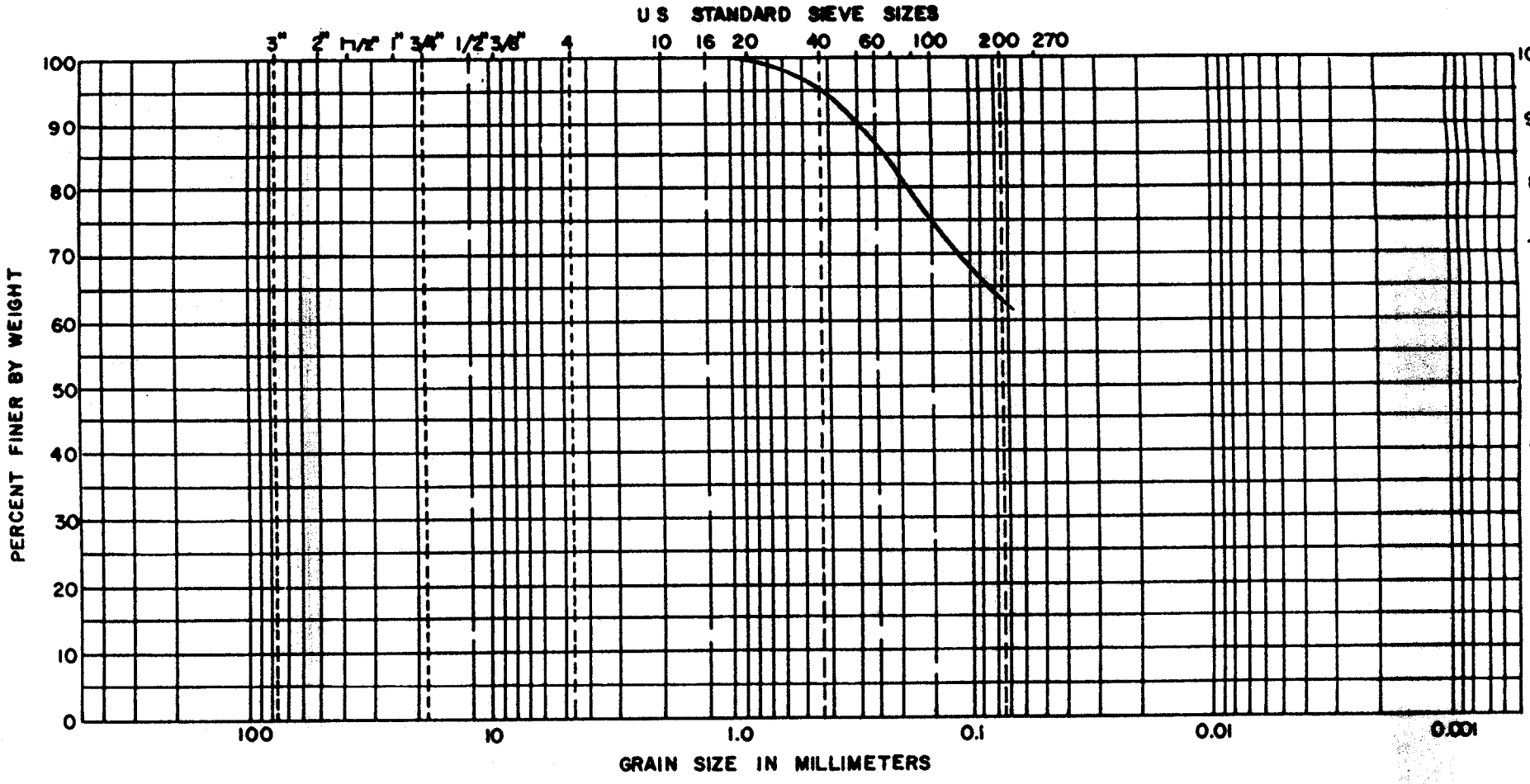
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-1 S 10	38.5' - 40'	--	--	--	--	GRAY-BROWN FINE SAND

JOB NO. 1054-94-119

GRAIN SIZE DISTRIBUTION

S&ME



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
UD	0-3 FT.	18.6	40	18	22	Dark Gray and Orange Sandy CLAY (CL)

JOB NO. 1051-94-119

GRAIN SIZE DISTRIBUTION

S&ME

S&ME

HYDRAULIC CONDUCTIVITY TEST
(Falling Head/Increasing Tailwater)
ASTM C 5084 METHOD (C)

JOB # 1051-94-119 JOB NAME: WASHINGTON COUNTY LANDFILL

DATE: 3-8-94 SAMPLE # 1 DEPTH : 0 - 3 ft.

SOIL DESCRIPTION: DARK GRAY and ORANGE SANDY CLAY (CL)

NOTES : Test specimen taken from upper portion of U.D. tube.

LL-40; PL-18; PI-22

UNDISTURBED (X) REMOLDED ( ) STANDARD PROCTOR
MAX DRY DENSITY lbs./cu.ft.
OPTIMUM MOISTURE %
% COMPACTION %

SAMPLE DATA :

Length	8.07	cm.	Moisture Content	18.6	%
Diameter	7.20	cm.	Wet Density	129.5	lb/ft3
Area	40.72	sq.cm.	Dry Density	109.2	lb/ft3
Volume	328.57	cu.cm.	Initial Saturation	92.4	%
Wet Weight	681.62	grams	Final Saturation	100.0	%
Dry Weight	574.72	grams	Initial Void Ratio	0.544	
WATER TEMP. (C)	22.0		Porosity	0.352	
CORRECTION FACTOR	0.9531		Spec. G. (apparent)	2.70	

TEST DATA

k = (aL/2At) X In(h1/h2)
RATIO = Hv1-Hv2 / Hc2
(hv1-hc1=h1) INITIAL LOSS
(hv2-hc2=h2) FINAL LOSS
i = h2/L

k = HYDRAULIC CONDUCTIVITY
L = 8.07 cm. length of sample
A = 40.72 sq.cm. area of sample
a = 0.72 sq.cm. area of burett
t = Elapsed time of test (seconds)
i = HYDRAULIC GRADIENT

Elapsed t/sec.	Hv1	Hc1	Hv2	Hc2	h1	h2	RATIO Out/In	(i) H.G.
8760	50.0	0.0	37.9	11.5	50.0	26.4	1.05	3.3
10920	50.0	0.0	35.5	13.6	50.0	21.9	1.07	2.7
11460	50.0	0.0	35.3	13.7	50.0	21.6	1.07	2.7
31800	50.0	0.0	26.7	22.0	50.0	4.7	1.06	0.6

1. k = 5.2E-06 cm./sec.
2. k = 5.4E-06 cm./sec.
3. k = 5.2E-06 cm./sec.
4. k = 5.3E-06 cm./sec.

AVERAGE :
k = 5.0E-06 cm./sec.
i = 2.3
RATIO = 1.06

FINAL (k) VALUE AVERAGE WITH WATER TEMPERATURE CORRECTION.

Tested by: D. CARVER

S&ME, Inc. 3100 Spring Forest Road, Raleigh, North Carolina 27604, (919) 872-2660, Fax (919) 790-9827
Mailing address: P.O. Box 58069, Raleigh, North Carolina 27658-8069

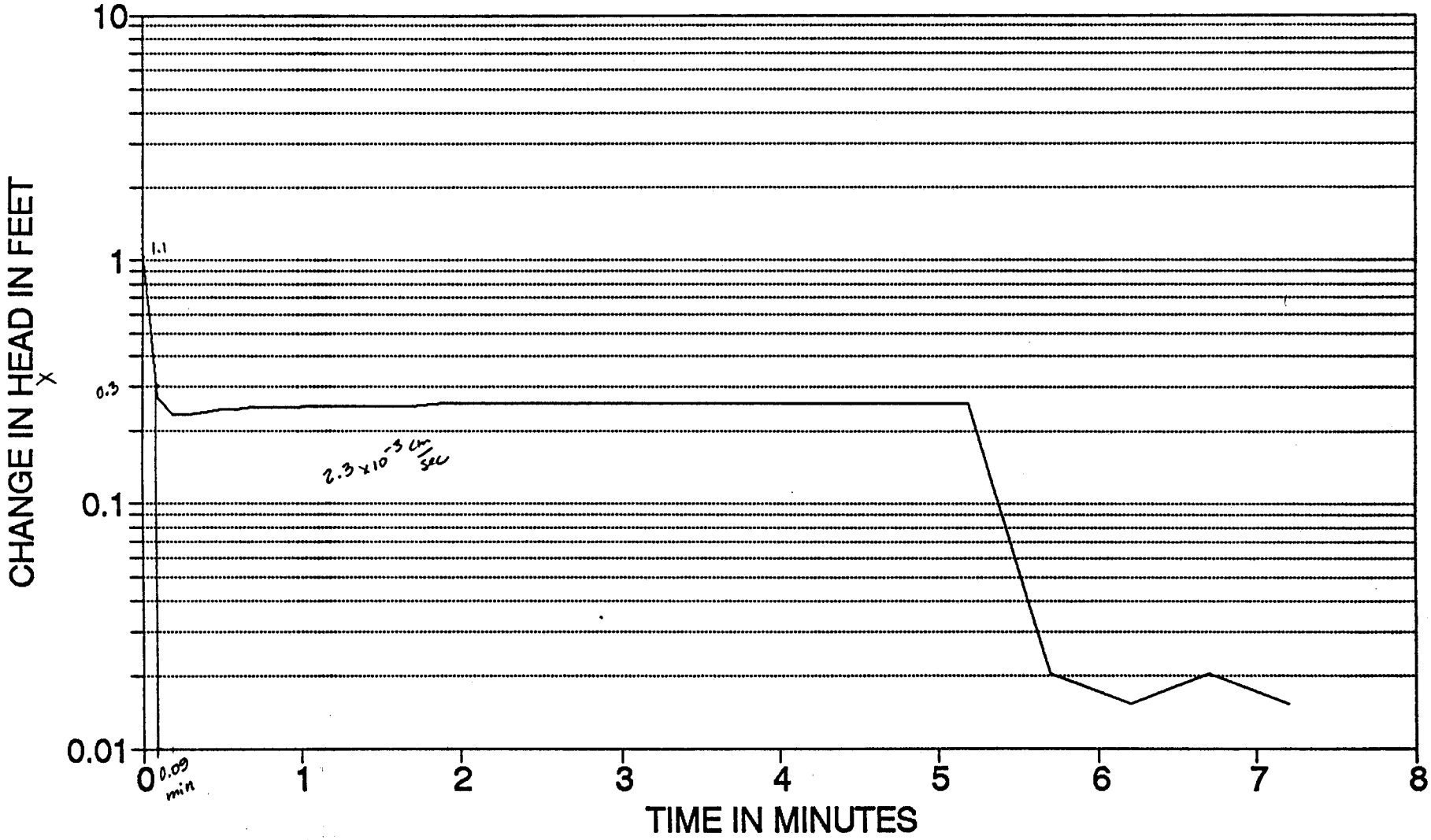
Printed on Recycled Paper

APPENDIX III
AQUIFER TEST RESULTS

ABSTRACT

This appendix contains a brief discussion of the Bouwer and Rice Analysis of hydraulic conductivities from slug tests; the graphs of the change in water level with time; intercept points and values used in the calculations; copies of the data recorded; and calculation of seepage velocity.

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER S 1 TEST 1



—— WELL RECHARGE CURVE

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-1 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
10 feet to 20.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

2.5E-03	cm./sec.
2.2	m./day
2601	ft./yr.
53.3	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
0.56 feet to Water Table
8.5 inch - Borehole Diameter
20 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-1 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

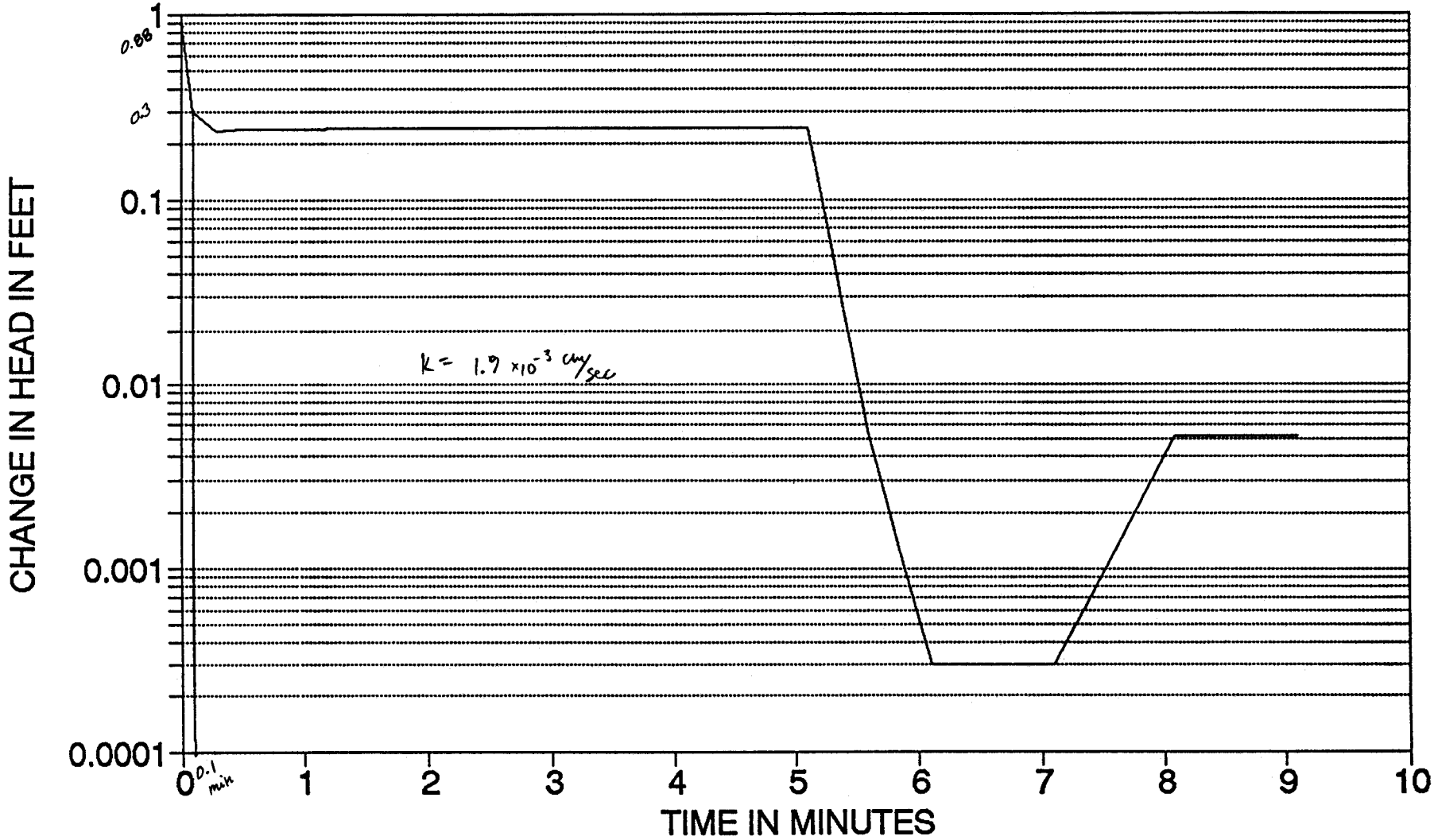
Intercept with the Y axis(Yo):	1.1	Feet @	0	Minutes
X intercept at (Yt):	0.3	Feet @	0.09	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	592.531	
H (cm)	2116.53	
Le/Rw	28.2353	
Lw/Rw	54.8894	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	1.1	
Yt	0.3	
t (sec)	5.4	
Ln((H-Lw)/Rw))	4.95001	
Ln(Lw/Rw)	4.00532	
Ln(Re/Rw)	2.52723	
Ln(Yo/Yt)	1.29928	
K (cm/sec)	0.00251	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER S11 TEST 2



WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-1
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION:	Sand, sandy clay, clayey sand
UNIFIED SOIL CLASSIFICATION	

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	1.38	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	21.38	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	1.94	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	0.88	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	0.3	Feet
Yt at time (t2):	0.1	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-1 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
10 feet to 20.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

1.9E-03	cm./sec.
1.6	m./day
1939	ft./yr.
39.7	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
0.56 feet to Water Table
8.5 inch - Borehole Diameter
20 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-1 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

Intercept with the Y axis(Yo):	0.88	Feet @	0	Minutes
X intercept at (Yt):	0.3	Feet @	0.1	Minutes

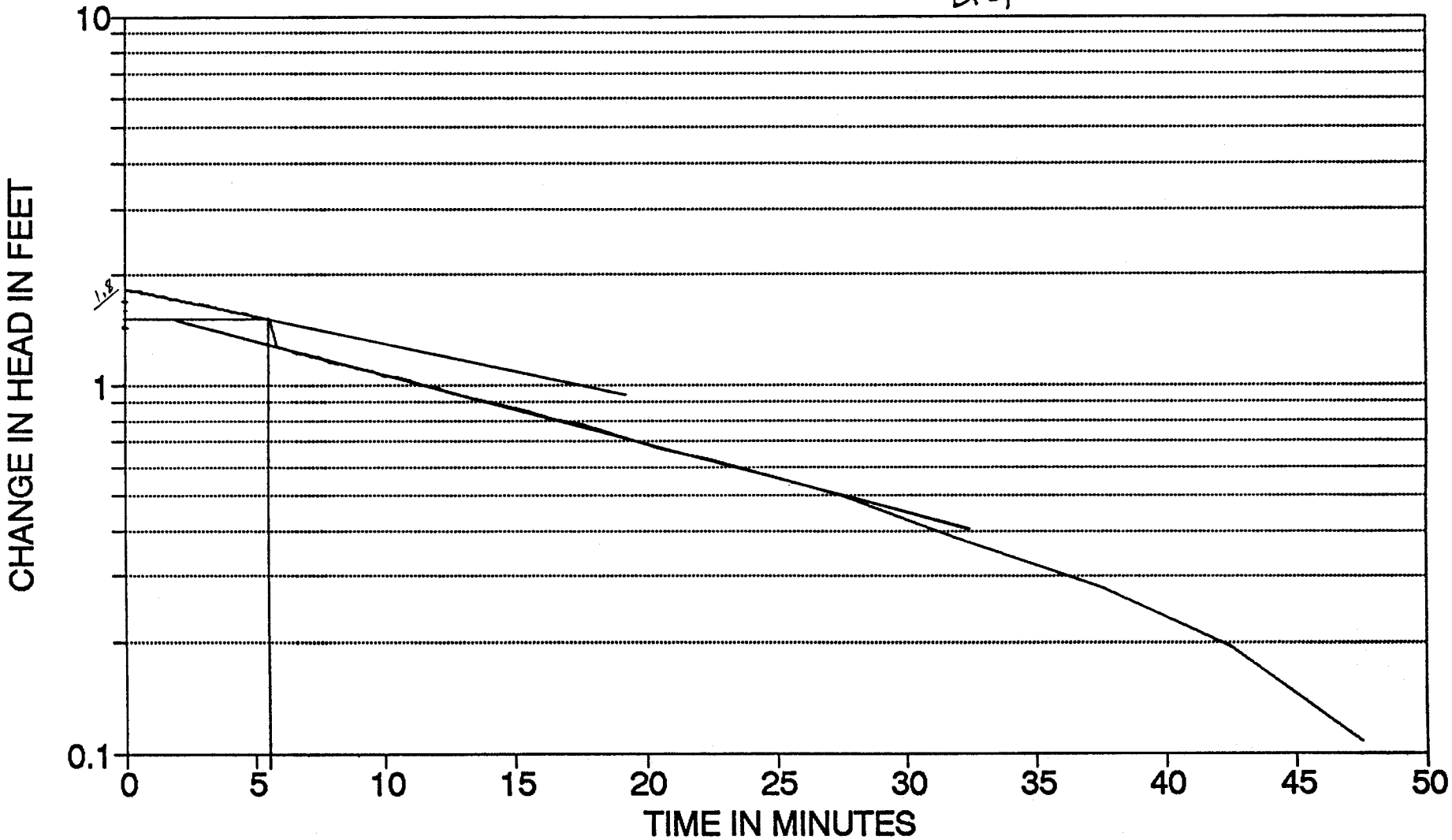
4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	592.531	
H (cm)	2116.53	
Le/Rw	28.2353	
Lw/Rw	54.8894	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	0.88	
Yt	0.3	
t (sec)	6	
Ln((H-Lw)/Rw))	4.95001	
Ln(Lw/Rw)	4.00532	
Ln(Re/Rw)	2.52723	
Ln(Yo/Yt)	1.07614	
K (cm/sec)	0.00187	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - PIEZOMETER 11-D TEST 1

DP-1



WELL RECHARGE CURVE

1.9E-4
.2
1.92
3.0

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	DP-1
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	3.42	Feet
TOTAL DEPTH OF WELL:	53.42	Feet
INSIDE DIAMETER OF WELL:	2	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	3.94	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	1.7	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	1.85	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	1.6	Feet
Yt at time (t2):	5.5	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: DP-1 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
40 feet to 50.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

1.4E-05	cm./sec.
0.0	m./day
14	ft./yr.
0.3	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

2 inch - Well Diameter
10 foot - Screen Length
0.52 feet to Water Table
8.5 inch - Borehole Diameter
50 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number DP-1 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

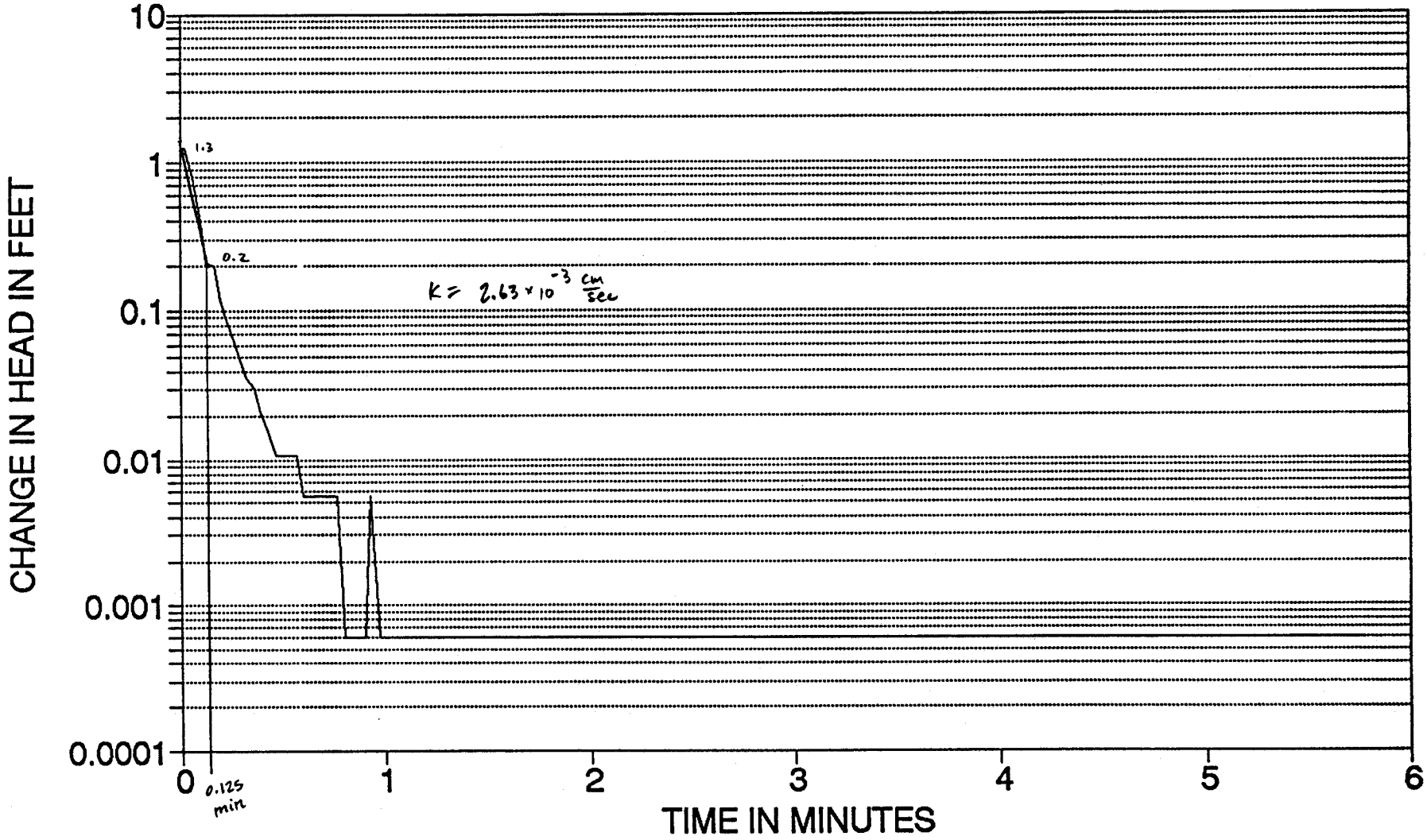
Intercept with the Y axis(Yo):	1.85	Feet @	0	Minutes
X intercept at (Yt):	1.6	Feet @	5.5	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	2.54	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	1508.15	
H (cm)	2117.75	
Le/Rw	28.2353	
Lw/Rw	139.708	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	1.85	
Yt	1.6	
t (sec)	330	
Ln((H-Lw)/Rw))	4.03372	
Ln(Lw/Rw)	4.93956	
Ln(Re/Rw)	2.91149	
Ln(Yo/Yt)	0.14518	
K (cm/sec)	1.4E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER S2 TEST 1



WELL RECHARGE CURVE

(G13-G12) > G17

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-2
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	0.94	Feet
TOTAL DEPTH OF WELL:	20.69	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	6.24	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	1.3	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	0.2	Feet
Yt at time (t2):	0.125	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-2 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
9.75 feet to 19.8 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

2.6E-03	cm./sec.
2.3	m./day
2721	ft./yr.
55.8	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
5.3 feet to Water Table
8.5 inch - Borehole Diameter
19.75 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-2 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

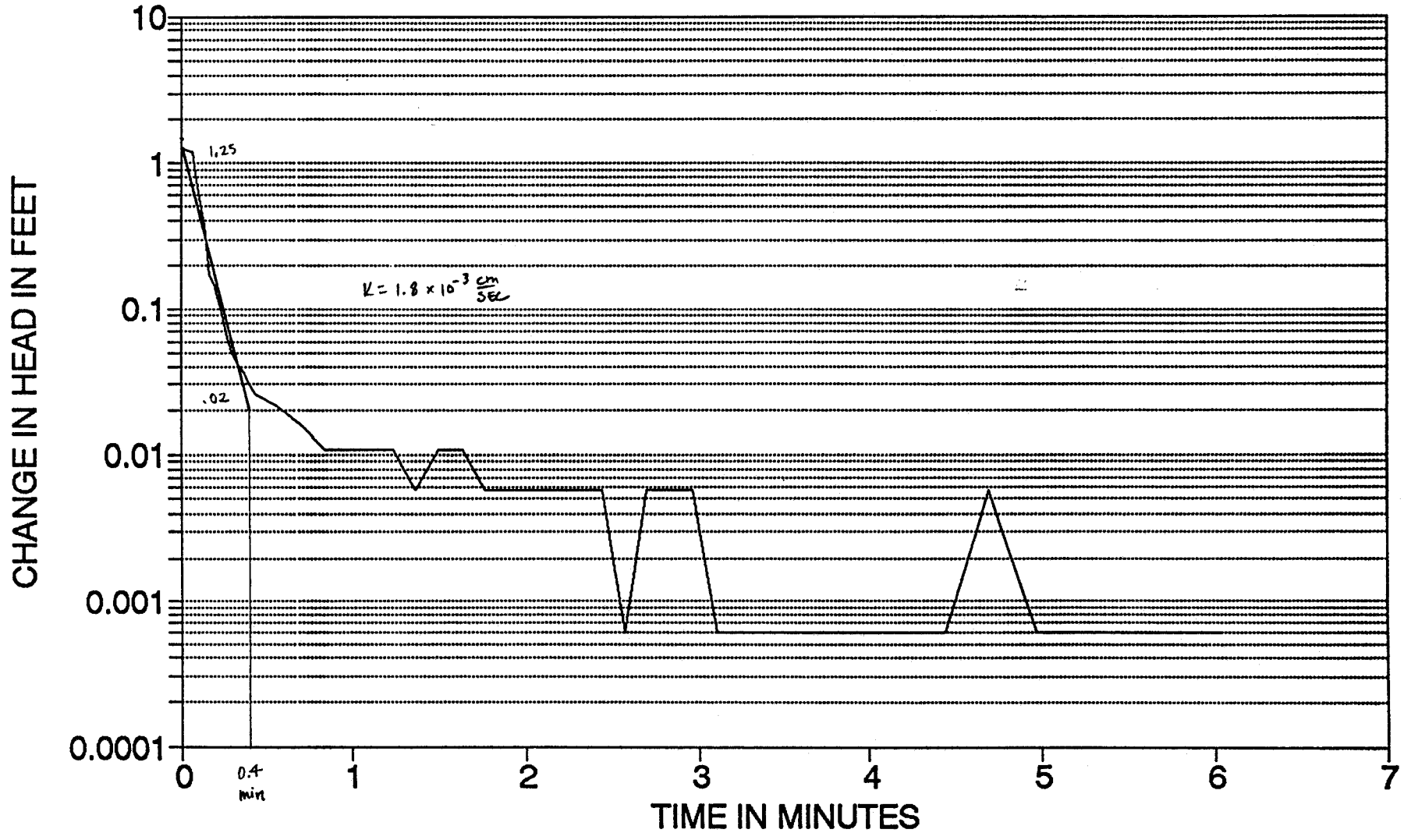
Intercept with the Y axis(Yo):	1.3	Feet @	0	Minutes
X intercept at (Yt):	0.2	Feet @	0.125	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	440.436	
H (cm)	1972.06	
Le/Rw	28.2353	
Lw/Rw	40.8	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	1.3	
Yt	0.2	
t (sec)	7.5	
Ln((H-Lw)/Rw))	4.955	
Ln(Lw/Rw)	3.70868	
Ln(Re/Rw)	2.54925	
Ln(Yo/Yt)	1.8718	
K (cm/sec)	0.00263	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - PIEZOMETER S2 TEST 2



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-2
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	0.94	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	20.69	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	6.24	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	1.25	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	0.02	Feet
Yt at time (t2):	0.4	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-2 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
9.75 feet to 19.8 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

1.8E-03	cm./sec.
1.6	m./day
1879	ft./yr.
38.5	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
5.3 feet to Water Table
8.5 inch - Borehole Diameter
19.75 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-2 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

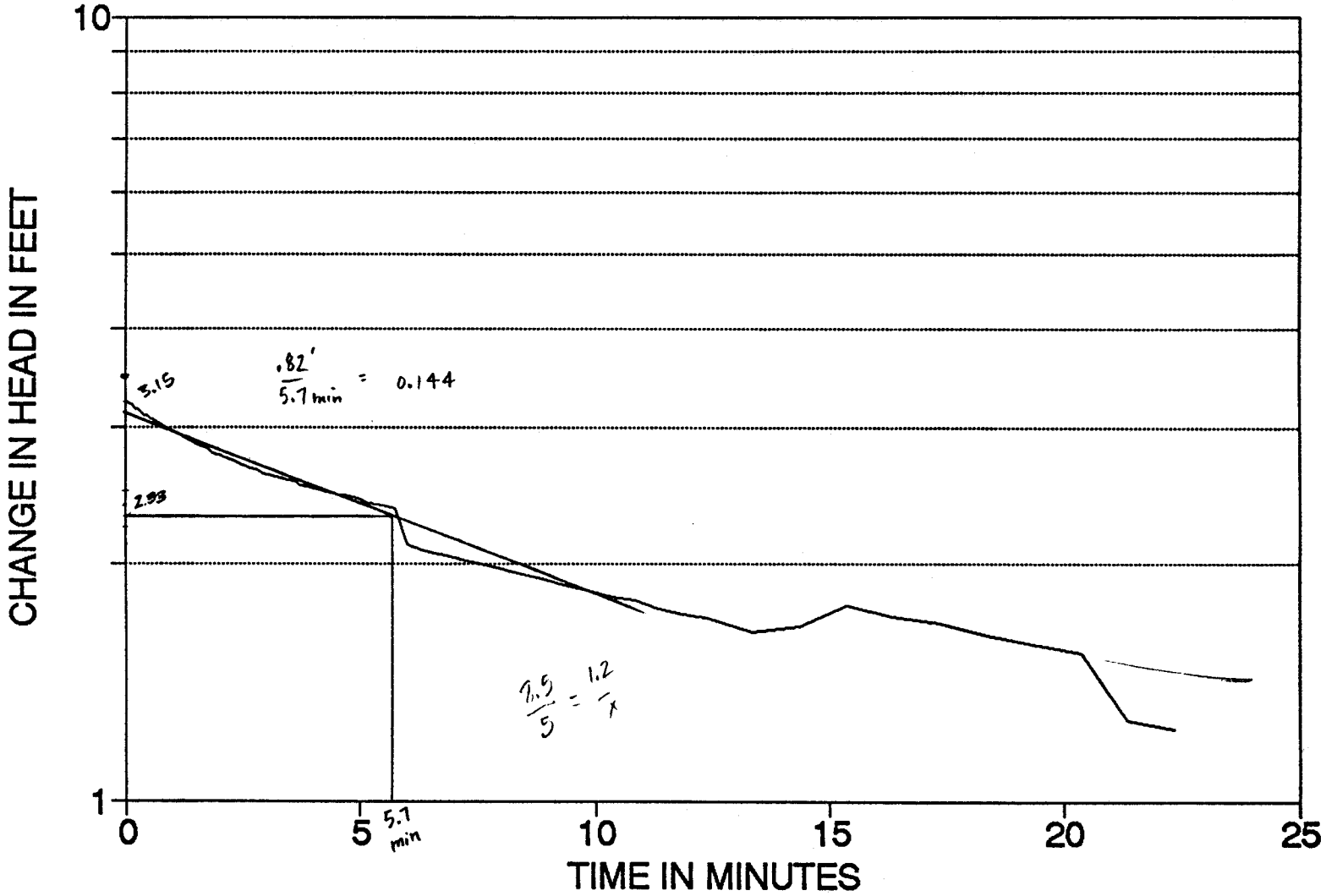
Intercept with the Y axis(Yo):	1.25	Feet @	0	Minutes
X intercept at (Yt):	0.02	Feet @	0.4	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	440.436	
H (cm)	1972.06	
Le/Rw	28.2353	
Lw/Rw	40.8	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	1.25	
Yt	0.02	
t (sec)	24	
Ln((H-Lw)/Rw))	4.955	
Ln(Lw/Rw)	3.70868	
Ln(Re/Rw)	2.54925	
Ln(Yo/Yt)	4.13517	
K (cm/sec)	0.00182	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER DP2 TEST 1



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME: Washington County C&D Landfill
PROJECT LOCATION: Plymouth, N.C.
PROJECT NUMBER: 1054-94-119
WELL IDENTIFICATION: DP-2
DATE OF TEST: February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand
UNIFIED SOIL CLASSIFICATION:
The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

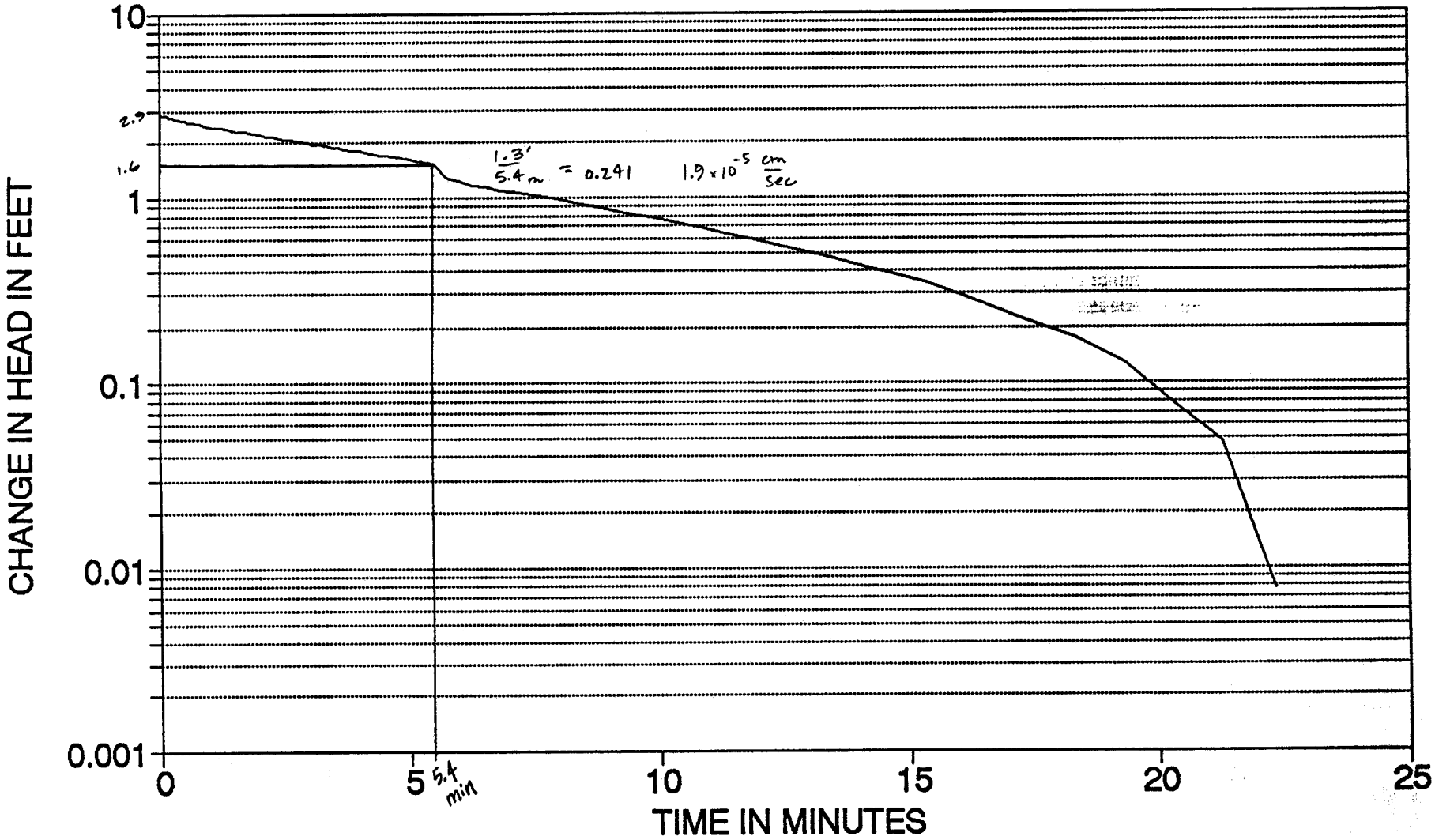
HEIGHT OF DATUM ABOVE GROUND: 0.55 Feet
(Show subgrade completions as minus)
TOTAL DEPTH OF WELL: 50.55 Feet
INSIDE DIAMETER OF WELL: 1.25 Inches
DIAMETER OF THE BOREHOLE: 8.5 Inches
LENGTH OF SCREEN INTERVAL: 10 Feet
DEPTH TO THE STABILIZED WATER TABLE: 3.82 Feet
DEPTH TO AN IMPERMEABLE SURFACE: 70 Feet
(Measured from the ground surface)
SLUG (IN) or SLUG (OUT): I or O
APPROXIMATE CHANGE IN WATER LEVEL: 1.6 Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the chan in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo): 15 Feet
Yo at time (t1): 0 Minutes
Intercept with the X axis (Xt): 3 Feet
Yt at time (t2): 5.7 Minutes

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - PIEZOMETER ~~S3~~ SP-3 TEST 1



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-3
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	2.19	Feet
TOTAL DEPTH OF WELL:	27.12	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	5.46	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	2.9	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	1.6	Feet
Yt at time (t2):	5.4	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-3 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

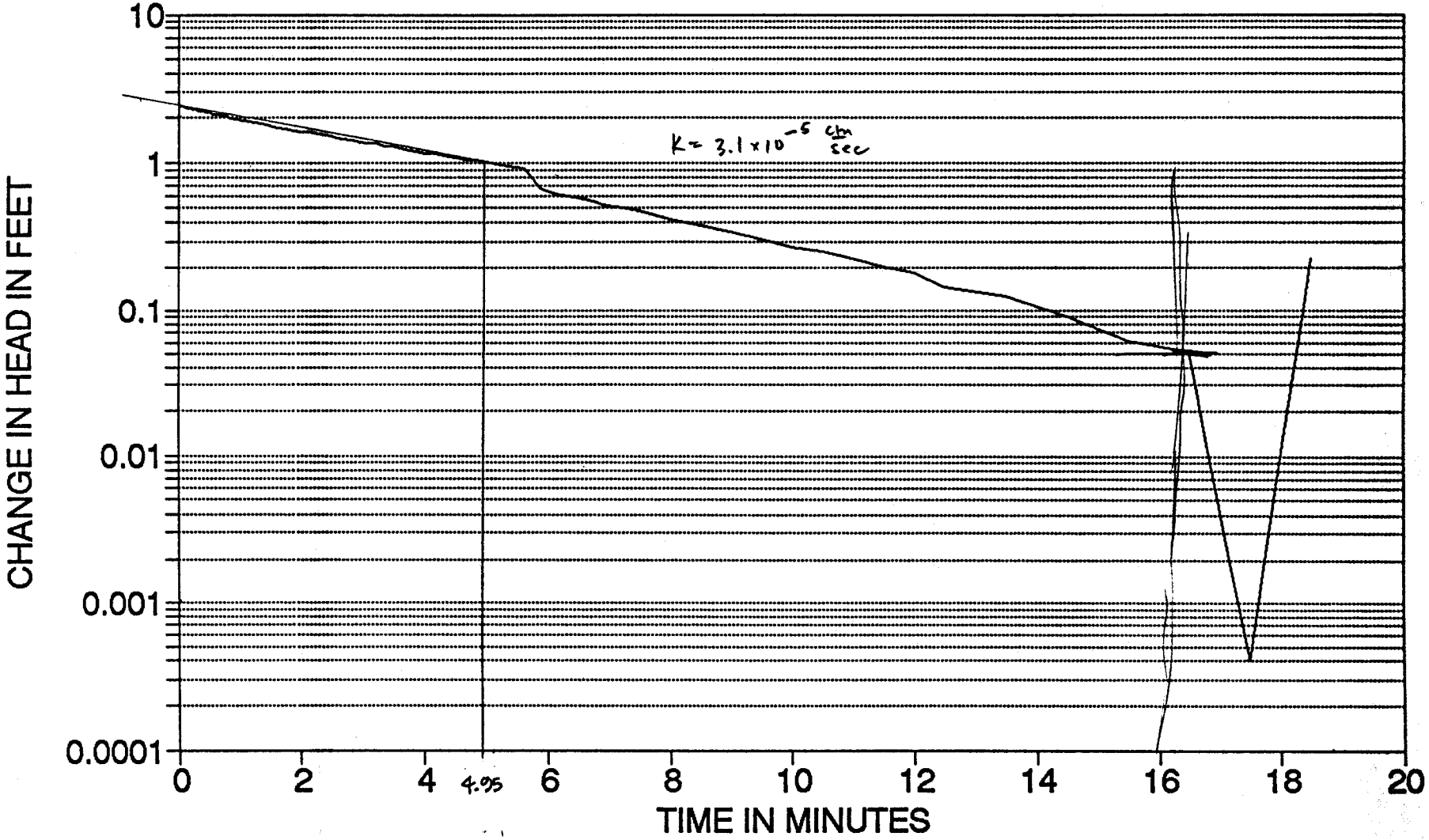
Intercept with the Y axis(Yo):	2.9	Feet @	0	Minutes
X intercept at (Yt):	1.6	Feet @	5.4	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	660.197	
H (cm)	2033.93	
Le/Rw	28.2353	
Lw/Rw	61.1576	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	2.9	
Yt	1.6	
t (sec)	324	
Ln((H-Lw)/Rw))	4.8462	
Ln(Lw/Rw)	4.11345	
Ln(Re/Rw)	2.51891	
Ln(Yo/Yt)	0.59471	
K (cm/sec)	1.9E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER 4-D TEST 1



Y_0 = 2.5 @ T=0

Y_T = 1.0 @ 4.95 min

—— WELL RECHARGE CURVE

H19 - H17 - H22

H

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: DP-4 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
40 feet to 50.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

3.1E-05	cm./sec.
0.0	m./day
33	ft./yr.
0.7	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
0.72 feet to Water Table
8.5 inch - Borehole Diameter
50 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number DP-4 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

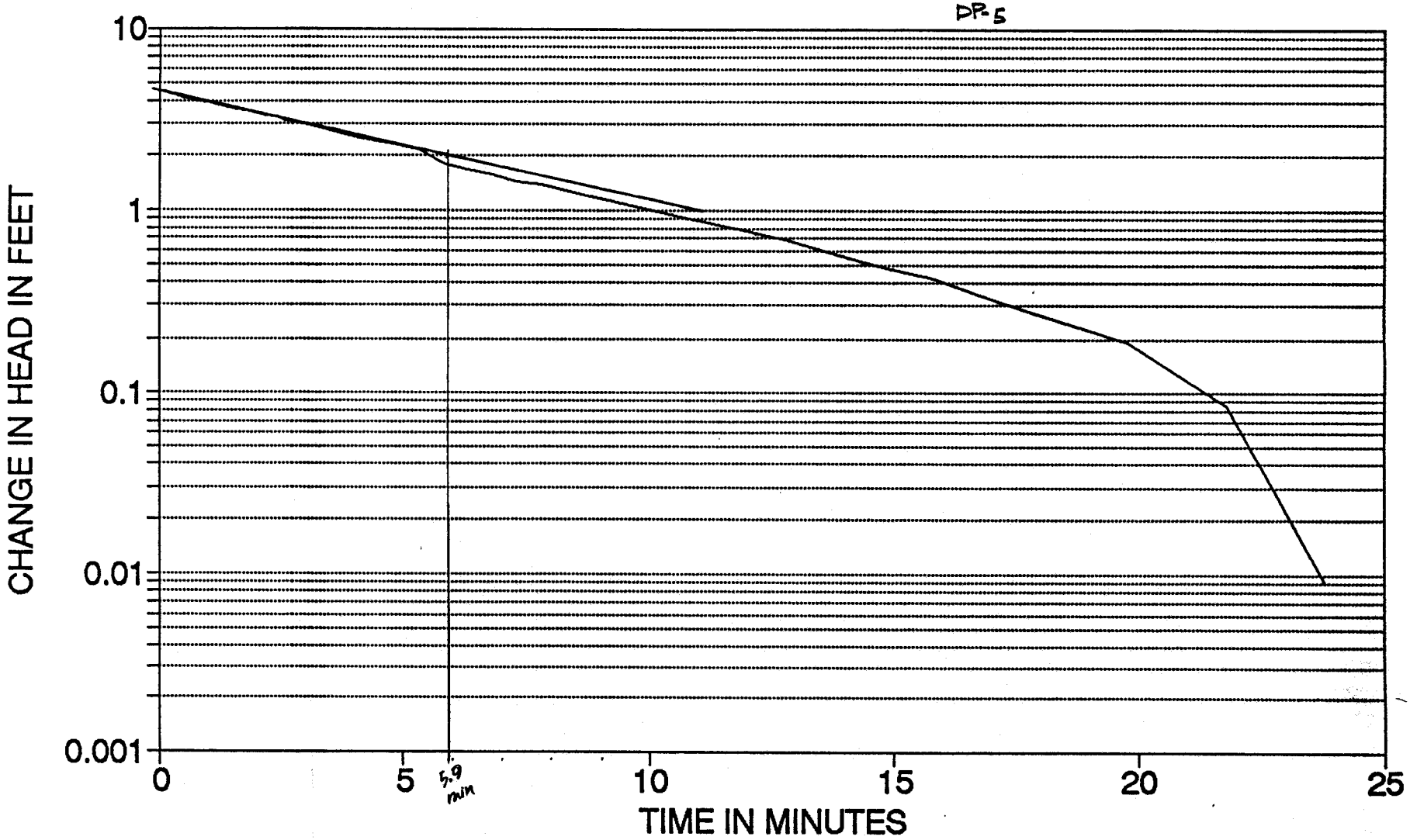
Intercept with the Y axis(Yo):	2.5	Feet @	0	Minutes
X intercept at (Yt):	1	Feet @	4.95	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	1502.05	
H (cm)	2111.65	
Le/Rw	28.2353	
Lw/Rw	139.144	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	2.5	
Yt	1	
t (sec)	297	
Ln((H-Lw)/Rw))	4.03372	
Ln(Lw/Rw)	4.93551	
Ln(Re/Rw)	2.46573	
Ln(Yo/Yt)	0.91629	
K (cm/sec)	3.1E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER ~~D5~~ DP-5 TEST 1



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	DP-5
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	1.81	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	51.81	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	8.88	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	4.5	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	4.5	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	2	Feet
Yt at time (t2):	5.9	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: DP-5 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
40 feet to 50.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

2.3E-05	cm./sec.
0.0	m./day
24	ft./yr.
0.5	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
7.07 feet to Water Table
8.5 inch - Borehole Diameter
50 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number DP-5 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

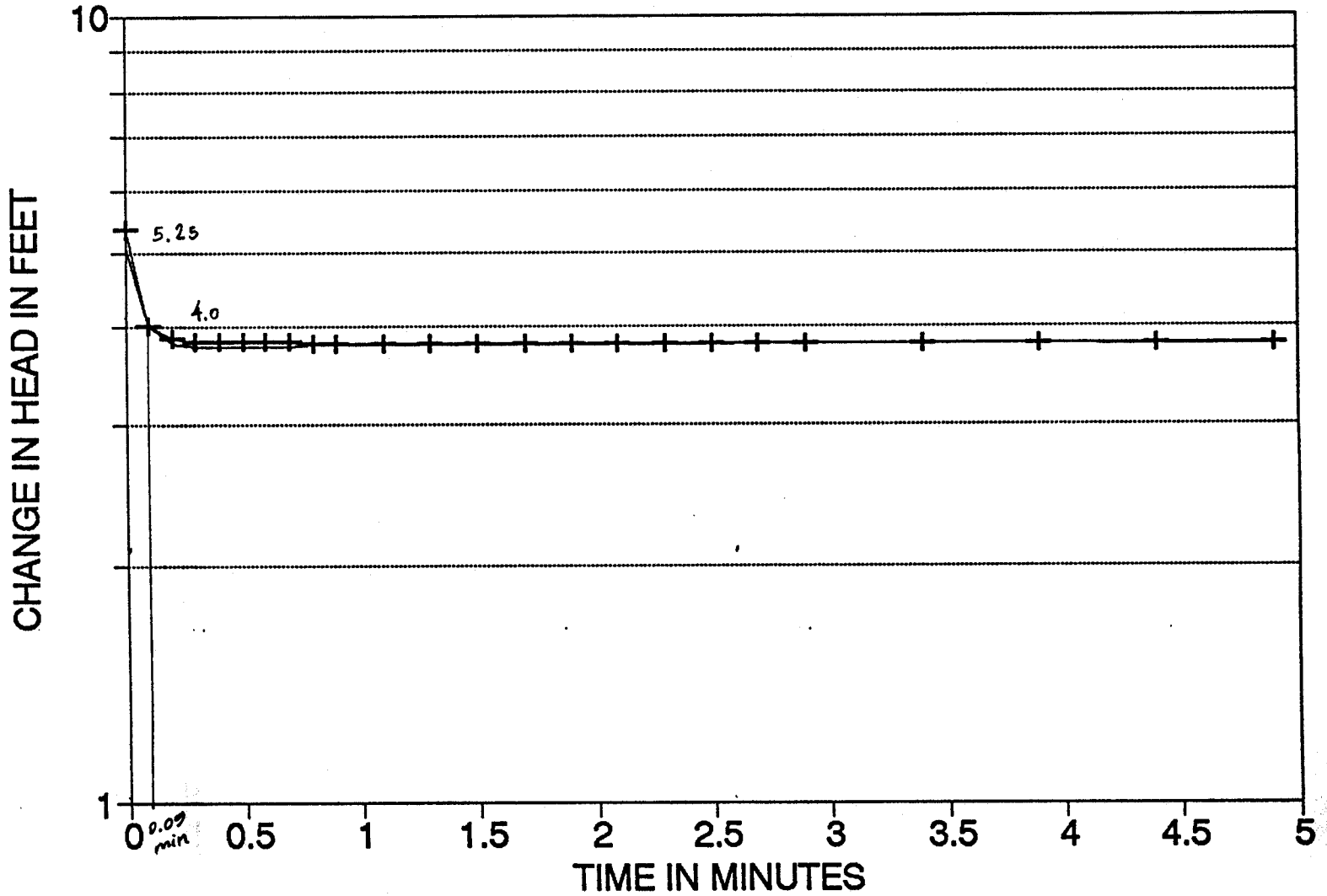
Intercept with the Y axis(Yo):	4.5	Feet @	0	Minutes
X intercept at (Yt):	2	Feet @	5.9	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	1308.51	
H (cm)	1918.11	
Le/Rw	28.2353	
Lw/Rw	121.214	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	4.5	
Yt	2	
t (sec)	354	
Ln((H-Lw)/Rw))	4.03372	
Ln(Lw/Rw)	4.79756	
Ln(Re/Rw)	2.47214	
Ln(Yo/Yt)	0.81093	
K (cm/sec)	2.3E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - SP-6 TEST 1&2



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-6
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	1.56	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	21.56	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	3.81	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	5.25	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	4	Feet
Yt at time (t2):	0.09	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-6 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
10 feet to 20.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

5.3E-04	cm./sec.
0.5	m./day
546	ft./yr.
11.2	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
2.25 feet to Water Table
8.5 inch - Borehole Diameter
20 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-6 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

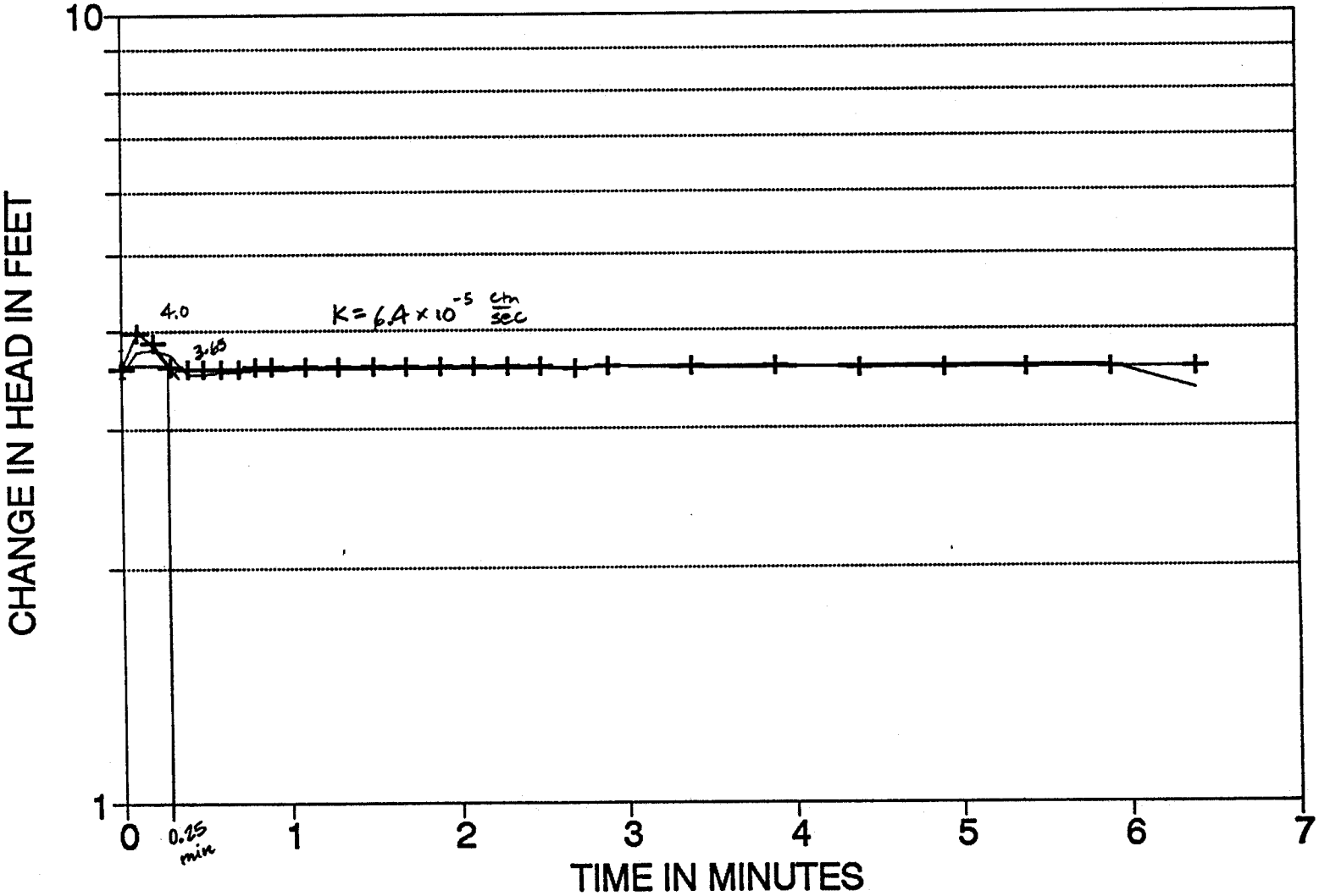
Intercept with the Y axis(Yo):	5.25	Feet @	0	Minutes
X intercept at (Yt):	4	Feet @	0.09	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	541.02	
H (cm)	2065.02	
Le/Rw	28.2353	
Lw/Rw	50.1176	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	5.25	
Yt	4	
t (sec)	5.4	
Ln((H-Lw)/Rw))	4.95001	
Ln(Lw/Rw)	3.91437	
Ln(Re/Rw)	2.53361	
Ln(Yo/Yt)	0.27193	
K (cm/sec)	0.00053	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - SP-7 TESTS 1&2



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-7
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	0.81	Feet
TOTAL DEPTH OF WELL:	20.81	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	3.15	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	3	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	4	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	3.65	Feet
Yt at time (t2):	0.25	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-7 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
10 feet to 20.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

6.4E-05	cm./sec.
0.1	m./day
66	ft./yr.
1.4	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
2.34 feet to Water Table
8.5 inch - Borehole Diameter
20 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-7 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

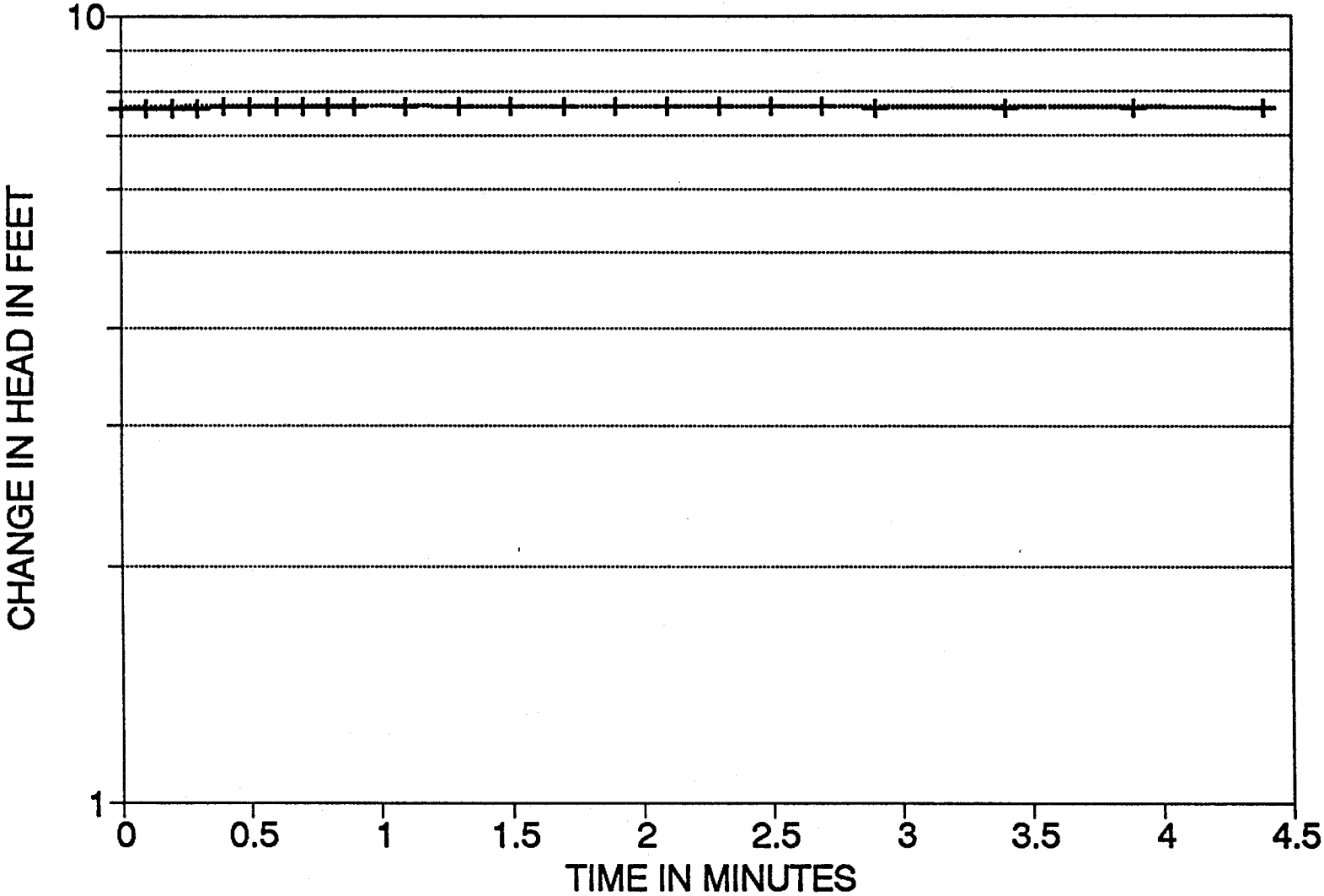
Intercept with the Y axis(Yo):	4	Feet @	0	Minutes
X intercept at (Yt):	3.65	Feet @	0.25	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	538.277	
H (cm)	2062.28	
Le/Rw	28.2353	
Lw/Rw	49.8635	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	4	
Yt	3.65	
t (sec)	15	
Ln((H-Lw)/Rw))	4.95001	
Ln(Lw/Rw)	3.90929	
Ln(Re/Rw)	2.53397	
Ln(Yo/Yt)	0.09157	
K (cm/sec)	6.4E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - SP-5 TESTS 1&2



WELL RECHARGE CURVE

Project Name:	Washington County C&D Landfill	Test Parameters:
Site Location:	Washingon County	S/N SDEE-03A-SN-3132 Block 1
Project Number:	1054-94-119	
		Program: STEP TEST
Well Number:	PZ S-1	Readings: 29
Test Number:	Test 1	Start Time: 02:55:02
		Start Date: 01/01
		Range: 0009 PSI
		Channels: 1
		Units: Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:06
Readings 10

Time	Chnl 1
0.00	+3.4929
0.10	+3.4929
0.20	+4.3547
0.30	+3.5436
0.40	+3.5030
0.50	+3.5030
0.60	+3.5081
0.70	+3.5132
0.80	+3.5132
0.90	+3.5183

Step 2
Interval 00:00:12
Readings 10

Time	Chnl 1
1.10	+3.5183
1.30	+3.5233
1.50	+3.5233
1.70	+3.5233
1.90	+3.5233
2.10	+3.5284
2.30	+3.5284
2.50	+3.5284
2.70	+3.5284
2.90	+3.5284

Step 3
Interval 00:00:30
Readings 10

Time	Chnl 1
3.40	+3.5284
3.90	+3.5284
4.40	+3.5284
4.90	+3.5284
5.40	+3.5284
5.90	+3.2901
6.40	+3.2851
6.90	+3.2901
7.40	+3.2851

Test 1 aborted at Step 3

Project Name:	Washington County C&D Landfill	Test Parameters:	
Site Location:	Washington County	S/N SDEE-03A-SN-3132	Block 1
Project Number:	1054-94-119		
		Program:	STEP TEST
Well Number:	PZ 5-D	Readings:	43
Test Number:	Test 1	Start Time:	00:36:47
		Start Date:	01/01
		Range:	0009 PSI
		Channels:	1
		Units:	Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:06
Readings 10

Time	Chnl 1
0.00	+6.5499
0.10	+9.5866
0.20	+9.5308
0.30	+9.4700
0.40	+9.3888
0.50	+9.3077
0.60	+9.2317
0.70	+9.1658
0.80	+9.0999
0.90	+9.0441

Step 2
Interval 00:00:12
Readings 10

Time	Chnl 1
1.10	+8.9326
1.30	+8.8363
1.50	+8.7399
1.70	+8.6487
1.90	+8.5574
2.10	+8.4662
2.30	+8.3749
2.50	+8.2887
2.70	+8.2026
2.90	+8.1214

Step 3
Interval 00:00:30
Readings 10

Time	Chnl 1
3.40	+7.8781
3.90	+7.6804
4.40	+7.5080
4.90	+7.3610
5.40	+7.2140
5.90	+6.8439
6.40	+6.7172
6.90	+6.6158
7.40	+6.5042
7.90	+6.4282

Step 4
Interval 00:01:00
Readings 10

Time	Chnl 1
8.90	+6.2305
9.90	+6.0784
10.90	+5.9466
11.90	+5.8401
12.90	+5.7286
13.90	+5.6171
14.90	+5.5309
15.90	+5.4700
16.90	+5.3839
17.90	+5.3180

Step 5
Interval 00:02:00
Readings 10

Time	Chnl 1
19.90	+5.2318
21.90	+5.1253
23.90	+5.0493

Test 1 aborted at Step 5

Project Name: Washington County C&D Landfill
Site Location: Washington County
Project Number: 1054-94-119

Well Number: PZ 2-D
Test Number: Test 1

Test Parameters:
S/N SDEE-03A-SN-3132 Block 1

Program: STEP TEST
Readings: 90
Start Time: 20:05:16
Start Date: 01/01
Range: 0009 PSI
Channels: 1
Units: Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:02
Readings 30

Time	Chnl 1
0.00	+3.6298
0.03	+3.6298
0.07	+3.6298
0.10	+3.6298
0.13	+4.0962
0.17	+6.1240
0.20	+6.7222
0.23	+6.8743
0.27	+6.8895
0.30	+6.8794
0.33	+6.8642
0.37	+6.8540
0.40	+6.8388
0.43	+6.8236
0.47	+6.8135
0.50	+6.8034
0.53	+6.7932
0.57	+6.7831
0.60	+6.7729
0.63	+6.7628
0.67	+6.7527
0.70	+6.7425
0.73	+6.7324
0.77	+6.7273
0.80	+6.7172
0.83	+6.7070
0.87	+6.7020
0.90	+6.6918
0.93	+6.6868
0.97	+6.6766

Step 2
Interval 00:00:08
Readings 30

Time	Chnl 1
1.10	+6.6411
1.23	+6.6107
1.37	+6.5803
1.50	+6.5499
1.63	+6.5245
1.77	+6.4941
1.90	+6.4688
2.03	+6.4434
2.17	+6.4130
2.30	+6.3927
2.43	+6.3674
2.57	+6.3471
2.70	+6.3268
2.83	+6.3065
2.97	+6.2863
3.10	+6.2710
3.23	+6.2508
3.37	+6.2356
3.50	+6.2203
3.63	+6.2051
3.77	+6.1899
3.90	+6.1747
4.03	+6.1595
4.17	+6.1443
4.30	+6.1342
4.43	+6.1190
4.57	+6.1088
4.70	+6.0936
4.83	+6.0835
4.97	+6.0733

Step 3
Interval 00:00:16
Readings 10

Time	Chnl 1
5.23	+6.0480
5.50	+6.0226
5.77	+6.0024
6.03	+5.9821
6.30	+5.7337
6.57	+5.7032
6.83	+5.6830
7.10	+5.6678
7.37	+5.6475
7.63	+5.6272

Step 4
Interval 00:00:30
Readings 10

Time	Chnl 1
8.13	+5.5968
8.63	+5.5613
9.13	+5.5309
9.63	+5.4903
10.13	+5.4650
10.63	+5.4295
11.13	+5.4092
11.63	+5.3687
12.13	+5.3382
12.63	+5.3180

Step 5
Interval 00:01:00
Readings 10

Time	Chnl 1
13.63	+5.2521
14.63	+5.2825
15.63	+5.3839
16.63	+5.3332
17.63	+5.2926
18.63	+5.2419
19.63	+5.1963
20.63	+5.1557
21.63	+4.8870
22.63	+4.8516

Step 6
Interval 00:05:00
Readings 0

Time	Chnl 1

no readings

Project Name: Washington County C&D Landfill
Site Location: Washington Co.
Project Number: 1054-94-119

Well Number: PZ 1-D
Test Number: Test 1

Test Parameters:
S/N SDEE-03A-SN-3132 Block 1

Program: STEP TEST
Readings: 95
Start Time: 18:35:16
Start Date: 01/01
Range: 0009 PSI
Channels: 1
Units: Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:02
Readings 30

Time	Chnl 1
0.00	+4.8516
0.03	+5.7032
0.07	+5.8046
0.10	+5.9010
0.13	+5.9567
0.17	+5.9364
0.20	+5.9314
0.23	+5.9314
0.27	+5.9263
0.30	+5.9263
0.33	+5.9263
0.37	+5.9212
0.40	+5.9263
0.43	+5.9212
0.47	+5.9212
0.50	+5.9212
0.53	+5.9162
0.57	+5.9162
0.60	+5.9162
0.63	+5.9060
0.67	+5.9111
0.70	+5.9060
0.73	+5.9060
0.77	+5.9010
0.80	+5.9060
0.83	+5.8959
0.87	+5.8959
0.90	+5.8908
0.93	+5.8908
0.97	+5.8908

Step 2
Interval 00:00:08
Readings 30

Time	Chnl 1
1.10	+5.8807
1.23	+5.8705
1.37	+5.8655
1.50	+5.8553
1.63	+5.8503
1.77	+5.8401
1.90	+5.8300
2.03	+5.8249
2.17	+5.8148
2.30	+5.8097
2.43	+5.7996
2.57	+5.7945
2.70	+5.7844
2.83	+5.7793
2.97	+5.7692
3.10	+5.7641
3.23	+5.7539
3.37	+5.7489
3.50	+5.7387
3.63	+5.7337
3.77	+5.7235
3.90	+5.7185
4.03	+5.7083
4.17	+5.7032
4.30	+5.6931
4.43	+5.6880
4.57	+5.6779
4.70	+5.6728
4.83	+5.6678
4.97	+5.6576

Step 3
Interval 00:00:16
Readings 10

Time	Chnl 1
5.23	+5.6424
5.50	+5.6272
5.77	+5.6120
6.03	+5.3788
6.30	+5.3585
6.57	+5.3433
6.83	+5.3281
7.10	+5.3180
7.37	+5.3028
7.63	+5.2977

Step 4
Interval 00:00:30
Readings 10

Time	Chnl 1
8.13	+5.2571
8.63	+5.2419
9.13	+5.2115
9.63	+5.1912
10.13	+5.1659
10.63	+5.1557
11.13	+5.1304
11.63	+5.1050
12.13	+5.0949
12.63	+5.0645

Step 5
Interval 00:01:00
Readings 10

Time	Chnl 1
13.63	+5.0239
14.63	+4.9834
15.63	+4.9479
16.63	+4.9073
17.63	+4.8870
18.63	+4.8465
19.63	+4.8110
20.63	+4.7755
21.63	+4.7502
22.63	+4.7299

Step 6
Interval 00:05:00
Readings 5

Time	Chnl 1
27.63	+4.5981
32.63	+4.4713
37.63	+4.3801
42.63	+4.2939
47.63	+4.2077

Project Name:
Site Location:
Project Number: 1054-04-119

Well Number: ~~MW~~ PZ 4-D
Test Number: Test 1

Test Parameters:
S/N SDEE-03A-SN-3132 Block 1

Program: STEP TEST
Readings: 87
Start Time: 22:04:09
Start Date: 01/01
Range: 0009 PSI
Channels: 1
Units: Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:02
Readings 30

Time	Chnl 1
0.00	+3.5132
0.03	+3.5081
0.07	+3.5081
0.10	+3.5081
0.13	+3.5081
0.17	+4.4916
0.20	+5.5410
0.23	+5.4650
0.27	+5.4498

Step 2
Interval 00:00:08
Readings 30

Time	Chnl 1
1.10	+5.0848
1.23	+5.0391
1.37	+4.9935
1.50	+4.9529
1.63	+4.9124
1.77	+4.8769
1.90	+4.8363
2.03	+4.8009
2.17	+4.7654

Step 3
Interval 00:00:16
Readings 10

Time	Chnl 1
5.23	+4.1925
5.50	+4.1570
5.77	+4.1266
6.03	+3.8883
6.30	+3.8376
6.57	+3.8174
6.83	+3.7920
7.10	+3.7667
7.37	+3.7362

Step 4
Interval 00:00:30
Readings 10

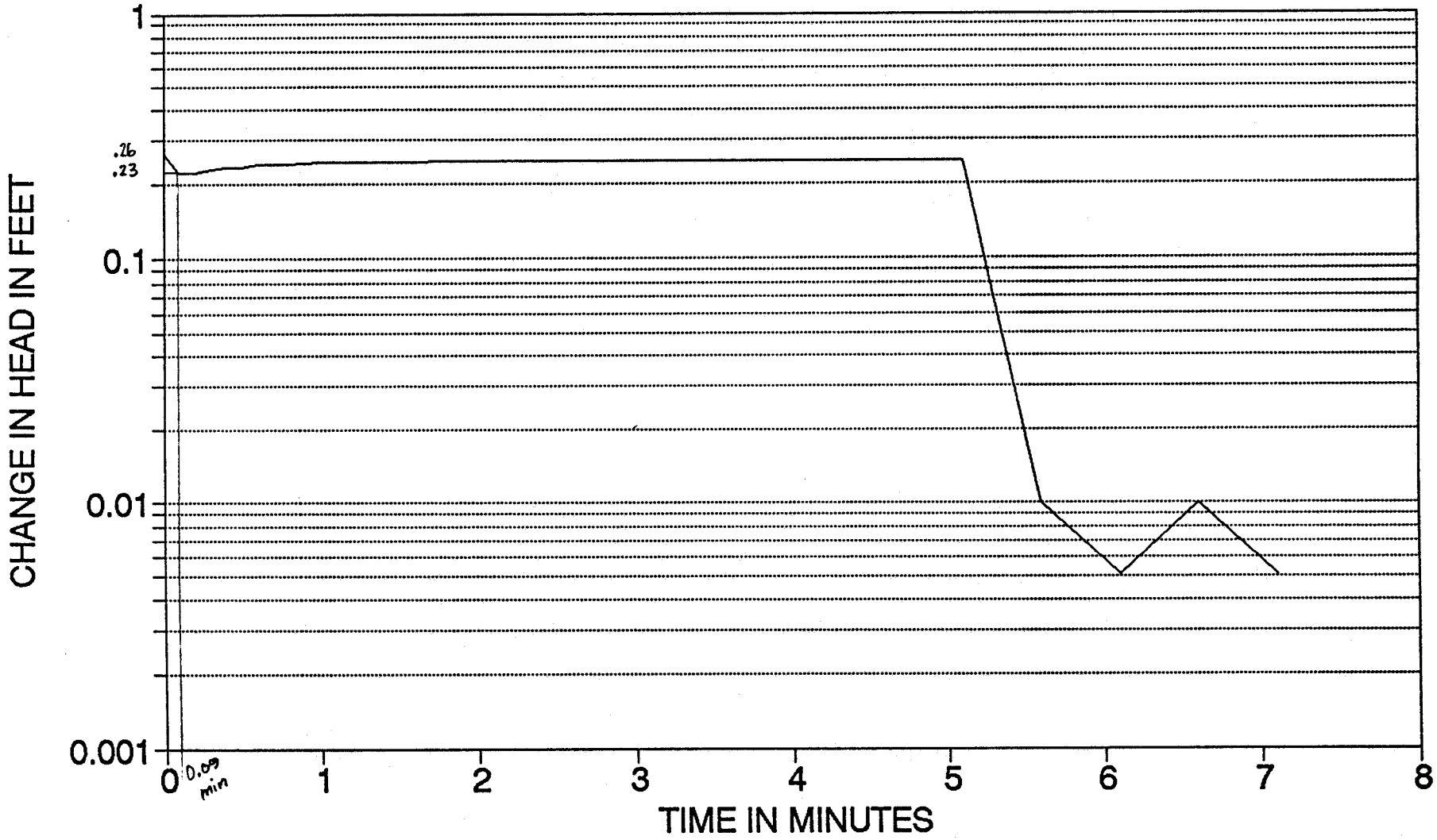
Time	Chnl 1
8.13	+3.6703
8.63	+3.6450
9.13	+3.6146
9.63	+3.5892
10.13	+3.5385
10.63	+3.5183
11.13	+3.4929
11.63	+3.4676
12.13	+3.4523

Step 5
Interval 00:01:00
Readings 10

Time	Chnl 1
13.63	+3.3915
14.63	+3.3763
15.63	+3.3459
16.63	+3.3256
17.63	+3.3104
18.63	+3.3155
19.63	+3.5081

Test 1 aborted at Step 5

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER SP11 TEST 1



—— WELL RECHARGE CURVE

APPENDIX IV
OTHER DOCUMENTS

ABSTRACT

This appendix contains other documents reviewed during the study. It includes the monitor well information for the existing landfill and a discussion of the Seismic Risk Map.

WEA

Wilson Engineering Associates, Inc.

P.O. Box 12015
Research Triangle Park
North Carolina 27709

Durham (919) 544-1735
Raleigh (919) 556-0515
Wilmington (919) 270-3016

July 6, 1989

Mr. Bill Diehl
Diehl and Phillips, P. A.
219 East Chatham Street
Cary, North Carolina 27511

RE: Washington County Landfill
Washington County, North Carolina
WEA Project Number 89-078-EA

Dear Mr. Diehl:

As authorized by Washington County, Wilson Engineering Associates, Inc. has completed the installation of groundwater monitoring wells at the Washington County Landfill located in Washington County, North Carolina.

Enclosed please find the results of our subsurface exploration and installation of four (4) groundwater monitoring wells for the Washington County Landfill located in Washington County, North Carolina. Two (2) soil borings were performed in the groundwater monitoring well locations MW-2 and MW-4 and four (4) groundwater monitoring wells were set in the shallow aquifer.

Subsurface Conditions

The results of the two (2) soil borings at MW-2 and MW-4 and the analysis of the cuttings from MW-1 and MW-3 indicated that there is a dense clayey silty sand layer at approximately 23.0

to 26.0 feet below the existing ground surface at the site. Above the silty clayey sand layer, a layer of medium to coarse sand with a trace of silt was encountered. Near the ground surface, approximately 4.0 to 7.0 feet of a very clayey sand was encountered. Well logs and soil boring logs for the four (4) monitoring wells are included in the Appendix to this report for your records.

As discussed with you, I spoke with Mr. Ed Berry regarding the landfill's monitoring wells and requirements were to put the screened section of the well in the most permeable section of the shallow aquifer. Based on the two (2) borings and the four (4) augers performed at the site, the most permeable shallow aquifer appears to extend from approximately 6.0 to 10.0 feet to 23.0 to 26.0 feet. Therefore, the groundwater monitoring wells were set to approximately 22.0 to 25.0 feet below the existing ground surface.

Grain size analyses performed in our laboratory indicate that the sandy layer would have a permeability of approximately 4.8 x 10^{-2} cm/sec and the clayey silty fine sandy would have a permeability of approximately 1.2 x 10^{-3} cm/sec. These approximations are based on Hazens formula for sands. Based on the grain size analysis, the upper sand would be approximately 44 times as permeable as the gray silty clayey sand.

Monitoring Well Construction

Therefore, since it appears that the gray silty clayey sand was continuous from MW-2 to MW-4 and the dark gray dense layer was encountered in the cuttings at MW-1 and MW-3, the well screens were set in the permeable layer just above the gray silty clayey sand.

The monitoring wells were set using 6 inch ID hollow stem augers, the screens were set at depths noted on Table I and the annulus around the screens were backfilled with 2S Sand to 1 foot above the screen. Then a Bentonite seal was placed and the hole was grouted to the surface where a locking protector cap was set in the concrete.

The wells were then developed by bailing approximately 10 gallons from each well.

Surveying

One remaining item that needs to be performed at the site is to establish the elevation of the top of the plastic casing to establish the elevations of the groundwater in the wells. The county needs to secure sampling and testing from a local laboratory, or we would be glad to handle sampling and testing for you if you so desire.

If you have any questions with regard to the information contained in this letter, please do not hesitate to contact us.

Respectfully,

WILSON ENGINEERING ASSOCIATES, INC.

Benjamin V. Wilson, P. E.
Senior Engineer/President

Attachments

cc: Mr. Bobby Lufty
NCDEM - Division of Solids & Hazardous Waste

BVW:pjk

LOG OF HAND AUGER BORING NO. MW-1

JOB NAME: Washington County Landfill

SITE LOCATION: Washington County

WILSON ENGINEERING ASSOCIATES, INC.

ELEVATION	DEPTH	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	NOTES
						SURFACE ELEVATION	
						TOPSOIL	
	5					CLAYEY SILTY SAND, Tan. (SM-SC)	
	10						
	15					SAND, Tan to gray. (SW) NOTE: Saturated	
	20						
	25					CLAYEY SILTY FINE SAND, trace of mica, dark gray. (SM-SC)	
	30					BORING TERMINATED AT 27.0 FEET Hollow Stem Auger Used Full Depth	

CALIBRATED PENETROMETER TONS/FT² — 1 2 3 4 5 7 9

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % — 10 20 30 40 50 70 90

DYNAMIC CONE PENETRATION BLOWS/1.75" — 10 20 30 40 50 70 90

NOTES: (N) WATER LEVEL IN BOREHOLE AT "N" HOURS AFTER BORING

D = _____ DRY DENSITY FROM UNDISTURBED SAMPLE LBS/FT³

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU THE TRANSITION MAY BE GRADUAL.

SHEET NO. 1 OF 1	BORING STARTED	
DRAWN: BNO CHECKED BVW	BORING COMPLETED	
WEA JOB NO. 89-978 EA	CREW	

WILSON ENGINEERING ASSOCIATES, INC.
P.O. Box 12015
Research Triangle Park
North Carolina 27709
Durham (919) 544-1736
Raleigh (919) 360-0515
Wilmington (919) 270-3016

BL1

LOG OF HAND AUGER BORING NO. MW-2

JOB NAME: Washington County Landfill

SITE LOCATION: Washington County

WILSON ENGINEERING ASSOCIATES, INC.

ELEVATION / DEPTH	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	NOTES	DYNAMIC CONE PENETRATION BLOWS/1.75"
					SURFACE ELEVATION		
5					CLAYEY SILTY SAND, tan to brown. (SC-SM)		11
10					FINE SAND, some silt, gray. (SP) NOTE: Saturated		19
15							21
20					FINE TO MEDIUM SAND, trace of silt, light gray to tan. (SW) NOTE: Saturated		27
25					CLAYEY SILTY FINE SAND, trace of mica, dark gray. (SM-SC)		6
30					BORING TERMINATED AT 27.0 FEET Hollow Stem Auger Used Full Depth		Suspect boring terminated at 25'

CALIBRATED PENETROMETER TONS/FT² (1, 2, 3, 4, 5, 7, 8)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50, 70, 90)

NOTES: N — WATER LEVEL IN BOREHOLE AT "N" HOURS AFTER BORING

D = _____ DRY DENSITY FROM UNDISTURBED SAMPLE LBS/FT³

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU THE TRANSITION MAY BE GRADUAL.

SHEET NO. 1 OF 1		BORING STARTED	6/8/89
DRAWN: BNO	CHECKED BVW	BORING COMPLETED	6/8/89
WEA JOB NO. 89-078 EA		CREW	WRM/PS

WILSON ENGINEERING ASSOCIATES, INC.
P.O. Box 12015
Research Triangle Park
North Carolina 27709
Durham (919) 544-1736
Raleigh (919) 546-0515
Wilmington (919) 270-3016

BL1

LOG OF HAND AUGER BORING NO. MW-3

JOB NAME: Washington County Landfill

SITE LOCATION: Washington County

WILSON ENGINEERING ASSOCIATES, INC.

ELEVATION	DEPTH	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	NOTES
						SURFACE ELEVATION	
	5					CLAYEY SILTY SAND, Tan to brown. (SM-SC)	
	10						
	15					SAND, Tan to white. (SW) NOTE: Saturated	
	20						
	25					CLAYEY SILTY FINE SAND, dark gray. (SM-SC)	
	30					BORING TERMINATED AT 25.0 FEET Hollow Stem Auger Used Full Depth	

CALIBRATED PENETROMETER TONS/FT² (1 2 3 4 5 7 9)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50 70 90)

DYNAMIC CONE PENETRATION BLOWS/1.75" (10 20 30 40 50 70 90)

Any split spoon sample

NOTES: N — WATER LEVEL IN BOREHOLE AT "N" HOURS AFTER BORING

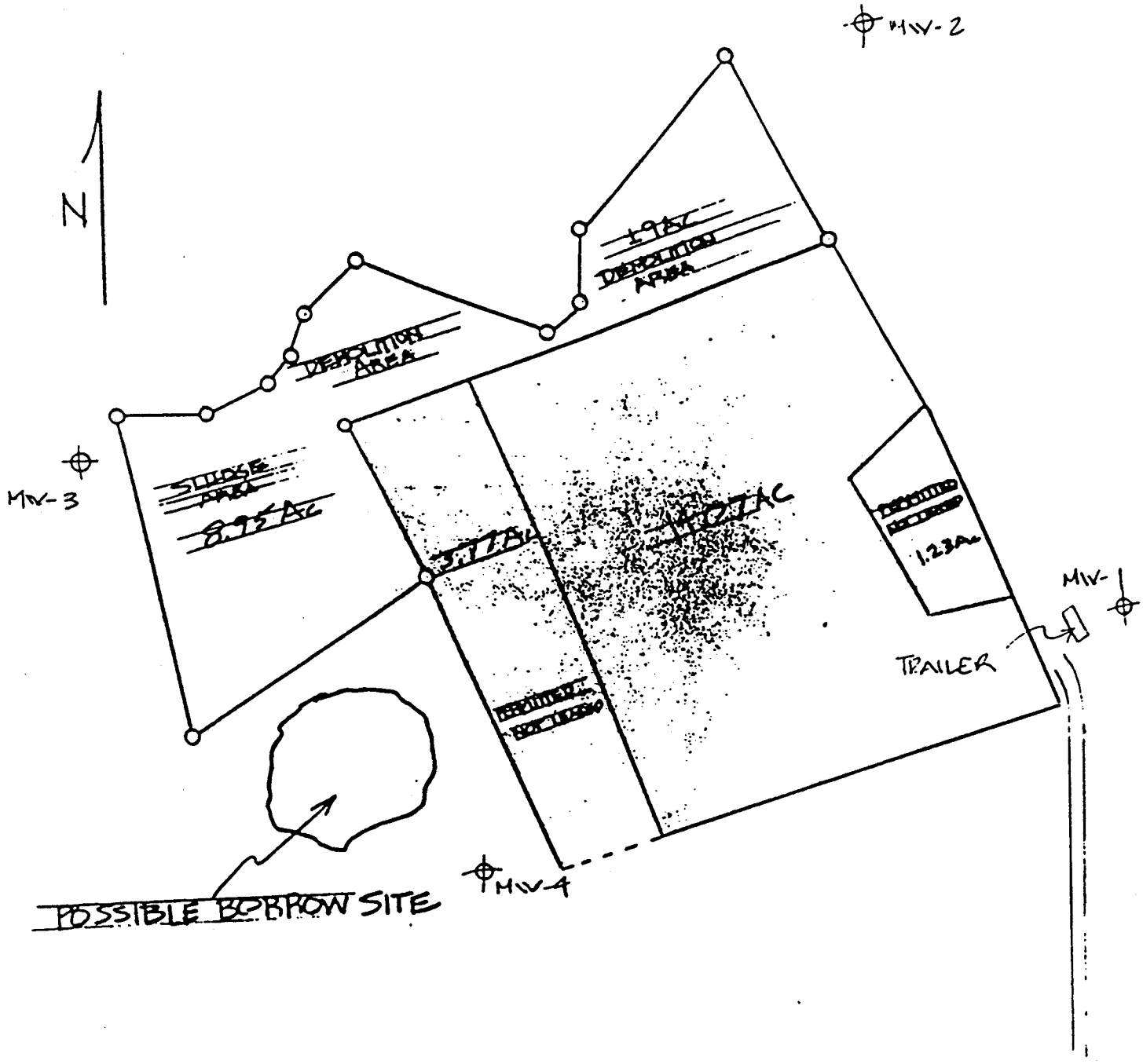
D = _____ DRY DENSITY FROM UNDISTURBED SAMPLE LBS/FT³

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU THE TRANSITION MAY BE GRADUAL.

SHEET NO. 1 OF 1	BORING STARTED
DRAWN: BNO CHECKED BVW	BORING COMPLETED
WEA JOB NO. 89-078 EA	CREW

WILSON ENGINEERING ASSOCIATES, INC.
P.O. Box 12015
Research Triangle Park
North Carolina 27709
Durham (919) 544-1736
Raleigh (919) 566-0519
Wilmington (919) 270-3016

BL1



WASHINGTON CO. LANDFILL

SCALE: 1" = 200'

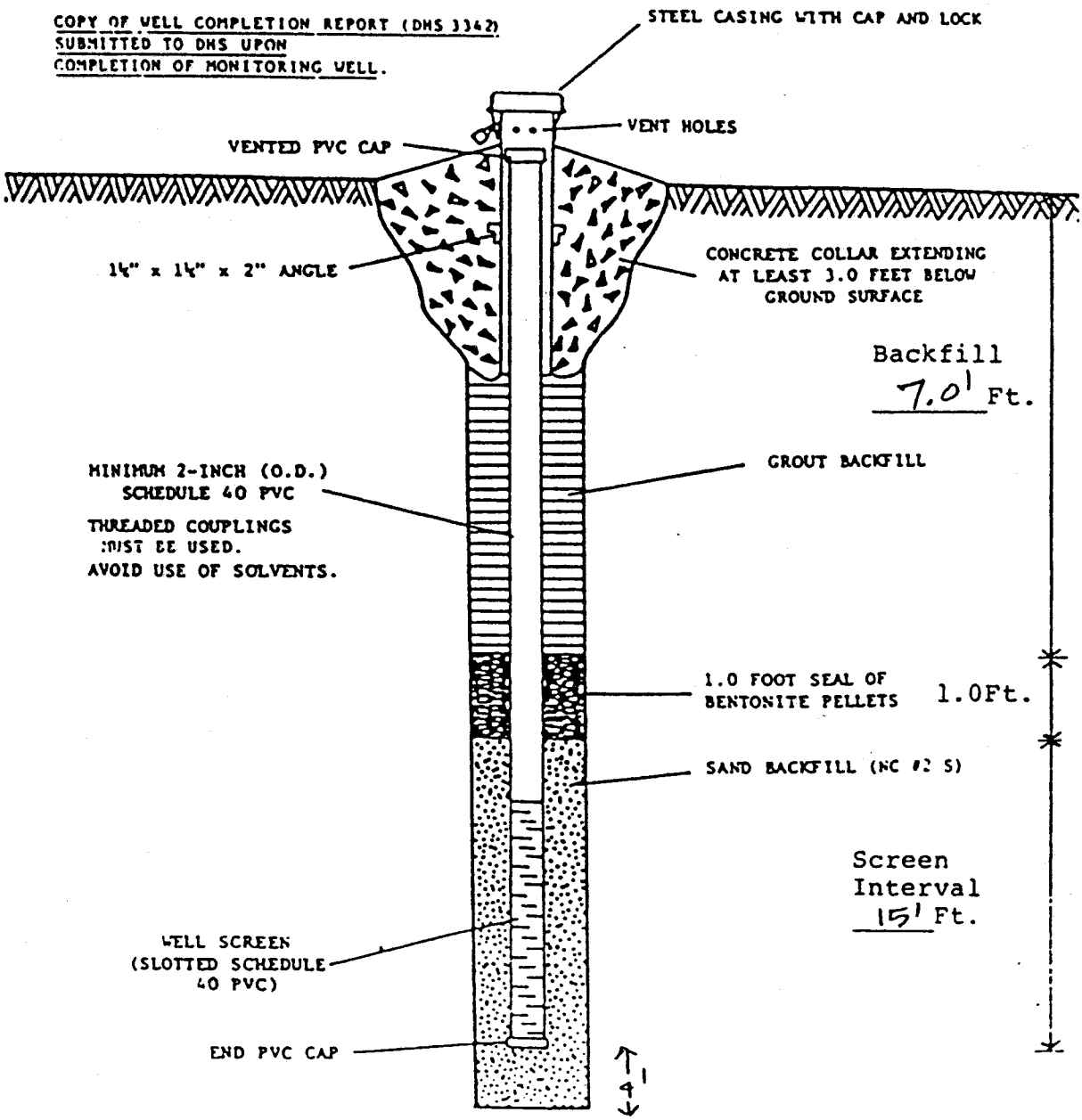
WEA
Wilson Engineering Associates, Inc.

P O Box 12015
Research Triangle Park
North Carolina 27709

Durham (919) 544-1735
Raleigh (919) 556-0515
Wilmington (919) 799-5537

Well Installation Diagram

For MW-1



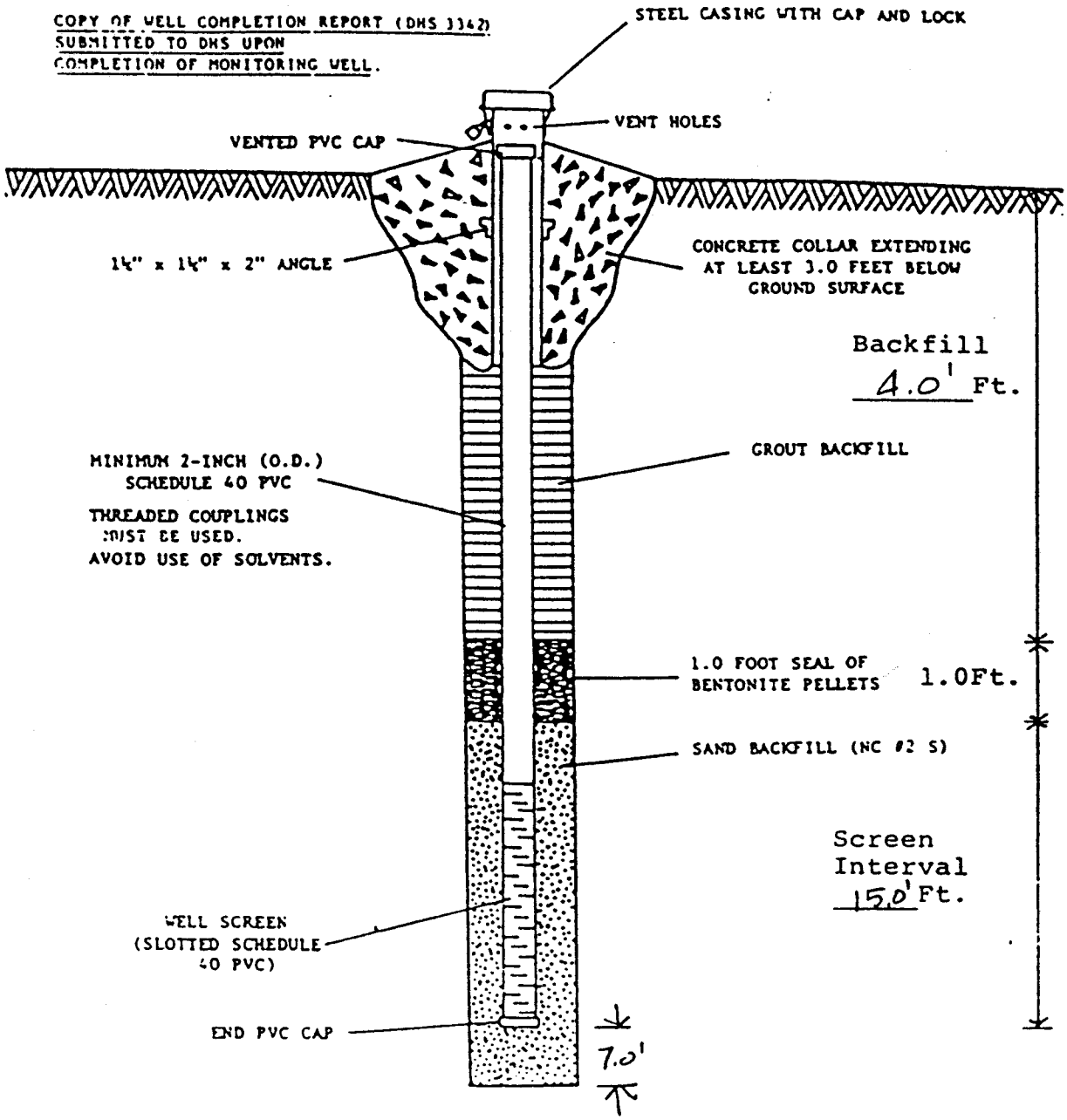
Wilson Engineering Associates, Inc.

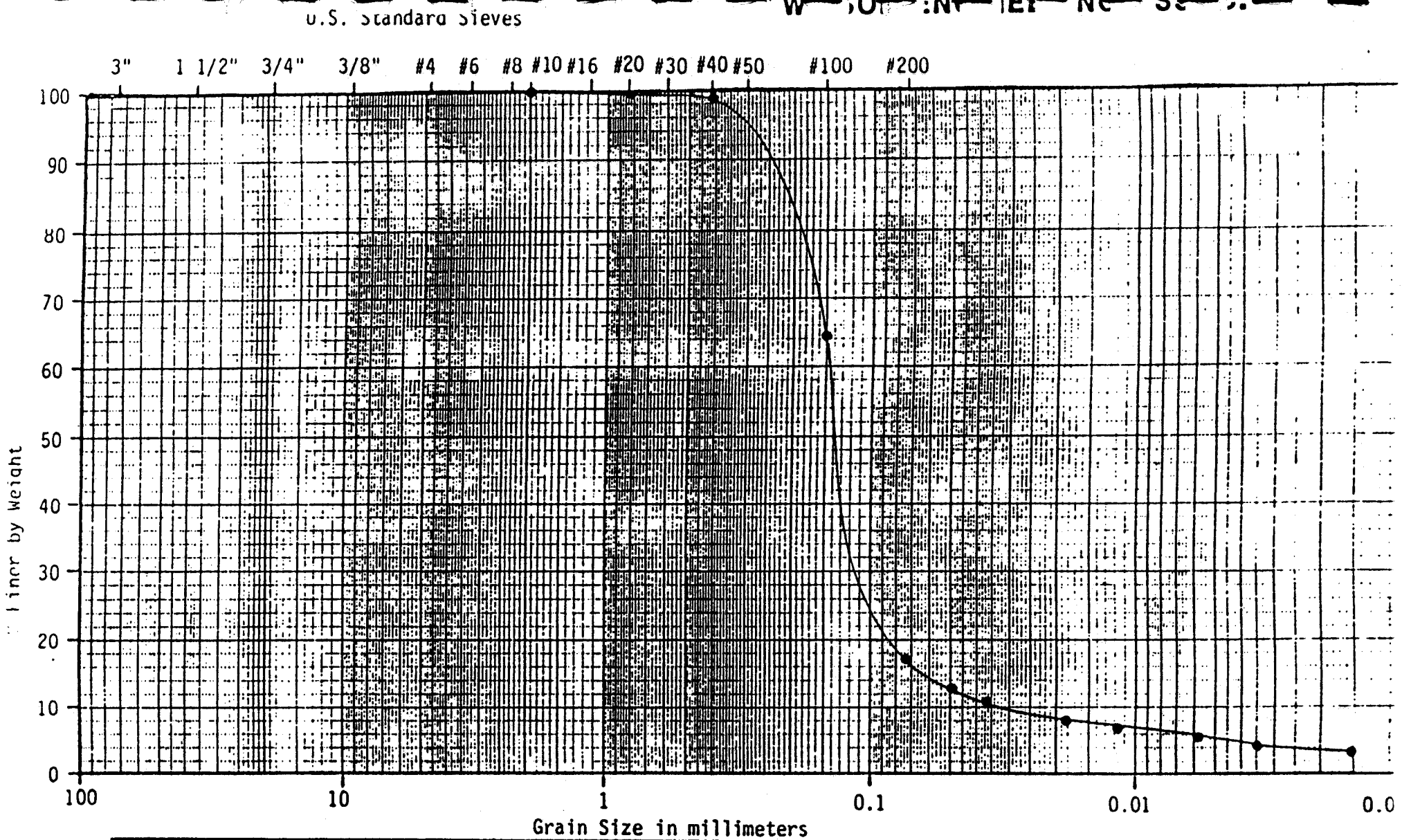
P.O. Box 12015
Research Triangle Park
North Carolina 27709

Durham (919) 544-1735
Raleigh (919) 556-0515
Wilmington (919) 799-5537

Well Installation Diagram

For MW-2





COARSE	FINE	COARSE	MEDIUM	FINE	
GRAVEL		SAND			FINES

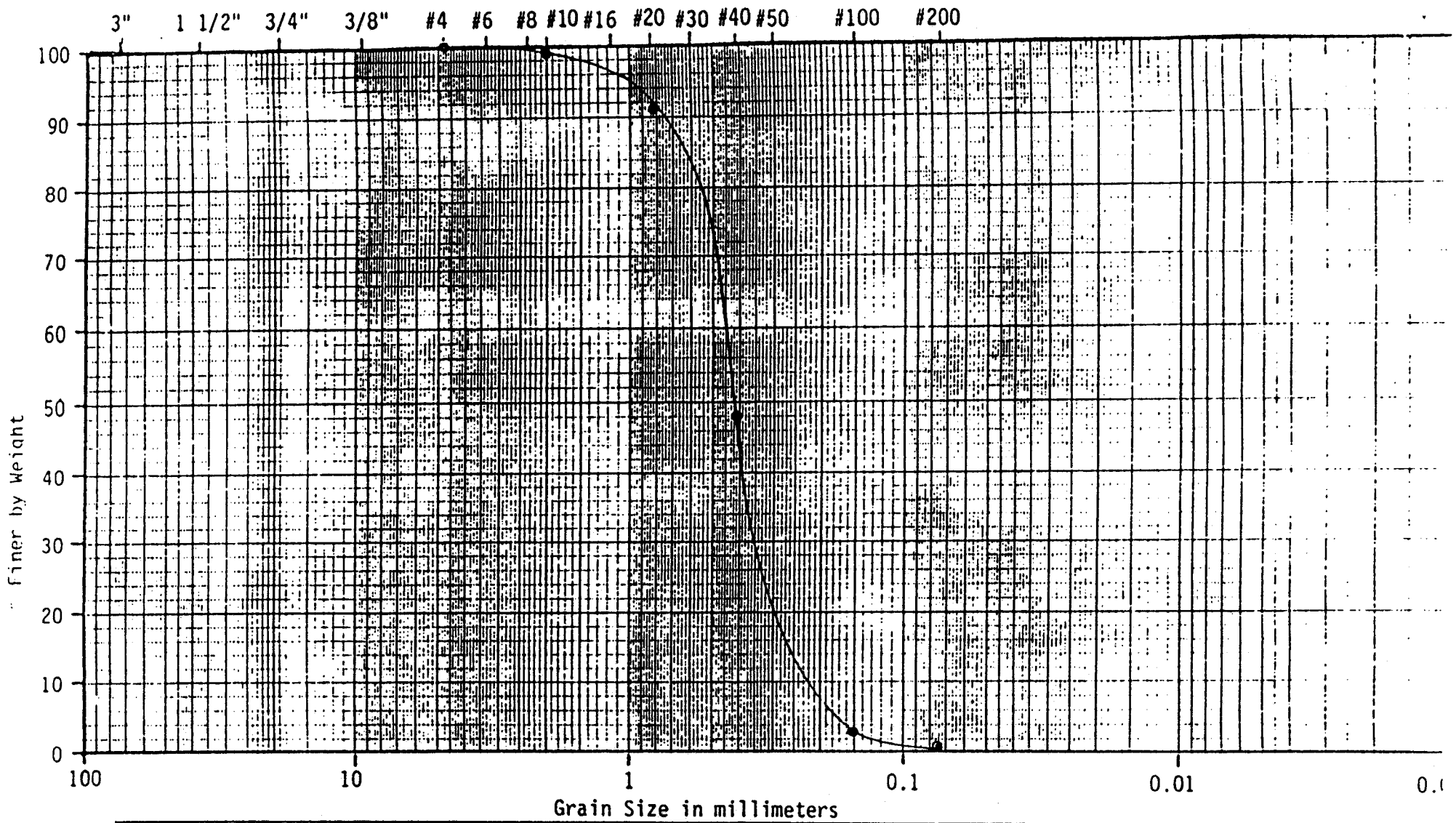
GRAIN SIZE DISTRIBUTION

Project Name Washington County Landfill

Date July 11, 1989

Sample MW4; S-5

Project No. 89-078-EA



COARSE	FINE	COARSE	MEDIUM	FINE	
GRAVEL		SAND			FINES

GRAIN SIZE DISTRIBUTION

Project Name Washington County Landfill

Project No. 89-078-EA

Date July 11, 1989

Sample MW4: S-3

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.

The fault rupture length relat'onship 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.

REFERENCES

Aggarwal, Y.P., and Sykes, L.R., 1978, Earthquakes, faults, and nuclear power plants in southern New York and northern New Jersey: Science, v. 200, p. 425-429.

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.

Bender, Bernice, and Campbell, K.W., 1989, A short note on the selection of minimum magnitude for use in seismic hazard analysis: Seismological Society of America Bulletin, v. 79, p. 199-204.

Cornell, C.A., and Winterstein, S.R., 1988, Temporal and magnitude dependence in earthquake recurrence models: Bulletin of the Seismological Society of America, v. 78, p. 1522-1537.

Electric Power Research Institute (EPRI), 1987, Seismic hazard methodology for the central and eastern United States, Vol. II: Responses to NRC Questions, p. 2-12.

Federal Emergency Management Agency, 1985, NEHRP (National Earthquake Hazards Reduction Program) recommended provisions for the development of seismic regulations for new buildings, 1985 Edition, part 2, Commentary: Earthquake Hazards Reduction Series 18, Building Seismic Safety Council, 200 p.

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.

_____1982, Results of core drilling of the Ramapo fault and Sky Meadow Road, Rockland County, New York, and assessment of evidence for reactivation to produce current seismicity: U.S. Geological Survey Miscellaneous Investigations Series Map I-1401, 1 sheet.

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

Processed Silica Berm
Slope Stability Analysis

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

February 27, 1991

Diehl & Phillips
219 East Chatham Street
Cary, North Carolina 27511

Attention: Mr. Alen Keith

SUBJECT: REPORT OF GEOTECHNICAL SERVICES
AND LABORATORY TESTING - WASHINGTON COUNTY LANDFILL
WASHINGTON COUNTY LANDFILL DIKE AND COVER MATERIAL
PLYMOUTH, NORTH CAROLINA
LAW ENGINEERING JOB NO. J47291-6356

Dear Mr. Keith:

Law Engineering has completed the geotechnical services and laboratory testing for the proposed dike and cover material for the Washington County Landfill located in Plymouth, North Carolina. These services were requested and authorized by Mr. William C. Diehl, P.E. in general accordance with our Proposal P47291-3704. The results of our study, including summaries of the field exploration, laboratory testing analyses and our recommendations for slope design and earthwork construction procedures for this project are submitted herewith.

PROJECT INFORMATION

Project information has been provided by Mr. Alan Keith of Diehl & Phillips. We have drawings entitled Washington County Sanitary Landfill Vertical Expansion which were prepared by Diehl & Phillips and dated December 14, 1989. Additional project information has been provided by Mr. Gary Alberg of the North Carolina Department of Environmental Health and Natural Resources.

3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

We understand waste materials (alum sludge) from American Cyanamid located on the Weyerhaeuser Facility in Plymouth, North Carolina are to be used as borrow material at the Washington County Landfill located just east of Plymouth off of N.C. 308. The proposed uses of the borrow would include placement as a landfill cover and vertically raising an existing dike at the landfill. A portion of the existing dike has been constructed at the landfill with the alum sludge. The finished dike is to be 15 feet in height and will retain landfill debris. The alum sludge to be used for cover and raising the dike will be blended with agricultural grade lime.

FIELD EXPLORATION

To evaluate the existing dike material in-place density testing was conducted within the top one foot. Hand auger borings with dynamic cone penetrometer testing were performed at one foot intervals to a depth of six feet. The results of the field testing are attached in the Appendix of this report.

Sealed bulk samples of the alum sludge and lime mix were obtained at various locations along the dike and at stockpiled areas (see Drawing No. 1 attached). These samples were transported to our laboratory for visual observations by the engineer and laboratory testing.

In addition to field testing of the dike materials, hand auger borings with dynamic cone penetrometer testing were performed in the near surface soils in front of the dike. The results of the field testing are attached in the Appendix of this report.

LABORATORY TESTING

The proposed dike and cover material consisting of an alum sludge and lime mixture was transported to our office for laboratory testing. The laboratory testing included the following:

- Standard Proctor compaction testing.
- Consolidated undrained tri-axial testing of recompacted samples, saturated and unsaturated.
- Atterberg Limits for shrink swell characterization.
- Permeability testing of recompacted samples, saturated and unsaturated.

The results of our laboratory testing can be found in the Appendix of this report.

DISCUSSION

Compaction Characteristics: Based on the laboratory test results, the alum sludge/lime mixture appears to have an affinity for water/moisture similar to a non-plastic silt. As such, the compaction characteristics of this material require special attention to moisture control. The material requires moisture contents on the order of 58% to achieve maximum dry densities during compaction based on the standard Proctor test results. However, satisfactory compaction levels presently exist at much lower moisture contents.

Field density tests on the alum sludge previously placed in the existing dike indicated compacted dry densities over 100% of the standard Proctor maximum dry density at well below the optimum moisture content (field test locations 1 and 4), see Drawing No. 1. The results of the dynamic cone penetration further indicate a relatively uniform consistency with depth. As a result, the in-place dike material appears to be reasonably compacted.

Future placement of the alum sludge should be conducted similar to soil fill. We recommend the material be placed in 8 to 10 inch thick lifts and compacted to at least 95% of the standard Proctor maximum dry density. Additional moisture control may be required to facilitate compaction.

The materials optimum moisture content is very close to its liquid limit. As such, compaction of the material will require close monitoring of moisture content during placement. The use of vibratory compaction equipment (i.e., pneumatic vibratory drum rollers) should be discouraged as vibratory action could induce pore pressures to occur that may cause moisture contents at optimum conditions to increase to or above the materials liquid limit and may induce liquefaction of the material.

Cover Material: Although the material has an affinity for water and is moderately impervious ($K=2x10^{-5}$ cm/sec.) at optimum moisture contents (on the order of 58%). Although the shrinkage limit is high and the plasticity index is low (which typically equates to low probability of shrink well potential).

The optimum moisture content for this material is above the shrinkage limit. Based on our testing of this material, volumetric shrinkage in the range of the liquid limit and the shrinkage limit is high (over 30%). By these considerations, the material should be suitable for landfill cover provided field testing is conducted as outlined below.

As the material is not a soil, we recommend that a test area be designated at the site for placement of a trial cover layer to verify the adequacy of the material for use as a cover.

The trial cover layer should be placed at the thickness planned for the landfill cover, placed over similar materials as the cover would be (i.e., garbage) and should be approximately 75 feet by 75 feet in plan dimension to reflect actual construction placement of the material. The material should be placed in 8 to 10 inch thick lifts and compacted to 95% of the Standard Proctor maximum dry density at or slightly above the optimum moisture content. Once placed, the trial cover layer could be tested for field permeability and monitored for signs of shrinkage over a period of time. Should shrinkage cracks develop another test section should be placed as outlined above except moisture contents should be well less than optimum and near the shrinkage limit (approximately 47%). In order to determine the adequacy of the material for use as a cover material, it should be noted that a reduction in moisture content could yield a high permeability for the in-place material.

<u>Dike Slope Stability</u>: The vertical expansion is proposed to have a maximum dike height of 15 feet and will retain approximately 23 feet of garbage. The back slope side of the dike (side retaining garbage) will have a geometry of 1±(H):1(V) while the front slope will have a geometry ranging from 2(H):1(V) maximum to a flatter 3(H):1(V) slope. The front and back slopes will be separated by a 15 feet wide crest.

A computerized slope stability analysis and hand calculation was performed for both the 2(H):1(V) and 3(H):1(V) front slope, vertically expanded cross sections. Strength parameters determined in the laboratory for the alum sludge material under saturated conditions and assumed strength parameters for the landfill debris (garbage) and the underlying sands were used in the analysis.

A summary of the analysis are tabulated below:

Front Slope Cross Section	Type of Analysis	FS Circular	FS Sliding Wedge
2(H):1(V)	Total	2.32	3.17
2(H):1(V)	Effective	-	3.45
3(H):1(V)	Total	2.59	3.66
3(H):1(V)	Effective	-	3.98

Based on the results above, a suitable factor of safety (greater than 1.30) against circular and sliding wedge instability was determined for the proposed vertically expanded 2(H):1(V) and 3(H):1(V) front slopes.

Due to the materials' lack of cohesion and light unit weight, the material may be prone to erode easily, as such the flatter slopes are recommended where possible. To minimize the erosion potential, the material placed may be periodically tracked down along the front slope face by wide tracked construction equipment. This would serve to add additional compaction effort along the front slope face and in addition will help to seal off the material.

Once the dike material is in place to its full height and prior to placing a final cover to promote a vegetative growth, it may be necessary to scarify or bench the front face of the slope to properly place the final cover.

CLOSING

We have appreciated being of service to you on this phase of the project and are prepared to assist you with any future needs. If you have any questions concerning this report or any of our testing and consulting services, please not hesitate to contact this office.

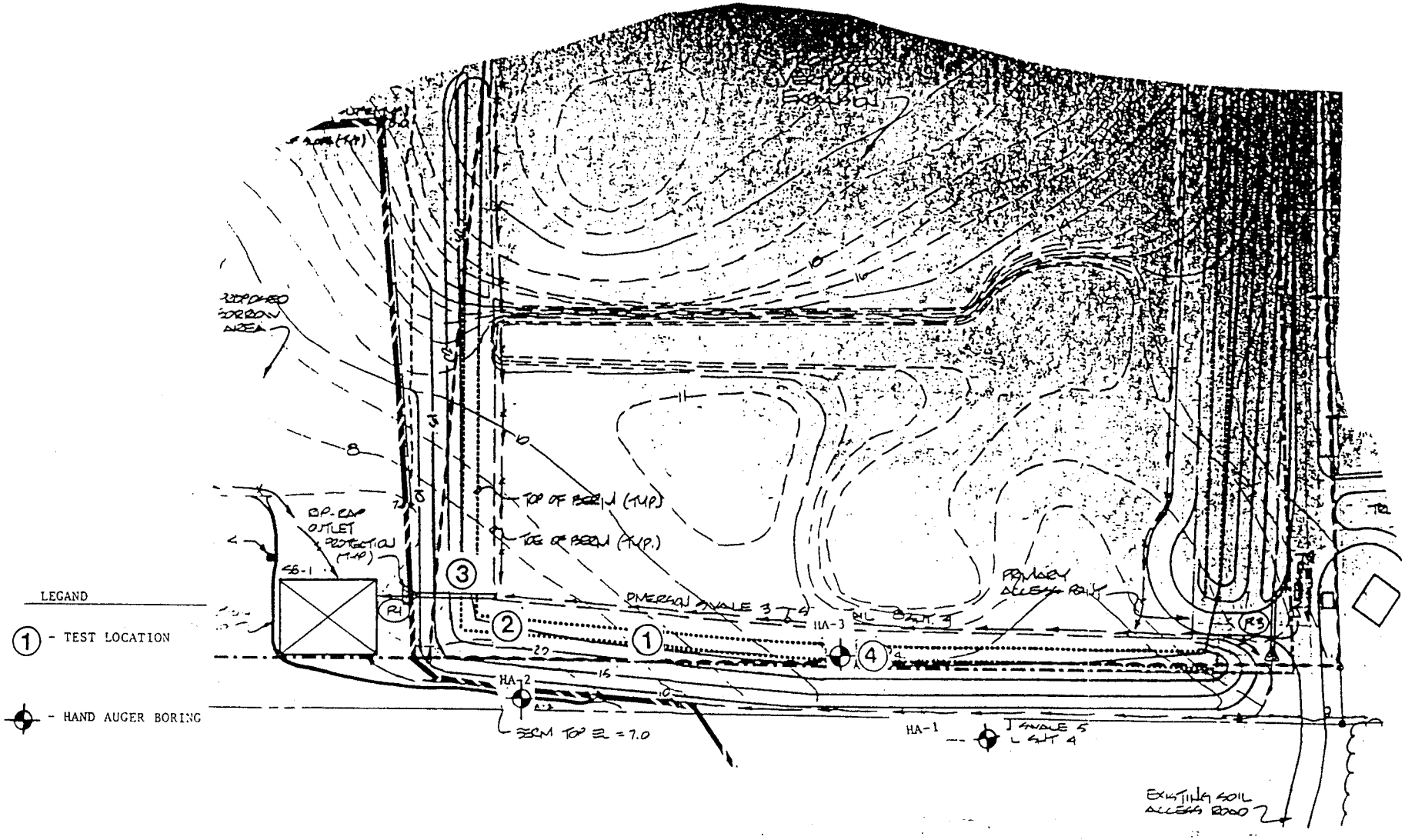
Sincerely
LAW ENGINEERING

David E. Miller, P.E.
Geotechnical Project Engineer

Barney C. Hale

Barney C. Hale, P.E.
Senior Geotechnical Engineer

APPENDIX



WASHINGTON COUNTY LAND FILL EXPANSION	LAW ENGINEERING RALEIGH, NORTH CAROLINA	
HAND AUGER AND TEST LOCATIONS	SCALE 1"=100'	Drawn: DEM Checked: DEM Date: 2/26/91
		Job No. J-6356 Dwg. No. 1

Location	Depth Below Ground Surface (Ft.)	Penetrometer Value	Depth(Ft.)	Soil Description
HA-1	0	12-10-11	0-3.0	Slightly silty tan and gray fine sand (SP/SM)
	1	10- 7- 8	3.0-5.0	Greenish gray sandy clay (CL/SC)
	2	5- 6- 5		
	3	9- 8-10		
	4	10-10-10		
	5	15+		
HA-2	0	9- 8- 7	0.0-4.0	Tan to gray clayey sand
	1	7- 5- 6	4.0-5.0	Tan to gray clayey sand (SC)
	2	5- 6- 5		
	3	5- 5- 5		
	4	7- 6- 8		
	5	8- 5- 6		
HA-3	0	5- 4- 4		Alum Sludge
	1	3- 3- 3		
	2	7- 3- 5		
	3	4- 5- 5		
	4	5- 4- 5		
	5	6- 5- 4		
	6	5- 5- 4		

LAW ENGINEERING

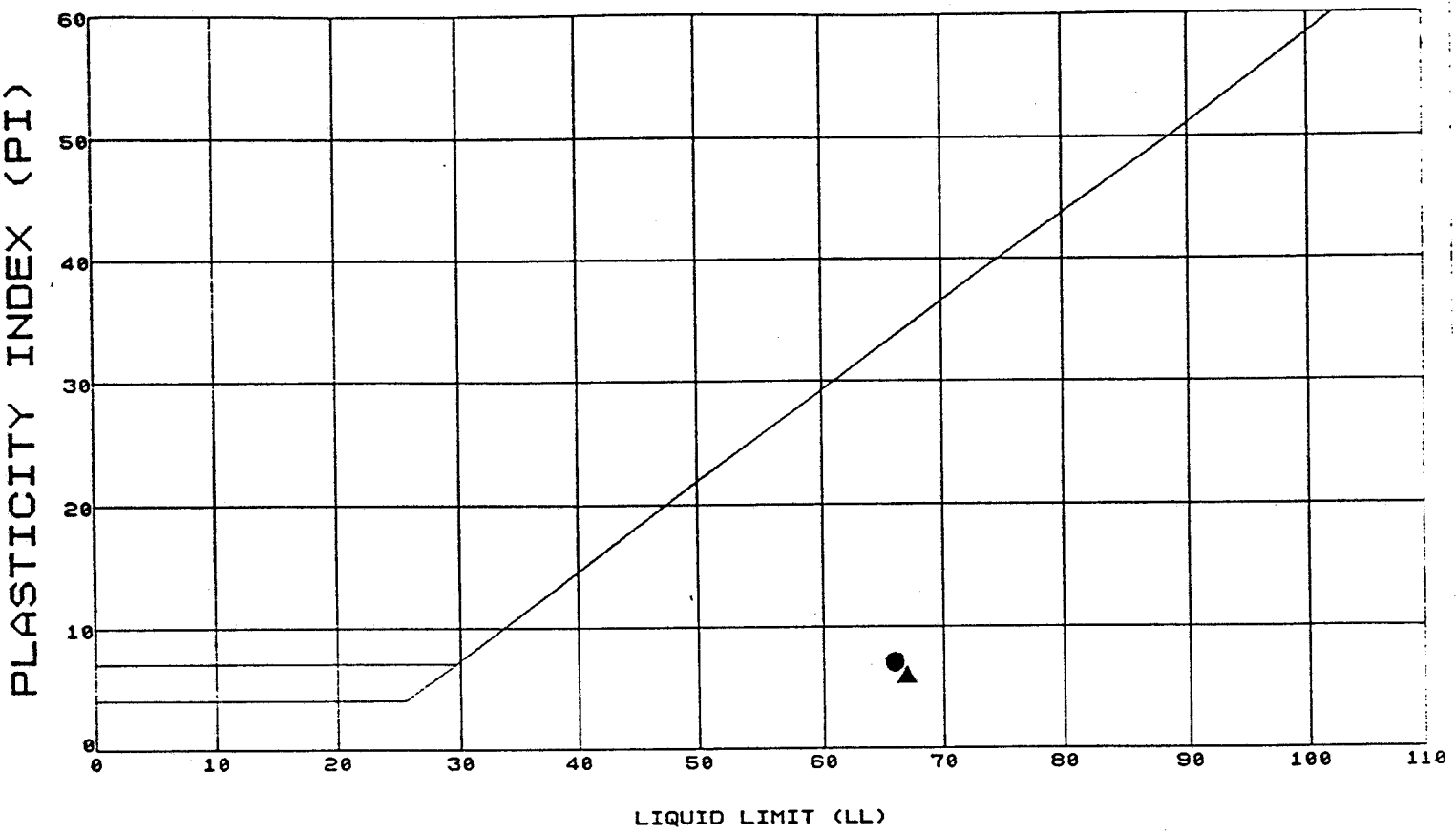
3301 ATLANTIC AVE.
RALEIGH, NORTH CAROLINA

WASHINGTON COUNTY LANDFILL

JOB NO. J-6356

LOCATION NO.	DEPTH FEET	SAMPLE NO.	COEFFICIENT OF PERMEABILITY (CM/SEC)	UNIT WEIGHT pcf		MAXIMUM STANDARD DRY DENSITY	% STANDARD DENSITY	STRENGTH ø C[PSF] (±)	SHRINKAGE LIMIT	ATTERBERG LIMITS		
				WET	DRY					LL	PL	PI
1	1.0	BAG-1		91.2	74.1	59.4	100+		46	67	61	6
2	1.0	BAG-2		62.5	44.9	58.8	76					
3	1.0	BAG-3		75.5	50.9	58.7	87		46	66	59	7
4	1.0	BAG-4		95.3	75.7	59.4	100+					
3	REMOLDED	BAG-3	2.53×10^{-6}				95±					
3	REMOLDED *	BAG-3	2.071×10^{-6}				95±					
3	REMOLDED	BAG-3					95±	TOTAL 28.5°; 100				
3	REMOLDED	BAG-3					95±	EFFECTIVE 31.3°; 100				
3	REMOLDED *	BAG-3					95±	TOTAL 34.0°; 200				
3	REMOLDED *	BAG-3					95±	EFFECTIVE 35.8°; 125				

* UNSATURATED



LEGEND:

● BAG 1 1.0

▲ BAG 3 1.0

LL	PL	PI
66	59	7
67	61	6

REMARKS:
SHRINKAGE LIMITS:
BAG 1: 46
BAG 3: 46

February 1991

WASHINGTON COUNTY LANDFILL - J-6356

ATTERBERG LIMITS' RESULTS

FIGURE 1

LAW ENGINEERING

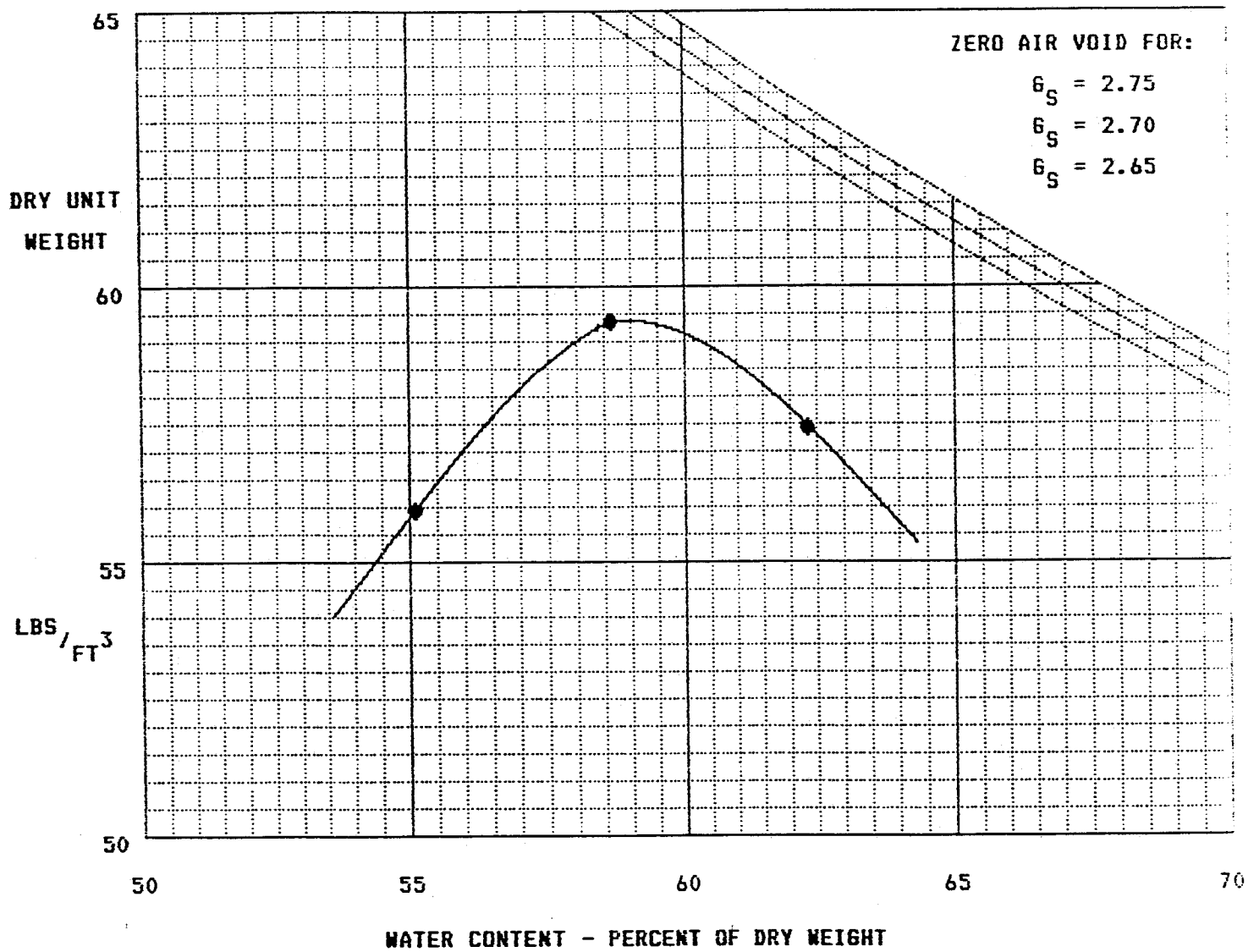
LAW ENGINEERING

STANDARD PROCTOR REPORT
ASTM D-698A

DATE: FEBRUARY 3, 1991
PROJECT NUMBER: J-6356
PROJECT NAME: WASHINGTON COUNTY LANDFILL
CLIENT: DIEHL & PHILLIPS
SAMPLE NUMBER: 1
FIELD MOISTURE:

SOIL DESCRIPTION:
ALUM MUD AND SANDY MIXTURE; ± 6 MONTHS OLD
PROPOSED USE:
LANDFILL BERM
SOURCE LOCATION:
WEYERHAEUSER CO.; PLYMOUTH, NC

MOISTURE - DENSITY RELATIONSHIP



OPTIMUM MOISTURE CONTENT 58.8 MAXIMUM DRY DENSITY 59.4

Bob Feel

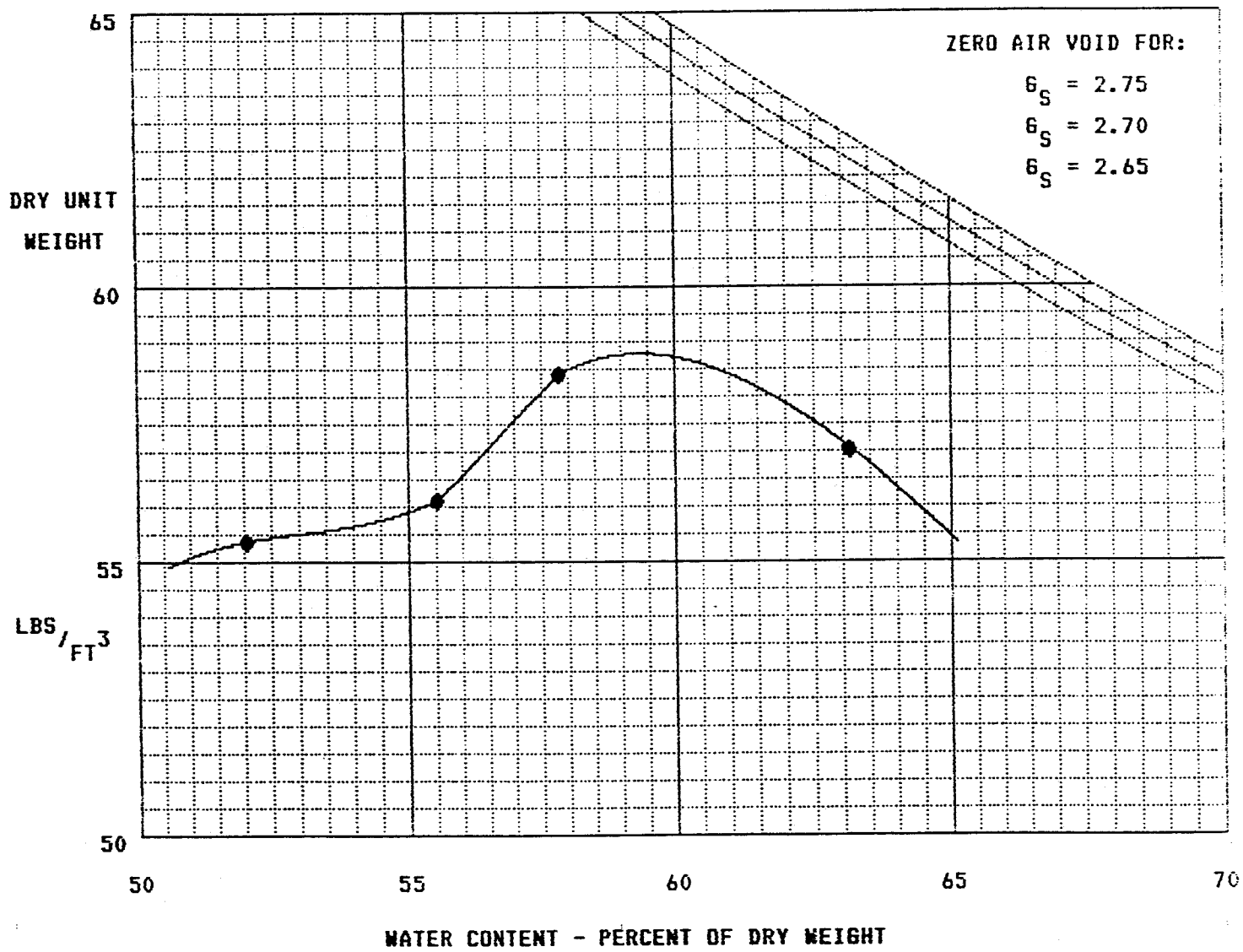
LAW ENGINEERING

STANDARD PROCTOR REPORT
ASTM D-698A

DATE: FEBRUARY 3, 1991
PROJECT NUMBER: J-6356
PROJECT NAME: WASHINGTON COUNTY LANDFILL
CLIENT: DIEHL & PHILLIPS
SAMPLE NUMBER: 2
FIELD MOISTURE:

SOIL DESCRIPTION:
ALUM MUD AND PFIZER LIME GRIT MIXTURE; 3 TO 4 MONTHS OLD
PROPOSED USE:
LANDFILL BERM
SOURCE LOCATION:
WEYERHAEUSER CO.; PLYMOUTH, NC

MOISTURE - DENSITY RELATIONSHIP



OPTIMUM MOISTURE CONTENT 59.3 MAXIMUM DRY DENSITY 58.8

Bob Heel

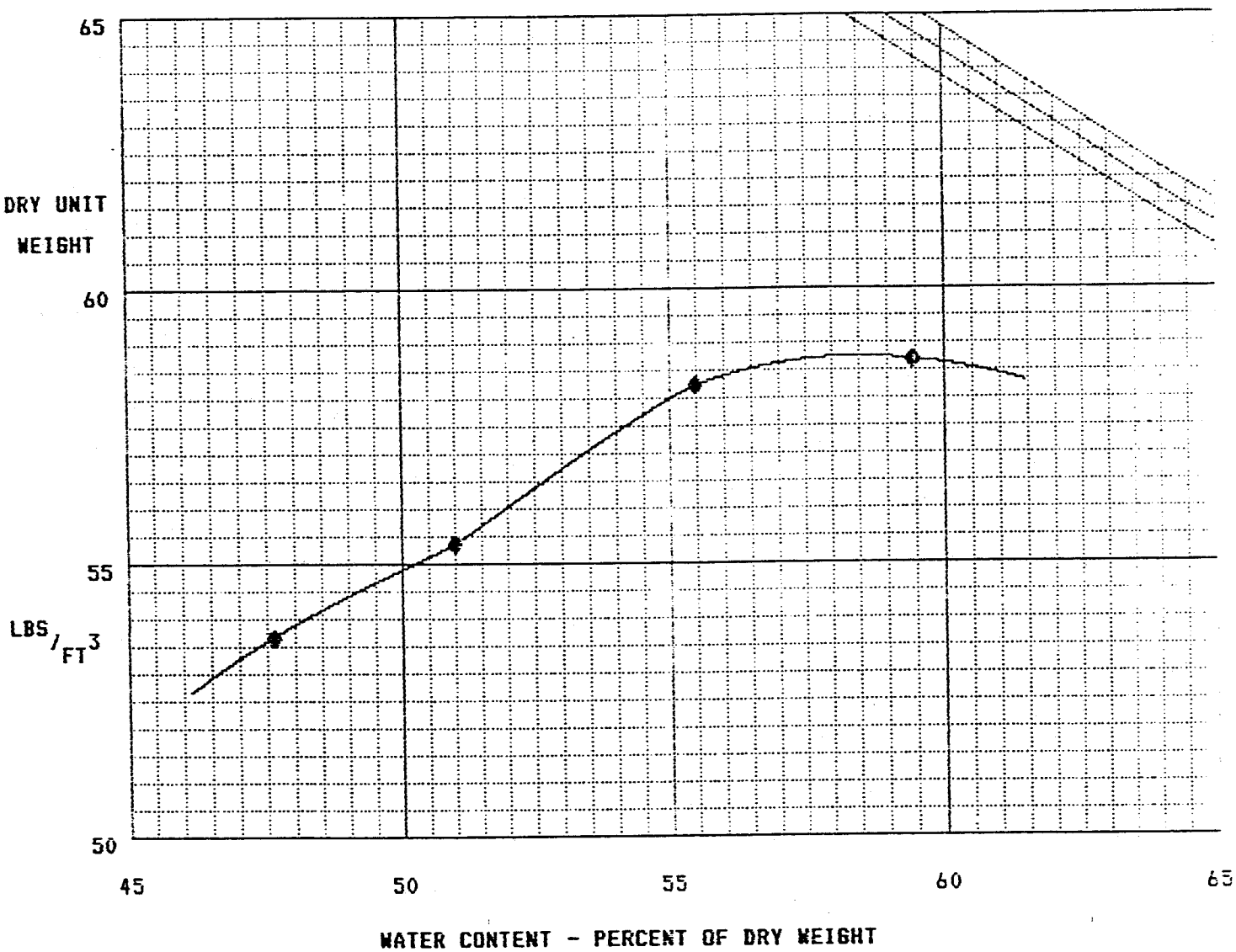
LAW ENGINEERING

STANDARD PROCTOR REPORT
ASTM D-698A

DATE: JANUARY 31, 1991
PROJECT NUMBER: WASHINGTON COUNTY LANDFILL
PROJECT NAME: J-6356
CLIENT: DIEHL & PHILLIPS
SAMPLE NUMBER: 3
FIELD MOISTURE:

SOIL DESCRIPTION:
ALUM MUD
PROPOSED USE:
LANDFILL BERM
SOURCE LOCATION:
WEYERHAEUSER CO.; PLYMOUTH, NC

MOISTURE - DENSITY RELATIONSHIP



OPTIMUM MOISTURE CONTENT 58.5 MAXIMUM DRY DENSITY 58.7

Bob Keel

LAW ENGINEERING

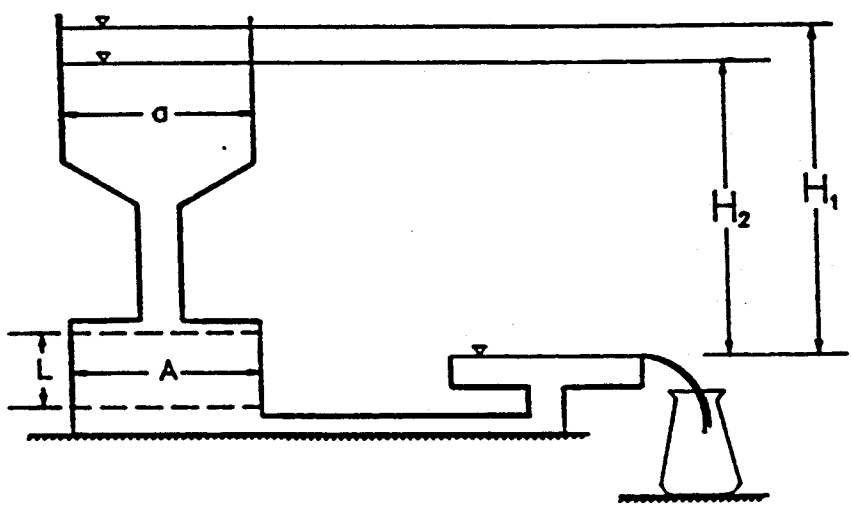
REPORT OF COEFFICIENT OF PERMEABILITY

CLIENT: County of Washington c/o Diehl & Phillips **DATE:** February 6, 1991

PROJECT: Washington Co. Landfill **JOB NO.:** J-6356

Bag #3, Remolded
Unsaturated

$$K = \frac{2.3al}{At} \times \log_{10} H_1/H_2$$



a = 1.27 cm^2

l = 5.50 cm

A = 42.12 cm^2

t = as shown

H_1= 102.23 cm

H_2= as shown

K = as shown

t (sec)	H_2 (cm)	K (cm/sec)
60	100.01	8.422×10^{-5}
600	96.84	1.213×10^{-5}
13,920	71.12	2.071×10^{-6}

LAW ENGINEERING

REPORT OF COEFFICIENT OF PERMEABILITY

CLIENT: County of Washington
c/o Diehl & Phillips

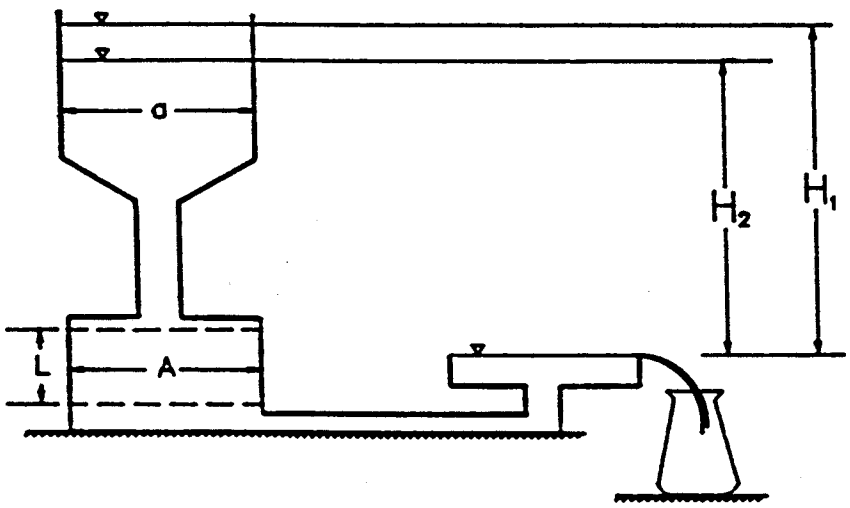
DATE: February 6, 1991

PROJECT: Washington Co. Landfill

JOB NO.: J-6356

Bag #3, Remolded
Saturated

$$K = \frac{2.3al}{At} \times \log_{10} H_1/H_2$$



$a = 1.27 \quad cm^2$

$l = 5.50 \quad cm$

$A = 40.67 \quad cm^2$

$t = 1740 \quad sec$

$H_1 = 100.33 \quad cm$

$H_2 = 97.79 \quad cm$

$K = 2.53 \times 10^{-6}$ cm/sec

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:21 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356
Client: WASHINGTON COUNTY
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - SATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 1

Sample No. 1 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	1.48	1.36	
Height change, in		0.09	
Height, in	3.00	2.91	
Weight, grams	122.2		
Water volume change, cc		5.33	
Moisture, %	58.8	51.9	58.8
Dry density, pcf	56.8	69.7	
Saturation, %	81.5	100.0	
Void ratio	1.912	1.375	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.1657 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.670 % per minute
Consolidation cell pressure = 15 psi
Consolidation back pressure = 10 psi
Consolidation effective confining stress = 5 psi
Peak deviator stress = 11.72 psi at reading no. 5
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	20.0	0.0	0.0	0.00	5.00	5.00	1.00	10.0	5.00	0.00
1	0.0300	0.015	26.0	1.0	0.5	0.68	5.00	5.68	1.14	10.0	5.34	0.34
2	0.0450	0.030	60.0	6.6	1.0	4.54	5.00	9.54	1.91	10.0	7.27	2.27
3	0.0600	0.045	97.0	12.8	1.5	8.69	4.80	13.49	2.81	10.2	9.14	4.34
4	0.0750	0.060	114.0	15.6	2.1	10.55	4.60	15.15	3.29	10.4	9.87	5.27
5	0.0900	0.075	125.0	17.4	2.6	11.72	4.50	16.22	3.60	10.5	10.36	5.86

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:21 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356
Client: WASHINGTON COUNTY
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - SATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 1

Sample No. 2 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	1.48	1.38	
Height change, in		0.08	
Height, in	3.00	2.93	
Weight, grams	122.2		
Water volume change, cc		2.41	
Moisture, %	58.8	55.7	58.8
Dry density, pcf	56.8	66.8	
Saturation, %	81.5	100.0	
Void ratio	1.912	1.475	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.1657 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.670 % per minute
Consolidation cell pressure = 20 psi
Consolidation back pressure = 10 psi
Consolidation effective confining stress = 10 psi
Peak deviator stress = 23.59 psi at reading no. 4
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	34.0	0.0	0.0	0.00	10.00	10.00	1.00	10.0	10.00	0.00
1	0.0300	0.015	120.0	14.3	0.5	9.45	9.50	18.95	1.99	10.5	14.23	4.73
2	0.0450	0.030	190.0	25.8	1.0	17.06	9.00	26.06	2.90	11.0	17.53	8.53
3	0.0600	0.045	229.0	32.3	1.5	21.21	8.80	30.01	3.41	11.2	19.41	10.61
4	0.0750	0.060	252.0	36.1	2.1	23.59	8.60	32.19	3.74	11.4	20.39	11.79

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:21 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356
Client: WASHINGTON COUNTY
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - SATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 1

Sample No. 3 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	1.48	1.44	
Height change, in		0.34	
Height, in	3.00	2.66	
Weight, grams	122.2		
Water volume change, cc		2.91	
Moisture, %	58.8	55.0	58.8
Dry density, pcf	56.8	67.3	
Saturation, %	81.5	100.0	
Void ratio	1.912	1.458	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.1657 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.670 % per minute
Consolidation cell pressure = 30 psi
Consolidation back pressure = 10 psi
Consolidation effective confining stress = 20 psi
Peak deviator stress = 37.93 psi at reading no. 6
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	145.0	0.0	0.0	0.00	19.50	19.50	1.00	10.5	19.50	0.00
1	0.0300	0.015	288.0	23.7	0.6	14.39	18.70	33.09	1.77	11.3	25.89	7.19
2	0.0450	0.030	400.0	42.3	1.1	25.51	18.00	43.51	2.42	12.0	30.75	12.75
3	0.0600	0.045	463.0	52.7	1.7	31.63	17.50	49.13	2.81	12.5	33.31	15.81
4	0.0750	0.060	500.0	58.8	2.3	35.11	17.10	52.21	3.05	12.9	34.65	17.55
5	0.0900	0.075	525.0	63.0	2.8	37.36	16.90	54.26	3.21	13.1	35.58	18.68

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
6	0.1050	0.090	533.0	64.3	3.4	37.93	16.70	54.63	3.27	13.3	35.66	18.96
7	0.1200	0.105	525.0	63.0	3.9	36.93	16.70	53.63	3.21	13.3	35.16	18.46
8	0.1500	0.135	500.0	58.8	5.1	34.09	16.80	50.89	3.03	13.2	33.85	17.05
9	0.1800	0.165	493.0	57.7	6.2	33.02	16.70	49.72	2.98	13.3	33.21	16.51
10	0.2100	0.195	496.0	58.2	7.3	32.91	16.60	49.51	2.98	13.4	33.05	16.45
11	0.2500	0.235	500.0	58.8	8.8	32.74	16.50	49.24	2.98	13.5	32.87	16.37
12	0.2700	0.255	499.0	58.7	9.6	32.38	16.50	48.88	2.96	13.5	32.69	16.19
13	0.3000	0.285	491.0	57.3	10.7	31.25	16.40	47.65	2.91	13.6	32.03	15.63
14	0.3400	0.325	492.0	57.5	12.2	30.82	16.40	47.22	2.88	13.6	31.81	15.41

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:22 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356
Client: WASHINGTON COUNTY
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - SATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 1

Sample No. 4 Data

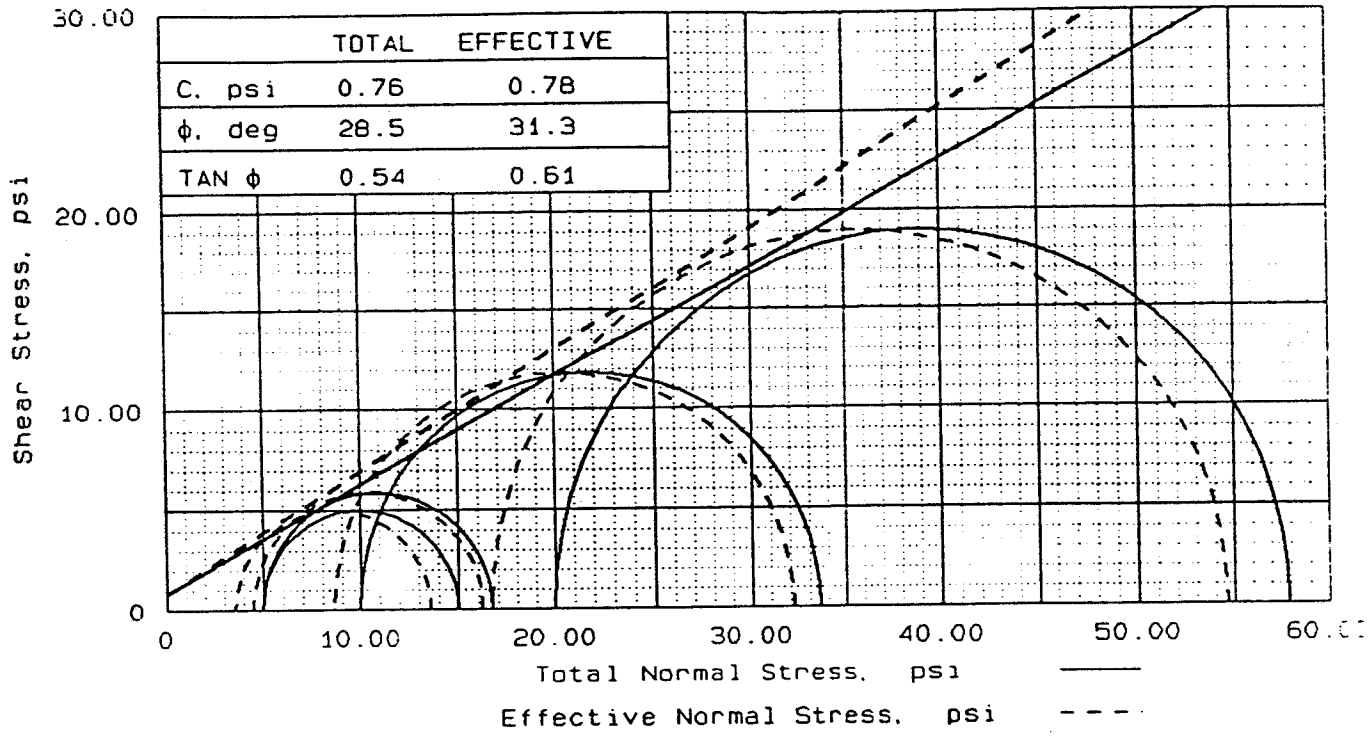
Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

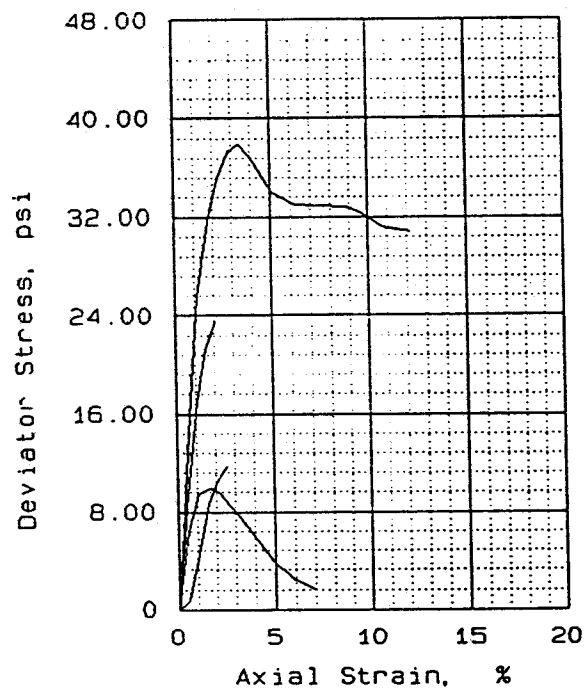
Sample Parameters	Before Test	At Testing	After Test
Diameter, in	1.48	1.27	
Height change, in		0.21	
Height, in	3.00	2.79	
Weight, grams	122.2		
Water volume change, cc		16.13	
Moisture, %	58.8	37.8	58.8
Dry density, pcf	56.8	82.6	
Saturation, %	81.5	100.0	
Void ratio	1.912	1.003	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.1657 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.670 % per minute
Consolidation cell pressure = 26 psi
Consolidation back pressure = 21 psi
Consolidation effective confining stress = 5 psi
Peak deviator stress = 9.99 psi at reading no. 3
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	25.0	0.0	0.0	0.00	4.20	4.20	1.00	21.8	4.20	0.00
1	0.0300	0.015	74.0	8.1	0.5	6.35	3.50	9.85	2.81	22.5	6.67	3.17
2	0.0450	0.030	98.0	12.1	1.1	9.40	3.50	12.90	3.69	22.5	8.20	4.70
3	0.0600	0.045	103.0	12.9	1.6	9.99	3.60	13.59	3.78	22.4	8.60	5.00
4	0.0750	0.060	100.0	12.4	2.2	9.56	3.60	13.16	3.65	22.4	8.38	4.78
5	0.0900	0.075	92.0	11.1	2.7	8.49	3.60	12.09	3.36	22.4	7.85	4.25





SAMPLE NO.		1	2	3	4
INITIAL	WATER CONTENT, %	58.8	58.8	58.8	58.8
	DRY DENSITY, pcf	56.8	56.8	56.8	56.8
	SATURATION, %	81.5	81.5	81.5	81.5
	VOID RATIO	1.912	1.912	1.912	1.912
	DIAMETER, in	1.48	1.48	1.48	1.48
	HEIGHT, in	3.00	3.00	3.00	3.00
AT TEST	WATER CONTENT, %	51.9	55.7	55.0	37.8
	DRY DENSITY, pcf	69.7	66.8	67.3	82.8
	SATURATION, %	100.0	100.0	100.0	100.0
	VOID RATIO	1.375	1.475	1.458	1.003
	DIAMETER, in	1.36	1.38	1.44	1.27
	HEIGHT, in	2.91	2.93	2.66	2.79
BACK PRESSURE, psi		10.00	10.00	10.00	21.00
CELL PRESSURE, psi		15.00	20.00	30.00	25.00
FAILURE STRESS, psi		11.72	23.59	37.93	9.99
PORE PRESSURE, psi		10.50	11.40	13.30	22.40
STRAIN RATE, %/min.		0.670	0.670	0.670	0.670
ULTIMATE STRESS, psi					
PORE PRESSURE, psi					
$\bar{\sigma}_1$ FAILURE, psi		16.22	32.19	54.63	13.59
$\bar{\sigma}_3$ FAILURE, psi		4.5	8.6	16.7	3.6

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: ALUM MUD

LL= 65 PL= 59 PI= 6.0
SPECIFIC GRAVITY= 2.65
REMARKS:

CLIENT: WASHINGTON COUNTY

PROJECT: WASHINGTON COUNTY LANDFILL

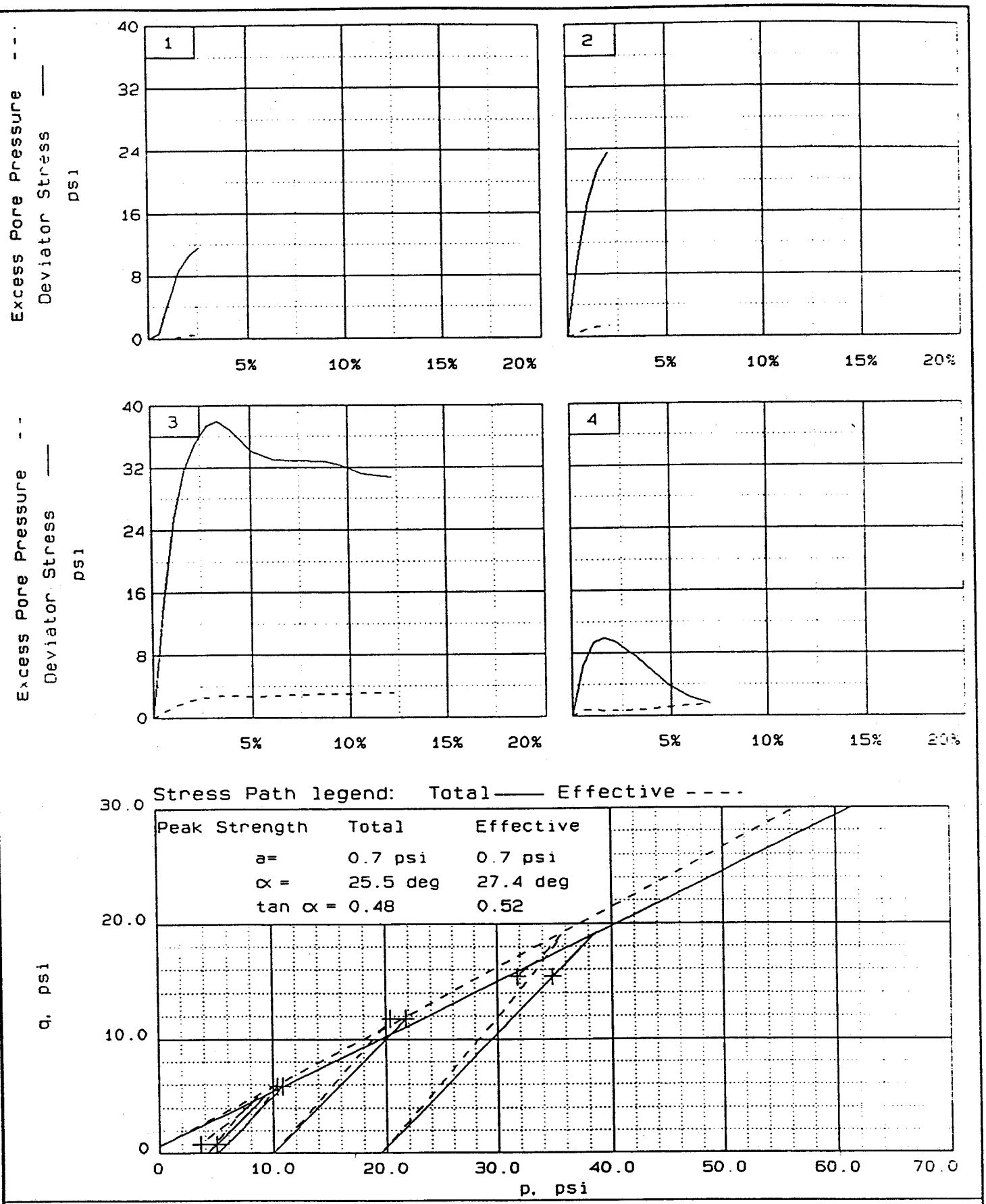
SAMPLE LOCATION: BAG 1 - SATURATED

PROJ. NO.: J-6356 DATE: 2/14/91

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING

FIG. NO. 1



Client: WASHINGTON COUNTY

Project: WASHINGTON COUNTY LANDFILL

Location: BAG 1 - SATURATED

File: 6356 Project No.: J-6356 Page 2/2 Fig. No. 1

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:38 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356DRY
Client:
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - UNSATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 2

Sample No. 1 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.83	2.73	
Height change, in		0.33	
Height, in	5.59	5.26	
Weight, grams	827.1		
Water volume change, cc		0.00	
Moisture, %	58.8	58.8	58.8
Dry density, pcf	56.4	64.7	
Saturation, %	80.7	100.0	
Void ratio	1.932	1.558	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 1.500 % per minute
Consolidation cell pressure = 20 psi
Consolidation back pressure = 0 psi
Consolidation effective confining stress = 20 psi
Peak deviator stress = 55.79 psi at reading no. 13
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	40.0	0.0	0.0	0.00	20.00	20.00	1.00	0.0	20.00	0.00
1	0.0300	0.015	140.0	68.0	0.3	11.62	20.00	31.62	1.58	0.0	25.81	5.81
2	0.0450	0.030	230.0	129.2	0.6	22.02	20.00	42.02	2.10	0.0	31.01	11.01
3	0.0600	0.045	309.0	182.9	0.9	31.09	19.90	50.99	2.56	0.1	35.45	15.55
4	0.0750	0.060	371.0	225.1	1.1	38.15	19.60	57.75	2.95	0.4	38.67	19.07
5	0.0900	0.075	411.0	252.3	1.4	42.63	19.50	62.13	3.19	0.5	40.82	21.32

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:41 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356DRY
Client:
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - UNSATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 2

Sample No. 2 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.83	2.79	
Height change, in		0.09	
Height, in	5.59	5.51	
Weight, grams	827.1		
Moisture, %	58.8	58.8	58.8
Dry density, pcf	56.4	59.1	
Saturation, %	80.7	86.6	
Void ratio	1.932	1.799	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 1.500 % per minute
Consolidation cell pressure = 10 psi
Consolidation back pressure = 0 psi
Consolidation effective confining stress = 10 psi
Peak deviator stress = 22.46 psi at reading no. 5
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	85.0	0.0	0.0	0.00	10.00	10.00	1.00	0.0	10.00	0.00
1	0.0300	0.015	151.0	44.9	0.3	7.34	10.00	17.34	1.73	0.0	13.67	3.67
2	0.0450	0.030	211.0	85.7	0.5	13.97	9.90	23.87	2.41	0.1	16.89	6.99
3	0.0600	0.045	250.0	112.2	0.8	18.25	9.90	28.15	2.84	0.1	19.02	9.12
4	0.0750	0.060	277.0	130.6	1.1	21.17	9.80	30.97	3.16	0.2	20.39	10.59
5	0.0850	0.070	289.0	138.7	1.3	22.46	9.80	32.26	3.29	0.2	21.03	11.23

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:43 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356DRY
Client:
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - UNSATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 2

Sample No. 3 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.83	2.78	
Height change, in		0.11	
Height, in	5.59	5.49	
Weight, grams	827.1		
Moisture, %	58.8	58.8	58.8
Dry density, pcf	56.4	59.8	
Saturation, %	80.7	88.1	
Void ratio	1.932	1.769	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 1.500 % per minute
Consolidation cell pressure = 5 psi
Consolidation back pressure = 0 psi
Consolidation effective confining stress = 5 psi
Peak deviator stress = 15.25 psi at reading no. 6
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	64.0	0.0	0.0	0.00	5.00	5.00	1.00	0.0	5.00	0.00
1	0.0300	0.015	110.0	31.3	0.3	5.15	5.00	10.15	2.03	0.0	7.58	2.58
2	0.0450	0.030	145.0	55.1	0.5	9.05	5.00	14.05	2.81	0.0	9.52	4.52
3	0.0600	0.045	172.0	73.4	0.8	12.03	5.00	17.03	3.41	0.0	11.02	6.02
4	0.0750	0.060	188.0	84.3	1.1	13.78	5.00	18.78	3.76	0.0	11.89	6.89
5	0.0900	0.075	196.0	89.8	1.4	14.62	5.00	19.62	3.92	0.0	12.31	7.31
6	0.1050	0.090	202.0	93.8	1.6	15.25	5.00	20.25	4.05	0.0	12.62	7.62

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:47 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356DRY
Client:
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - UNSATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 2

Sample No. 4 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

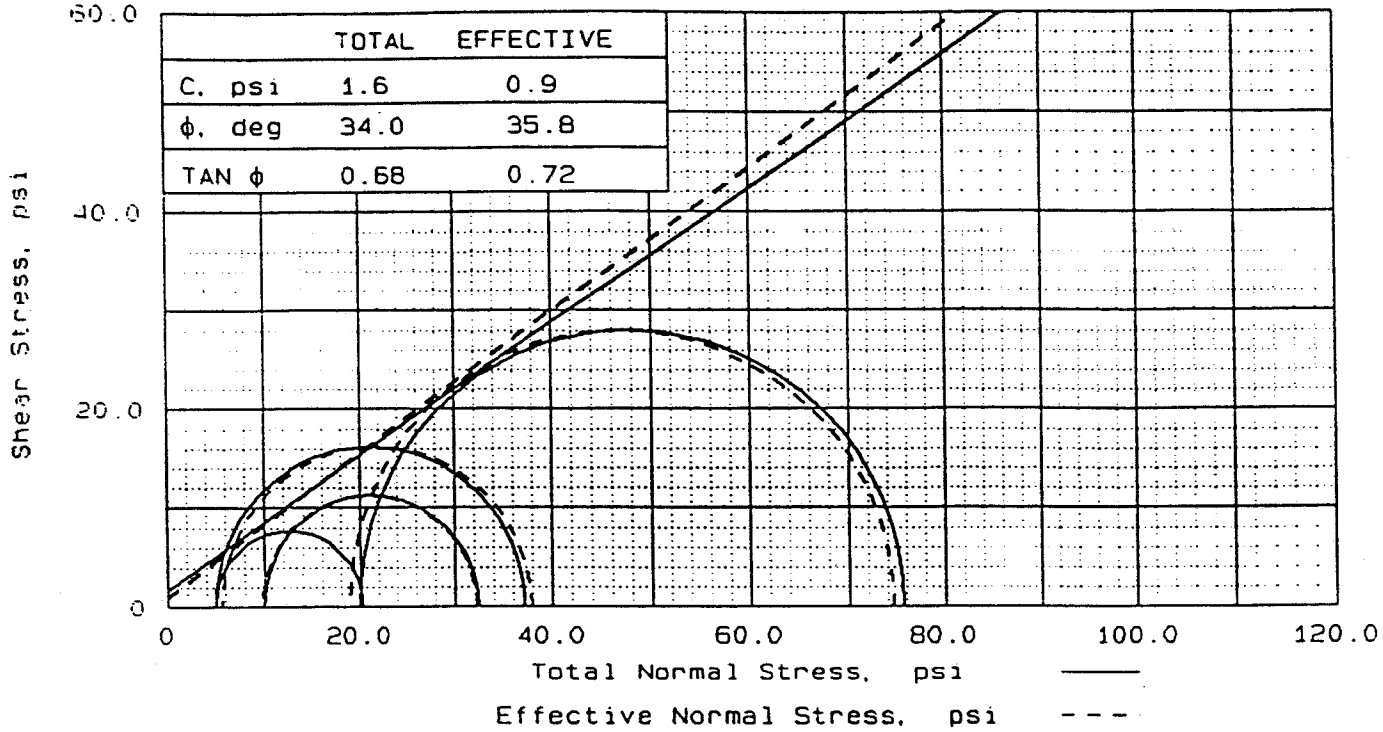
Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.83	2.63	
Height change, in		0.39	
Height, in	5.59	5.20	
Weight, grams	827.1		
Moisture, %	58.8	58.8	58.8
Dry density, pcf	56.4	70.5	
Saturation, %	80.7	115.7	
Void ratio	1.932	1.347	

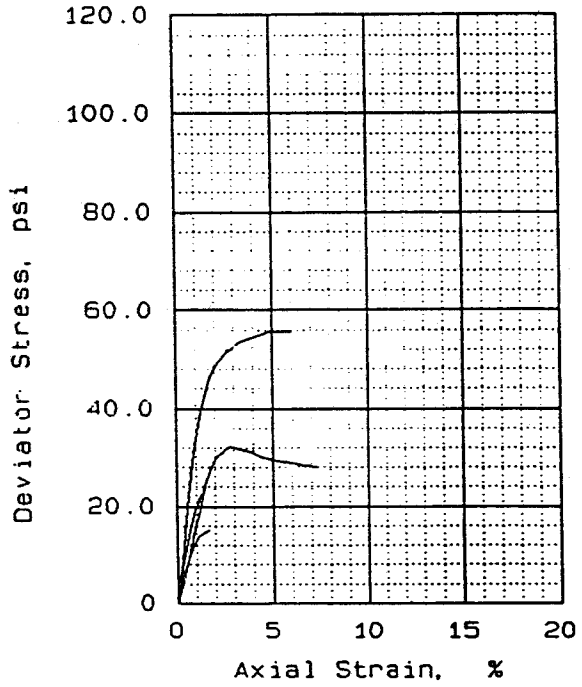
Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 1.500 % per minute
Consolidation cell pressure = 5 psi
Consolidation back pressure = 0 psi
Consolidation effective confining stress = 5 psi
Peak deviator stress = 32.24 psi at reading no. 9
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	40.0	0.0	0.0	0.00	5.00	5.00	1.00	0.0	5.00	0.00
1	0.0300	0.015	75.0	23.8	0.3	4.38	5.00	9.38	1.88	0.0	7.19	2.19
2	0.0450	0.030	115.0	51.0	0.6	9.37	5.00	14.37	2.87	0.0	9.68	4.68
3	0.0600	0.045	156.0	78.9	0.9	14.45	5.10	19.55	3.83	-0.1	12.32	7.22
4	0.0750	0.060	195.0	105.4	1.2	19.25	5.20	24.45	4.70	-0.2	14.82	9.62
5	0.0900	0.075	236.0	133.3	1.4	24.27	5.20	29.47	5.67	-0.2	17.33	12.13
6	0.1050	0.090	261.0	150.3	1.7	27.28	5.20	32.48	6.25	-0.2	18.84	13.64

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
7	0.1200	0.105	282.0	164.6	2.0	29.79	5.20	34.99	6.73	-0.2	20.09	14.89
8	0.1500	0.135	299.0	176.1	2.6	31.69	5.50	37.19	6.76	-0.5	21.35	15.85
9	0.1600	0.145	304.0	179.5	2.8	32.24	5.70	37.94	6.66	-0.7	21.82	16.12
10	0.2100	0.195	299.0	176.1	3.8	31.32	6.00	37.32	6.22	-1.0	21.66	15.66
11	0.2400	0.225	291.0	170.7	4.3	30.17	6.20	36.37	5.87	-1.2	21.29	15.09
12	0.2700	0.255	288.0	168.6	4.9	29.63	6.20	35.83	5.78	-1.2	21.01	14.81
13	0.3000	0.285	286.0	167.3	5.5	29.21	6.20	35.41	5.71	-1.2	20.81	14.61
14	0.3300	0.315	285.0	166.6	6.1	28.92	6.30	35.22	5.59	-1.3	20.76	14.46
15	0.3600	0.345	282.0	164.6	6.6	28.39	6.30	34.69	5.51	-1.3	20.49	14.19
16	0.3900	0.375	280.0	163.2	7.2	27.98	6.30	34.28	5.44	-1.3	20.29	13.99





SAMPLE NO.		1	2	3	4
INITIAL	WATER CONTENT, %	58.8	58.8	58.8	58.8
	DRY DENSITY, pcf	56.4	56.4	56.4	56.4
	SATURATION, %	80.7	80.7	80.7	80.7
	VOID RATIO	1.932	1.932	1.932	1.932
	DIAMETER, in	2.83	2.83	2.83	2.83
	HEIGHT, in	5.59	5.59	5.59	5.59
AT TEST	WATER CONTENT, %	58.8	58.8	58.8	58.8
	DRY DENSITY, pcf	64.7	59.1	59.8	70.5
	SATURATION, %	100.0	86.6	88.1	115.7
	VOID RATIO	1.558	1.799	1.769	1.347
	DIAMETER, in	2.73	2.79	2.78	2.63
	HEIGHT, in	5.26	5.51	5.49	5.20
BACK PRESSURE, psi		0.0	0.0	0.0	0.0
CELL PRESSURE, psi		20.0	10.0	5.0	5.0
FAILURE STRESS, psi		55.8	22.5	15.2	32.2
PORE PRESSURE, psi		1.1	0.2	0.0	-0.7
STRAIN RATE, %/min.		1.500	1.500	1.500	1.500
ULTIMATE STRESS, psi					
PORE PRESSURE, psi					
$\bar{\sigma}_1$ FAILURE, psi		74.7	32.3	20.2	37.9
$\bar{\sigma}_3$ FAILURE, psi		18.9	9.8	5	5.7

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: ALUM MUD

LL= 65 PL= 59 PI= 6.0
SPECIFIC GRAVITY= 2.65
REMARKS:

CLIENT:

PROJECT: WASHINGTON COUNTY LANDFILL

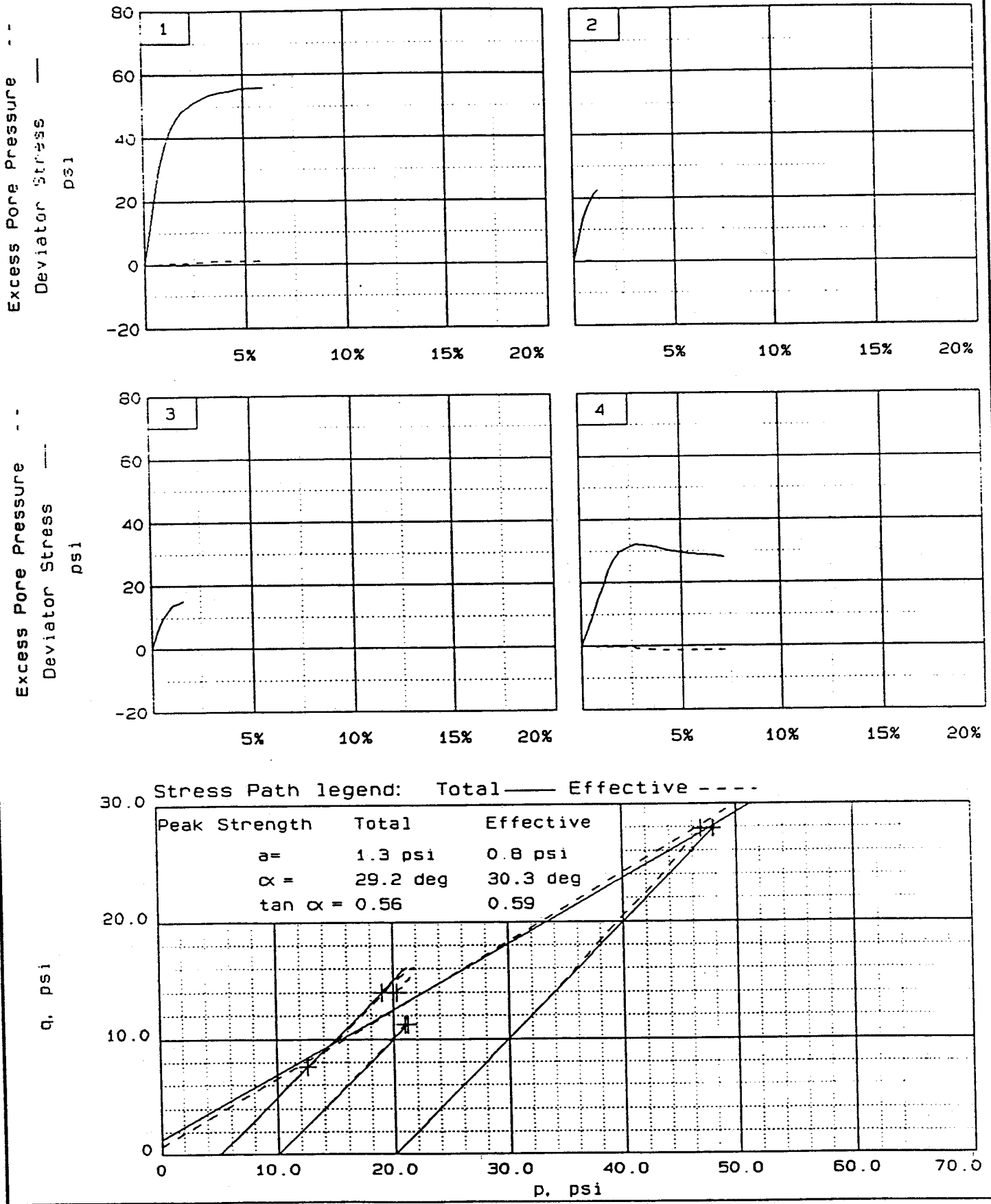
SAMPLE LOCATION: BAG 1 - UNSATURATED

PROJ. NO.: J-6356 DATE: 2/14/91

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING

FIG. NO. 2



Client:

Project: WASHINGTON COUNTY LANDFILL

Location: BAG 1 - UNSATURATED

File: 6356DRY Project No.: J-6356 Page 2/2 Fig. No. 2

** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	2/21/91
Time of Run:	9:30
Run By:	FSM
Input Data Filename:	A:GARBAGE1.IN
Output Filename:	A:GARBAGE1.OUT

PROBLEM DESCRIPTION WASHINGTON CO. LANDFILL

BOUNDARY COORDINATES

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	20.00	50.00	20.00	3
2	50.00	20.00	95.00	35.00	2
3	95.00	35.00	110.00	35.00	2
4	110.00	35.00	132.00	43.00	1
5	132.00	43.00	180.00	43.00	1
6	110.00	35.00	125.00	20.00	2
7	50.00	20.00	125.00	20.00	3
8	125.00	20.00	140.00	5.00	3
9	.00	5.00	140.00	5.00	4
10	140.00	5.00	180.00	5.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	100.0	10.0	.00	.0	1
2	56.0	56.0	100.0	28.5	.00	.0	2
3	120.0	120.0	.0	32.0	.00	.0	3
4	100.0	100.0	.0	28.0	.00	.0	4

9	112.53	24.66
10	122.20	27.55
11	131.83	30.93
12	140.84	34.79
13	149.85	39.13
14	156.91	43.00

Circle Center At X = 61.9 ; Y = 210.1 and Radius, 192.3

*** 2.589 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.33	20.00
2	43.22	18.46
3	53.18	17.57
4	63.17	17.32
5	73.16	17.71
6	83.11	19.75
7	92.97	20.42
8	102.70	22.73
9	112.26	25.66
10	121.61	29.19
11	130.72	33.33
12	139.54	38.04
13	147.53	43.00

Circle Center At X = 62.1 ; Y = 172.4 and Radius, 155.1

*** 2.687 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.44	20.00
2	54.34	18.53
3	64.29	17.56
4	74.28	17.07
5	84.28	17.08
6	94.27	17.58
7	104.22	18.58
8	114.11	20.06
9	123.91	22.02
10	133.61	24.47
11	143.17	27.39
12	152.58	30.78
13	161.81	34.63
14	170.84	38.93
15	178.39	43.00

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	15.00
2	180.00	15.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 50.00 ft.

Each Surface Terminates Between X = 95.00 ft.
and X = 180.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

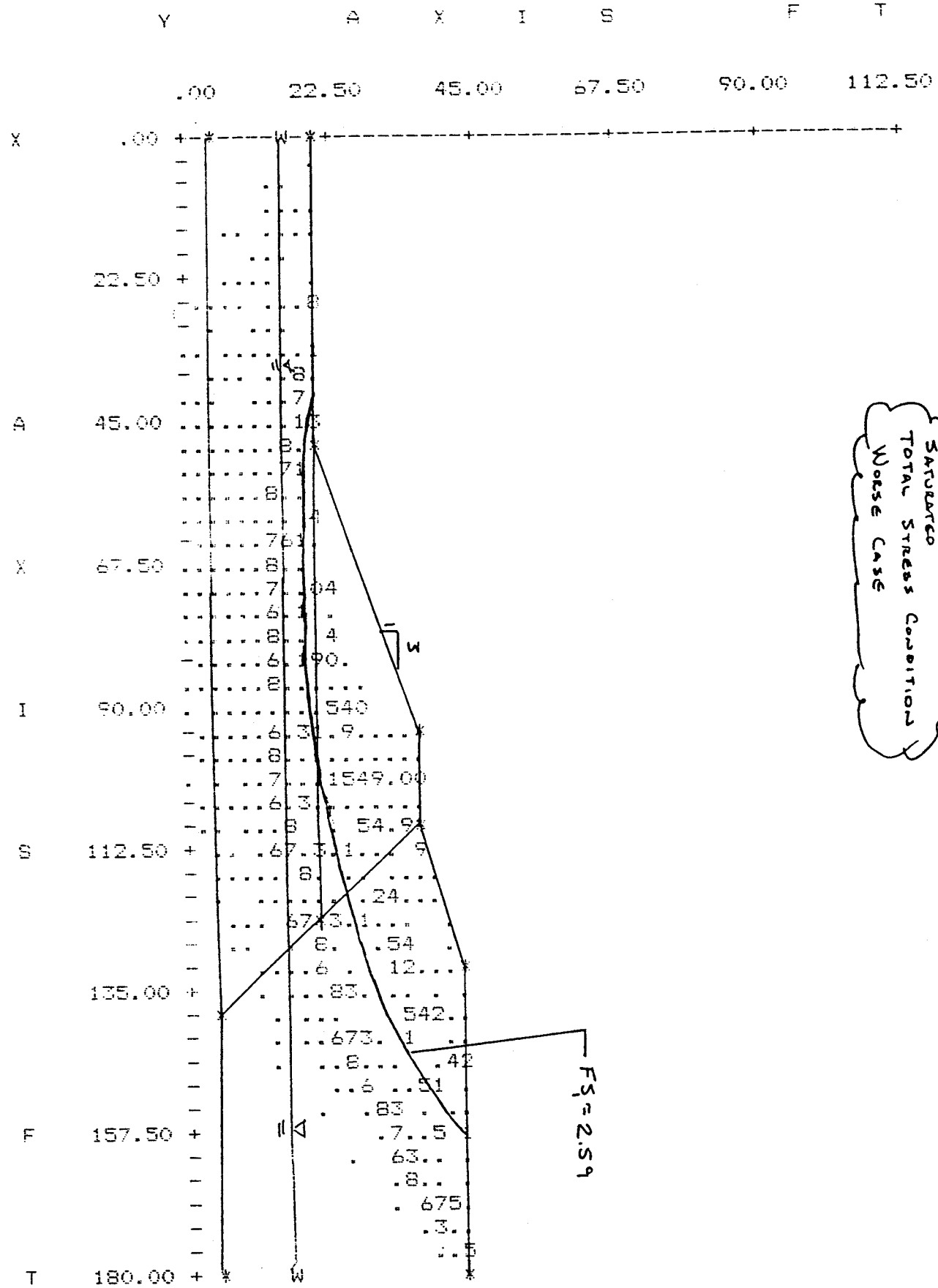
1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method *

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.33	20.00
2	43.26	18.77
3	53.23	18.06
4	63.23	17.86
5	73.23	18.19
6	83.19	19.04



SATURATED
TOTAL STRESS CONDITION
WORSE CASE

** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	2/21/91
Time of Run:	9:45
Run By:	FSM
Input Data Filename:	A:GARBAGE2.IN
Output Filename:	A:GARBAGE2.OUT

PROBLEM DESCRIPTION WASHINGTON CO. LANDFILL

BOUNDARY COORDINATES

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	20.00	65.00	20.00	3
2	65.00	20.00	95.00	35.00	2
3	95.00	35.00	110.00	35.00	2
4	110.00	35.00	132.00	43.00	1
5	132.00	43.00	180.00	43.00	1
6	110.00	35.00	125.00	20.00	2
7	50.00	20.00	125.00	20.00	3
8	125.00	20.00	140.00	5.00	3
9	.00	5.00	140.00	5.00	4
10	140.00	5.00	180.00	5.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	100.0	10.0	.00	.0	1
2	56.0	56.0	100.0	28.5	.00	.0	2
3	120.0	120.0	.0	32.0	.00	.0	3
4	100.0	100.0	.0	28.0	.00	.0	4

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	15.00
2	180.00	15.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 65.00 ft.

Each Surface Terminates Between X = 95.00 ft.
and X = 180.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.00	20.00
2	74.85	18.25
3	84.80	17.31
4	94.80	17.18
5	104.78	17.88
6	114.66	19.40
7	[illegible]	[illegible]

9	143.11	28.71
10	151.98	33.32
11	160.44	38.65
12	166.23	43.00

Circle Center At X = 91.3 ; Y = 139.0 and Radius, 121.9

*** 2.315 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	57.78	20.00
2	67.67	18.53
3	77.63	17.65
4	87.63	17.35
5	97.62	17.63
6	107.58	18.50
7	117.48	19.95
8	127.27	21.97
9	136.93	24.56
10	146.42	27.71
11	155.71	31.41
12	164.77	35.65
13	173.57	40.41
14	177.75	43.00

Circle Center At X = 87.8 ; Y = 188.4 and Radius, 171.1

*** 2.391 ***

1

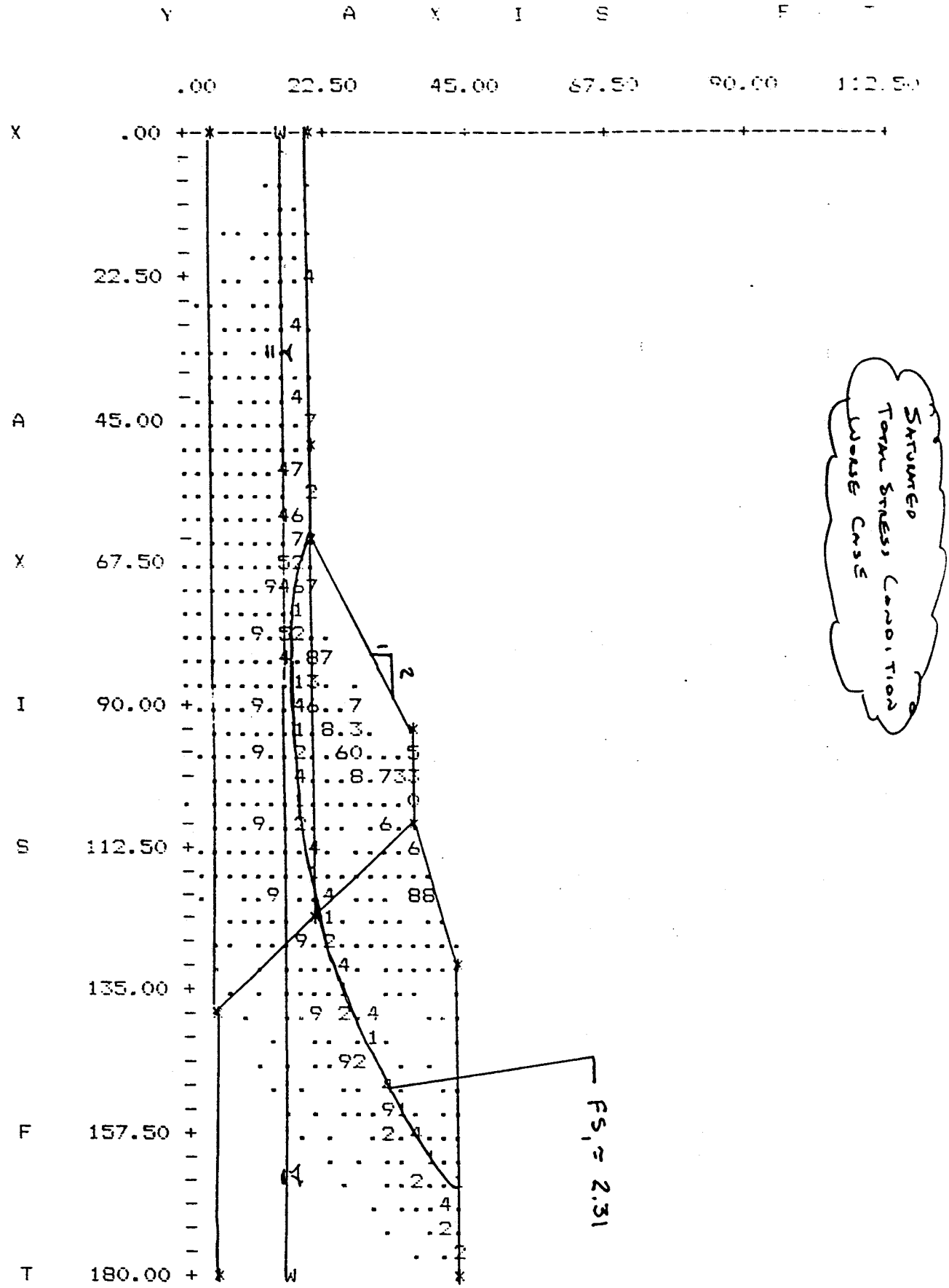
Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	57.78	20.00
2	67.50	17.64
3	77.49	18.02
4	87.01	21.08
5	95.34	26.62
6	101.85	34.21
7	102.22	35.00

Circle Center At X = 71.2 ; Y = 54.0 and Radius, 36.5

*** 2.468 ***

Failure Surface Specified By 17 Coordinate Points



Saturated
Total Stress Condition
Worse Case

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

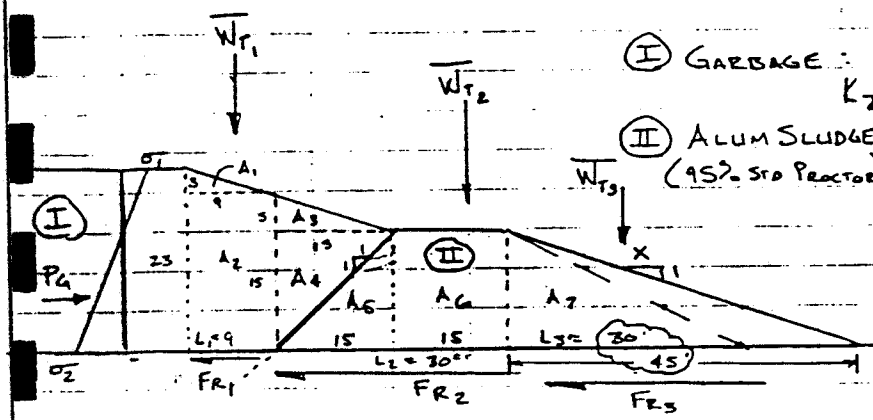
JOB NO. J6356 SHEET 1 OF 2

JOB NAME WASHINGTON Co LANDFILL

SUBJECT SLIDING WEDGE ANALYSIS

BY DEM DATE 2/25/91

CHECKED BY _____ DATE _____



(I) GARBAGE: $\phi_G = 10°$; $C_G = 100$ PSF; 75 PCF $= \gamma_G$

$K_{a_G} = \tan^2(45 - \phi/2) = 0.704$

(II) ALUM SLUDGE: $\phi_T = 28.5°$; $C_T = 100$ PSF; 56 PCF $= \gamma_{AS}$

(95% STD PROCTOR) $\phi' = 31.3°$; $C' = 100$ PSF; 56 PCF $= \gamma_{AS}$

$A_1 = 3(9)/2 = 13.5\ FT^2$; $W_{T_1} = A_1 \gamma_G = (13.5)(75) = 1012\ lb/FT \downarrow$

$A_2 = 9(15) = 135\ FT^2$; $W_{T_2} = A_2 \gamma_G = (135)(75) = 10{,}125\ lb/FT \downarrow$

$A_3 = 5(15)/2 = 37.5\ FT^2$; $W_{T_3} = A_3 \gamma_G = (37.5)(75) = 2{,}812\ lb/FT \downarrow$

$A_4 = 15(15)/2 = 112.5\ FT^2$; $W_{T_4} = A_4 \gamma_G = (112.5)(75) = 8{,}437\ lb/FT \downarrow$

$A_5 = 15(15)/2 = 112.5\ FT^2$; $W_{T_5} = A_5 \gamma_{AS} = (112.5)(56) = 6{,}300\ lb/FT \downarrow$

$A_6 = 15(15) = 225\ FT^2$; $W_{T_6} = A_6 \gamma_{AS} = (225)(56) = 12{,}600\ lb/FT \downarrow$

$A_7 = (x(15))\,15/2 = 112.5x\ FT^2$; $W_{T_7} = A_7 \gamma_{AS} = (112.5x)(56) = 6300x\ lb/FT \downarrow$

$F_{R_1} = W_{T_1} \tan\phi_G + C_G L_1 = (W_{T_1} + W_{T_2}) \tan 10° + (100)(9) = (1012 + 10{,}125) \tan 10° + 900 = 2864\ lb/FT \leftarrow$

$F_{R_2} = W_{T_2} \tan\phi + C L_2 = (\overset{2812}{W_{T_3}} + \overset{8437}{W_{T_4}} + \overset{6300}{W_{T_5}} + \overset{12{,}600}{W_{T_6}}) \tan\phi + 100(30) = [30{,}149 \tan\phi + 3000]\ lb/FT \leftarrow$

$F_{R_3} = W_{T_3} \tan\phi + C L_3 = \overset{6300x}{W_{T_7}} \tan\phi + 100((x)15) = (6300x) \tan\phi + 1500x \leftarrow$

$F_R = F_{R_1} + F_{R_2} + F_{R_3} = 2864 + 30{,}149 \tan\phi + 3000 + (6300x) \tan\phi + 1500x \leftarrow$

$F_R = 1500x + (30{,}149 + 6300x) \tan\phi + 5864\ lb/FT \leftarrow$

$\sigma_1 = K_{a_G} \gamma_G Z - 2c_G \sqrt{K_{a_G}} = (0.704)(75)(0) - 2(100)\sqrt{0.704} = 52.8(0) - 168 = -168\ PSF \rightarrow$

$\sigma_2 = 52.8(23) - 168 = 1047\ PSF \rightarrow$

$P_G = (\sigma_1 + \sigma_2)\,23/2 = (-168 + 1047)\,23/2 = 10{,}104\ lb/FT \rightarrow$

LAW ENGINEERING
GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS
3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

JOB NO. J6356 SHEET 2 OF 2
JOB NAME WASHINGTON CO. LANDFILL
SUBJECT SLIDING WEDGE ANALYSIS
BY DEM DATE 2/25/91
CHECKED BY _____ DATE _____

$$FS_{SLIDING} \approx \frac{F_R}{P_G} \approx \frac{1500x + (30{,}149 + 6300x)\tan\phi + 5864}{10{,}104} \approx FS$$

2(H) : 1(V) ⇒ x = 2

$$FS_{2:1} \approx \frac{3000 + (42{,}749)\tan\phi + 5864}{10{,}104} \approx \frac{42{,}749\tan\phi + 8864}{10{,}104}$$

3(H) : 1(V) ⇒ x = 3

$$FS_{3:1} \approx \frac{4500 + (49{,}049)\tan\phi + 5864}{10{,}104} \approx \frac{49{,}049\tan\phi + 10{,}364}{10{,}104}$$

TYPE OF ANALYSIS	FACTOR OF SAFETY (SLIDING)	
	$FS_{2:1}$	$FS_{3:1}$
TOTAL $\phi_T = 28.5°$	3.17	3.66
EFFECTIVE $\phi' = 31.3°$	3.45	3.98

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

March 5, 1991

Diehl & Phillips
219 East Chatham Street
Cary, North Carolina 27511

Attention: Mr. Alen Keith

SUBJECT: REPORT OF GEOTECHNICAL SERVICES
AND LABORATORY TESTING - WASHINGTON COUNTY LANDFILL
WASHINGTON COUNTY LANDFILL DIKE & COVER MATERIAL
PLYMOUTH, NORTH CAROLINA
LAW ENGINEERING JOB NO. J47291-6356

Dear Mr. Keith:

Based on our telephone conversations of March 1,1991 regarding the potential volume change of the material placed for the dike and the permeability of the saturated and unsaturated permeabilities of the material at optimum moisture content in our report dated February 27, 1991. We have the following clarifications and recommendations.

To minimize potential shrinkage of the material placed in the dike, the material should be placed below the optimum moisture content (i.e., 58%±) and closer to the shrinkage limit (47%±). This may require additional compaction effort in order to achieve 95% of the standard maximum dry density.

The unsaturated permeability of the material to be used as a cover was approximately $2x10^{-5}$ cm/sec at 95% of the standard Proctor maximum dry density at an optimum moisture content of approximately 59%±. However as the material becomes saturated with time, it will become less permeable as shown by our laboratory testing. The permeability of the cover material noted on Page 3 of our report notes the moderately impervious nature of the material as $K=2x10^{-5}$ cm/sec. However, in its saturated state the material yields a permeability coefficient of $K=2x10^{-6}$ cm/sec.

3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

We are available to discuss our recommendations with you and to provide additional studies or services necessary to complete the project. We have enjoyed assisting you and look forward to serving as your consultant on the remainder of this project and on future projects.

Very truly yours,

LAW ENGINEERING

David E. Miller, P.E.
Geotechnical Project Engineer

Barney C. Hale, P.E.
Senior Geotechnical Engineer

DEM/BCH/pap

Washington County Commissioners Resolution to Provide
Construction & Demolition Waste Landfill
and
County Statement Regarding Zoning

and

Land Clearing and Inert Debris Landfill Notification

WASHINGTON COUNTY

PLYMOUTH, NORTH CAROLINA

P.O. BOX 1007
27962

July 1, 1994

To Whom It May Concern:

Washington County does not have in effect a Zoning Ordinance; therefore, the only document needed to comply with is the Land Use Plan. Upon review there are no inconsistencies with the Land Use Plan or any other plans in Washington County as to the Construction and Demolition Landfill Site.

Please contact this office with any questions as to this project.

Sincerely,

Lee Smith
County Manager

WATER SAFETY RESOLUTION: The County Manager reviewed a resolution requesting a no wake zone on Conaby Creek and reviewed the NC Wildlife Resources Commission Procedures for establishing local water safety regulations.

Commissioner Waters made a motion to approve the Resolution Establishing "No Wake" zones on Conaby Creek. Commissioner Lamb seconded, motion carried unanimously.

MANAGER'S REPORT: The Manager informed the Board that a Hurricane seminar will be held on July 20, 1994 at the Vernon James Research Center.

Water System Phase II - The Manager informed the Board that he has called Raleigh regarding the application and he is still waiting to hear from them.

Water System Phase III - The Manager informed the Board that the Preliminary has been forwarded to Marvin Howell, Farmers Home Administration.

Creswell Produce Packing Plant - The Board discussed the progress of the Creswell Produce Packing Plant.

LANDFILL CLOSURE: The Manager asked that the Board rescind the motion of June 27 which rejected the bids for landfill closure which would allow him to be able to negotiate with the lowest bidder. He stated that the estimates given to him were approximately $108,000 short and have discussed an interfund load with the Finance Officer. Ms. Critcher, Finance Officer, stated that as the cash becomes short, the County could have an interfund loan, which can be paid back over the next upcoming years. The Manager reminded the Board that the landfill would have to be closed by October 9 to avoid Sub Title D regulations.

Commissioner Waters made a motion to rescind the motion from the last meeting (rejecting the bids for landfill closure) and to allow the Manager to negotiate with the lowest bidder for the closure and capping of the landfill. Commissioner Davenport seconded, motion carried unanimously.

CONSTRUCTION AND DEMOLITION LANDFILL SITE: The Manager reminded the Board that the C&D site has to be formally approved by the Board.

Commissioner Lamb made a motion to approve the Construction and Demolition site as proposed by Diehl and Phillips. Commissioner Davenport seconded, motion carried unanimously.

RECESS

WASHINGTON COUNTY FIRE COMMISSION ORDINANCE: The County Manager briefed the Board on the need for a Fire Commission Ordinance and briefed the Board on the proposed ordinance stating that this ordinance would establish a fire commission which would be the liaison between the Board and fire departments. Discussion ensued.

Commissioner Lamb made a motion to approve the Washington County Fire Commission Ordinance as presented. Commissioner Waters seconded, motion carried unanimously.

HEALTH DEPARTMENT: Commissioner Davenport briefed the Board on a complaint from a resident in the Creswell area who had requested that a representative from the Health Department inspect their property. They were told it would be two weeks and now have been postponed another week. Commissioner Waters stated that the district now has three Sanitarians. The Board discussed alternate septic systems, management entity, etc. Commissioner Waters also informed the Board that the Albemarle Commission is planning to put some money into Tyrrell County for administrative fees, engineering, etc.

EXECUTIVE SESSION: Commissioner Davenport made a motion to go into executive session to discuss personnel, property disposition, and litigation. Commissioner Lamb seconded, motion carried unanimously.

Commissioner Waters made a motion to come out of executive session, Commissioner Lamb seconded, motion carried unanimously.

I, Lois C. Askew, Clerk of the Board of Commissioners of Washington County, North Carolina do hereby certify that the foregoing is a true copy of the minutes of the Washington County Board of Commissioners, at a meeting held on July 5, 1994.

Witness my hand and the corporate seal of the said County, this the 12 day of July 1994.

Lois C. Askew
Lois C. Askew, Clerk
Washington County Board of
Commissioners

BOARD OF COMMISSIONERS
WASHINGTON COUNTY, NC

State of North Carolina
Department of Environment, Health, and Natural Resources

512 North Salisbury Street • Raleigh, North Carolina 27604

James B. Hunt, Jr., Governor

Division of Solid Waste Management
Solid Waste Section
Telephone (919) 733-4996

Jonathan B. Howes, Secretary

LAND CLEARING AND INERT DEBRIS LANDFILL NOTIFICATION

Pursuant to 15A NCAC 13B .0563(2)(a), the land owner(s) and operator(s) of any Land Clearing and Inert Debris Landfill under two (2) acres in size shall submit this notification form to the Division prior to constructing or operating the landfill. This form must be filed for recordation in the Register of Deeds' Office. The Register of Deeds shall index the notification under the name of the owner(s) of the land in the county or counties in which the land is located. The Register's seal and the date, book, and page number of recording must be included on this form when submitted to the Division. **This notification is not valid to authorize operation of a landfill unless complete, accurate, and recorded as required by 15A NCAC 13B .0563(2)(b).**

1. Facility Name: Washington County Landfill
2. Facility location (street address): Landfill Road
   City: Roper County: Washington Zip: 27970
3. The land on which this landfill is located is described in the deed recorded in:
   deed book: 322, 324 page: 585,587,793 county: Washington
4. Name of land owner: Washington County
5. Mailing address of land owner: Post Office Box 1007
   City: Plymouth State: N.C. Zip: 27962
6. Telephone number of land owner: (919) 793-5823
   If the land is owned by more than one person, attach additional sheets with the name, address, and phone number of all additional land owners.
7. Name of operator: Washington County
8. Trade or business name of operator: Washington County
9. Mailing address of operator: PO Box 1007
   City: Plymouth State: N.C. Zip: 27962
10. Telephone number of operator: (919) 793-5823
    If the landfill is operated by more than one person, attach additional sheets with the name, address, and phone number of all additional operators.
11. Projected use of land after completion of landfill operations: LCI&D and Borrow material...

The following are the applicability, siting, and operating criteria for Land Clearing and Inert Debris Landfills operating under notification.

.0101 DEFINITIONS

(72) "Land clearing waste" means solid waste which is generated solely from land clearing activities such as stumps, trees, limbs, brush, grass, and other naturally occurring vegetative material.

(73) "Land clearing and inert debris landfill" means a facility for the land disposal of land clearing waste, concrete, brick, concrete block, uncontaminated soil, gravel and rock, untreated and unpainted wood, and yard trash.

(74) "Yard trash" means solid waste resulting from landscaping and yard maintenance such as brush, grass, tree limbs, and similar vegetative materials.

.0563 APPLICABILITY REQUIREMENTS FOR LAND CLEARING AND INERT DEBRIS (LCID) LANDFILLS

Management of land clearing and inert debris shall be in accordance with the State hierarchy for managing solid waste as provided for under N.C.G.S. § 130A-309.04(a). Disposal in a landfill is considered to be the least desirable method of managing land clearing and inert debris. Where landfilling is necessary, the requirements of this Rule apply.

(1) An individual permit from the Division of Solid Waste Management is not required for Land Clearing and Inert Debris (LCID) landfills that meet all of the following conditions:

- (a) The facility is to be operated for the disposal of land clearing waste, inert debris, untreated wood, and yard trash. Operations must be consistent and in compliance with the local government solid waste management plan as approved by the Division of Solid Waste Management.
- (b) The total disposal area is under two acres in size.
- (c) The facility and practices comply with the siting criteria under Rule .0564, and operational requirements under Rule .0566.
- (d) The fill activity is not exempt from, and must comply with all other Federal, State, or Local laws, ordinances, Rules, regulations, or orders, including but not limited to zoning restrictions, flood plain restrictions, wetland restrictions, sedimentation and erosion control requirements, and mining regulations.

(2) Where an individual permit is not required, the following applies:

- (a) The owner of the land where the landfill is located must notify the Division on a prescribed form, duly signed, notarized, and recorded as per Rule .0563(2)(b). The operator of the landfill, if different from the land owner, shall also sign the notification form.
- (b) The owner must file the prescribed notification form for recordation in the Register of Deeds' Office. The Register of Deeds shall index the notification in the grantor index under the name of the owner of the land in the county or counties in which the land is located. A copy of the recorded notification, affixed with the Register's seal and the date, book and page number of recording shall be sent to the Division of Solid Waste Management.
- (c) When the land on which the Land Clearing and Inert Debris Landfill is sold, leased, conveyed, or transferred in any manner, the deed or other instrument of transfer shall contain in the description section in no smaller type than that used in the body of the deed or instrument a statement that the property has been used as a Land Clearing and Inert Debris Landfill and a reference by book and page to the recordation of the notification.

.0564 SITING CRITERIA FOR LAND CLEARING AND INERT DEBRIS (LCID) LANDFILLS

The following siting criteria shall apply for Land Clearing and Inert Debris (LCID) landfills:

(1) Facilities or practices, shall not be located in the 100-year floodplain.

(2) Facilities or practices shall not cause or contribute to the taking of any endangered or threatened species of plants, fish, or wildlife.

(3) Facilities or practices shall not result in the destruction or adverse modification of the critical habitat of endangered or threatened species as identified in 50 CFR Part 17 which is hereby incorporated by reference including any subsequent amendments and editions. This material is available for inspection at the Department of Environment, Health, and Natural Resources, Division of Solid Waste Management, 401 Oberlin Road, Raleigh, North Carolina 27605 where copies can be obtained at no cost.

(4) Facilities or practices shall not damage or destroy an archaeological or historical site.

(5) Facilities or practices shall not cause an adverse impact on a state park, recreation or scenic area, or any other lands included in the state nature and historic preserve.

(6) Facilities shall not be located in any wetland as defined in the Clean Water Act, Section 404(b).

(7) It must be shown that adequate suitable soils are available for cover, either from on or off site.

(8) Land Clearing and Inert Debris landfills shall meet the following surface and ground water requirements:

- (a) Facilities or practices shall not cause a discharge of pollutants into waters of the state that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES), under Section 402 of the Clean Water Act, as amended.
- (b) Facilities or practices shall not cause a discharge of dredged materials or fill material into waters of the state that is in violation of the requirements under Section 404 of the Clean Water Act, as amended.
- (c) Facilities or practices shall not cause non-point source pollution of waters of the state that violates assigned water quality standards.
- (d) Waste in landfills with a disposal area greater than two acres shall be placed a minimum of four feet above the seasonal high water table, except where an alternative separation is approved by the Division.
- (e) Waste in landfills with a disposal area less than two acres shall be placed above the seasonal high water table.

(9) The facility shall meet the following minimum buffer requirements:

- (a) 50 feet from the waste boundary to all surface waters of the state as defined in G.S. 143-212.
- (b) 100 feet from the disposal area to property lines, residential dwellings, commercial or public buildings, and wells.
- (c) Buffer requirements may be adjusted as necessary to insure adequate protection of public health and the environment.

(10) The facility shall meet all requirements of any applicable zoning ordinance.

.0566 OPERATIONAL REQUIREMENTS FOR LAND CLEARING AND INERT DEBRIS (LCID) LANDFILLS

Land Clearing and Inert Debris (LCID) landfills shall meet the following operational requirements:

(1) Operational plans shall be approved and followed as specified for the facility.

(2) The facility shall only accept those solid wastes which it is permitted to receive.

(3) Solid waste shall be restricted to the smallest area feasible and compacted as densely as practical into cells.

(4) Adequate soil cover shall be applied monthly, or when the active area reaches one acre in size, whichever occurs first.
(5) 120 calendar days after completion of any phase of disposal operations, or upon revocation of a permit, the disposal area shall be covered with a minimum of one foot of suitable soil cover sloped to allow surface water runoff in a controlled manner. The Division may require further action in order to correct any condition which is or may become injurious to the public health, or a nuisance to the community.
(6) Adequate erosion control measures, structures, or devices shall be utilized to prevent silt from leaving the site and to prevent excessive on site erosion.
(7) Provisions for a ground cover sufficient to restrain erosion must be accomplished within 30 working days or 120 calendar days upon completion of any phase of landfill development.
(8) The facility shall be adequately secured by means of gates, chains, berms, fences, etc. to prevent unauthorized access except when an operator is on duty. An attendant shall be on duty at all times while the landfill is open for public use to assure compliance with operational requirements and to prevent acceptance of unauthorized wastes.
(9) Access roads shall be of all-weather construction and properly maintained.
(10) Surface water shall be diverted from the working face and shall not be impounded over waste.
(11) Solid waste shall not be disposed of in water.
(12) Open burning of solid waste is prohibited.
(13) The concentration of explosive gases generated by the facility shall not exceed:
(a) Twenty-five percent of the lower explosive limit for the gases in facility structures.
(b) The lower explosive limit for the gases at the property boundary.
(14) Leachate shall be properly managed on site through the use of current best management practices.
(15) Should the Division deem it necessary, ground water or surface water monitoring, or both, may be required as provided for under Rules .0601 and .0602 of this Subchapter.
(16) A sign shall be posted at the facility entrance showing the contact name and number in case of an emergency and the permit number. The permit number requirement is not applicable for facilities not requiring an individual permit.

Certification by Land Owner:

I certify that the information provided by me in this notification is true, accurate, and complete to the best of my knowledge. The facility siting and disposal operations of this Land Clearing & Inert Debris landfill will comply with the requirements of Sections .0563, .0564 and .0566 of 15A NCAC 13B, North Carolina Solid Waste Management Rules. The facility and operations of this landfill will also comply with all applicable Federal, State, and Local laws, rules, regulations, and ordinances. Where the operator is different from the land owner, I, the land owner, have knowledge of the operator's plans to dispose of solid waste on the land and I specifically grant permission for the operation of the landfill. I understand that both the land owner and operator are jointly and severally liable for improper operations and proper closure of the landfill as provided for by North Carolina General Statute 130A-309.27. I further understand that North Carolina General Statute 130A-22 provides for administrative penalties of up to five thousand dollars ($5,000.00) per day per each violation of the Solid Waste Management Rules. I further understand that the Solid Waste Management Rules may be revised or amended in the future and that the facility siting and operations of this landfill will be required to comply with all such revisions or amendments.

Lee Smith, County Manager — Print Name (Owner)
[signature] — Signature (Owner)
08/05/93 — Date

North Carolina

Washington County

I, Elaine G. Davis, a Notary Public for said County and State, do hereby certify that Lee Smith, County Manager personally appeared before me this day and acknowledged the due execution of the foregoing instrument.

Witness my hand and official seal, this the 5 day of August, 1993.

(Official Seal) ELAINE G. DAVIS NOTARY PUBLIC WASHINGTON COUNTY, NC

Elaine G. Davis
Notary Public

My commission expires 8-13, 1994.

STATE OF NORTH CAROLINA, COUNTY OF WASHINGTON
The foregoing or annexed certificate (s) of Elaine G Davis

is (are) certified to be correct. This instrument was presented for registration and recorded in this office in Book 341, Page 174.
This 5 day of August, 1993 at 3:24 o'clock P.M.

Greta H. Barber
Register of Deeds

By: Asst.

PRELIMINARY ENDANGERED SPECIES AND WETLANDS SURVEY

WASHINGTON COUNTY LANDFILL,
NORTH CAROLINA

May, 1994

Prepared by Jamie Shern, Forest Ecologist

S&EC

Soil & Environmental Consultants, Inc.

244 West Millbrook Road ■ Raleigh, North Carolina 27609 ■ (919) 846-5900 ■ Fax (919) 846-9467

ENDANGERED SPECIES

The US Fish and Wildlife Service lists four federally endangered or threatened species occurring in Washington County. See Appendix A for listing. This survey for endangered species focused primarily on the bald eagle (*Haliaeetus leucocephalus)* as the other current federally protected species listed are sea turtles which do not have potential habitat on or adjacent to the site.

BALD EAGLE, *HALIAEETUS LEUCOCEPHALUS*

Bald eagles are federally listed endangered in the southeastern U.S.

Bald eagles are large and dark in the body, 32-43" (81-109 cm) long, with a white head, white tail, and yellow bill. The wingspread is about 7 feet (2.1 m). Young birds lack the white head and tail, and have a dark bill and pale markings on the belly, tail, and under the wings. The lower section of the leg has no feathers. Nests are cone-shaped, 6-8 feet (1.8-2.4 m) from top to bottom, and 6 feet (1.8 m) or more in diameter.

Bald eagles in the Southeast frequently build their nests in the transition zone between forest and marsh or open water. Nests are typically constructed in dominant live pines or cypress trees that provide a good view and clear flight path, usually less than ½ mile from open water. The nearest large bodies of water to the site is the Albemarle Sound 0.7 mile away. Winter roosts are usually in dominant trees, similar to nesting trees, but may be somewhat farther from water. Non-nesting eagles are most abundant in the northern coastal plain and along the Pee Dee-Yadkin River system, where they occur throughout the year (Henson 1990, US Fish and Wildlife Service 1992). There are some tall trees surrounding the perimeter of the property. No trees on the property would be suitable for roosting or nesting (see Photo 1), nor were any eagles sighted on or immediately adjacent to the site. The nearest recorded sighting of a bald eagle (NHP, Westover quadrangle) is 1.25 miles west northwest of the property, near Conaby Creek (Figure 1).

WETLANDS

The presence of jurisdictional wetlands on-site was based on the three parameter approach; hydric soils, hydrophytic vegetation, and wetland hydrology , as described in the U. S. Army Corps of Engineers 1987 Wetland Deliniation Manual.

SOILS

Hydric soil series of the site include Muckalee and Roanoke. Nonhydric soil series of the site include: Conetoe and Augusta. Some of the site has been extensively impacted by it's past use for borrow material which has compacted the soil and removed the surface horizons.

VEGETATION

Most vegetation on the area was cleared within the past twenty years. Much of the site has naturally regenerated to a dense young pine stand. Vegetation in the natural wetland areas around the perimeter of the site include; swamp tupelo (*Nyssa biflora),* red maple (*Acer rubrum*), inkberry (*Ilex glabra*), laurel-leaf briar (*Smilax lauriflora*), and cinnamon fern (*Osmunda cinnamomea*).

HYDROLOGY

Natural drainage has been restricted by the erection of soil berms and roadbeds. The result is shallow ponded water in some areas(see Photo 2). Mallard ducks (*Anas platyrhynchos*), a great blue heron (*Ardea herodias*), and an unidentified wading bird were observed foraging in one such area. The margins of some of these old excavated and compacted borrow areas have "naturalized" with wetland vegetation (*Typha latifolia, Juncus effusus* and others) present. Naturally occurring wetland areas on site are located around the perimeter of the property. Wetlands encroach in peripheral drainageways. Some areas of the site were not surveyed due to prohibitively thick vegetation. Approximate wetland locations are shown on Figure 2.

CONCLUSIONS

ENDANGERED SPECIES

No currently listed or proposed federally protected species are likely to occur on the proposed construction/demolition landfill site in Washington County, North Carolina.

WETLANDS

The majority of the property proposed to be utilized for a construction/demolition landfill does not appear to be jurisdictional wetland. A forthcoming site meeting with the Corps of Engineers is expected to confirm our delineation. Nationwide permits may be sufficient to permit the proposed utilization of the site if impacts to adjacent wetlands to the south and west, and other wetland areas on the site, are minimized and/or avoided. Review of a final site plan will be necessary to determine which, if any, permits will be required.

References

Henson, T.H. 1990. Bald eagle. In: Lee, D.S. and J.F. Parnell (eds.). Endangered, Threatened and Rare Fauna of North Carolina, Part III. A Re-evaluation of the Birds. Occasional Papers of the North Carolina Biological Survey. North Carolina Museum of Natural Sciences, Raleigh, NC.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1964. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill, NC.

U.S. Fish and Wildlife Service. 1992. Endangered and Threatened Species of the Southeastern United States (The Red Book). Prepared by Ecological Services, Division of Endangered Species, Southeast Region. Government Printing Office, Washington, DC.

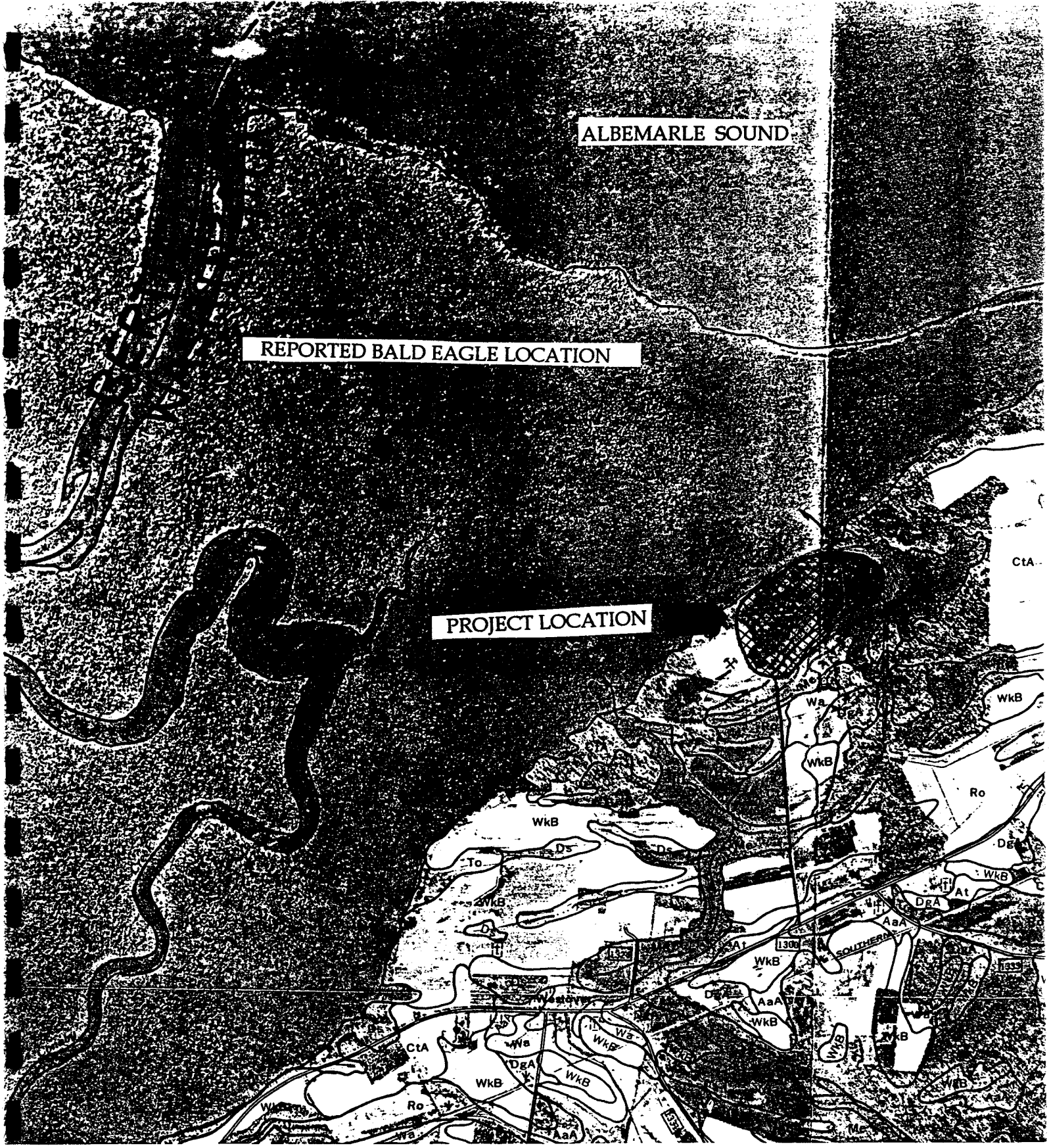


Figure 1 -- Project Site and Nearest Bald Eagle Location Map of the Washington County Landfill Expansion Area

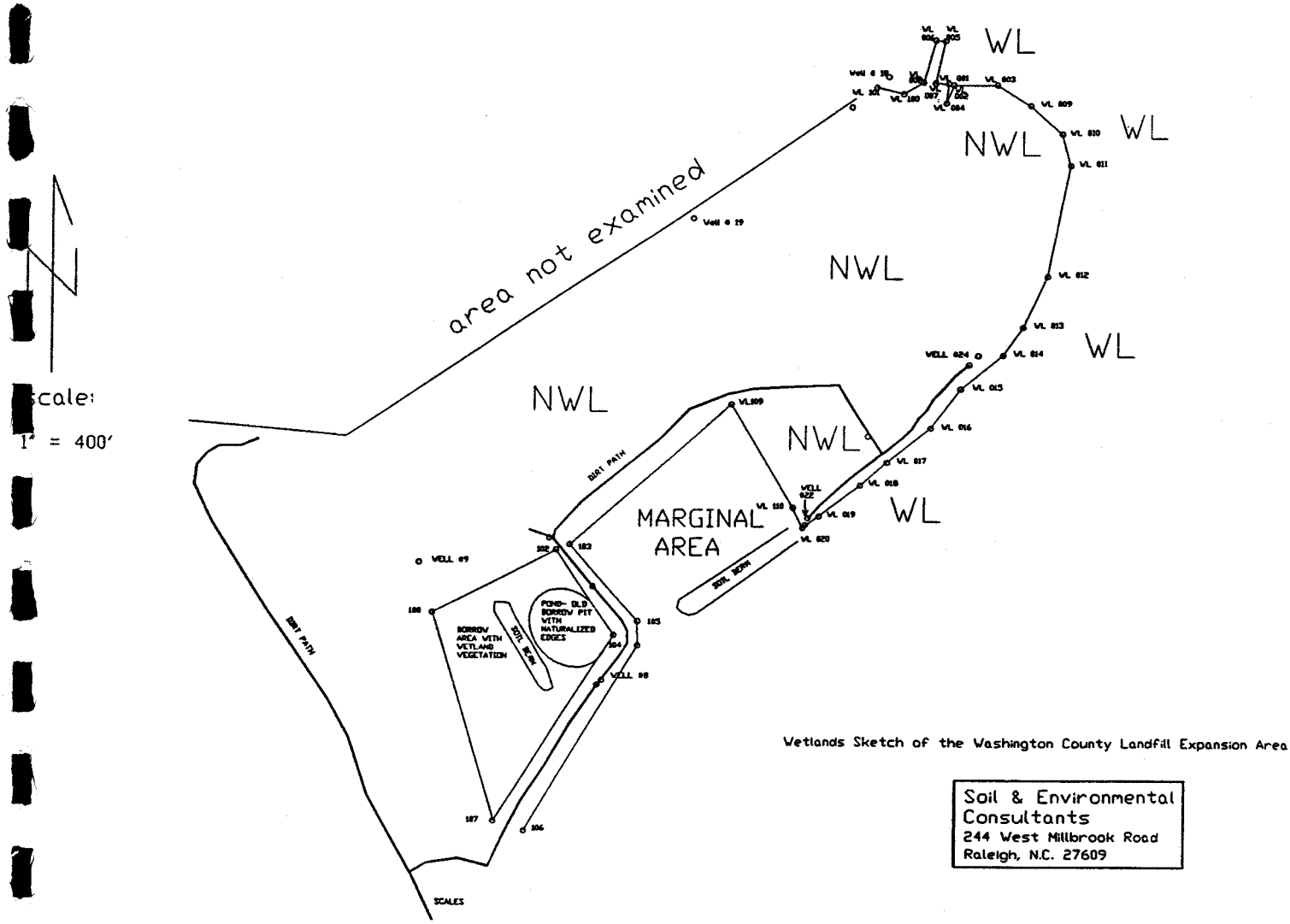


Figure 2 – Wetlands Sketch Map of the Washington County Landfill Expansion Area

Appendix A– Federally Listed Protected Species in Washington County, NC

REVISED APRIL 13, 1992

Washington County

Bald eagle (Haliaeetus leucocephalus) - E
Kemp's Ridley sea turtle (Lepidochelys kempi) - E
Loggerhead sea turtle (Caretta caretta) - T
Green sea turtle (Chelonia mydas) - T

Sea turtles when "in the water" and the shortnose sturgeon are under the jurisdiction of the National Marine Fisheries Service and should be contacted concerning your agency's responsibilities under Section 7 of the Endangered Species Act. Their address is:

National Marine Fisheries Service
U.S. Department of Commerce
9450 Koger Boulevard
Duval Building
St. Petersburg, Florida 33702

There are species which, although not now listed or officially proposed for listing as endangered or threatened, are under status review by the Service. These "Candidate"(C1 and C2) species are not legally protected under the Act, and are not subject to any of its provisions, including Section 7, until they are formally proposed or listed as threatened or endangered. We are providing the below list of candidate species which may occur within the project area for the purpose of giving you advance notification. These species may be listed in the future, at which time they will be protected under the Act. In the meantime, we would appreciate anything you might do for them.

Waccamaw killifish (Fundulus waccamensis) - C2
Green floater (Lasmigona subviridis) - C2

Site Photographs

(1) Typical Young Pine and Mixed Pine - Hardwood Stands

(2) Naturalized Borrow Area

An Archæological Survey of the Proposed Washington County Landfill, Westover Vicinity, Washington County, North Carolina.

Thomas Hargrove

February 1994

ER -87-7561

A Report Submitted to Diehl & Phillips, Engineers,
by
Archæological Research Consultants, Inc.,
Raleigh, North Carolina.

Contents

Management Summary 1
Introduction 2
Physical Environment 2
Prehistoric Background 3
Ethnohistoric Background 5
Archæological Research in the Project Vicinity 6
Historical Background 6
Field Methods 7
Results of the Survey 7
Standards of Significance 9
Recommendations 10
References Cited 11

List of Figures

Follows Page

Figure 1: North Carolina and the project area 2

Figure 2: Washington County and the project area 2

Figure 3: The Westover or White Marsh vicinity and the project area 2

Figure 4: The proposed landfill expansion tract, with 31WH17 2

Figure 5: The project area in 1932 7

Figure 6: Looking northward across the site and the adjoining borrow pit 8

MANAGEMENT SUMMARY

The archæological survey of the proposed Washington County landfill covered approximately 71 acres near Westover in northwestern Washington 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 much of the project area is forested, the survey relied heavily on screened shovel tests at intervals of 30 m (100 feet). In areas with exposed ground surfaces (for instance, access and logging roads), the surveyors closely examined the area for prehistoric and historic artifacts.

The survey recorded one archæological site, 31WH17, a historic site (late eighteenth - late twentieth century), which also has a minor prehistoric lithic component. Most of the former site area has apparently been destroyed during the creation of borrow pits. The survival of any intact archæological remains of the historic settlement is highly unlikely. The site does not seem eligible for nomination to the National Register of Historic Places.

We do not recommend additional archæological work on the proposed landfill expansion, as it is now designed.

INTRODUCTION

Project title: An Archæological Survey of the Proposed Washington County Landfill Expansion, Westover Vicinity, Washington County, North Carolina (ER -87-7561).

Location of the project: The proposed landfill expansion covers about 71 acres on the east side of the current landfill, which is about 1.3 miles northeast of Westover in northwestern Washington County (see Figures 1, 2, and 3).

Contracting organization: Diehl & Phillips, P.A. (for Washington County).

Principal Investigator and Field Director: Thomas H. Hargrove.

Field Crew: Patricia Samford, Sara Bon, Briece Edwards.

Dates of survey: January, 1994.

The following sections 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* and the 1992 edition of the style guide for *American Antiquity* (volume 54, number 4). 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.

PHYSICAL ENVIRONMENT

The project area is in the Lower Coastal Plain's Pamlico System, which features broad, level plains divided by sounds, estuaries, and shallow, widely spaced streams (Daniels et al. 1984:20). The terrain of the tract features a dry, low, level ridge, bordered by lower and wetter drainage areas. Elevations range from about 4.5 feet to about 12 feet above mean sea level. From a geological perspective, the area is just east of the Suffolk Scarp, falling into the Coastal Plain's Quaternary deposits of sand, gravel, clay, and peat (North Carolina Geological Survey 1985). The soil on the higher sections of the tract is Conetoe loamy fine sand, a well-drained soil found on low ridges. The soil found on lower elevations toward the Roanoke River is Dorovan muck, a frequently flooded type, with a water table at or near the ground surface. Other low areas are made up of poorly drained Muckalee loam or Augusta fine sandy loam (Tant 1981). The area is drained by small, intermittent tributaries of the Roanoke River, which is separated from the project area by about one mile of swampland. Conaby Creek is about one mile to the west. Under natural conditions, the local forests on the higher elevations would have included longleaf and loblolly pine, hickory, red maple, sweet gum, black tupelo, post oak, white oak, and red oak. Wetter areas would have included bald cypress, pond pine, swamp tupelo, water tupelo, waxmyrtle, redbay, ash, and red maple (Tant 1981).

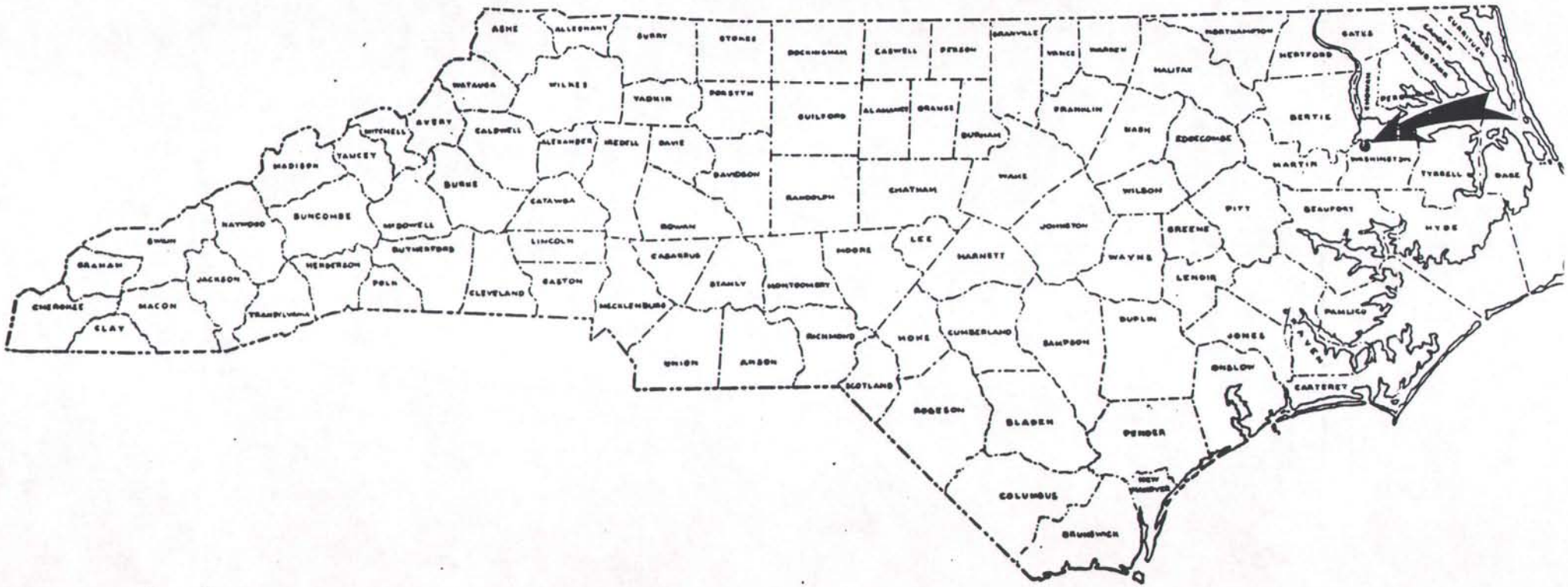


Figure 1: North Carolina and the project area (arrow).

Base map: North Carolina Division of Archives and History.

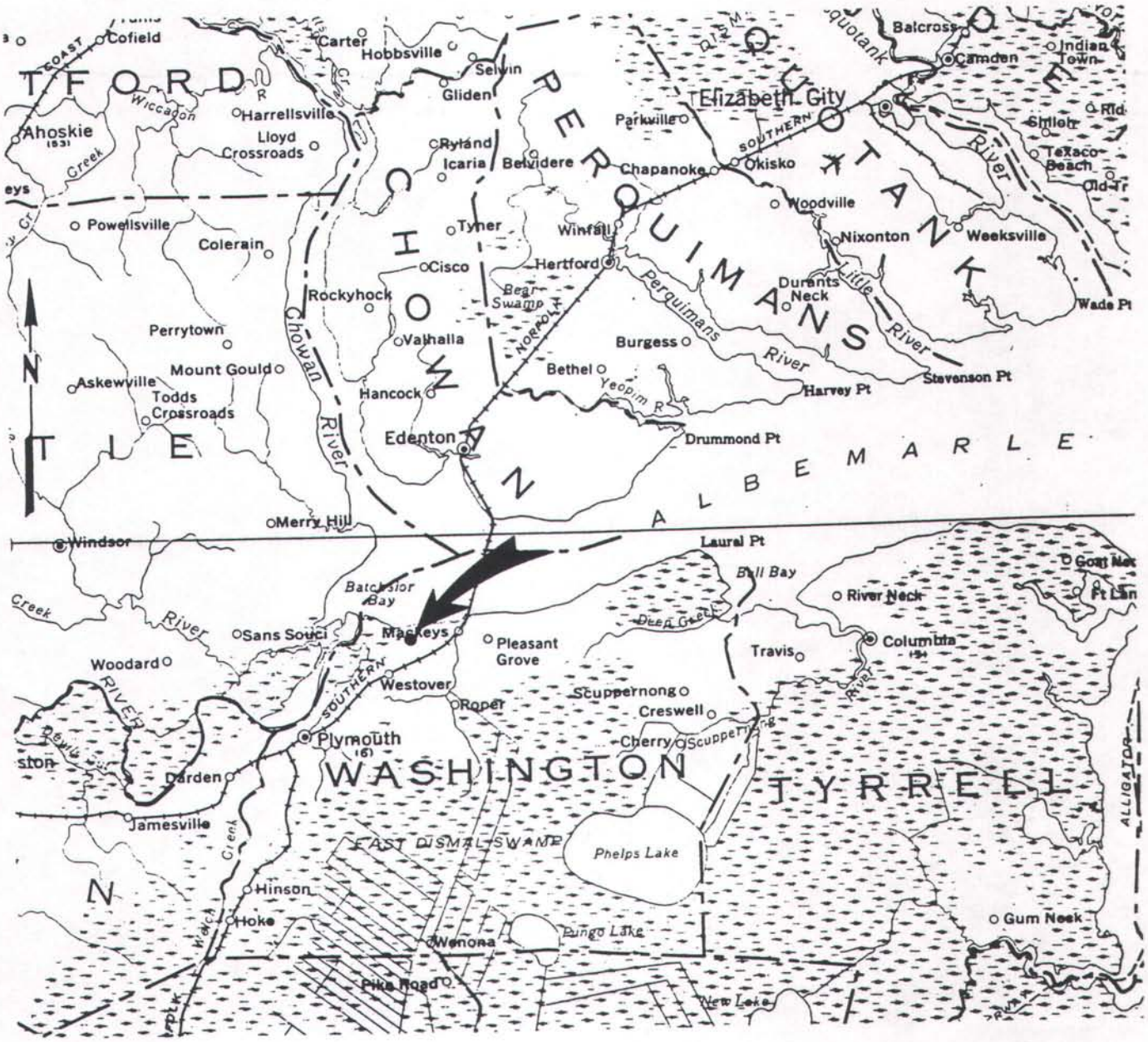


Figure 2: Washington County and the project area (arrow).

Base map: U.S.G.S. *State of North Carolina.*

Scale: one inch = eight miles

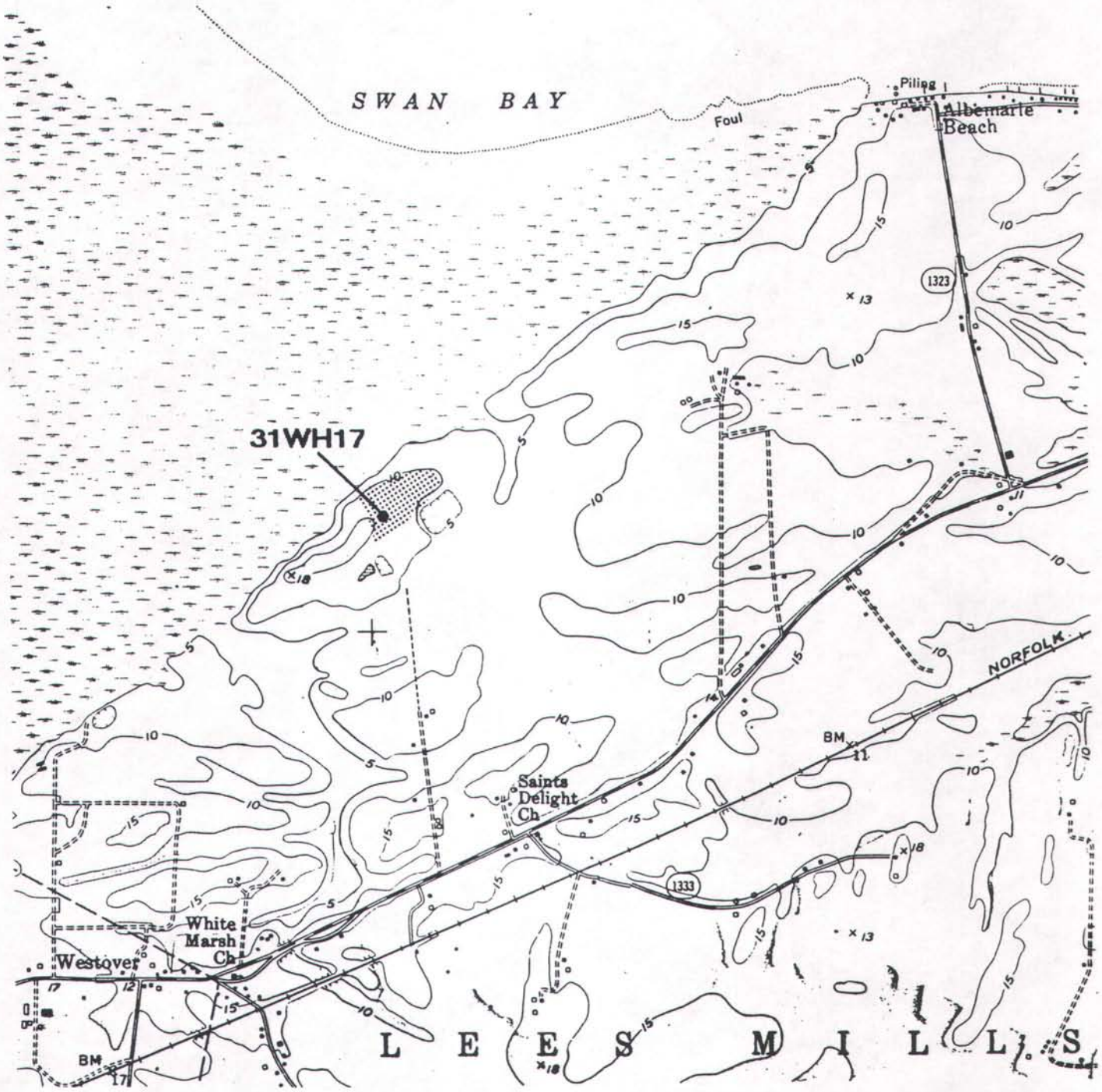


Figure 3: The Westover or White Marsh vicinity and the project area (shaded).

Base map: U.S.G.S. *Westover* quad.

SCALE 1:24 000

1 .5 0 KILOMETERS 1 2
1000 0 METERS 1000 2000
1 .5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000
FEET

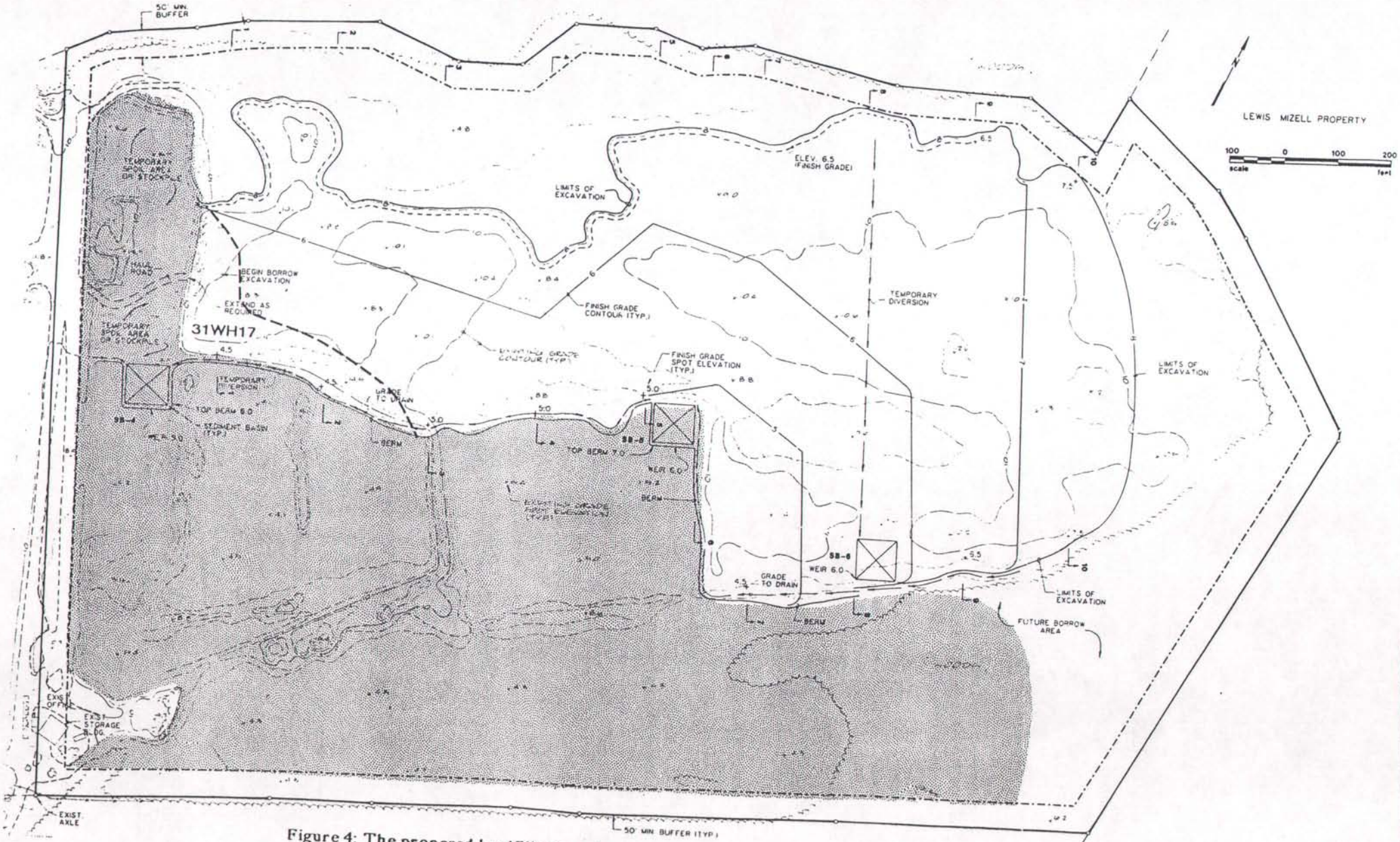


Figure 4: The proposed landfill expansion tract, with 31WH17. Present borrow pits are shaded.

Large parts of the survey tract have been severely disturbed by borrow pits (see Figure 4). Other sections of the tract were apparently logged within the last ten years and are now covered with a dense secondary growth of small trees and vines.

PREHISTORIC BACKGROUND

Sustained prehistoric research on the coast of North Carolina has been a relatively recent phenomenon. Much of the work has taken place within the last 20 years, following the establishment of academic programs in archaeology at East Carolina University and at UNC - Wilmington, as well as the establishment of cultural resource management programs on the state level. Some of this information has been synthesized by David Phelps of ECU and published by the North Carolina Division of Archives and History (Phelps 1983). The following description of the coast's prehistory comes largely from this recent synthesis. Information more specific to the western Albemarle Sound region comes from Phelps (1982).

Paleo-Indian: 12,000 - 8,000 B.C. (Phelps 1983: 18-22)

The earliest known human occupants of the North Carolina coast were the Paleo- Indians, appearing at the close of the last Ice Age and so far known only from isolated finds of their fluted projectile points. The environment of the Paleo-Indian period in eastern North Carolina was radically different from the one we see today. One major difference was in the sea level, which was much lower than the modern sea level. One estimate places the sea level during Paleo- Indian times (about 12,000 B.C.) at about 38 meters, or 125 feet, below the present water surface. Most of the now-submerged Continental Shelf was exposed land, and the ancient coastline was scores of miles east of its modern position. By the close of the Paleo-Indian period, water from the melting ice sheets had raised the sea level on the coast to about 28 meters, or 92 feet, below its present level (Blackwelder, Pilkey, and Howard 1979). Vegetation on the coastal plain, to judge from pollen studies in the Dismal Swamp and from the Bladen Lakes area, consisted of relatively open forests of jack pine and spruce (Whitehead 1973; Delcourt and Delcourt 1981). We know almost nothing about the settlement patterns, social organization, or subsistence strategies of the Paleo-Indians in North Carolina in general. The Paleo-Indians of the coast are likely to remain the most obscure, since many of their sites are now submerged on the Continental Shelf.

The Archaic Period: 8,000 - 1,000 B.C. (Phelps 1983:22-29)

By about 9,000 or 8,000 B.C., rising temperatures had created a cool, temperate "northern hardwoods" or "mixed hardwoods" type of forest, featuring species such as sugar maple, beech, birch, hemlock, and white pine (Whitehead 1973; Delcourt and Delcourt 1981). By about 7,000 B.C., the sea level had risen to a point about 26.8 meters (about 88 feet) below the present level, still exposing many miles of the Continental Shelf (Blackwelder et al. 1979). The characteristic cultures of the Early Archaic period (8,000 - 5,000 B.C.) are generally recognized by their distinctive corner-notched projectile points such as the Palmer and Kirk types (Coe 1964). Again, we know relatively little about the coastal cultures of the Early Archaic period, but in broad outline they were probably also nomadic hunters and gatherers, adapted to modern environments with smaller game animals and more temperate vegetation than in the earlier environment during the close of the Ice Age.

During the Middle Archaic period (5,000-3,000 B.C.), a warming and drying climatic

trend occurred over much of the Southeastern United States. During this Hypsithermal Interval, eastern North Carolina's vegetation changed to drier communities of oak, hickory, and ash (Delcourt and Delcourt 1980:227). By the beginning of the period, the sea level had risen to about 14 meters (about 46 feet) below the present sea level (De Pratter and Howard 1981). Several projectile point types characterize this period on the coastal plain: Stanly, Morrow Mountain, Guilford, and Halifax (Coe 1964). Again, prehistorians assume that the people who produced these points were nomadic hunters and gatherers. To date, we have no reports of excavated sites from this period on the coast, although Middle Archaic sites are often found in the area.

By about 3,000 B.C., forests in the region were essentially like the pine, oak-hickory, and cypress-gum communities seen today (Delcourt and Delcourt 1981). Sea level rose to a level about 1.5 meters (about 5 feet) below the present surface (De Pratter and Howard 1981). At this point, the long chain of barrier islands called the Outer Banks began to form, separating the ocean from the bays and estuaries and creating the modern sounds and estuaries, such as Albemarle Sound (Dolan et al 1980; Schoenbaum 1982:8).

The major diagnostic artifact of the Late Archaic period (4,000-1,000 B.C.) is the broad-bladed Savannah River point, although ceramic vessels also appear on the coast at around 2,500 - 2,000 B.C. The Late Archaic period was probably still a period of hunters and gatherers, but nomadism may have been on the wane and more sedentary villages on the increase (Phelps 1983: 22-29).

In a study of the prehistory of the Chowan River basin on the north side of Albemarle Sound, Phelps (1982:11-12) has suggested that Archaic sites occur in the area in three major varieties: permanent base camps on banks or bluffs overlooking major streams; seasonal base camps on banks or bluffs by tributary streams or swamp margins; and small, special activity sites scattered throughout the area and less dependent on nearby water sources or well-drained soils. The small lithic component at 31WH17 (represented by two quartz flakes) might represent one of these Archaic special activity sites.

Early Woodland: 1,000-300 B.C.

The diagnostic artifacts of the period are a ceramic type with coarse sand temper and surfaces decorated by cord marks, net impressions, fabric impressions, or simple stamp designs. On the northern coastal plain (including our study area), the type is called "Deep Creek;" on the southern coastal plain, a similar type is called "New River." The characteristic point types are the large, triangular Roanoke points and probably the small, stemmed Gypsy points. In the eastern United States, the Woodland period is commonly marked by at least three characteristics: ceramics; the bow and arrow; and farming. Although ceramics are present in North Carolina's Early Woodland period, and the triangular points are evidence for the appearance of the bow and arrow, evidence for the practice of farming is still largely absent. We still lack direct evidence that maize, squash, beans, or other typical Woodland crops of the time had begun to play a role in the coastal cultures (Phelps 1983: 29-32).

Middle Woodland: 300 B.C.- A.D. 800

Along coastal North Carolina, the remains of Middle Woodland societies are characterized by a typical ceramic type with sand-and-grit temper and surface treatments using fabric impressions, cord marks, net impressions, incisions, or smoothed surfaces. The northern variety is called Mount Pleasant, while the southern variety is called Cape Fear. Another typical ceramic type is Hanover ware, tempered with crushed pot sherds ("grog") and decorated with cord marks or fabric impressions. Small triangular Roanoke projectile points are typical (Phelps 1983:32-36).

With the Middle Woodland, we start to see the modern sea level and coastline for the first time.

Late Woodland: A.D. 800 - European settlement (late seventeenth-early eighteenth centuries)

In the Late Woodland period, we see archaeological cultures that can be directly linked to the Indian peoples described by the early European explorers in the region. The Indians on the sounds and estuaries of the Tidewater north of the Neuse River basin were the "Colington" cultures, the Algonkian-speaking peoples encountered by the English during the Roanoke voyages of the 1580s. Colington ceramics are tempered with crushed shell and decorated with fabric impressions, simple stamping, incisions, or left with plain surfaces (Phelps 1983).

Early and Middle Woodland settlement patterns in the nearby Chowan River basin, according to Phelps (1982:12-14), strongly resemble the settlement patterns of the preceding Archaic hunters and gatherers. This resemblance might be further evidence that the Early and Middle Woodland cultures of the region were not farming societies with relatively stable village life, but still followed a largely nomadic, hunting and gathering way of life. A striking change occurs with the appearance of Late Woodland cultures, however. The Chowan River basin's Late Woodland Colington sites occur on high, sandy bluffs or ridges along rivers or major tributaries, and especially on large areas of well-drained, arable land. Phelps has suggested that the Late Woodland settlements fall into five categories: capital towns, such as those visited by the English explorers in the 1580s; large villages; small villages; isolated farmsteads; and special activity camps for hunting and fishing.

ETHNOHISTORIC BACKGROUND

The English explorations of the 1580s resulted in the disastrous "Lost Colony" on Roanoke Island but also in a great deal of useful ethnographic information in the form of eyewitness accounts by Arthur Barlowe, Ralph Lane, and Thomas Hariot, and watercolor maps and paintings by John White (Corbitt 1953). Various versions of the maps based on these explorations show several Indian towns at the western end of Albemarle Sound. The towns closest to the project area were probably *Tandaquomuc* (either a Weapemeoc or Chowanoke settlement), which was north of the Roanoke River, and *Moratuc*, which was probably on the south bank of the Roanoke River near the mouth of Welch Creek (Quinn 1955: 858-859), which now forms Washington County's western boundary (see Figure 2).

By the middle of the 1600s, English settlers from Virginia had begun to drift into the Albemarle region and displace the native inhabitants. The Weapemeoc were apparently greatly reduced by Old World diseases during the early Contact period and broke up into small villages that were eventually engulfed by the English settlements on the north side of the Albemarle Sound. The last historical reference to the Weapemeoc is a 1740 petition by the Yeopim for permission to dispose of their land. The more powerful Chowanoke, in contrast, went to war with the English in 1675. After the defeat of the Chowanoke, they were confined to a small reservation on Bennett's Creek. Their English neighbors continued to whittle away even at this small territory, and the Chowanoke numbers declined until 1754, when the commander of the Chowan County militia reported that "there is but one Indian Nation in Chowan County, which are called the Chowan Indians, but their strength is nothing and their condition very deplorable by the artifice and cunning of some of their neighbors. I am informed they consist of two men and five women and children, which two white men would at any time overcome" (Mook 1944:221-223).

ARCHÆOLOGICAL RESEARCH IN THE PROJECT VICINITY

A review of the site files in the Office of State Archæology shows that no prehistoric sites have been recorded in the project area, and that only 16 archæological sites (including historic sites) had been recorded in all of Washington County at the time of our survey.

HISTORICAL BACKGROUND

Background research on the project area included a review of maps and secondary historical sources in the North Carolina State Archives and in the North Carolina Collection at UNC Chapel Hill. The Washington County Historical Society has informed us that its members do not know of any sites in the immediate area. The nearest historic site mentioned in the Society's letter is the Blount house (1799 - 1810), about two miles east of the project area (Patricia Jane Monte, Curator, Washington County Historical Society, Plymouth; personal communication).

Although the English explored the Albemarle Sound in the 1580s, European colonization of the area did not take place for decades afterwards. A Jamestown settler, John Pory, visited the area in 1622 and reported that it contained vast numbers of pine trees that could support a naval stores industry. A traveller from Bermuda reported in 1636 that Englishmen were visiting the western Albemarle region and had begun exploiting the pine trees to produce "sperrits of rosin" (Powell 1975:14). The first permanent English settlement took place as late as the 1650s, when Nathaniel Batts occupied a house at the western end of Albemarle Sound.

One of the earliest grants made in the landfill vicinity was issued to Edward Moseley on August 29, 1713: "450 acres in Chowan Precinct at a place commonly called White Marsh in Morattock, joining Cullumb Flynn, a Pocoson, a branch, the White Marsh, and the road to Pamptico" (Hofmann 1979:109). The 1733 map of the colony of North Carolina, drawn by Moseley himself, labels this area "White Marsh," a name commemorated in the local post office's name as late as 1882 (Powell 1968:527). Edward Moseley (1682 ? - 1749) was possibly the "single most important political figure in the first half of the eighteenth century in North Carolina" (Price 1991:332). Moseley settled in the Albemarle region around 1704 and entered into a long and controversial political career, which included positions as Royal councilman, General Assemblyman and speaker, surveyor general, treasurer for the province, chief justice of the colony, and baron of the Exchequer (Price 1991:332). In 1711, Moseley was living in a home on the north side of Albemarle Sound (Saunders 1886:764). In 1715, he acquired almost 1,000 acres in grants near the Pungo River, and by the time of his death in 1749, he owned over 30,000 acres scattered throughout the coastal areas of the colony (Hofmann 1979:68,69; Price 1991). His 1733 map of the colony shows his own home still on the north side of the Albemarle Sound, southeast of Edenton (Moseley 1733). In 1735, he moved to Rocky Point on the Northeast Cape Fear River (Price 1991:332), so it seems unlikely that he ever occupied his land at White Marsh.

Although Moseley probably did not live on his land in Washington County, settlement was already advanced enough for the construction of mills on Kendrick's Creek near present-day Roper. The nearby area between the Roanoke River and Conaby Creek became a center of trade and a port by the 1720s. The town of Plymouth was formally established there in 1787, although it was not incorporated until 1807. Washington County was created from Tyrrell County in 1799,

and Plymouth became the county seat in 1823 (up until that time, the county courthouse was at Lee's Mills, now Roper) (Washington County Historical Society n.d.). From the ceramics (pearlwares and creamwares) found in the project area at 31WH17 (see below), we know that someone was occupying the tract by at least the last quarter of the eighteenth century.

A map of the western section of Albemarle Sound created by the United States Coast and Geodetic Survey in 1860 (Coast Chart #41) shows parts of the shore and its vicinity in great detail, but our project area was too far from the Sound or the Roanoke River to appear on the map. Our first detailed map of the project vicinity is the 1932 soil map of Washington County (Figure 5). This map shows one structure (probably 31WH17) in the project tract.

FIELD METHODS

Since much of the project area is covered with secondary, post-logging growth, the survey relied heavily on screened shovel tests at intervals of 30 m (100 feet). The shovel tests measured about 35 to 45 cm (14 to 18 inches) across and were excavated into the underlying subsoil. The soil from the shovel tests was screened through 1/4 inch hardware cloth. In areas with exposed ground surfaces (disturbed areas adjacent to borrow pits, access roads, patches exposed during logging, etc.), the surveyors closely examined the area for prehistoric and historic artifacts.

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 1944 (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 1944 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 description of the archæological site recorded during our survey of the project area. We include information on the site's periods of occupation, 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 site. The site form submitted to the Office of State Archæology lists additional environmental information (elevation, distance from water, etc.). Later sections address the question of site significance and recommendations.

The survey recorded one historic-period archæological site, with a minor prehistoric component. Figures 3 and 4 show the location of the site. The site number is assigned by the Office of State Archæology (OSA) under the national system of site identification, in which "31" stands for North Carolina, "WH" stands for Washington County, and the last number represents the order in which the site was entered into the OSA site files for that county. The accession number is also assigned by the OSA. This number is inked onto the artifacts to help in future identification after curation.

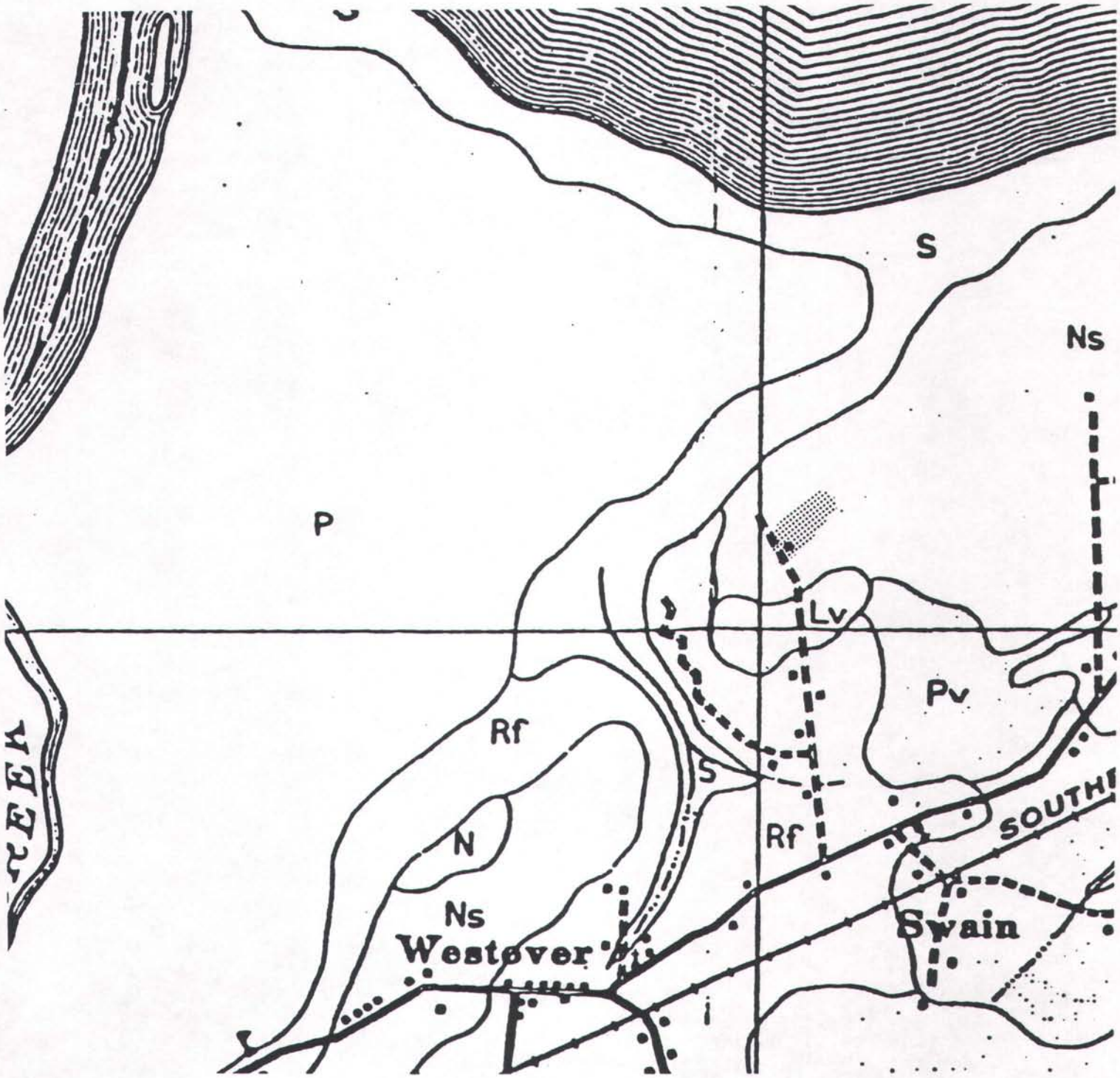


Figure 5: The project area in 1932 (shaded).

Base map: Davis and Goodman 1932.

31WH17 (Accession #94 - 021)

Type of site: The site is predominantly a historic-period occupation, with a minor prehistoric lithic component (two quartz flakes). The low-density scatters of historic-period artifacts (analyzed by Patricia Samford) range from the late eighteenth century to the mid or late twentieth century. The lack of substantial numbers of architectural artifacts (for example, concentrations of brick, ballast stone from foundations, window glass, nails) suggests that the house itself stood in the area of the current borrow pits, south or west of the find spot (Figure 4). Given the massive disturbances and the absence of parts of the site, the house site's original dimensions are impossible to determine. The house might have been the structure shown on the 1932 soil map of the county (Figure 5). The 1954 *Westover* quad map shows no structure on the tract.

Glass fragments

bottle (machine-made), brown	2
bottle (machine-made), blue	5
bottle, colorless non-leaded	8
bottle, colorless non-leaded, painted design	8
bottle (whole), colorless non-leaded, machine-made perfume bottle	1
bottle, molded,colorless non-leaded, marked OR	1
pressed table glass, light green	1
table glass, colorless non-leaded	1
pressed table glass, colorless non-leaded	3
pressed table glass, colorless leaded	2
cut table glass, colorless leaded	2
pressed table glass, opaque white	1
canning jar liner, opaque white	1
cosmetic jar, machine made (Pond's 24)	1

Ceramics

creamware, plain rim, undecorated soup plate	1
pearlware, undecorated	16
pearlware, molded floral design	1
pearlware, shell edge, blue	1
whiteware, shell edge, blue	1
whiteware, printed underglaze, blue	3
whiteware, painted underglaze, green	1
whiteware, undecorated	8
yelloware, undecorated	4
refined white earthenware, burned	1
refined white earthenware, glaze	

Figure 6: Looking northward across the site and the adjoining borrow pit .

missing	1
refined white earthenware, sponged, brown	1
porcellaneous hotel china, printed underglaze, black	2
porcellaneous, undecorated	1
Chinese porcelain, painted underglaze, blue	1
stoneware, grey bodied, brown salt glaze	1
stoneware bottle, buff bodied	1

Other

button, white glass	1
painted plaster	2
mussel shells	2
oyster shells	3
brick fragments	3

How recorded: During a surface inspection of cleared areas adjacent to the borrow pits, the surveyors found glass, ceramics, two flakes, and other artifacts exposed on the surface. Surface visibility was good to excellent -- about 60 to 100%.

Environment: The site is on the exposed remnant of a low ridge of Conetoe loamy fine sand.

Signs of preservation or disturbance: Borrow pits have removed any sections of the site that might have been to the south and west (Figure 4)/ During the course of land-clearing on the remaining section of this low ridge, heavy earthmoving equipment was used to push brush and tree limbs into a central area. Most of the soil's A horizon appears to have been removed or displaced. The potential for site preservation seems very low.

Research potential: The high degree of disturbance diminishes the potential for additional research.

Impact of the project: The site is in the area scheduled for landfill excavation and construction.

STANDARDS OF SIGNIFICANCE

Our evaluations of archæological significance come from 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 1986:1)

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 (National Park Service 1986:1).

For prehistoric sites, the most relevant criterion is "D." Does the prehistoric component of the site have the potential to produce significant information and new insights on the region's prehistoric past? The prehistoric remains are represented by only two quartz flakes. Even in the absence of wide-spread disturbances, such sparse prehistoric remains would not seem likely to yield significant prehistoric information.

For most historic-period archæological sites, the most relevant criterion is also "D," and we must ask whether this historic sites has the potential to produce significant information and new insights on the region's history. An eighteenth century occupation site with reasonably intact remains would be a valuable archæological asset for studying early settlement of the Albemarle region of North Carolina. However, the wide-spread and thorough disturbances experienced by the site make the survival of intact archæological remains highly unlikely. The site does not seem eligible for nomination to the National Register of Historic Places.

RECOMMENDATIONS

We do not recommend additional archæological work on the proposed landfill expansion, as it is now designed.

REFERENCES CITED

Blackwelder, Blake W., Orrin H. Pilkey, and James D. Howard
1979 Late Wisconsinan sea levels on the southeast United States Atlantic shelf based on in-place shoreline indicators. *Science* 204: 618-620.

Coe, Joffre L.
1964 The formative cultures of the Carolina Piedmont. *Transactions of the American Philosophical Society* 54(5):1-130.

Corbitt, David Leroy
1953 *Explorations, descriptions, and attempted settlements of Carolina, 1584-1590.* North Carolina Department of Archives and History, Raleigh, North Carolina.

Daniels, R.B., H.J. Kleiss, S.W. Buol, H.J. Byrd, and J.A. Phillips
1984 Soil systems in North Carolina. *North Carolina State University, North Carolina Agricultural Research Service, Bulletin* 467.

Davis, W.A., and K.V. Goodman
1932 *Soil survey of Washington County, North Carolina.* United States Department of Agriculture.

Delcourt, Paul A., and Hazel R. Delcourt
1980 Pollen preservation and Quaternary environmental history in the southeastern United States. *Palynology* 4:215-231.

1981 Vegetation maps for eastern North America: 40,000 years Before Present to the present. In *Geobotany II,* edited by Robert C. Romans. Plenum Press, New York.

DePratter, Chester, and James D. Howard
1981 Evidence for a sea level lowstand between 4,500 and 2,400 years Before Present on the southeast coast of the United States. *Journal of Sedimentary Petrology* 51(4): 1287-1295.

Dolan, Robert, Bruce Hayden, and Harry Lins
1980 Barrier islands. *American Scientist* 68 (1):16-25.

Hofmann, Margaret M.
1979 *Province of North Carolina, 1663-1729: abstracts of land patents.* Roanoke News, Weldon, North Carolina.

Mook, Maurice A.
1944 Algonkian ethnohistory of the Carolina sound. *Journal of the Washington Academy of Sciences* 34 (6).

Moseley, Edward
1733 *A new and correct map of the province of North Carolina, by Edward Moseley, late Surveyor-General of the said province, 1733.* Reprinted by the North Carolina Division of Archives and History, Raleigh, North Carolina.

National Park Service
1986 Guidelines for completing National Register forms. *National Register Bulletin* 16.

North Carolina Geological Survey
1985 *Geologic map of North Carolina.* Department of Natural Resources and Community Development, Raleigh, North Carolina.

Phelps, David S.
1982 Archaeology of the Chowan River basin: a preliminary study. *East Carolina University, Department of Sociology and Anthropology, Archaeology Laboratory, Archaeological Research Report* 4.

1983 Archæology of the North Carolina coast and coastal plain: problems and hypotheses. *The Prehistory of North Carolina: An Archæological Symposium*, edited by Mark A. Mathis and Jeffrey L. Crow. North Carolina Division of Archives and History, Raleigh, North Carolina.

Powell, William S.
1968 *The North Carolina gazetteer.* University of North Carolina Press, Chapel Hill, North Carolina.

1975 Human settlement and profile: history. *North Carolina Atlas: Portrait of a Changing Southern State,* edited by J.W. Clay, J.M. Orr, Jr., and A.W. Stuart. University of North Carolina Press, Chapel Hill, North Carolina.

Price, William S., Jr.
1991 Edward Moseley. *Dictionary of North Carolina Biography,* edited by William S. Powell. UNC Press.

Quinn, David Beers (editor)
1955 *The Roanoke voyages, 1584-1590.* The Hakluyt Society, London.

Saunders, William L.
1886 *The colonial records of North Carolina* (volume 1). Hale, Raleigh.

Schoenbaum, Thomas J.
1982 *Islands, capes, and sounds: the North Carolina coast.* John F. Blair, Winston-Salem, North Carolina.

Tant, Phillip L.
1981 *Soil survey of Washington County, North Carolina.* United States Department of Agriculture.

Washington County Historical Society
n.d. *Historic Washington County.* Washington County Historical Society, Plymouth, North Carolina.

Whitehead, Donald R.
1973 Late-Wisconsin vegetational changes in unglaciated eastern North America. *Quaternary Research* 3:621-631.

Earthwork Calculations
for
Landfill Cover and Berm Construction

COVER SOIL EARTHWORK CALCULATIONS

SECTION	DISTANCE (FT)	CUT AREA (SF)	CUT VOLUME (CY)	TOTAL CUT (CY)
	0			
3		1,535		0
	200		8,481	
4		255		8,481
	200		2,796	
5		0		11,277
8		0		11,277
	200		10,833	
9		2,925		22,110
	200		18,352	
0		2,030		40,462
	100		3,759	
TOTAL ESTIMATED COVER SOIL AVAILABLE				44,221

BERN CONSTRUCTION EARTHWORK ESTIMATE

NORTH BERM

544 SF/FT X 545 FT = 296,480/27 = 10,980 CY

SHORT NORTH-SOUTH BERMS

544 SF/FT X 3 X 100 FT = 163,200/27 = 6,044 CY

FUTURE BERMS

SOUTH BERM

544 SF/FT X 545 FT = 296,480/27 = 10,980 CY

NORTH-SOUTH BERMS

544 SF/FT X 3 X 200 FT = 326,400/27 = 12,089 CY

TOTAL FUTURE BERMS = 23,069 CY

Diehl and Phillips authorized completion of an off-site borrow evaluation. The results of the Borrow Study is contained in a separate report.

4.0 INVESTIGATIVE PROCEDURES

4.1 SUBSURFACE INVESTIGATION

The following paragraphs describe the activities associated with the investigation of the 71 acre tract of land proposed for construction of a C&D debris landfill. The work included the drilling of seven soil borings, 11 temporary piezometer installations, aquifer testing, and a traverse of the property.

4.1.1 Soil Test Borings

Seven (7) soil test borings, B-1 through B-7, were drilled at the approximate locations shown on Figure 1. The borings were located in the field by S&ME personnel using existing landmarks and site topography as references. Upon completion of the drilling, the locations were surveyed to establish the actual boring locations and to provide elevation data. The surveying was performed by Roanoke Land Surveying of Williamston, N.C. in February, 1994. The location of the borings/piezometers are shown in Figure 1. (The figures can be found in this report following the text.) The location coordinates are summarized in Table 1.

The borings were performed using a CME 450 drill rig mounted on an all-terrain vehicle. Access improvements to the site were accomplished with Washington County landfill equipment and personnel. All of the borings were advanced to a termination depth of 50 feet below the land surface.

A combination of hollow stem auger and wet rotary drilling methods were used to advance the borings. The augers were advanced to each sample interval. Accumulated sand and sediment was removed from the augers, prior to sampling, by washing the

accumulated material from the augers with the drill rod and water obtained from the site.

Standard Penetration Tests were performed at selected intervals during the drilling in accordance with ASTM D-I586-67 to provide an index for estimating soil strength and relative density. The samples were visually classified in the field according to the Unified Soil Classification System. Portions of the samples were scanned with an Organic Vapor Analyzer (OVA) for the presence of volatile compounds in the soil. The remaining portions of each sample were placed in jars for possible laboratory testing.

Several undisturbed (Shelby Tube) samples were obtained during the drilling for possible laboratory permeability testing. Bulk samples were not obtained as construction will utilize off-site borrow source for cover soils. The results of the borrow investigation are contained in a separate report.

4.1.2 Soil Headspace Analysis

Portions of each recovered split spoon sample were placed in resealable plastic bags and sealed. The sealed bag was kneaded to facilitate volatilization of any compounds present in the soil. After allowing the headspace within the bag to stabilize, the bag was pierced with the tip of an Organic Vapor Analyzer (OVA) to determine the presence and concentration of volatile compounds contained in the soil. As methane is detected as a volatile compound, the OVA can be used to evaluate soil for accumulations of landfill derived methane.

4.1.3 Piezometer Installation

Eleven (11) temporary piezometers were installed to determine stabilized groundwater levels across the site and to perform in-situ permeability testing of the surficial aquifer. Four deep piezometers were installed in borings, B-1, B-2, B-4 and B-5, at the completion

4.2 AQUIFER TESTS

In-situ permeability (slug) testing was performed in all of the piezometers. The tests were performed by quickly adding one gallon of distilled water to the piezometer casing and monitoring the recovery rate of the piezometer with a pressure transducer. The pressure transducer was attached to a data recorder which recorded the drop in water level in the piezometer during its recovery. The data was filtered and evaluated using the Bouwer and Rice Approximation to estimate Hydraulic Conductivity (K).

4.3 LABORATORY PROCEDURES

The laboratory procedures utilized for the tests performed on soil samples obtained during the study are listed below according to the American Society of Test Methods (ASTM) test number designation.

Selected Standard Penetration Test (SPT) samples were submitted for classification testing to confirm the visual classifications made in the field, to establish variability of soils within each of the geologic units, and to establish the engineering properties of the site soils. These tests included:

- Grain Size Determination, with Hydrometer Analysis of Fines ASTM D-422.
- Natural Moisture Content ASTM D-2216.
- Plasticity Indices (Atterburg Limits) ASTM D-4318.
- Falling Head Permeability Test ASTM D-5084 (Method C)

5.0 PHYSIOGRAPHY AND HYDROGEOLOGY

5.1 PHYSIOGRAPHY

North Carolina is divided into three provinces, based on the physiographic changes of the land mass that occur from the coast to the mountains. These provinces include: the Coastal Plain, Piedmont, and Blue Ridge.

The Coastal Plain Province, located along the eastern third of the state, consists of two natural divisions, the easternmost or Tidewater region is characterized by flat to subdued topography and in many areas, poorly drained soils. The western half of the Coastal Plain is higher in elevation, with gently rolling topography, and is generally better drained than the Tidewater.

Washington County is located within the Tidewater region of the Coastal Plain Physiographic Province of North Carolina. The Coastal Plain region has been formed during past transgressive and regressive changes in sea level. As such, the topography is relatively flat.

5.2 GEOLOGY

The Coastal Plain Region has formed through deposition of an eastward thickening wedge of sediments on crystalline bedrock. The sediments consist of interbedded sands and clays, limestone, sandstone and calcareous clays.

Within the site area, the sediments dip to the east-southeast. The total thickness of the sequence of sediments is estimated to be between 1500 and 2000 feet thick in the Plymouth, N.C. area(Lawrence and Hoffman, 1993).

5.3 HYDROGEOLOGY

The thick series of sediments present within the Coastal Plain can be divided into separate formations or aquifers according to the age of their deposition and according to the characteristics of the groundwater contained within each formation.

5.3.1 Stratigraphic Sequence

Surficial soils in the region consist of a series of undifferentiated deposits of marine, fluvial, eolian, and lacustrine environments formed over the past two million years. These deposits generally consist of fine-grained sands with interbedded clays. The undifferented deposits have a thickness of between 30 and 50 feet.

The Yorktown formation is present beneath the undifferentiated surficial deposits. The Yorktown formation typically consists of gray clayey sands and silty clays with interbedded shell material. The Yorktown extends to a depth of approximately 95 to 100 feet below existing ground surface.

The Pungo River formation exists beneath the Yorktown formation. This formation consists of phosphatic sands and thin shell limestone beds. The Pungo River formation extends to a depth of approximately 110 to 115 feet below the existing ground surface and lies unconformably on the Castle Hayne limestone.

The Castle Hayne formation consists largely of loose to poorly consolidated light gray fossiliferous limestone. The limestone is usually quite fossiliferous and in many places is composed predominantly of shell material.

5.3.2 Groundwater Occurrence

There are three aquifers of interest present in the Plymouth, N.C. area: the surficial aquifer (water table aquifer),the Yorktown Formation, and the underlying Castle Hayne aquifer. Domestic water supplies can be obtained from all three aquifers. Most water supplies in the plymouth area are obtain water from the Castle Hayne formation. There are no known water supply wells located within 2000 feet of the landfill.

5.4 SITE TOPOGRAPHY AND SURFACE DRAINAGE

5.4.1 Site Topography

The proposed C&D landfill site is characterized by relatively flat topography that gradually slopes downward to the north and south from an east-west ridge or divide that bisects the site. The eastern and northeastern boundaries of the property are adjacent to wooded wetland areas. There is roughly 8 feet of relief across the site. Highest elevations occur at about 12 feet above mean sea level (MSL) in the central portion of the site. Lowest elevations occur along the wetland fringes and within the areas of the site that have been utilized in the past for borrow materials.

5.4.2 Site Drainage

The site is located within the drainage basin of the Roanoke River as it enters the Albemarle Sound. The central portion of the site is elevated above the surrounding ground surface and tends to drain radially. The east portion of the site has been excavated to just above the water table. During the time of the investigation, site drainage within this area of the site was to the north via an excavated ditch emptying into the wetland area north of the site.

Seepage was noted over a broad area along the western property boundary, adjacent to the existing landfill. The seepage appeared to be impacted by landfill leachate. The excavated ditch tends to create a drainage divide separating the proposed site from the existing landfill.

5.5 SITE LITHOLOGY

The borings encountered four stratigraphic units at the site. Simply, the stratigraphic sequence present within 50 feet of the ground surface consists of 20 to 28 feet of relatively clean sand containing an interbedded gray silty clay. These units rest on fine grained silts containing interbedded silty sand and clay, that in turn, rest on the clays and silts of the Yorktown formation.

The boring and piezometer locations and the position of the five geologic sections through the site are shown on Figure 1. The generalized lithology is illustrated in on the Geologic Sections included as Figures 2 through 6. Soil symbols for the sections are shown opposite the section. Actual conditions encountered at the test borings are shown on the Test Boring Records included in Appendix I. The following paragraphs describe the simplified lithology of the site.

The surficial soils generally consist of approximately 6 inches of organically stained sandy topsoil. At B-4, the surface soils were highly organic (muck), more characteristic of wetland areas north of the site. Topsoil materials were not encountered at B-1, as the upper soils have been removed at this location.

The topsoil horizon is underlain by 15 to 28 feet of relatively clean light brown, orange, to tan sands containing one or more clay interbeds. Near the ground surface, the sands are fine-grained. They tend to coarsen with depth, to medium to coarse sand with small (pea) gravel at the base of the unit. Standard penetration tests indicate that the sand is

of loose to medium dense relative density.

Light gray with orange silty clay to sandy clay soils exist between elevation 7 to elevation minus 11, within areas of the site. The clay was encountered 5 of the 7 borings. The clay averages 3 to 5 feet in thickness, ranging from approximately 1 foot in thickness in HA-1 to about 11 feet in B-6. The clay soils were not encountered in borings B-1, B-2 and B-4.

The clay is exposed in the borrow excavation north of B-1. Hand auger boring, HA-1 was performed in this area to obtain a sample of the clay for laboratory testing. The clay at this location is approximately 12 inches thick. The clay appears to be laterally discontinuous as it was not observed over most of the borrow area.

It is likely that the sand and clay have been deposited in the recent past by the Roanoke River as a series of bank and channel deposits. Thus, the clay exists as one or more lenticular beds within the sand.

The near surface sands rest on fine-grained sandy and silty soils that are characteristically darker (gray to dark brown) in color and contain some finely-divided decayed organic matter. Typically, this unit is comprised of silt with numerous very fine sand partings. The unit contains lenses of silty to clean fine sand and silty clay. Four borings, B-1, B-2, B-6 and B-7 encountered a very dense fine sand strata near the top of this unit (elevation minus 23 to minus 26). The silt soils tend to become finer-grained and more clayey below elevation minus 35.

Blue gray clayey silt of the Yorktown Formation was identified in the sample obtained from B-4 at a depth from 48.5 to 50 feet. The Yorktown classification was based on the characteristic blue gray color and a lack of organic matter. No shell material was observed in the sample. Lower portions of the overlying organic (containing) silt are

similar in apparent grain size to the underlying Yorktown materials, indicative of reworking of the Yorktown materials by the Roanoke River.

5.6 SITE HYDROGEOLOGY

Soil borings performed at the site indicated varying depths and thickness of clay sub-units within the surficial Coastal Plain sediments. Generally, shallow clay deposits in the area are lenticular and discontinuous. They may form localized groundwater barriers. they are not extensive to form confining layers.

Both shallow and deep piezometers were installed at the proposed landfill site. Water levels differed between shallow and deep piezometer pairs by an average of 1.0 foot, indicating a downward groundwater flow component.

5.7 GROUNDWATER

Two piezometric maps have been constructed from the stabilized water level information obtained from the shallow and deep piezometers on February 22, 1994. The maps are included as Figures 7 and 8. Table 2 shows a summary of groundwater elevations obtained in the piezometers during the period between January and February 1994.

5.7.1 Shallow Water Table Aquifer

Groundwater flows from areas of higher potential to areas of lower potential much as surface water drains from higher topography to lower topography. Figure 7 shows our interpretation of the water table surface contours represented as a series of contours for the measurements obtained on February 22, 1994.

Groundwater flow is towards the north and east, perpendicular to the potentiometric contours. The general direction of flow within the site is toward the north, with groundwater discharging into the wetland fringe surrounding the Albemarle Sound. Figure 7 shows groundwater flow in the northwest corner of the site to be towards the east, apparently due to the influence of the adjacent landfill.

Gradients vary across the site. They are flattest within the southeast quadrant of the site, increasing to approximately 0.004 feet per foot in the northeast quadrant. They are steepest in the northwest quadrant at 0.17 feet per foot.

5.7.2 Deep Potentiometric Surface

Groundwater levels within the deeper piezometers are reflected in the piezometric map shown as Figure 8. The map shows a similar piezometric surface, a subdued reflection of the water table surface. The mounding effect present in the northwest corner of the site in Figure 7 is also present in Figure 8. Gradients range from 0.004 feet per foot in the northwest quadrant of the site to 0.001 feet per foot in the northeast quadrant. The depressed water levels in the deeper piezometers indicates a downward (non-horizontal) flow component is present at the site. The water levels and the boring information do not indicate confining strata are present within the 50 foot boring depth.

5.8 Hydraulic Conductivity of the Surficial Aquifer

The site soils can be divided into 4 general strata types; the upper sands and interbedded clay, the underlying fine sandy to clayey silts containing some fine organic matter, and the Yorktown silt and clay. Permeability (hydraulic conductivity) values were determined for the upper three soil types using several different methods. The borings did not penetrate into the Yorktown material sufficiently to facilitate testing of this unit.

5.8.1 Upper Sands

It is very difficult to obtain undisturbed samples of clean sands for laboratory testing. In-situ tests were performed in the shallow piezometers to determine their conductivity. Calculated values based on the Bouwer and Rice Approximation yielded values of K that ranged from 2.5×10^{-3} cm/sec to 1.8×10^{-3} cm/sec in SP-1 and SP-2, screened almost entirely in sand. The lowest value, 6.4×10^{-5} cm/sec, was obtained from SP-7. Boring information indicates the screen interval for SP-7 is also in sand. The values shown for the tests on Table 3 seem to be much lower than would be expected from the relatively clean sands.

The in-situ tests suggested lower conductivity values than would be expected. Grain size distribution curves were analyzed using the Hazen Method to estimate hydraulic conductivity. This method yielded values on the order of 2.0×10^{-2} cm/sec which are more in line with published values (Fetter). Table 4 summarizes the hydraulic conductivity values determined from the gradation curves.

A value of 2.0×10^{-2} cm/sec was used as the estimated Hydraulic Conductivity (K) of the upper sands.

5.8.2 Upper Clay

Laboratory testing was performed on one sample of the near surface clay. The test indicates the hydraulic conductivity is 5×10^{-6} cm/sec. This value was utilized for **K** in the upper clay.

5.8.3 Underlying Silts

The deeper piezometers were also tested to determine the hydraulic conductivity of the screen interval of 40 to 50 feet below the ground surface. Values of 9.0×10^{-6} cm/sec to 1.4×10^{-5} cm/sec were calculated from the test data. Much higher values are indicated in the clean to silty sands present as lenses in this formation. Estimates of K based on the gradation tests indicates conductivity values on the order of 1 to 2×10^{-2} cm/sec. A value of 2×10^{-2} cm/sec was used for **K** in the cleaner portions of the underlying soils. 2×10^{-5} cm/sec was used for the silts and clays.

5.9 GROUNDWATER MOVEMENT

The rate of groundwater movement can be estimated with the Darcy equation using values of porosity, flow gradient and hydraulic conductivity. Using the values shown below for **K** and an estimated porosity of .35, annual velocities were calculated for the major soil types at the site.

SOIL TYPE	HYDRAULIC CONDUCTIVITY (K)
• Surficial Sands	2.0×10^{-2} cm/sec.
• Surficial Clay	5.0×10^{-6} cm/sec.
• Deeper Silt/Clay	2.0×10^{-5} cm/sec.
• Clean sands within the deeper Silt/Clay	2.0×10^{-2} cm/sec.

Based on groundwater flow gradients, groundwater velocities range from approximately 240 feet to greater than 10,000 feet in the upper sands. The lower value would occur within the northeast quadrant of the site where the landfill would be positioned. The higher value occurs in the northwest quadrant where the seepage was observed. Velocities in the clay are on the order of 3 feet per year or less. This value is likely of

minor importance as the clays are discontinuous. Ground water tends to flow around the clay lenses because of the higher seepage rates of the sand, making this value less significant.

Velocities within the deeper soils are lower. Within the relatively clean sands velocities could be expected to range from approximately 60 feet per year to approximately 240 ft/yr. Calculated velocities in the silt/clay soil was less than 1 ft/yr.

The depressed water level elevations in the deeper piezometers indicate a downward groundwater flow component is present in the deeper silts, and underlying clays and silts of the Yorktown formation. However these soils exhibit much lower conductivity values. The extensiveness and fine grained nature of these soils tends to act as a groundwater barrier or aquitard.

6.0 SOIL CONSERVATION SERVICE SOIL MAPPING

The Soil Conservation Service (SCS) has mapped the major soil series within Washington County. SCS soils data is useful for preliminary site planning as many of the soil characteristics and engineering properties are outlined in tabular form. Table 5 summarizes selected SCS soil characteristics of the site soils with respect to shallow excavations and landfills.

The entire site area has been mapped as Conetoe Series (Cta) soil. The Conetoe consists of well drained soils that have formed in loamy fluvial and marine sediments. Slopes range from 0 to 3 percent. The depth to groundwater is greater than 6 feet.

Augusta (At), Dorovan (Do), and Mucklee (Me) series soils have been mapped adjacent to the site. All of these soils have a shallow depth to groundwater. The Dorovan Series are highly organic. They may be encountered within the outer fringes of the property.

7.0 ANALYTICAL RESULTS

7.1 OVA ANALYSIS OF SOIL SAMPLES

An Organic Vapor Analyzer (OVA) was used to scan the site soils that were obtained during drilling with a split spoon sampler. Table shows a summary of the OVA readings for the seven borings according to sample depth. The table lists two values for each sample interval. The values, shown in the columns marked S and M, indicate the concentration of volatile organic compounds detected in the soil with the standard tip (S) and the charcoal filter or methane tip (M).

With the exception of B-4 and B-6, elevated OVA readings were not encountered until a depth of 18.5 feet to 23.5 feet. OVA readings tended to increase with increasing depth then remain more or less constant to the 50 foot depth.

The elevated readings are probably due to the presence of methane and other gasses such as carbon disulfide released during decomposition of the organic matter present in these soils. OVA values were higher at shallower depths in B-4 and B-6 in clay soils with some organic matter.

The elevated OVA readings are likely not due to methane from the existing landfill, but rather from the organic matter contained in the deeper site soils.

The elevated OVA readings have no impact on use of the site for construction. As there will be no construction activities that disturb the deeper soils.

7.2 LABORATORY DETERMINATION OF SOIL PROPERTIES

Selected soil samples, representative of the major soil groupings present at the site were

subjected to laboratory determination of their physical properties. The results of the tests are shown on Table 7.

7.2.1 Site Soil Classification Groupings

Soils at the site are classified according to the Unified Soil Classification System as:

- (SP) for the relatively clean sands containing less than 5 % fines.
- (SM) or (SC) for samples containing greater than 12% of predominately silt fines. The SM classification is utilized where the percentage of silt exceeds clay and the SC qualifier is used for more clayey fines.
- (MH and CH) for cohesive samples with high Plasticity Indices.
- (ML and CL), where the total percentage of silt and clay exceeded the sand content.

7.2.2 Grain Size Determinations

Table 7 shows a summary of the Grain Size Tests performed on selected split spoon samples. The grain size analyses indicate a majority of the upper sands are classified as SP, relatively clean sand with little fines. Fines, classified as silt and clay, range between 2% and 5%. Typically, approximately 90% of the sample is classified as medium sand.

The uniformity coefficient (Cu) shown in Table 4 is a measurement of how well or how poorly-graded the particle sizes are for a given sample. The Uniformity Coefficient is determined from the ratio of the grain size that is 60% finer by weight (D_{60}) compared to the grain size that is 10% finer by weight (D_{10}). Most of the samples have uniformity coefficients of less than 4, indicating they are well-graded.

7.2.3 Natural Moisture Content

Natural moisture content was determined for near surface clay. The moisture content was 18.6 percent by weight. Volumetric Moisture Content is 32.5 percent. When compared to porosity (35.2 percent), it appears that the upper clay is almost fully saturated. With the exception of the surficial samples, all of the other samples were obtained from beneath the water table, and were assumed to be saturated.

7.2.4 Porosity

Porosity was determined on 1 sample of the upper clay. Porosity of the undisturbed clay is 35.2 percent. This value is within typical ranges for fine sandy silty clay. (Fetter, 1988)

7.2.5 Laboratory Permeability

The permeability of the surficial clay was evaluated by performing a laboratory permeability test on an undisturbed sample (Shelby Tube) of the clay. The sample was 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. The sample was saturated under a back pressure of 100 psi prior to running the falling head permeability test. The test was performed with an effective confining pressure of 2 psi and hydraulic heads of about 40 centimeters (cm) of water across a sample length of 8.07 cm. Both inflow and outflow of water were monitored during the test. Testing continued until steady flow was achieved. The hydraulic conductivity of the clay was measured at 5×10^{-6} cm /sec.

8.0 SITE SUITABILITY

Conclusions and recommendations regarding suitability of this site for the proposed construction are based on our evaluation of the field and laboratory data generated during the study, and experience with similar projects and subsurface conditions.

S&ME, Inc. requests the opportunity to confirm, extend, or modify the following recommendations, should the scope of work change significantly from that presented in this report or should additional site or subsurface information become available, or be discovered during construction.

8.1 SUITABILITY OF THE SITE

Design and construction must take into account soil conditions typical of eastern North Carolina. Fine to medium grained sandy soils predominate the near surface. There are no fine-grained soils available for cover at this site. Sufficient quantities of cover soils are available off-site, in close proximity to the proposed landfill. Shallow groundwater conditions occur across the site, which will allow negligible embeddment of the waste. Once siting criteria have been established, additional borings should be performed to evaluate local variations in subsurface conditions .

8.2 MONITORING OF SURFACE AND GROUNDWATER

The proposed landfill site is located adjacent to the wetland fringe of the Albemarle Sound. Several surface water bodies are present in the immediate vicinity of the landfill. The wetland areas will allow adequate monitoring of surface water quality in the vicinity of the landfill. The affect of the landfill on groundwater quality will be determined by analysis of groundwater samples collected from monitor wells placed around the landfill.

8.2.1 Groundwater Monitoring

Groundwater samples will be obtained from the monitor wells installed in the vicinity of the landfill prior to its operation. These water quality data will serve as background data by which to evaluate any impacts to the groundwater from the landfill operations. A series of wells will be installed outside of the landfill cells. Additional monitor wells may be added as subsequent cells are constructed to increase the areal extent of the monitored area.

As the sand soils present above elevation minus 30 are the most permeable horizon, monitor wells should be screened to the top of the finer materials encountered beneath the sand. Screen lengths of 15 to 20 feet should be sufficient to monitor this zone.

Actual requirements for monitoring, including the number and location of wells required will be provided during the design phase of the project. Since groundwater impact from the existing landfill has been noted the new landfill should be located as far to the east as possible to allow separation from the existing landfill.

The well locations will be based on groundwater flow direction and subsurface conditions that may present preferential groundwater flow paths. The sampling events will monitor any compounds that accumulated near the water table surface, as well as denser compounds that would tend to accumulate at the base of the sand strata.

8.3 GEOLOGIC LOCATION RESTRICTIONS

Several geologic conditions restrict the use of sites for landfills. Solid Waste Management Rules restrict construction of landfills within seismically active areas unless it can be shown that the landfills are designed to withstand earthquake forces. In addition, landfills may be restricted if weak or unstable soils are present, or if faults exist within 200 feet of

the site.

8.3.1 Faults

Current landfill regulations prohibit the construction of new landfills within 200 feet of a fault that has displacement in the last 10,000 years (Holocene time to the present) unless it can be demonstrated that the structural integrity of the landfill will be protective of human health and the environment.

Based on our review of available literature, we can find no evidence of any known or suspected faults within 10 miles of the site. The closest suspected fault is the Roanoke Island - Goldsboro Fault. As the extent of this fault is entirely covered by Coastal Plan sediments, its suspected location is based on a pattern of truncated magnetic anomalies. The fault is oriented east-southwest passing beneath Roanoke Island, and the towns of Greenville, Farmville, and Goldsboro. Figure 9 shows a reproduced portion of Plate 1 (NCGS - Bulletin 95, 1993). The location of the fault is shown as being covered by 1,500 to 2,000 feet of sediments in the Plymouth Area.

8.3.2 Seismically Active Zones

North Carolina Solid Waste Management Rules define a Seismic Impact Zone as an area with a 10 percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percent of the earth's gravitational field will exceed 0.10 g in 250 years.

Our review of available literature, suggests the site is not located in a Seismic Impact Zone. This region of the Coastal Plain Province is considered to be inactive relative to potential seismic and tectonic activity.

Figure 10 shows a reproduction of a portion of Map C from "Probabilistic Earthquake acceleration and Velocity Maps for the United States and Puerto Rico",(U.S. Geological Survey Map MF2120, by Algermissen et al, 1990). The proposed landfill is located within an area where the peak acceleration is not expected to exceed 0.09g in 250 years.

8.3.3 Unstable Areas

No widespread weak or unstable areas were observed during a traverse of the site that would preclude its use as a landfill. Soil conditions were encountered in the sands that ranged from very dense to loose relative densities. Variations in soil strength and settlement characteristics will be addressed during an additional phase of the work performed for design of the landfill.

REFERENCES

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.

Bouwer, H.,1989, The Bouwer and Rice Slug Test - An Update: Ground water, Volume 27, Number 3,pp 304-309.

Fetter, C. W., 1988, Applied Hydrogeology: Charles E. Merril Publishing Co., 592 pp.

Lawrence, D.P., and Hoffman,C.W., 1993, Geology of basement Rocks Beneath the North Carolina Coastal Plain: North Carolina Geological Survey Bulletin 95, 60 pp, Plate 1.

Nelson, P. F., 1964, Geology and Ground-Water Resources of the Swanquarter Area, North Carolina: North Carolina Department of Water Resources Ground-water Bulletin 4, 79 pp.

North Carolina Geological Survey, 1985, Geological Map of North Carolina: North Carolina Dept. of Natural Resources and Community Development, Raleigh, N.C., 1 Sheet.

Soil Survey of Washington County, 1981, USDA Soil Conservation Service.

TABLE 1
PIEZOMETER AND BORING LOCATIONS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

PIEZOMETER OR BORING LOCATION	NORTH CAROLINA PLANE COORDINATE SYSTEM		GROUND SURFACE ELEVATION	TOP OF CASING ELEVATION
	NORTH COORDINATE	EAST COORDINATE		
SP-1	798,243.40	2,691,263.00	5.3	6.68
DP-1	798,242.50	2,691,285.66	3.8	7.22
SP-2	798,688.75	2,691,425.31	8.4	9.34
DP-2	798,674.62	2,691,447.54	7.4	7.95
SP-3	799,045.01	2,691,887.85	6.5	8.69
SP-4	799,374.25	2,692,333.87	4.0	8.08
DP-4	799,391.85	2,692,362.09	3.1	6.38
SP-5	797,987.33	2,691,695.99	10.3	12.11
DP-5	797,973.65	2,691,690.77	10.5	11.31
SP-6	798,347.41	2,692,170.32	6.2	7.76
SP-7	798,741.20	2,692,593.64	6.3	7.11

NOTE: Survey data provided by Roanoke Land Surveying

TABLE 2
SUMMARY OF WATER LEVEL READINGS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

PIEZOMETER NUMBER	GROUNDWATER ELEVATION ON DATE SHOWN		
	24 HRS ATB	FEB 14, 1994	FEB. 22, 1994
SP-1	2.8	4.68	4.74
DP-1	3.3	3.22	3.28
SP-2	3.2	NR	3.10
DP-2	0.0	1.4	2.13
SP-3	3.3	3.25	3.23
SP-4	1.0	3.17	3.30
DP-4	1.6	1.77	2.38
SP-5	4.2	NR	3.87
DP-5	2.9	3.05	3.23
SP-6	3.9	3.95	3.95
SP-7	3.8	4.30	3.96

Notes: Piezometer numbers correspond with boring numbers. DP-4 was installed in Boring B-4. Shallow piezometers (SP) were installed in offset borings. Piezometer/boring locations are shown on Figure 1.

Initial water level readings were obtained approximately 24 hours after termination of boring (ATB). The dates of boring completion ranged from January 18 through February 4, 1994. The date of completion is shown on each test boring record.

Groundwater elevations are based on ground surface and top of casing elevations furnished by Roanoke Land Surveying.

TABLE 3
ESTIMATED HYDRAULIC CONDUCTIVITY FROM IN-SITU MEASUREMENTS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

PIEZOMETER NO.	HYDRAULIC CONDUCTIVITY (K) in cm/sec	SCREEN INTERVAL DEPTH	LITHOLOGY OF SCREENED INTERVAL
IN-SITU MEASUREMENTS - SHALLOW PIEZOMETERS			
SP-1 Test (1) Test (2)	 2.5×10^{-3} 1.9×10^{-3}	10-20 Ft.	Medium to Coarse Sand, 10' to 18' Silty Clay, 18' to 20'
SP-2 Test (1) Test (2)	 2.6×10^{-3} 1.8×10^{-3}	10-20 Ft.	Medium to Coarse Sand, 10' to 20'
SP-3	 1.9×10^{-5}	15-25 Ft.	Medium to Coarse Sand, 15' to 23' Silty Clay, 23, to 25'
SP-6 Test (1) Test (2)	 5.3×10^{-4} 5.3×10^{-4}	10-20 Ft.	Sandy Silty Clay, 10' to 16' Silty Fine Sand, 16' to 21'
SP-7 Test (1) Test (2)	 6.4×10^{-5} 6.4×10^{-5}	10-20 Ft.	Medium Sand, 10' to 18' Coarse Sand with Gravel, 18' to 20'
IN-SITU MEASUREMENTS - DEEP PIEZOMETERS			
DP-1	1.4×10^{-5}	40-50 Ft.	Fine Sand, 40' to 41' Fine Sandy Silty Clay, 41' to 50'
DP-2	9.0×10^{-6}	40-50 Ft.	Fine Sandy Silt, 40' to 46' Clayey Silt, 46' to 50'
DP-4	3.1×10^{-5} 3.3×10^{-5} (H)	40-50 Ft.	Silty Fine Sand, 40' to 48' Clayey Silt, 48' to 50'
DP-5	2.3×10^{-5}	40-50 Ft.	Fine Sandy Silt, 40' to 50'

Note: All hydraulic conductivity values were estimated using the Bouwer & Rice Approximation
(H) Hydraulic conductivity value estimated by Horslev method

TABLE 4
ESTIMATED VALUES OF HYDRAULIC CONDUCTIVITY FROM GRAIN SIZE
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

BORING NUMBER	SAMPLE DEPTH IN FEET	EFFECTIVE GRAIN SIZE (D_{10})	UNIFORMITY COEFFICIENT (D_{60})/D_{10}	HYDRAULIC CONDUCTIVITY K M CM/SEC	SOIL CLASSIFICATION
B-1	3.5-5.0	0.19 mm	2.11	3.6×10^{-2}	Tan Brown Fine Sand (SP)
B-1	38.5-40.0	0.16 mm	1.56	2.6×10^{-2}	Gray Brown Fine Sand (SP)
B-3	8.5-10.0	0.13 mm	2.15	1.7×10^{-2}	Brown and Tan Fine Sand (SP)
B-4	1-2.5	0.12 mm	2.42	1.4×10^{-2}	Gray and Brown Fine Sand (SP)
B-4	23.5-25.0	0.10 mm	2.3	1×10^{-2}	Gray Fine Sand (SP)

otes: Hydraulic conductivity estimated from Hazen's Method
Effective grain size (D_{10})is obtained from the gradation tests

TABLE 5
SELECTED SCS SOIL CHARACTERISTICS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

Soil Series Type Symbol	Conetoe Cta	Dorovan Do	Muckalee Me	Augusta At
General Soil Characteristics and Areal Extent				
Approximate Extent of Soil Group	100 Percent Entire Site	Possible North Fringe of Site	Possible Southeast Fringe	Possible Southwest Edge
Slope	0 to 3 Percent	Less than 1 Percent	Less than 2 Percent	0 to 2 Percent
Depth to High Water Table	Greater than 6 Feet	0.5 to 1.0 Feet	0.5 to 1.5 Feet	1.0 to 2.0 Feet
Soil Reaction (pH)	4.5 to 6.0	4.5 to 5.5	5.1 to 7.3	4.5 to 6.0
Corrosivity Steel/Concrete	Low/High	High/High	High/Moderate	High/Moderate
General Soil Suitability for Construction or Site Development				
Sanitary Landfill Area	Severe: Seepage	Severe: Floods	Severe: Floods	Severe: Wetness
Daily Cover for Landfill	Poor: Too Sandy	Poor: Excess Humus	Poor: Wetness	Fair: Wetness
Shallow Excavations	Severe: Cutbanks Cave	Severe: Excess Humus	Severe - Wetness Cutbacks Cave	Severe: Wetness
Embankments Dikes & Levees	Severe: Seepage - Piping	Severe: Excess Humus	Severe - Wetness Seepage - Piping	Severe: Piping Wetness
Description of Suitability Ratings (1)				
Good, Slight	Soil properties are favorable for the specified use. Limitations are minor and easily overcome.			
Fair, Moderate	Soil properties are unfavorable, but can be overcome or modified by special planning or design.			
Poor, Severe	Soil properties are so unfavorable and difficult to correct that major soil reclamation, special design, or intensive maintenance is required.			

1) Suitability ratings are based on the soil characteristics exhibited in the near surface soils to depths of 89 inches or less.
Source: Soil Survey of Washington County, N.C., 1981, USDA Soil Conservation Service

TABLE 6
SUMMARY OF OVA DATA
WASHINGTON COUNTY LANDFILL
SOIL BORINGS - JANUARY, 1994
S&ME PROJECT NO. 1054-94-119

BORING	B-1		B-2		B-3		B-4		B-5		B-6		B-7	
DEPTH INTERVAL	S	M	S	M	S	M	S	M	S	M	S	M	S	M
	ALL VALUES SHOWN BELOW ARE IN PARTS PER MILLION													
1.0 - 2.5	0	0	0	0	3	0	0	0	4	2	0	0	0	0
3.5 - 5.0	0	0	0	0	0	0	30	15	2	1	0	0	0	0
6.0 - 7.5	0	0	0	0	2	0	NR	NR	2	0	300	40	0	0
8.5 - 10.0	0	0	0	0	0	0	700	85	0	0	75	10	0	0
13.5 - 15.0	0	0	0	0	0	0	85	4	0	0	30	0	0	0
18.5 - 20.0	40	4	NR	NR	3	0	30	0	0	0	30	0	200	50
23.5 - 25.0	110	25	1	0	30	0	7	0	3	0	90	30	350	40
28.5 - 30.0	120	44	400	60	50	50	UD	UD	40	15	80	25	400	60
33.5 - 35.0	200	32	200	40	50	20	85	25	100	15	100	25	300	25
38.5 - 40.0	10	0	700	200	NE	NE	NR	NR	400	40	150	30	350	40
43.5 - 45.0	38	0	800	70	100	10	NR	NR	400	35	200	12	600	100
48.5 - 50.0	100	15	600	150	100	30	200	15	390	90	175	20	700	100

NOTES: S = Standard Tip
M = Methane filter tip
NR = No sample recovered
UD = Undisturbed sample, no analysis performed
NE = No entry, no analysis performed

TABLE 7
SUMMARY OF LABORATORY
SOIL CLASSIFICATION TESTS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

GRADATION TESTS

BORING	B-1	B-1	B-3	B-4	B-4	B-5	UD
DEPTH	3.5-5.0	38.5-4.0	8.5-10	1.0-2.5	23.5-25	33.5-35	1.0-3.0
SIEVE SIZE	ALL VALUES SHOWN ARE PERCENT PASSING THE SIEVE SIZE SHOWN						
3/8"	100		100		60		
#4	99.6	100	99.1	100	100	100	100
#10	98.7	100	96.7	100	100	99.4	100
#20	92.8	99.7	88.4	99.9	100	99.2	99.6
#40	60.8	94.4	71.0	91.6	99.3	98.9	95.3
#60	15.5	60.5	46.9	44.8	84.3	97.3	87.9
#100	3.6	9.7	12.0	10.2	18.8	63.5	75.6
#200	1.4	3.9	4.9	5.0	4.9	50.4	62.4

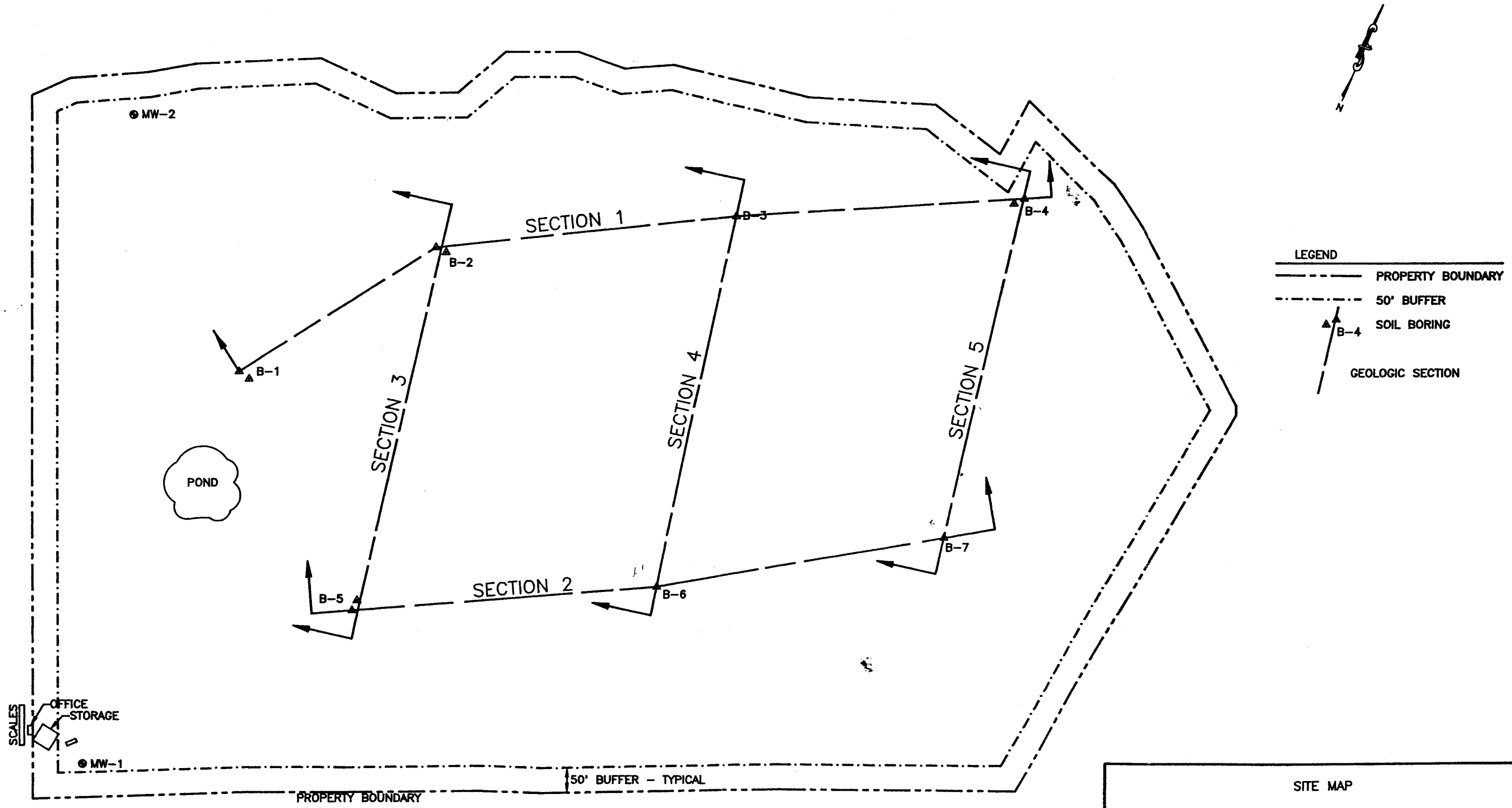
ATTERBERG LIMITS TESTS

BORING	B-2	B-3	B-6	B-6	UD
DEPTH	28.5-30.0	43.5-45	8.5-10.0	48.5-50	1.0-3.0
LIQUID LIMIT (LL)	33	61	105	28	40
PLASTICITY INDEX (PI)	1	29	70	12	22
SOIL CLASSIF.	SM	MH	CH	CL	CL

LABORATORY HYDRAULIC CONDUCTIVITY TEST

LABORATORY PERMEABILITY TEST - ASTM C-5084, Method C

BORING	DEPTH INTERVAL IN FEET	CALCULATED HYDRAULIC CONDUCTIVITY (K)	SOIL DESCRIPTION
Hand Auger #1 (UD)	1.0 - 3.0	5.0×10^{-6} CM/SEC	Dark Gray and Orange Sandy Clay
PHYSICAL PROPERTIES TESTS			
	Porosity	0.352	
	Specific Gravity	2.70	
	Moisture Content	18.6%	



0 100 200 300 400

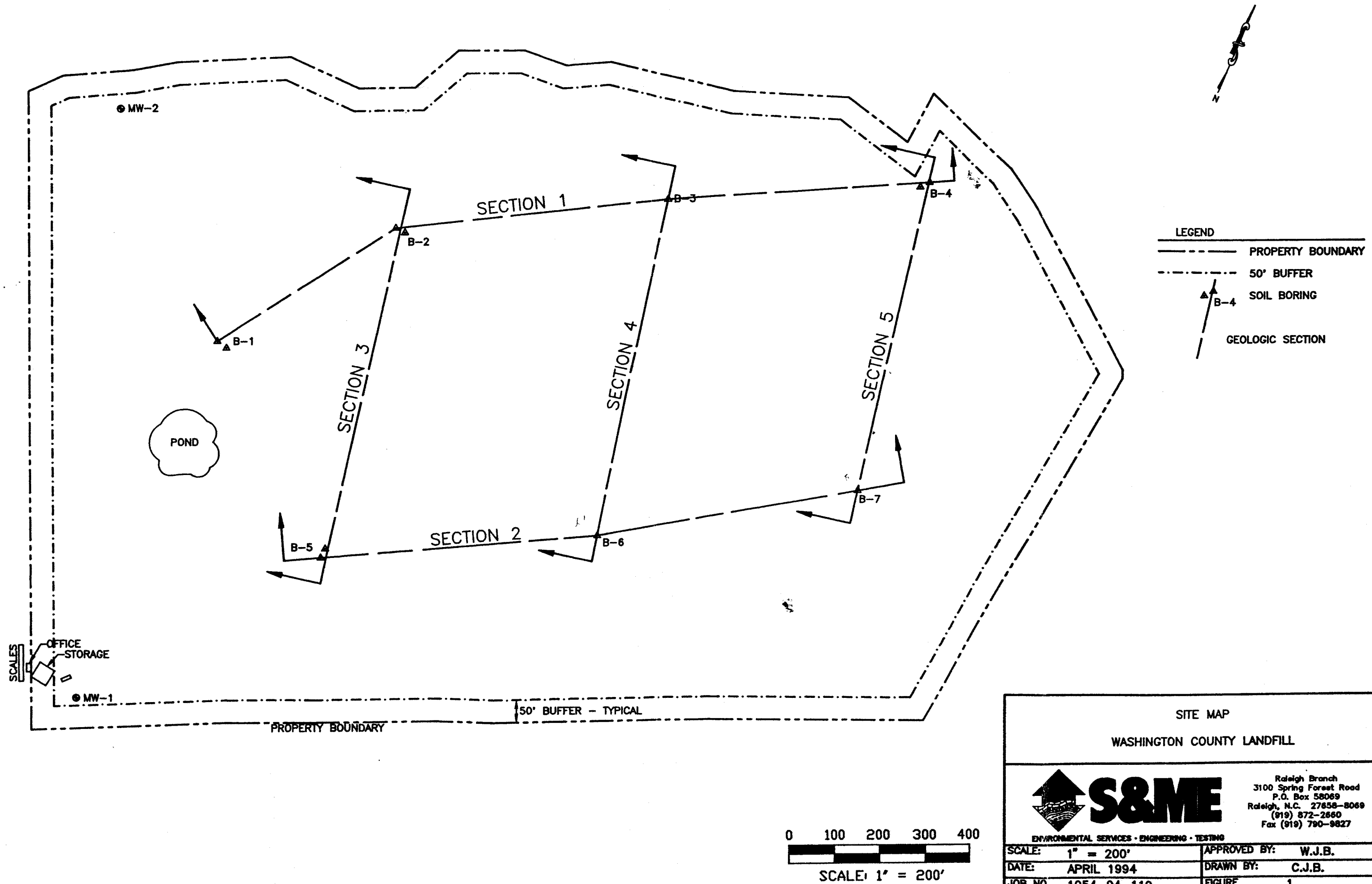
SCALE: 1" = 200'

SITE MAP

WASHINGTON COUNTY LANDFILL

S&ME
ENVIRONMENTAL SERVICES • ENGINEERING • TESTING
Raleigh Branch
3100 Spring Forest Road
P.O. Box 58069
Raleigh, N.C. 27658-8069
(919) 872-2660
Fax (919) 790-9827

SCALE:	1" = 200'	APPROVED BY:	W.J.B.
DATE:	APRIL 1994	DRAWN BY:	C.J.B.
JOB NO.	1054-94-119	FIGURE	1



SITE MAP

WASHINGTON COUNTY LANDFILL

S&ME

ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

Raleigh Branch
3100 Spring Forest Road
P.O. Box 58069
Raleigh, N.C. 27658-8069
(919) 872-2660
Fax (919) 790-9827

SCALE:	1" = 200'	APPROVED BY:	W.J.B.
DATE:	APRIL 1994	DRAWN BY:	C.J.B.
JOB NO.	1054-94-119	FIGURE	1

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

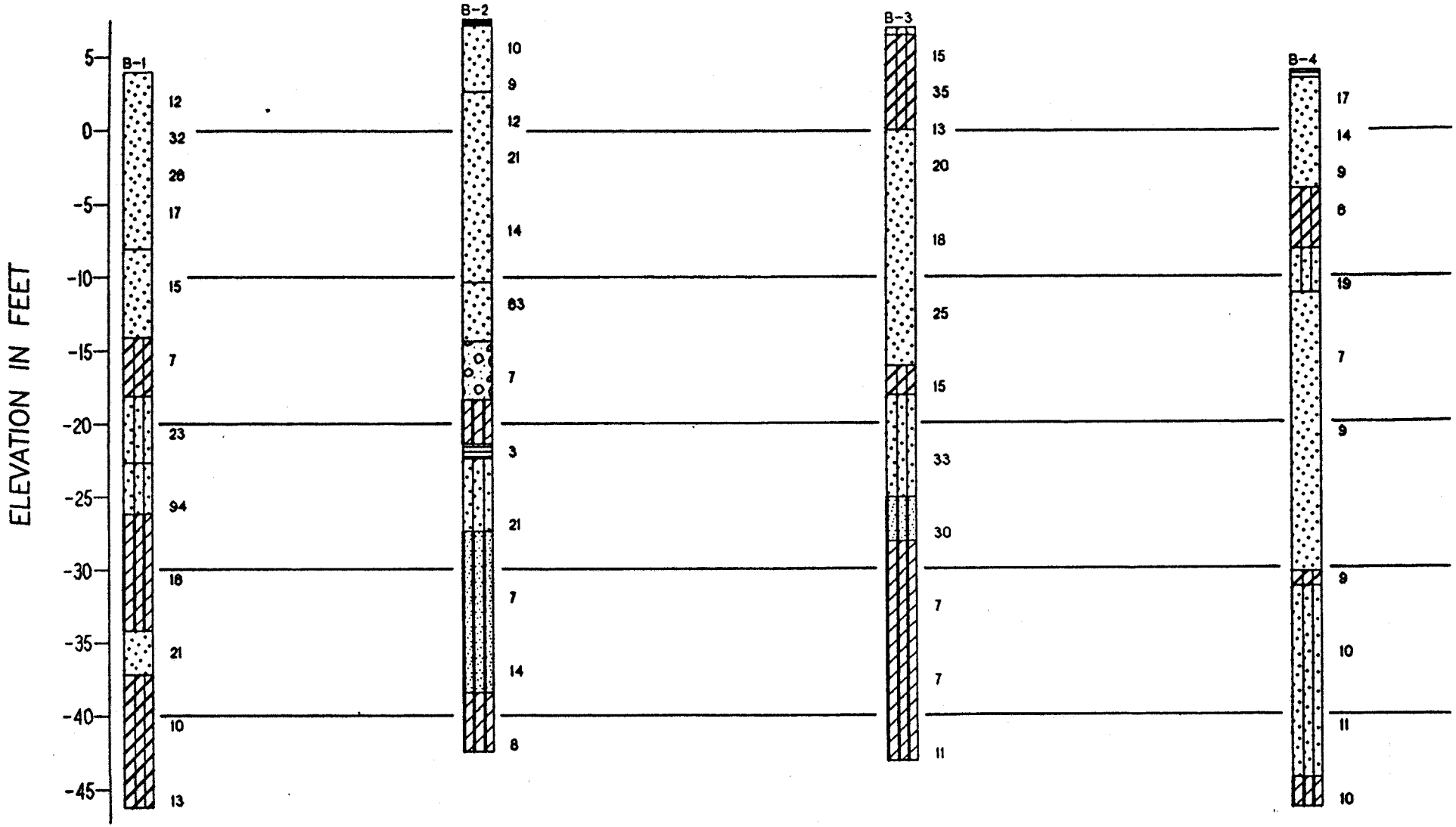
RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME
Environmental Services ▪ Engineering ▪ Testing

GEOLOGIC SECTION 1



SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	2

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

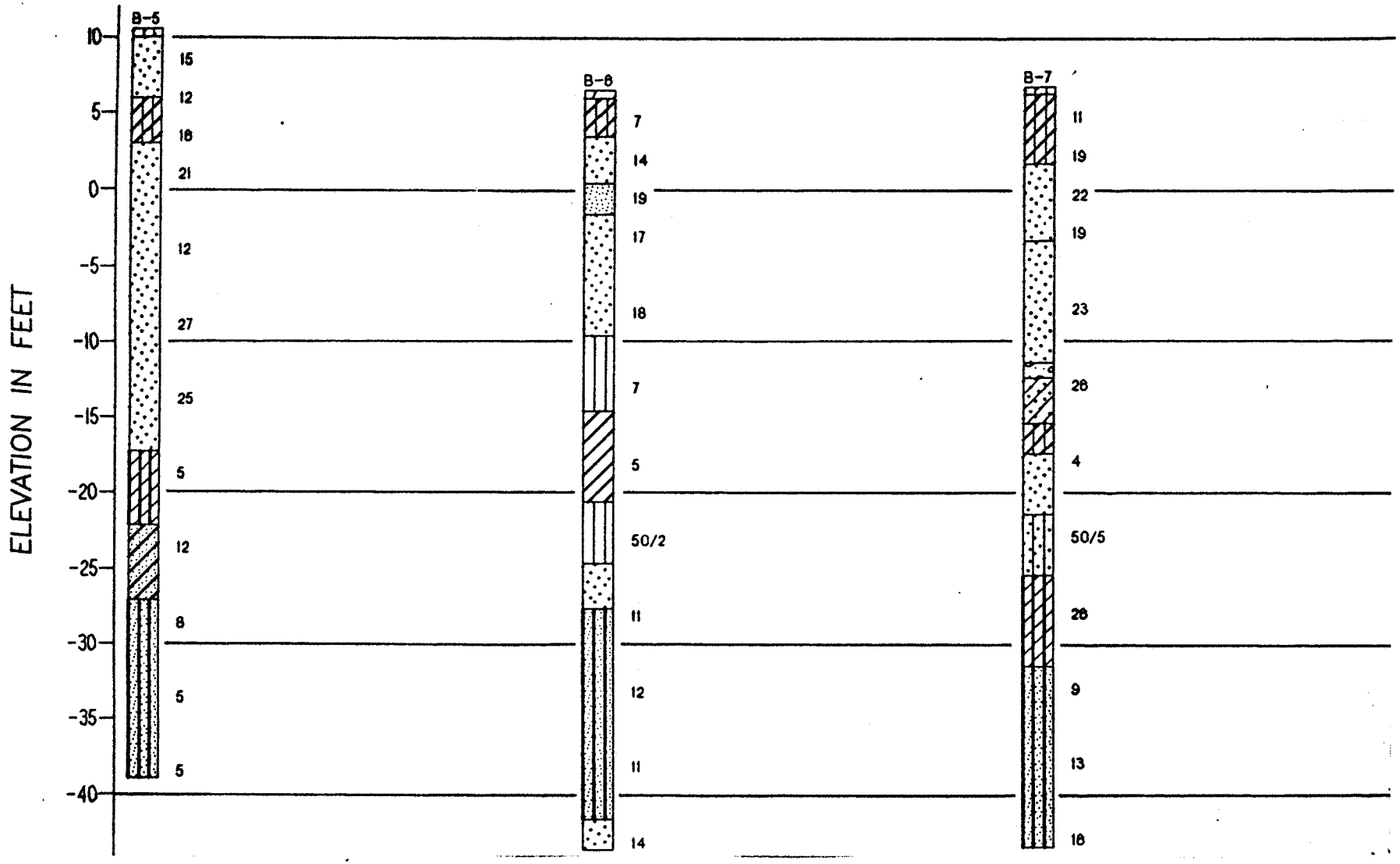
OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME

Environmental Services # Engineering # Testing

GEOLOGIC SECTION 2



SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	3

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

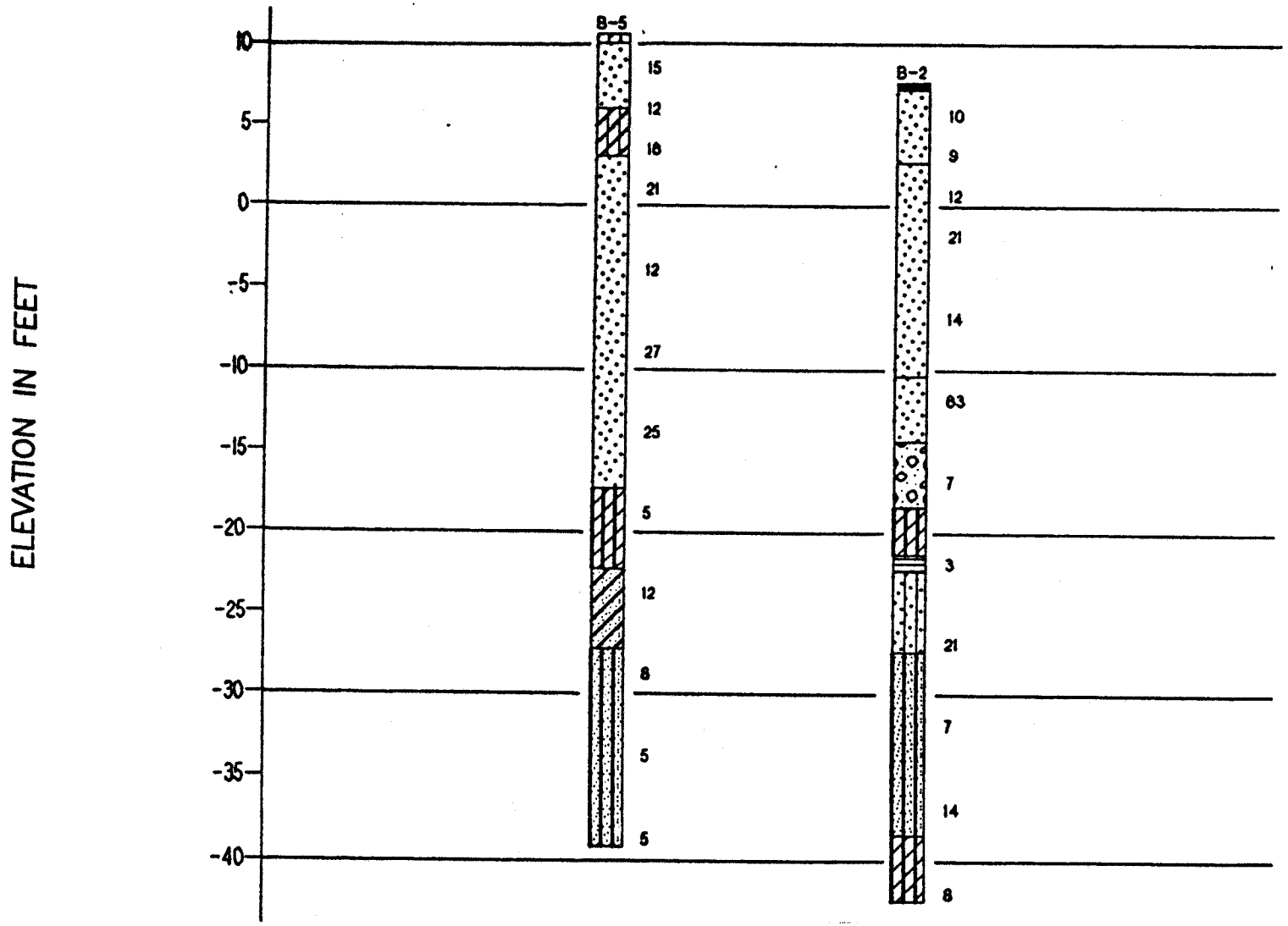
OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME

Environmental Services * Engineering * Testing

GEOLOGIC SECTION 3



SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	4

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

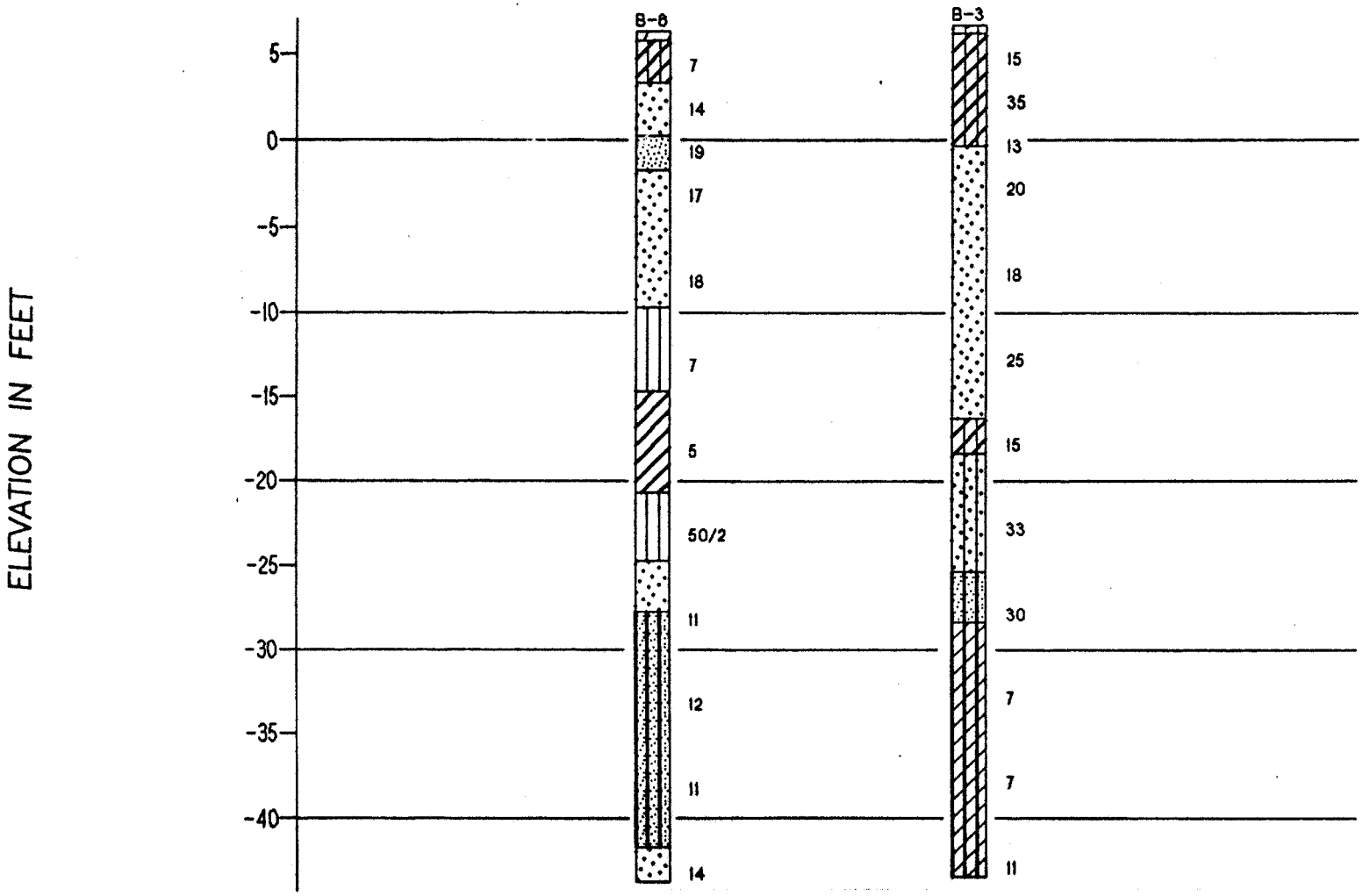
OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME

Environmental Services # Engineering # Testing

GEOLOGIC SECTION 4



SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	5

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

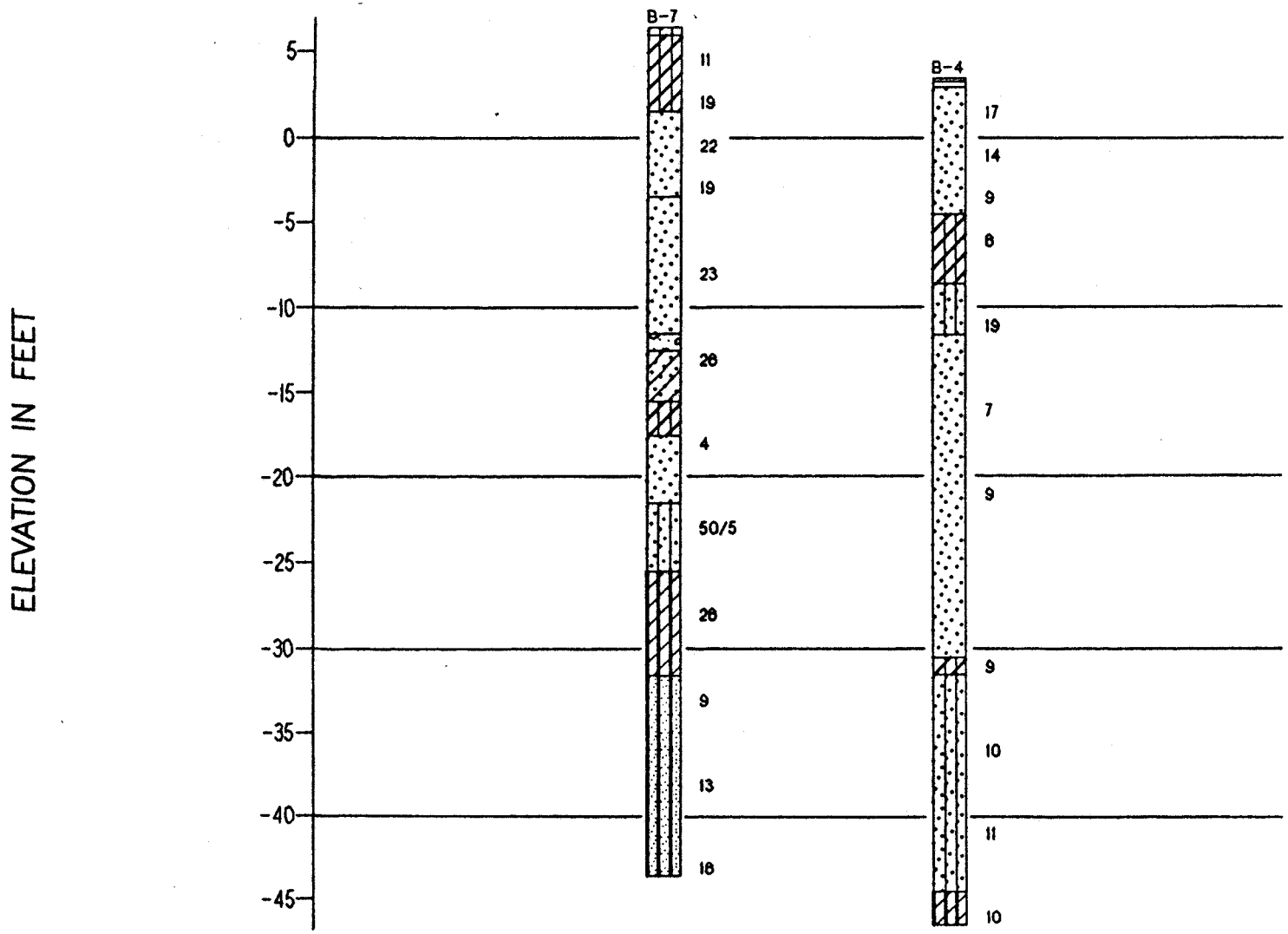
OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME

Environmental Services * Engineering * Testing

GEOLOGIC SECTION 5

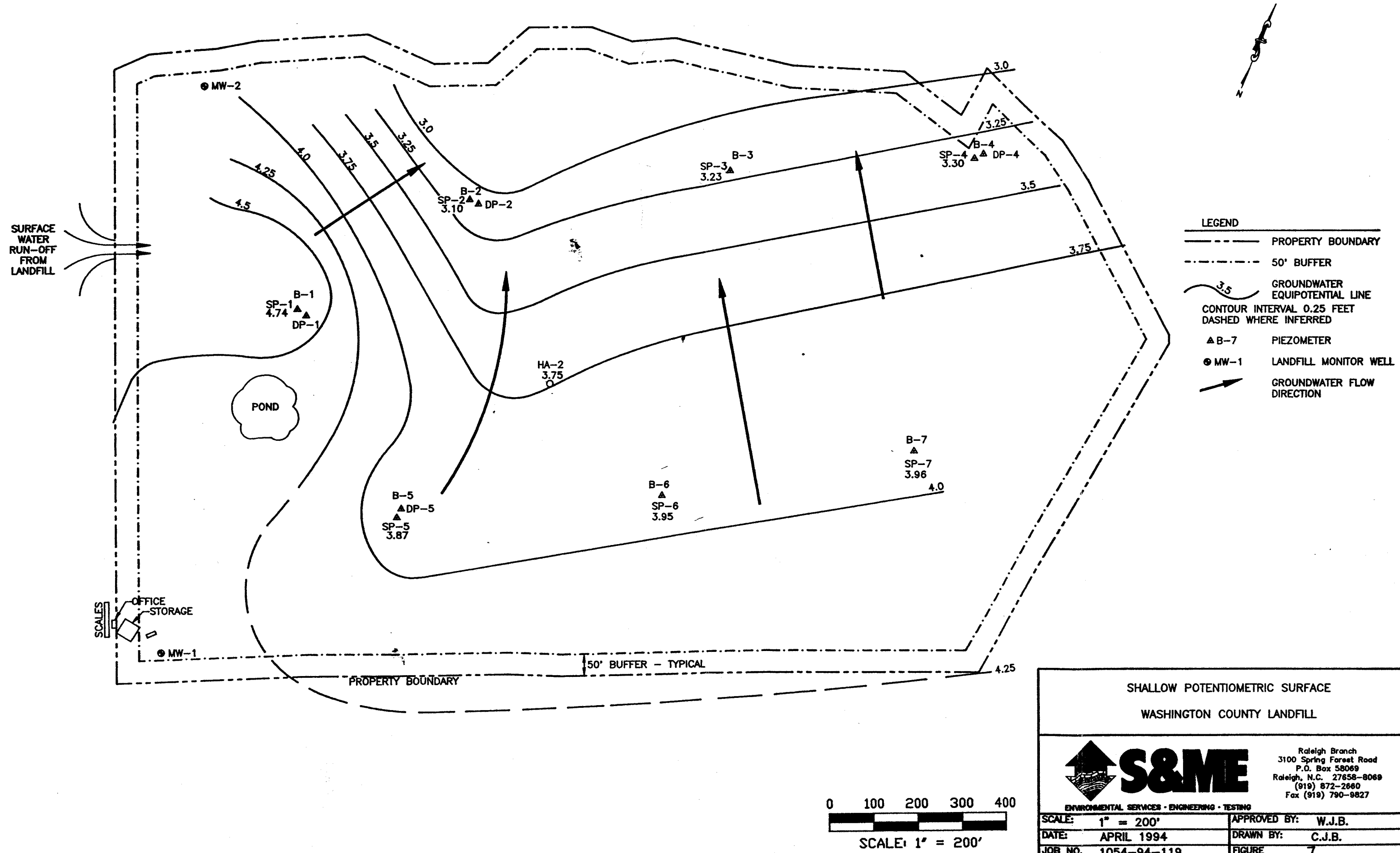


SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	6



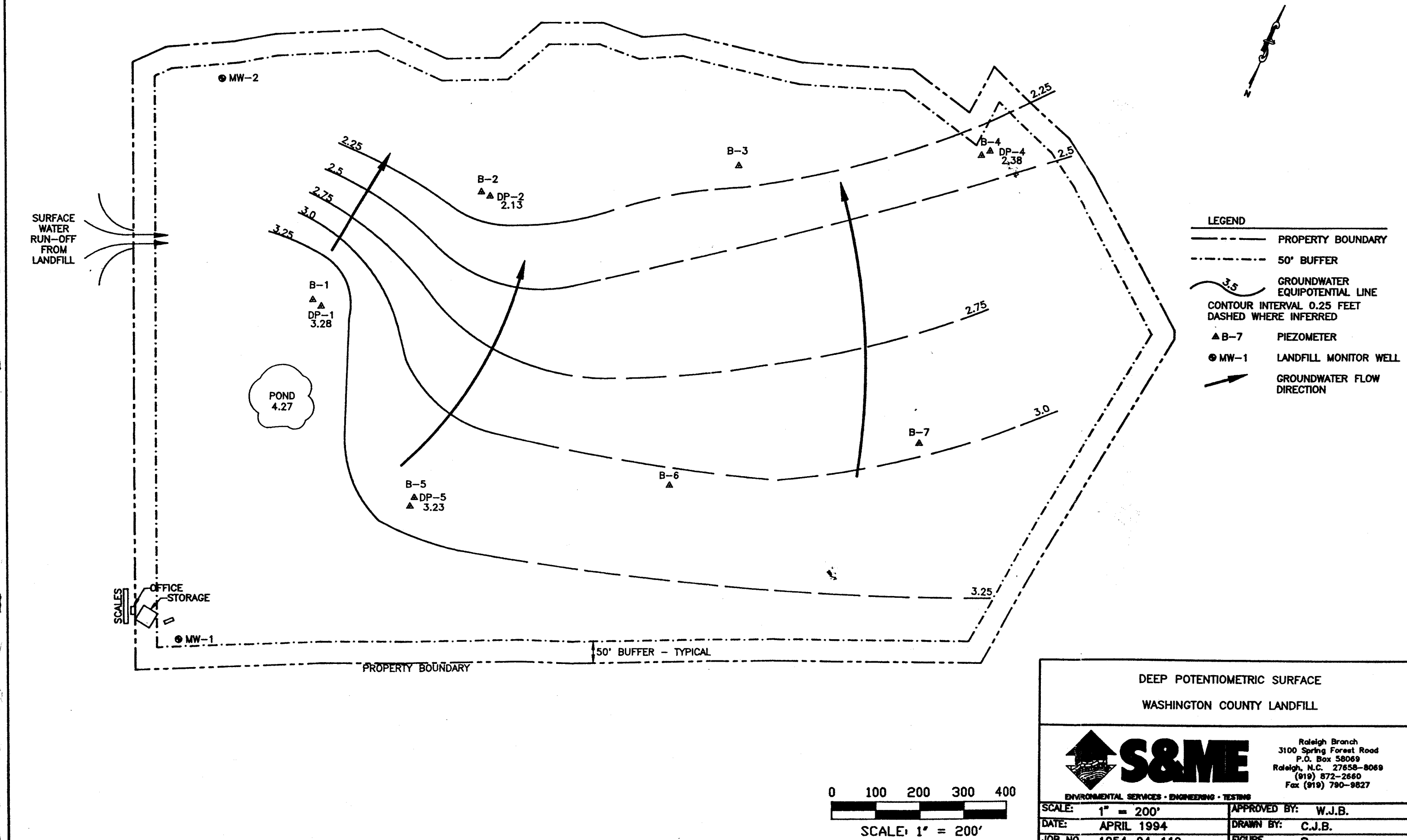
SHALLOW POTENTIOMETRIC SURFACE

WASHINGTON COUNTY LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

Raleigh Branch
3100 Spring Forest Road
P.O. Box 58069
Raleigh, N.C. 27658-8069
(919) 872-2660
Fax (919) 790-9827

SCALE:	1" = 200'	APPROVED BY:	W.J.B.
DATE:	APRIL 1994	DRAWN BY:	C.J.B.
JOB NO.	1054-94-119	FIGURE	7



DEEP POTENTIOMETRIC SURFACE

WASHINGTON COUNTY LANDFILL

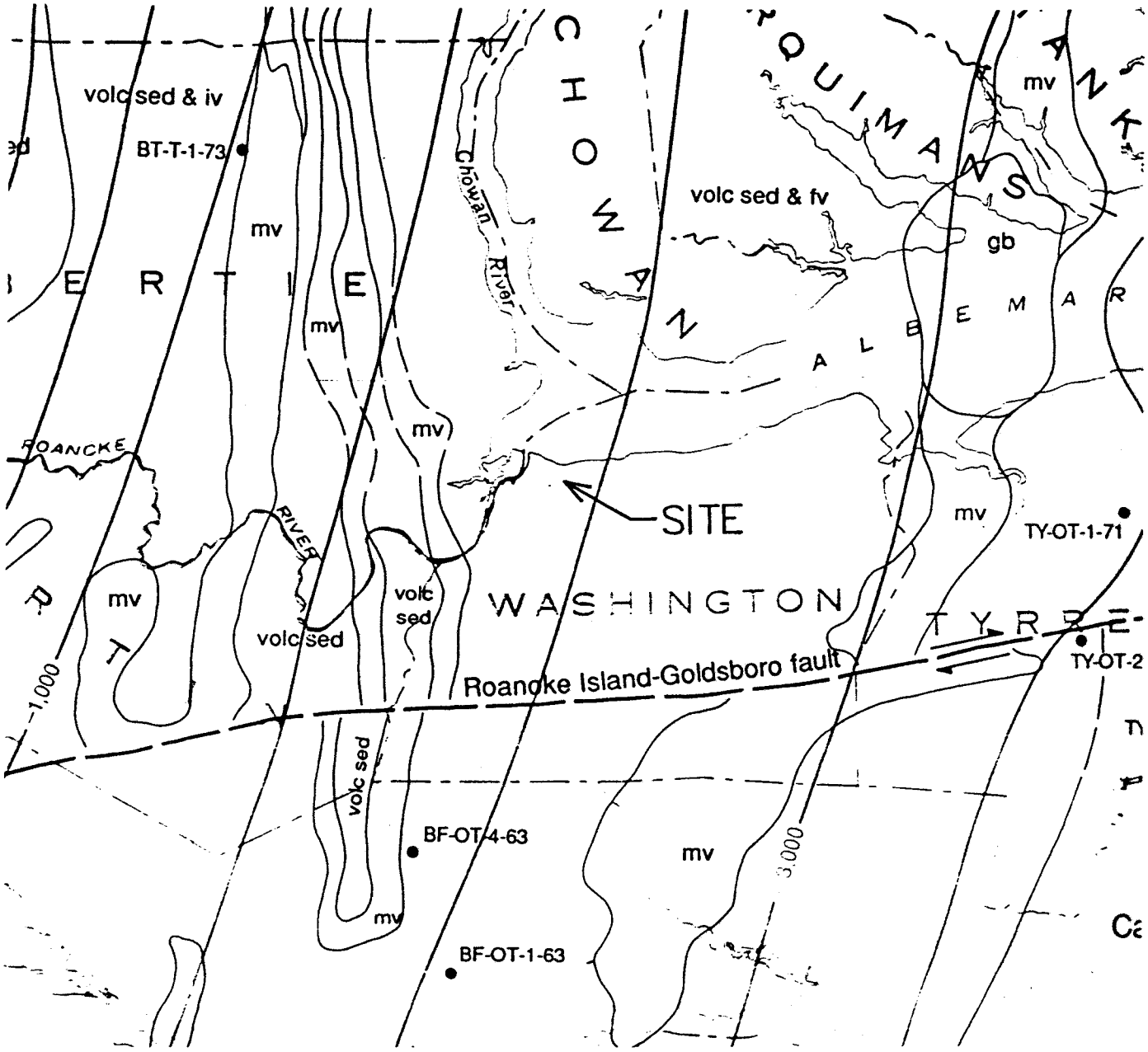
S&ME

ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

Raleigh Branch
3100 Spring Forest Road
P.O. Box 58069
Raleigh, N.C. 27658-8069
(919) 872-2660
Fax (919) 790-9827

SCALE:	1" = 200'	APPROVED BY:	W.J.B.
DATE:	APRIL 1994	DRAWN BY:	C.J.B.
JOB NO.	1054-94-119	FIGURE	8

SOURCE: Geology of basement rocks beneath the North Carolina Coastal Plain
North Carolina Geological Survey Bulletin 95, 1993



LEGEND

Fault compiled from literature sources – arrows indicate direction of relative displacement

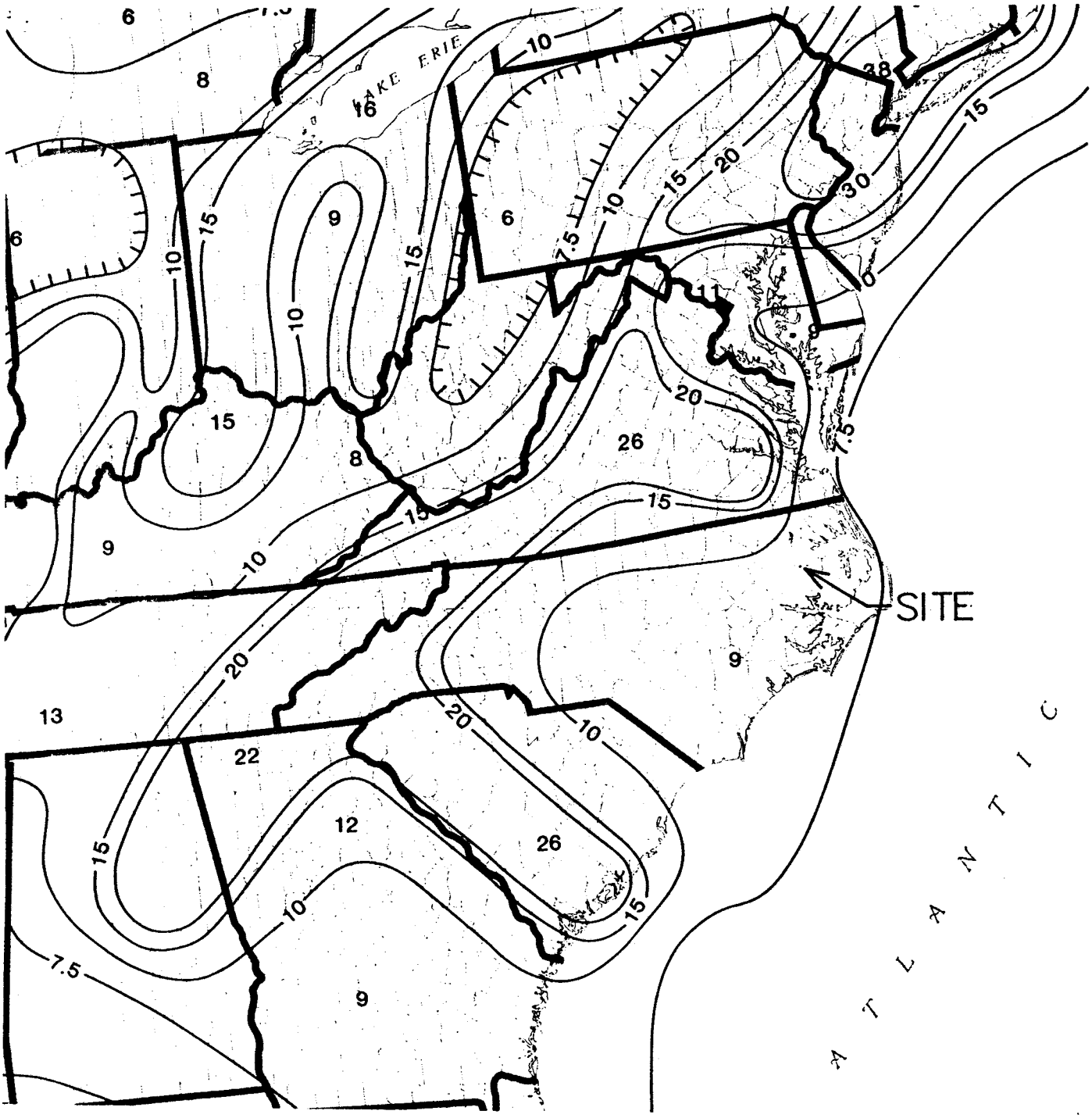
Inferred fault – arrows show direction of inferred relative displacement

Inferred thrust fault – saw teeth are on upper plate

200 Structure contour on basement surface in feet relative to mean level – the contour interval varies as follows:
From +200 feet to –1000 feet – 200–foot contour interval
From –1000 feet to –2000 feet – 500–foot contour interval
From –2000 feet to –10,000 feet – 1000–foot contour interval

FAULT MAP WASHINGTON COUNTY C & D LANDFILL	S&ME ENVIRONMENTAL SERVICES • ENGINEERING • TESTING	APPROVED BY: W.J.B. DRAWN BY: SCALE: 1 INCH=8 MILES Approx. JOB NO. 1054–94–119 FIGURE 9

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.

SEISMIC HAZARD MAP WASHINGTON COUNTY C & D LANDFILL	S&ME ENVIRONMENTAL SERVICES · ENGINEERING · TESTING	APPROVED BY: W.J.B. DRAWN BY: SCALE: 1:7,500,000 JOB NO. 1054-94-119 FIGURE 10

APPENDIX I
SOIL TEST BORING RECORDS

ABSTRACT

This appendix contains the Test Boring Records for borings B-1 through B-7. The location coordinates for each of these borings is shown on Table 1. The boring information is shown graphically on the Geologic Sections (Figures 2 through 6).

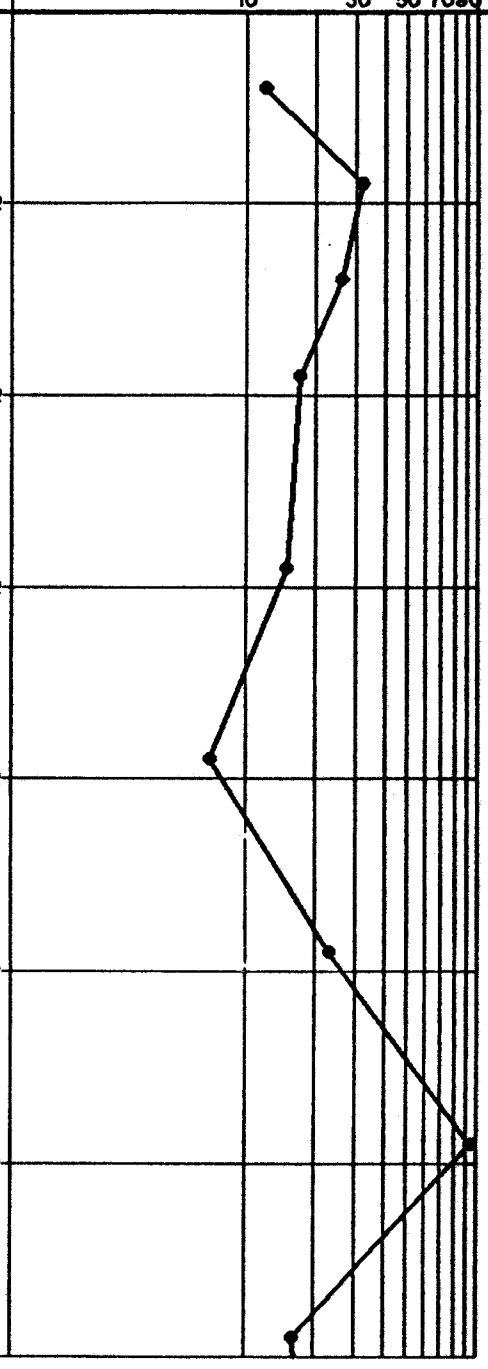
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-1

PROJECT NO.:	1054-94-119	ELEVATION:	3.8
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-18-94	WATER LEVEL:	0'-7"
DRILLING METHOD:	Hollow Stem Auger	DRILL RIG:	CME 450

NOTES:
Piezometer (DP-1) installed in boring at completion. Screen interval 40 to 50'. Shallow piezometer installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Medium Dense to Dense Tan to Light Brown Fine to Medium **SAND** (SP)					
5						-1.2	32
							28
10						-6.2	17
		Medium Dense Tan Medium to Coarse **SAND** (SP)					
15						-11.2	15
		Firm Gray Silty **CLAY** (CL)					
20						-16.2	7
		Medium Dense Gray Silty, Clayey Fine SAND with Fine Partially Decayed Organic Matter (SM)					
25						-21.2	23
		Very Dense Gray Silty Fine **SAND** (SM)					
30						-26.2	94
		Very Stiff Gray Fine Sandy Clayey **SILT** (ML)					
35						-31.2	16

Standard Penetration Test Data (Blows/ft)



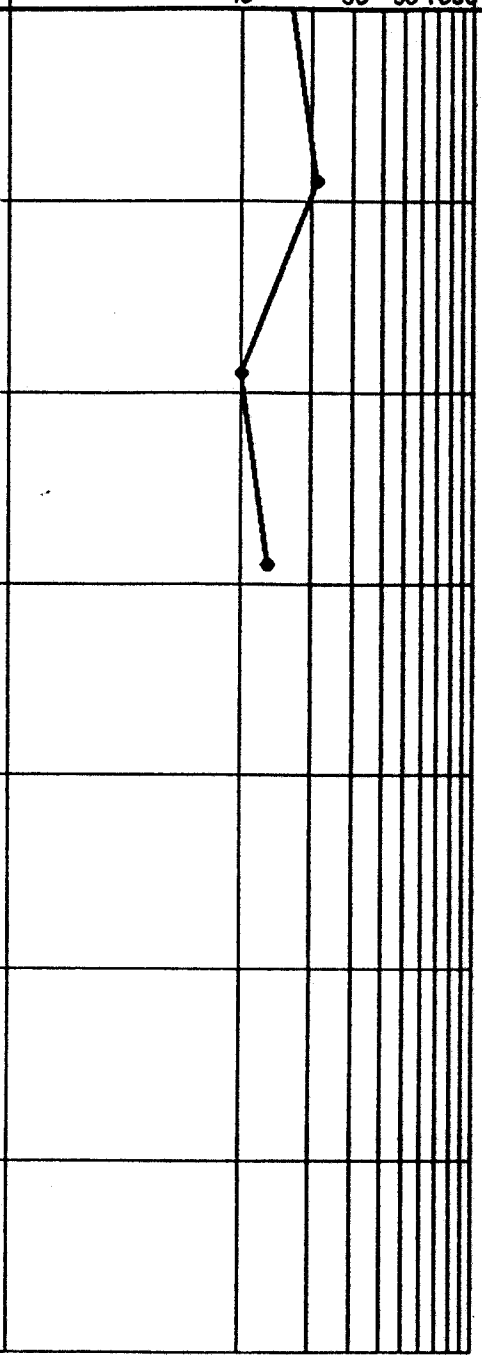
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-1
PROJECT NO.:	1054-94-119	ELEVATION:	3.8
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-18-94	WATER LEVEL:	0'-7"
DRILLING METHOD:	Hollow Stem Auger	DRILL RIG:	CME 450

NOTES:
Piezometer (DP-1) installed in boring at completion. Screen interval 40 to 50'. Shallow piezometer installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Medium Dense Gray Brown Fine SAND (SP)					
40						-36.2	21
		Stiff Gray Fine Sandy Silty CLAY (CL)					
45						-41.2	10
50						-46.2	13
		Boring Terminated at 50.0'					
55						-51.2	
60						-56.2	
65						-61.2	
70						-66.2	

Standard Penetration Test Data (Blows/ft)



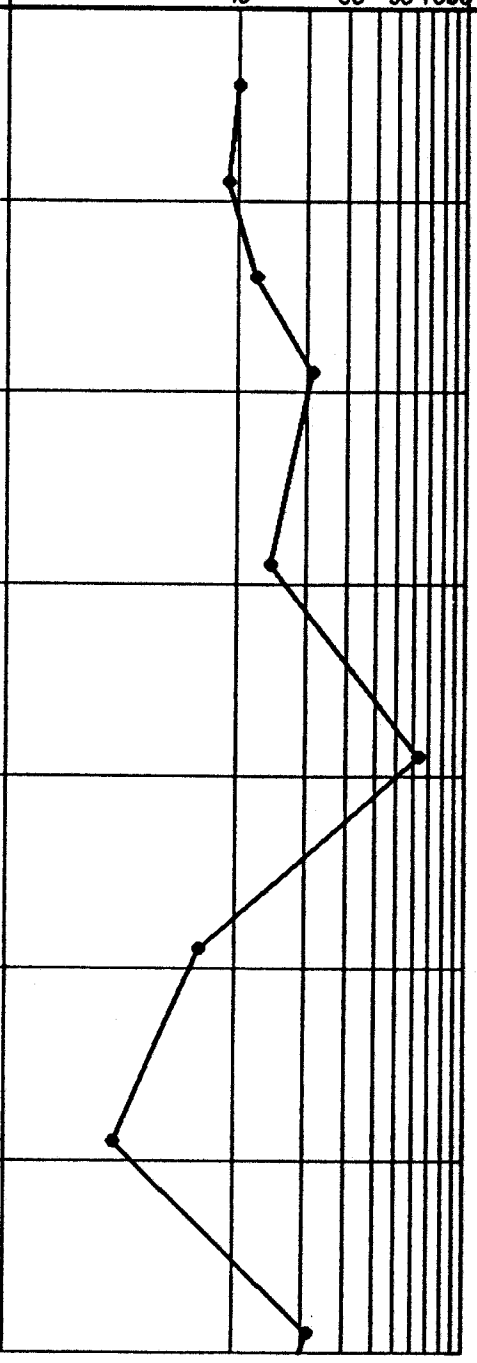
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-2
PROJECT NO.:	1054-94-119	ELEVATION:	7.4
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-27-94	WATER LEVEL:	8'-0"
DRILLING METHOD:	H.S.A./Wet Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-2) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
	Topsoil (SM)					
	Loose Tan to Light Brown Medium **SAND**					10
5	Medium Dense Tan to Light Brown Medium **SAND** (SP)				2.4	9
						12
10					-2.6	21
15					-7.6	14
20	Very Dense Tan Medium to Coarse **SAND** (SP)				-12.6	63
25	Loose Tan Coarse SAND and Small **GRAVEL** (SP-GP)				-17.6	7
	Soft Gray Fine Sandy Clayey **SILT** with Fine Decayed Organic Matter (ML-CL)					
30	Decayed Wood				-22.6	3
	Medium Dense Gray Silty Fine **SAND** with Fine Decayed Organic Matter (SM)					
35					-27.6	21

Standard Penetration Test Data (Blows/ft)



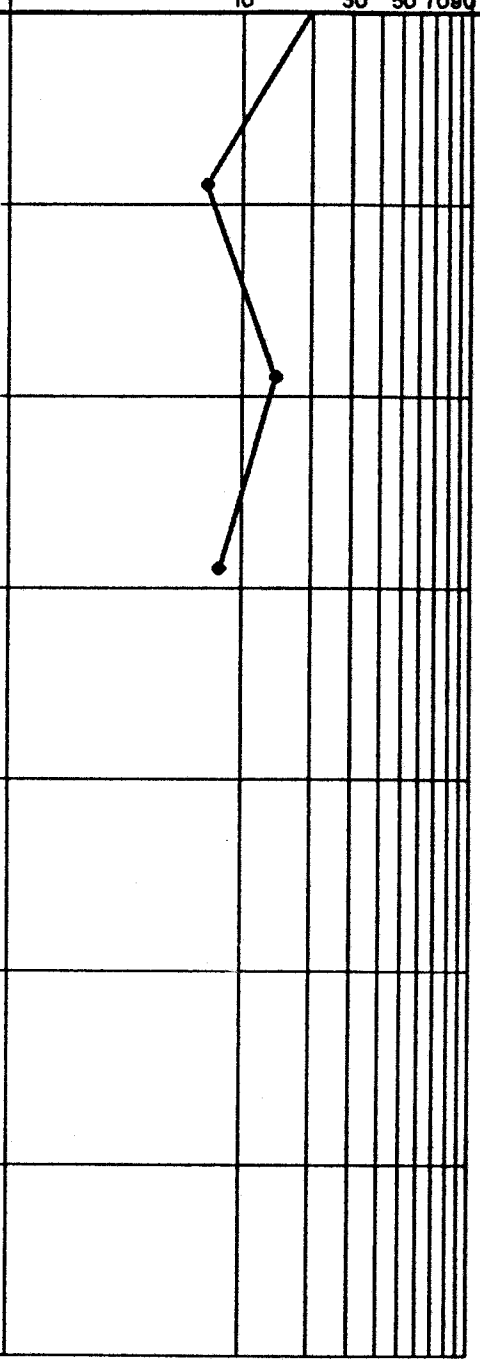
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-2
PROJECT NO.:	1054-94-119	ELEVATION:	7.4
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-27-94	WATER LEVEL:	8'-0"
DRILLING METHOD:	H.S.A./Wet Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-2) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Firm to Stiff Gray Fine Sandy SILT with Fine Decayed Organic Matter (ML)					
40						-32.6	7
45						-37.6	14
		Firm Gray Clayey SILT, with Fine Decayed Organic Matter (ML-CL)					
50		*Boring Terminated at 50.0'*				-42.6	8
55						-47.6	
60						-52.6	
65						-57.6	
70						-62.6	

Standard Penetration Test Data (Blows/ft)



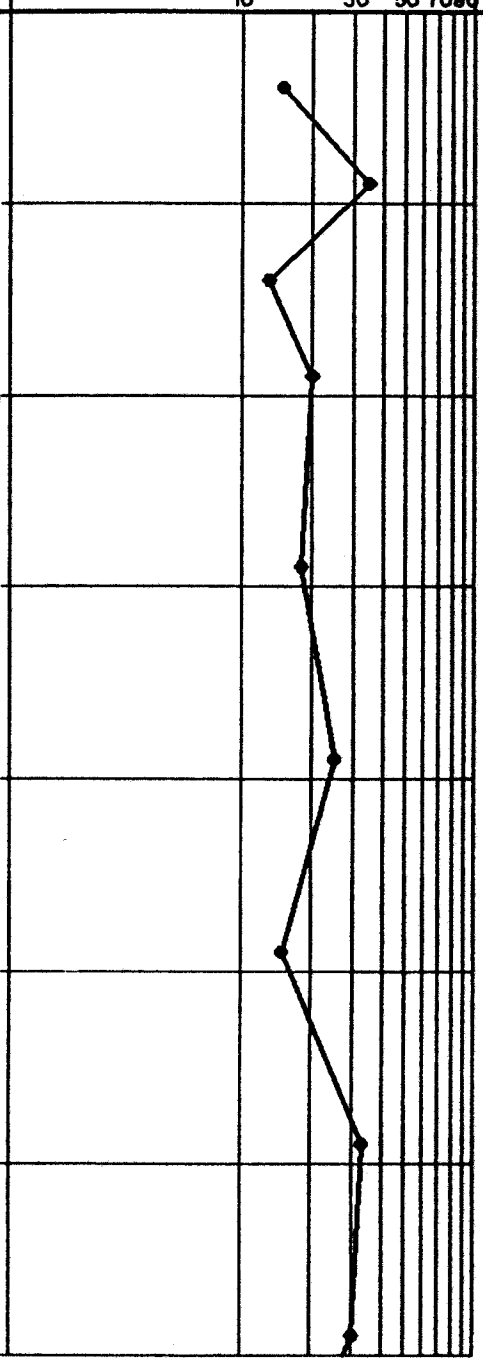
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-3
PROJECT NO.:	1054-94-119	ELEVATION:	8.5
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-2-94	WATER LEVEL:	3' - 3"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer installed in off-set boring.
Screened at 16' to 25 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Topsoil (SM)					
		Stiff to Very Stiff Tan and Gray Fine Sandy Silty Clay, with Some Roots (CL)					15, 35
5						1.5	
		Medium Dense Tan to Orange Brown Fine to Medium with Some Coarse SAND (SP)					13, 20
10						-3.5	
15						-8.5	18
20						-13.5	25
		Stiff Gray Silty CLAY (CL)					
25						-18.5	15
		Dense Gray Silty Fine to Medium SAND, with Fine Organic Matter (SM)					
30						-23.5	33
		Very Stiff Gray Very Fine Sandy SILT, with Fine Organic Matter (ML)					
35						-28.5	30

Standard Penetration Test Data (Blows/ft)

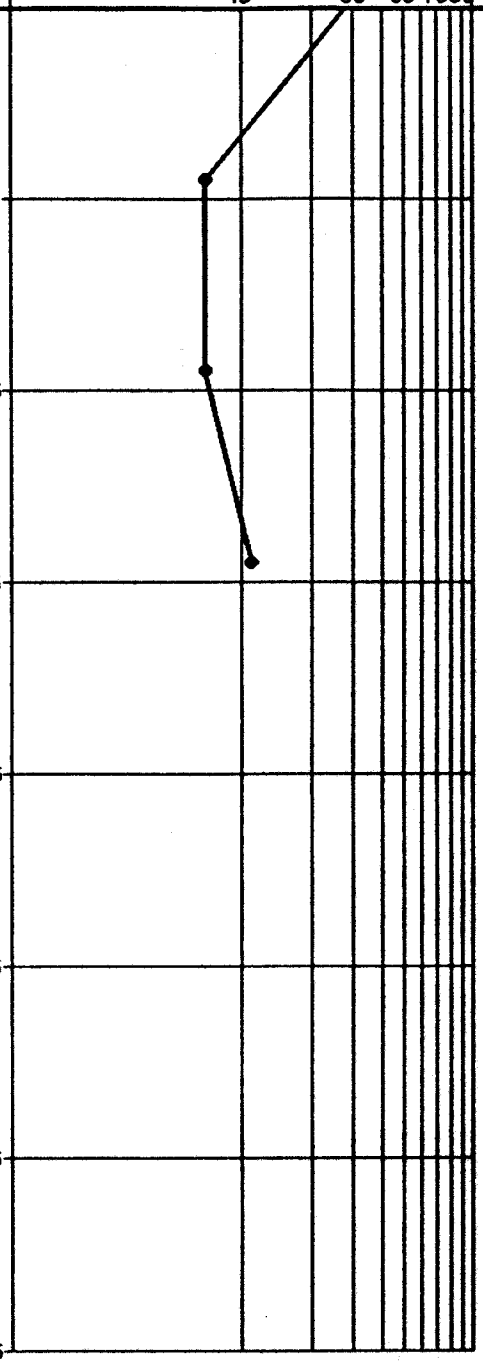


S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-3
PROJECT NO.:	1054-94-119	ELEVATION:	6.5
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-2-94	WATER LEVEL:	3' - 3"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer installed in off-set boring.
Screened at 15' to 25 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Firm to Stiff Dark Gray Clayey SILT, with Trace of Fine Sand (MH)					
40						-33.5	7
45						-38.5	7
50		*Boring Terminated at 50.0'*				-43.5	11
55						-48.5	
60						-53.5	
65						-58.5	
70						-63.5	



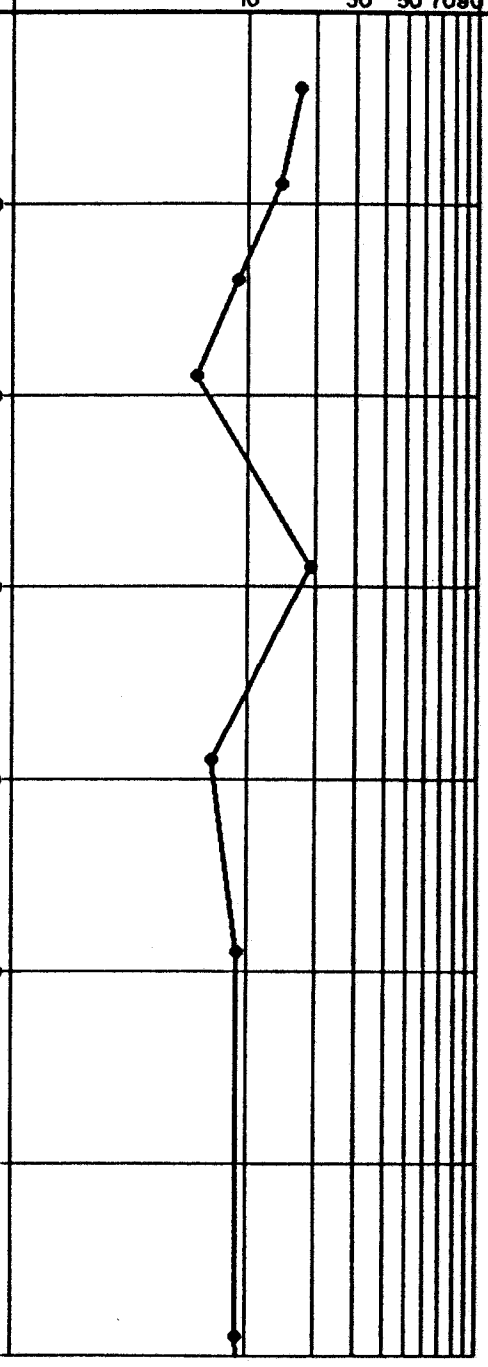
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-4
PROJECT NO.:	1054-94-119	ELEVATION:	3.1
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-28-94	WATER LEVEL:	1' - 4"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-4) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer (SP-4) installed in offset boring. Screened at 28-38 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVN (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Very Organic Topsoil (OL)					
		Loose to Medium Dense Light Gray and Light Brown Fine **SAND** (SP)					17, 14, 9
5						-1.9	
		Firm Tan and Gray Silty **CLAY**, with Trace of Roots and Organic Matter (CL)					6
10						-6.9	
		Medium Dense Brown Silty Fine **SAND**, with Some Decayed Organic Matter (SM)					19
15						-11.9	
		Loose Dark Gray Fine **SAND**, with Trace of Silt and Fine Organic Matter (SP)					7
20						-16.9	
25						-21.9	9
30						-26.9	
35		Stiff Gray Silty **CLAY** (CL)	S2			-31.9	9

Standard Penetration Test Data (Blows/ft)



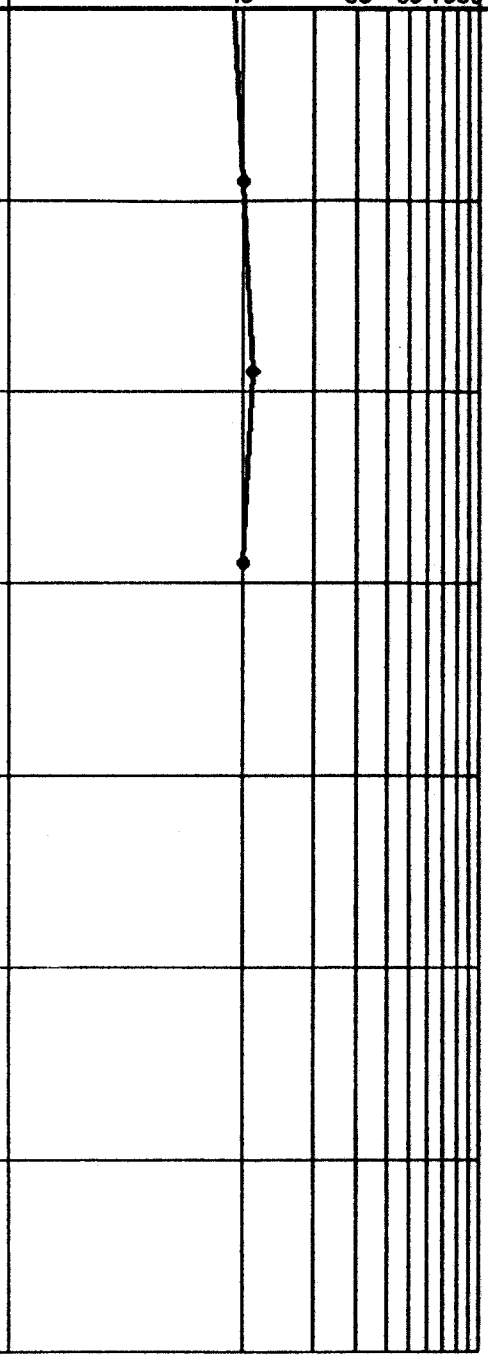
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-4
PROJECT NO.:	1054-94-119	ELEVATION:	3.1
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-28-94	WATER LEVEL:	1' - 4"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-4) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer (SP-4) installed in offset boring. Screened at 28-38 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Loose to Medium Dense Gray Silty Fine SAND (SM)					
40						-38.9	10
45						-41.9	11
		Stiff Blue Gray Clayey SILT (MH)					
50		*Boring Terminated at 50.0'*				-46.9	10
55						-51.9	
60						-56.9	
65						-61.9	
70						-66.9	

Standard Penetration Test Data (Blows/ft)



S&ME
Environmental Services
Engineering * Testing

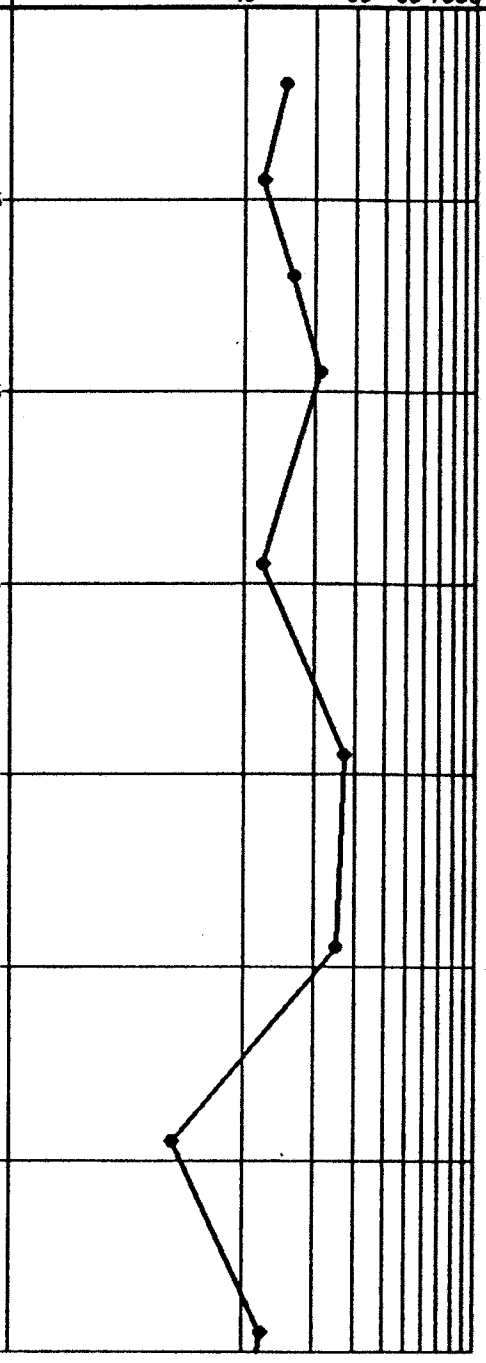
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-5

PROJECT NO.:	1054-94-119	ELEVATION:	10.5
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-28-94	WATER LEVEL:	7' - 3"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-5) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer (SP-5) installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Topsoil, Brown Silty **SAND** (SM)					
		Medium Dense Light Brown and Tan Fine to Medium **SAND** (SP)					15
5		Very Stiff Light Gray Fine Sandy Silty **CLAY** (CL)				5.5	12
							18
		Medium Dense Light Gray and Tan Medium **SAND**, with Some Coarse Sand and Pea Gravel (SP-SW)					21
10						.5	
15						-4.5	12
20						-9.5	27
25						-14.5	25
30		Firm Brown Gray Fine Sandy Clayey **SILT** with Some Fine Decayed Organic Matter (ML)				-19.5	5
35		Stiff Dark Gray Silty Sandy **CLAY**, with Trace of Organic Matter (CL)				-24.5	12

Standard Penetration Test Data (Blows/ft)



S&ME
Environmental Services
Engineering * Testing

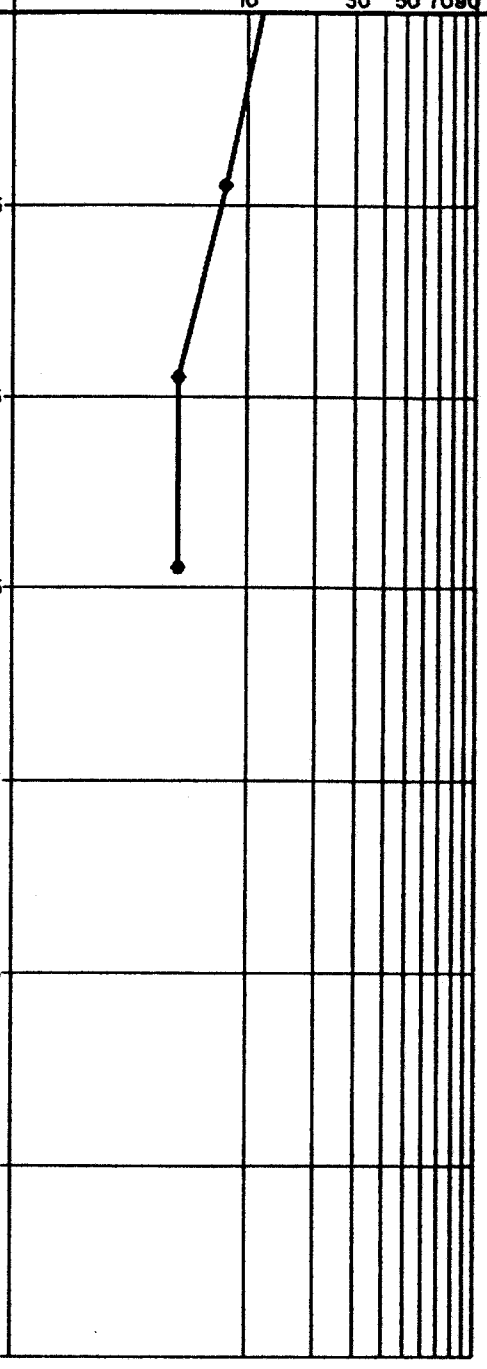
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-5

PROJECT NO.:	1054-94-119	ELEVATION:	10.5
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-28-94	WATER LEVEL:	7' - 3"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-5) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer (SP-5) installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Firm Dark Gray Clayey Fine Sandy SILT with Some Fine Organic Matter (ML)					
40						-29.5	8
45						-34.5	5
50		*Boring Terminated at 50.0'*				-39.5	5
55						-44.5	
60						-49.5	
65						-54.5	
70						-59.5	

Standard Penetration Test Data (Blows/ft)



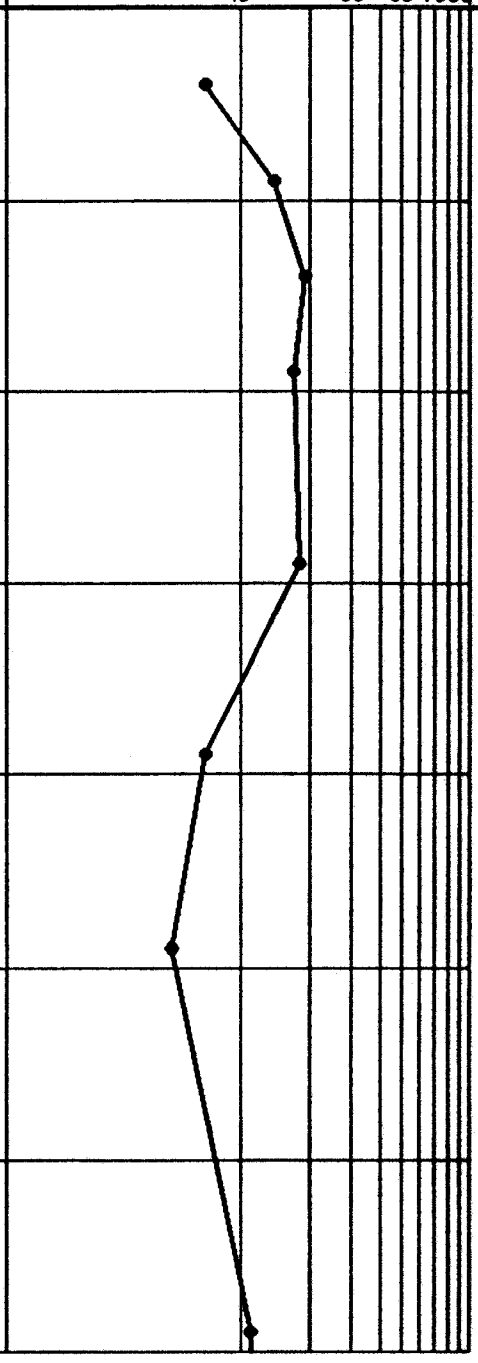
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-6
PROJECT NO.:	1054-94-119	ELEVATION:	8.2
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-2-94	WATER LEVEL:	2' - 3"
DRILLING METHOD:	H.S.A.	DRILL RIG:	CME - 450

NOTES:
Piezometer (SP-6) installed in adjacent boring. Screened from 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Topsoil, Brown Silty **SAND** (SM)					
		Loose Tan Fine to Medium **SAND** (SP)					7
		WHICH IS IT					
		Stiff Gray with Orange Silty **CLAY** (CL)					14
5						1.2	
		Medium Dense Tan and Gray Clayey **SAND** (SC)					19
		Very Stiff Tan and Gray Brown Fine Sandy Silty **CLAY** (CL)					17
10						-3.8	
15						-8.8	18
		Loose Gray Silty Fine **SAND** (SM)					
20						-13.8	7
		Firm Gray Clayey **SILT** with Some Fine Organic Matter (MH)					
25						-18.8	5
		Very Dense Dark Gray Silty Fine **SAND** with Fine Organic Matter (SM)					
30						-23.8	50/2
		Stiff Gray Silty **CLAY** (CH)					
35		Stiff Gray Very Fine Sandy **SILT** (ML)				-28.8	11

Standard Penetration Test Data (Blows/ft)



S&ME
Environmental Services
Engineering * Testing

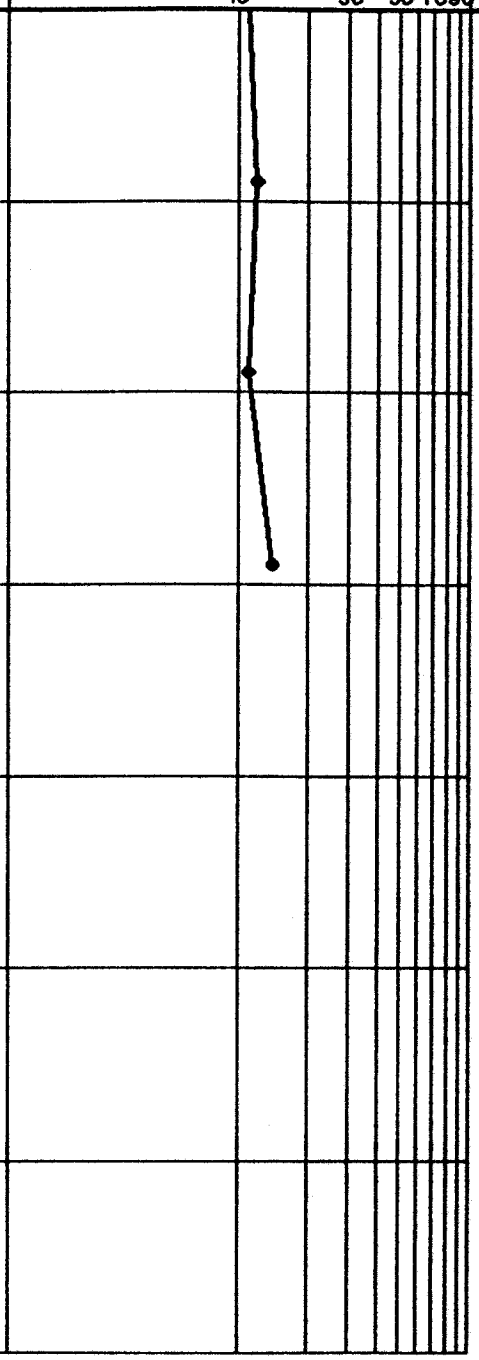
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-6

PROJECT NO.:	1054-94-119	ELEVATION:	8.2
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-2-94	WATER LEVEL:	2' - 3"
DRILLING METHOD:	H.S.A.	DRILL RIG:	CME - 450

NOTES:
Piezometer (SP-6) installed in adjacent boring. Screened from 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
40						-33.8	12
45						-38.8	11
		Stiff Dark Gray Silty CLAY (CH)					14
50		*Boring Terminated at 50.0'*				-43.8	
55						-48.8	
60						-53.8	
65						-58.8	
70						-63.8	

Standard Penetration Test Data (Blows/ft)



S&ME
Environmental Services
Engineering * Testing

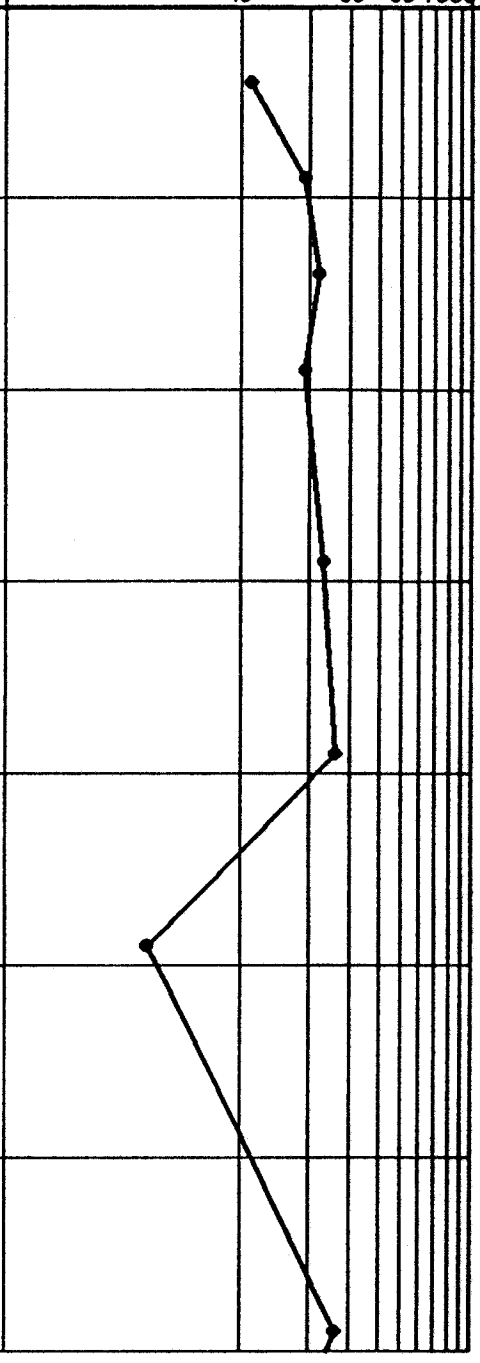
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-7

PROJECT NO.:	1054-94-119	ELEVATION:	8.3
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-4-94	WATER LEVEL:	2'-0"
DRILLING METHOD:	H.S.A./Tri-cone	DRILL RIG:	CME - 450

NOTES:
Shallow piezometer installed in adjacent borehole. Screened from 10 to 20 feet.

DEPTH (ft)	Soil Description	ELEV.	BPF
	Topsoil, Brown Silty **SAND** (SM-ML)		
	Stiff to Very Stiff Light Gray with Orange Silty **CLAY** (CL)		11
5		1.3	19
	Medium Dense Light Gray Silty Fine to Medium **SAND** (SM)		22
10		-3.7	19
	Medium Dense Tan Medium **SAND** (SP)		
15		-8.7	23
	Medium Dense Tan to Brown Coarse **SAND** with Pea Gravel (SP-GP)		
20		-13.7	26
	Medium Dense Gray Silty Clayey Fine **SAND** (SC)		
	Soft Gray Silty **CLAY** (CL)		
25	Very Loose Brown Tan Fine **SAND** (SP)	-18.7	4
	Very Dense Gray Silty Fine **SAND** (SM)		
30		-23.7	50/5
	Very Stiff Gray Clayey **SILT**, with Some Fine Organic Matter (MH)		
35		-28.7	26

Standard Penetration Test Data (Blows/ft)



OVM (ppm) | WATER LEVEL | SAMPLE

S&ME
Environmental Services
Engineering * Testing

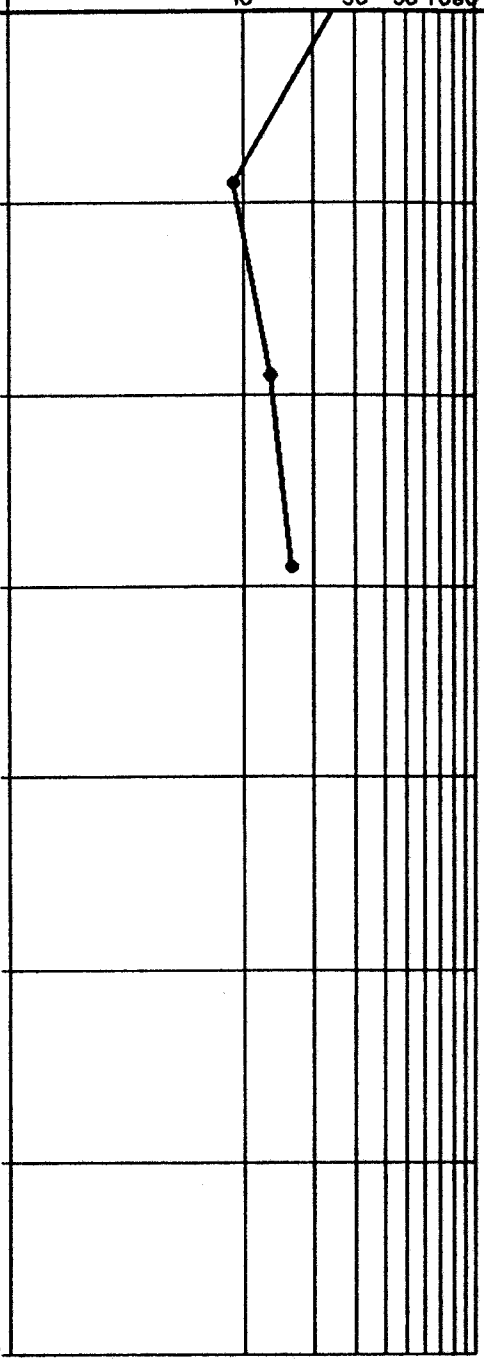
PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-7

PROJECT NO.:	1054-94-119	ELEVATION:	8.3
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-4-94	WATER LEVEL:	2'-0"
DRILLING METHOD:	H.S.A./Tri-cone	DRILL RIG:	CME - 450

NOTES:
Shallow piezometer installed in adjacent borehole. Screened from 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
40		Stiff Gray Clayey Sandy SILT with Fine Organic Matter (ML)				-33.7	9
45						-38.7	13
50		*Boring Terminated at 50.0'*				-43.7	16
55						-48.7	
60						-53.7	
65						-58.7	
70						-63.7	

Standard Penetration Test Data (Blows/ft)



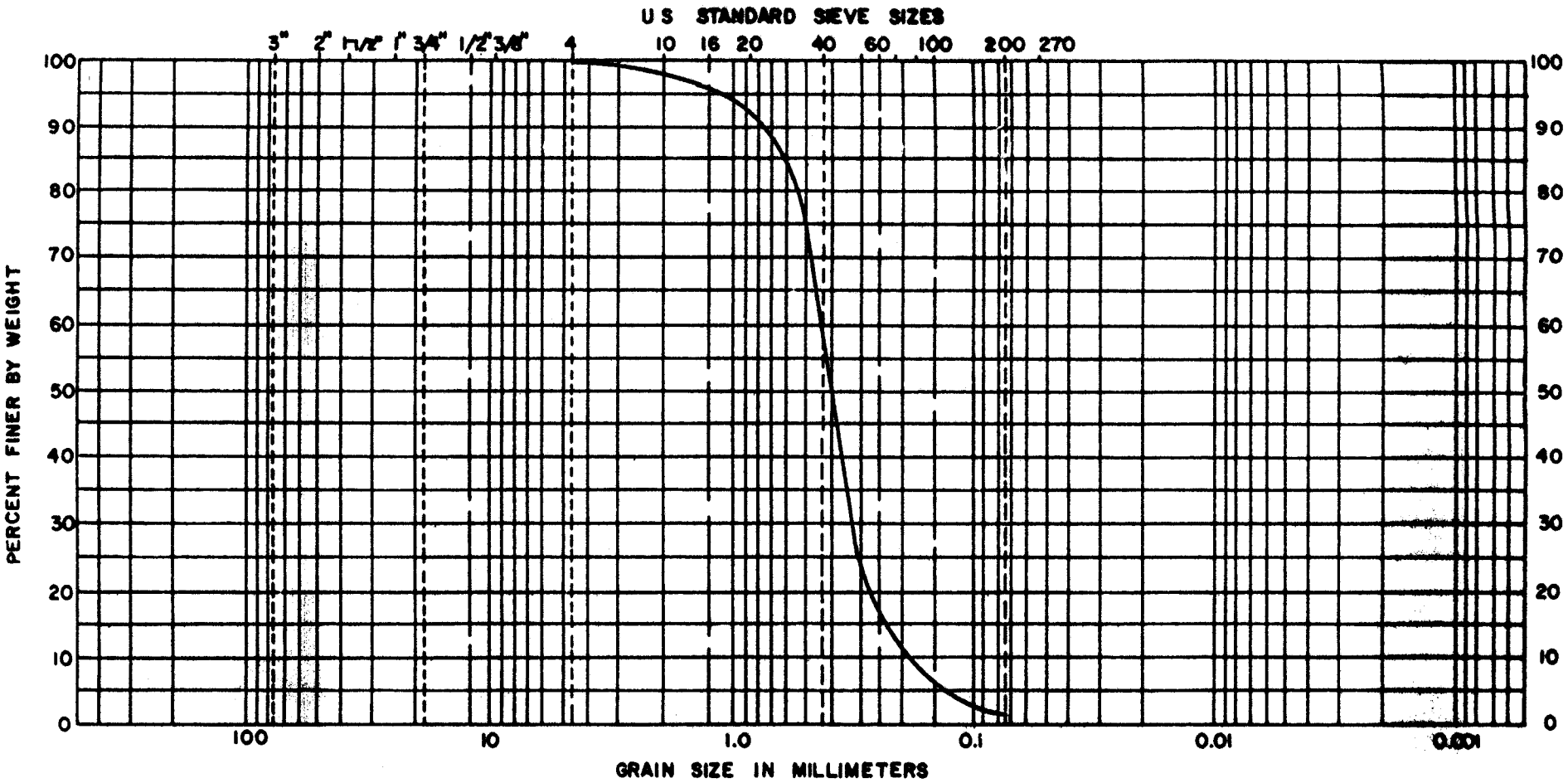
S&ME
Environmental Services
Engineering * Testing

APPENDIX II
LABORATORY TEST RESULTS

ABSTRACT

This appendix contains information developed during the determination of the physical properties and engineering properties of the site soils. It contains copies of the Gradation Tests (Grain Size Determination) and a summary sheet for the Permeability Test.

172A



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

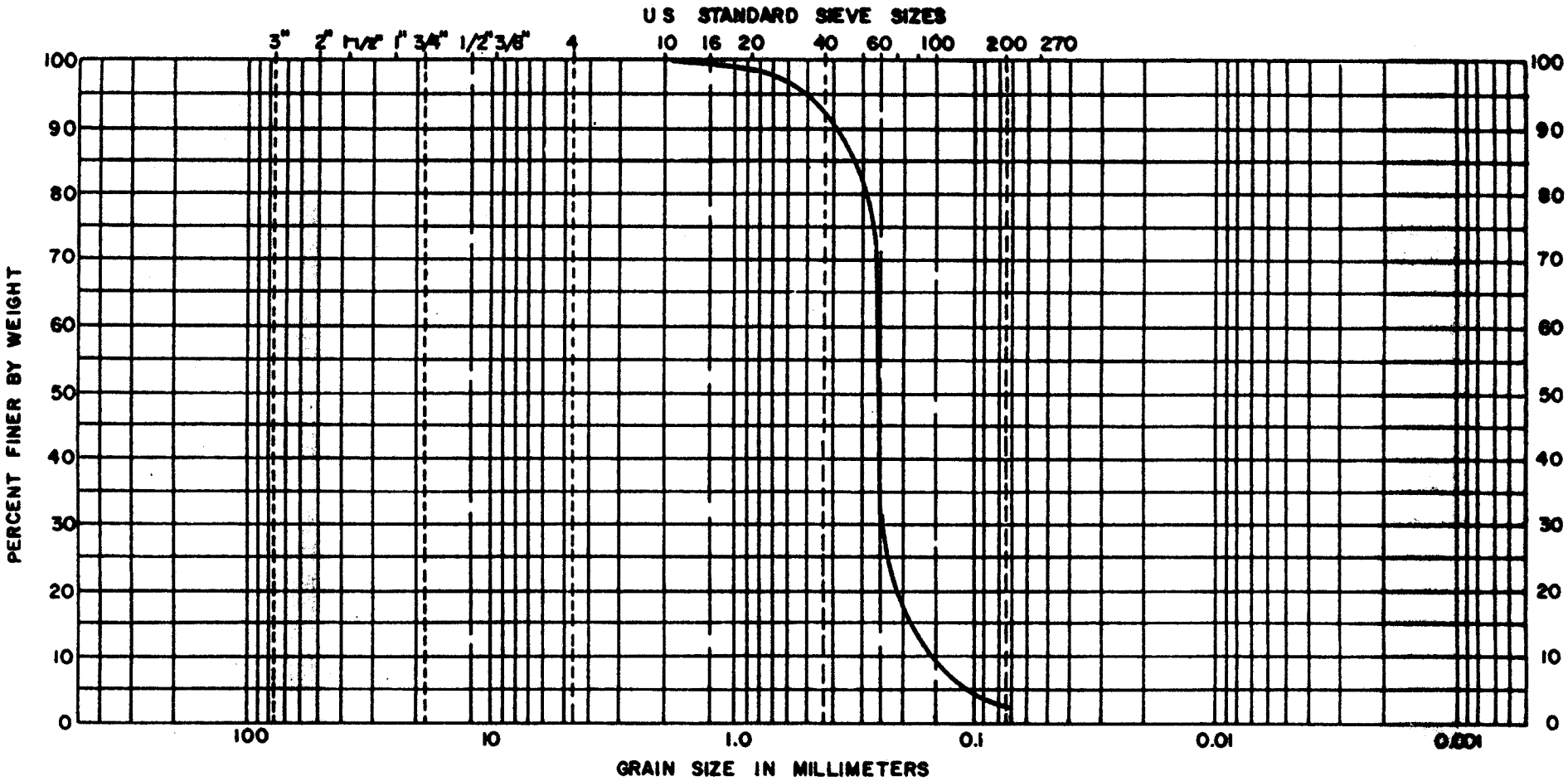
BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-1 S 2	3.5' - 5'	--	--	--	--	TAN-BROWN FINE SAND

JOB NO. 1054-94-119

GRAIN SIZE DISTRIBUTION

S&ME

172A



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

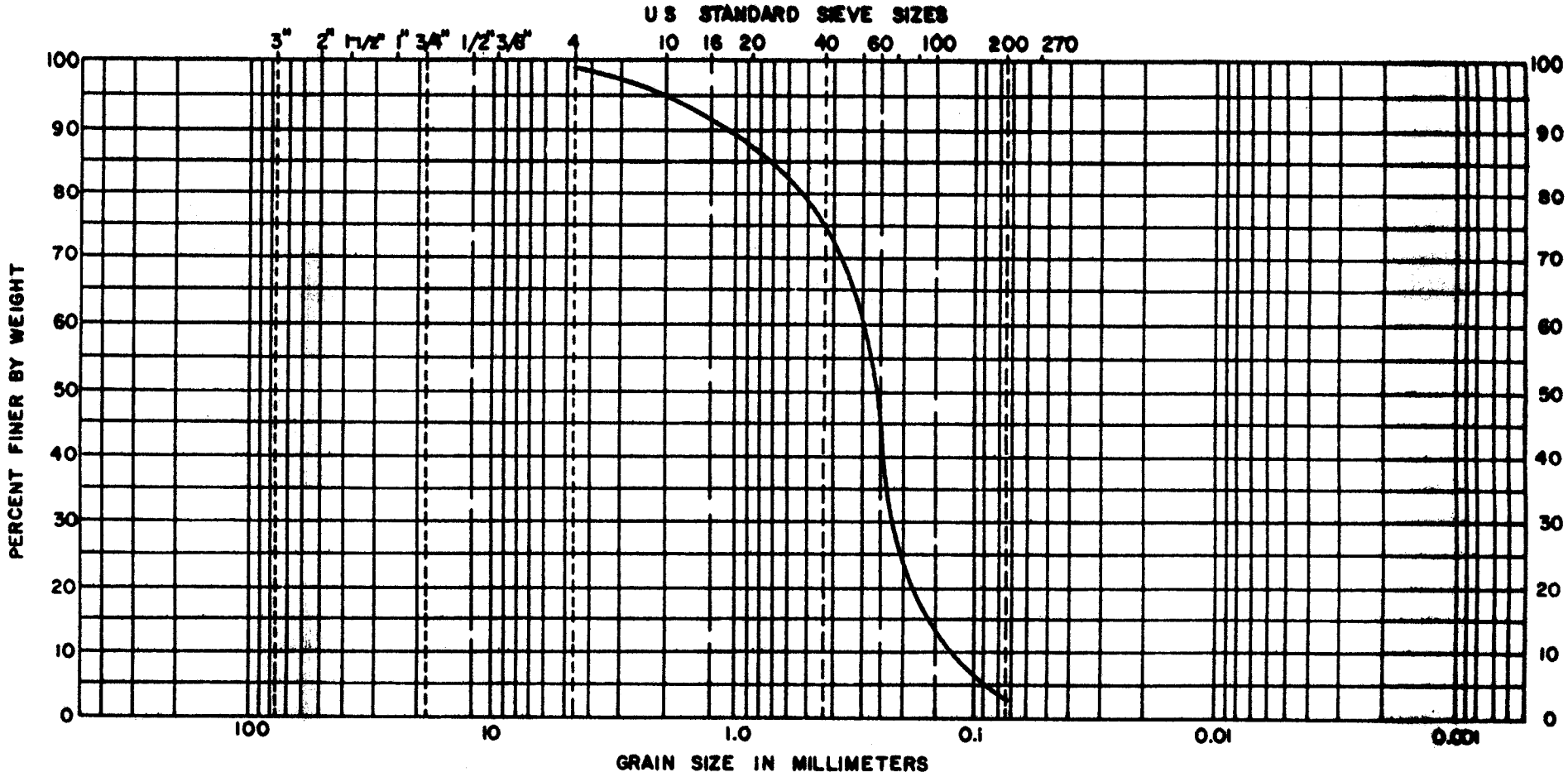
BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-1 S 10	38.5' - 40'	--	--	--	--	GRAY-BROWN FINE SAND

JOB NO. 1054-94-119

GRAIN SIZE DISTRIBUTION

S&ME

172A



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

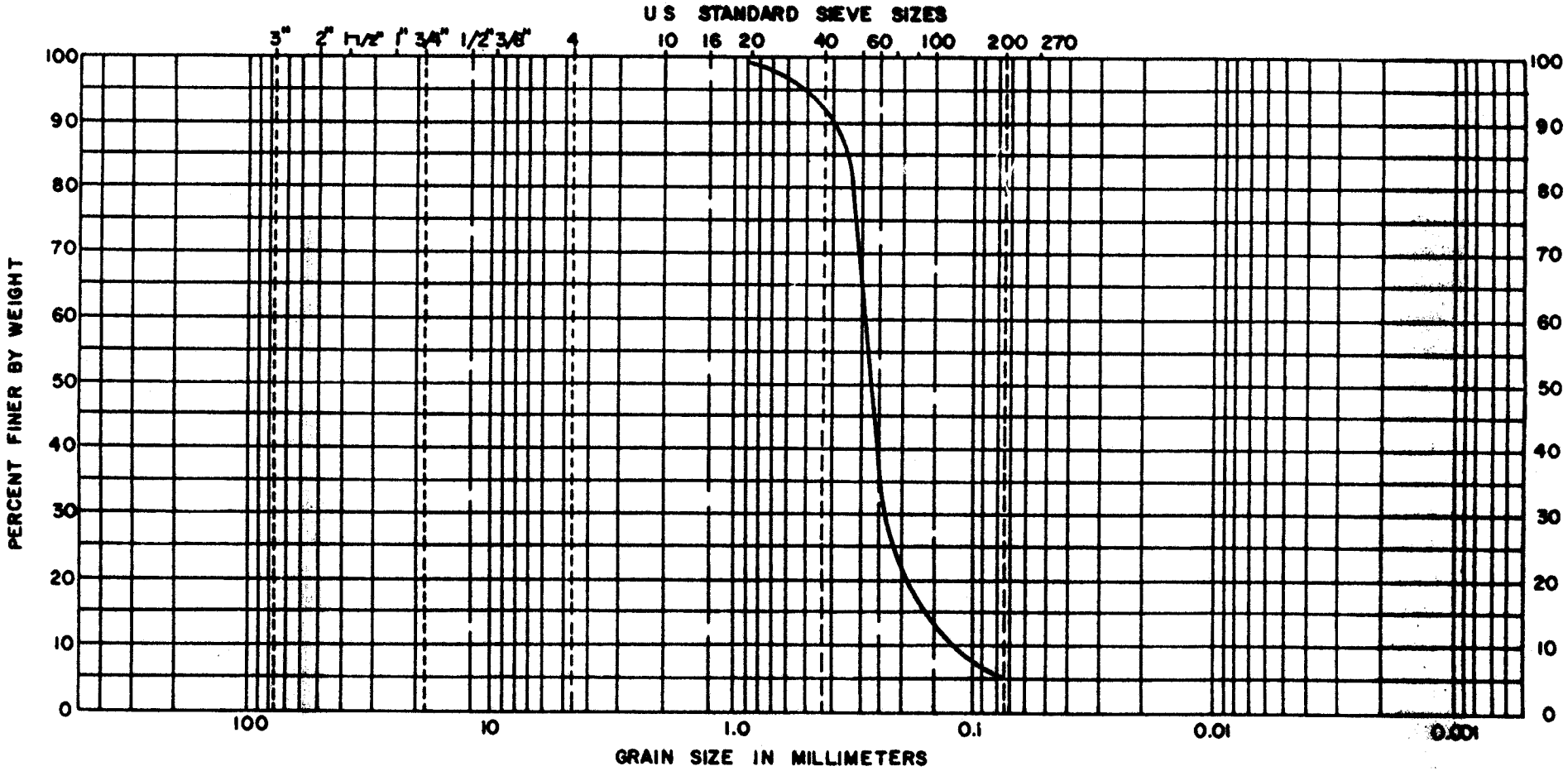
BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-3 S 4	8.5' - 10'	--	--	--	--	LIGHT BROWN & TAN FINE SAND

JOB NO. 1054-94-119

GRAIN SIZE DISTRIBUTION

S&ME

172A



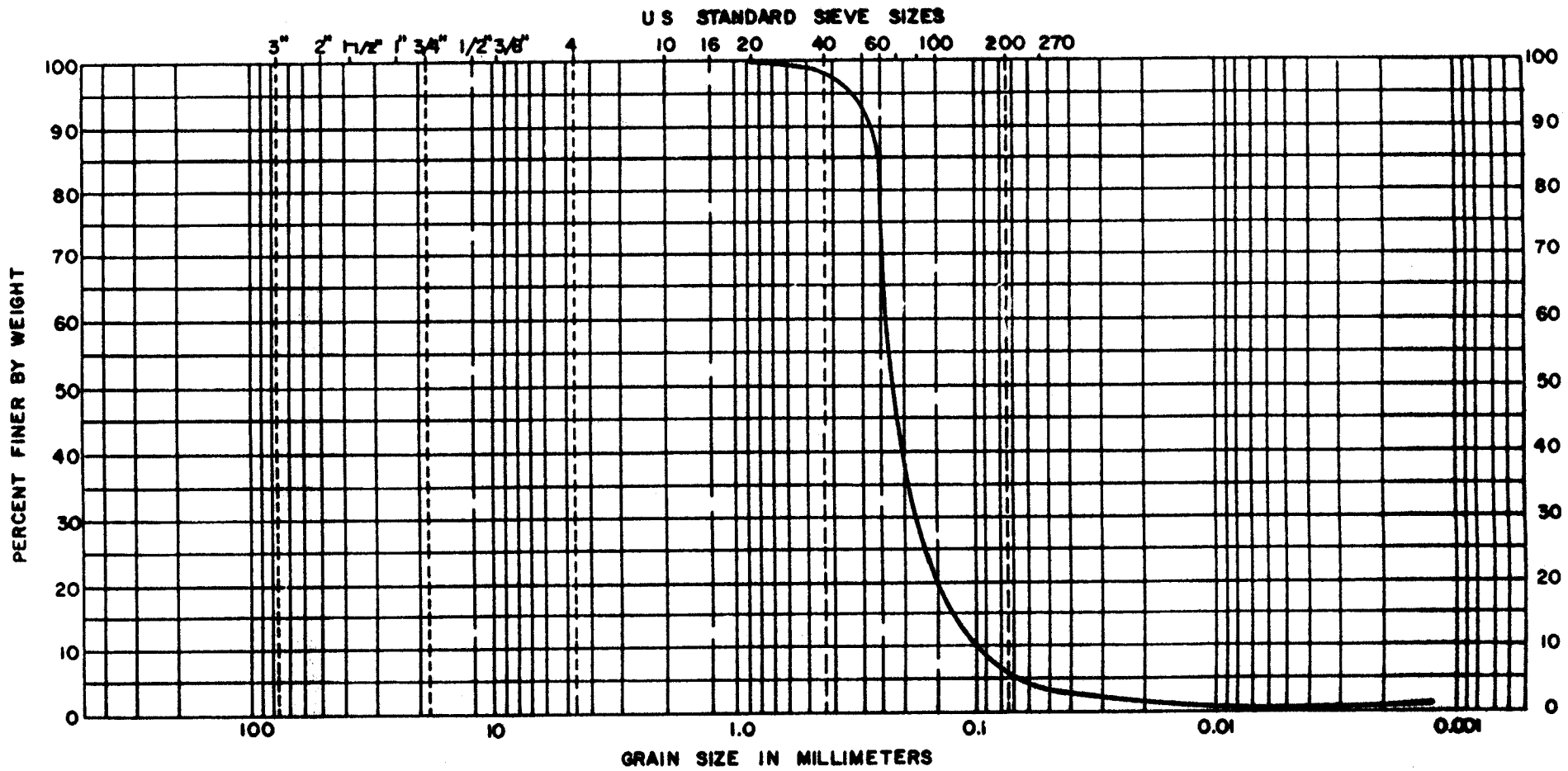
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-4 S I	1' - 2.5'	--	--	--	--	LIGHT GRAY & BROWN FINE SAND

JOB NO. 1054-94-119

GRAIN SIZE DISTRIBUTION

S&ME



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

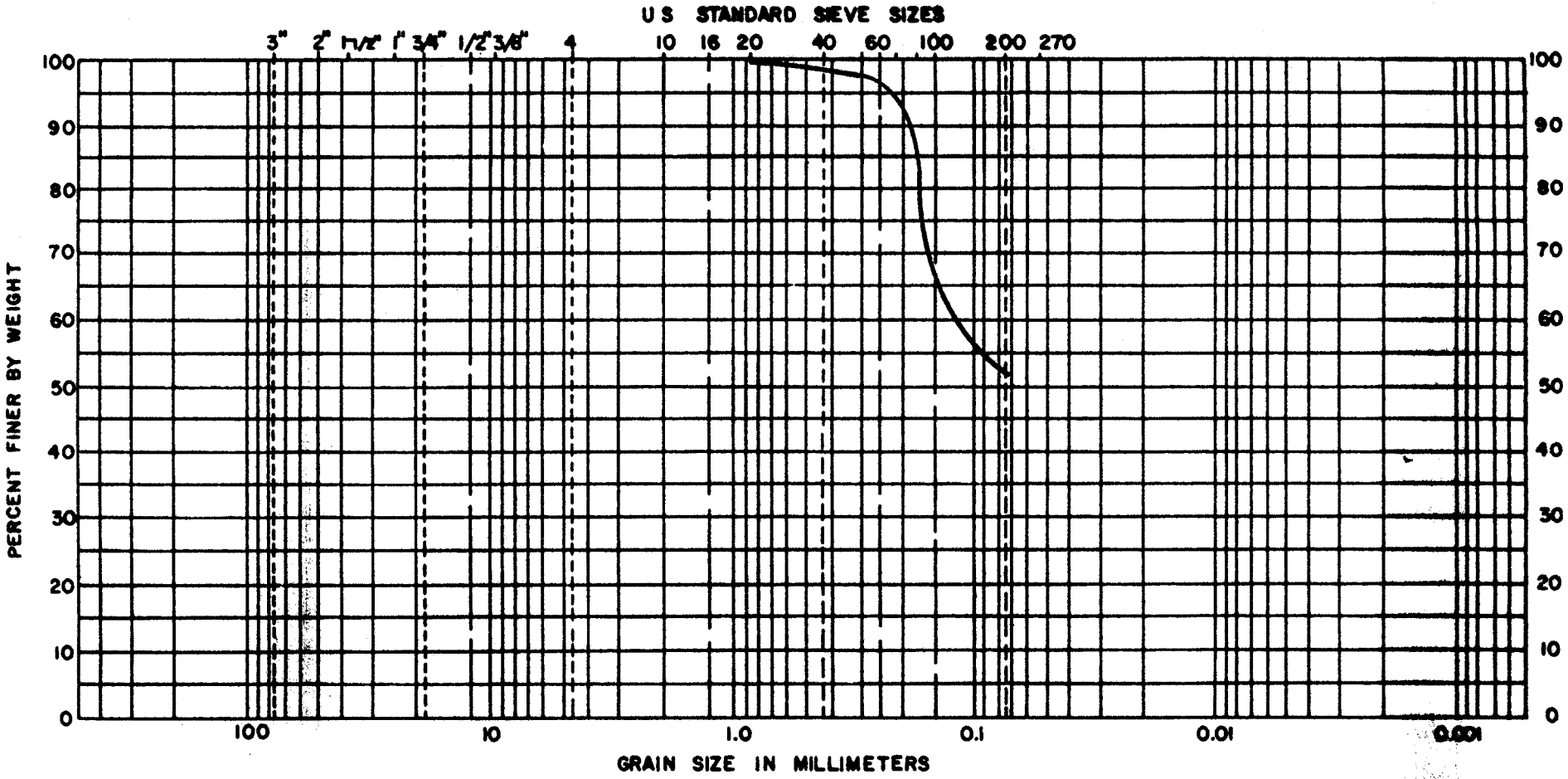
BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-4 S 7	23.5' - 25'	--	--	--	--	DARK GRAY FINE SAND

JOB NO. 1054-94-119

GRAIN SIZE DISTRIBUTION

S&ME

172A



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

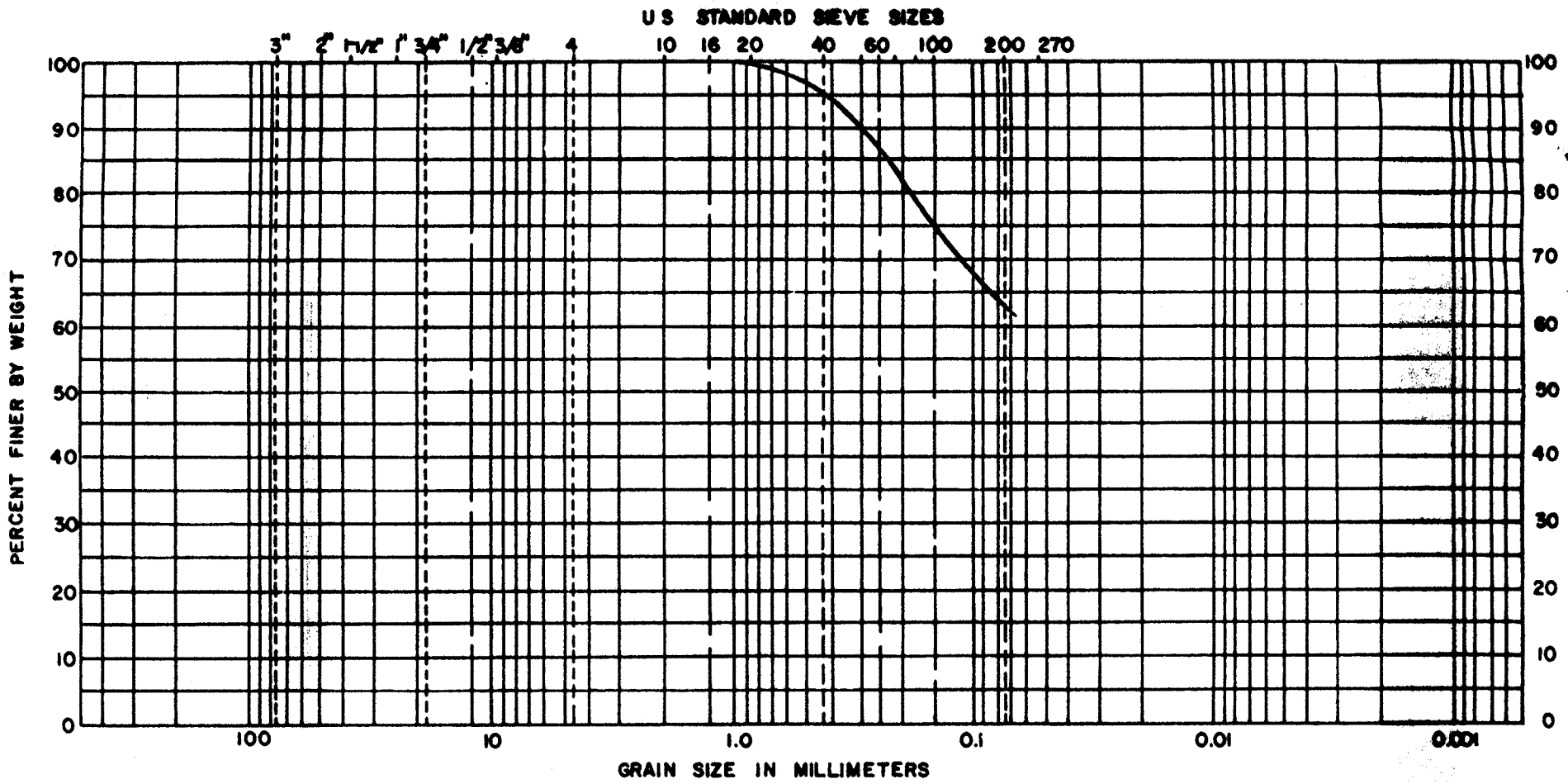
BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-5 S 9	33.5' - 35'	--	--	--	--	DARK GRAY VERY SANDY CLAY (CL)

JOB NO. 1054-94-119

GRAIN SIZE DISTRIBUTION

S&ME

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
UD	0-3 FT.	18.6	40	18	22	Dark Gray and Orange Sandy CLAY (CL)

JOB NO. 1051-94-119

GRAIN SIZE DISTRIBUTION

S&ME

S&ME

HYDRAULIC CONDUCTIVITY TEST
(Falling Head/Increasing Tailwater)
ASTM C 5084 METHOD (C)

JOB # 1051-94-119 JOB NAME: WASHINGTON COUNTY LANDFILL

DATE: 3-8-94 SAMPLE # 1 DEPTH : 0 - 3 ft.

SOIL DESCRIPTION: DARK GRAY and ORANGE SANDY CLAY (CL)

NOTES : Test specimen taken from upper portion of U.D. tube.

LL-40; PL-18; PI-22

UNDISTURBED (X) REMOLDED ( ) STANDARD PROCTOR
MAX DRY DENSITY lbs./cu.ft.
OPTIMUM MOISTURE %
% COMPACTION %

SAMPLE DATA :

Length	8.07	cm.	Moisture Content	18.6	%
Diameter	7.20	cm.	Wet Density	129.5	lb/ft3
Area	40.72	sq.cm.	Dry Density	109.2	lb/ft3
Volume	328.57	cu.cm.	Initial Saturation	92.4	%
Wet Weight	681.62	grams	Final Saturation	100.0	%
Dry Weight	574.72	grams	Initial Void Ratio	0.544	
WATER TEMP. (C)	22.0		Porosity	0.352	
CORRECTION FACTOR	0.9531		Spec. G. (apparent)	2.70	

TEST DATA

k = (aL/2At) X In(h1/h2)
RATIO = Hv1-Hv2 / Hc2
(hv1-hc1=h1) INITIAL LOSS
(hv2-hc2=h2) FINAL LOSS
i = h2/L

k = HYDRAULIC CONDUCTIVITY
L = 8.07 cm. length of sample
A = 40.72 sq.cm. area of sample
a = 0.72 sq.cm. area of burett
t = Elapsed time of test (seconds)
i = HYDRAULIC GRADIENT

Elapsed t/sec.	Hv1	Hc1	Hv2	Hc2	h1	h2	RATIO Out/In	(i) H.G.
8760	50.0	0.0	37.9	11.5	50.0	26.4	1.05	3.3
10920	50.0	0.0	35.5	13.6	50.0	21.9	1.07	2.7
11460	50.0	0.0	35.3	13.7	50.0	21.6	1.07	2.7
31800	50.0	0.0	26.7	22.0	50.0	4.7	1.06	0.6

1. k = 5.2E-06 cm./sec.
2. k = 5.4E-06 cm./sec.
3. k = 5.2E-06 cm./sec.
4. k = 5.3E-06 cm./sec.

AVERAGE :
k = 5.0E-06 cm./sec.
i = 2.3
RATIO = 1.06

FINAL (k) VALUE AVERAGE WITH WATER TEMPERATURE CORRECTION.

Tested by: D. CARVER

S&ME, Inc. 3100 Spring Forest Road, Raleigh, North Carolina 27604, (919) 872-2660, Fax (919) 790-9827
Mailing address: P.O. Box 58069, Raleigh, North Carolina 27658-8069

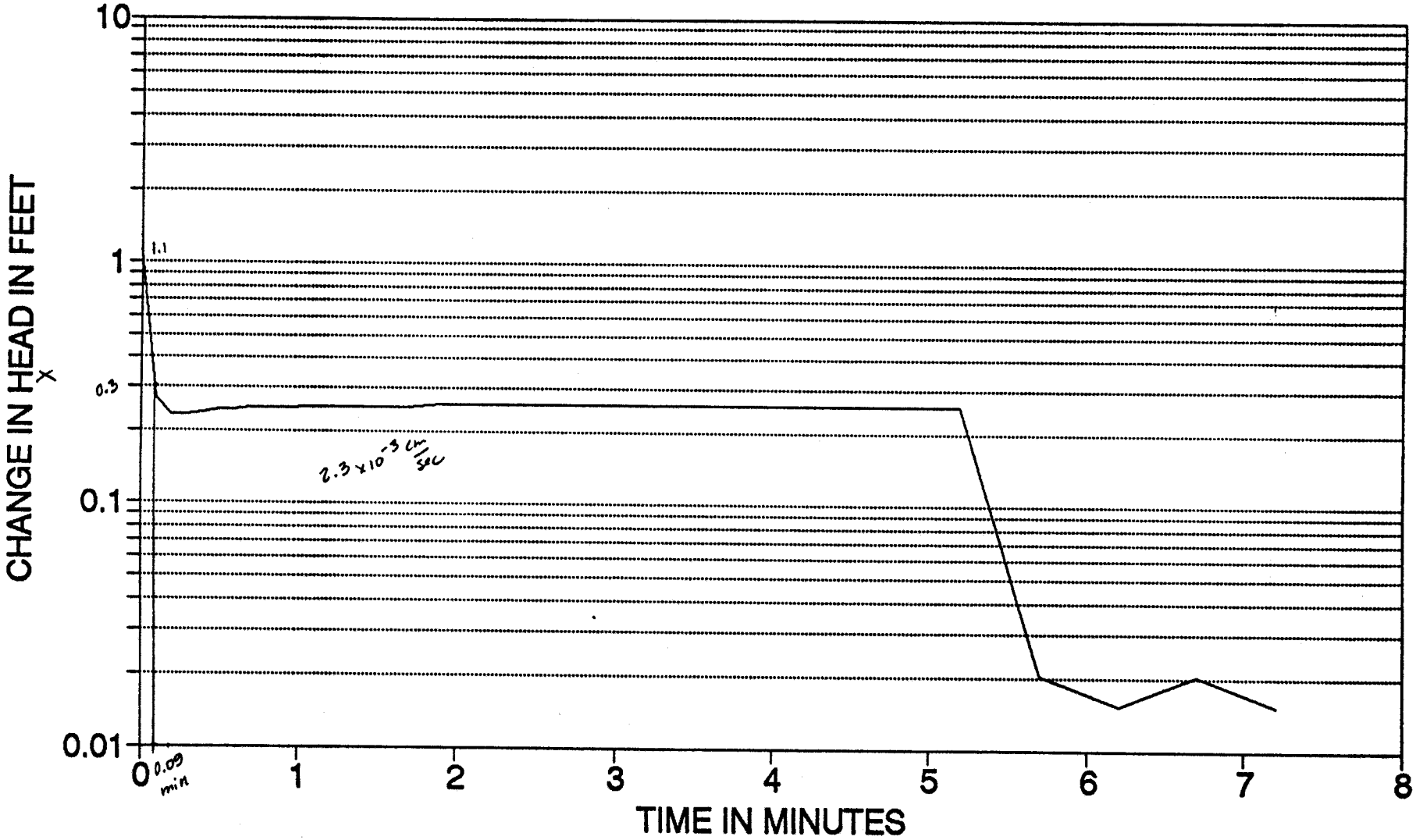
Printed on Recycled Paper

APPENDIX III
AQUIFER TEST RESULTS

ABSTRACT

This appendix contains a brief discussion of the Bouwer and Rice Analysis of hydraulic conductivities from slug tests; the graphs of the change in water level with time; intercept points and values used in the calculations; copies of the data recorded; and calculation of seepage velocity.

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER S 1 TEST 1



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-1
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	1.38	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	21.38	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	1.94	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	1.1	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	0.3	Feet
Yt at time (t2):	0.09	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-1 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
10 feet to 20.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

2.5E-03	cm./sec.
2.2	m./day
2601	ft./yr.
53.3	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
0.56 feet to Water Table
8.5 inch - Borehole Diameter
20 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-1 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

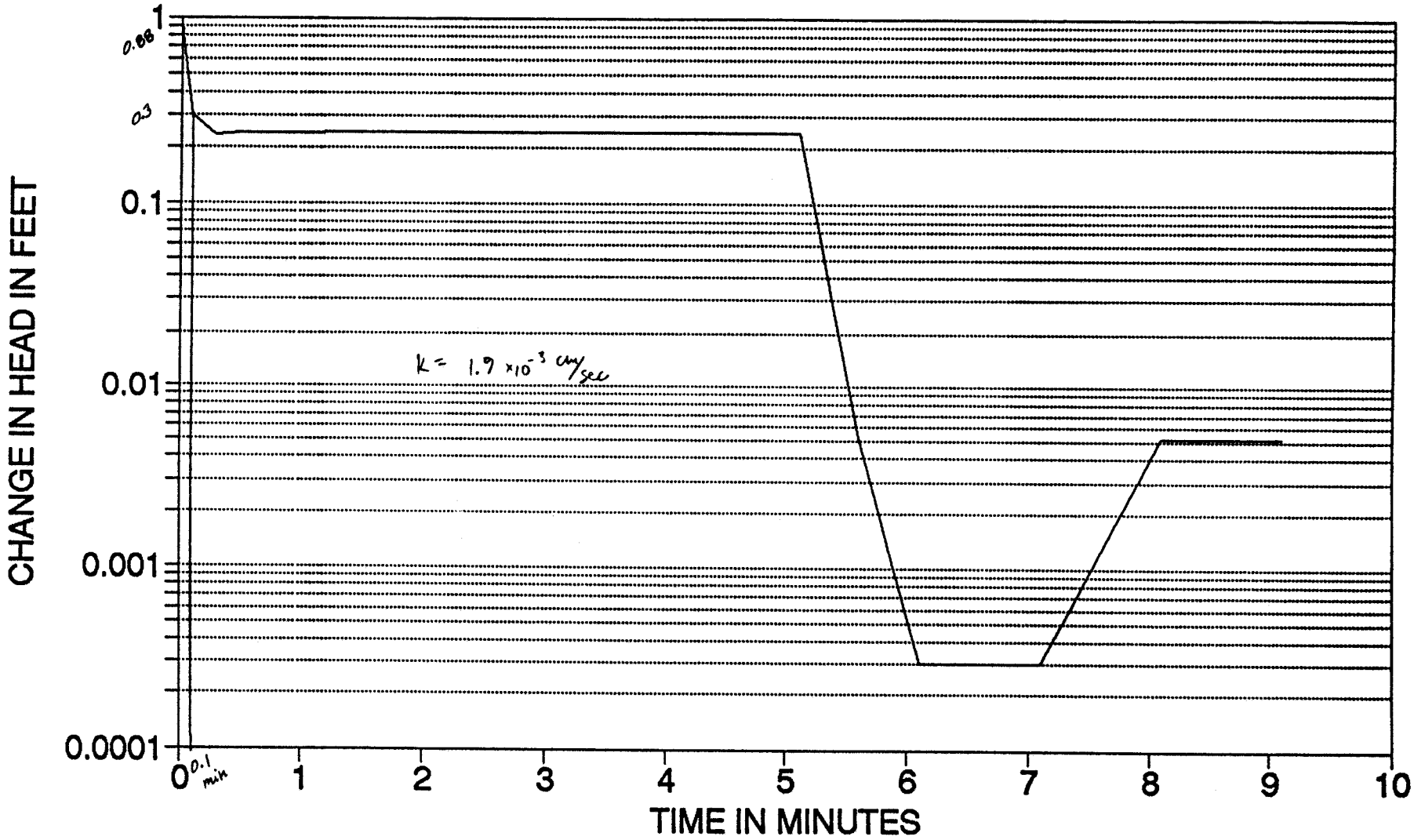
Intercept with the Y axis(Yo):	1.1	Feet @	0	Minutes
X intercept at (Yt):	0.3	Feet @	0.09	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	592.531	
H (cm)	2116.53	
Le/Rw	28.2353	
Lw/Rw	54.8894	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	1.1	
Yt	0.3	
t (sec)	5.4	
Ln((H-Lw)/Rw))	4.95001	
Ln(Lw/Rw)	4.00532	
Ln(Re/Rw)	2.52723	
Ln(Yo/Yt)	1.29928	
K (cm/sec)	0.00251	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER S11 TEST 2



WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-1
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	1.38	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	21.38	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	1.94	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	0.88	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	0.3	Feet
Yt at time (t2):	0.1	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-1 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
10 feet to 20.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

1.9E-03	cm./sec.
1.6	m./day
1939	ft./yr.
39.7	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
0.56 feet to Water Table
8.5 inch - Borehole Diameter
20 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-1 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

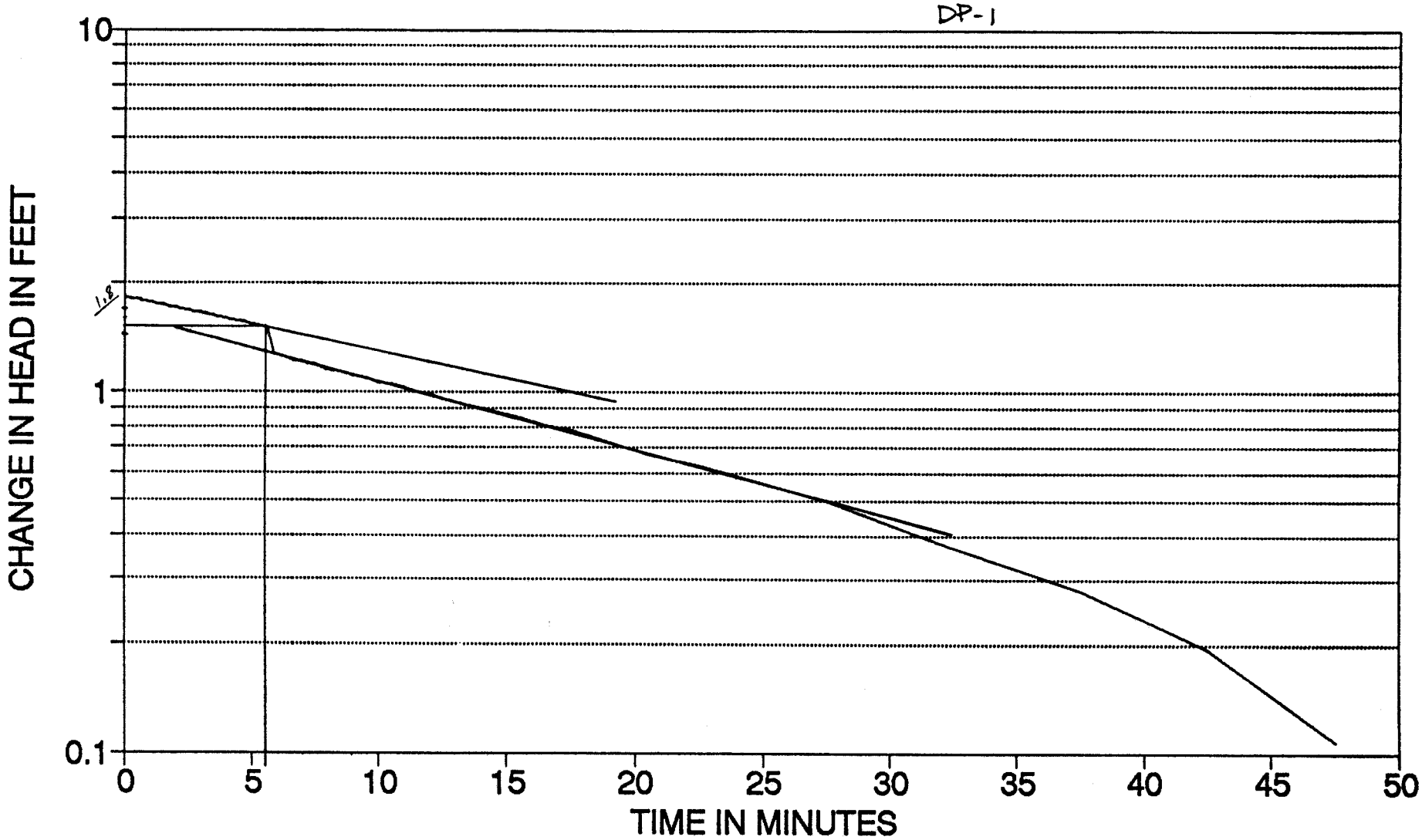
Intercept with the Y axis(Yo):	0.88	Feet @	0	Minutes
X intercept at (Yt):	0.3	Feet @	0.1	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	592.531	
H (cm)	2116.53	
Le/Rw	28.2353	
Lw/Rw	54.8894	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	0.88	
Yt	0.3	
t (sec)	6	
Ln((H-Lw)/Rw))	4.95001	
Ln(Lw/Rw)	4.00532	
Ln(Re/Rw)	2.52723	
Ln(Yo/Yt)	1.07614	
K (cm/sec)	0.00187	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - PIEZOMETER 11-D TEST 1



WELL RECHARGE CURVE

1.9E-4
.2
1.92
3.9

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	DP-1
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	3.42	Feet
TOTAL DEPTH OF WELL:	53.42	Feet
INSIDE DIAMETER OF WELL:	2	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	3.94	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	1.7	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	1.85	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	1.6	Feet
Yt at time (t2):	5.5	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: DP-1 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
40 feet to 50.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

1.4E-05	cm./sec.
0.0	m./day
14	ft./yr.
0.3	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

2 inch - Well Diameter
10 foot - Screen Length
0.52 feet to Water Table
8.5 inch - Borehole Diameter
50 feet - Depth of Well
70 feet to Impermeable Surfa
The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number DP-1 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

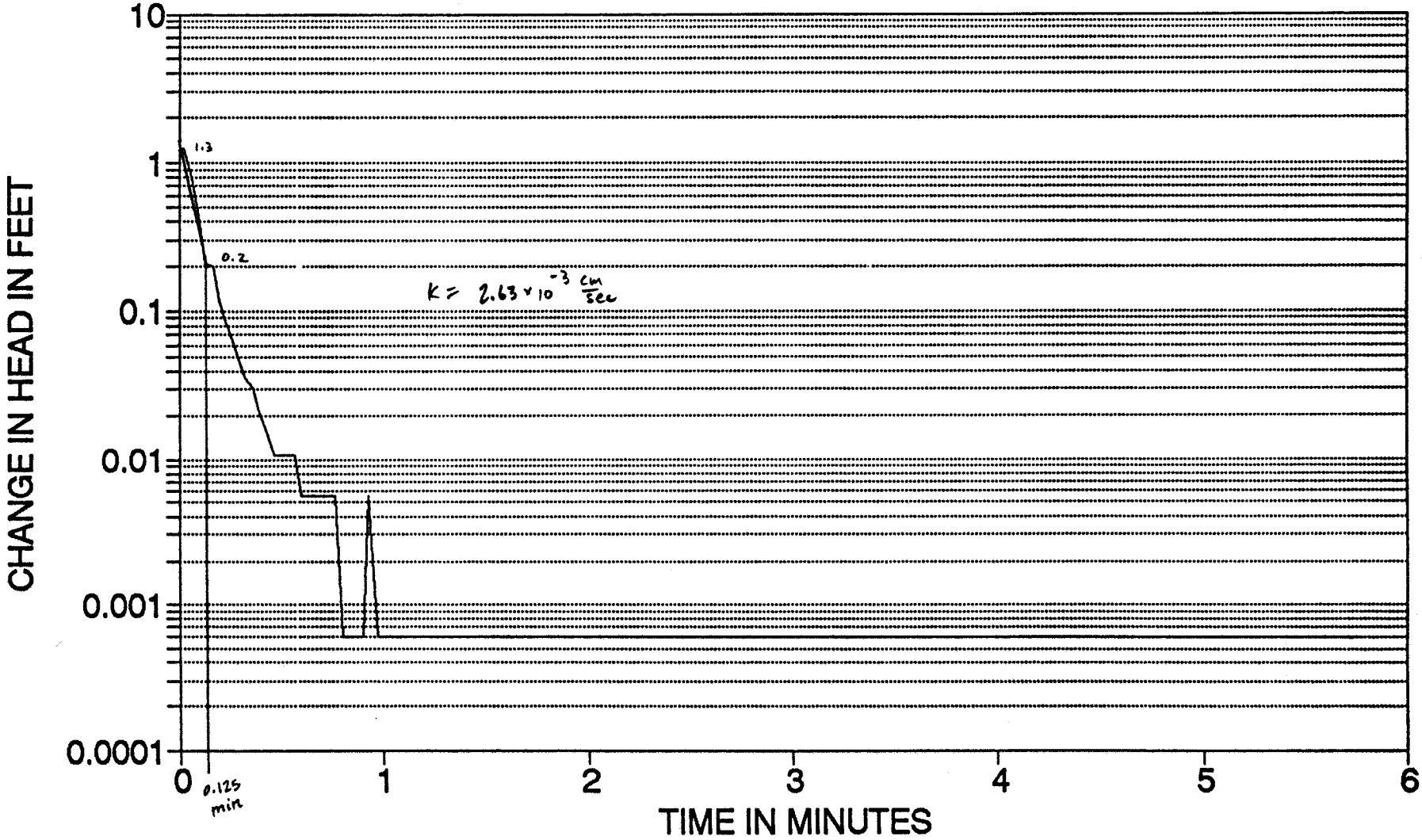
Intercept with the Y axis(Yo):	1.85	Feet @	0	Minutes
X intercept at (Yt):	1.6	Feet @	5.5	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	2.54	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	1508.15	
H (cm)	2117.75	
Le/Rw	28.2353	
Lw/Rw	139.708	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	1.85	
Yt	1.6	
t (sec)	330	
Ln((H-Lw)/Rw))	4.03372	
Ln(Lw/Rw)	4.93956	
Ln(Re/Rw)	2.91149	
Ln(Yo/Yt)	0.14518	
K (cm/sec)	1.4E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER S2 TEST 1



—— WELL RECHARGE CURVE

(G13-G12) > G17

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-2
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	0.94	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	20.69	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	6.24	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	1.3	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	0.2	Feet
Yt at time (t2):	0.125	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-2 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
9.75 feet to 19.8 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

2.6E-03	cm./sec.
2.3	m./day
2721	ft./yr.
55.8	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
5.3 feet to Water Table
8.5 inch - Borehole Diameter
19.75 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-2 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

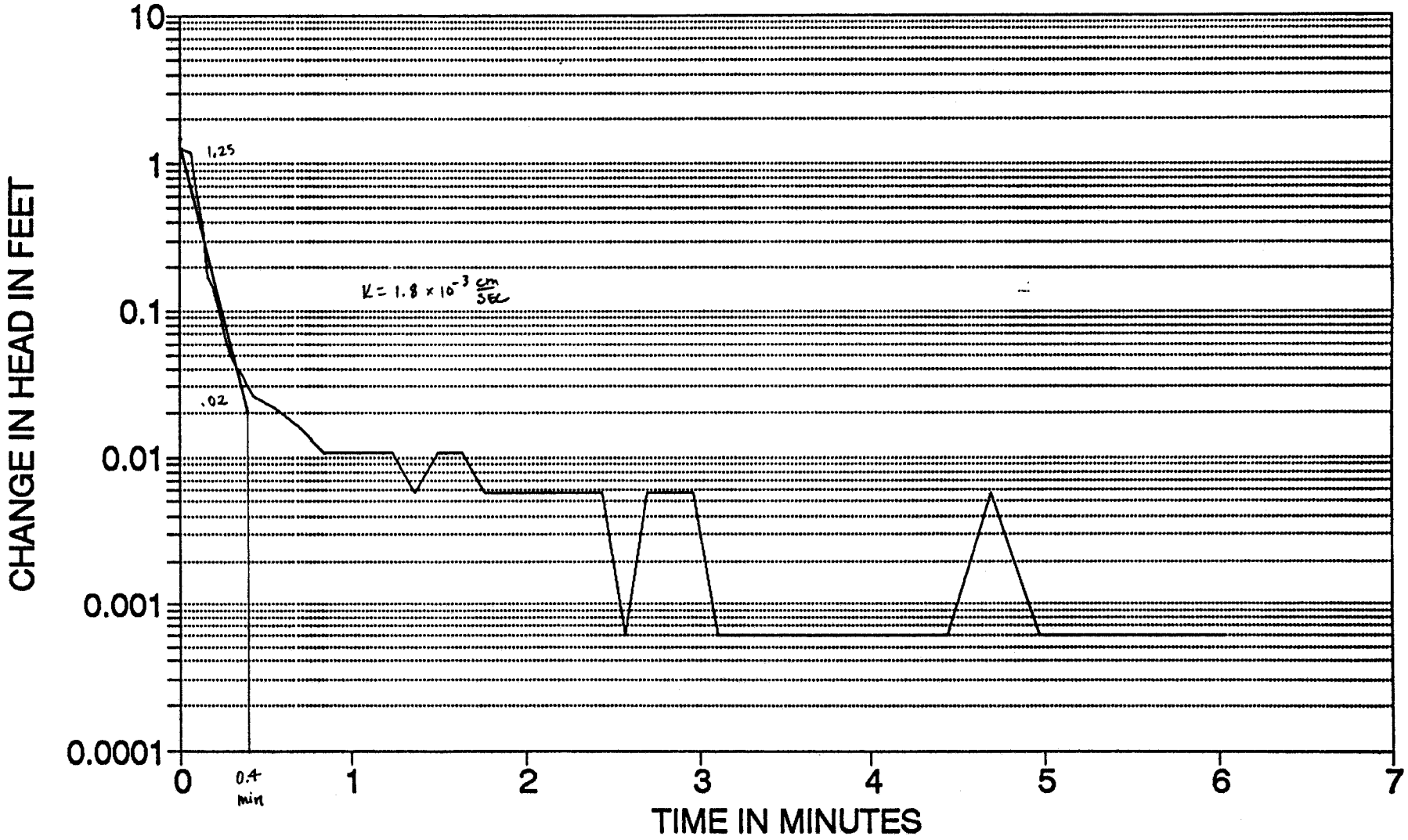
Intercept with the Y axis(Yo):	1.3	Feet @	0	Minutes
X intercept at (Yt):	0.2	Feet @	0.125	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	440.436	
H (cm)	1972.06	
Le/Rw	28.2353	
Lw/Rw	40.8	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	1.3	
Yt	0.2	
t (sec)	7.5	
Ln((H-Lw)/Rw))	4.955	
Ln(Lw/Rw)	3.70868	
Ln(Re/Rw)	2.54925	
Ln(Yo/Yt)	1.8718	
K (cm/sec)	0.00263	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - PIEZOMETER S2 TEST 2



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-2
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	0.94	Feet
TOTAL DEPTH OF WELL:	20.69	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	6.24	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	1.25	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	0.02	Feet
Yt at time (t2):	0.4	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-2 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
9.75 feet to 19.8 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

1.8E-03	cm./sec.
1.6	m./day
1879	ft./yr.
38.5	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
5.3 feet to Water Table
8.5 inch - Borehole Diameter
19.75 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-2 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

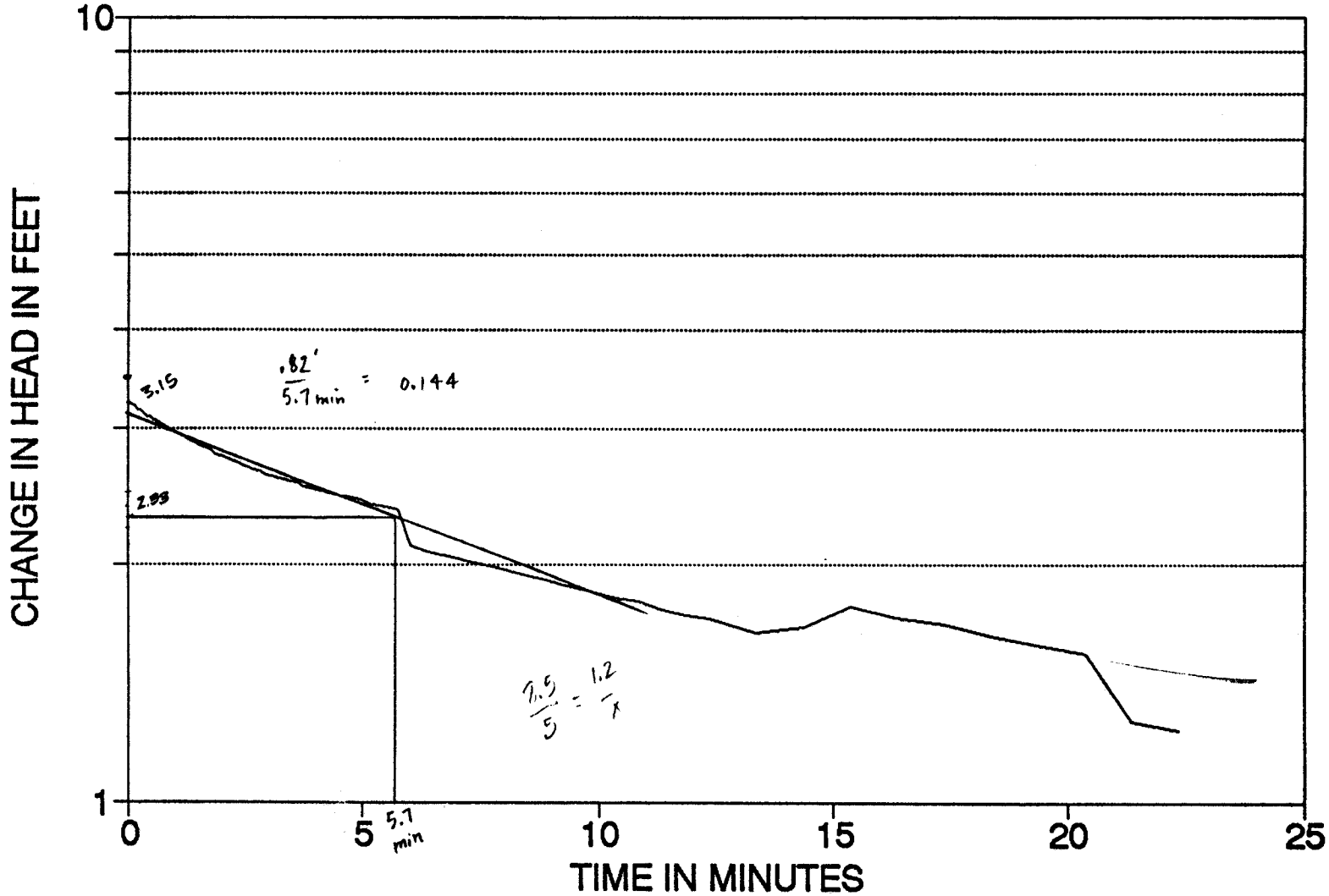
Intercept with the Y axis(Yo):	1.25	Feet @	0	Minutes
X intercept at (Yt):	0.02	Feet @	0.4	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	440.436	
H (cm)	1972.06	
Le/Rw	28.2353	
Lw/Rw	40.8	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	1.25	
Yt	0.02	
t (sec)	24	
Ln((H-Lw)/Rw))	4.955	
Ln(Lw/Rw)	3.70868	
Ln(Re/Rw)	2.54925	
Ln(Yo/Yt)	4.13517	
K (cm/sec)	0.00182	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER DP2 TEST 1



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME: Washington County C&D Landfill
PROJECT LOCATION: Plymouth, N.C.
PROJECT NUMBER: 1054-94-119
WELL IDENTIFICATION: DP-2
DATE OF TEST: February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand
UNIFIED SOIL CLASSIFICATION:

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: 0.55 Feet
(Show subgrade completions as minus)
TOTAL DEPTH OF WELL: 50.55 Feet
INSIDE DIAMETER OF WELL: 1.25 Inches
DIAMETER OF THE BOREHOLE: 8.5 Inches
LENGTH OF SCREEN INTERVAL: 10 Feet
DEPTH TO THE STABILIZED WATER TABLE: 3.82 Feet
DEPTH TO AN IMPERMEABLE SURFACE: 70 Feet
(Measured from the ground surface)
SLUG (IN) or SLUG (OUT): I or O
APPROXIMATE CHANGE IN WATER LEVEL: 1.6 Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the chan in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo): 15 Feet
Yo at time (t1): 0 Minutes
Intercept with the X axis (Xt): 3 Feet
Yt at time (t2): 5.7 Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 30

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No.054-94-119

Well Number: Date of February, 1994

Description of the Aquifer: Screen Interval:
Sand, sandy clay, clayey sand 40 feet 50 to 60 feet
Unified Soil Class:

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

9.0E-06	cm./sec.
0.0	m./day
9	ft./yr.
0.2	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter 8.5 inch - Borehole Diameter
10 foot - Screen Length 50 feet - Depth of Well
5.27 feet to Water Table 70 feet to Impermeable Surfa
The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below t

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 30

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No. 54-94-119

Well Number Date of Test: 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

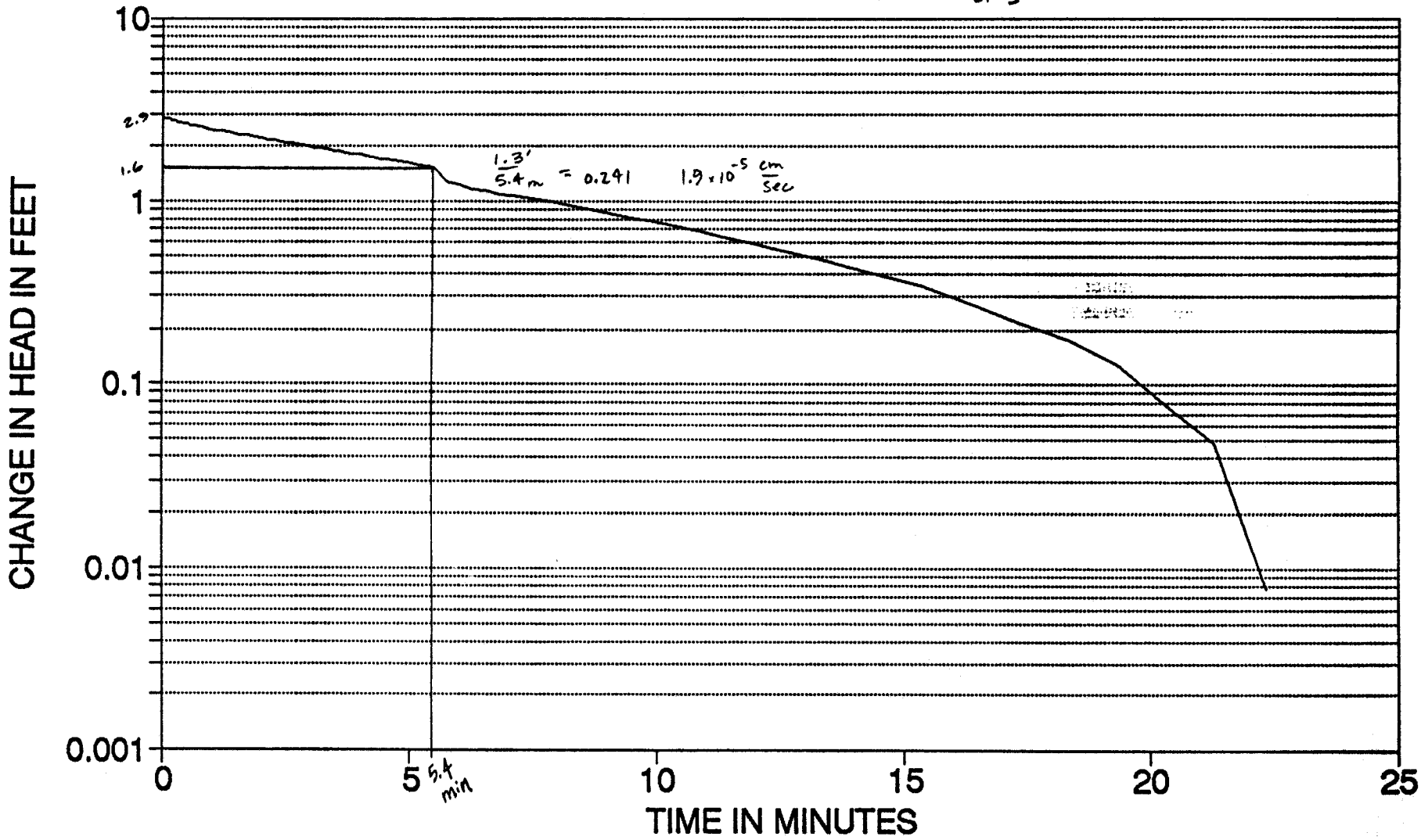
Intercept with the Y axis (Yo) 3.15 Feet @ 0 Minutes
X intercept at (Yt): 2.33 Feet @ 5.7 Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875
Rw (cm)	10.795
Le (cm)	304.8
Lw (cm)	1363.37
H (cm)	1972.97
Le/Rw	28.2353
Lw/Rw	126.296
A	from Fig. 2 2.2*
B	from Fig. 2 2.3*
C	from Fig. 2 1.8* Value not used
Yo	3.15
Yt	2.33
t (sec)	342
Ln((H-Lw)/Rw)	4.03372
Ln(Lw/Rw)	4.83863
Ln(Re/Rw)	2.4702
Ln(Yo/Yt)	0.30153
K (cm/sec)	9E-06

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - PIEZOMETER ~~S3~~ SP-3 TEST 1



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-3
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	2.19	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	27.12	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	5.46	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	2.9	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	1.6	Feet
Yt at time (t2):	5.4	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-3 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
14.93 feet to 24.9 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

1.9E-05	cm./sec.
0.0	m./day
20	ft./yr.
0.4	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
3.27 feet to Water Table
8.5 inch - Borehole Diameter
24.93 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-3 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

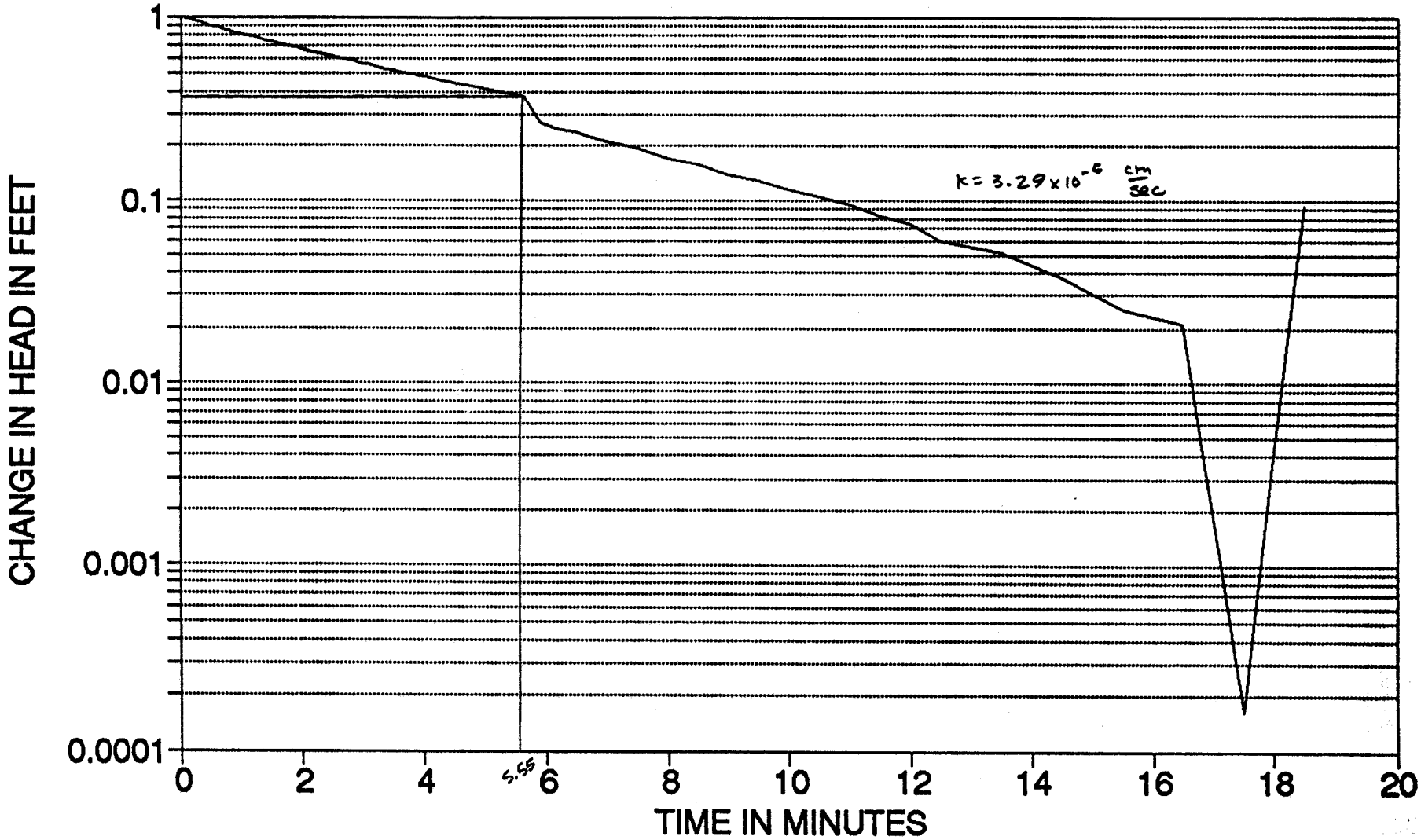
Intercept with the Y axis(Yo):	2.9	Feet @	0	Minutes
X intercept at (Yt):	1.6	Feet @	5.4	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	660.197	
H (cm)	2033.93	
Le/Rw	28.2353	
Lw/Rw	61.1576	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	2.9	
Yt	1.6	
t (sec)	324	
Ln((H-Lw)/Rw))	4.8462	
Ln(Lw/Rw)	4.11345	
Ln(Re/Rw)	2.51891	
Ln(Yo/Yt)	0.59471	
K (cm/sec)	1.9E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - D-4 (HVORSLEV)



—— WELL RECHARGE CURVE

4/2 3.1/x

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	DP-4
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	3.28	Feet
TOTAL DEPTH OF WELL:	53.28	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	4	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	2.2	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	2.5	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	1	Feet
Yt at time (t2):	4.95	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: DP-4 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
40 feet to 50.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

3.1E-05	cm./sec.
0.0	m./day
33	ft./yr.
0.7	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
0.72 feet to Water Table
8.5 inch - Borehole Diameter
50 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number DP-4 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

Intercept with the Y axis(Yo):	2.5	Feet @	0	Minutes
X intercept at (Yt):	1	Feet @	4.95	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	1502.05	
H (cm)	2111.65	
Le/Rw	28.2353	
Lw/Rw	139.144	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	2.5	
Yt	1	
t (sec)	297	
Ln((H-Lw)/Rw))	4.03372	
Ln(Lw/Rw)	4.93551	
Ln(Re/Rw)	2.46573	
Ln(Yo/Yt)	0.91629	
K (cm/sec)	3.1E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	DP-5
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND:	1.81	Feet
(Show subgrade completions as minus)		
TOTAL DEPTH OF WELL:	51.81	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	8.88	Feet
DEPTH TO AN IMPERMEABLE SURFACE:	70	Feet
(Measured from the ground surface)		
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	4.5	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	4.5	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	2	Feet
Yt at time (t2):	5.9	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: DP-5 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
40 feet to 50.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

2.3E-05	cm./sec.
0.0	m./day
24	ft./yr.
0.5	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
7.07 feet to Water Table
8.5 inch - Borehole Diameter
50 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-6
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	1.56	Feet
TOTAL DEPTH OF WELL:	21.56	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	3.81	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	N/A	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	5.25	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	4	Feet
Yt at time (t2):	0.09	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-6 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
10 feet to 20.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

5.3E-04	cm./sec.
0.5	m./day
546	ft./yr.
11.2	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
2.25 feet to Water Table
8.5 inch - Borehole Diameter
20 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-6 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

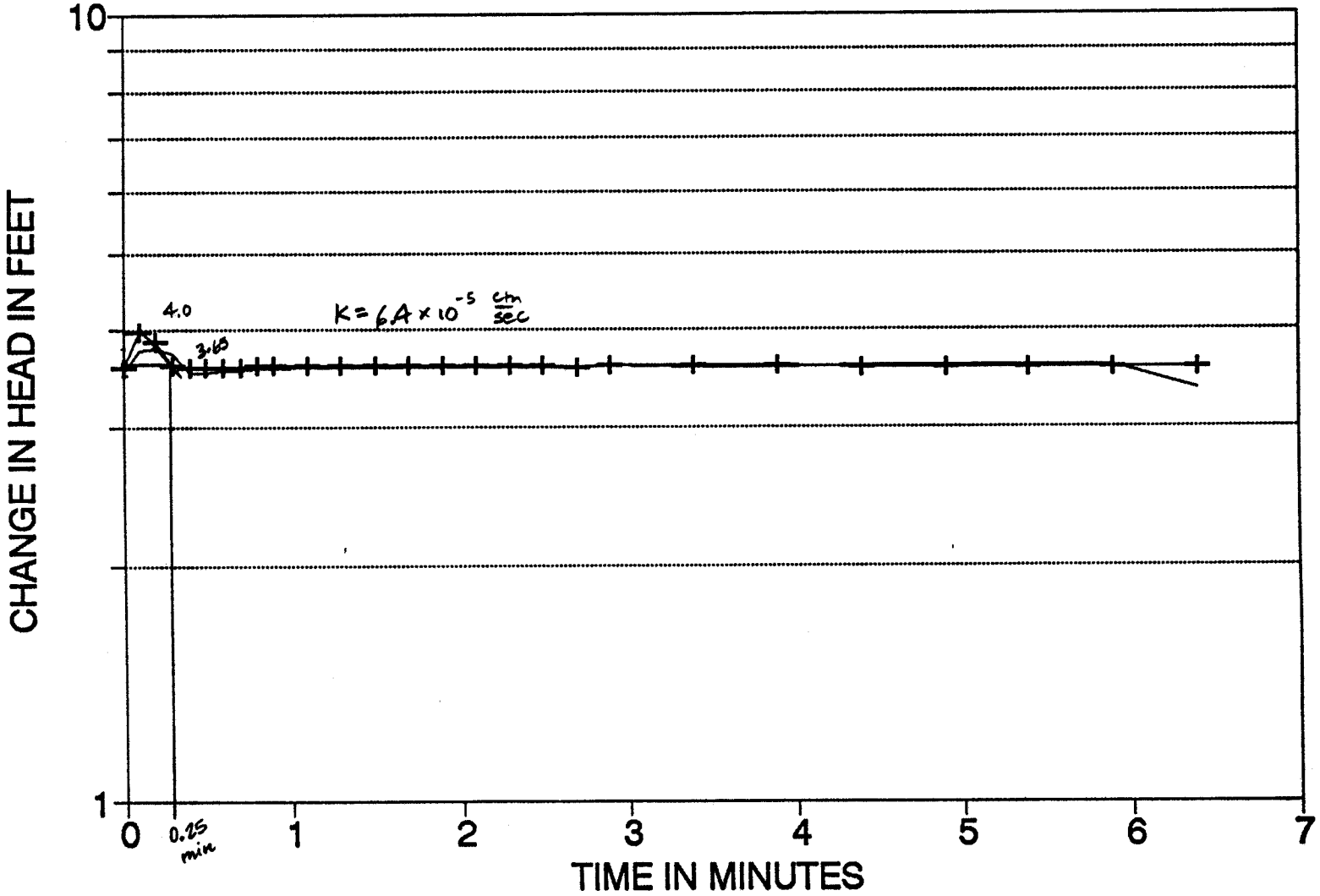
Intercept with the Y axis(Yo):	5.25	Feet @	0	Minutes
X intercept at (Yt):	4	Feet @	0.09	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	541.02	
H (cm)	2065.02	
Le/Rw	28.2353	
Lw/Rw	50.1176	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	5.25	
Yt	4	
t (sec)	5.4	
Ln((H-Lw)/Rw))	4.95001	
Ln(Lw/Rw)	3.91437	
Ln(Re/Rw)	2.53361	
Ln(Yo/Yt)	0.27193	
K (cm/sec)	0.00053	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - SP-7 TESTS 1&2



—— WELL RECHARGE CURVE

DATA INPUT SHEET

PROJECT NAME:	Washington County C&D Landfill
PROJECT LOCATION:	Plymouth, N.C.
PROJECT NUMBER:	1054-94-119
WELL IDENTIFICATION:	SP-7
DATE OF TEST:	February, 1994

AQUIFER DESCRIPTION: Sand, sandy clay, clayey sand

UNIFIED SOIL CLASSIFICATION

The following values are obtained by measurement of the well or from well records. All measurements are from top of casing or:

HEIGHT OF DATUM ABOVE GROUND: (Show subgrade completions as minus)	0.81	Feet
TOTAL DEPTH OF WELL:	20.81	Feet
INSIDE DIAMETER OF WELL:	1.25	Inches
DIAMETER OF THE BOREHOLE:	8.5	Inches
LENGTH OF SCREEN INTERVAL:	10	Feet
DEPTH TO THE STABILIZED WATER TABLE:	3.15	Feet
DEPTH TO AN IMPERMEABLE SURFACE: (Measured from the ground surface)	70	Feet
SLUG (IN) or SLUG (OUT):	I	I or O
APPROXIMATE CHANGE IN WATER LEVEL:	3	Feet

BLOCK 1 CHANNEL: 1 (Entry not required)

The following values are obtained from the Semi-log graph of the change in water level with time. Both intercepts are required.

Intercept with the Y axis (Yo):	4	Feet
Yo at time (t1):	0	Minutes
Intercept with the X axis (Xt):	3.65	Feet
Yt at time (t2):	0.25	Minutes

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number: SP-7 Date of Test: February, 1994

Description of the Aquifer:
Sand, sandy clay, clayey sand
Unified Soil Class:

Screen Interval:
10 feet to 20.0 feet

1. The Hydraulic Conductivity of the aquifer within the screen interval shown, was determined using the Bouwer and Rice Analysis.

6.4E-05	cm./sec.
0.1	m./day
66	ft./yr.
1.4	gal/day/sq ft.

2. THESE CONDITIONS WERE SPECIFIED FOR THE ANALYSIS:

1.25 inch - Well Diameter
10 foot - Screen Length
2.34 feet to Water Table
8.5 inch - Borehole Diameter
20 feet - Depth of Well
70 feet to Impermeable Surfa

The slug was added to the well
The screen is fully submerged
The well is partially penetrating. The impermeable surface is below the scre

BOUWER and RICE ANALYSIS for HYDRAULIC CONDUCTIVITY
Using the Slug Test Method (continued from page 1)
Ref:Bouwer and Rice,Groundwater, Vol.27,No.3, May-June 1989, pgs. 304-

Washington County C&D Landfill
Plymouth, N.C.
S&ME Project No: 1054-94-119

Well Number SP-7 Date of Test: February, 1994

3. THE FOLLOWING RECHARGE GRAPH INTERCEPTS WERE USED:
(The graph is shown on the following page)

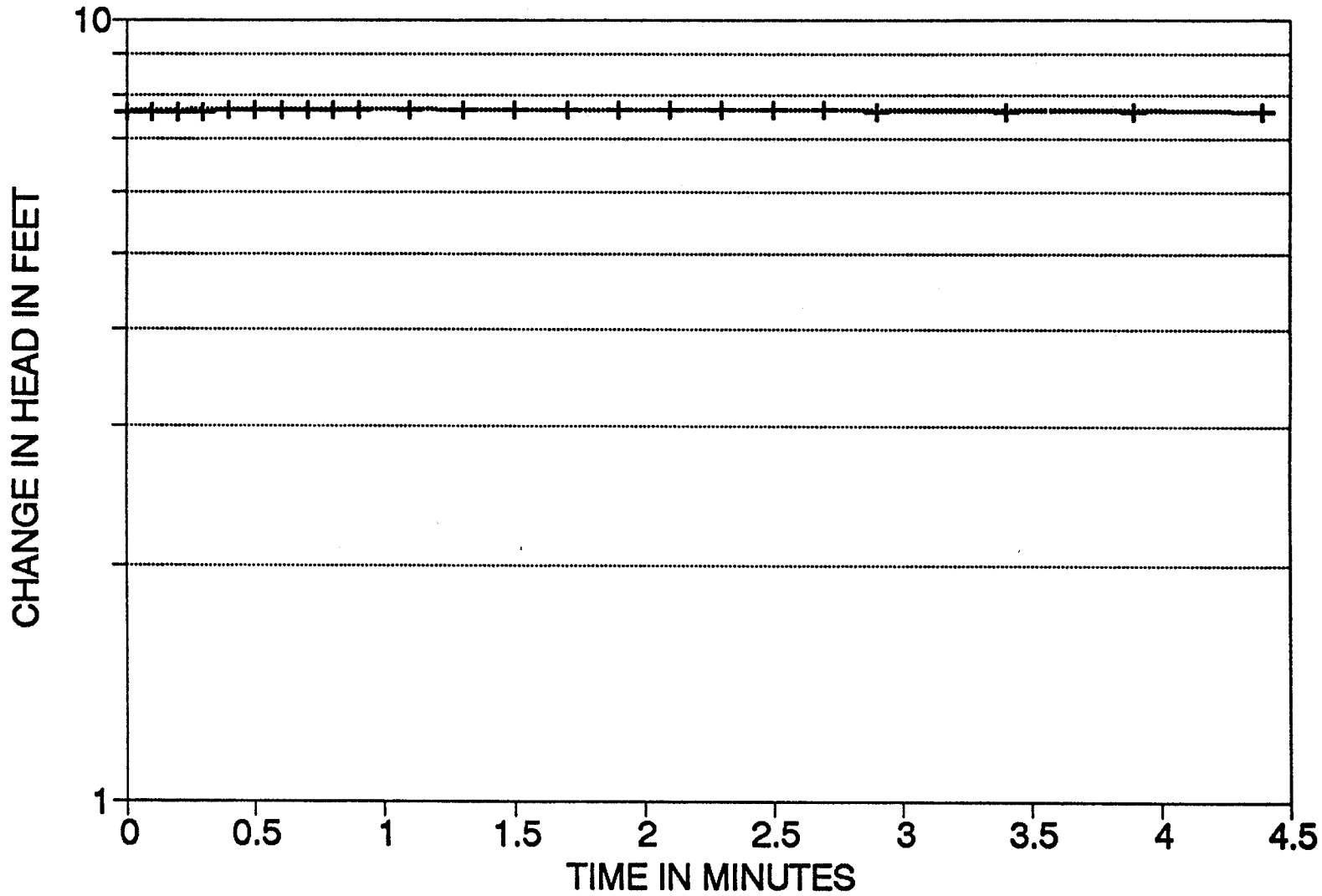
Intercept with the Y axis(Yo):	4	Feet @	0	Minutes
X intercept at (Yt):	3.65	Feet @	0.25	Minutes

4. THE FOLLOWING VALUES WERE USED IN THE ANALYSIS

Rc (cm)	1.5875	
Rw (cm)	10.795	
Le (cm)	304.8	
Lw (cm)	538.277	
H (cm)	2062.28	
Le/Rw	28.2353	
Lw/Rw	49.8635	
A from Fig. 2 *	2.2	
B from Fig. 2 *	0.3	
C from Fig.2 *	1.8	Value not used
Yo	4	
Yt	3.65	
t (sec)	15	
Ln((H-Lw)/Rw))	4.95001	
Ln(Lw/Rw)	3.90929	
Ln(Re/Rw)	2.53397	
Ln(Yo/Yt)	0.09157	
K (cm/sec)	6.4E-05	

* Dimensionless parameters as a function of Le/Rw shown on figure 2 of the analysis method

WASHINGTON COUNTY LANDFILL
AQUIFER TEST - SP-5 TESTS 1&2



WELL RECHARGE CURVE

Project Name:	Washington County C&D Landfill	Test Parameters:	
Site Location:	Washingon County	S/N SDEE-03A-SN-3132	Block 1
Project Number:	1054-94-119		
		Program:	STEP TEST
Well Number:	PZ S-1	Readings:	29
Test Number:	Test 1	Start Time:	02:55:02
		Start Date:	01/01
		Range:	0009 PSI
		Channels:	1
		Units:	Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:06
Readings 10

Time	Chnl 1
0.00	+3.4929
0.10	+3.4929
0.20	+4.3547
0.30	+3.5436
0.40	+3.5030
0.50	+3.5030
0.60	+3.5081
0.70	+3.5132
0.80	+3.5132
0.90	+3.5183

Step 2
Interval 00:00:12
Readings 10

Time	Chnl 1
1.10	+3.5183
1.30	+3.5233
1.50	+3.5233
1.70	+3.5233
1.90	+3.5233
2.10	+3.5284
2.30	+3.5284
2.50	+3.5284
2.70	+3.5284
2.90	+3.5284

Step 3
Interval 00:00:30
Readings 10

Time	Chnl 1
3.40	+3.5284
3.90	+3.5284
4.40	+3.5284
4.90	+3.5284
5.40	+3.5284
5.90	+3.2901
6.40	+3.2851
6.90	+3.2901
7.40	+3.2851

Test 1 aborted at Step 3

Project Name: Washington County C&D Landfill
Site Location: Washington County
Project Number: 1054-94-119

Well Number: PZ 5-D
Test Number: Test 1

Test Parameters:
S/N SDEE-03A-SN-3132 Block 1

Program: STEP TEST
Readings: 43
Start Time: 00:36:47
Start Date: 01/01
Range: 0009 PSI
Channels: 1
Units: Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:06
Readings 10

Time	Chnl 1
0.00	+6.5499
0.10	+9.5866
0.20	+9.5308
0.30	+9.4700
0.40	+9.3888
0.50	+9.3077
0.60	+9.2317
0.70	+9.1658
0.80	+9.0999
0.90	+9.0441

Step 2
Interval 00:00:12
Readings 10

Time	Chnl 1
1.10	+8.9326
1.30	+8.8363
1.50	+8.7399
1.70	+8.6487
1.90	+8.5574
2.10	+8.4662
2.30	+8.3749
2.50	+8.2887
2.70	+8.2026
2.90	+8.1214

Step 3
Interval 00:00:30
Readings 10

Time	Chnl 1
3.40	+7.8781
3.90	+7.6804
4.40	+7.5080
4.90	+7.3610
5.40	+7.2140
5.90	+6.8439
6.40	+6.7172
6.90	+6.6158
7.40	+6.5042
7.90	+6.4282

Step 4
Interval 00:01:00
Readings 10

Time	Chnl 1
8.90	+6.2305
9.90	+6.0784
10.90	+5.9466
11.90	+5.8401
12.90	+5.7286
13.90	+5.6171
14.90	+5.5309
15.90	+5.4700
16.90	+5.3839
17.90	+5.3180

Step 5
Interval 00:02:00
Readings 10

Time	Chnl 1
19.90	+5.2318
21.90	+5.1253
23.90	+5.0493

Test 1 aborted at Step 5

Project Name:	Washington County C&D Landfill
Site Location:	Washington County
Project Number:	1054-94-119
Well Number:	PZ 2-D
Test Number:	Test 1

Test Parameters:
S/N SDEE-03A-SN-3132 Block 1

Program: STEP TEST
Readings: 90
Start Time: 20:05:16
Start Date: 01/01
Range: 0009 PSI
Channels: 1
Units: Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:02
Readings 30

Time	Chnl 1
0.00	+3.6298
0.03	+3.6298
0.07	+3.6298
0.10	+3.6298
0.13	+4.0962
0.17	+6.1240
0.20	+6.7222
0.23	+6.8743
0.27	+6.8895
0.30	+6.8794
0.33	+6.8642
0.37	+6.8540
0.40	+6.8388
0.43	+6.8236
0.47	+6.8135
0.50	+6.8034
0.53	+6.7932
0.57	+6.7831
0.60	+6.7729
0.63	+6.7628
0.67	+6.7527
0.70	+6.7425
0.73	+6.7324
0.77	+6.7273
0.80	+6.7172
0.83	+6.7070
0.87	+6.7020
0.90	+6.6918
0.93	+6.6868
0.97	+6.6766

Step 2
Interval 00:00:08
Readings 30

Time	Chnl 1
1.10	+6.6411
1.23	+6.6107
1.37	+6.5803
1.50	+6.5499
1.63	+6.5245
1.77	+6.4941
1.90	+6.4688
2.03	+6.4434
2.17	+6.4130
2.30	+6.3927
2.43	+6.3674
2.57	+6.3471
2.70	+6.3268
2.83	+6.3065
2.97	+6.2863
3.10	+6.2710
3.23	+6.2508
3.37	+6.2356
3.50	+6.2203
3.63	+6.2051
3.77	+6.1899
3.90	+6.1747
4.03	+6.1595
4.17	+6.1443
4.30	+6.1342
4.43	+6.1190
4.57	+6.1088
4.70	+6.0936
4.83	+6.0835
4.97	+6.0733

Step 3
Interval 00:00:16
Readings 10

Time	Chnl 1
5.23	+6.0480
5.50	+6.0226
5.77	+6.0024
6.03	+5.9821
6.30	+5.7337
6.57	+5.7032
6.83	+5.6830
7.10	+5.6678
7.37	+5.6475
7.63	+5.6272

Step 4
Interval 00:00:30
Readings 10

Time	Chnl 1
8.13	+5.5968
8.63	+5.5613
9.13	+5.5309
9.63	+5.4903
10.13	+5.4650
10.63	+5.4295
11.13	+5.4092
11.63	+5.3687
12.13	+5.3382
12.63	+5.3180

Step 5
Interval 00:01:00
Readings 10

Time	Chnl 1
13.63	+5.2521
14.63	+5.2825
15.63	+5.3839
16.63	+5.3332
17.63	+5.2926
18.63	+5.2419
19.63	+5.1963
20.63	+5.1557
21.63	+4.8870
22.63	+4.8516

Step 6
Interval 00:05:00
Readings 0

Time	Chnl 1

no readings

Project Name: Washington County C&D Landfill
Site Location: Washington Co.
Project Number: 1054-94-119

Well Number: PZ 1-D
Test Number: Test 1

Test Parameters:
S/N SDEE-03A-SN-3132 Block 1

Program: STEP TEST
Readings: 95
Start Time: 18:35:16
Start Date: 01/01
Range: 0009 PSI
Channels: 1
Units: Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:02
Readings 30

Time	Chnl 1
0.00	+4.8516
0.03	+5.7032
0.07	+5.8046
0.10	+5.9010
0.13	+5.9567
0.17	+5.9364
0.20	+5.9314
0.23	+5.9314
0.27	+5.9263
0.30	+5.9263
0.33	+5.9263
0.37	+5.9212
0.40	+5.9263
0.43	+5.9212
0.47	+5.9212
0.50	+5.9212
0.53	+5.9162
0.57	+5.9162
0.60	+5.9162
0.63	+5.9060
0.67	+5.9111
0.70	+5.9060
0.73	+5.9060
0.77	+5.9010
0.80	+5.9060
0.83	+5.8959
0.87	+5.8959
0.90	+5.8908
0.93	+5.8908
0.97	+5.8908

Step 2
Interval 00:00:08
Readings 30

Time	Chnl 1
1.10	+5.8807
1.23	+5.8705
1.37	+5.8655
1.50	+5.8553
1.63	+5.8503
1.77	+5.8401
1.90	+5.8300
2.03	+5.8249
2.17	+5.8148
2.30	+5.8097
2.43	+5.7996
2.57	+5.7945
2.70	+5.7844
2.83	+5.7793
2.97	+5.7692
3.10	+5.7641
3.23	+5.7539
3.37	+5.7489
3.50	+5.7387
3.63	+5.7337
3.77	+5.7235
3.90	+5.7185
4.03	+5.7083
4.17	+5.7032
4.30	+5.6931
4.43	+5.6880
4.57	+5.6779
4.70	+5.6728
4.83	+5.6678
4.97	+5.6576

Step 3
Interval 00:00:16
Readings 10

Time	Chnl 1
5.23	+5.6424
5.50	+5.6272
5.77	+5.6120
6.03	+5.3788
6.30	+5.3585
6.57	+5.3433
6.83	+5.3281
7.10	+5.3180
7.37	+5.3028
7.63	+5.2977

Step 4
Interval 00:00:30
Readings 10

Time	Chnl 1
8.13	+5.2571
8.63	+5.2419
9.13	+5.2115
9.63	+5.1912
10.13	+5.1659
10.63	+5.1557
11.13	+5.1304
11.63	+5.1050
12.13	+5.0949
12.63	+5.0645

Step 5
Interval 00:01:00
Readings 10

Time	Chnl 1
13.63	+5.0239
14.63	+4.9834
15.63	+4.9479
16.63	+4.9073
17.63	+4.8870
18.63	+4.8465
19.63	+4.8110
20.63	+4.7755
21.63	+4.7502
22.63	+4.7299

Step 6
Interval 00:05:00
Readings 5

Time	Chnl 1
27.63	+4.5981
32.63	+4.4713
37.63	+4.3801
42.63	+4.2939
47.63	+4.2077

Project Name:
Site Location:
Project Number: 1054-04-119

Well Number: ~~MW~~ PZ 4-D
Test Number: Test 1

Test Parameters:
S/N SDEE-03A-SN-3132 Block 1

Program: STEP TEST
Readings: 87
Start Time: 22:04:09
Start Date: 01/01
Range: 0009 PSI
Channels: 1
Units: Ft-H2O

SUMMARY OF TIME AND WATER COLUMN PRESSURE VALUES DURING TEST

Step 1
Interval 00:00:02
Readings 30

Time	Chnl 1
0.00	+3.5132
0.03	+3.5081
0.07	+3.5081
0.10	+3.5081
0.13	+3.5081
0.17	+4.4916
0.20	+5.5410
0.23	+5.4650
0.27	+5.4498

Step 2
Interval 00:00:08
Readings 30

Time	Chnl 1
1.10	+5.0848
1.23	+5.0391
1.37	+4.9935
1.50	+4.9529
1.63	+4.9124
1.77	+4.8769
1.90	+4.8363
2.03	+4.8009
2.17	+4.7654

Step 3
Interval 00:00:16
Readings 10

Time	Chnl 1
5.23	+4.1925
5.50	+4.1570
5.77	+4.1266
6.03	+3.8883
6.30	+3.8376
6.57	+3.8174
6.83	+3.7920
7.10	+3.7667
7.37	+3.7362

Step 4
Interval 00:00:30
Readings 10

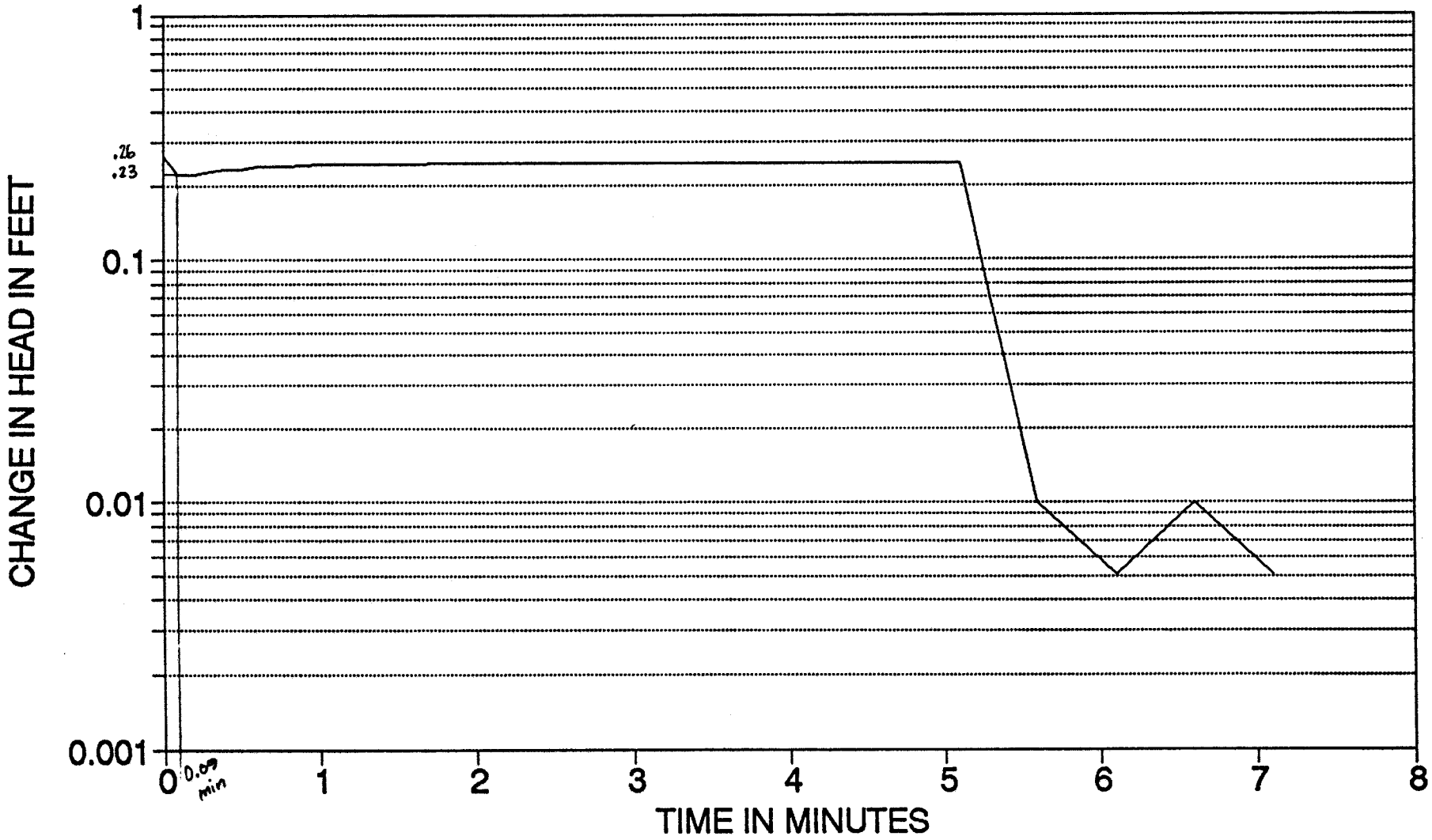
Time	Chnl 1
8.13	+3.6703
8.63	+3.6450
9.13	+3.6146
9.63	+3.5892
10.13	+3.5385
10.63	+3.5183
11.13	+3.4929
11.63	+3.4676
12.13	+3.4523

Step 5
Interval 00:01:00
Readings 10

Time	Chnl 1
13.63	+3.3915
14.63	+3.3763
15.63	+3.3459
16.63	+3.3256
17.63	+3.3104
18.63	+3.3155
19.63	+3.5081

Test 1 aborted at Step 5

WASHINGTON COUNTY C&D LANDFILL
AQUIFER TEST - PIEZOMETER SP11 TEST 1



—— WELL RECHARGE CURVE

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 relat'onship 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.

REFERENCES

Aggarwal, Y.P., and Sykes, L.R., 1978, Earthquakes, faults, and nuclear power plants in southern New York and northern New Jersey: Science, v. 200, p. 425-429.

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.

Bender, Bernice, and Campbell, K.W., 1989, A short note on the selection of minimum magnitude for use in seismic hazard analysis: Seismological Society of America Bulletin, v. 79, p. 199-204.

Cornell, C.A., and Winterstein, S.R., 1988, Temporal and magnitude dependence in earthquake recurrence models: Bulletin of the Seismological Society of America, v. 78, p. 1522-1537.

Electric Power Research Institute (EPRI), 1987, Seismic hazard methodology for the central and eastern United States, Vol. II: Responses to NRC Questions, p. 2-12.

Federal Emergency Management Agency, 1985, NEHRP (National Earthquake Hazards Reduction Program) recommended provisions for the development of seismic regulations for new buildings, 1985 Edition, part 2, Commentary: Earthquake Hazards Reduction Series 18, Building Seismic Safety Council, 200 p.

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.

_____1982, Results of core drilling of the Ramapo fault and Sky Meadow Road, Rockland County, New York, and assessment of evidence for reactivation to produce current seismicity: U.S. Geological Survey Miscellaneous Investigations Series Map I-1401, 1 sheet.

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

APPENDIX IV
OTHER DOCUMENTS

ABSTRACT

This appendix contains other documents reviewed during the study. It includes the monitor well information for the existing landfill and a discussion of the Seismic Risk Map.

Wilson Engineering Associates, Inc.

P.O. Box 12015
Research Triangle Park
North Carolina 27709

Durham (919) 544-1735
Raleigh (919) 556-0515
Wilmington (919) 270-3016

July 6, 1989

Mr. Bill Diehl
Diehl and Phillips, P. A.
219 East Chatham Street
Cary, North Carolina 27511

RE: Washington County Landfill
Washington County, North Carolina
WEA Project Number 89-078-EA

Dear Mr. Diehl:

As authorized by Washington County, Wilson Engineering Associates, Inc. has completed the installation of groundwater monitoring wells at the Washington County Landfill located in Washington County, North Carolina.

Enclosed please find the results of our subsurface exploration and installation of four (4) groundwater monitoring wells for the Washington County Landfill located in Washington County, North Carolina. Two (2) soil borings were performed in the groundwater monitoring well locations MW-2 and MW-4 and four (4) groundwater monitoring wells were set in the shallow aquifer.

Subsurface Conditions

The results of the two (2) soil borings at MW-2 and MW-4 and the analysis of the cuttings from MW-1 and MW-3 indicated that there is a dense clayey silty sand layer at approximately 23.0

to 26.0 feet below the existing ground surface at the site. Above the silty clayey sand layer, a layer of medium to coarse sand with a trace of silt was encountered. Near the ground surface, approximately 4.0 to 7.0 feet of a very clayey sand was encountered. Well logs and soil boring logs for the four (4) monitoring wells are included in the Appendix to this report for your records.

As discussed with you, I spoke with Mr. Ed Berry regarding the landfill's monitoring wells and requirements were to put the screened section of the well in the most permeable section of the shallow aquifer. Based on the two (2) borings and the four (4) augers performed at the site, the most permeable shallow aquifer appears to extend from approximately 6.0 to 10.0 feet to 23.0 to 26.0 feet. Therefore, the groundwater monitoring wells were set to approximately 22.0 to 25.0 feet below the existing ground surface.

Grain size analyses performed in our laboratory indicate that the sandy layer would have a permeability of approximately 4.8 x 10^{-2} cm/sec and the clayey silty fine sandy would have a permeability of approximately 1.2 x 10^{-3} cm/sec. These approximations are based on Hazens formula for sands. Based on the grain size analysis, the upper sand would be approximately 44 times as permeable as the gray silty clayey sand.

Monitoring Well Construction

Therefore, since it appears that the gray silty clayey sand was continuous from MW-2 to MW-4 and the dark gray dense layer was encountered in the cuttings at MW-1 and MW-3, the well screens were set in the permeable layer just above the gray silty clayey sand.

The monitoring wells were set using 6 inch ID hollow stem augers, the screens were set at depths noted on Table I and the annulus around the screens were backfilled with 2S Sand to 1 foot above the screen. Then a Bentonite seal was placed and the hole was grouted to the surface where a locking protector cap was set in the concrete.

The wells were then developed by bailing approximately 10 gallons from each well.

Surveying

One remaining item that needs to be performed at the site is to establish the elevation of the top of the plastic casing to establish the elevations of the groundwater in the wells. The county needs to secure sampling and testing from a local laboratory, or we would be glad to handle sampling and testing for you if you so desire.

If you have any questions with regard to the information contained in this letter, please do not hesitate to contact us.

Respectfully,

WILSON ENGINEERING ASSOCIATES, INC.

Benjamin V. Wilson, P. E.
Senior Engineer/President

Attachments

cc: Mr. Bobby Lufty
NCDEM - Division of Solids & Hazardous Waste

BVW:pjk

LOG OF HAND AUGER BORING NO. MW-1

JOB NAME: Washington County Landfill

SITE LOCATION: Washington County

WILSON ENGINEERING ASSOCIATES, INC.

CALIBRATED PENETROMETER TONS/FT² 1 2 3 4 5 7 9

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % 10 20 30 40 50 70 90

DYNAMIC CONE PENETRATION BLOWS/1.75" 10 20 30 40 50 70 90

ELEVATION	DEPTH	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	NOTES
						SURFACE ELEVATION	
						TOPSOIL	
	5					CLAYEY SILTY SAND, Tan. (SM-SC)	
	10						
	15					SAND, Tan to gray. (SW) NOTE: Saturated	
	20						
	25					CLAYEY SILTY FINE SAND, trace of mica, dark gray. (SM-SC)	
	30					BORING TERMINATED AT 27.0 FEET Hollow Stem Auger Used Full Depth	

NOTES: N WATER LEVEL IN BOREHOLE AT "N" HOURS AFTER BORING

D = _____ DRY DENSITY FROM UNDISTURBED SAMPLE LBS/FT³

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU THE TRANSITION MAY BE GRADUAL.

SHEET NO. 1	OF 1	BORING STARTED	
DRAWN: BNO	CHECKED BVW	BORING COMPLETED	
WEA JOB NO. 89-978 EA		CREW	

WILSON ENGINEERING ASSOCIATES, INC.
P.O. Box 12015
Research Triangle Park
North Carolina 27709
Durham (919) 544-1736
Raleigh (919) 366-0515
Wilmington (919) 270-3016

BL1

LOG OF HAND AUGER BORING NO. MW-2

JOB NAME: Washington County Landfill

SITE LOCATION: Washington County

WILSON ENGINEERING ASSOCIATES, INC.

ELEVATION / DEPTH	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	NOTES	DYNAMIC CONE PENETRATION BLOWS/1.75"
					SURFACE ELEVATION		
5					CLAYEY SILTY SAND, tan to brown. (SC-SM)		11
10					FINE SAND, some silt, gray. (SP) NOTE: Saturated		19
15							21
20					FINE TO MEDIUM SAND, trace of silt, light gray to tan. (SW) NOTE: Saturated		27
25					CLAYEY SILTY FINE SAND, trace of mica, dark gray. (SM-SC)		6
30					BORING TERMINATED AT 27.0 FEET Hollow Stem Auger Used Full Depth		suspect boring terminated at 25'

CALIBRATED PENETROMETER TONS/FT² (1, 2, 3, 4, 5, 7, 9)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50, 70, 90)

NOTES: ▽ N — WATER LEVEL IN BOREHOLE AT "N" HOURS AFTER BORING

D = _____ DRY DENSITY FROM UNDISTURBED SAMPLE LBS/FT³

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU THE TRANSITION MAY BE GRADUAL.

SHEET NO. 1 OF 1		BORING STARTED	6/8/89
DRAWN: BNO	CHECKED BVW	BORING COMPLETED	6/8/89
WEA JOB NO. 89-078 EA		CREW	WRM/PS

WILSON ENGINEERING ASSOCIATES, INC.
P.O. Box 12015
Research Triangle Park
North Carolina 27709
Durham (919) 544-1736
Raleigh (919) 546-0515
Wilmington (919) 270-3010

BL1

LOG OF HAND AUGER BORING NO. MW-3

JOB NAME: Washington County Landfill

SITE LOCATION: Washington County

WILSON ENGINEERING ASSOCIATES, INC.

ELEVATION / DEPTH	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	NOTES
					SURFACE ELEVATION	
5					CLAYEY SILTY SAND, Tan to brown. (SM-SC)	
10						
15					SAND, Tan to white. (SW) NOTE: Saturated	
20						
25					CLAYEY SILTY FINE SAND, dark gray. (SM-SC)	
30					BORING TERMINATED AT 25.0 FEET Hollow Stem Auger Used Full Depth	

CALIBRATED PENETROMETER TONS/FT² (1 2 3 4 5 7 9)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50 70 90)

DYNAMIC CONE PENETRATION BLOWS/1.75" (10 20 30 40 50 70 90)

Any split spoon sample?

NOTES: N — WATER LEVEL IN BOREHOLE AT "N" HOURS AFTER BORING

D = _____ DRY DENSITY FROM UNDISTURBED SAMPLE LBS/FT³

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU THE TRANSITION MAY BE GRADUAL.

SHEET NO. 1 OF 1

DRAWN: BNO CHECKED BVW

WEA JOB NO. 89-078 EA

BORING STARTED

BORING COMPLETED

CREW

WILSON ENGINEERING ASSOCIATES, INC.
P.O. Box 12015
Research Triangle Park
North Carolina 27709
Durham (919) 544-1736
Raleigh (919) 566-0519
Wilmington (910) 270-3016

BL1

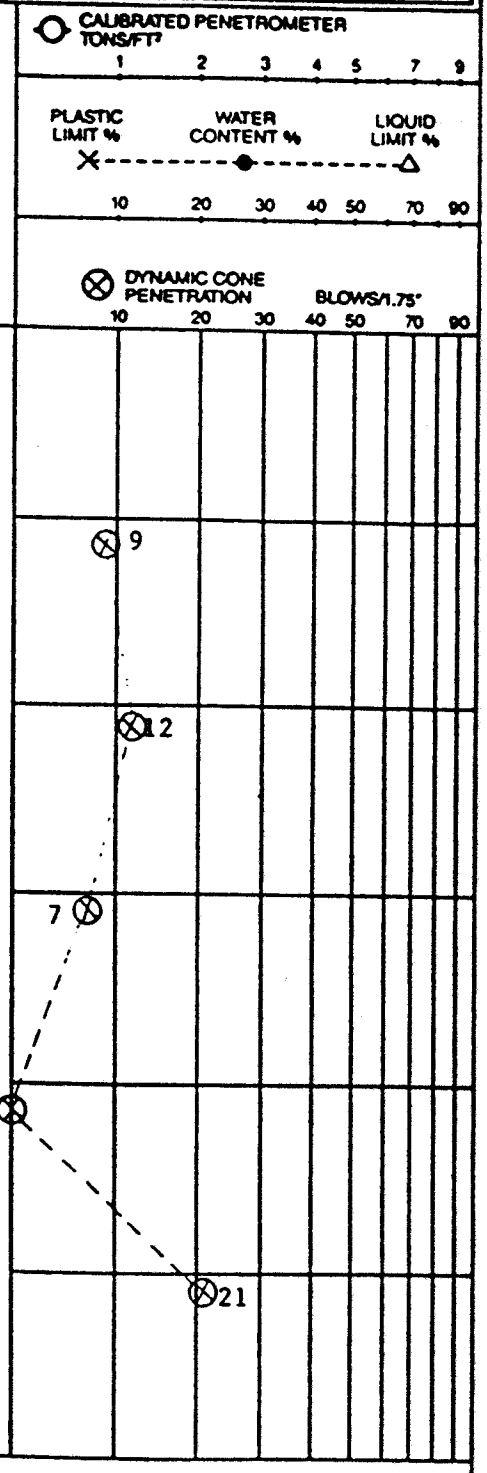
LOG OF HAND AUGER BORING NO. MW-4

JOB NAME: Washington County Landfill

SITE LOCATION: Washington County

WILSON ENGINEERING ASSOCIATES, INC.

ELEVATION	DEPTH	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	NOTES
						SURFACE ELEVATION	
						TOPSOIL	
	5					CLAYEY SILTY SAND, loose to medium dense, tan to brown. (SM-SC)	
	10					FINE SAND, some silt, medium dense, gray. (SP) NOTE: Saturated	
	15					MEDIUM TO COARSE SAND, trace of silt, very loose to loose, white. (SW) NOTE: Saturated	
	20						
	25					CLAYEY SILTY, FINE SAND, dark gray. (SM-SC)	
	30					BORING TERMINATED AT 26.5 FEET Hollow Stem Auger Used Full Depth	



NOTES: N WATER LEVEL IN BOREHOLE AT "N" HOURS AFTER BORING

* - WEIGHT OF ROD

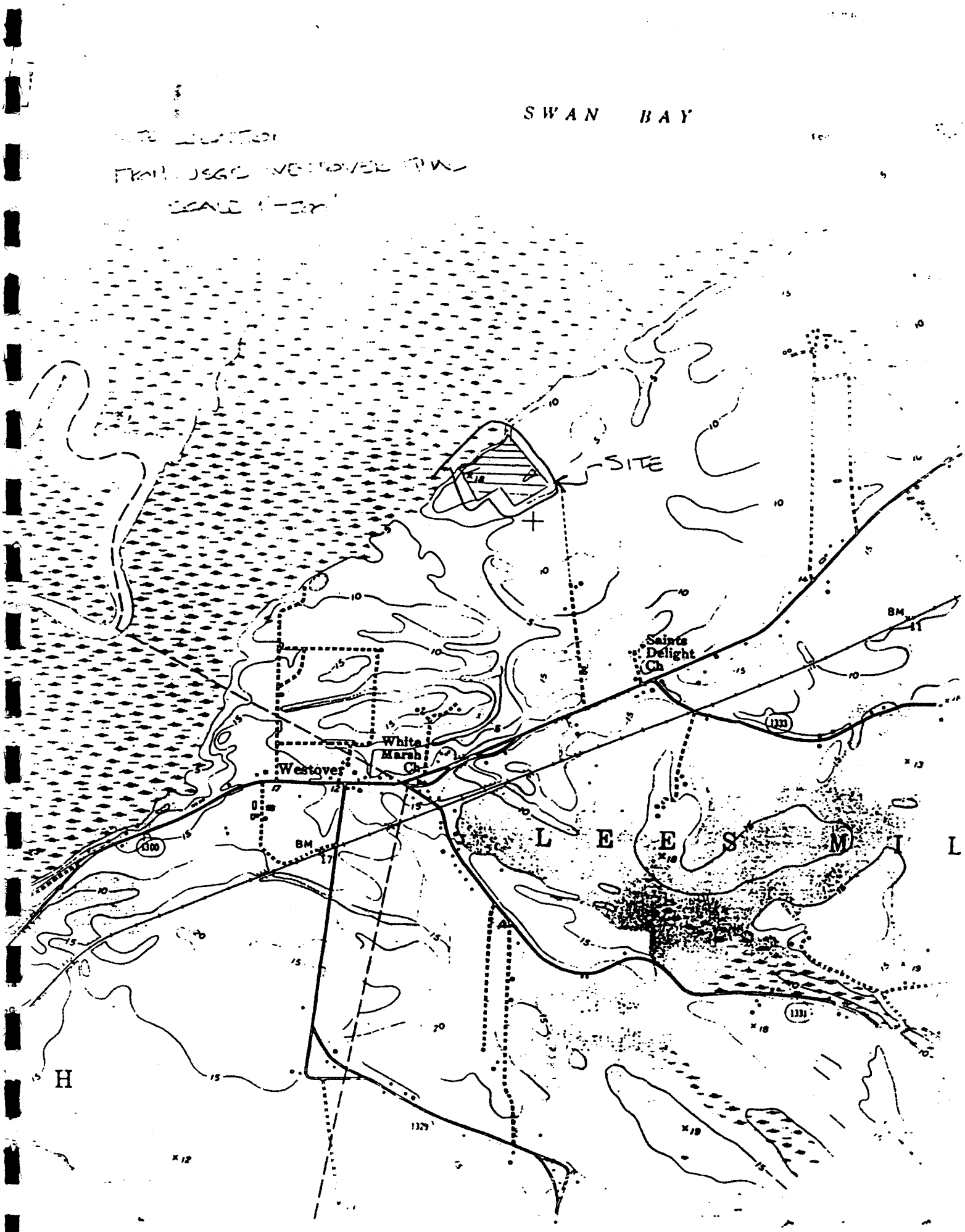
D = _____ DRY DENSITY FROM UNDISTURBED SAMPLE LBS/FT³

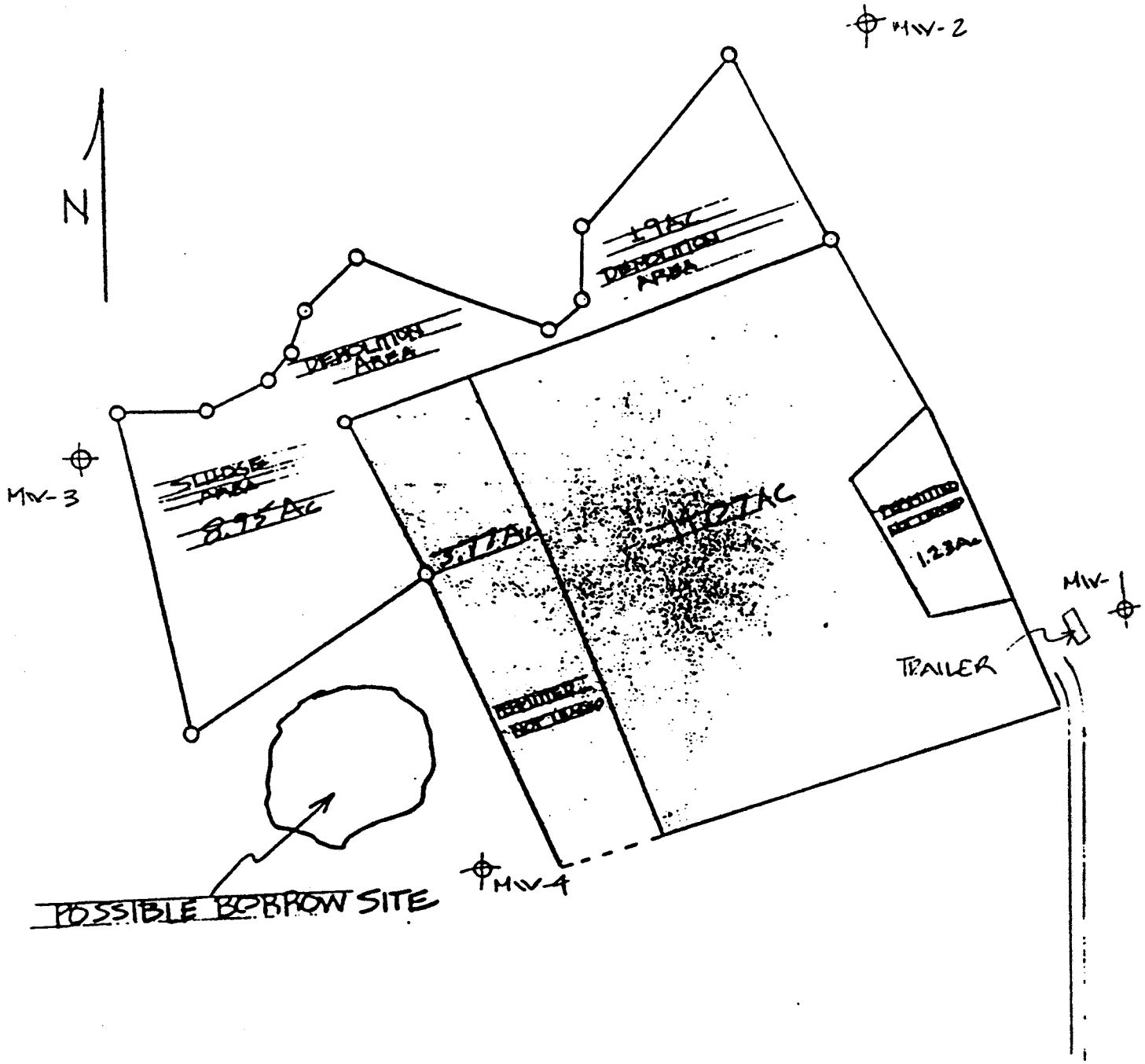
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU THE TRANSITION MAY BE GRADUAL.

SHEET NO. 1 OF 1		BORING STARTED	6/28/89
DRAWN: BNO	CHECKED BVW	BORING COMPLETED	6/28/89
WEA JOB NO. 89-078 EA		CREW	RP/HW

WILSON ENGINEERING ASSOCIATES, INC.
P.O. Box 12015
Research Triangle Park
North Carolina 27709
Durham (919) 544-1738
Raleigh (919) 366-0515
Wilmington (919) 270-3916

BL1


SWAN BAY
SITE
Saints Delight Ch
White Marsh Ch
Westover
L E E S M I L
H
1300
1333
1331
1329
BM



WASHINGTON CO. LANDFILL

SCALE: 1" = 200'

TABLE I

WELL CONSTRUCTION SUMMARY

WASHINGTON COUNTY LANDFILL

WASHINGTON COUNTY, NORTH CAROLINA

WEA PROJECT NUMBER 89-078-EA

WELL NO.	TOTAL DEPTH OF HOLE (FT)	CASING DEPTH (BELOW GROUND FT)	SCREEN INTERVAL	DATE COMPLETED
MW-1	27'	0-8 ~~23'~~	8' - 23'	6/29/89
MW-2	27'	0-5 ~~20'~~	5' - 20'	6/28/89
MW-3	25'	0-8 ~~23'~~	8' - 23'	6/29/89
MW-4	26.5'	0-4 ~~24'~~	4' - 24'	6/28/89

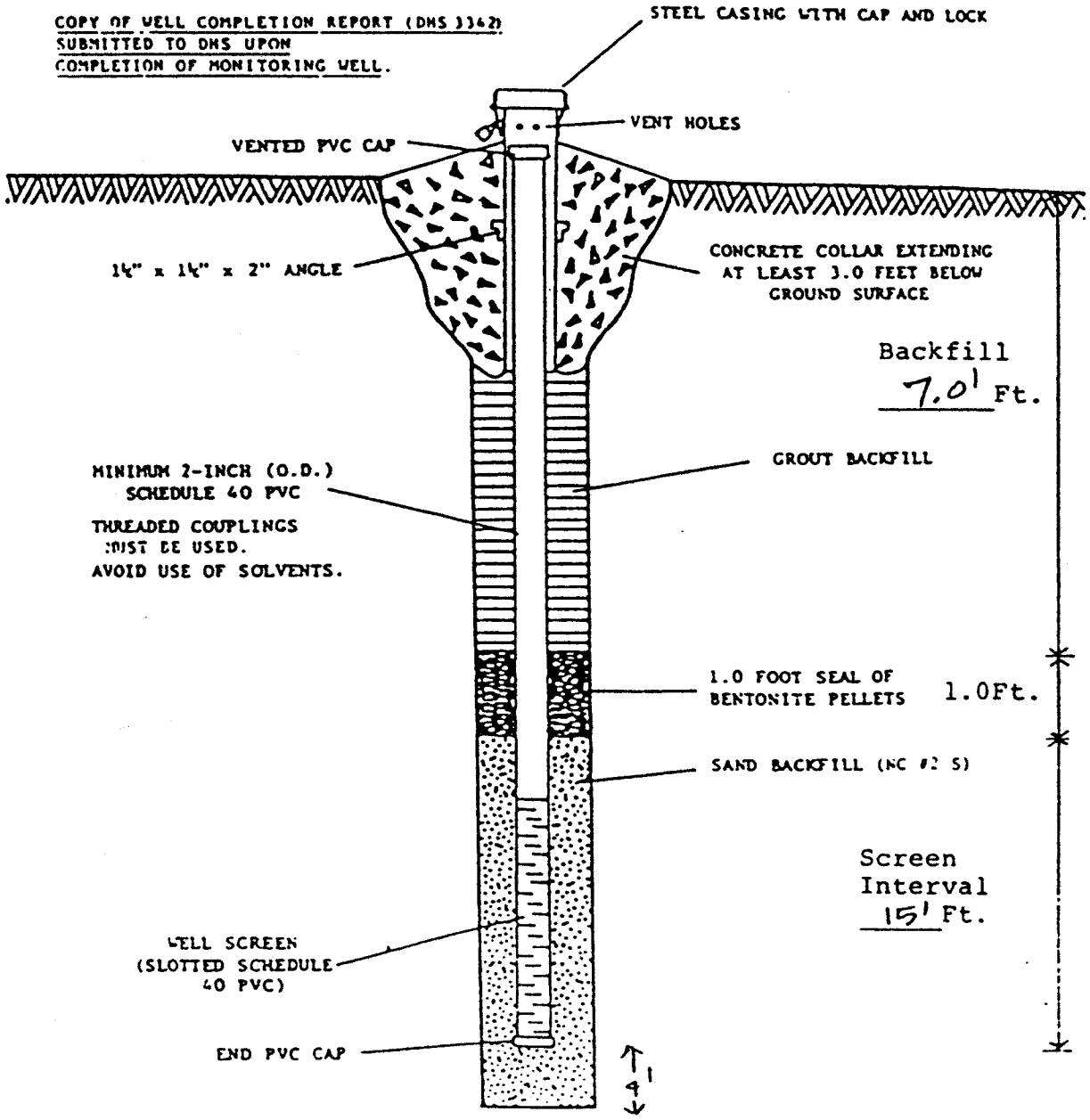
Wilson Engineering Associates, Inc.

P.O. Box 12015
Research Triangle Park
North Carolina 27709

Durham (919) 544-1735
Raleigh (919) 556-0515
Wilmington (919) 799-5537

Well Installation Diagram

For MW-1



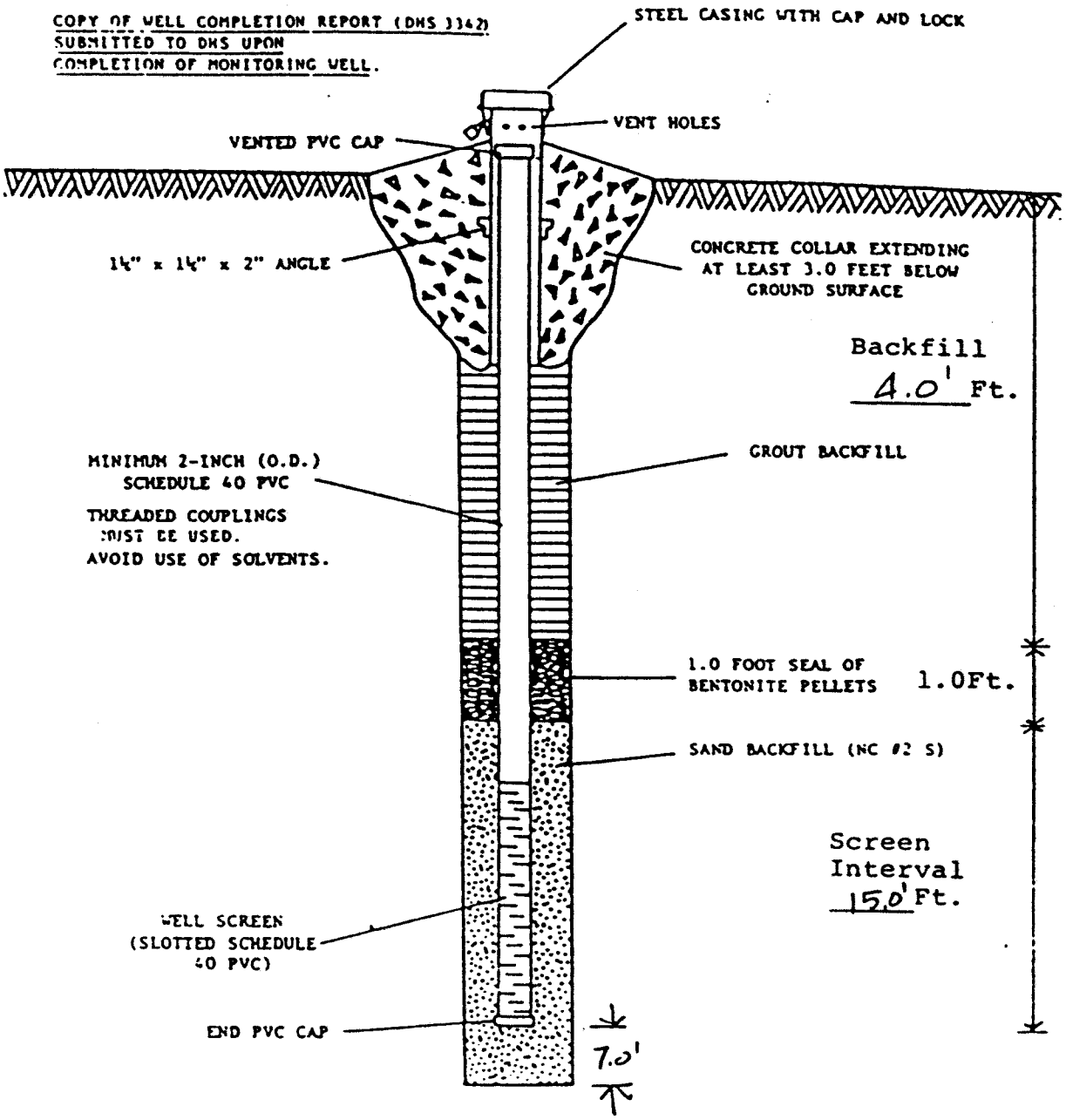
WEA
Wilson Engineering Associates, Inc.

P O Box 12015
Research Triangle Park
North Carolina 27709

Durham (919) 544-1735
Raleigh (919) 556-0515
Wilmington (919) 799-5537

Well Installation Diagram

For MW-2



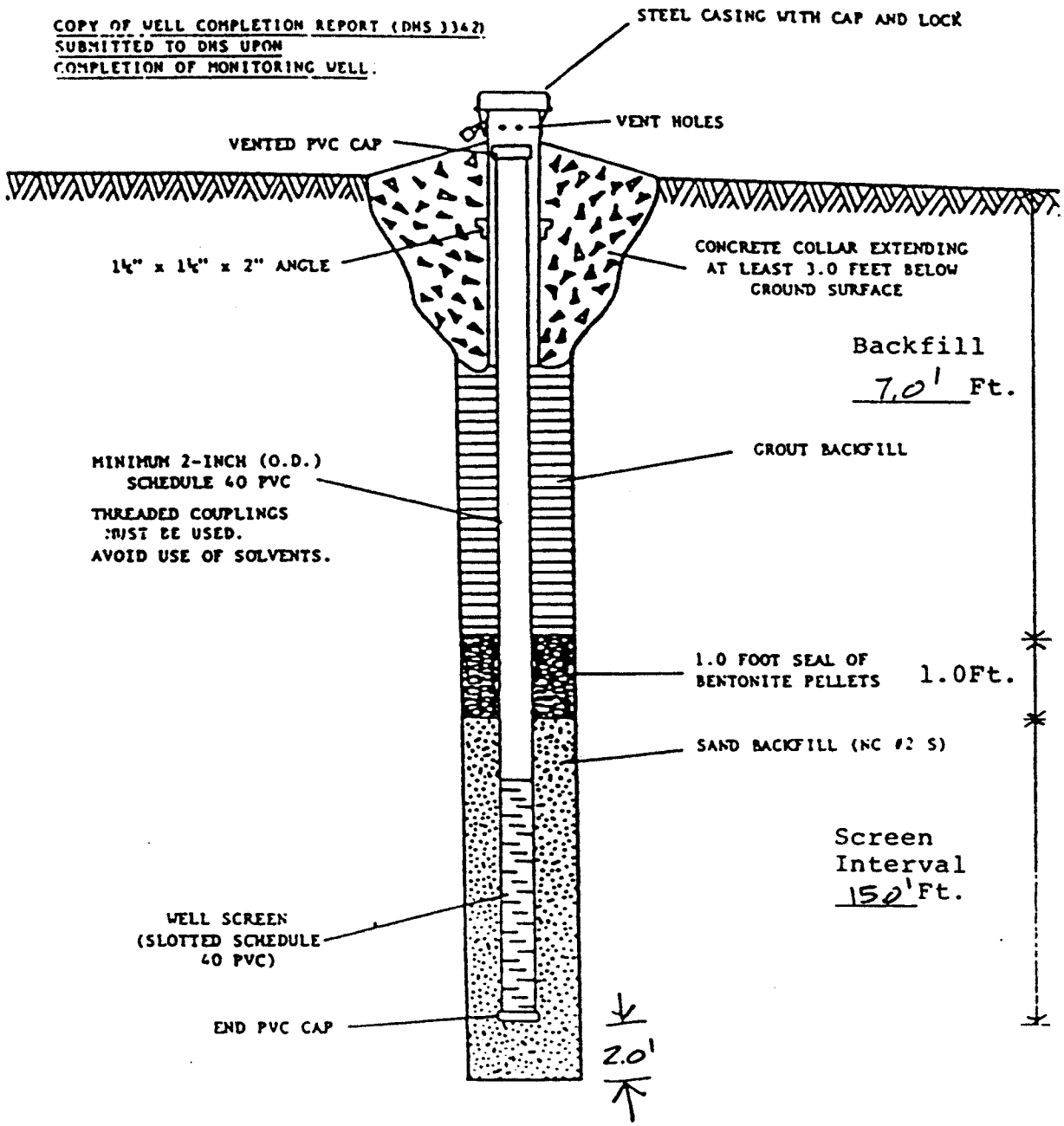
Wilson Engineering Associates, Inc.

P.O. Box 12015
Research Triangle Park
North Carolina 27709

Durham (919) 544-1735
Raleigh (919) 556-0515
Wilmington (919) 799-5537

Well Installation Diagram

For MW-3



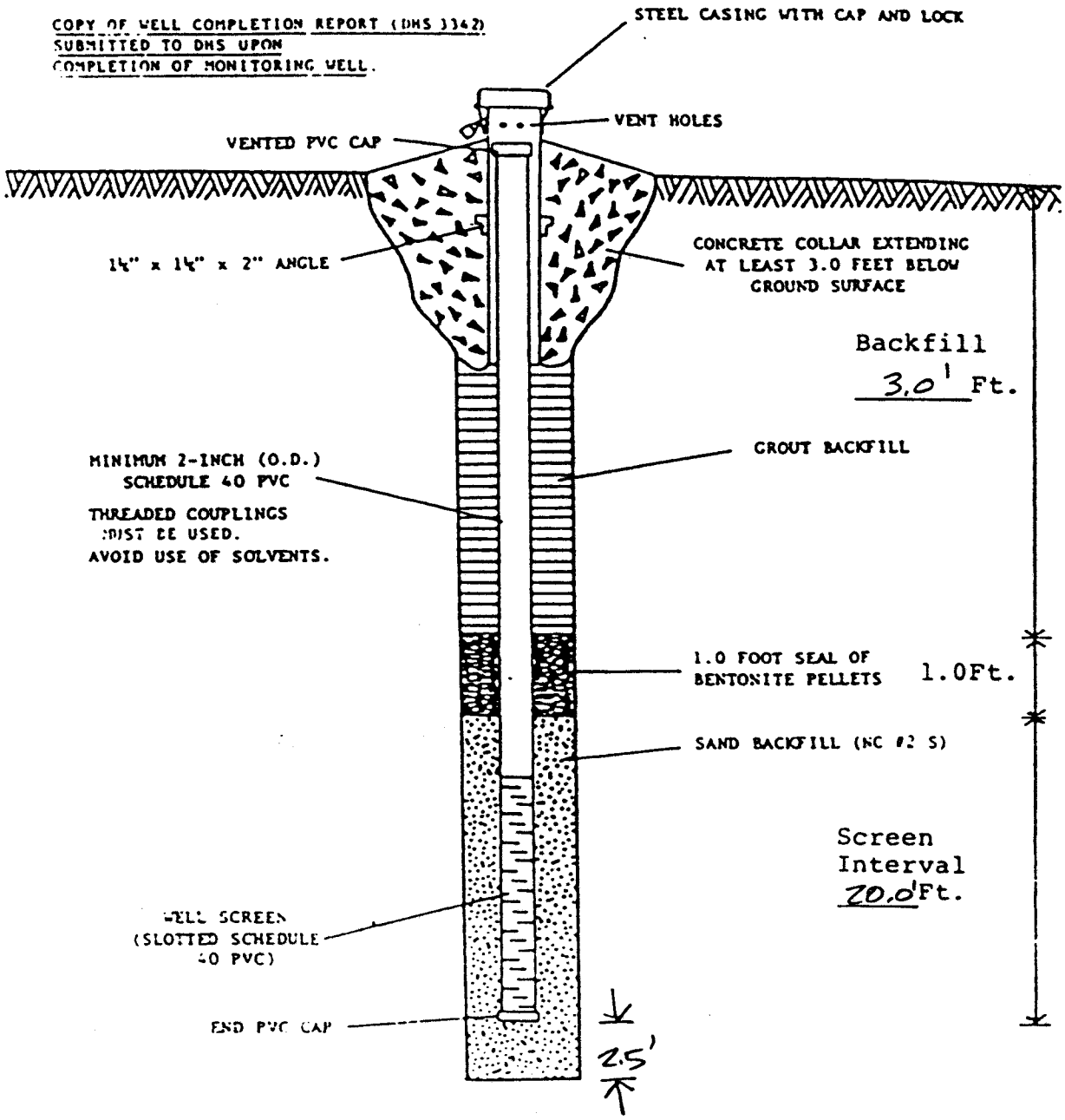
Wilson Engineering Associates, Inc.

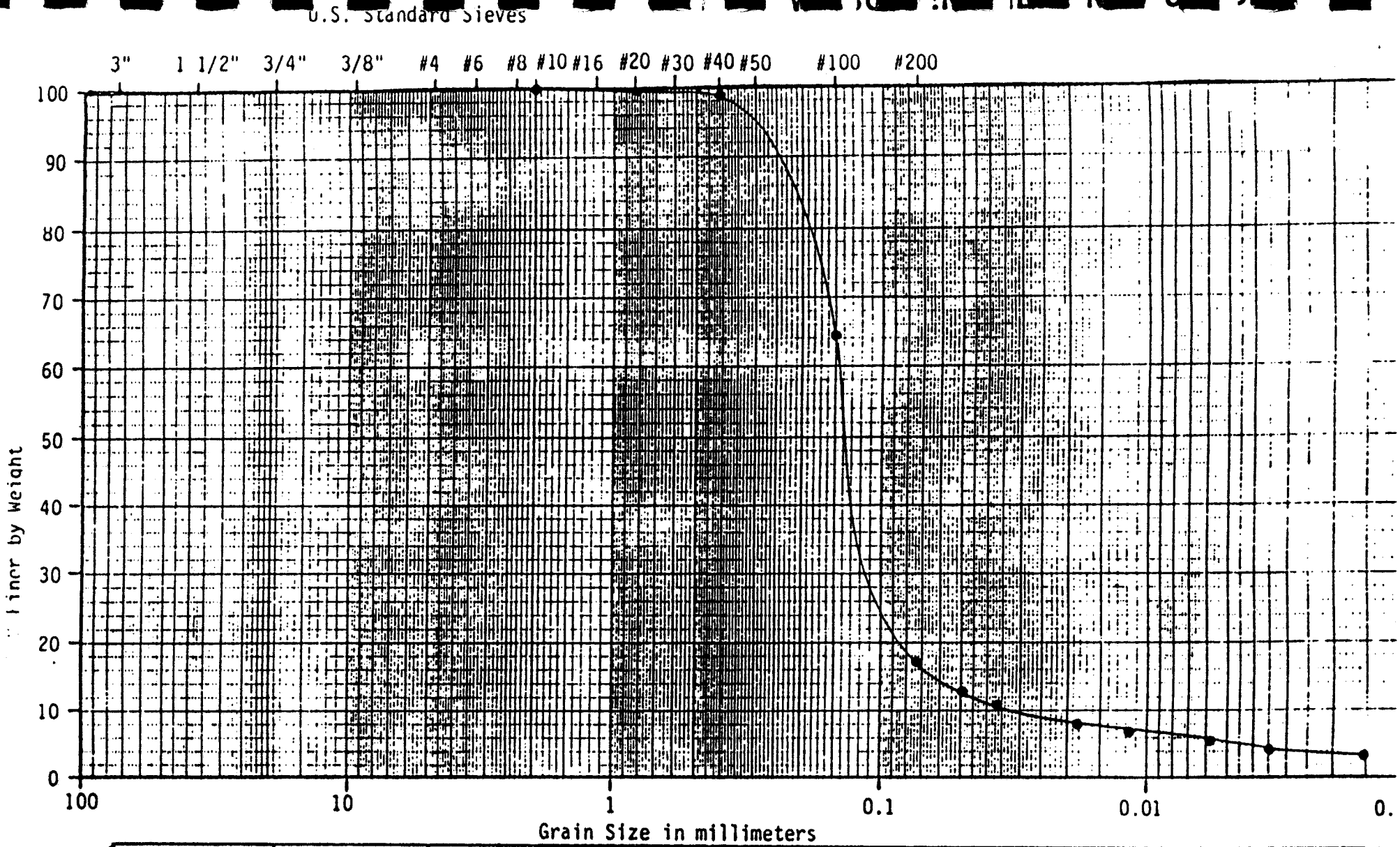
P.O. Box 12015
Research Triangle Park
North Carolina 27709

Durham (919) 544-1735
Raleigh (919) 556-0515
Wilmington (919) 799-5537

Well Installation Diagram

For MW-4





COARSE	FINE	COARSE	MEDIUM	FINE	
GRAVEL		SAND			FINES

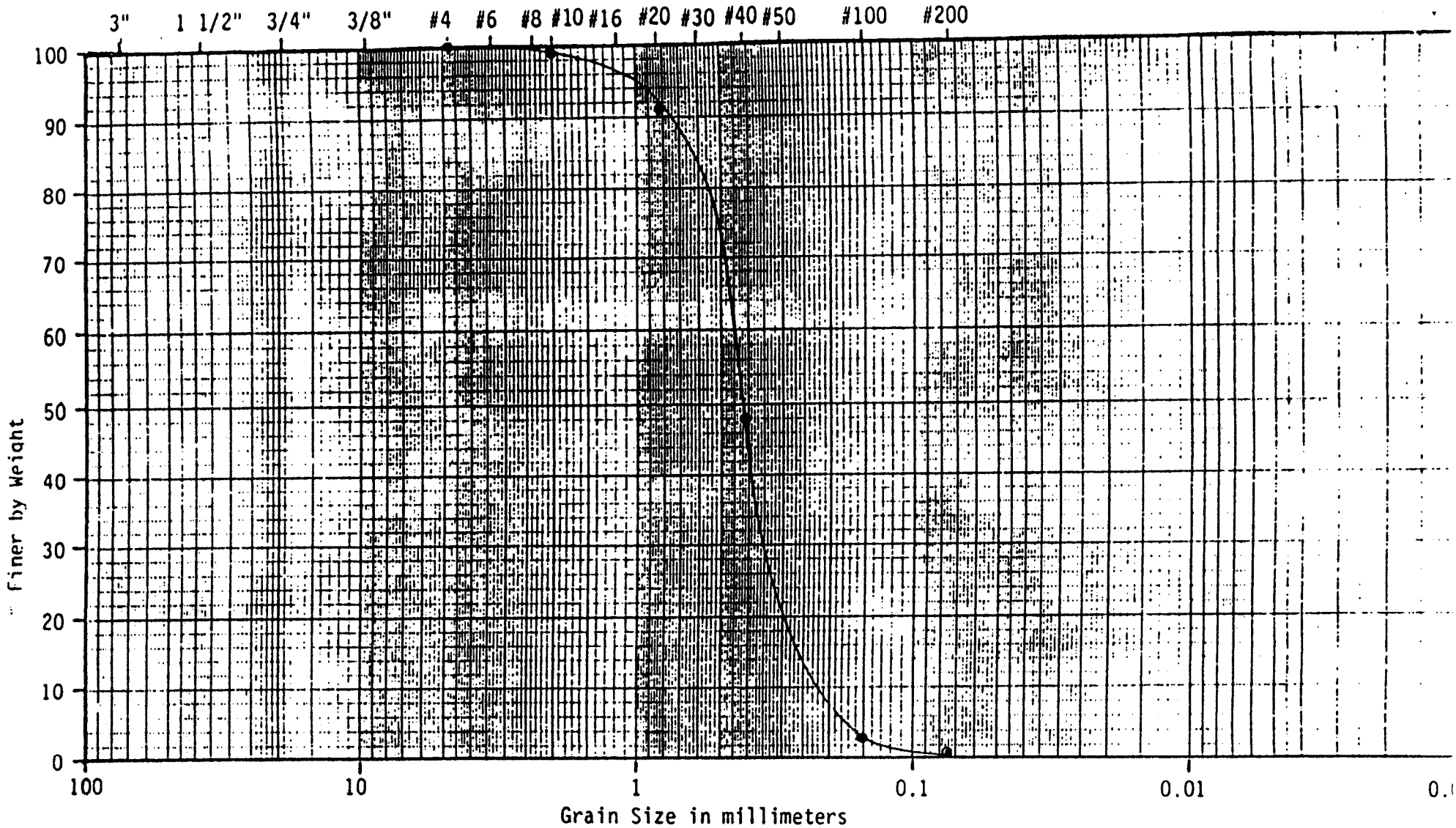
GRAIN SIZE DISTRIBUTION

Project Name Washington County Landfill

Project No. 89-078-EA

Date July 11, 1989

Sample MW4: S-5



COARSE	FINE	COARSE	MEDIUM	FINE	
GRAVEL		SAND			FINES

GRAIN SIZE DISTRIBUTION

Project Name Washington County Landfill

Project No. 89-078-EA

Date July 11, 1989

Sample MW4: S-3

Processed Silica Berm
Slope Stability Analysis

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

February 27, 1991

Diehl & Phillips
219 East Chatham Street
Cary, North Carolina 27511

Attention: Mr. Alen Keith

SUBJECT: REPORT OF GEOTECHNICAL SERVICES AND LABORATORY TESTING - WASHINGTON COUNTY LANDFILL WASHINGTON COUNTY LANDFILL DIKE AND COVER MATERIAL PLYMOUTH, NORTH CAROLINA LAW ENGINEERING JOB NO. J47291-6356

Dear Mr. Keith:

Law Engineering has completed the geotechnical services and laboratory testing for the proposed dike and cover material for the Washington County Landfill located in Plymouth, North Carolina. These services were requested and authorized by Mr. William C. Diehl, P.E. in general accordance with our Proposal P47291-3704. The results of our study, including summaries of the field exploration, laboratory testing analyses and our recommendations for slope design and earthwork construction procedures for this project are submitted herewith.

PROJECT INFORMATION

Project information has been provided by Mr. Alan Keith of Diehl & Phillips. We have drawings entitled Washington County Sanitary Landfill Vertical Expansion which were prepared by Diehl & Phillips and dated December 14, 1989. Additional project information has been provided by Mr. Gary Alberg of the North Carolina Department of Environmental Health and Natural Resources.

3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

We understand waste materials (alum sludge) from American Cyanamid located on the Weyerhaeuser Facility in Plymouth, North Carolina are to be used as borrow material at the Washington County Landfill located just east of Plymouth off of N.C. 308. The proposed uses of the borrow would include placement as a landfill cover and vertically raising an existing dike at the landfill. A portion of the existing dike has been constructed at the landfill with the alum sludge. The finished dike is to be 15 feet in height and will retain landfill debris. The alum sludge to be used for cover and raising the dike will be blended with agricultural grade lime.

FIELD EXPLORATION

To evaluate the existing dike material in-place density testing was conducted within the top one foot. Hand auger borings with dynamic cone penetrometer testing were performed at one foot intervals to a depth of six feet. The results of the field testing are attached in the Appendix of this report.

Sealed bulk samples of the alum sludge and lime mix were obtained at various locations along the dike and at stockpiled areas (see Drawing No. 1 attached). These samples were transported to our laboratory for visual observations by the engineer and laboratory testing.

In addition to field testing of the dike materials, hand auger borings with dynamic cone penetrometer testing were performed in the near surface soils in front of the dike. The results of the field testing are attached in the Appendix of this report.

LABORATORY TESTING

The proposed dike and cover material consisting of an alum sludge and lime mixture was transported to our office for laboratory testing. The laboratory testing included the following:

- Standard Proctor compaction testing.
- Consolidated undrained tri-axial testing of recompacted samples, saturated and unsaturated.
- Atterberg Limits for shrink swell characterization.
- Permeability testing of recompacted samples, saturated and unsaturated.

The results of our laboratory testing can be found in the Appendix of this report.

DISCUSSION

Compaction Characteristics: Based on the laboratory test results, the alum sludge/lime mixture appears to have an affinity for water/moisture similar to a non-plastic silt. As such, the compaction characteristics of this material require special attention to moisture control. The material requires moisture contents on the order of 58% to achieve maximum dry densities during compaction based on the standard Proctor test results. However, satisfactory compaction levels presently exist at much lower moisture contents.

Field density tests on the alum sludge previously placed in the existing dike indicated compacted dry densities over 100% of the standard Proctor maximum dry density at well below the optimum moisture content (field test locations 1 and 4), see Drawing No. 1. The results of the dynamic cone penetration further indicate a relatively uniform consistency with depth. As a result, the in-place dike material appears to be reasonably compacted.

Future placement of the alum sludge should be conducted similar to soil fill. We recommend the material be placed in 8 to 10 inch thick lifts and compacted to at least 95% of the standard Proctor maximum dry density. Additional moisture control may be required to facilitate compaction.

The materials optimum moisture content is very close to its liquid limit. As such, compaction of the material will require close monitoring of moisture content during placement. The use of vibratory compaction equipment (i.e., pneumatic vibratory drum rollers) should be discouraged as vibratory action could induce pore pressures to occur that may cause moisture contents at optimum conditions to increase to or above the materials liquid limit and may induce liquefaction of the material.

Cover Material: Although the material has an affinity for water and is moderately impervious ($K=2x10^{-5}$ cm/sec.) at optimum moisture contents (on the order of 58%). Although the shrinkage limit is high and the plasticity index is low (which typically equates to low probability of shrink well potential).

The optimum moisture content for this material is above the shrinkage limit. Based on our testing of this material, volumetric shrinkage in the range of the liquid limit and the shrinkage limit is high (over 30%). By these considerations, the material should be suitable for landfill cover provided field testing is conducted as outlined below.

As the material is not a soil, we recommend that a test area be designated at the site for placement of a trial cover layer to verify the adequacy of the material for use as a cover.

The trial cover layer should be placed at the thickness planned for the landfill cover, placed over similar materials as the cover would be (i.e., garbage) and should be approximately 75 feet by 75 feet in plan dimension to reflect actual construction placement of the material. The material should be placed in 8 to 10 inch thick lifts and compacted to 95% of the Standard Proctor maximum dry density at or slightly above the optimum moisture content. Once placed, the trial cover layer could be tested for field permeability and monitored for signs of shrinkage over a period of time. Should shrinkage cracks develop another test section should be placed as outlined above except moisture contents should be well less than optimum and near the shrinkage limit (approximately 47%). In order to determine the adequacy of the material for use as a cover material, it should be noted that a reduction in moisture content could yield a high permeability for the in-place material.

<u>Dike Slope Stability</u>: The vertical expansion is proposed to have a maximum dike height of 15 feet and will retain approximately 23 feet of garbage. The back slope side of the dike (side retaining garbage) will have a geometry of 1±(H):1(V) while the front slope will have a geometry ranging from 2(H):1(V) maximum to a flatter 3(H):1(V) slope. The front and back slopes will be separated by a 15 feet wide crest.

A computerized slope stability analysis and hand calculation was performed for both the 2(H):1(V) and 3(H):1(V) front slope, vertically expanded cross sections. Strength parameters determined in the laboratory for the alum sludge material under saturated conditions and assumed strength parameters for the landfill debris (garbage) and the underlying sands were used in the analysis.

A summary of the analysis are tabulated below:

Front Slope Cross Section	Type of Analysis	FS Circular	FS Sliding Wedge
2(H):1(V)	Total	2.32	3.17
2(H):1(V)	Effective	-	3.45
3(H):1(V)	Total	2.59	3.66
3(H):1(V)	Effective	-	3.98

Based on the results above, a suitable factor of safety (greater than 1.30) against circular and sliding wedge instability was determined for the proposed vertically expanded 2(H):1(V) and 3(H):1(V) front slopes.

Due to the materials' lack of cohesion and light unit weight, the material may be prone to erode easily, as such the flatter slopes are recommended where possible. To minimize the erosion potential, the material placed may be periodically tracked down along the front slope face by wide tracked construction equipment. This would serve to add additional compaction effort along the front slope face and in addition will help to seal off the material.

Once the dike material is in place to its full height and prior to placing a final cover to promote a vegetative growth, it may be necessary to scarify or bench the front face of the slope to properly place the final cover.

CLOSING

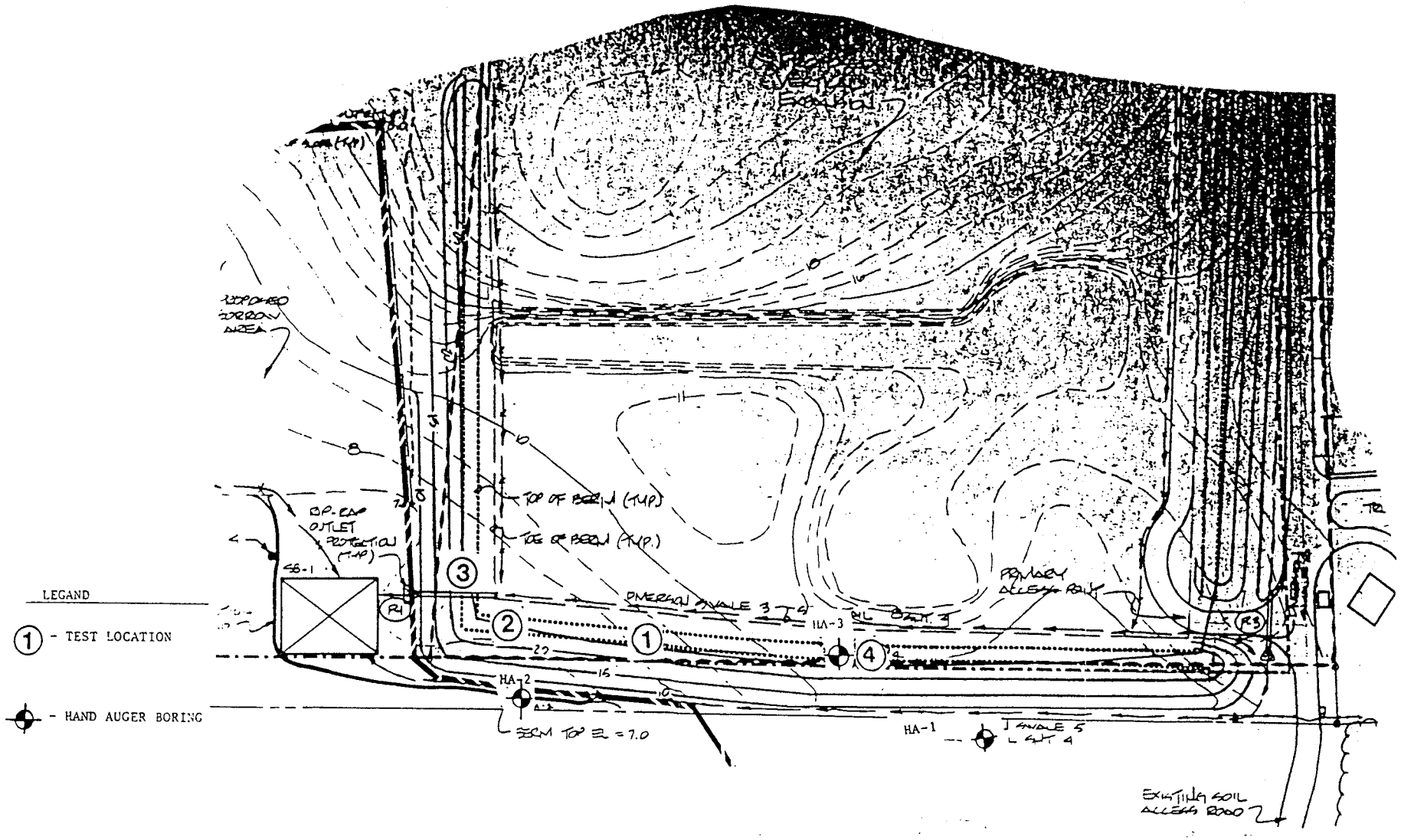
We have appreciated being of service to you on this phase of the project and are prepared to assist you with any future needs. If you have any questions concerning this report or any of our testing and consulting services, please not hesitate to contact this office.

Sincerely
LAW ENGINEERING

David E. Miller, P.E.
Geotechnical Project Engineer

Barney C. Hale, P.E.
Senior Geotechnical Engineer

APPENDIX



WASHINGTON COUNTY LAND FILL EXPANSION	LAW ENGINEERING RALEIGH, NORTH CAROLINA	
HAND AUGER AND TEST LOCATIONS	SCALE 1"=100'	Drawn: DEM Checked: DEM Date: 2/26/91
		Job No. J-6356 Dwg. No. 1

Location	Depth Below Ground Surface (Ft.)	Penetrometer Value	Depth(Ft.)	Soil Description
HA-1	0	12-10-11	0-3.0	Slightly silty tan and gray fine sand (SP/SM)
	1	10- 7- 8	3.0-5.0	Greenish gray sandy clay (CL/SC)
	2	5- 6- 5		
	3	9- 8-10		
	4	10-10-10		
	5	15+		
HA-2	0	9- 8- 7	0.0-4.0	Tan to gray clayey sand
	1	7- 5- 6	4.0-5.0	Tan to gray clayey sand (SC)
	2	5- 6- 5		
	3	5- 5- 5		
	4	7- 6- 8		
	5	8- 5- 6		
HA-3	0	5- 4- 4		Alum Sludge
	1	3- 3- 3		
	2	7- 3- 5		
	3	4- 5- 5		
	4	5- 4- 5		
	5	6- 5- 4		
	6	5- 5- 4		

LAW ENGINEERING

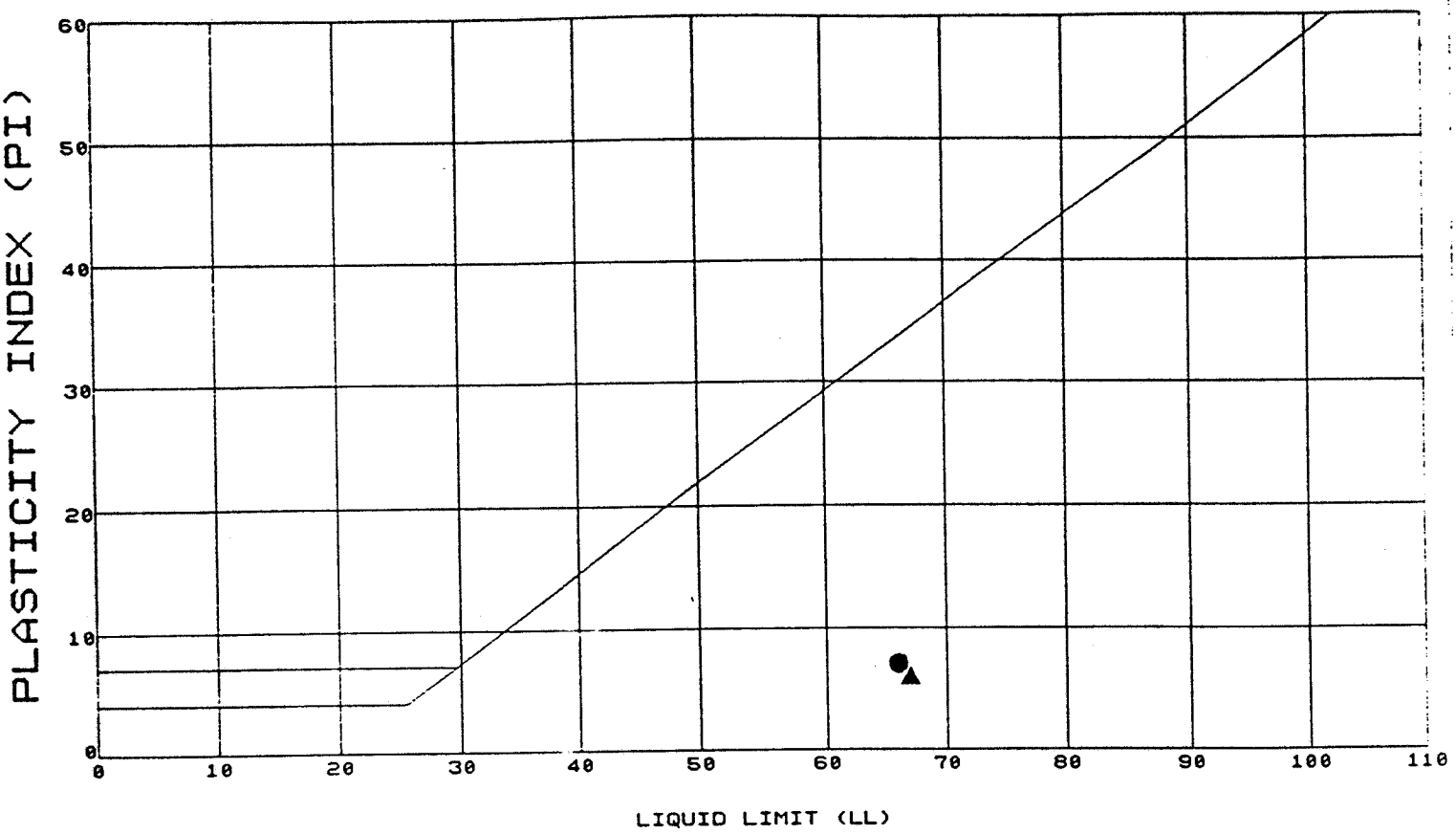
3301 ATLANTIC AVE.
RALEIGH, NORTH CAROLINA

WASHINGTON COUNTY LANDFILL

JOB NO. J-6356

LOCATION NO.	DEPTH FEET	SAMPLE NO.	COEFFICIENT OF PERMEABILITY (CM/SEC)	UNIT WEIGHT pcf		MAXIMUM STANDARD DRY DENSITY	% STANDARD DENSITY	STRENGTH ø C[PSF] (±)	SHRINKAGE LIMIT	ATTERBERG LIMITS		
				WET	DRY					LL	PL	PI
1	1.0	BAG-1		91.2	74.1	59.4	100+		46	67	61	6
2	1.0	BAG-2		62.5	44.9	58.8	76					
3	1.0	BAG-3		75.5	50.9	58.7	87		46	66	59	7
4	1.0	BAG-4		95.3	75.7	59.4	100+					
3	REMOLDED	BAG-3	2.53×10^{-6}				95±					
3	REMOLDED *	BAG-3	2.071×10^{-6}				95±					
3	REMOLDED	BAG-3					95±	TOTAL 28.5°; 100				
3	REMOLDED	BAG-3					95±	EFFECTIVE 31.3°; 100				
3	REMOLDED *	BAG-3					95±	TOTAL 34.0°; 200				
3	REMOLDED *	BAG-3					95±	EFFECTIVE 35.8°; 125				

* UNSATURATED



LEGEND:

● BAG 1 1.0

▲ BAG 3 1.0

LL	PL	PI
66	59	7
67	61	6

REMARKS:
SHRINKAGE LIMITS:
BAG 1: 46
BAG 3: 46

February 1991

WASHINGTON COUNTY LANDFILL - J-6356

ATTERBERG LIMITS' RESULTS

FIGURE 1

LAW ENGINEERING

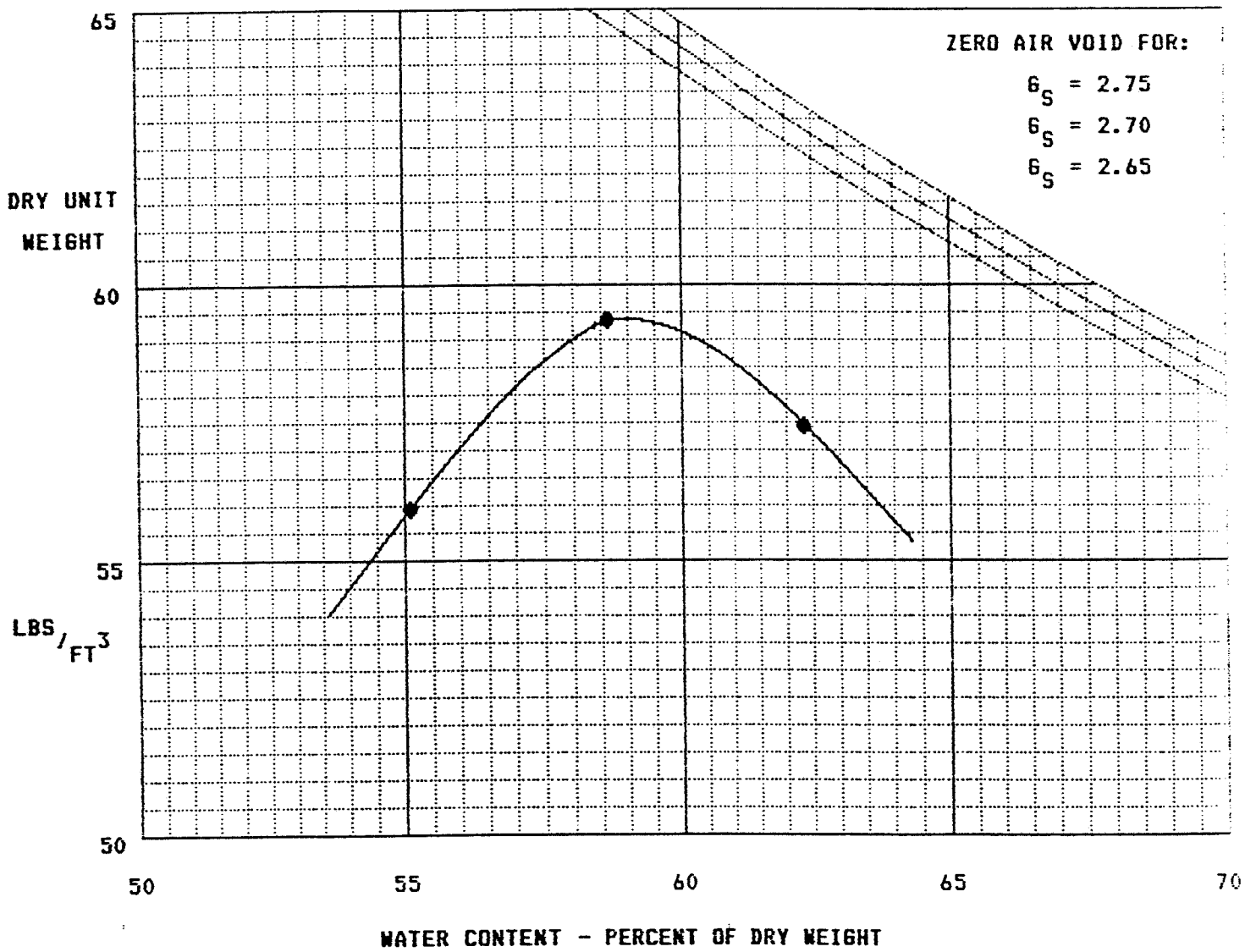
LAW ENGINEERING

STANDARD PROCTOR REPORT
ASTM D-698A

DATE: FEBRUARY 3, 1991
PROJECT NUMBER: J-6356
PROJECT NAME: WASHINGTON COUNTY LANDFILL
CLIENT: DIEHL & PHILLIPS
SAMPLE NUMBER: 1
FIELD MOISTURE:

SOIL DESCRIPTION:
ALUM MUD AND SANDY MIXTURE; ± 6 MONTHS OLD
PROPOSED USE:
LANDFILL BERM
SOURCE LOCATION:
WEYERHAEUSER CO.; PLYMOUTH, NC

MOISTURE - DENSITY RELATIONSHIP



OPTIMUM MOISTURE CONTENT 58.8 MAXIMUM DRY DENSITY 59.4

Bob Teel

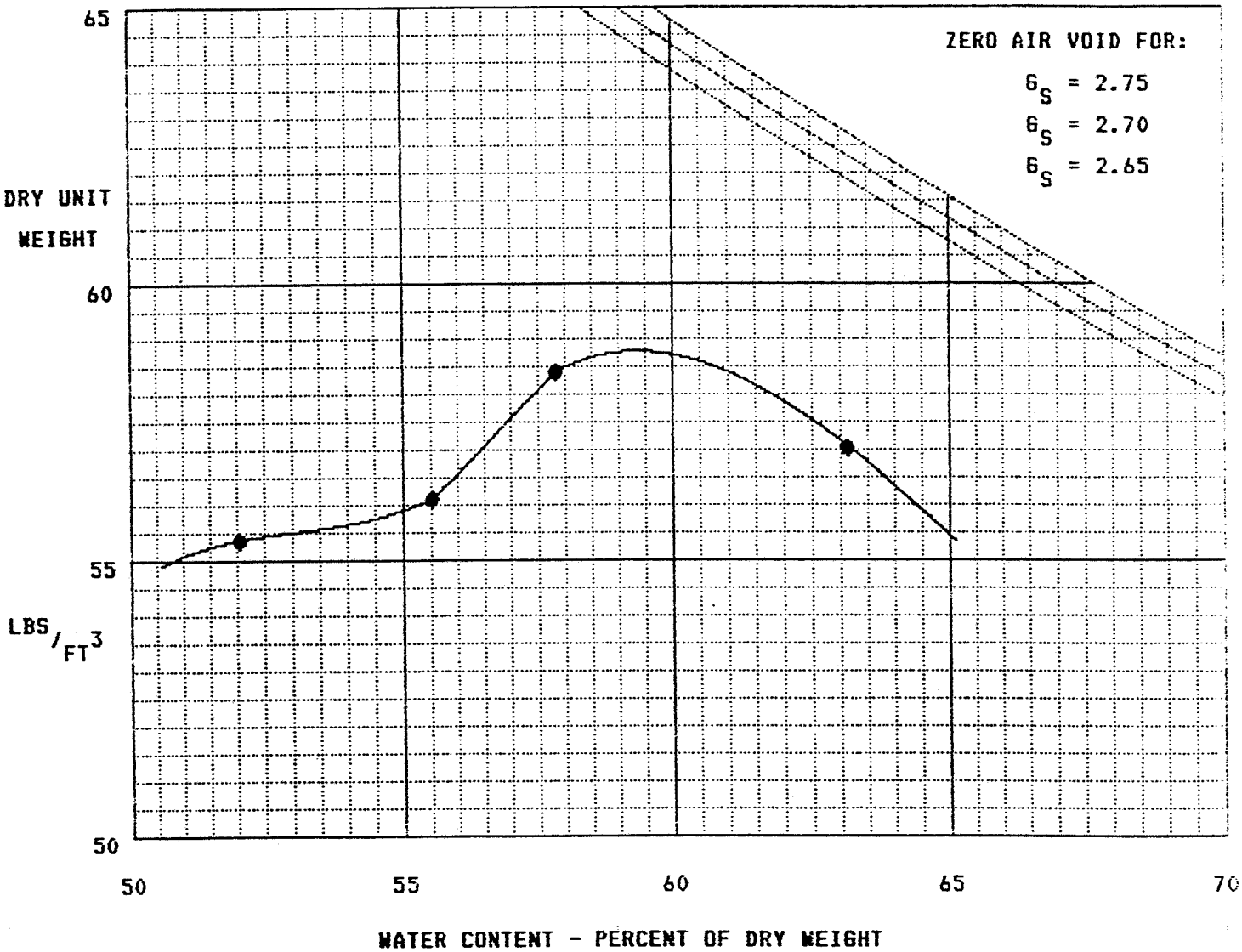
LAW ENGINEERING

STANDARD PROCTOR REPORT
ASTM D-698A

DATE: FEBRUARY 3, 1991
PROJECT NUMBER: J-6356
PROJECT NAME: WASHINGTON COUNTY LANDFILL
CLIENT: DIEHL & PHILLIPS
SAMPLE NUMBER: 2
FIELD MOISTURE:

SOIL DESCRIPTION:
ALUM MUD AND PFIZER LIME GRIT MIXTURE; 3 TO 4 MONTHS OLD
PROPOSED USE:
LANDFILL BERM
SOURCE LOCATION:
WEYERHAEUSER CO.; PLYMOUTH, NC

MOISTURE - DENSITY RELATIONSHIP



OPTIMUM MOISTURE CONTENT 59.3 MAXIMUM DRY DENSITY 58.8

Bob Feel

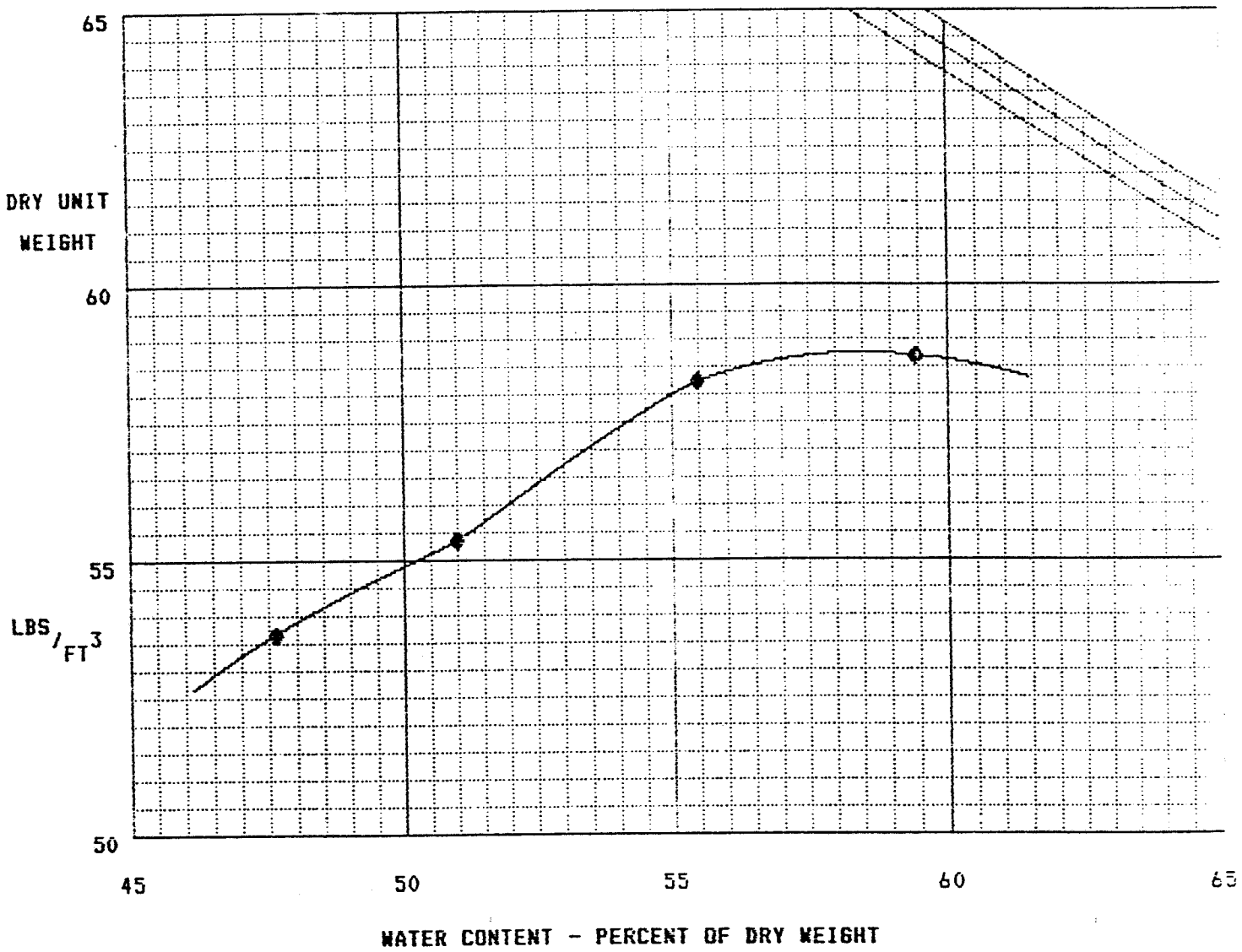
LAW ENGINEERING

STANDARD PROCTOR REPORT
ASTM D-698A

DATE: JANUARY 31, 1991
PROJECT NUMBER: WASHINGTON COUNTY LANDFILL
PROJECT NAME: J-6356
CLIENT: DIEHL & PHILLIPS
SAMPLE NUMBER: 3
FIELD MOISTURE:

SOIL DESCRIPTION:
ALUM MUD
PROPOSED USE:
LANDFILL BERM
SOURCE LOCATION:
WEYERHAEUSER CO.; PLYMOUTH, NC

MOISTURE - DENSITY RELATIONSHIP



OPTIMUM MOISTURE CONTENT 58.5 MAXIMUM DRY DENSITY 58.7

Bob Feel

LAW ENGINEERING

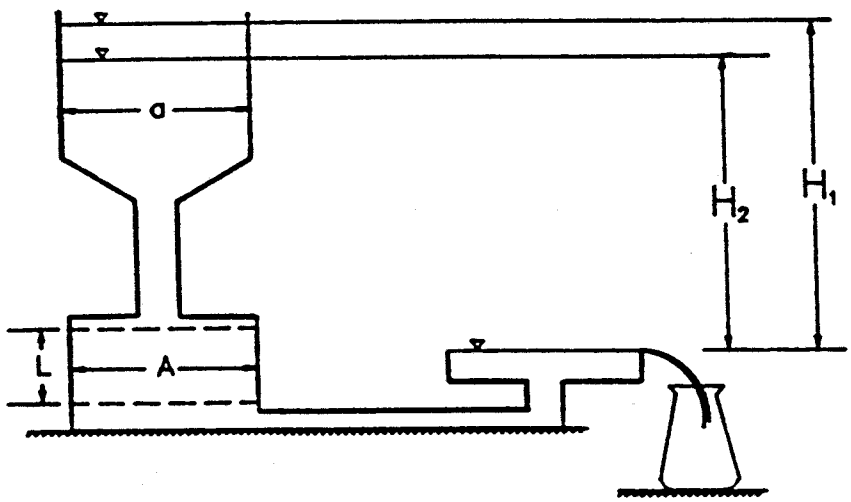
REPORT OF COEFFICIENT OF PERMEABILITY

CLIENT: County of Washington c/o Diehl & Phillips **DATE:** February 6, 1991

PROJECT: Washington Co. Landfill **JOB NO.:** J-6356

Bag #3, Remolded
Unsaturated

$$K = \frac{2.3al}{At} \times \log_{10} H_1/H_2$$



a = 1.27 cm^2

l = 5.50 cm

A = 42.12 cm^2

t = as shown

H_1= 102.23 cm

H_2= as shown

K = as shown

t (sec)	H_2 (cm)	K (cm/sec)
60	100.01	8.422×10^{-5}
600	96.84	1.213×10^{-5}
13,920	71.12	2.071×10^{-6}

LAW ENGINEERING

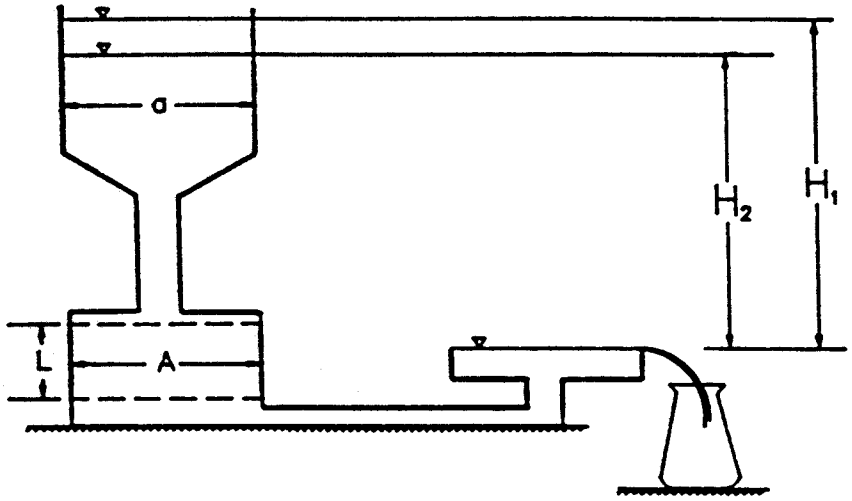
REPORT OF COEFFICIENT OF PERMEABILITY

CLIENT: County of Washington c/o Diehl & Phillips **DATE:** February 6, 1991

PROJECT: Washington Co. Landfill **JOB NO.:** J-6356

Bag #3, Remolded
Saturated

$$K = \frac{2.3al}{At} \times \log_{10} H_1/H_2$$



$a = 1.27 \quad cm^2$

$l = 5.50 \quad cm$

$A = 40.67 \quad cm^2$

$t = 1740 \quad sec$

$H_1 = 100.33 \quad cm$

$H_2 = 97.79 \quad cm$

$K = 2.53 \times 10^{-6}$ cm/sec

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:21 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356
Client: WASHINGTON COUNTY
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - SATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 1

Sample No. 1 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	1.48	1.36	
Height change, in		0.09	
Height, in	3.00	2.91	
Weight, grams	122.2		
Water volume change, cc		5.33	
Moisture, %	58.8	51.9	58.8
Dry density, pcf	56.8	69.7	
Saturation, %	81.5	100.0	
Void ratio	1.912	1.375	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.1657 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.670 % per minute
Consolidation cell pressure = 15 psi
Consolidation back pressure = 10 psi
Consolidation effective confining stress = 5 psi
Peak deviator stress = 11.72 psi at reading no. 5
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	20.0	0.0	0.0	0.00	5.00	5.00	1.00	10.0	5.00	0.00
1	0.0300	0.015	26.0	1.0	0.5	0.68	5.00	5.68	1.14	10.0	5.34	0.34
2	0.0450	0.030	60.0	6.6	1.0	4.54	5.00	9.54	1.91	10.0	7.27	2.27
3	0.0600	0.045	97.0	12.8	1.5	8.69	4.80	13.49	2.81	10.2	9.14	4.34
4	0.0750	0.060	114.0	15.6	2.1	10.55	4.60	15.15	3.29	10.4	9.87	5.27
5	0.0900	0.075	125.0	17.4	2.6	11.72	4.50	16.22	3.60	10.5	10.36	5.86

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:21 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356
Client: WASHINGTON COUNTY
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - SATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 1

Sample No. 3 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	1.48	1.44	
Height change, in		0.34	
Height, in	3.00	2.66	
Weight, grams	122.2		
Water volume change, cc		2.91	
Moisture, %	58.8	55.0	58.8
Dry density, pcf	56.8	67.3	
Saturation, %	81.5	100.0	
Void ratio	1.912	1.458	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.1657 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.670 % per minute
Consolidation cell pressure = 30 psi
Consolidation back pressure = 10 psi
Consolidation effective confining stress = 20 psi
Peak deviator stress = 37.93 psi at reading no. 6
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	145.0	0.0	0.0	0.00	19.50	19.50	1.00	10.5	19.50	0.00
1	0.0300	0.015	288.0	23.7	0.6	14.39	18.70	33.09	1.77	11.3	25.89	7.19
2	0.0450	0.030	400.0	42.3	1.1	25.51	18.00	43.51	2.42	12.0	30.75	12.75
3	0.0600	0.045	463.0	52.7	1.7	31.63	17.50	49.13	2.81	12.5	33.31	15.81
4	0.0750	0.060	500.0	58.8	2.3	35.11	17.10	52.21	3.05	12.9	34.65	17.55
5	0.0900	0.075	525.0	63.0	2.8	37.36	16.90	54.26	3.21	13.1	35.58	18.68

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:21 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356
Client: WASHINGTON COUNTY
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - SATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 1

Sample No. 2 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	1.48	1.38	
Height change, in		0.08	
Height, in	3.00	2.93	
Weight, grams	122.2		
Water volume change, cc		2.41	
Moisture, %	58.8	55.7	58.8
Dry density, pcf	56.8	66.8	
Saturation, %	81.5	100.0	
Void ratio	1.912	1.475	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.1657 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.670 % per minute
Consolidation cell pressure = 20 psi
Consolidation back pressure = 10 psi
Consolidation effective confining stress = 10 psi
Peak deviator stress = 23.59 psi at reading no. 4
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	34.0	0.0	0.0	0.00	10.00	10.00	1.00	10.0	10.00	0.00
1	0.0300	0.015	120.0	14.3	0.5	9.45	9.50	18.95	1.99	10.5	14.23	4.73
2	0.0450	0.030	190.0	25.8	1.0	17.06	9.00	26.06	2.90	11.0	17.53	8.53
3	0.0600	0.045	229.0	32.3	1.5	21.21	8.80	30.01	3.41	11.2	19.41	10.61
4	0.0750	0.060	252.0	36.1	2.1	23.59	8.60	32.19	3.74	11.4	20.39	11.79

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
6	0.1050	0.090	533.0	64.3	3.4	37.93	16.70	54.63	3.27	13.3	35.66	18.96
7	0.1200	0.105	525.0	63.0	3.9	36.93	16.70	53.63	3.21	13.3	35.16	18.46
8	0.1500	0.135	500.0	58.8	5.1	34.09	16.80	50.89	3.03	13.2	33.85	17.05
9	0.1800	0.165	493.0	57.7	6.2	33.02	16.70	49.72	2.98	13.3	33.21	16.51
10	0.2100	0.195	496.0	58.2	7.3	32.91	16.60	49.51	2.98	13.4	33.05	16.45
11	0.2500	0.235	500.0	58.8	8.8	32.74	16.50	49.24	2.98	13.5	32.87	16.37
12	0.2700	0.255	499.0	58.7	9.6	32.38	16.50	48.88	2.96	13.5	32.69	16.19
13	0.3000	0.285	491.0	57.3	10.7	31.25	16.40	47.65	2.91	13.6	32.03	15.63
14	0.3400	0.325	492.0	57.5	12.2	30.82	16.40	47.22	2.88	13.6	31.81	15.41

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:22 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356
Client: WASHINGTON COUNTY
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - SATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 1

Sample No. 4 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

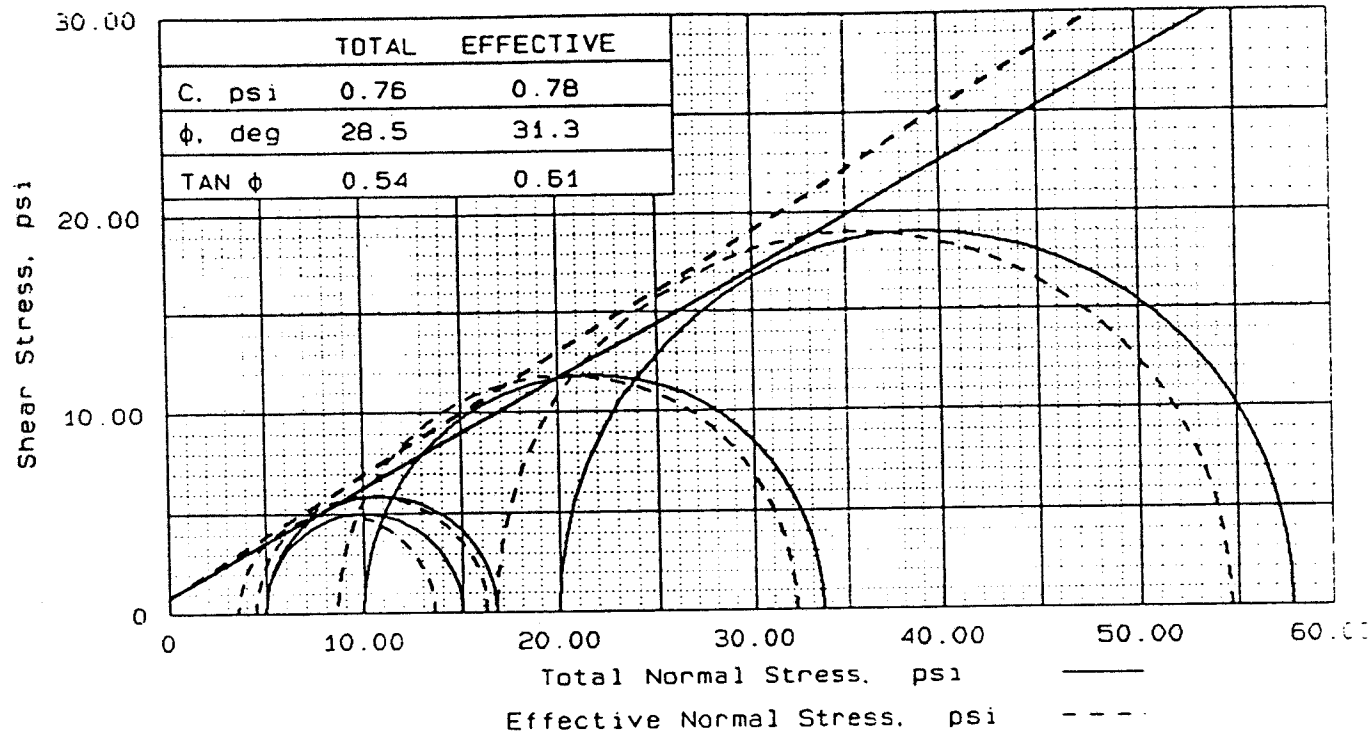
Sample Parameters	Before Test	At Testing	After Test
Diameter, in	1.48	1.27	
Height change, in		0.21	
Height, in	3.00	2.79	
Weight, grams	122.2		
Water volume change, cc		16.13	
Moisture, %	58.8	37.8	58.8
Dry density, pcf	56.8	82.6	
Saturation, %	81.5	100.0	
Void ratio	1.912	1.003	

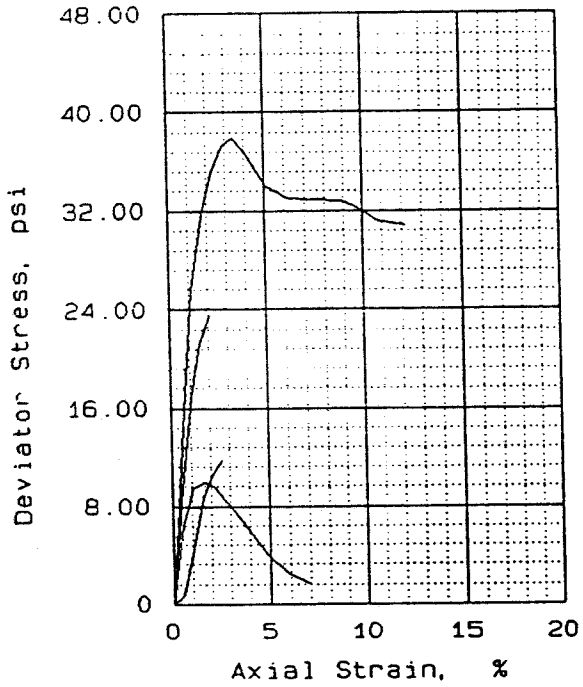
Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.1657 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.670 % per minute
Consolidation cell pressure = 26 psi
Consolidation back pressure = 21 psi
Consolidation effective confining stress = 5 psi
Peak deviator stress = 9.99 psi at reading no. 3
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	25.0	0.0	0.0	0.00	4.20	4.20	1.00	21.8	4.20	0.00
1	0.0300	0.015	74.0	8.1	0.5	6.35	3.50	9.85	2.81	22.5	6.67	3.17
2	0.0450	0.030	98.0	12.1	1.1	9.40	3.50	12.90	3.69	22.5	8.20	4.70
3	0.0600	0.045	103.0	12.9	1.6	9.99	3.60	13.59	3.78	22.4	8.60	5.00
4	0.0750	0.060	100.0	12.4	2.2	9.56	3.60	13.16	3.65	22.4	8.38	4.78
5	0.0900	0.075	92.0	11.1	2.7	8.49	3.60	12.09	3.36	22.4	7.85	4.25

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
6	0.1050	0.090	85.0	9.9	3.2	7.56	3.50	11.06	3.16	22.5	7.28	3.78
7	0.1200	0.105	76.0	8.5	3.8	6.39	3.50	9.89	2.83	22.5	6.70	3.20
8	0.1500	0.135	57.0	5.3	4.8	3.97	3.10	7.07	2.28	22.9	5.08	1.98
9	0.1800	0.165	45.0	3.3	5.9	2.45	2.90	5.35	1.84	23.1	4.13	1.23
10	0.2100	0.195	38.0	2.2	7.0	1.57	2.80	4.37	1.56	23.2	3.59	0.79





SAMPLE NO.		1	2	3	4
INITIAL	WATER CONTENT, %	58.8	58.8	58.8	58.8
	DRY DENSITY, pcf	56.8	56.8	56.8	56.8
	SATURATION, %	81.5	81.5	81.5	81.5
	VOID RATIO	1.912	1.912	1.912	1.912
	DIAMETER, in	1.48	1.48	1.48	1.48
	HEIGHT, in	3.00	3.00	3.00	3.00
AT TEST	WATER CONTENT, %	51.9	55.7	55.0	37.8
	DRY DENSITY, pcf	69.7	66.8	67.3	82.6
	SATURATION, %	100.0	100.0	100.0	100.0
	VOID RATIO	1.375	1.475	1.458	1.003
	DIAMETER, in	1.36	1.38	1.44	1.27
	HEIGHT, in	2.91	2.93	2.66	2.79
BACK PRESSURE, psi		10.00	10.00	10.00	21.00
CELL PRESSURE, psi		15.00	20.00	30.00	25.00
FAILURE STRESS, psi		11.72	23.59	37.93	9.99
PORE PRESSURE, psi		10.50	11.40	13.30	22.40
STRAIN RATE, %/min.		0.670	0.670	0.670	0.670
ULTIMATE STRESS, psi					
PORE PRESSURE, psi					
$\bar{\sigma}_1$ FAILURE, psi		16.22	32.19	54.63	13.59
$\bar{\sigma}_3$ FAILURE, psi		4.5	8.6	16.7	3.6

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: ALUM MUD

LL= 65 PL= 59 PI= 6.0
SPECIFIC GRAVITY= 2.65
REMARKS:

CLIENT: WASHINGTON COUNTY

PROJECT: WASHINGTON COUNTY LANDFILL

SAMPLE LOCATION: BAG 1 - SATURATED

PROJ. NO.: J-6356 DATE: 2/14/91

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING

FIG. NO. 1

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:38 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356DRY
Client:
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - UNSATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 2

Sample No. 1 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.83	2.73	
Height change, in		0.33	
Height, in	5.59	5.26	
Weight, grams	827.1		
Water volume change, cc		0.00	
Moisture, %	58.8	58.8	58.8
Dry density, pcf	56.4	64.7	
Saturation, %	80.7	100.0	
Void ratio	1.932	1.558	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 1.500 % per minute
Consolidation cell pressure = 20 psi
Consolidation back pressure = 0 psi
Consolidation effective confining stress = 20 psi
Peak deviator stress = 55.79 psi at reading no. 13
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	40.0	0.0	0.0	0.00	20.00	20.00	1.00	0.0	20.00	0.00
1	0.0300	0.015	140.0	68.0	0.3	11.62	20.00	31.62	1.58	0.0	25.81	5.81
2	0.0450	0.030	230.0	129.2	0.6	22.02	20.00	42.02	2.10	0.0	31.01	11.01
3	0.0600	0.045	309.0	182.9	0.9	31.09	19.90	50.99	2.56	0.1	35.45	15.55
4	0.0750	0.060	371.0	225.1	1.1	38.15	19.60	57.75	2.95	0.4	38.67	19.07
5	0.0900	0.075	411.0	252.3	1.4	42.63	19.50	62.13	3.19	0.5	40.82	21.32

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:41 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356DRY
Client:
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - UNSATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 2

Sample No. 2 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.83	2.79	
Height change, in		0.09	
Height, in	5.59	5.51	
Weight, grams	827.1		
Moisture, %	58.8	58.8	58.8
Dry density, pcf	56.4	59.1	
Saturation, %	80.7	86.6	
Void ratio	1.932	1.799	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 1.500 % per minute
Consolidation cell pressure = 10 psi
Consolidation back pressure = 0 psi
Consolidation effective confining stress = 10 psi
Peak deviator stress = 22.46 psi at reading no. 5
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	85.0	0.0	0.0	0.00	10.00	10.00	1.00	0.0	10.00	0.00
1	0.0300	0.015	151.0	44.9	0.3	7.34	10.00	17.34	1.73	0.0	13.67	3.67
2	0.0450	0.030	211.0	85.7	0.5	13.97	9.90	23.87	2.41	0.1	16.89	6.99
3	0.0600	0.045	250.0	112.2	0.8	18.25	9.90	28.15	2.84	0.1	19.02	9.12
4	0.0750	0.060	277.0	130.6	1.1	21.17	9.80	30.97	3.16	0.2	20.39	10.59
5	0.0850	0.070	289.0	138.7	1.3	22.46	9.80	32.26	3.29	0.2	21.03	11.23

TRIAXIAL COMPRESSION TEST 2-14-1991
CU with pore pressures 1:43 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356DRY
Client:
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - UNSATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 2

Sample No. 3 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.83	2.78	
Height change, in		0.11	
Height, in	5.59	5.49	
Weight, grams	827.1		
Moisture, %	58.8	58.8	58.8
Dry density, pcf	56.4	59.8	
Saturation, %	80.7	88.1	
Void ratio	1.932	1.769	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 1.500 % per minute
Consolidation cell pressure = 5 psi
Consolidation back pressure = 0 psi
Consolidation effective confining stress = 5 psi
Peak deviator stress = 15.25 psi at reading no. 6
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	64.0	0.0	0.0	0.00	5.00	5.00	1.00	0.0	5.00	0.00
1	0.0300	0.015	110.0	31.3	0.3	5.15	5.00	10.15	2.03	0.0	7.58	2.58
2	0.0450	0.030	145.0	55.1	0.5	9.05	5.00	14.05	2.81	0.0	9.52	4.52
3	0.0600	0.045	172.0	73.4	0.8	12.03	5.00	17.03	3.41	0.0	11.02	6.02
4	0.0750	0.060	188.0	84.3	1.1	13.78	5.00	18.78	3.76	0.0	11.89	6.89
5	0.0900	0.075	196.0	89.8	1.4	14.62	5.00	19.62	3.92	0.0	12.31	7.31
6	0.1050	0.090	202.0	93.8	1.6	15.25	5.00	20.25	4.05	0.0	12.62	7.62

TRIAXIAL COMPRESSION TEST
CU with pore pressures

2-14-1991
1:47 pm

Project Data

Project No.: J-6356 Date: 2/14/91 Data file: 6356DRY
Client:
Project: WASHINGTON COUNTY LANDFILL
Sample location: BAG 1 - UNSATURATED
Sample description: ALUM MUD
Remarks:
Fig No. 2

Sample No. 4 Data

Type of sample:
Specific Gravity= 2.65 LL= 65 PL= 59 PI= 6

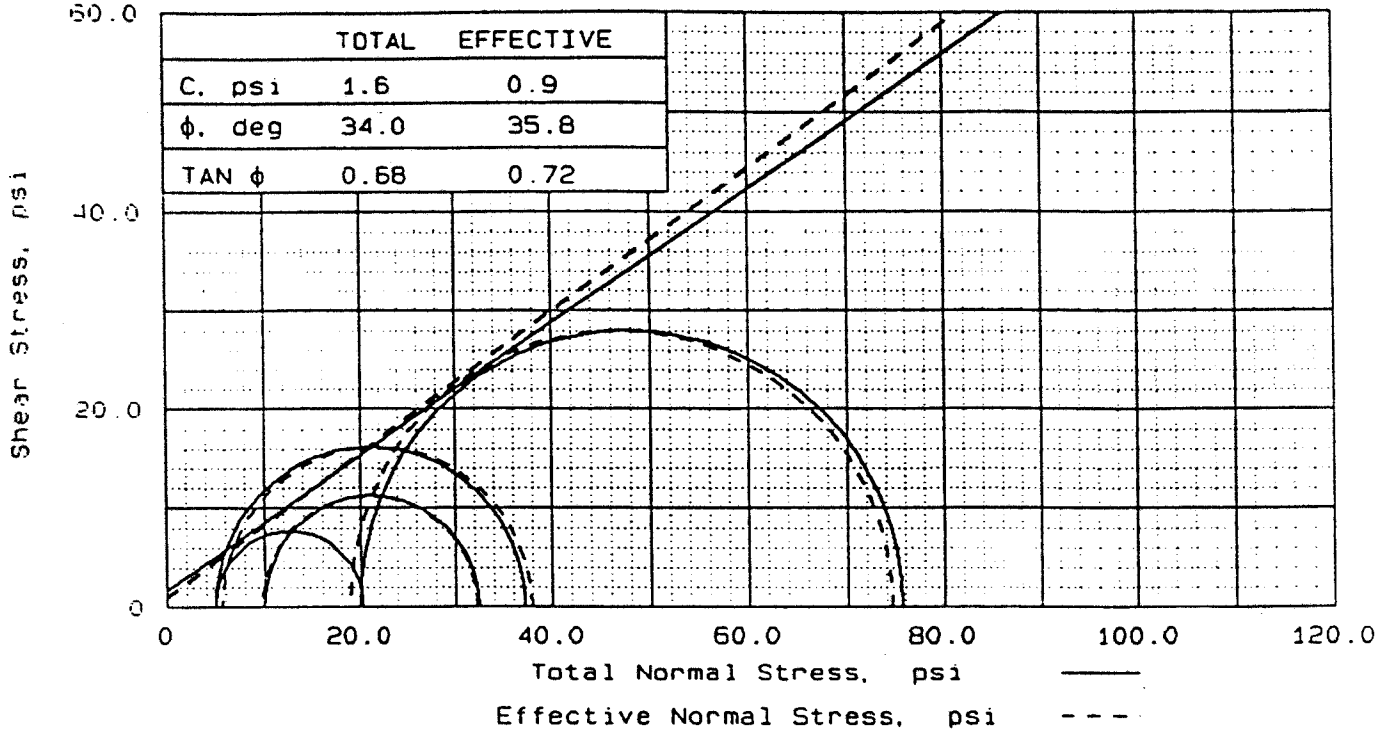
Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.83	2.63	
Height change, in		0.39	
Height, in	5.59	5.20	
Weight, grams	827.1		
Moisture, %	58.8	58.8	58.8
Dry density, pcf	56.4	70.5	
Saturation, %	80.7	115.7	
Void ratio	1.932	1.347	

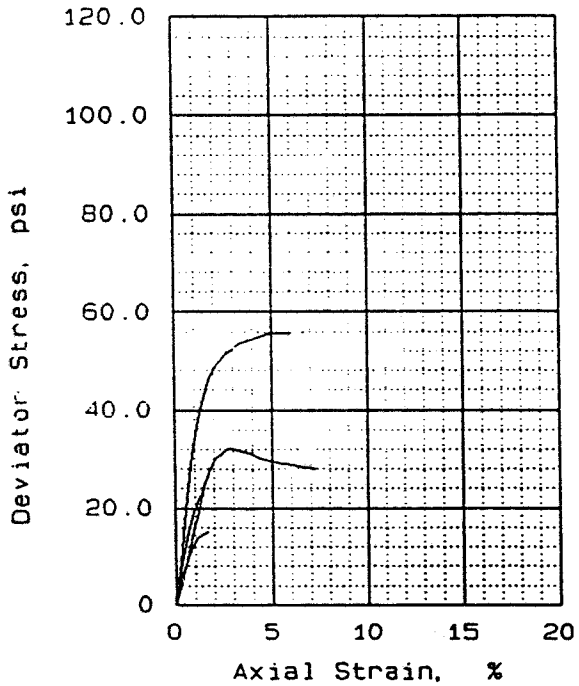
Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 1.500 % per minute
Consolidation cell pressure = 5 psi
Consolidation back pressure = 0 psi
Consolidation effective confining stress = 5 psi
Peak deviator stress = 32.24 psi at reading no. 9
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Major psi	1:3 Ratio	Pore Pres. psi	P psi	Q psi
0	0.0150	0.000	40.0	0.0	0.0	0.00	5.00	5.00	1.00	0.0	5.00	0.00
1	0.0300	0.015	75.0	23.8	0.3	4.38	5.00	9.38	1.88	0.0	7.19	2.19
2	0.0450	0.030	115.0	51.0	0.6	9.37	5.00	14.37	2.87	0.0	9.68	4.68
3	0.0600	0.045	156.0	78.9	0.9	14.45	5.10	19.55	3.83	-0.1	12.32	7.22
4	0.0750	0.060	195.0	105.4	1.2	19.25	5.20	24.45	4.70	-0.2	14.82	9.62
5	0.0900	0.075	236.0	133.3	1.4	24.27	5.20	29.47	5.67	-0.2	17.33	12.13
6	0.1050	0.090	261.0	150.3	1.7	27.28	5.20	32.48	6.25	-0.2	18.84	13.64

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress psi	Effective Stresses Minor psi	Effective Stresses Major psi	Effective Stresses 1:3 Ratio	Pore Pres. psi	P psi	Q psi
7	0.1200	0.105	282.0	164.6	2.0	29.79	5.20	34.99	6.73	-0.2	20.09	14.89
8	0.1500	0.135	299.0	176.1	2.6	31.69	5.50	37.19	6.76	-0.5	21.35	15.85
9	0.1600	0.145	304.0	179.5	2.8	32.24	5.70	37.94	6.66	-0.7	21.82	16.12
10	0.2100	0.195	299.0	176.1	3.8	31.32	6.00	37.32	6.22	-1.0	21.66	15.66
11	0.2400	0.225	291.0	170.7	4.3	30.17	6.20	36.37	5.87	-1.2	21.29	15.09
12	0.2700	0.255	288.0	168.6	4.9	29.63	6.20	35.83	5.78	-1.2	21.01	14.81
13	0.3000	0.285	286.0	167.3	5.5	29.21	6.20	35.41	5.71	-1.2	20.81	14.61
14	0.3300	0.315	285.0	166.6	6.1	28.92	6.30	35.22	5.59	-1.3	20.76	14.46
15	0.3600	0.345	282.0	164.6	6.6	28.39	6.30	34.69	5.51	-1.3	20.49	14.19
16	0.3900	0.375	280.0	163.2	7.2	27.98	6.30	34.28	5.44	-1.3	20.29	13.99





SAMPLE NO.		1	2	3	4
INITIAL	WATER CONTENT, %	58.8	58.8	58.8	58.8
	DRY DENSITY, pcf	56.4	56.4	56.4	56.4
	SATURATION, %	80.7	80.7	80.7	80.7
	VOID RATIO	1.932	1.932	1.932	1.932
	DIAMETER, in	2.83	2.83	2.83	2.83
	HEIGHT, in	5.59	5.59	5.59	5.59
AT TEST	WATER CONTENT, %	58.8	58.8	58.8	58.8
	DRY DENSITY, pcf	64.7	59.1	59.8	70.5
	SATURATION, %	100.0	86.6	88.1	115.7
	VOID RATIO	1.558	1.799	1.769	1.347
	DIAMETER, in	2.73	2.79	2.78	2.63
	HEIGHT, in	5.26	5.51	5.49	5.20
BACK PRESSURE, psi		0.0	0.0	0.0	0.0
CELL PRESSURE, psi		20.0	10.0	5.0	5.0
FAILURE STRESS, psi		55.8	22.5	15.2	32.2
PORE PRESSURE, psi		1.1	0.2	0.0	-0.7
STRAIN RATE, %/min.		1.500	1.500	1.500	1.500
ULTIMATE STRESS, psi					
PORE PRESSURE, psi					
$\bar{\sigma}_1$ FAILURE, psi		74.7	32.3	20.2	37.9
$\bar{\sigma}_3$ FAILURE, psi		18.9	9.8	5	5.7

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE:
DESCRIPTION: ALUM MUD

LL= 65 PL= 59 PI= 6.0
SPECIFIC GRAVITY= 2.65
REMARKS:

CLIENT:

PROJECT: WASHINGTON COUNTY LANDFILL

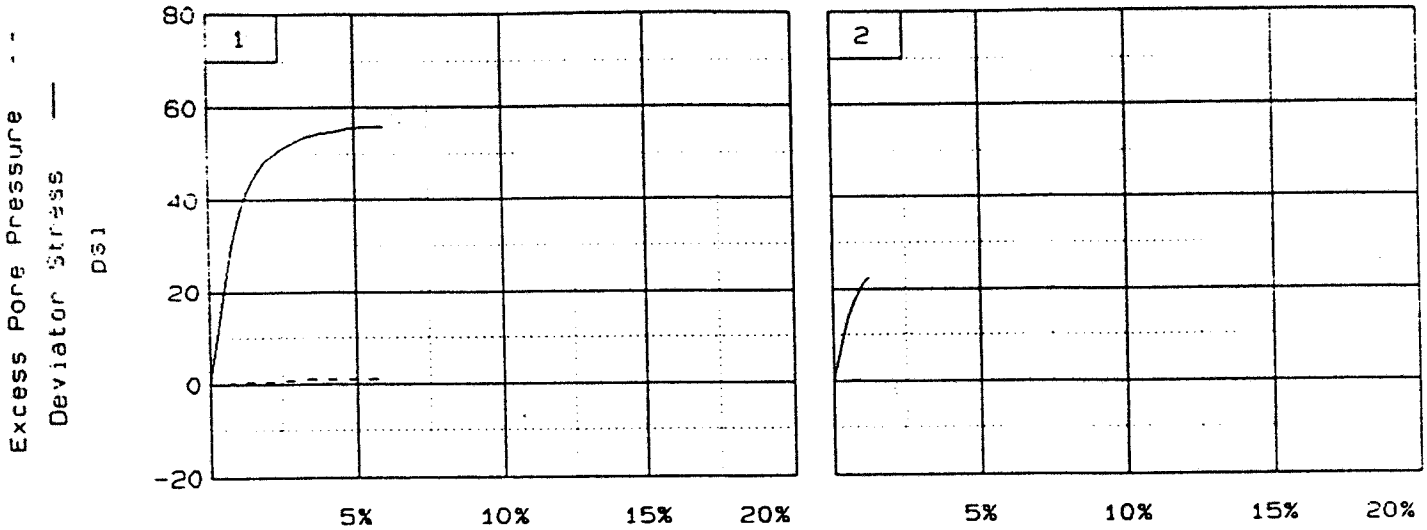
SAMPLE LOCATION: BAG 1 - UNSATURATED

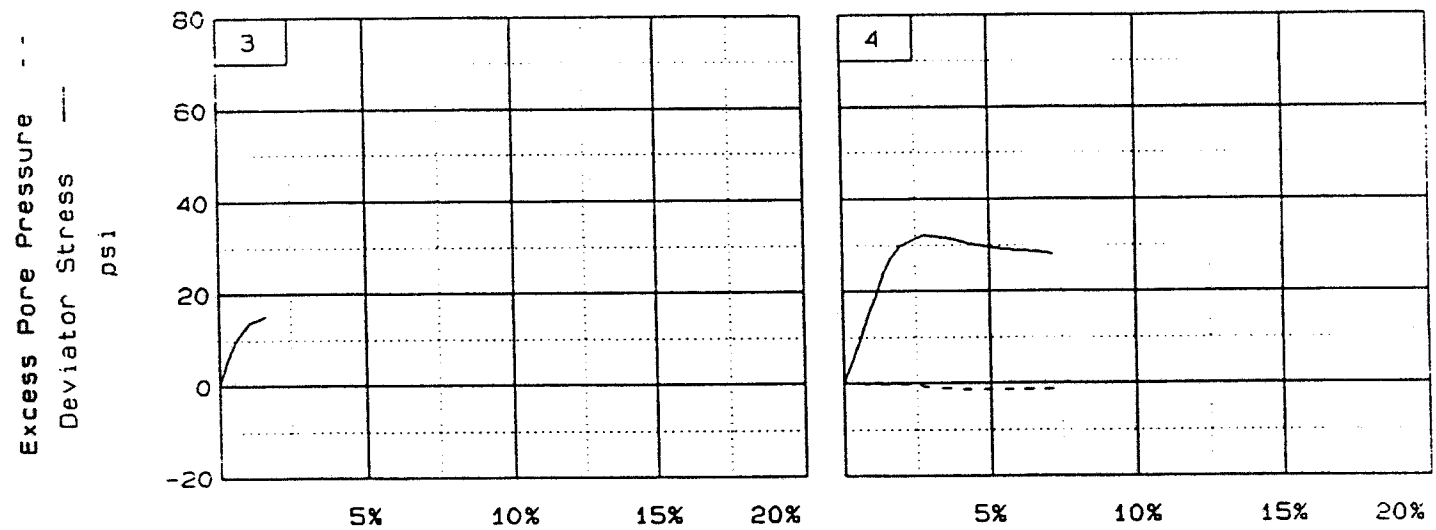
PROJ. NO.: J-6356 DATE: 2/14/91

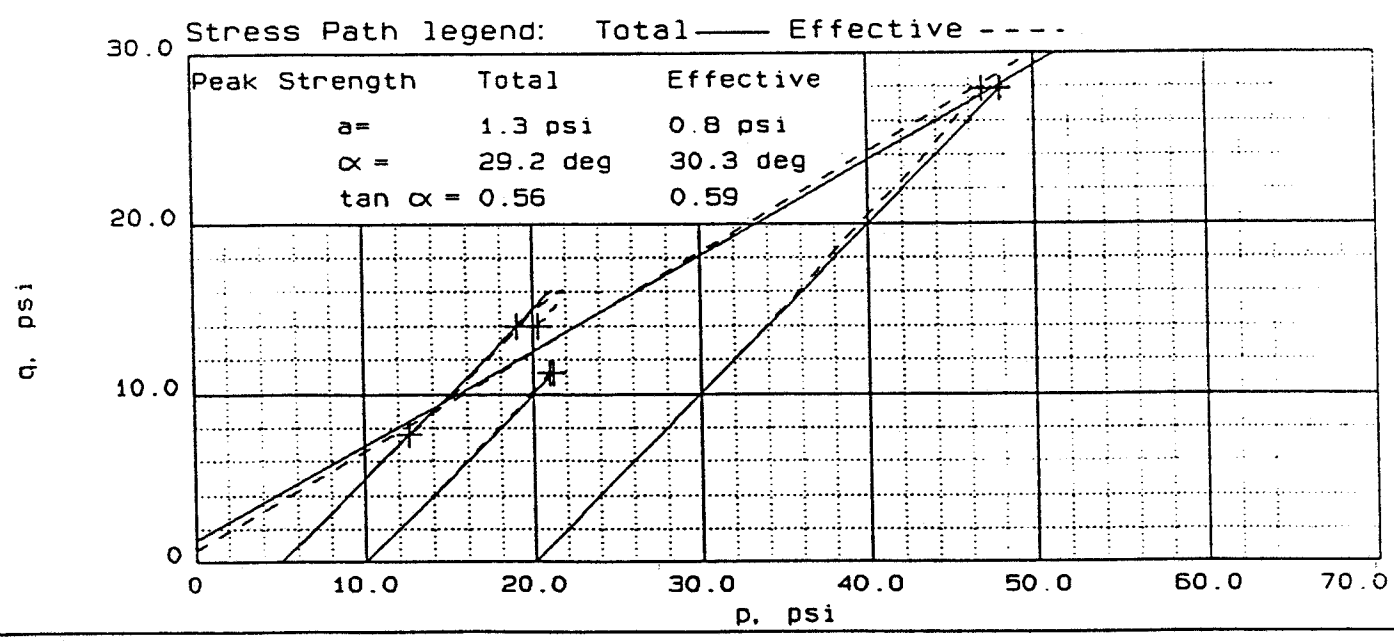
TRIAXIAL COMPRESSION TEST

LAW ENGINEERING

FIG. NO. 2







Client:

Project: WASHINGTON COUNTY LANDFILL

Location: BAG 1 - UNSATURATED

File: 6356DRY Project No.: J-6356 Page 2/2 Fig. No. 2

** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	2/21/91
Time of Run:	9:30
Run By:	FSM
Input Data Filename:	A:GARBAGE1.IN
Output Filename:	A:GARBAGE1.OUT

PROBLEM DESCRIPTION WASHINGTON CO. LANDFILL

BOUNDARY COORDINATES

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	20.00	50.00	20.00	3
2	50.00	20.00	95.00	35.00	2
3	95.00	35.00	110.00	35.00	2
4	110.00	35.00	132.00	43.00	1
5	132.00	43.00	180.00	43.00	1
6	110.00	35.00	125.00	20.00	2
7	50.00	20.00	125.00	20.00	3
8	125.00	20.00	140.00	5.00	3
9	.00	5.00	140.00	5.00	4
10	140.00	5.00	180.00	5.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	100.0	10.0	.00	.0	1
2	56.0	56.0	100.0	28.5	.00	.0	2
3	120.0	120.0	.0	32.0	.00	.0	3
4	100.0	100.0	.0	28.0	.00	.0	4

9	112.53	24.66
10	122.20	27.55
11	131.62	30.93
12	140.84	34.79
13	149.85	39.13
14	156.91	43.00

Circle Center At X = 61.9 ; Y = 210.1 and Radius, 192.3

*** 2.589 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.33	20.00
2	43.22	18.46
3	53.18	17.57
4	63.17	17.32
5	73.16	17.71
6	83.11	19.75
7	92.97	20.42
8	102.70	22.73
9	112.26	25.66
10	121.61	29.19
11	130.72	33.33
12	139.54	38.04
13	147.53	43.00

Circle Center At X = 62.1 ; Y = 172.4 and Radius, 155.1

*** 2.687 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.44	20.00
2	54.34	18.53
3	64.29	17.56
4	74.28	17.07
5	84.28	17.08
6	94.27	17.58
7	104.22	18.58
8	114.11	20.06
9	123.91	22.02
10	133.61	24.47
11	143.17	27.39
12	152.58	30.78
13	161.81	34.63
14	170.84	38.93
15	178.39	43.00

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	15.00
2	180.00	15.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 50.00 ft.

Each Surface Terminates Between X = 95.00 ft.
and X = 180.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

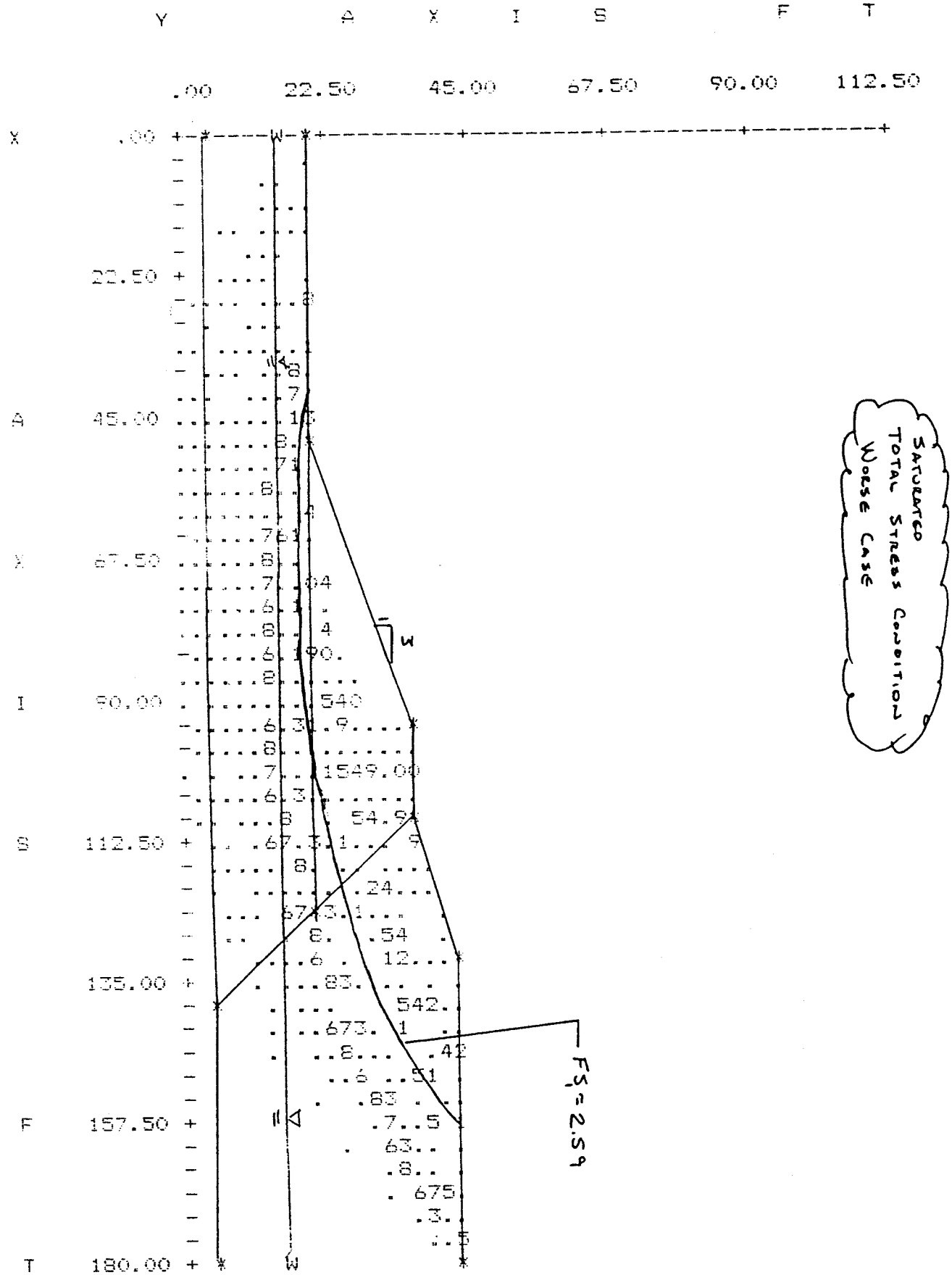
1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method *

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.33	20.00
2	43.26	18.77
3	53.23	18.06
4	63.23	17.86
5	73.23	18.19
6	83.19	19.04



SATURATED
TOTAL STRESS CONDITION
WORSE CASE

** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	2/21/91
Time of Run:	9:45
Run By:	FSM
Input Data Filename:	A:GARBAGE2.IN
Output Filename:	A:GARBAGE2.OUT

PROBLEM DESCRIPTION WASHINGTON CO. LANDFILL

BOUNDARY COORDINATES

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	20.00	65.00	20.00	3
2	65.00	20.00	95.00	35.00	2
3	95.00	35.00	110.00	35.00	2
4	110.00	35.00	132.00	43.00	1
5	132.00	43.00	180.00	43.00	1
6	110.00	35.00	125.00	20.00	2
7	50.00	20.00	125.00	20.00	3
8	125.00	20.00	140.00	5.00	3
9	.00	5.00	140.00	5.00	4
10	140.00	5.00	180.00	5.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	75.0	75.0	100.0	10.0	.00	.0	1
2	56.0	56.0	100.0	28.5	.00	.0	2
3	120.0	120.0	.0	32.0	.00	.0	3
4	100.0	100.0	.0	28.0	.00	.0	4

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	15.00
2	180.00	15.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 65.00 ft.

Each Surface Terminates Between X = 95.00 ft.
and X = 180.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.00	20.00
2	74.85	18.25
3	84.80	17.31
4	94.80	17.18
5	104.78	17.88
6	114.66	19.40
7	124.38	21.71

9	143.11	28.71
10	151.98	33.32
11	160.44	38.65
12	166.23	43.00

Circle Center At X = 91.3 ; Y = 139.0 and Radius, 121.9

*** 2.315 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	57.78	20.00
2	67.67	18.53
3	77.63	17.65
4	87.63	17.35
5	97.62	17.63
6	107.58	18.50
7	117.48	19.95
8	127.27	21.97
9	136.93	24.56
10	146.42	27.71
11	155.71	31.41
12	164.77	35.65
13	173.57	40.41
14	177.75	43.00

Circle Center At X = 87.8 ; Y = 188.4 and Radius, 171.1

*** 2.391 ***

1

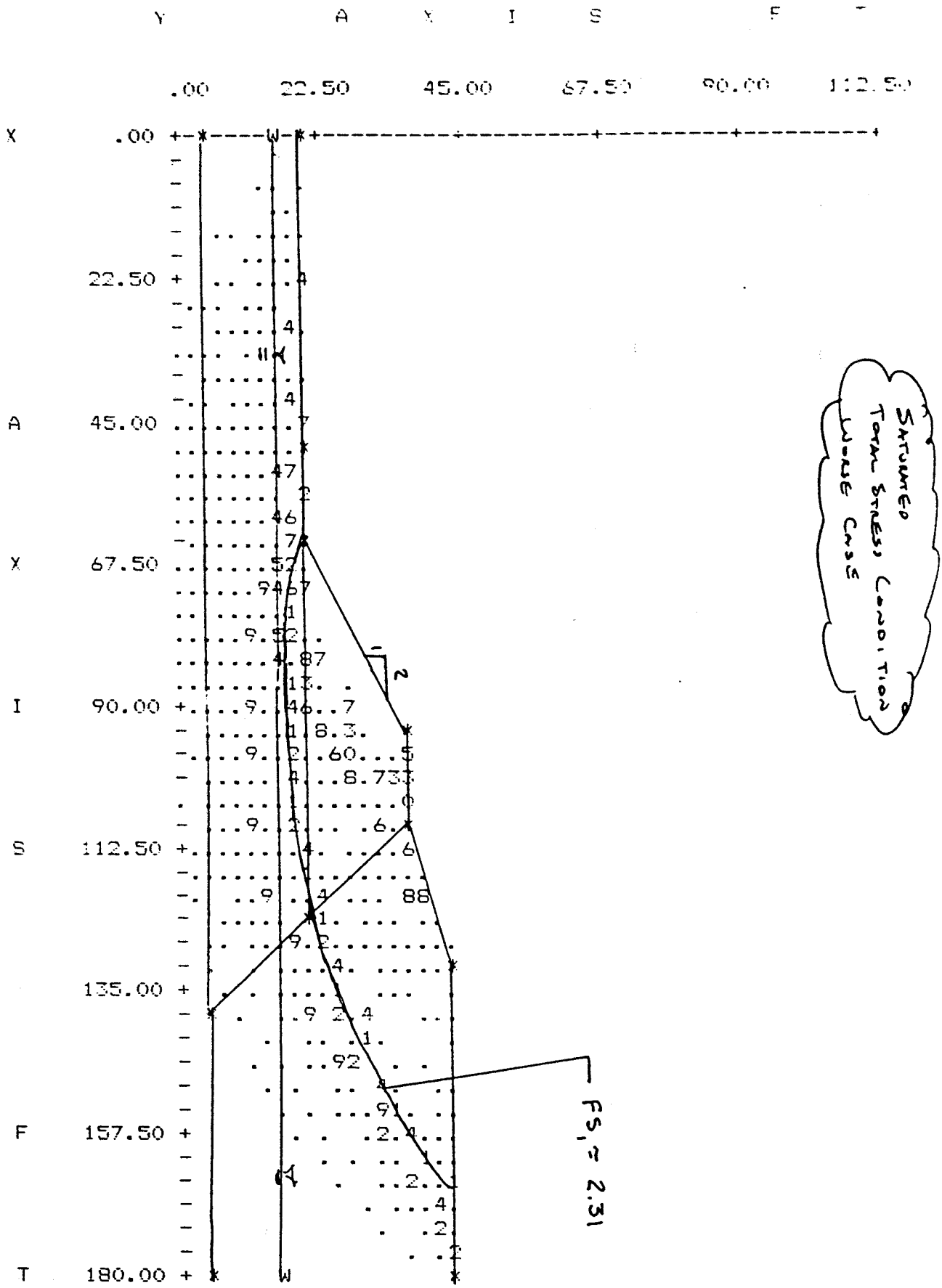
Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	57.78	20.00
2	67.50	17.64
3	77.49	18.02
4	87.01	21.08
5	95.34	26.62
6	101.85	34.21
7	102.22	35.00

Circle Center At X = 71.2 ; Y = 54.0 and Radius, 36.5

*** 2.468 ***

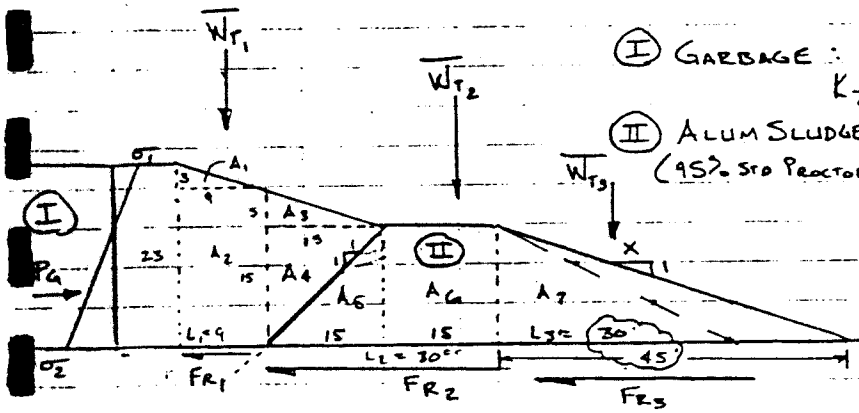
Failure Surface Specified By 17 Coordinate Points



SATURATED
TOTAL STRESS CONDITION
WORSE CASE

LAW ENGINEERING
GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS
3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

JOB NO. J6356 SHEET 1 OF 2
JOB NAME WASHINGTON Co LANDFILL
SUBJECT SLIDING WEDGE ANALYSIS
BY DEM DATE 2/25/91
CHECKED BY _____ DATE _____



(I) GARBAGE: $\phi_G = 10°$; $C_G = 100$ PSF; 75 PCF $= \gamma_G$
$K_{a_G} = \tan^2(45 - \phi/2) = 0.704$

(II) ALUM SLUDGE: $\phi_T = 28.5°$; $C_T = 100$ PSF; 56 PCF $= \gamma_{AS}$
(95% STD PROCTOR) $\phi' = 31.3°$; $C' = 100$ PSF; 56 PCF $= \gamma_{AS}$

$A_1 = 3(9)/2 = 13.5\ FT^2$; $W_{T_1} = A_1 \gamma_G = (13.5)(75) = 1012\ lb/FT \downarrow$

$A_2 = 9(15) = 135\ FT^2$; $W_{T_2} = A_2 \gamma_G = (135)(75) = 10{,}125\ lb/FT \downarrow$

$A_3 = 5(15)/2 = 37.5\ FT^2$; $W_{T_3} = A_3 \gamma_G = (37.5)(75) = 2{,}812\ lb/FT \downarrow$

$A_4 = 15(15)/2 = 112.5\ FT^2$; $W_{T_4} = A_4 \gamma_G = (112.5)(75) = 8{,}437\ lb/FT \downarrow$

$A_5 = 15(15)/2 = 112.5\ FT^2$; $W_{T_5} = A_5 \gamma_{AS} = (112.5)(56) = 6{,}300\ lb/FT \downarrow$

$A_6 = 15(15) = 225\ FT^2$; $W_{T_6} = A_6 \gamma_{AS} = (225)(56) = 12{,}600\ lb/FT \downarrow$

$A_7 = (x(15))\,15/2 = 112.5x\ FT^2$; $W_{T_7} = A_7 \gamma_{AS} = (112.5x)(56) = 6300x\ lb/FT \downarrow$

$F_{R_1} = \overline{W}_{T_1} \tan\phi_G + C_G L_1 = (W_{T_1} + W_{T_2}) \tan 10° + (100)(9) = (1012 + 10{,}125) \tan 10° + 900 = 2864\ lb/FT \leftarrow$

$F_{R_2} = \overline{W}_{T_2} \tan\phi + C L_2 = (\overset{2812}{W_{T_3}} + \overset{8437}{W_{T_4}} + \overset{6300}{W_{T_5}} + \overset{12{,}600}{W_{T_6}}) \tan\phi + 100(30) = [30{,}149 \tan\phi + 3000]\ lb/FT \leftarrow$

$F_{R_3} = \overline{W}_{T_3} \tan\phi + C L_3 = \overset{6300x}{W_{T_7}} \tan\phi + 100((x)15) = (6300x) \tan\phi + 1500x \leftarrow$

$F_R = F_{R_1} + F_{R_2} + F_{R_3} = 2864 + 30{,}149 \tan\phi + 3000 + (6300x) \tan\phi + 1500x \leftarrow$

$F_R = 1500x + (30{,}149 + 6300x) \tan\phi + 5864\ lb/FT \leftarrow$

$\sigma_T = K_{a_G} \gamma_G Z - 2C_G \sqrt{K_{a_G}} = (0.704)(75)(0) - 2(100)\sqrt{0.704} = 52.8(0) - 168 = -168\ PSF \rightarrow$

$\sigma_2 = 52.8(23) - 168 = 1047\ PSF \rightarrow$

$P_G = (\sigma_T + \sigma_2)\,23/2 = (-168 + 1047)\,23/2 = 10{,}104\ lb/FT \rightarrow$

LAW ENGINEERING
GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS
3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

JOB NO. J6356 SHEET 2 OF 2
JOB NAME WASHINGTON CO. LANDFILL
SUBJECT SLIDING WEDGE ANALYSIS
BY DEM DATE 2/25/91
CHECKED BY _____ DATE _____

$$FS_{SLIDING} = \frac{F_R}{P_G} = \frac{1500x + (30{,}149 + 6300x)\tan\phi + 5864}{10{,}104} = FS$$

2(H) : 1(V) ⇒ x = 2

$$FS_{2:1} = \frac{3000 + (42{,}749)\tan\phi + 5864}{10{,}104} = \frac{42{,}749\tan\phi + 8864}{10{,}104}$$

3(H) : 1(V) ⇒ x = 3

$$FS_{3:1} = \frac{4500 + (49{,}049)\tan\phi + 5864}{10{,}104} = \frac{49{,}049\tan\phi + 10{,}364}{10{,}104}$$

TYPE OF ANALYSIS	FACTOR OF SAFETY (SLIDING)	
	$FS_{2:1}$	$FS_{3:1}$
TOTAL $\phi_t = 28.5°$	3.17	3.66
EFFECTIVE $\phi' = 31.3°$	3.45	3.98

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

March 5, 1991

Diehl & Phillips
219 East Chatham Street
Cary, North Carolina 27511

Attention: Mr. Alen Keith

SUBJECT: REPORT OF GEOTECHNICAL SERVICES
AND LABORATORY TESTING - WASHINGTON COUNTY LANDFILL
WASHINGTON COUNTY LANDFILL DIKE & COVER MATERIAL
PLYMOUTH, NORTH CAROLINA
LAW ENGINEERING JOB NO. J47291-6356

Dear Mr. Keith:

Based on our telephone conversations of March 1,1991 regarding the potential volume change of the material placed for the dike and the permeability of the saturated and unsaturated permeabilities of the material at optimum moisture content in our report dated February 27, 1991. We have the following clarifications and recommendations.

To minimize potential shrinkage of the material placed in the dike, the material should be placed below the optimum moisture content (i.e., 58%±) and closer to the shrinkage limit (47%±). This may require additional compaction effort in order to achieve 95% of the standard maximum dry density.

The unsaturated permeability of the material to be used as a cover was approximately $2x10^{-5}$ cm/sec at 95% of the standard Proctor maximum dry density at an optimum moisture content of approximately 59%±. However as the material becomes saturated with time, it will become less permeable as shown by our laboratory testing. The permeability of the cover material noted on Page 3 of our report notes the moderately impervious nature of the material as $K=2x10^{-5}$ cm/sec. However, in its saturated state the material yields a permeability coefficient of $K=2x10^{-6}$ cm/sec.

3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

We are available to discuss our recommendations with you and to provide additional studies or services necessary to complete the project. We have enjoyed assisting you and look forward to serving as your consultant on the remainder of this project and on future projects.

Very truly yours,

LAW ENGINEERING

David E. Miller, P.E.
Geotechnical Project Engineer

Barney C. Hale, P.E.
Senior Geotechnical Engineer

DEM/BCH/pap

Washington County Commissioners Resolution to Provide
Construction & Demolition Waste Landfill
and
County Statement Regarding Zoning

and

Land Clearing and Inert Debris Landfill Notification

WASHINGTON COUNTY

PLYMOUTH, NORTH CAROLINA

P.O. BOX 1007
27962

July 1, 1994

To Whom It May Concern:

Washington County does not have in effect a Zoning Ordinance; therefore, the only document needed to comply with is the Land Use Plan. Upon review there are no inconsistencies with the Land Use Plan or any other plans in Washington County as to the Construction and Demolition Landfill Site.

Please contact this office with any questions as to this project.

Sincerely,

Lee Smith
County Manager

WATER SAFETY RESOLUTION: The County Manager reviewed a resolution requesting a no wake zone on Conaby Creek and reviewed the NC Wildlife Resources Commission Procedures for establishing local water safety regulations.

Commissioner Waters made a motion to approve the Resolution Establishing "No Wake" zones on Conaby Creek. Commissioner Lamb seconded, motion carried unanimously.

MANAGER'S REPORT: The Manager informed the Board that a Hurricane seminar will be held on July 20, 1994 at the Vernon James Research Center.

Water System Phase II - The Manager informed the Board that he has called Raleigh regarding the application and he is still waiting to hear from them.

Water System Phase III - The Manager informed the Board that the Preliminary has been forwarded to Marvin Howell, Farmers Home Administration.

Creswell Produce Packing Plant - The Board discussed the progress of the Creswell Produce Packing Plant.

LANDFILL CLOSURE: The Manager asked that the Board rescind the motion of June 27 which rejected the bids for landfill closure which would allow him to be able to negotiate with the lowest bidder. He stated that the estimates given to him were approximately $108,000 short and have discussed an interfund load with the Finance Officer. Ms. Critcher, Finance Officer, stated that as the cash becomes short, the County could have an interfund loan, which can be paid back over the next upcoming years. The Manager reminded the Board that the landfill would have to be closed by October 9 to avoid Sub Title D regulations.

Commissioner Waters made a motion to rescind the motion from the last meeting (rejecting the bids for landfill closure) and to allow the Manager to negotiate with the lowest bidder for the closure and capping of the landfill. Commissioner Davenport seconded, motion carried unanimously.

CONSTRUCTION AND DEMOLITION LANDFILL SITE: The Manager reminded the Board that the C&D site has to be formally approved by the Board.

Commissioner Lamb made a motion to approve the Construction and Demolition site as proposed by Diehl and Phillips. Commissioner Davenport seconded, motion carried unanimously.

RECESS

WASHINGTON COUNTY FIRE COMMISSION ORDINANCE: The County Manager briefed the Board on the need for a Fire Commission Ordinance and briefed the Board on the proposed ordinance stating that this ordinance would establish a fire commission which would be the liaison between the Board and fire departments. Discussion ensued.

Commissioner Lamb made a motion to approve the Washington County Fire Commission Ordinance as presented. Commissioner Waters seconded, motion carried unanimously.

HEALTH DEPARTMENT: Commissioner Davenport briefed the Board on a complaint from a resident in the Creswell area who had requested that a representative from the Health Department inspect their property. They were told it would be two weeks and now have been postponed another week. Commissioner Waters stated that the district now has three Sanitarians. The Board discussed alternate septic systems, management entity, etc. Commissioner Waters also informed the Board that the Albemarle Commission is planning to put some money into Tyrrell County for administrative fees, engineering, etc.

EXECUTIVE SESSION: Commissioner Davenport made a motion to go into executive session to discuss personnel, property disposition, and litigation. Commissioner Lamb seconded, motion carried unanimously.

Commissioner Waters made a motion to come out of executive session, Commissioner Lamb seconded, motion carried unanimously.

I, Lois C. Askew, Clerk of the Board of Commissioners of Washington County, North Carolina do hereby certify that the foregoing is a true copy of the minutes of the Washington County Board of Commissioners, at a meeting held on July 5, 1994.

Witness my hand and the corporate seal of the said County, this the 12 day of July 1994.

Lois C. Askew
Lois C. Askew, Clerk
Washington County Board of
Commissioners

BOARD OF COMMISSIONERS
WASHINGTON COUNTY, NC

State of North Carolina
Department of Environment, Health, and Natural Resources
512 North Salisbury Street • Raleigh, North Carolina 27604
Division of Solid Waste Management
Solid Waste Section
Telephone (919) 733-4996

James B. Hunt, Jr., Governor

Jonathan B. Howes, Secretary

LAND CLEARING AND INERT DEBRIS LANDFILL NOTIFICATION

Pursuant to 15A NCAC 13B .0563(2)(a), the land owner(s) and operator(s) of any Land Clearing and Inert Debris Landfill under two (2) acres in size shall submit this notification form to the Division prior to constructing or operating the landfill. This form must be filed for recordation in the Register of Deeds' Office. The Register of Deeds shall index the notification under the name of the owner(s) of the land in the county or counties in which the land is located. The Register's seal and the date, book, and page number of recording must be included on this form when submitted to the Division. **This notification is not valid to authorize operation of a landfill unless complete, accurate, and recorded as required by 15A NCAC 13B .0563(2)(b).**

1. Facility Name: Washington County Landfill
2. Facility location (street address): Landfill Road
   City: Roper County: Washington Zip: 27970
3. The land on which this landfill is located is described in the deed recorded in:
   deed book: 322, 324 page: 585,587,793 county: Washington
4. Name of land owner: Washington County
5. Mailing address of land owner: Post Office Box 1007
   City: Plymouth State: N.C. Zip: 27962
6. Telephone number of land owner: (919) 793-5823
   If the land is owned by more than one person, attach additional sheets with the name, address, and phone number of all additional land owners.
7. Name of operator: Washington County
8. Trade or business name of operator: Washington County
9. Mailing address of operator: PO Box 1007
   City: Plymouth State: N.C. Zip: 27962
10. Telephone number of operator: (919) 793-5823
    If the landfill is operated by more than one person, attach additional sheets with the name, address, and phone number of all additional operators.
11. Projected use of land after completion of landfill operations: LCI&D and Borrow material...

The following are the applicability, siting, and operating criteria for Land Clearing and Inert Debris Landfills operating under notification.

.0101 DEFINITIONS

(72) "Land clearing waste" means solid waste which is generated solely from land clearing activities such as stumps, trees, limbs, brush, grass, and other naturally occurring vegetative material.

(73) "Land clearing and inert debris landfill" means a facility for the land disposal of land clearing waste, concrete, brick, concrete block, uncontaminated soil, gravel and rock, untreated and unpainted wood, and yard trash.

(74) "Yard trash" means solid waste resulting from landscaping and yard maintenance such as brush, grass, tree limbs, and similar vegetative materials.

.0563 APPLICABILITY REQUIREMENTS FOR LAND CLEARING AND INERT DEBRIS (LCID) LANDFILLS

Management of land clearing and inert debris shall be in accordance with the State hierarchy for managing solid waste as provided for under N.C.G.S. § 130A-309.04(a). Disposal in a landfill is considered to be the least desirable method of managing land clearing and inert debris. Where landfilling is necessary, the requirements of this Rule apply.

(1) An individual permit from the Division of Solid Waste Management is not required for Land Clearing and Inert Debris (LCID) landfills that meet all of the following conditions:

(a) The facility is to be operated for the disposal of land clearing waste, inert debris, untreated wood, and yard trash. Operations must be consistent and in compliance with the local government solid waste management plan as approved by the Division of Solid Waste Management.

(b) The total disposal area is under two acres in size.

(c) The facility and practices comply with the siting criteria under Rule .0564, and operational requirements under Rule .0566.

(d) The fill activity is not exempt from, and must comply with all other Federal, State, or Local laws, ordinances, Rules, regulations, or orders, including but not limited to zoning restrictions, flood plain restrictions, wetland restrictions, sedimentation and erosion control requirements, and mining regulations.

(2) Where an individual permit is not required, the following applies:

(a) The owner of the land where the landfill is located must notify the Division on a prescribed form, duly signed, notarized, and recorded as per Rule .0563(2)(b). The operator of the landfill, if different from the land owner, shall also sign the notification form.

(b) The owner must file the prescribed notification form for recordation in the Register of Deeds' Office. The Register of Deeds shall index the notification in the grantor index under the name of the owner of the land in the county or counties in which the land is located. A copy of the recorded notification, affixed with the Register's seal and the date, book and page number of recording shall be sent to the Division of Solid Waste Management.

(c) When the land on which the Land Clearing and Inert Debris Landfill is sold, leased, conveyed, or transferred in any manner, the deed or other instrument of transfer shall contain in the description section in no smaller type than that used in the body of the deed or instrument a statement that the property has been used as a Land Clearing and Inert Debris Landfill and a reference by book and page to the recordation of the notification.

.0564 SITING CRITERIA FOR LAND CLEARING AND INERT DEBRIS (LCID) LANDFILLS

The following siting criteria shall apply for Land Clearing and Inert Debris (LCID) landfills:

(1) Facilities or practices, shall not be located in the 100-year floodplain.

(2) Facilities or practices shall not cause or contribute to the taking of any endangered or threatened species of plants, fish, or wildlife.

(3) Facilities or practices shall not result in the destruction or adverse modification of the critical habitat of endangered or threatened species as identified in 50 CFR Part 17 which is hereby incorporated by reference including any subsequent amendments and editions. This material is available for inspection at the Department of Environment, Health, and Natural Resources, Division of Solid Waste Management, 401 Oberlin Road, Raleigh, North Carolina 27605 where copies can be obtained at no cost.

(4) Facilities or practices shall not damage or destroy an archaeological or historical site.

(5) Facilities or practices shall not cause an adverse impact on a state park, recreation or scenic area, or any other lands included in the state nature and historic preserve.

(6) Facilities shall not be located in any wetland as defined in the Clean Water Act, Section 404(b).

(7) It must be shown that adequate suitable soils are available for cover, either from on or off site.

(8) Land Clearing and Inert Debris landfills shall meet the following surface and ground water requirements:

(a) Facilities or practices shall not cause a discharge of pollutants into waters of the state that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES), under Section 402 of the Clean Water Act, as amended.

(b) Facilities or practices shall not cause a discharge of dredged materials or fill material into waters of the state that is in violation of the requirements under Section 404 of the Clean Water Act, as amended.

(c) Facilities or practices shall not cause non-point source pollution of waters of the state that violates assigned water quality standards.

(d) Waste in landfills with a disposal area greater than two acres shall be placed a minimum of four feet above the seasonal high water table, except where an alternative separation is approved by the Division.

(e) Waste in landfills with a disposal area less than two acres shall be placed above the seasonal high water table.

(9) The facility shall meet the following minimum buffer requirements:

(a) 50 feet from the waste boundary to all surface waters of the state as defined in G.S. 143-212.

(b) 100 feet from the disposal area to property lines, residential dwellings, commercial or public buildings, and wells.

(c) Buffer requirements may be adjusted as necessary to insure adequate protection of public health and the environment.

(10) The facility shall meet all requirements of any applicable zoning ordinance.

.0566 OPERATIONAL REQUIREMENTS FOR LAND CLEARING AND INERT DEBRIS (LCID) LANDFILLS

Land Clearing and Inert Debris (LCID) landfills shall meet the following operational requirements:

(1) Operational plans shall be approved and followed as specified for the facility.

(2) The facility shall only accept those solid wastes which it is permitted to receive.

(3) Solid waste shall be restricted to the smallest area feasible and compacted as densely as practical into cells.

(4) Adequate soil cover shall be applied monthly, or when the active area reaches one acre in size, whichever occurs first.

(5) 120 calendar days after completion of any phase of disposal operations, or upon revocation of a permit, the disposal area shall be covered with a minimum of one foot of suitable soil cover sloped to allow surface water runoff in a controlled manner. The Division may require further action in order to correct any condition which is or may become injurious to the public health, or a nuisance to the community.

(6) Adequate erosion control measures, structures, or devices shall be utilized to prevent silt from leaving the site and to prevent excessive on site erosion.

(7) Provisions for a ground cover sufficient to restrain erosion must be accomplished within 30 working days or 120 calendar days upon completion of any phase of landfill development.

(8) The facility shall be adequately secured by means of gates, chains, berms, fences, etc. to prevent unauthorized access except when an operator is on duty. An attendant shall be on duty at all times while the landfill is open for public use to assure compliance with operational requirements and to prevent acceptance of unauthorized wastes.

(9) Access roads shall be of all-weather construction and properly maintained.

(10) Surface water shall be diverted from the working face and shall not be impounded over waste.

(11) Solid waste shall not be disposed of in water.

(12) Open burning of solid waste is prohibited.

(13) The concentration of explosive gases generated by the facility shall not exceed:

(a) Twenty-five percent of the lower explosive limit for the gases in facility structures.

(b) The lower explosive limit for the gases at the property boundary.

(14) Leachate shall be properly managed on site through the use of current best management practices.

(15) Should the Division deem it necessary, ground water or surface water monitoring, or both, may be required as provided for under Rules .0601 and .0602 of this Subchapter.

(16) A sign shall be posted at the facility entrance showing the contact name and number in case of an emergency and the permit number. The permit number requirement is not applicable for facilities not requiring an individual permit.

Certification by Land Owner:

I certify that the information provided by me in this notification is true, accurate, and complete to the best of my knowledge. The facility siting and disposal operations of this Land Clearing & Inert Debris landfill will comply with the requirements of Sections .0563, .0564 and .0566 of 15A NCAC 13B, North Carolina Solid Waste Management Rules. The facility and operations of this landfill will also comply with all applicable Federal, State, and Local laws, rules, regulations, and ordinances. Where the operator is different from the land owner, I, the land owner, have knowledge of the operator's plans to dispose of solid waste on the land and I specifically grant permission for the operation of the landfill. I understand that both the land owner and operator are jointly and severally liable for improper operations and proper closure of the landfill as provided for by North Carolina General Statute 130A-309.27. I further understand that North Carolina General Statute 130A-22 provides for administrative penalties of up to five thousand dollars ($5,000.00) per day per each violation of the Solid Waste Management Rules. I further understand that the Solid Waste Management Rules may be revised or amended in the future and that the facility siting and operations of this landfill will be required to comply with all such revisions or amendments.

Lee Smith, County Manager	[signature]	08/05/93
Print Name (Owner)	Signature (Owner)	Date

North Carolina

Washington County

I, Elaine G. Davis, a Notary Public for said County and State, do hereby certify that Lee Smith, County Manager personally appeared before me this day and acknowledged the due execution of the foregoing instrument.

Witness my hand and official seal, this the 5 day of August, 19 93.

(Official Seal) ELAINE G. DAVIS NOTARY PUBLIC WASHINGTON COUNTY, NC

Elaine G. Davis
Notary Public

My commission expires 8-13, 1994.

STATE OF NORTH CAROLINA, COUNTY OF WASHINGTON
The foregoing or annexed certificate (s) of Elaine G. Davis

is (are) certified to be correct. This instrument was presented for registration and recorded in this office in Book 341, Page 174.
This 5 day of August, 1993 at 3:24 o'clock P.M.

Greta H. Barber
Register of Deeds

By: Asst.

PRELIMINARY ENDANGERED SPECIES AND WETLANDS SURVEY

WASHINGTON COUNTY LANDFILL,

NORTH CAROLINA

May, 1994

Prepared by Jamie Shern, Forest Ecologist

S&EC

Soil & Environmental Consultants, Inc.

244 West Millbrook Road ■ Raleigh, North Carolina 27609 ■ (919) 846-5900 ■ Fax (919) 846-9467

ENDANGERED SPECIES

The US Fish and Wildlife Service lists four federally endangered or threatened species occurring in Washington County. See Appendix A for listing. This survey for endangered species focused primarily on the bald eagle (*Haliaeetus leucocephalus)* as the other current federally protected species listed are sea turtles which do not have potential habitat on or adjacent to the site.

BALD EAGLE, *HALIAEETUS LEUCOCEPHALUS*

Bald eagles are federally listed endangered in the southeastern U.S.

Bald eagles are large and dark in the body, 32-43" (81-109 cm) long, with a white head, white tail, and yellow bill. The wingspread is about 7 feet (2.1 m). Young birds lack the white head and tail, and have a dark bill and pale markings on the belly, tail, and under the wings. The lower section of the leg has no feathers. Nests are cone-shaped, 6-8 feet (1.8-2.4 m) from top to bottom, and 6 feet (1.8 m) or more in diameter.

Bald eagles in the Southeast frequently build their nests in the transition zone between forest and marsh or open water. Nests are typically constructed in dominant live pines or cypress trees that provide a good view and clear flight path, usually less than ½ mile from open water. The nearest large bodies of water to the site is the Albemarle Sound 0.7 mile away. Winter roosts are usually in dominant trees, similar to nesting trees, but may be somewhat farther from water. Non-nesting eagles are most abundant in the northern coastal plain and along the Pee Dee-Yadkin River system, where they occur throughout the year (Henson 1990, US Fish and Wildlife Service 1992). There are some tall trees surrounding the perimeter of the property. No trees on the property would be suitable for roosting or nesting (see Photo 1), nor were any eagles sighted on or immediately adjacent to the site. The nearest recorded sighting of a bald eagle (NHP, Westover quadrangle) is 1.25 miles west northwest of the property, near Conaby Creek (Figure 1).

WETLANDS

The presence of jurisdictional wetlands on-site was based on the three parameter approach; hydric soils, hydrophytic vegetation, and wetland hydrology , as described in the U. S. Army Corps of Engineers 1987 Wetland Deliniation Manual.

SOILS

Hydric soil series of the site include Muckalee and Roanoke. Nonhydric soil series of the site include: Conetoe and Augusta. Some of the site has been extensively impacted by it's past use for borrow material which has compacted the soil and removed the surface horizons.

VEGETATION

Most vegetation on the area was cleared within the past twenty years. Much of the site has naturally regenerated to a dense young pine stand. Vegetation in the natural wetland areas around the perimeter of the site include; swamp tupelo (*Nyssa biflora),* red maple (*Acer rubrum*), inkberry (*Ilex glabra*), laurel-leaf briar (*Smilax lauriflora*), and cinnamon fern (*Osmunda cinnamomea*).

HYDROLOGY

Natural drainage has been restricted by the erection of soil berms and roadbeds. The result is shallow ponded water in some areas(see Photo 2). Mallard ducks (*Anas platyrhynchos*), a great blue heron (*Ardea herodias*), and an unidentified wading bird were observed foraging in one such area. The margins of some of these old excavated and compacted borrow areas have "naturalized" with wetland vegetation (*Typha latifolia, Juncus effusus* and others) present. Naturally occurring wetland areas on site are located around the perimeter of the property. Wetlands encroach in peripheral drainageways. Some areas of the site were not surveyed due to prohibitively thick vegetation. Approximate wetland locations are shown on Figure 2.

CONCLUSIONS

ENDANGERED SPECIES

No currently listed or proposed federally protected species are likely to occur on the proposed construction/demolition landfill site in Washington County, North Carolina.

WETLANDS

The majority of the property proposed to be utilized for a construction/demolition landfill does not appear to be jurisdictional wetland. A forthcoming site meeting with the Corps of Engineers is expected to confirm our delineation. Nationwide permits may be sufficient to permit the proposed utilization of the site if impacts to adjacent wetlands to the south and west, and other wetland areas on the site, are minimized and/or avoided. Review of a final site plan will be necessary to determine which, if any, permits will be required.

References

Henson, T.H. 1990. Bald eagle. In: Lee, D.S. and J.F. Parnell (eds.). Endangered, Threatened and Rare Fauna of North Carolina, Part III. A Re-evaluation of the Birds. Occasional Papers of the North Carolina Biological Survey. North Carolina Museum of Natural Sciences, Raleigh, NC.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1964. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill, NC.

U.S. Fish and Wildlife Service. 1992. Endangered and Threatened Species of the Southeastern United States (The Red Book). Prepared by Ecological Services, Division of Endangered Species, Southeast Region. Government Printing Office, Washington, DC.

Figure 1 – Project Site and Nearest Bald Eagle Location Map of the Washington County Landfill Expansion Area

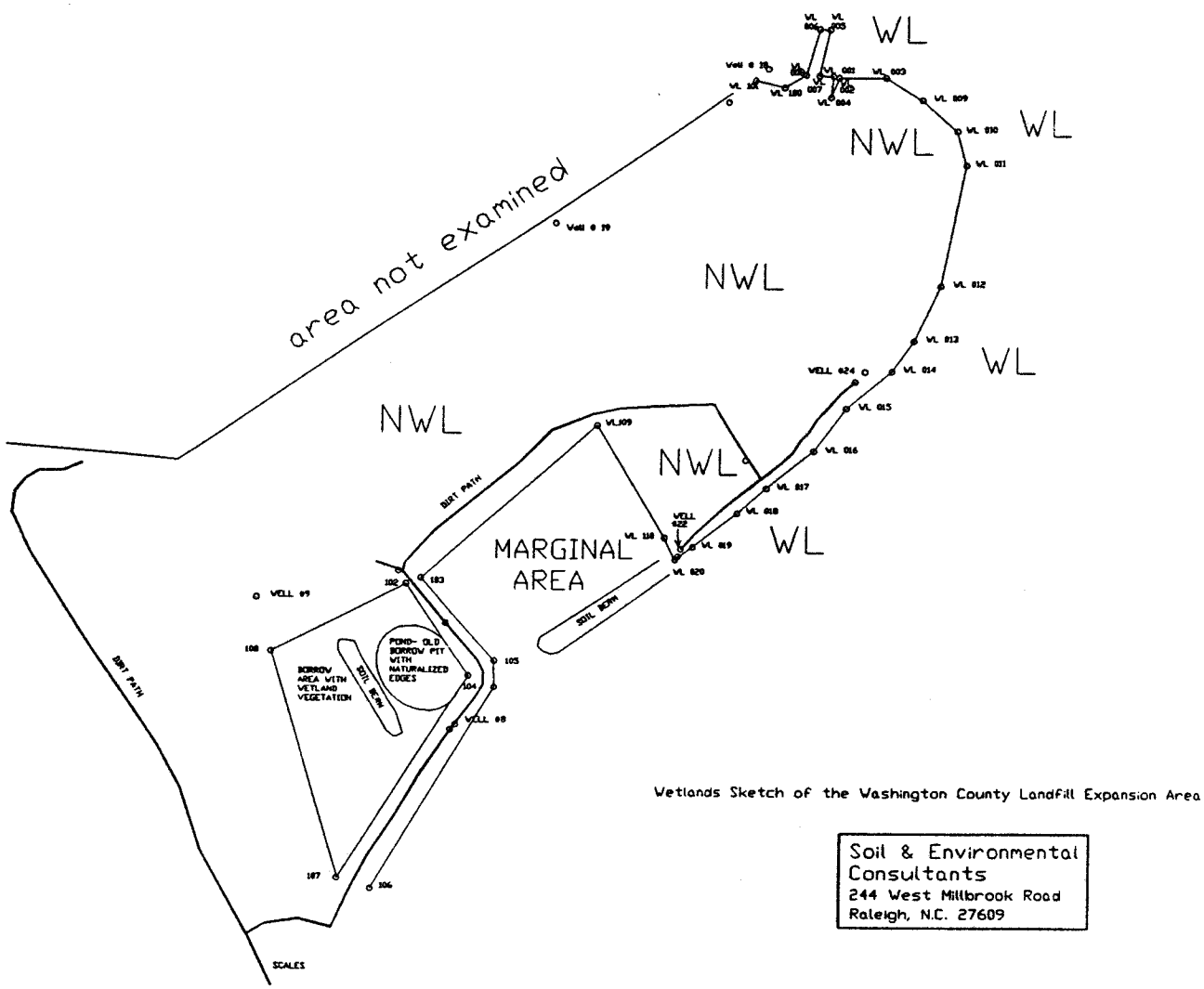


Figure 2 – Wetlands Sketch Map of the Washington County Landfill Expansion Area

Appendix A– Federally Listed Protected Species in Washington County, NC

REVISED APRIL 13, 1992

Washington County

Bald eagle (Haliaeetus leucocephalus) - E
Kemp's Ridley sea turtle (Lepidochelys kempi) - E
Loggerhead sea turtle (Caretta caretta) - T
Green sea turtle (Chelonia mydas) - T

Sea turtles when "in the water" and the shortnose sturgeon are under the jurisdiction of the National Marine Fisheries Service and should be contacted concerning your agency's responsibilities under Section 7 of the Endangered Species Act. Their address is:

National Marine Fisheries Service
U.S. Department of Commerce
9450 Koger Boulevard
Duval Building
St. Petersburg, Florida 33702

There are species which, although not now listed or officially proposed for listing as endangered or threatened, are under status review by the Service. These "Candidate"(C1 and C2) species are not legally protected under the Act, and are not subject to any of its provisions, including Section 7, until they are formally proposed or listed as threatened or endangered. We are providing the below list of candidate species which may occur within the project area for the purpose of giving you advance notification. These species may be listed in the future, at which time they will be protected under the Act. In the meantime, we would appreciate anything you might do for them.

Waccamaw killifish (Fundulus waccamensis) - C2
Green floater (Lasmigona subviridis) - C2

Site Photographs

(1) Typical Young Pine and Mixed Pine - Hardwood Stands

(2) Naturalized Borrow Area

An Archæological Survey of the Proposed Washington County Landfill, Westover Vicinity, Washington County, North Carolina.

Thomas Hargrove

February 1994

ER -87-7561

A Report Submitted to Diehl & Phillips, Engineers,
by
Archæological Research Consultants, Inc.,
Raleigh, North Carolina.

List of Figures

Follows Page

Figure 1: North Carolina and the project area 2

Figure 2: Washington County and the project area 2

Figure 3: The Westover or White Marsh vicinity and the project area 2

Figure 4: The proposed landfill expansion tract, with 31WH17 2

Figure 5: The project area in 1932 7

Figure 6: Looking northward across the site and the adjoining borrow pit 8

MANAGEMENT SUMMARY

The archæological survey of the proposed Washington County landfill covered approximately 71 acres near Westover in northwestern Washington 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 much of the project area is forested, the survey relied heavily on screened shovel tests at intervals of 30 m (100 feet). In areas with exposed ground surfaces (for instance, access and logging roads), the surveyors closely examined the area for prehistoric and historic artifacts.

The survey recorded one archæological site, 31WH17, a historic site (late eighteenth - late twentieth century), which also has a minor prehistoric lithic component. Most of the former site area has apparently been destroyed during the creation of borrow pits. The survival of any intact archæological remains of the historic settlement is highly unlikely. The site does not seem eligible for nomination to the National Register of Historic Places.

We do not recommend additional archæological work on the proposed landfill expansion, as it is now designed.

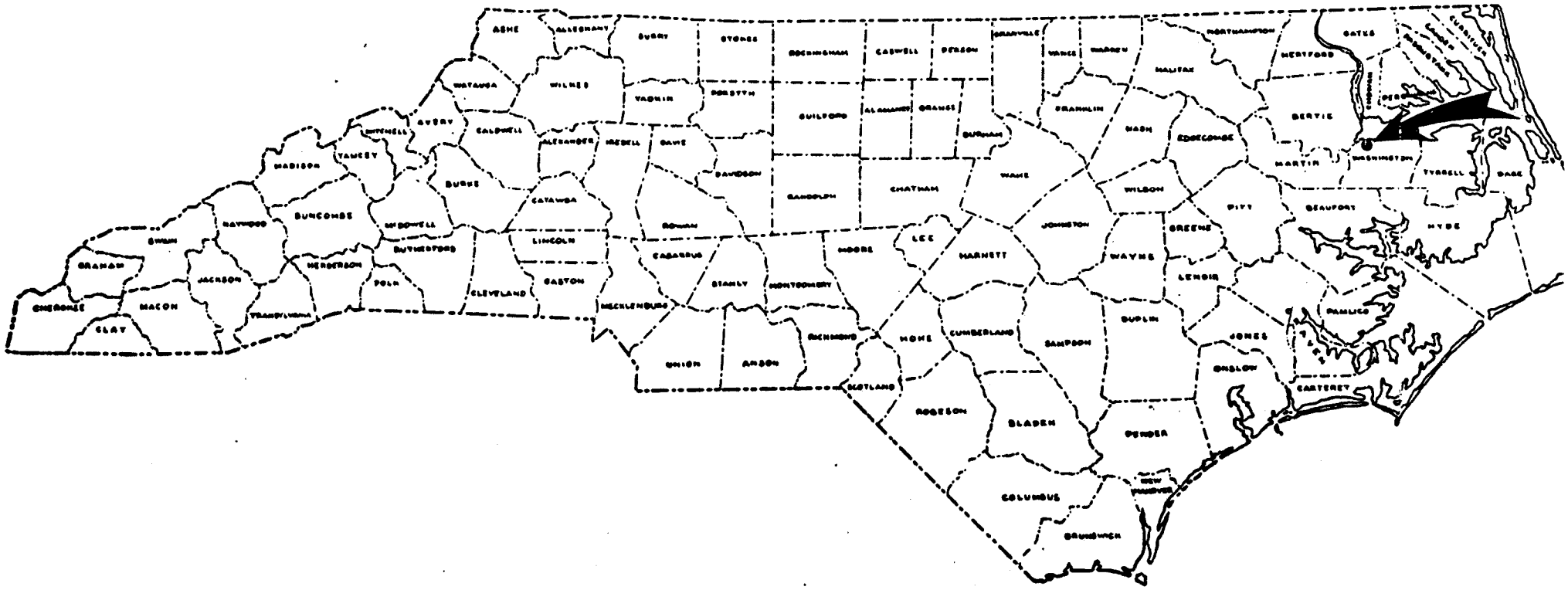


Figure 1: North Carolina and the project area (arrow).

Base map: North Carolina Division of Archives and History.

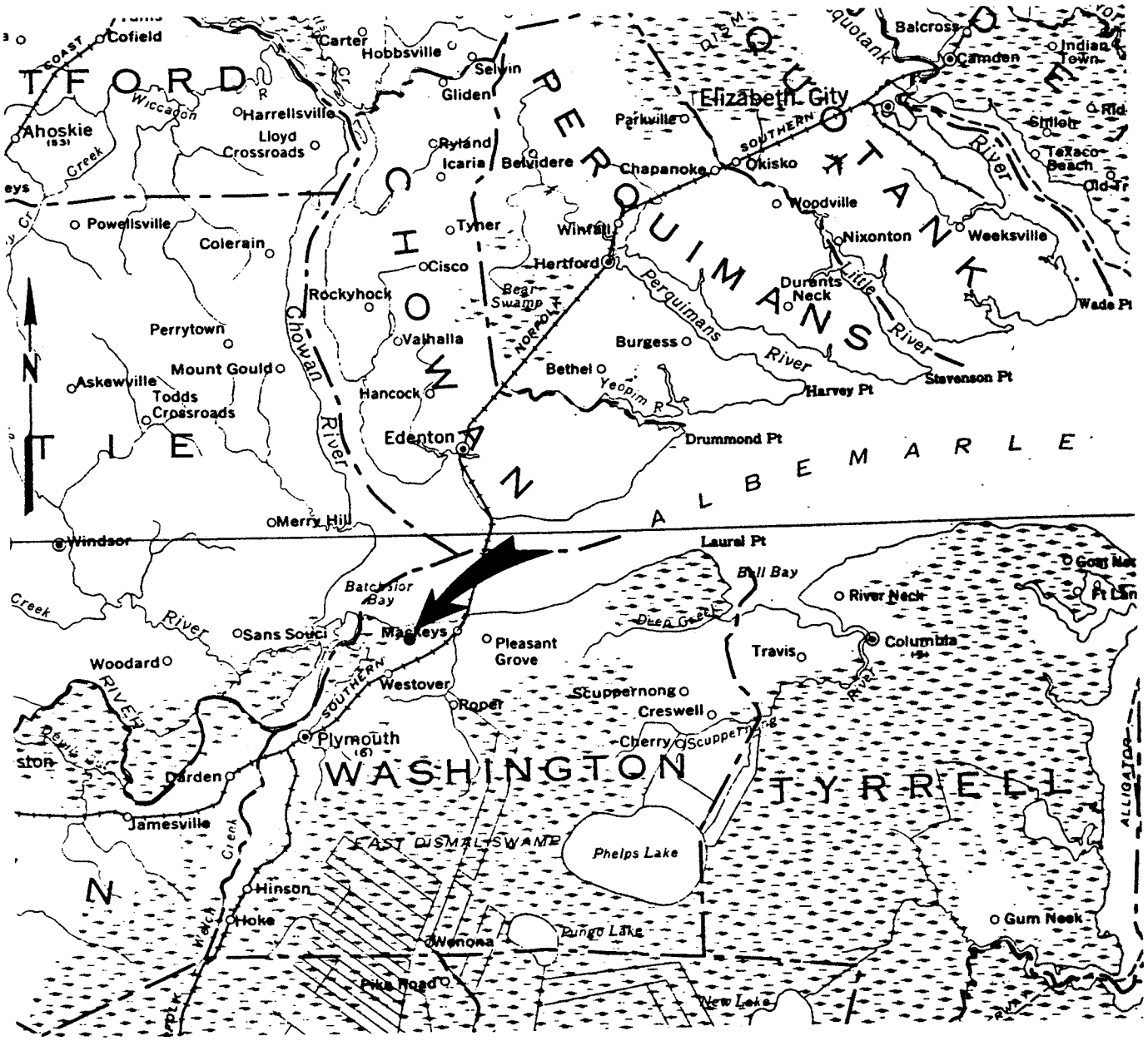


Figure 2: Washington County and the project area (arrow).

Base map: U.S.G.S. *State of North Carolina.*

Scale: one inch = eight miles

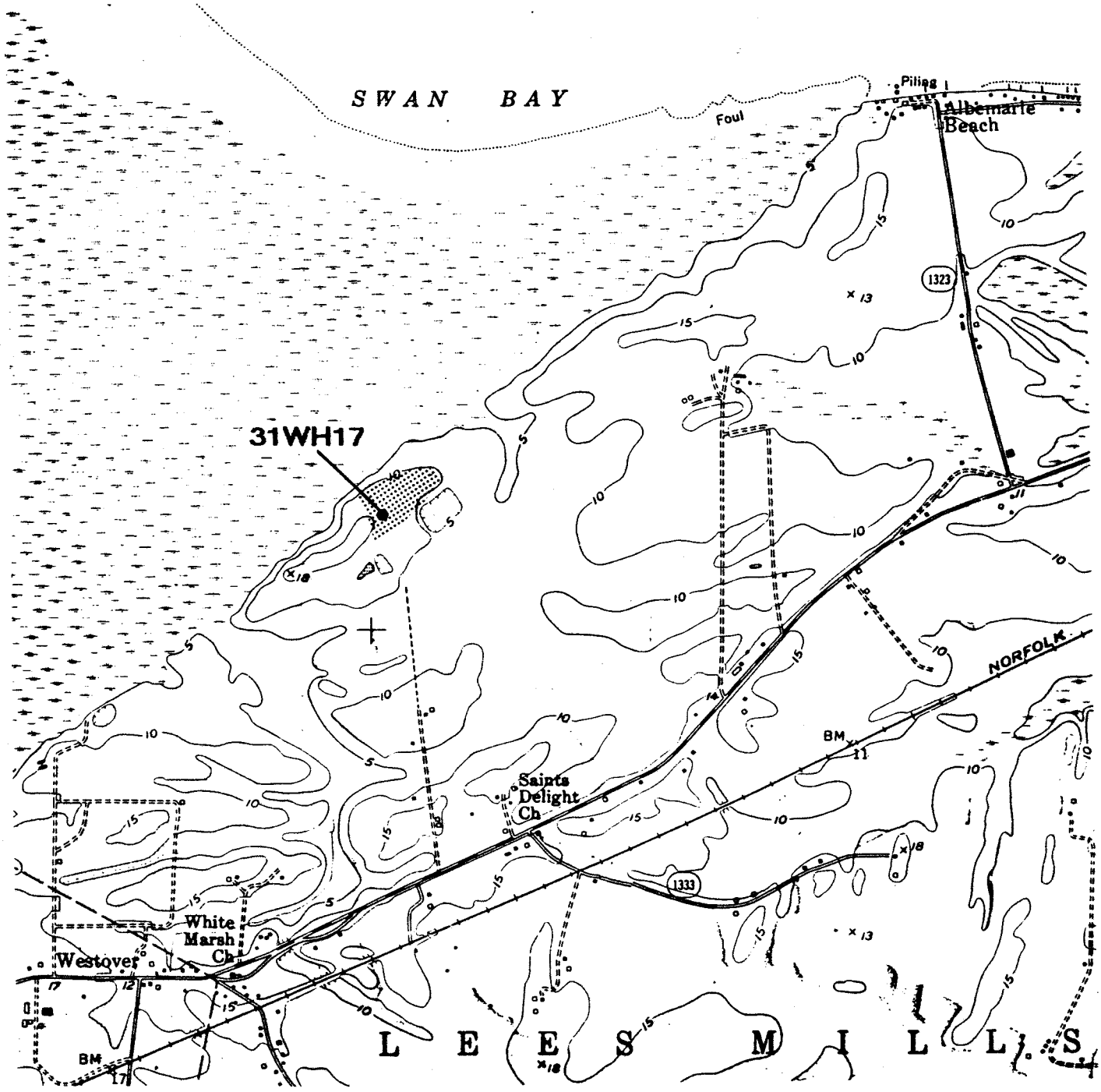
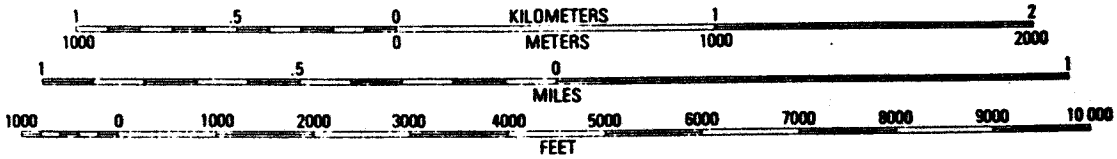


Figure 3: The Westover or White Marsh vicinity and the project area (shaded).

Base map: U.S.G.S. *Westover* quad.

SCALE 1:24 000



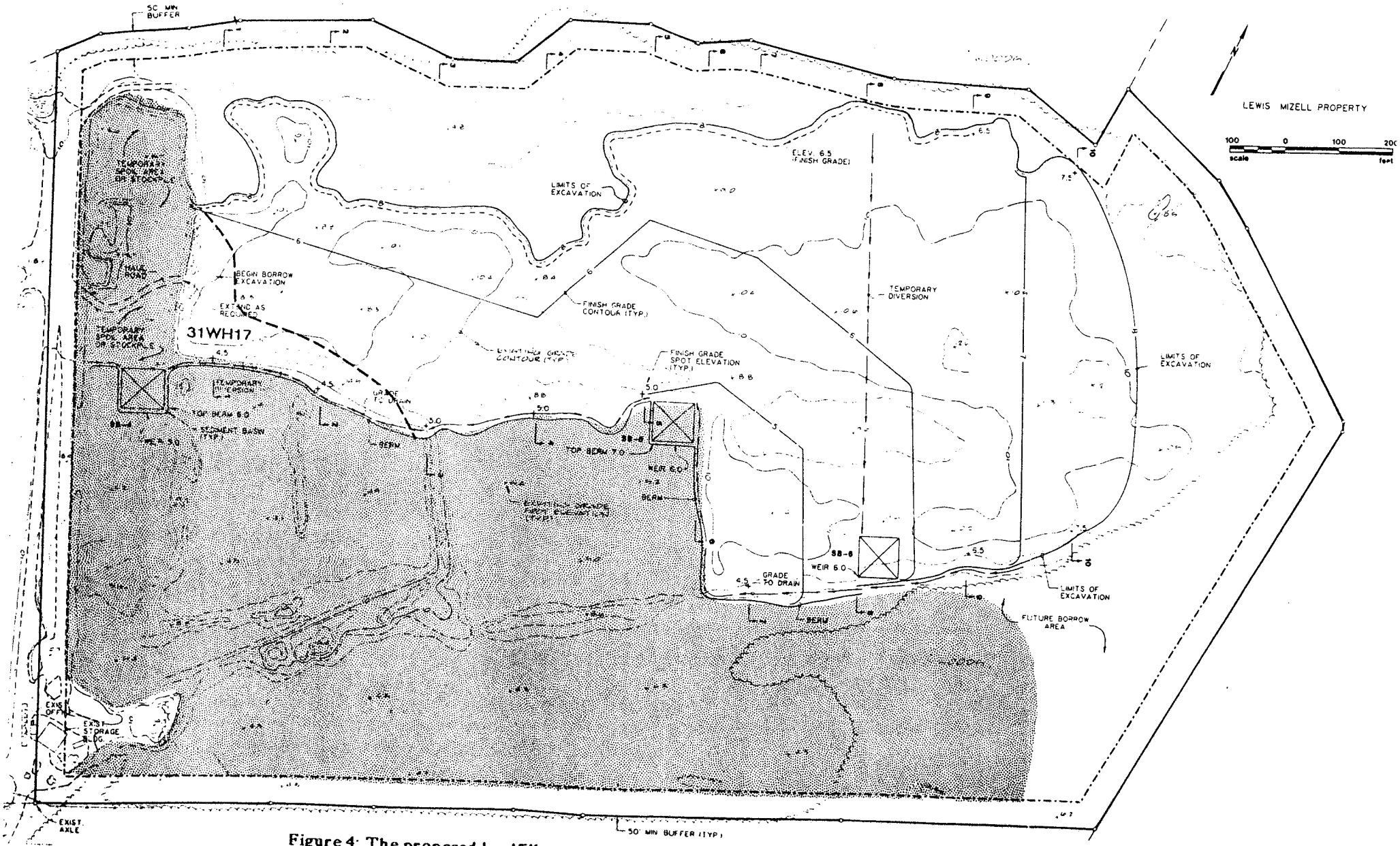


Figure 4: The proposed landfill expansion tract, with 31WH17. Present borrow pits are shaded

Large parts of the survey tract have been severely disturbed by borrow pits (see Figure 4). Other sections of the tract were apparently logged within the last ten years and are now covered with a dense secondary growth of small trees and vines.

PREHISTORIC BACKGROUND

Sustained prehistoric research on the coast of North Carolina has been a relatively recent phenomenon. Much of the work has taken place within the last 20 years, following the establishment of academic programs in archaeology at East Carolina University and at UNC - Wilmington, as well as the establishment of cultural resource management programs on the state level. Some of this information has been synthesized by David Phelps of ECU and published by the North Carolina Division of Archives and History (Phelps 1983). The following description of the coast's prehistory comes largely from this recent synthesis. Information more specific to the western Albemarle Sound region comes from Phelps (1982).

Paleo-Indian: 12,000 - 8,000 B.C. (Phelps 1983: 18-22)

The earliest known human occupants of the North Carolina coast were the Paleo- Indians, appearing at the close of the last Ice Age and so far known only from isolated finds of their fluted projectile points. The environment of the Paleo-Indian period in eastern North Carolina was radically different from the one we see today. One major difference was in the sea level, which was much lower than the modern sea level. One estimate places the sea level during Paleo- Indian times (about 12,000 B.C.) at about 38 meters, or 125 feet, below the present water surface. Most of the now-submerged Continental Shelf was exposed land, and the ancient coastline was scores of miles east of its modern position. By the close of the Paleo-Indian period, water from the melting ice sheets had raised the sea level on the coast to about 28 meters, or 92 feet, below its present level (Blackwelder, Pilkey, and Howard 1979). Vegetation on the coastal plain, to judge from pollen studies in the Dismal Swamp and from the Bladen Lakes area, consisted of relatively open forests of jack pine and spruce (Whitehead 1973; Delcourt and Delcourt 1981). We know almost nothing about the settlement patterns, social organization, or subsistence strategies of the Paleo-Indians in North Carolina in general. The Paleo-Indians of the coast are likely to remain the most obscure, since many of their sites are now submerged on the Continental Shelf.

The Archaic Period: 8,000 - 1,000 B.C. (Phelps 1983:22-29)

By about 9,000 or 8,000 B.C., rising temperatures had created a cool, temperate "northern hardwoods" or "mixed hardwoods" type of forest, featuring species such as sugar maple, beech, birch, hemlock, and white pine (Whitehead 1973; Delcourt and Delcourt 1981). By about 7,000 B.C., the sea level had risen to a point about 26.8 meters (about 88 feet) below the present level, still exposing many miles of the Continental Shelf (Blackwelder et al. 1979). The characteristic cultures of the Early Archaic period (8,000 - 5,000 B.C.) are generally recognized by their distinctive corner-notched projectile points such as the Palmer and Kirk types (Coe 1964). Again, we know relatively little about the coastal cultures of the Early Archaic period, but in broad outline they were probably also nomadic hunters and gatherers, adapted to modern environments with smaller game animals and more temperate vegetation than in the earlier environment during the close of the Ice Age.

During the Middle Archaic period (5,000-3,000 B.C.), a warming and drying climatic

trend occurred over much of the Southeastern United States. During this Hypsithermal Interval, eastern North Carolina's vegetation changed to drier communities of oak, hickory, and ash (Delcourt and Delcourt 1980:227). By the beginning of the period, the sea level had risen to about 14 meters (about 46 feet) below the present sea level (De Pratter and Howard 1981). Several projectile point types characterize this period on the coastal plain: Stanly, Morrow Mountain, Guilford, and Halifax (Coe 1964). Again, prehistorians assume that the people who produced these points were nomadic hunters and gatherers. To date, we have no reports of excavated sites from this period on the coast, although Middle Archaic sites are often found in the area.

By about 3,000 B.C., forests in the region were essentially like the pine, oak-hickory, and cypress-gum communities seen today (Delcourt and Delcourt 1981). Sea level rose to a level about 1.5 meters (about 5 feet) below the present surface (De Pratter and Howard 1981). At this point, the long chain of barrier islands called the Outer Banks began to form, separating the ocean from the bays and estuaries and creating the modern sounds and estuaries, such as Albemarle Sound (Dolan et al 1980; Schoenbaum 1982:8).

The major diagnostic artifact of the Late Archaic period (4,000-1,000 B.C.) is the broad-bladed Savannah River point, although ceramic vessels also appear on the coast at around 2,500 - 2,000 B.C. The Late Archaic period was probably still a period of hunters and gatherers, but nomadism may have been on the wane and more sedentary villages on the increase (Phelps 1983: 22-29).

In a study of the prehistory of the Chowan River basin on the north side of Albemarle Sound, Phelps (1982:11-12) has suggested that Archaic sites occur in the area in three major varieties: permanent base camps on banks or bluffs overlooking major streams; seasonal base camps on banks or bluffs by tributary streams or swamp margins; and small, special activity sites scattered throughout the area and less dependent on nearby water sources or well-drained soils. The small lithic component at 31WH17 (represented by two quartz flakes) might represent one of these Archaic special activity sites.

Early Woodland: 1,000-300 B.C.

The diagnostic artifacts of the period are a ceramic type with coarse sand temper and surfaces decorated by cord marks, net impressions, fabric impressions, or simple stamp designs. On the northern coastal plain (including our study area), the type is called "Deep Creek;" on the southern coastal plain, a similar type is called "New River." The characteristic point types are the large, triangular Roanoke points and probably the small, stemmed Gypsy points. In the eastern United States, the Woodland period is commonly marked by at least three characteristics: ceramics; the bow and arrow; and farming. Although ceramics are present in North Carolina's Early Woodland period, and the triangular points are evidence for the appearance of the bow and arrow, evidence for the practice of farming is still largely absent. We still lack direct evidence that maize, squash, beans, or other typical Woodland crops of the time had begun to play a role in the coastal cultures (Phelps 1983: 29-32).

Middle Woodland: 300 B.C.- A.D. 800

Along coastal North Carolina, the remains of Middle Woodland societies are characterized by a typical ceramic type with sand-and-grit temper and surface treatments using fabric impressions, cord marks, net impressions, incisions, or smoothed surfaces. The northern variety is called Mount Pleasant, while the southern variety is called Cape Fear. Another typical ceramic type is Hanover ware, tempered with crushed pot sherds ("grog") and decorated with cord marks or fabric impressions. Small triangular Roanoke projectile points are typical (Phelps 1983:32-36).

With the Middle Woodland, we start to see the modern sea level and coastline for the first time.

Late Woodland: A.D. 800 - European settlement (late seventeenth-early eighteenth centuries)

In the Late Woodland period, we see archaeological cultures that can be directly linked to the Indian peoples described by the early European explorers in the region. The Indians on the sounds and estuaries of the Tidewater north of the Neuse River basin were the "Colington" cultures, the Algonkian-speaking peoples encountered by the English during the Roanoke voyages of the 1580s. Colington ceramics are tempered with crushed shell and decorated with fabric impressions, simple stamping, incisions, or left with plain surfaces (Phelps 1983).

Early and Middle Woodland settlement patterns in the nearby Chowan River basin, according to Phelps (1982:12-14), strongly resemble the settlement patterns of the preceding Archaic hunters and gatherers. This resemblance might be further evidence that the Early and Middle Woodland cultures of the region were not farming societies with relatively stable village life, but still followed a largely nomadic, hunting and gathering way of life. A striking change occurs with the appearance of Late Woodland cultures, however. The Chowan River basin's Late Woodland Colington sites occur on high, sandy bluffs or ridges along rivers or major tributaries, and especially on large areas of well-drained, arable land. Phelps has suggested that the Late Woodland settlements fall into five categories: capital towns, such as those visited by the English explorers in the 1580s; large villages; small villages; isolated farmsteads; and special activity camps for hunting and fishing.

ETHNOHISTORIC BACKGROUND

The English explorations of the 1580s resulted in the disastrous "Lost Colony" on Roanoke Island but also in a great deal of useful ethnographic information in the form of eyewitness accounts by Arthur Barlowe, Ralph Lane, and Thomas Hariot, and watercolor maps and paintings by John White (Corbitt 1953). Various versions of the maps based on these explorations show several Indian towns at the western end of Albemarle Sound. The towns closest to the project area were probably *Tandaquomuc* (either a Weapemeoc or Chowanoke settlement), which was north of the Roanoke River, and *Moratuc*, which was probably on the south bank of the Roanoke River near the mouth of Welch Creek (Quinn 1955: 858-859), which now forms Washington County's western boundary (see Figure 2).

By the middle of the 1600s, English settlers from Virginia had begun to drift into the Albemarle region and displace the native inhabitants. The Weapemeoc were apparently greatly reduced by Old World diseases during the early Contact period and broke up into small villages that were eventually engulfed by the English settlements on the north side of the Albemarle Sound. The last historical reference to the Weapemeoc is a 1740 petition by the Yeopim for permission to dispose of their land. The more powerful Chowanoke, in contrast, went to war with the English in 1675. After the defeat of the Chowanoke, they were confined to a small reservation on Bennett's Creek. Their English neighbors continued to whittle away even at this small territory, and the Chowanoke numbers declined until 1754, when the commander of the Chowan County militia reported that "there is but one Indian Nation in Chowan County, which are called the Chowan Indians, but their strength is nothing and their condition very deplorable by the artifice and cunning of some of their neighbors. I am informed they consist of two men and five women and children, which two white men would at any time overcome" (Mook 1944:221-223).

ARCHÆOLOGICAL RESEARCH IN THE PROJECT VICINITY

A review of the site files in the Office of State Archæology shows that no prehistoric sites have been recorded in the project area, and that only 16 archæological sites (including historic sites) had been recorded in all of Washington County at the time of our survey.

HISTORICAL BACKGROUND

Background research on the project area included a review of maps and secondary historical sources in the North Carolina State Archives and in the North Carolina Collection at UNC Chapel Hill. The Washington County Historical Society has informed us that its members do not know of any sites in the immediate area. The nearest historic site mentioned in the Society's letter is the Blount house (1799 - 1810), about two miles east of the project area (Patricia Jane Monte, Curator, Washington County Historical Society, Plymouth; personal communication).

Although the English explored the Albemarle Sound in the 1580s, European colonization of the area did not take place for decades afterwards. A Jamestown settler, John Pory, visited the area in 1622 and reported that it contained vast numbers of pine trees that could support a naval stores industry. A traveller from Bermuda reported in 1636 that Englishmen were visiting the western Albemarle region and had begun exploiting the pine trees to produce "sperrits of rosin" (Powell 1975:14). The first permanent English settlement took place as late as the 1650s, when Nathaniel Batts occupied a house at the western end of Albemarle Sound.

One of the earliest grants made in the landfill vicinity was issued to Edward Moseley on August 29, 1713: "450 acres in Chowan Precinct at a place commonly called White Marsh in Morattock, joining Cullumb Flynn, a Pocoson, a branch, the White Marsh, and the road to Pamptico" (Hofmann 1979:109). The 1733 map of the colony of North Carolina, drawn by Moseley himself, labels this area "White Marsh," a name commemorated in the local post office's name as late as 1882 (Powell 1968:527). Edward Moseley (1682 ? - 1749) was possibly the "single most important political figure in the first half of the eighteenth century in North Carolina" (Price 1991:332). Moseley settled in the Albemarle region around 1704 and entered into a long and controversial political career, which included positions as Royal councilman, General Assemblyman and speaker, surveyor general, treasurer for the province, chief justice of the colony, and baron of the Exchequer (Price 1991:332). In 1711, Moseley was living in a home on the north side of Albemarle Sound (Saunders 1886:764). In 1715, he acquired almost 1,000 acres in grants near the Pungo River, and by the time of his death in 1749, he owned over 30,000 acres scattered throughout the coastal areas of the colony (Hofmann 1979:68,69; Price 1991). His 1733 map of the colony shows his own home still on the north side of the Albemarle Sound, southeast of Edenton (Moseley 1733). In 1735, he moved to Rocky Point on the Northeast Cape Fear River (Price 1991:332), so it seems unlikely that he ever occupied his land at White Marsh.

Although Moseley probably did not live on his land in Washington County, settlement was already advanced enough for the construction of mills on Kendrick's Creek near present-day Roper. The nearby area between the Roanoke River and Conaby Creek became a center of trade and a port by the 1720s. The town of Plymouth was formally established there in 1787, although it was not incorporated until 1807. Washington County was created from Tyrrell County in 1799,

and Plymouth became the county seat in 1823 (up until that time, the county courthouse was at Lee's Mills, now Roper) (Washington County Historical Society n.d.). From the ceramics (pearlwares and creamwares) found in the project area at 31WH17 (see below), we know that someone was occupying the tract by at least the last quarter of the eighteenth century.

A map of the western section of Albemarle Sound created by the United States Coast and Geodetic Survey in 1860 (Coast Chart #41) shows parts of the shore and its vicinity in great detail, but our project area was too far from the Sound or the Roanoke River to appear on the map. Our first detailed map of the project vicinity is the 1932 soil map of Washington County (Figure 5). This map shows one structure (probably 31WH17) in the project tract.

FIELD METHODS

Since much of the project area is covered with secondary, post-logging growth, the survey relied heavily on screened shovel tests at intervals of 30 m (100 feet). The shovel tests measured about 35 to 45 cm (14 to 18 inches) across and were excavated into the underlying subsoil. The soil from the shovel tests was screened through 1/4 inch hardware cloth. In areas with exposed ground surfaces (disturbed areas adjacent to borrow pits, access roads, patches exposed during logging, etc.), the surveyors closely examined the area for prehistoric and historic artifacts.

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 1944 (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 1944 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 description of the archæological site recorded during our survey of the project area. We include information on the site's periods of occupation, 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 site. The site form submitted to the Office of State Archæology lists additional environmental information (elevation, distance from water, etc.). Later sections address the question of site significance and recommendations.

The survey recorded one historic-period archæological site, with a minor prehistoric component. Figures 3 and 4 show the location of the site. The site number is assigned by the Office of State Archæology (OSA) under the national system of site identification, in which "31" stands for North Carolina, "WH" stands for Washington County, and the last number represents the order in which the site was entered into the OSA site files for that county. The accession number is also assigned by the OSA. This number is inked onto the artifacts to help in future identification after curation.

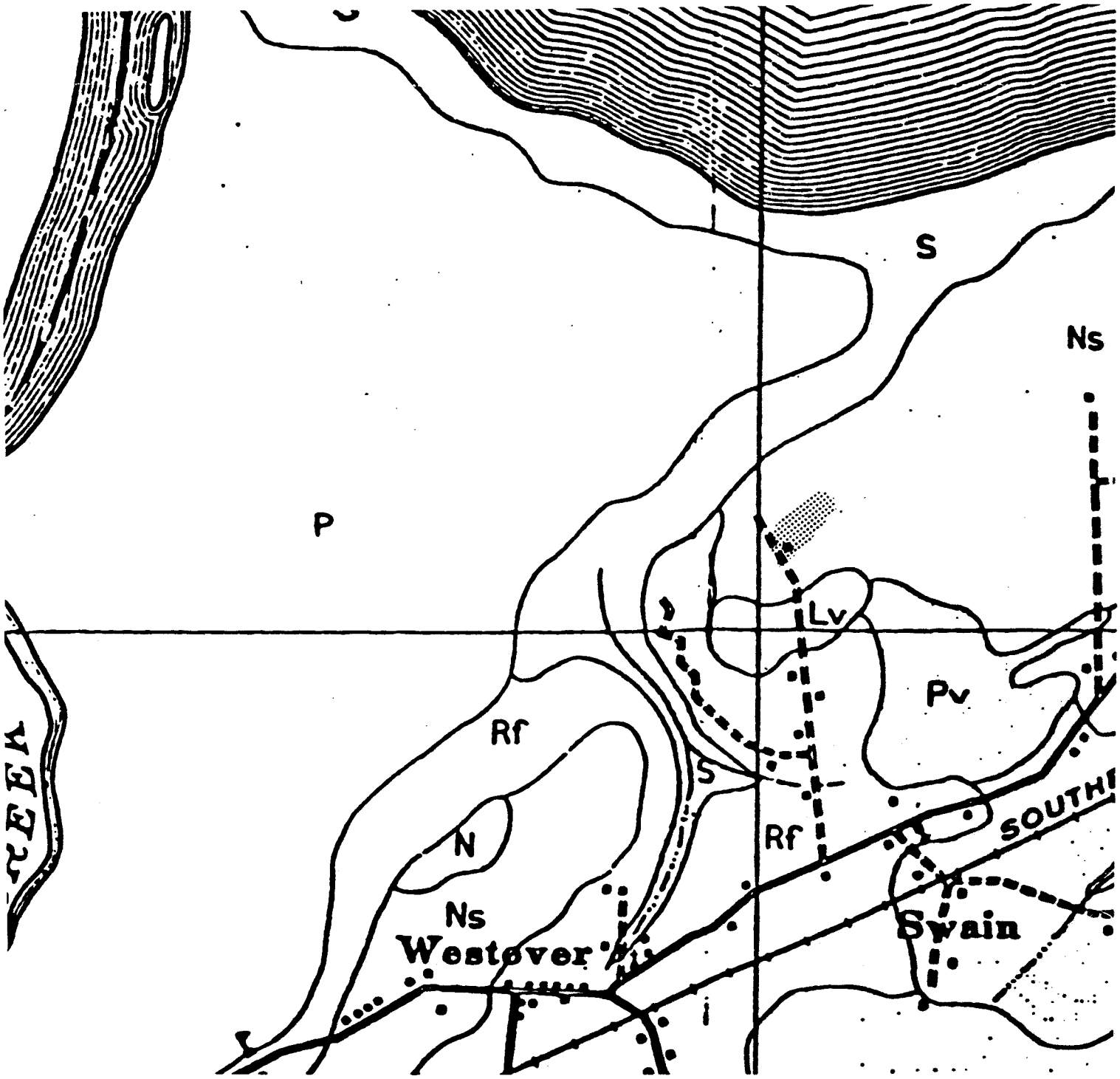


Figure 5: The project area in 1932 (shaded).

Base map: Davis and Goodman 1932.

31WH17 (Accession #94 - 021)

Type of site: The site is predominantly a historic-period occupation, with a minor prehistoric lithic component (two quartz flakes). The low-density scatters of historic-period artifacts (analyzed by Patricia Samford) range from the late eighteenth century to the mid or late twentieth century. The lack of substantial numbers of architectural artifacts (for example, concentrations of brick, ballast stone from foundations, window glass, nails) suggests that the house itself stood in the area of the current borrow pits, south or west of the find spot (Figure 4). Given the massive disturbances and the absence of parts of the site, the house site's original dimensions are impossible to determine. The house might have been the structure shown on the 1932 soil map of the county (Figure 5). The 1954 *Westover* quad map shows no structure on the tract.

Glass fragments

bottle (machine-made), brown	2
bottle (machine-made), blue	5
bottle, colorless non-leaded	8
bottle, colorless non-leaded, painted design	8
bottle (whole), colorless non-leaded, machine-made perfume bottle	1
bottle, molded,colorless non-leaded, marked OR	1
pressed table glass, light green	1
table glass, colorless non-leaded	1
pressed table glass, colorless non-leaded	3
pressed table glass, colorless leaded	2
cut table glass, colorless leaded	2
pressed table glass, opaque white	1
canning jar liner, opaque white	1
cosmetic jar, machine made (Pond's 24)	1

Ceramics

creamware, plain rim, undecorated soup plate	1
pearlware, undecorated	16
pearlware, molded floral design	1
pearlware, shell edge, blue	1
whiteware, shell edge, blue	1
whiteware, printed underglaze, blue	3
whiteware, painted underglaze, green	1
whiteware, undecorated	8
yelloware, undecorated	4
refined white earthenware, burned	1
refined white earthenware, glaze	

Figure 6: Looking northward across the site and the adjoining borrow pit .

missing	1
refined white earthenware, sponged, brown	1
porcellaneous hotel china, printed underglaze, black	2
porcellaneous, undecorated	1
Chinese porcelain, painted underglaze, blue	1
stoneware, grey bodied, brown salt glaze	1
stoneware bottle, buff bodied	1

Other

button, white glass	1
painted plaster	2
mussel shells	2
oyster shells	3
brick fragments	3

How recorded: During a surface inspection of cleared areas adjacent to the borrow pits, the surveyors found glass, ceramics, two flakes, and other artifacts exposed on the surface. Surface visibility was good to excellent -- about 60 to 100%.

Environment: The site is on the exposed remnant of a low ridge of Conetoe loamy fine sand.

Signs of preservation or disturbance: Borrow pits have removed any sections of the site that might have been to the south and west (Figure 4)/ During the course of land-clearing on the remaining section of this low ridge, heavy earthmoving equipment was used to push brush and tree limbs into a central area. Most of the soil's A horizon appears to have been removed or displaced. The potential for site preservation seems very low.

Research potential: The high degree of disturbance diminishes the potential for additional research.

Impact of the project: The site is in the area scheduled for landfill excavation and construction.

STANDARDS OF SIGNIFICANCE

Our evaluations of archæological significance come from 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 1986:1)

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 (National Park Service 1986:1).

For prehistoric sites, the most relevant criterion is "D." Does the prehistoric component of the site have the potential to produce significant information and new insights on the region's prehistoric past? The prehistoric remains are represented by only two quartz flakes. Even in the absence of wide-spread disturbances, such sparse prehistoric remains would not seem likely to yield significant prehistoric information.

For most historic-period archæological sites, the most relevant criterion is also "D," and we must ask whether this historic sites has the potential to produce significant information and new insights on the region's history. An eighteenth century occupation site with reasonably intact remains would be a valuable archæological asset for studying early settlement of the Albemarle region of North Carolina. However, the wide-spread and thorough disturbances experienced by the site make the survival of intact archæological remains highly unlikely. The site does not seem eligible for nomination to the National Register of Historic Places.

RECOMMENDATIONS

We do not recommend additional archæological work on the proposed landfill expansion, as it is now designed.

REFERENCES CITED

Blackwelder, Blake W., Orrin H. Pilkey, and James D. Howard
1979 Late Wisconsinan sea levels on the southeast United States Atlantic shelf based on in-place shoreline indicators. *Science* 204: 618-620.

Coe, Joffre L.
1964 The formative cultures of the Carolina Piedmont. *Transactions of the American Philosophical Society* 54(5):1-130.

Corbitt, David Leroy
1953 *Explorations, descriptions, and attempted settlements of Carolina, 1584-1590.* North Carolina Department of Archives and History, Raleigh, North Carolina.

Daniels, R.B., H.J. Kleiss, S.W. Buol, H.J. Byrd, and J.A. Phillips
1984 Soil systems in North Carolina. *North Carolina State University, North Carolina Agricultural Research Service, Bulletin* 467.

Davis, W.A., and K.V. Goodman
1932 *Soil survey of Washington County, North Carolina.* United States Department of Agriculture.

Delcourt, Paul A., and Hazel R. Delcourt
1980 Pollen preservation and Quaternary environmental history in the southeastern United States. *Palynology* 4:215-231.

1981 Vegetation maps for eastern North America: 40,000 years Before Present to the present. In *Geobotany II,* edited by Robert C. Romans. Plenum Press, New York.

DePratter, Chester, and James D. Howard
1981 Evidence for a sea level lowstand between 4,500 and 2,400 years Before Present on the southeast coast of the United States. *Journal of Sedimentary Petrology* 51(4): 1287-1295.

Dolan, Robert, Bruce Hayden, and Harry Lins
1980 Barrier islands. *American Scientist* 68 (1):16-25.

Hofmann, Margaret M.
1979 *Province of North Carolina, 1663-1729: abstracts of land patents.* Roanoke News, Weldon, North Carolina.

Mook, Maurice A.
1944 Algonkian ethnohistory of the Carolina sound. *Journal of the Washington Academy of Sciences* 34 (6).

Moseley, Edward
1733 *A new and correct map of the province of North Carolina, by Edward Moseley, late Surveyor-General of the said province, 1733.* Reprinted by the North Carolina Division of Archives and History, Raleigh, North Carolina.

National Park Service
1986 Guidelines for completing National Register forms. *National Register Bulletin* 16.

North Carolina Geological Survey
1985 *Geologic map of North Carolina.* Department of Natural Resources and Community Development, Raleigh, North Carolina.

Phelps, David S.
1982 Archaeology of the Chowan River basin: a preliminary study. *East Carolina University, Department of Sociology and Anthropology, Archaeology Laboratory, Archaeological Research Report* 4.

1983 Archæology of the North Carolina coast and coastal plain: problems and hypotheses. *The Prehistory of North Carolina: An Archæological Symposium*, edited by Mark A. Mathis and Jeffrey L. Crow. North Carolina Division of Archives and History, Raleigh, North Carolina.

Powell, William S.
1968 *The North Carolina gazetteer.* University of North Carolina Press, Chapel Hill, North Carolina.

1975 Human settlement and profile: history. *North Carolina Atlas: Portrait of a Changing Southern State,* edited by J.W. Clay, J.M. Orr, Jr., and A.W. Stuart. University of North Carolina Press, Chapel Hill, North Carolina.

Price, William S., Jr.
1991 Edward Moseley. *Dictionary of North Carolina Biography,* edited by William S. Powell. UNC Press.

Quinn, David Beers (editor)
1955 *The Roanoke voyages, 1584-1590.* The Hakluyt Society, London.

Saunders, William L.
1886 *The colonial records of North Carolina* (volume 1). Hale, Raleigh.

Schoenbaum, Thomas J.
1982 *Islands, capes, and sounds: the North Carolina coast.* John F. Blair, Winston-Salem, North Carolina.

Tant, Phillip L.
1981 *Soil survey of Washington County, North Carolina.* United States Department of Agriculture.

Washington County Historical Society
n.d. *Historic Washington County.* Washington County Historical Society, Plymouth, North Carolina.

Whitehead, Donald R.
1973 Late-Wisconsin vegetational changes in unglaciated eastern North America. *Quaternary Research* 3:621-631.

Earthwork Calculations
for
Landfill Cover and Berm Construction

COVER SOIL EARTHWORK CALCULATIONS

SECTION	DISTANCE (FT)	CUT AREA (SF)	CUT VOLUME (CY)	TOTAL CUT (CY)
	0			
3		1,535		0
	200		8,481	
4		255		8,481
	200		2,796	
5		0		11,277
8		0		11,277
	200		10,833	
9		2,925		22,110
	200		18,352	
0		2,030		40,462
	100		3,759	
TOTAL ESTIMATED COVER SOIL AVAILABLE				44,221

BERN CONSTRUCTION EARTHWORK ESTIMATE

NORTH BERM

544 SF/FT X 545 FT = 296,480/27 = 10,980 CY

SHORT NORTH-SOUTH BERMS

544 SF/FT X 3 X 100 FT = 163,200/27 = 6,044 CY

FUTURE BERMS

SOUTH BERM

544 SF/FT X 545 FT = 296,480/27 = 10,980 CY

NORTH-SOUTH BERMS

544 SF/FT X 3 X 200 FT = 326,400/27 = 12,089 CY

TOTAL FUTURE BERMS = 23,069 CY

*NOTE: THIS SITE APPLICATION IS REPLACED BY THE REVISE BINDER DATED JAN 31, 1995. THIS BINDER IS FOR REFERENCE ONLY.

Carmen Johnson
94-04

Fac/Perm/Co ID # | Date | Doc ID# | DIN

SITE APPLICATION REPORT

FOR

PROPOSED

CONSTRUCTION AND DEMOLITION WASTE LANDFILL
AND TIRE MONOFILL

FOR

COUNTY OF WASHINGTON

FOR REVIEW ONLY

PRINTED

NOV 11 1994

ON

NORTH CAROLINA PROFESSIONAL SEAL 13371 ENGINEER ALAN R. HEITH

Alan R. Heith
10/31/94

Prepared by:

Diehl & Phillips, P.A.
Consulting Engineers
219 E. Chatham Street
Cary, NC 27511

SITE APPLICATION REPORT

FOR

PROPOSED

CONSTRUCTION AND DEMOLITION WASTE LANDFILL
AND TIRE MONOFILL

FOR

COUNTY OF WASHINGTON

NORTH CAROLINA
PROFESSIONAL
SEAL
13371
ENGINEER
ALAN R. KEITH

Alan R. Keith
10/31/94

Prepared by:

Diehl & Phillips, P.A.
Consulting Engineers
219 E. Chatham Street
Cary, NC 27511

1.0 GENERAL:

The County of Washington currently owns a 71 acre tract adjacent to the closed Washington County landfill, off NC 308 near Roper, NC. The proposed site is partially wooded and has been used as a borrow site for cover soil and a portion of the site is currently in use as a land clearing and inert debris disposal area. The County of Washington proposes to develop this site as a construction and demolition waste landfill and a tire monofill. This report and accompanying materials constitutes a site application for the proposed landfill.

2.0 LOCATION AND SURROUNDING AREA:

Accompanying this report is a plan set including details on the site, surrounding area, and special features. Sheet 1 is a map at a scale of 1-inch equals 400 feet showing the area within ¼ mile of the site boundary as required by North Carolina Solid Waste Management Rules 15A NCAC 13B (Rules) section .0504(1a).

The proposed site abuts the wetlands bordering the Roanoke River and Albemarle Sound. Only agricultural land and woodland are adjacent to the site. Washington County does not have a zoning ordinance, therefore, zoning is not shown. Existing drainage canals are shown. The 100 year flood level in the vicinity is elevation 8 MSL which will cover a portion of the site. Excerpts from Federal Emergency Management Agency maps are included in the Appendix for flood information.

Sheet 2 of the plan set is a map at a scale of 1-inch equals 1,000 feet showing the area within 2 miles of the site as required by section .0504(1b) of the Rules. Groundwater use in the vicinity is limited to residential wells and wells for corp irrigation. No surface water intakes are within 2 miles of the site. There are some swine, poultry and agricultural operations nearby. There are no residential subdivisions or airports within 2 miles of the site. Also included in the Appendix is an aerial photograph at a scale of 1-inch equals 2,000 feet showing the area surrounding the site.

3.0 Geological and Hydrological Study

Included with this report is the "Geological and Hydrologic Report - Proposed Washington County C&D Debris Landfill - Washington County, NC" by S&ME, Inc. covering the requirements of Section .0504(1c) of the Rules.

4.0 Conceptual Design

The proposed facility will be constructed largely above ground. The subsurface investigation for the site indicates the water table is very near the ground surface. In order to maintain buffer distance between the waste and the water table, landfilling will occur above ground.

The County utilized process silica or alum mud to construct berms in 1991 to enclose the sanitary landfill vertical expansion adjacent to

the proposed site. The process silica is an industrial byproduct of alum production at a Cytec Industries plant in Plymouth, NC. Washington County has between 15,000 and 20,000 cubic yards of processed silica stockpiled on the existing landfill site.

Berms approximately 15 feet high were successfully constructed for the sanitary landfill vertical expansion which closed in October, 1994. Similar berms are proposed to enclose the C&D landfill and tire monofill. Law Engineering performed slope stability analyses for the processed silica berms which were approved by the NC Division of Solid Waste Management with the Washington County Amendment to Permit - Vertical Expansion in 1991. A copy of the slope stability analysis is included in the Appendix. Sheet 4 of the accompanying plan set illustrates the proposed berms.

The stockpiled processed silica will be utilized to construct the northern berm of the landfill. Three shorter berms will be constructed perpendicular to the north berm to separate the C&D waste from tires and to confine the waste. Landfilling will begin against the north berm proceeding across the entire face of the berm in lifts approximately 5-feet high. The first lift of waste cells will proceed to the end of the short north-south berms. Upon completion of the first lift, a second lift will start against the north berm working to the south followed by a third lift. The tire monofill will proceed similarly.

Closure of the C&D area and the tire monofill could be accomplished at any time. The working face will be sloped for drainage away from previously filled area. Final capping per State Rules would fully close the landfill.

Should permitting allow continuation of the landfill/monofill, the three north-south berms could be extended from the initially constructed berms to provide more landfill volume. Alum production continues at Cytec, therefore processed silica is currently produced. With State and County approval, additional processed silica could be used for additional berm construction. Otherwise native soils would be utilized as practical for berm construction.

Operation of the C&D area and tire monofill will require cover soils. Native soils will be used for cover material. Borrow areas east and west of the landfill/monofill will be excavated for cover material. Borrow areas are indicated on sheet 3 of the accompanying plan set. Approximate earthwork calculations are included in the Appendix. Suitable erosion control measures would be provided to control sedimentation. Monitoring wells will be provided for compliance with groundwater regulations. Existing scales will be used to track waste received by the facility. Buffers of at least 200-feet from the property line to waste areas will be maintained.

5.0 Local Government Approval

A copy of a resolution by the Washington County Commissioners is included in the Appendix illustrating their willingness to provide the proposed facility. The facility is not located in or near a

municipality, therefore the County has jurisdiction. Also included is a letter stating that there is no County zoning ordinance in effect.

6.0 Siting Criteria Met

Section .0503(1) of the Solid Waste Management Rules covers criteria for siting of new landfills. As discussed in Section 2.0 the 100-year flood does cover part of the site. However, wastes will be placed outside the flood zone.

Attached in the Appendix is a copy of a report from Soil & Environmental Consultants entitled "Preliminary Endangered Species and Wetlands Surveys." This report notes that no endangered species habitats were found on the site. Bald eagles and sea turtles are federally listed species for Washington County. The site does not have shoreline access for sea turtles nor trees suitable for Bald eagle nests.

Attached in the Appendix is a copy of a report by Archaeological Research Consultants, Inc. entitled "An Archaeological Survey of the Proposed Washington County Landfill". The report notes that one historic-period archaeological site with a minor prehistoric component was discovered. The site was found to be disturbed and therefore is not recommended for additional archaeological work.

There are no State Parks, recreation areas, scenic areas, nature or historic preserves in the immediate vicinity of the site. There are no airports within 10,000 feet of the site. Cover soils are available from borrow sites within the 71 acre tract. Earthwork calculations are included in the Appendix.

7.0 Landfill Data

The proposed construction and demolition waste landfill and tire monofill will serve the residents of Washington County North Carolina. Population data from the NC Department of Administration for Washington County is as follows:

YEAR	WASHINGTON COUNTY POPULATION
1970	14,038
1980	14,801
1990	13,997
2000	13,205
2010	12,408
2020	11,470

Municipal solid waste from Washington County is currently disposed of at the regional privately owned facility in Bertie County. Municipal waste will continue to be disposed of out of the County, at least for the length of the County's current contract. The existing County landfill is closed and will not receive any waste. The existing Washington County land clearing and inert debris disposal (LCID) area will continue to receive waste in the future. White goods and other recyclables are stored near the existing landfill offices until they are removed for recycling offsite. Recycling will continue in the future.

The facility proposed will dispose of wastes classified as construction and demolition wastes and used tires in separate areas. Material from building demolition, remodeling, repair, etc. are the types of material proposed for C&D disposal. Stumps and other land clearing waste would be disposed in the existing LCID area. Used tires would be disposed in the tire monofill. The County has a tire slicer to reduce the volume of the tires in the monofill.

County records collected prior to closure of the old landfill showed C&D waste receipts at approximately 50 to 75 tons per month or an annual receipt of approximately 750 tons. Since Washington County's population will not increase according to projections, it is assumed that the recorded volume would continue after the new C&D landfill is opened. Tires are currently collected and stored at the landfill for shipment to a tire recycler. Tire receipts are approximately 30,000 pounds per month at the landfill. Again this volume would be assumed to continue after opening a tire monofill.

Monthly waste volume estimates tributary to the landfill are assumed as follows:

C&D Waste:

$$75 \text{ Tons} \times \frac{2{,}000 \text{ Lbs.}}{\text{Tons}} \times \frac{\frac{1}{50} \text{ Lbs}}{\text{Cu.Ft.}} = 3{,}000 \text{ Cu.FT./Month}$$

or a 50' X 20' X 3' waste cell per month

Tires:

$$\frac{30{,}000 \text{ Lbs.}}{\text{Month}} \times \frac{\frac{1}{30} \text{ Lbs}}{\text{Cu.Ft.}} = 1{,}000 \text{ Cu.FT./Month}$$

or a 50' X 10' X 2' waste cell per month

Phase 1 of the proposed landfill (initially constructed berms) would confine approximately 300,000 cubic feet in the C&D area and 175,000 cubic feet in the tire monofill area. Allowing for daily cover, waste volume available is assumed to be approximately 270,000 cubic feet for C&D and 160,000 cubic feet for tires. Life of Phase 1 C&D and tire

monofill is estimated at approximately seven years maximum for C&D and 13 years (maximum) for tires.

Cover requirements are estimated at 3,600 cubic yards for daily cover and miscellaneous fill dirt for Phase 1 C&D and approximately 2,800 Cubic yards for the tire monofill Phase 1. Should the landfill continue in operation, an additional 7,500 cubic yards for C&D cover and 6,000 cubic yards for tires would ultimately be required not counting final cap or additional berm construction. The final cap for Phase 1, assuming a 2-foot thickness would require approximately 6,000 cubic yards of material with another 12,000 cubic yards to complete the landfill cap for future phases.

The County currently has the following equipment for use at the landfill:

> One (1) Caterpillar 953 tracked loader, one (1) Caterpillar D8 bulldozer, one (1) Dragline, one (1) Tandem dump truck, one (1) Tractor with implements, and one (1) Pick-up Truck.

The County successfully operated the old landfill for nearly seven years. The landfill personnel have considerable experience in earthmoving and landfill operation.

Sheet 4 of the accompanying plan set shows the proposed monitoring well locations for the new landfill. Groundwater movement as determined in the hydrologic site study is generally south to north. One up-gradient well is proposed along with three down-gradient wells.

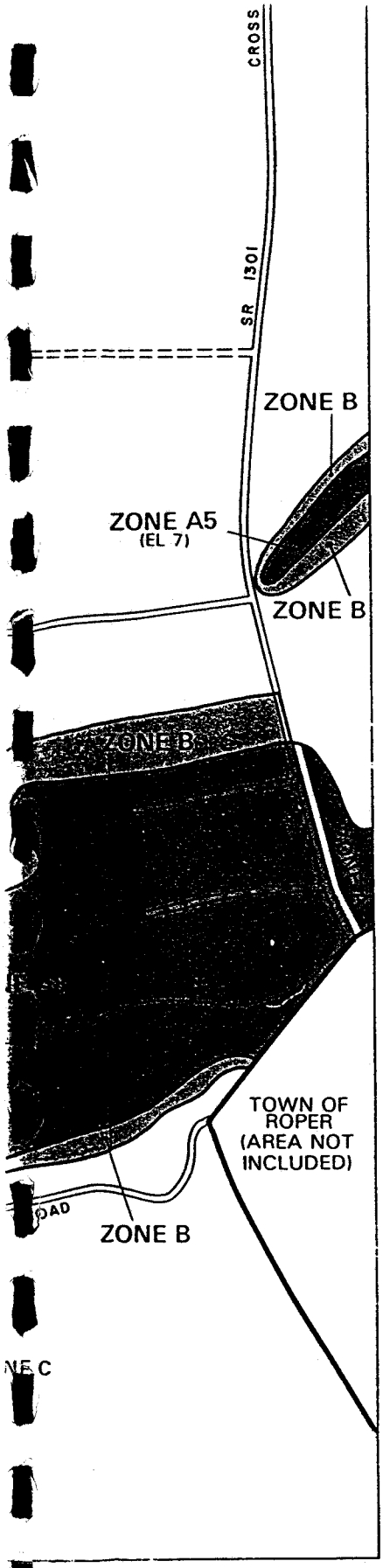
8.0 Conclusion

The proposed landfill is sited in a remote rural area adjacent to an existing closed landfill. Groundwater movement from the proposed site is directly toward wetlands and a large body of water. There is no existing or proposed development in the vicinity of the landfill. Large buffers (>200') can be maintained between the landfill site and the property lines which are controlled by the County. A buffer of over 1,000 feet would exist between the closed sanitary landfill and the tire monofill. Adequate cover soil is available on site. Access to the site is controlled. The County has existing scales, office, and equipment in place to serve the proposed facility. County personnel have extensive experience in operating the type of facility proposed.

Washington County has a need for a facility to dispose of construction and demolition wastes and used tires. The County currently pays to have waste shipped out of the County. Many of the components necessary to construct and operate a C&D waste facility are already in place at the site. The site is well suited for the proposed use. Therefore, the County feels proceeding with construction of a C&D landfill and a tire monofill are warranted.

APPENDIX

Excerpts from
Federal Emergency Management Agency (FEMA) Maps
for Washington County



To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620.

APPROXIMATE SCALE

1000 0 1000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

WASHINGTON COUNTY, NORTH CAROLINA

(UNINCORPORATED AREAS)

PANEL 45 OF 350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

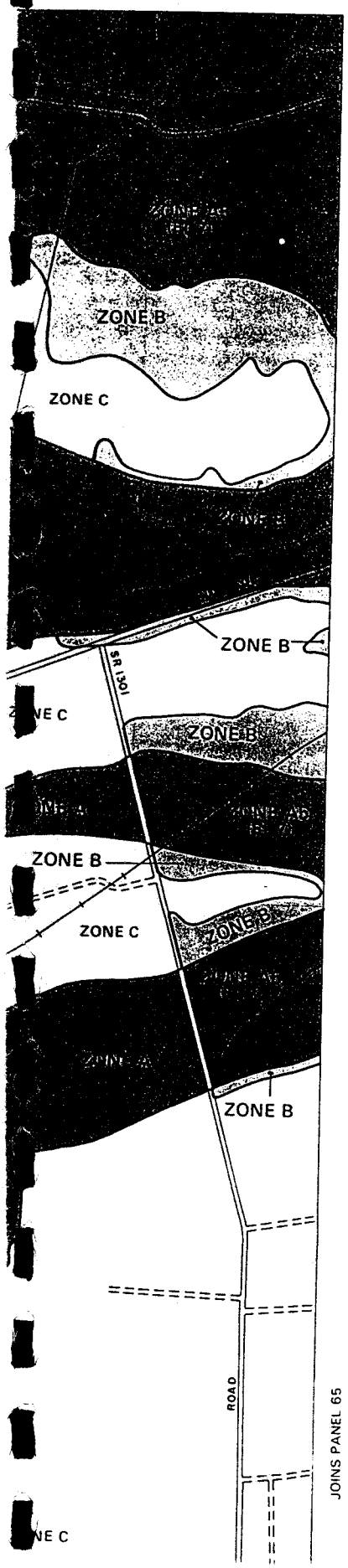
COMMUNITY-PANEL NUMBER

370247 0045 B

EFFECTIVE DATE:

AUGUST 19, 1985

Federal Emergency Management Agency



KEY TO MAP

500-Year Flood Boundary	
100-Year Flood Boundary	
Zone Designations*	ZONE B / ZONE B
100-Year Flood Boundary	
500-Year Flood Boundary	
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
Zone D Boundary	
River Mile	•M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (Zones A and V) may be protected by flood control structures.

This map is for flood insurance and flood plain management purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

The coastal flooding elevations shown may include the effects of wave action and may differ significantly from those developed by the National Weather Service for hurricane evacuation planning. Coastal base flood elevations apply only landward of the shoreline shown on this map.

For adjoining map panels, see separately printed Map Index.

INITIAL IDENTIFICATION:

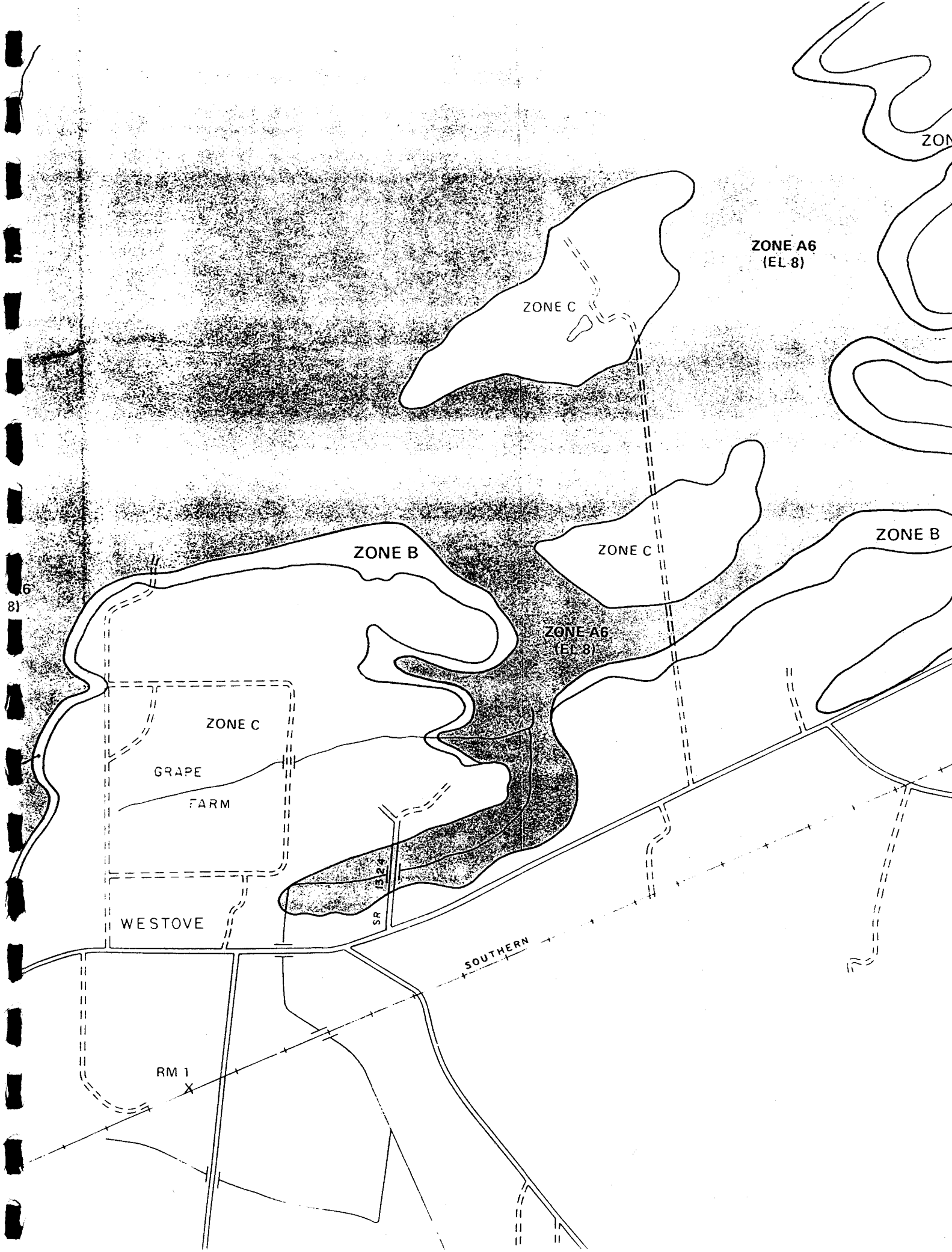
JUNE 9, 1978

FLOOD HAZARD BOUNDARY MAP REVISIONS:

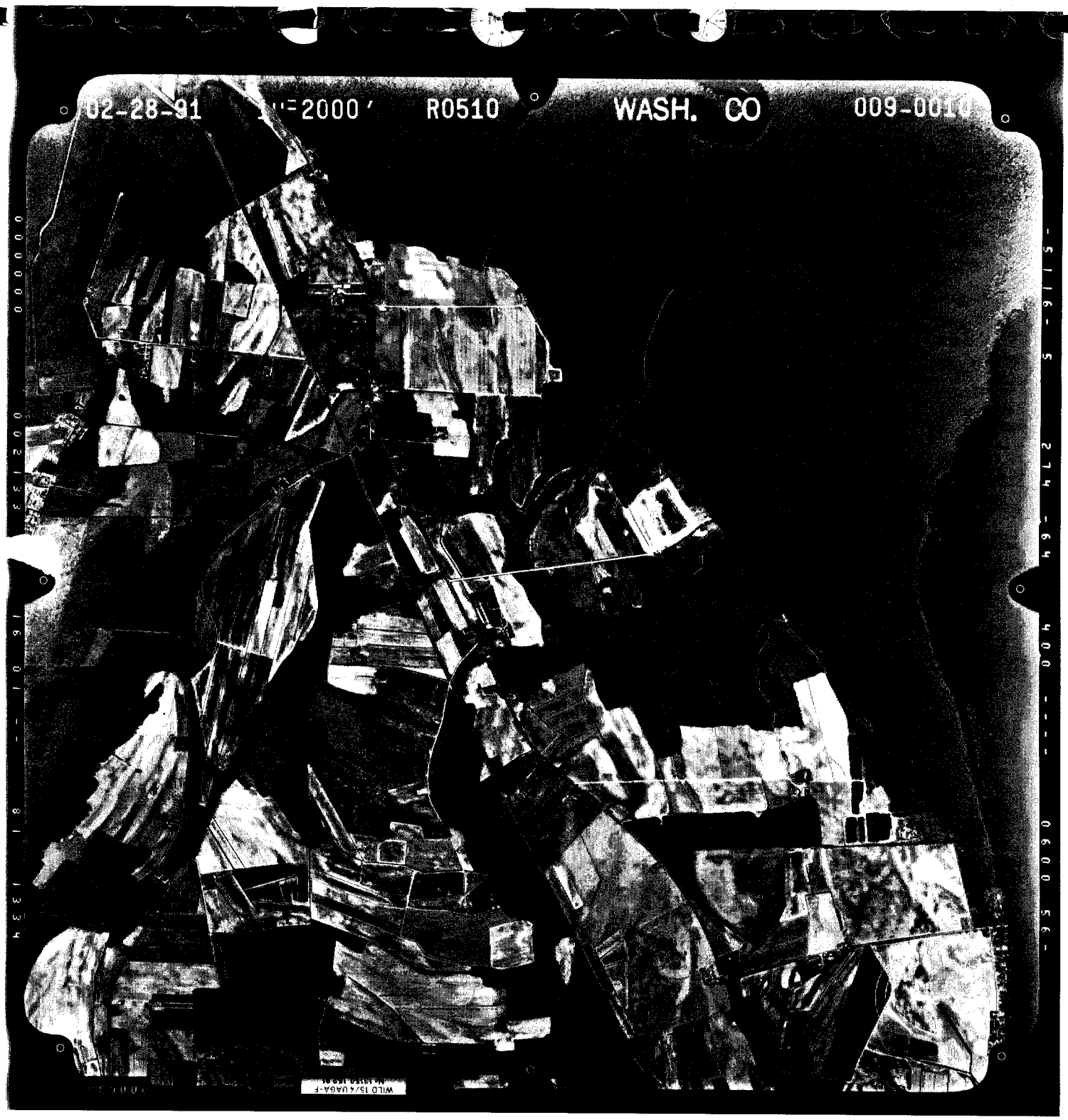
FLOOD INSURANCE RATE MAP EFFECTIVE:

AUGUST 19, 1985

FLOOD INSURANCE RATE MAP REVISIONS:


ZONE A6
(EL 8)
ZONE C
ZONE B
ZONE C
ZONE B
ZONE A6
(EL 8)
ZONE C
GRAPE
FARM
WESTOVE
SR 1324
SOUTHERN
RM 1

Aerial Photograph
Washington County Landfill and
Surrounding Area


02-28-91
1"=2000'
R0510
WASH. CO
009-0010

GEOLOGIC AND HYDROLOGIC REPORT
PROPOSED WASHINGTON COUNTY
C&D DEBRIS LANDFILL
WASHINGTON COUNTY, N.C.

S&ME, Inc. Project No. 1054-94-119

Prepared for:

Diehl and Phillips, P. A.
Consulting Engineers
219 E. Chatham street
Cary, NC 27511

Prepared By:

S&ME, Inc.
3100 Spring Forest Road (27604)
P.O. Box 58069
Raleigh, North Carolina 27658-8069

April 1994

S&ME

April, 18, 1993

Diehl and Phillips, P.A.
Consulting Engineers
219 E. Chatham Street
Cary, N.C. 27511

Attention: Mr. Alan Keith

Reference: Geologic and Hydrologic Report
Proposed Washington County C&D Landfill
Washington County, N.C.
S&ME Inc. Project No. 1054-94-119

Dear Mr. Keith,

S&ME, Inc. has completed the geologic and hydrologic study of the 71 acre site located adjacent to the existing Washington County Landfill. Our report follows this letter. The report describes the activities performed during the study, discusses the findings of the study, and presents our preliminary recommendations.

In summary, the site appears to be favorable for construction of the proposed C&D debris landfill. The site is typical of the Coastal Plain, it is underlain by unconsolidated soil materials to a depth of greater than 50 feet. These materials consist of sands and clayey to sandy silts.

No unusual geologic conditions were observed in the vicinity of the site that would restrict siting of the landfill. A shallow groundwater table and designated wetland areas will control the actual siting. Since groundwater occurs at a relatively shallow depth across

S&ME, Inc. 3100 Spring Forest Road, Raleigh, North Carolina 27604, (919) 872-2660, Fax (919) 790-9827
Mailing address: P.O. Box 58069, Raleigh, North Carolina 27658-8069

Printed on Recycled Paper

the site, landfill cell embeddment depths will be negligible. Groundwater flow is towards the north.

Groundwater quality and water table level are influenced by the existing landfill in the extreme northwestern corner of the site. In order to adequately monitor the new landfill, it should be located as far east as practical, leaving a buffer of several hundred feet between the new construction and the existing landfill. The conceptual plans discussed during our previous meeting would appear to allow a sufficient buffer for monitoring.

The results of the borrow investigation look favorable. Based on the test pit data, the clayey soils appear to be present in sufficient quantity for use as final cover. Laboratory permeability testing performed on remolded samples indicate the material, when adequately compacted, will have sufficiently low permeability characteristics to be used for construction. Preliminary information for the borrow investigation has been forwarded to you previously. The final report will be forwarded to you shortly. Please review the attached report and call us at (919) 872-2660 if you have any questions.

S&ME appreciates the opportunity to assist Diehl and Phillips during this phase of landfill development.

Sincerely,

S&ME, Inc.

for James N. Johnston
Environmental Engineer/Hydrogeologist

Walter J. Beckwith, P.G.
Senior Project Geologist

TABLE OF CONTENTS

PAGE #

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 2
- 2.1 SITE LOCATION 2
- 2.2 PROJECT BACKGROUND 2
- 2.3 CURRENT SITE USAGE 3

3.0 PURPOSE AND SCOPE 4
- 3.1 PURPOSE 4
- 3.2 SCOPE OF WORK 4

4.0 INVESTIGATIVE PROCEDURES 6
- 4.1 SUBSURFACE INVESTIGATION 6
  - 4.1.1 Soil Test Borings 6
  - 4.1.2 Soil Headspace Analysis 7
  - 4.1.3 Piezometer Installation 7
  - 4.1.4 Hand Auger Borings 8
  - 4.1.5 Site Traverse 8
- 4.2 AQUIFER TESTS 9
- 4.3 LABORATORY PROCEDURES 9

5.0 PHYSIOGRAPHY AND HYDROGEOLOGY 10
- 5.1 PHYSIOGRAPHY 10
- 5.2 GEOLOGY 10
- 5.3 HYDROGEOLOGY 11
  - 5.3.1 Stratigraphic Sequence 11
  - 5.3.2 Groundwater Occurrence 12
- 5.4 SITE TOPOGRAPHY AND SURFACE DRAINAGE 12
  - 5.4.1 Site Topography 12
  - 5.4.2 Site Drainage 12
- 5.5 SITE LITHOLOGY 13
- 5.6 SITE HYDROGEOLOGY 15
- 5.7 GROUNDWATER 15
  - 5.7.1 Shallow Water Table Aquifer 15
  - 5.7.2 Deep Potentiometric Surface 16
- 5.8 Hydraulic Conductivity of the Surficial Aquifer 16
  - 5.8.1 Upper Sands 17
  - 5.8.2 Upper Clay 17
  - 5.8.3 Underlying Silts 18
- 5.9 GROUNDWATER MOVEMENT 18

6.0 SOIL CONSERVATION SERVICE SOIL MAPPING 20

7.0 ANALYTICAL RESULTS 21
7.1 OVA ANALYSIS OF SOIL SAMPLES 21
7.2 LABORATORY DETERMINATION OF SOIL PROPERTIES 21
7.2.1 Site Soil Classification Groupings 22
7.2.2 Grain Size Determinations 22
7.2.3 Natural Moisture Content 23
7.2.4 Porosity 23
7.2.5 Laboratory Permeability 23

8.0 SITE SUITABILITY 24
8.1 SUITABILITY OF THE SITE 24
8.2 MONITORING OF SURFACE AND GROUNDWATER 24
8.2.1 Groundwater Monitoring 25
8.3 GEOLOGIC LOCATION RESTRICTIONS 25
8.3.1 Faults 26
8.3.2 Seismically Active Zones 26
8.3.3 Unstable Areas 27

REFERENCES 28

TABLES

Table 1	Piezometer & Boring Locations
Table 2	Summary of Water Level Readings
Table 3	Hydraulic Conductivity from In-situ measurements
Table 4	Hydraulic Conductivity from Grain Size
Table 5	Selected 505 Soil Characteristics
Table 6	Summary of OVA Data
Table 7	Summary of Laboratory Classification Tests

FIGURES

Figure 1	Site Map
Figure 2	Geologic Section 1
Figure 3	Geologic Section 2
Figure 4	Geologic Section 3
Figure 5	Geologic Section 4
Figure 6	Geologic Section 5
Figure 7	Shallow Potientric Map
Figure 8	Deep Potentiometric Map
Figure 9	Fault Map
Figure 10	Seismic Hazard Map

APPENDICES

Appendix I	Boring Records
Appendix II	Laboratory Test Records
Appendix III	Aquifer Test Records
Appendix IV	Other Documents

1.0 EXECUTIVE SUMMARY

S&ME, Inc. (S&ME) was authorized by Diehl and Phillips, P.A., in January 1994, to perform a hydrogeologic study of a 71 acre site proposed for construction of a Construction and Demolition (C&D) debris landfill for Washington County. Seven soil test borings were drilled on the site to classify the subsurface geology. Eleven piezometers were installed to determine the depth to groundwater. Selected soil samples were submitted for laboratory analysis for determination of their engineering properties and to confirm visual classifications.

Based on the preliminary subsurface information developed for this site, the site appears favorable for construction of the C&D debris landfill.

- Site conditions are typical of the Tidewater Region of North Carolina. Sandy soils are predominant at the ground surface. They are underlain by predominantly sandy and clayey silts.

- The depth to groundwater varies from less than 1 foot to 7 feet below the ground surface. Shallowest depths were found within portions of the site that have been previously used as a source of borrow soils. Groundwater flow is primarily to the north toward the wetland fringe of the Albemarle Sound.

- Soil permeability ranges from approximately 5×10^{-6} cm/sec in the near surface clays to approximately 1×10^{-2} cm/sec in the near surface sands. Underlying silts average approximately 2×10^{-5} cm/sec.

- No evidence of geologic location restrictions, such as faults or unstable soils, were found in the site area. The site is not located within a Seismic Impact area.

- Site conditions should allow adequate monitoring of surface and groundwater around the proposed landfill,since the existing landfill has resulted in an impact to groundwater in the vicinity of the northwest corner of the property. The new landfill should be located as far east as practical to allow adequate buffer between the two landfills for groundwater monitoring.

- The relatively shallow depth to groundwater will allow negligible cell embeddment in order to maintain acceptable separation between the waste and the seasonal high water table.

- Suitable borrow soils are available off-site for landfill cover.

2.0 INTRODUCTION

S&ME has completed the geologic and hydrologic study of the 71 acre site proposed for construction of a Construction and Demolition (C&D) debris landfill for Washington County. The study was authorized by Diehl and Phillips, P.A., who are under contract with Washington County to design the landfill.

2.1 SITE LOCATION

The existing facilities are located in northern Washington County north of N.C. highway 308 between Plymouth and Roper, North Carolina. The study area, proposed for construction of the C&D debris landfill, is located immediately east of the existing landfill. The site is bounded to the north by the wooded wetland fringe of the Albemarle Sound. It is bounded to the east and south by privately owned, wooded, undeveloped property. Access to the existing facility is provided by a 3,700 foot graveled road off of N.C. highway 308. A vicinity map showing the location of the site with respect to the Plymouth, North Carolina area is included in the application.

2.2 PROJECT BACKGROUND

Washington County is currently in the process of closing the county's existing sanitary waste landfill located adjacent to (west of) the proposed site. At the present time, the county's refuse is being landfilled outside the county. It is desirable to landfill the county's C&D waste within Washington County to reduce costs. The proposed facility would utilize the existing access road, security gate, earth moving equipment and scale house. There are no residences within 2,000 feet of the site at the present time. Surrounding property is either undeveloped or in cultivation.

2.3 CURRENT SITE USAGE

The current landfill facilities include several completed (closed) landfill cells, a soil stockpile, a processed silica stockpile, truck scales, and a scale house. Photographs showing the existing facilities are included with the application.

Approximately 25 percent of the proposed site has previously been used as a source of borrow soils, both by the landfill for cover material, and previously, by the North Carolina Department of Transportation during the improvements to US Highway 64 near Plymouth, N.C.

Most of the area used for borrow has been excavated to the water table. Standing water was observed in the west-central portion of the site. This water drains to the north through an excavated ditch. Leachate seepage was noted over a broad area west of the ditch.

Within the undisturbed portions of the site, the ground surface is elevated slightly above the surrounding land. In general, most of the land adjacent to the site boundaries is poorly drained and wooded. With the exception of the northwest corner of the site and a fringe along the existing landfill, the entire site has been timbered in the past and is now covered with a thick stand of immature hardwoods and underbrush.

3.0 PURPOSE AND SCOPE

3.1 PURPOSE

S&ME was retained by Diehl and Phillips, P.A., to determine the geologic and hydrogeologic setting of the site. The purpose of the study was to determine the general subsurface conditions within the 71 acre tract proposed for construction as required by the State of North Carolina Waste Management Rules - 15A NCAC 13B, as amended through January 4, 1994. Specifically, Section .504 (1) (c) i-iv and (g); Section .1622 (4, 5, and 6); and Section .1623 (a) (1 through 13) as they apply to general site studies for site application of a landfill construction permit. The findings, summarized in this report, will be included with the application and will be used for to provide preliminary information for design of the landfill.

3.2 SCOPE OF WORK

The scope of work consisted of the following tasks:

- Performance of a site reconnaissance to locate boring positions.
- Installation of seven soil borings. Borings not used for piezometer construction were to be abandoned by grouting at the completion of drilling in accordance with N.C. Well Abandonment Regulations.
- Installation of eleven piezometers to evaluate groundwater levels across the site and to establish aquifer characteristics through field tests.
- Determination of water levels in the wells and piezometers at intervals of 24 hours and seven (7) days following installation.
- Performance of laboratory classification testing and permeability testing on selected soil samples.

Realizing that insufficient fine grained soils exist within the site for reuse as cover material,

Diehl and Phillips authorized completion of an off-site borrow evaluation. The results of the Borrow Study is contained in a separate report.

4.0 INVESTIGATIVE PROCEDURES

4.1 SUBSURFACE INVESTIGATION

The following paragraphs describe the activities associated with the investigation of the 71 acre tract of land proposed for construction of a C&D debris landfill. The work included the drilling of seven soil borings, 11 temporary piezometer installations, aquifer testing, and a traverse of the property.

4.1.1 Soil Test Borings

Seven (7) soil test borings, B-1 through B-7, were drilled at the approximate locations shown on Figure 1. The borings were located in the field by S&ME personnel using existing landmarks and site topography as references. Upon completion of the drilling, the locations were surveyed to establish the actual boring locations and to provide elevation data. The surveying was performed by Roanoke Land Surveying of Williamston, N.C. in February, 1994. The location of the borings/piezometers are shown in Figure 1. (The figures can be found in this report following the text.) The location coordinates are summarized in Table 1.

The borings were performed using a CME 450 drill rig mounted on an all-terrain vehicle. Access improvements to the site were accomplished with Washington County landfill equipment and personnel. All of the borings were advanced to a termination depth of 50 feet below the land surface.

A combination of hollow stem auger and wet rotary drilling methods were used to advance the borings. The augers were advanced to each sample interval. Accumulated sand and sediment was removed from the augers, prior to sampling, by washing the

accumulated material from the augers with the drill rod and water obtained from the site.

Standard Penetration Tests were performed at selected intervals during the drilling in accordance with ASTM D-I586-67 to provide an index for estimating soil strength and relative density. The samples were visually classified in the field according to the Unified Soil Classification System. Portions of the samples were scanned with an Organic Vapor Analyzer (OVA) for the presence of volatile compounds in the soil. The remaining portions of each sample were placed in jars for possible laboratory testing.

Several undisturbed (Shelby Tube) samples were obtained during the drilling for possible laboratory permeability testing. Bulk samples were not obtained as construction will utilize off-site borrow source for cover soils. The results of the borrow investigation are contained in a separate report.

4.1.2 Soil Headspace Analysis

Portions of each recovered split spoon sample were placed in resealable plastic bags and sealed. The sealed bag was kneaded to facilitate volatilization of any compounds present in the soil. After allowing the headspace within the bag to stabilize, the bag was pierced with the tip of an Organic Vapor Analyzer (OVA) to determine the presence and concentration of volatile compounds contained in the soil. As methane is detected as a volatile compound, the OVA can be used to evaluate soil for accumulations of landfill derived methane.

4.1.3 Piezometer Installation

Eleven (11) temporary piezometers were installed to determine stabilized groundwater levels across the site and to perform in-situ permeability testing of the surficial aquifer. Four deep piezometers were installed in borings, B-1, B-2, B-4 and B-5, at the completion

of drilling. Seven shallow piezometers were installed in shallow off-set borings located adjacent to the soil test borings.

The piezometers were constructed of 1.25-inch schedule 40 PVC flush threaded casing and .010" slotted screen. Ten foot (10') screen lengths were utilized for the piezometers. The well materials were installed through the augers. Filter sand was placed in the annular space between the outside of the screen and the boreholes as the augers were withdrawn. The sand was placed to a level above the screen. The top of the sand was sealed with several feet of hydrated bentonite pellets. The remaining portion of the borehole was filled with cuttings.

With the exception of SP-4, the screens for all of the other shallow piezometers were set at a depth of 10 to 20 feet. SP-4 was set from 28 to 38 feet. Construction of the shallow piezometers utilized the same procedures as the deep piezometers.

Borings, that were not converted to piezometers (B-3, B-6, and B-7) were grouted with neat cement grout at the completion of drilling.

4.1.4 Hand Auger Borings

Two hand auger borings, HA-1 and HA-2, were advanced at the site to determine near surface soil conditions, establish the depth to water and to obtain additional materials for laboratory testing. HA-1 was located at the northeast corner of the site within the excavated portion (borrow area) of the site. HA-2 was located in the center of the site.

4.1.5 Site Traverse

A transverse of the site was performed to locate any unusual site conditions such as springs (groundwater discharge points) and any potentially soft or unstable areas.

4.2 AQUIFER TESTS

In-situ permeability (slug) testing was performed in all of the piezometers. The tests were performed by quickly adding one gallon of distilled water to the piezometer casing and monitoring the recovery rate of the piezometer with a pressure transducer. The pressure transducer was attached to a data recorder which recorded the drop in water level in the piezometer during its recovery. The data was filtered and evaluated using the Bouwer and Rice Approximation to estimate Hydraulic Conductivity (K).

4.3 LABORATORY PROCEDURES

The laboratory procedures utilized for the tests performed on soil samples obtained during the study are listed below according to the American Society of Test Methods (ASTM) test number designation.

Selected Standard Penetration Test (SPT) samples were submitted for classification testing to confirm the visual classifications made in the field, to establish variability of soils within each of the geologic units, and to establish the engineering properties of the site soils. These tests included:

- Grain Size Determination, with Hydrometer Analysis of Fines ASTM D-422.
- Natural Moisture Content ASTM D-2216.
- Plasticity Indices (Atterburg Limits) ASTM D-4318.
- Falling Head Permeability Test ASTM D-5084 (Method C)

5.0 PHYSIOGRAPHY AND HYDROGEOLOGY

5.1 PHYSIOGRAPHY

North Carolina is divided into three provinces, based on the physiographic changes of the land mass that occur from the coast to the mountains. These provinces include: the Coastal Plain, Piedmont, and Blue Ridge.

The Coastal Plain Province, located along the eastern third of the state, consists of two natural divisions, the easternmost or Tidewater region is characterized by flat to subdued topography and in many areas, poorly drained soils. The western half of the Coastal Plain is higher in elevation, with gently rolling topography, and is generally better drained than the Tidewater.

Washington County is located within the Tidewater region of the Coastal Plain Physiographic Province of North Carolina. The Coastal Plain region has been formed during past transgressive and regressive changes in sea level. As such, the topography is relatively flat.

5.2 GEOLOGY

The Coastal Plain Region has formed through deposition of an eastward thickening wedge of sediments on crystalline bedrock. The sediments consist of interbedded sands and clays, limestone, sandstone and calcareous clays.

Within the site area, the sediments dip to the east-southeast. The total thickness of the sequence of sediments is estimated to be between 1500 and 2000 feet thick in the Plymouth, N.C. area(Lawrence and Hoffman, 1993).

5.3 HYDROGEOLOGY

The thick series of sediments present within the Coastal Plain can be divided into separate formations or aquifers according to the age of their deposition and according to the characteristics of the groundwater contained within each formation.

5.3.1 Stratigraphic Sequence

Surficial soils in the region consist of a series of undifferentiated deposits of marine, fluvial, eolian, and lacustrine environments formed over the past two million years. These deposits generally consist of fine-grained sands with interbedded clays. The undifferented deposits have a thickness of between 30 and 50 feet.

The Yorktown formation is present beneath the undifferentiated surficial deposits. The Yorktown formation typically consists of gray clayey sands and silty clays with interbedded shell material. The Yorktown extends to a depth of approximately 95 to 100 feet below existing ground surface.

The Pungo River formation exists beneath the Yorktown formation. This formation consists of phosphatic sands and thin shell limestone beds. The Pungo River formation extends to a depth of approximately 110 to 115 feet below the existing ground surface and lies unconformably on the Castle Hayne limestone.

The Castle Hayne formation consists largely of loose to poorly consolidated light gray fossiliferous limestone. The limestone is usually quite fossiliferous and in many places is composed predominantly of shell material.

5.3.2 Groundwater Occurrence

There are three aquifers of interest present in the Plymouth, N.C. area: the surficial aquifer (water table aquifer),the Yorktown Formation, and the underlying Castle Hayne aquifer. Domestic water supplies can be obtained from all three aquifers. Most water supplies in the plymouth area are obtain water from the Castle Hayne formation. There are no known water supply wells located within 2000 feet of the landfill.

5.4 SITE TOPOGRAPHY AND SURFACE DRAINAGE

5.4.1 Site Topography

The proposed C&D landfill site is characterized by relatively flat topography that gradually slopes downward to the north and south from an east-west ridge or divide that bisects the site. The eastern and northeastern boundaries of the property are adjacent to wooded wetland areas. There is roughly 8 feet of relief across the site. Highest elevations occur at about 12 feet above mean sea level (MSL) in the central portion of the site. Lowest elevations occur along the wetland fringes and within the areas of the site that have been utilized in the past for borrow materials.

5.4.2 Site Drainage

The site is located within the drainage basin of the Roanoke River as it enters the Albemarle Sound. The central portion of the site is elevated above the surrounding ground surface and tends to drain radially. The east portion of the site has been excavated to just above the water table. During the time of the investigation, site drainage within this area of the site was to the north via an excavated ditch emptying into the wetland area north of the site.

Seepage was noted over a broad area along the western property boundary, adjacent to the existing landfill. The seepage appeared to be impacted by landfill leachate. The excavated ditch tends to create a drainage divide separating the proposed site from the existing landfill.

5.5 SITE LITHOLOGY

The borings encountered four stratigraphic units at the site. Simply, the stratigraphic sequence present within 50 feet of the ground surface consists of 20 to 28 feet of relatively clean sand containing an interbedded gray silty clay. These units rest on fine grained silts containing interbedded silty sand and clay, that in turn, rest on the clays and silts of the Yorktown formation.

The boring and piezometer locations and the position of the five geologic sections through the site are shown on Figure 1. The generalized lithology is illustrated in on the Geologic Sections included as Figures 2 through 6. Soil symbols for the sections are shown opposite the section. Actual conditions encountered at the test borings are shown on the Test Boring Records included in Appendix I. The following paragraphs describe the simplified lithology of the site.

The surficial soils generally consist of approximately 6 inches of organically stained sandy topsoil. At B-4, the surface soils were highly organic (muck), more characteristic of wetland areas north of the site. Topsoil materials were not encountered at B-1, as the upper soils have been removed at this location.

The topsoil horizon is underlain by 15 to 28 feet of relatively clean light brown, orange, to tan sands containing one or more clay interbeds. Near the ground surface, the sands are fine-grained. They tend to coarsen with depth, to medium to coarse sand with small (pea) gravel at the base of the unit. Standard penetration tests indicate that the sand is

of loose to medium dense relative density.

Light gray with orange silty clay to sandy clay soils exist between elevation 7 to elevation minus 11, within areas of the site. The clay was encountered 5 of the 7 borings. The clay averages 3 to 5 feet in thickness, ranging from approximately 1 foot in thickness in HA-1 to about 11 feet in B-6. The clay soils were not encountered in borings B-1, B-2 and B-4.

The clay is exposed in the borrow excavation north of B-1. Hand auger boring, HA-1 was performed in this area to obtain a sample of the clay for laboratory testing. The clay at this location is approximately 12 inches thick. The clay appears to be laterally discontinuous as it was not observed over most of the borrow area.

It is likely that the sand and clay have been deposited in the recent past by the Roanoke River as a series of bank and channel deposits. Thus, the clay exists as one or more lenticular beds within the sand.

The near surface sands rest on fine-grained sandy and silty soils that are characteristically darker (gray to dark brown) in color and contain some finely-divided decayed organic matter. Typically, this unit is comprised of silt with numerous very fine sand partings. The unit contains lenses of silty to clean fine sand and silty clay. Four borings, B-1, B-2, B-6 and B-7 encountered a very dense fine sand strata near the top of this unit (elevation minus 23 to minus 26). The silt soils tend to become finer-grained and more clayey below elevation minus 35.

Blue gray clayey silt of the Yorktown Formation was identified in the sample obtained from B-4 at a depth from 48.5 to 50 feet. The Yorktown classification was based on the characteristic blue gray color and a lack of organic matter. No shell material was observed in the sample. Lower portions of the overlying organic (containing) silt are

similar in apparent grain size to the underlying Yorktown materials, indicative of reworking of the Yorktown materials by the Roanoke River.

5.6 SITE HYDROGEOLOGY

Soil borings performed at the site indicated varying depths and thickness of clay sub-units within the surficial Coastal Plain sediments. Generally, shallow clay deposits in the area are lenticular and discontinuous. They may form localized groundwater barriers. they are not extensive to form confining layers.

Both shallow and deep piezometers were installed at the proposed landfill site. Water levels differed between shallow and deep piezometer pairs by an average of 1.0 foot, indicating a downward groundwater flow component.

5.7 GROUNDWATER

Two piezometric maps have been constructed from the stabilized water level information obtained from the shallow and deep piezometers on February 22, 1994. The maps are included as Figures 7 and 8. Table 2 shows a summary of groundwater elevations obtained in the piezometers during the period between January and February 1994.

5.7.1 Shallow Water Table Aquifer

Groundwater flows from areas of higher potential to areas of lower potential much as surface water drains from higher topography to lower topography. Figure 7 shows our interpretation of the water table surface contours represented as a series of contours for the measurements obtained on February 22, 1994.

Groundwater flow is towards the north and east, perpendicular to the potentiometric contours. The general direction of flow within the site is toward the north, with groundwater discharging into the wetland fringe surrounding the Albemarle Sound. Figure 7 shows groundwater flow in the northwest corner of the site to be towards the east, apparently due to the influence of the adjacent landfill.

Gradients vary across the site. They are flattest within the southeast quadrant of the site, increasing to approximately 0.004 feet per foot in the northeast quadrant. They are steepest in the northwest quadrant at 0.17 feet per foot.

5.7.2 Deep Potentiometric Surface

Groundwater levels within the deeper piezometers are reflected in the piezometric map shown as Figure 8. The map shows a similar piezometric surface, a subdued reflection of the water table surface. The mounding effect present in the northwest corner of the site in Figure 7 is also present in Figure 8. Gradients range from 0.004 feet per foot in the northwest quadrant of the site to 0.001 feet per foot in the northeast quadrant. The depressed water levels in the deeper piezometers indicates a downward (non-horizontal) flow component is present at the site. The water levels and the boring information do not indicate confining strata are present within the 50 foot boring depth.

5.8 Hydraulic Conductivity of the Surficial Aquifer

The site soils can be divided into 4 general strata types; the upper sands and interbedded clay, the underlying fine sandy to clayey silts containing some fine organic matter, and the Yorktown silt and clay. Permeability (hydraulic conductivity) values were determined for the upper three soil types using several different methods. The borings did not penetrate into the Yorktown material sufficiently to facilitate testing of this unit.

5.8.1 Upper Sands

It is very difficult to obtain undisturbed samples of clean sands for laboratory testing. In-situ tests were performed in the shallow piezometers to determine their conductivity. Calculated values based on the Bouwer and Rice Approximation yielded values of K that ranged from 2.5×10^{-3} cm/sec to 1.8×10^{-3} cm/sec in SP-1 and SP-2, screened almost entirely in sand. The lowest value, 6.4×10^{-5} cm/sec, was obtained from SP-7. Boring information indicates the screen interval for SP-7 is also in sand. The values shown for the tests on Table 3 seem to be much lower than would be expected from the relatively clean sands.

The in-situ tests suggested lower conductivity values than would be expected. Grain size distribution curves were analyzed using the Hazen Method to estimate hydraulic conductivity. This method yielded values on the order of 2.0×10^{-2} cm/sec which are more in line with published values (Fetter). Table 4 summarizes the hydraulic conductivity values determined from the gradation curves.

A value of 2.0×10^{-2} cm/sec was used as the estimated Hydraulic Conductivity (K) of the upper sands.

5.8.2 Upper Clay

Laboratory testing was performed on one sample of the near surface clay. The test indicates the hydraulic conductivity is 5×10^{-6} cm/sec. This value was utilized for **K** in the upper clay.

5.8.3 Underlying Silts

The deeper piezometers were also tested to determine the hydraulic conductivity of the screen interval of 40 to 50 feet below the ground surface. Values of 9.0×10^{-6} cm/sec to 1.4×10^{-5} cm/sec were calculated from the test data. Much higher values are indicated in the clean to silty sands present as lenses in this formation. Estimates of K based on the gradation tests indicates conductivity values on the order of 1 to 2×10^{-2} cm/sec. A value of 2×10^{-2} cm/sec was used for **K** in the cleaner portions of the underlying soils. 2×10^{-5} cm/sec was used for the silts and clays.

5.9 GROUNDWATER MOVEMENT

The rate of groundwater movement can be estimated with the Darcy equation using values of porosity, flow gradient and hydraulic conductivity. Using the values shown below for **K** and an estimated porosity of .35, annual velocities were calculated for the major soil types at the site.

SOIL TYPE	HYDRAULIC CONDUCTIVITY (K)
• Surficial Sands	2.0×10^{-2} cm/sec.
• Surficial Clay	5.0×10^{-6} cm/sec.
• Deeper Silt/Clay	2.0×10^{-5} cm/sec.
• Clean sands within the deeper Silt/Clay	2.0×10^{-2} cm/sec.

Based on groundwater flow gradients, groundwater velocities range from approximately 240 feet to greater than 10,000 feet in the upper sands. The lower value would occur within the northeast quadrant of the site where the landfill would be positioned. The higher value occurs in the northwest quadrant where the seepage was observed. Velocities in the clay are on the order of 3 feet per year or less. This value is likely of

minor importance as the clays are discontinuous. Ground water tends to flow around the clay lenses because of the higher seepage rates of the sand, making this value less significant.

Velocities within the deeper soils are lower. Within the relatively clean sands velocities could be expected to range from approximately 60 feet per year to approximately 240 ft/yr. Calculated velocities in the silt/clay soil was less than 1 ft/yr.

The depressed water level elevations in the deeper piezometers indicate a downward groundwater flow component is present in the deeper silts, and underlying clays and silts of the Yorktown formation. However these soils exhibit much lower conductivity values. The extensiveness and fine grained nature of these soils tends to act as a groundwater barrier or aquitard.

6.0 SOIL CONSERVATION SERVICE SOIL MAPPING

The Soil Conservation Service (SCS) has mapped the major soil series within Washington County. SCS soils data is useful for preliminary site planning as many of the soil characteristics and engineering properties are outlined in tabular form. Table 5 summarizes selected SCS soil characteristics of the site soils with respect to shallow excavations and landfills.

The entire site area has been mapped as Conetoe Series (Cta) soil. The Conetoe consists of well drained soils that have formed in loamy fluvial and marine sediments. Slopes range from 0 to 3 percent. The depth to groundwater is greater than 6 feet.

Augusta (At), Dorovan (Do), and Mucklee (Me) series soils have been mapped adjacent to the site. All of these soils have a shallow depth to groundwater. The Dorovan Series are highly organic. They may be encountered within the outer fringes of the property.

7.0 ANALYTICAL RESULTS

7.1 OVA ANALYSIS OF SOIL SAMPLES

An Organic Vapor Analyzer (OVA) was used to scan the site soils that were obtained during drilling with a split spoon sampler. Table shows a summary of the OVA readings for the seven borings according to sample depth. The table lists two values for each sample interval. The values, shown in the columns marked S and M, indicate the concentration of volatile organic compounds detected in the soil with the standard tip (S) and the charcoal filter or methane tip (M).

With the exception of B-4 and B-6, elevated OVA readings were not encountered until a depth of 18.5 feet to 23.5 feet. OVA readings tended to increase with increasing depth then remain more or less constant to the 50 foot depth.

The elevated readings are probably due to the presence of methane and other gasses such as carbon disulfide released during decomposition of the organic matter present in these soils. OVA values were higher at shallower depths in B-4 and B-6 in clay soils with some organic matter.

The elevated OVA readings are likely not due to methane from the existing landfill, but rather from the organic matter contained in the deeper site soils.

The elevated OVA readings have no impact on use of the site for construction. As there will be no construction activities that disturb the deeper soils.

7.2 LABORATORY DETERMINATION OF SOIL PROPERTIES

Selected soil samples, representative of the major soil groupings present at the site were

subjected to laboratory determination of their physical properties. The results of the tests are shown on Table 7.

7.2.1 Site Soil Classification Groupings

Soils at the site are classified according to the Unified Soil Classification System as:

- (SP) for the relatively clean sands containing less than 5 % fines.
- (SM) or (SC) for samples containing greater than 12% of predominately silt fines. The SM classification is utilized where the percentage of silt exceeds clay and the SC qualifier is used for more clayey fines.
- (MH and CH) for cohesive samples with high Plasticity Indices.
- (ML and CL), where the total percentage of silt and clay exceeded the sand content.

7.2.2 Grain Size Determinations

Table 7 shows a summary of the Grain Size Tests performed on selected split spoon samples. The grain size analyses indicate a majority of the upper sands are classified as SP, relatively clean sand with little fines. Fines, classified as silt and clay, range between 2% and 5%. Typically, approximately 90% of the sample is classified as medium sand.

The uniformity coefficient (Cu) shown in Table 4 is a measurement of how well or how poorly-graded the particle sizes are for a given sample. The Uniformity Coefficient is determined from the ratio of the grain size that is 60% finer by weight (D_{60}) compared to the grain size that is 10% finer by weight (D_{10}). Most of the samples have uniformity coefficients of less than 4, indicating they are well-graded.

7.2.3 Natural Moisture Content

Natural moisture content was determined for near surface clay. The moisture content was 18.6 percent by weight. Volumetric Moisture Content is 32.5 percent. When compared to porosity (35.2 percent), it appears that the upper clay is almost fully saturated. With the exception of the surficial samples, all of the other samples were obtained from beneath the water table, and were assumed to be saturated.

7.2.4 Porosity

Porosity was determined on 1 sample of the upper clay. Porosity of the undisturbed clay is 35.2 percent. This value is within typical ranges for fine sandy silty clay. (Fetter, 1988)

7.2.5 Laboratory Permeability

The permeability of the surficial clay was evaluated by performing a laboratory permeability test on an undisturbed sample (Shelby Tube) of the clay. The sample was 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. The sample was saturated under a back pressure of 100 psi prior to running the falling head permeability test. The test was performed with an effective confining pressure of 2 psi and hydraulic heads of about 40 centimeters (cm) of water across a sample length of 8.07 cm. Both inflow and outflow of water were monitored during the test. Testing continued until steady flow was achieved. The hydraulic conductivity of the clay was measured at 5×10^{-6} cm /sec.

8.0 SITE SUITABILITY

Conclusions and recommendations regarding suitability of this site for the proposed construction are based on our evaluation of the field and laboratory data generated during the study, and experience with similar projects and subsurface conditions.

S&ME, Inc. requests the opportunity to confirm, extend, or modify the following recommendations, should the scope of work change significantly from that presented in this report or should additional site or subsurface information become available, or be discovered during construction.

8.1 SUITABILITY OF THE SITE

Design and construction must take into account soil conditions typical of eastern North Carolina. Fine to medium grained sandy soils predominate the near surface. There are no fine-grained soils available for cover at this site. Sufficient quantities of cover soils are available off-site, in close proximity to the proposed landfill. Shallow groundwater conditions occur across the site, which will allow negligible embeddment of the waste. Once siting criteria have been established, additional borings should be performed to evaluate local variations in subsurface conditions .

8.2 MONITORING OF SURFACE AND GROUNDWATER

The proposed landfill site is located adjacent to the wetland fringe of the Albemarle Sound. Several surface water bodies are present in the immediate vicinity of the landfill. The wetland areas will allow adequate monitoring of surface water quality in the vicinity of the landfill. The affect of the landfill on groundwater quality will be determined by analysis of groundwater samples collected from monitor wells placed around the landfill.

the site.

8.3.1 Faults

Current landfill regulations prohibit the construction of new landfills within 200 feet of a fault that has displacement in the last 10,000 years (Holocene time to the present) unless it can be demonstrated that the structural integrity of the landfill will be protective of human health and the environment.

Based on our review of available literature, we can find no evidence of any known or suspected faults within 10 miles of the site. The closest suspected fault is the Roanoke Island - Goldsboro Fault. As the extent of this fault is entirely covered by Coastal Plan sediments, its suspected location is based on a pattern of truncated magnetic anomalies. The fault is oriented east-southwest passing beneath Roanoke Island, and the towns of Greenville, Farmville, and Goldsboro. Figure 9 shows a reproduced portion of Plate 1 (NCGS - Bulletin 95, 1993). The location of the fault is shown as being covered by 1,500 to 2,000 feet of sediments in the Plymouth Area.

8.3.2 Seismically Active Zones

North Carolina Solid Waste Management Rules define a Seismic Impact Zone as an area with a 10 percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percent of the earth's gravitational field will exceed 0.10 g in 250 years.

Our review of available literature, suggests the site is not located in a Seismic Impact Zone. This region of the Coastal Plain Province is considered to be inactive relative to potential seismic and tectonic activity.

REFERENCES

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.

Bouwer, H.,1989, The Bouwer and Rice Slug Test - An Update: Ground water, Volume 27, Number 3,pp 304-309.

Fetter, C. W., 1988, Applied Hydrogeology: Charles E. Merril Publishing Co., 592 pp.

Lawrence, D.P., and Hoffman,C.W., 1993, Geology of basement Rocks Beneath the North Carolina Coastal Plain: North Carolina Geological Survey Bulletin 95, 60 pp, Plate 1.

Nelson, P. F., 1964, Geology and Ground-Water Resources of the Swanquarter Area, North Carolina: North Carolina Department of Water Resources Ground-water Bulletin 4, 79 pp.

North Carolina Geological Survey, 1985, Geological Map of North Carolina: North Carolina Dept. of Natural Resources and Community Development, Raleigh, N.C., 1 Sheet.

Soil Survey of Washington County, 1981, USDA Soil Conservation Service.

TABLE 1
PIEZOMETER AND BORING LOCATIONS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

PIEZOMETER OR BORING LOCATION	NORTH CAROLINA PLANE COORDINATE SYSTEM		GROUND SURFACE ELEVATION	TOP OF CASING ELEVATION
	NORTH COORDINATE	EAST COORDINATE		
SP-1	798,243.40	2,691,263.00	5.3	6.68
DP-1	798,242.50	2,691,285.66	3.8	7.22
SP-2	798,688.75	2,691,425.31	8.4	9.34
DP-2	798,674.62	2,691,447.54	7.4	7.95
SP-3	799,045.01	2,691,887.85	6.5	8.69
SP-4	799,374.25	2,692,333.87	4.0	8.08
DP-4	799,391.85	2,692,362.09	3.1	6.38
SP-5	797,987.33	2,691,695.99	10.3	12.11
DP-5	797,973.65	2,691,690.77	10.5	11.31
SP-6	798,347.41	2,692,170.32	6.2	7.76
SP-7	798,741.20	2,692,593.64	6.3	7.11

NOTE: Survey data provided by Roanoke Land Surveying

TABLE 2
SUMMARY OF WATER LEVEL READINGS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

PIEZOMETER NUMBER	GROUNDWATER ELEVATION ON DATE SHOWN		
	24 HRS ATB	FEB 14, 1994	FEB. 22, 1994
SP-1	2.8	4.68	4.74
DP-1	3.3	3.22	3.28
SP-2	3.2	NR	3.10
DP-2	0.0	1.4	2.13
SP-3	3.3	3.25	3.23
SP-4	1.0	3.17	3.30
DP-4	1.6	1.77	2.38
SP-5	4.2	NR	3.87
DP-5	2.9	3.05	3.23
SP-6	3.9	3.95	3.95
SP-7	3.8	4.30	3.96

Notes: Piezometer numbers correspond with boring numbers. DP-4 was installed in Boring B-4. Shallow piezometers (SP) were installed in offset borings. Piezometer/boring locations are shown on Figure 1.

Initial water level readings were obtained approximately 24 hours after termination of boring (ATB). The dates of boring completion ranged from January 18 through February 4, 1994. The date of completion is shown on each test boring record.

Groundwater elevations are based on ground surface and top of casing elevations furnished by Roanoke Land Surveying.

TABLE 3
ESTIMATED HYDRAULIC CONDUCTIVITY FROM IN-SITU MEASUREMENTS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

PIEZOMETER NO.	HYDRAULIC CONDUCTIVITY (K) in cm/sec	SCREEN INTERVAL DEPTH	LITHOLOGY OF SCREENED INTERVAL
IN-SITU MEASUREMENTS - SHALLOW PIEZOMETERS			
SP-1 Test (1) Test (2)	 2.5×10^{-3} 1.9×10^{-3}	10-20 Ft.	Medium to Coarse Sand, 10' to 18' Silty Clay, 18' to 20'
SP-2 Test (1) Test (2)	 2.6×10^{-3} 1.8×10^{-3}	10-20 Ft.	Medium to Coarse Sand, 10' to 20'
SP-3	 1.9×10^{-5}	15-25 Ft.	Medium to Coarse Sand, 15' to 23' Silty Clay, 23, to 25'
SP-6 Test (1) Test (2)	 5.3×10^{-4} 5.3×10^{-4}	10-20 Ft.	Sandy Silty Clay, 10' to 16' Silty Fine Sand, 16' to 21'
SP-7 Test (1) Test (2)	 6.4×10^{-5} 6.4×10^{-5}	10-20 Ft.	Medium Sand, 10' to 18' Coarse Sand with Gravel, 18' to 20'
IN-SITU MEASUREMENTS - DEEP PIEZOMETERS			
DP-1	1.4×10^{-5}	40-50 Ft.	Fine Sand, 40' to 41' Fine Sandy Silty Clay, 41' to 50'
DP-2	9.0×10^{-6}	40-50 Ft.	Fine Sandy Silt, 40' to 46' Clayey Silt, 46' to 50'
DP-4	3.1×10^{-5} 3.3×10^{-5} (H)	40-50 Ft.	Silty Fine Sand, 40' to 48' Clayey Silt, 48' to 50'
DP-5	2.3×10^{-5}	40-50 Ft.	Fine Sandy Silt, 40' to 50'

Note: All hydraulic conductivity values were estimated using the Bouwer & Rice Approximation
(H) Hydraulic conductivity value estimated by Horslev method

TABLE 4
ESTIMATED VALUES OF HYDRAULIC CONDUCTIVITY FROM GRAIN SIZE
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

BORING NUMBER	SAMPLE DEPTH IN FEET	EFFECTIVE GRAIN SIZE (D_{10})	UNIFORMITY COEFFICIENT (D_{60})/D_{10}	HYDRAULIC CONDUCTIVITY K M CM/SEC	SOIL CLASSIFICATION
B-1	3.5-5.0	0.19 mm	2.11	3.6×10^{-2}	Tan Brown Fine Sand (SP)
B-1	38.5-40.0	0.16 mm	1.56	2.6×10^{-2}	Gray Brown Fine Sand (SP)
B-3	8.5-10.0	0.13 mm	2.15	1.7×10^{-2}	Brown and Tan Fine Sand (SP)
B-4	1-2.5	0.12 mm	2.42	1.4×10^{-2}	Gray and Brown Fine Sand (SP)
B-4	23.5-25.0	0.10 mm	2.3	1×10^{-2}	Gray Fine Sand (SP)

otes: Hydraulic conductivity estimated from Hazen's Method
Effective grain size (D_{10})is obtained from the gradation tests

TABLE 6
SUMMARY OF OVA DATA
WASHINGTON COUNTY LANDFILL
SOIL BORINGS - JANUARY, 1994
S&ME PROJECT NO. 1054-94-119

BORING	B-1		B-2		B-3		B-4		B-5		B-6		B-7	
DEPTH INTERVAL	S	M	S	M	S	M	S	M	S	M	S	M	S	M
	ALL VALUES SHOWN BELOW ARE IN PARTS PER MILLION													
1.0 - 2.5	0	0	0	0	3	0	0	0	4	2	0	0	0	0
3.5 - 5.0	0	0	0	0	0	0	30	15	2	1	0	0	0	0
6.0 - 7.5	0	0	0	0	2	0	NR	NR	2	0	300	40	0	0
8.5 - 10.0	0	0	0	0	0	0	700	85	0	0	75	10	0	0
13.5 - 15.0	0	0	0	0	0	0	85	4	0	0	30	0	0	0
18.5 - 20.0	40	4	NR	NR	3	0	30	0	0	0	30	0	200	50
23.5 - 25.0	110	25	1	0	30	0	7	0	3	0	90	30	350	40
28.5 - 30.0	120	44	400	60	50	50	UD	UD	40	15	80	25	400	60
33.5 - 35.0	200	32	200	40	50	20	85	25	100	15	100	25	300	25
38.5 - 40.0	10	0	700	200	NE	NE	NR	NR	400	40	150	30	350	40
43.5 - 45.0	38	0	800	70	100	10	NR	NR	400	35	200	12	600	100
48.5 - 50.0	100	15	600	150	100	30	200	15	390	90	175	20	700	100

NOTES: S = Standard Tip
NR = No sample recovered
NE = No entry, no analysis performed
M = Methane filter tip
UD = Undisturbed sample, no analysis performed

TABLE 7
SUMMARY OF LABORATORY
SOIL CLASSIFICATION TESTS
WASHINGTON COUNTY LANDFILL
S&ME PROJECT NO. 1054-94-119

GRADATION TESTS

BORING	B-1	B-1	B-3	B-4	B-4	B-5	UD
DEPTH	3.5-5.0	38.5-4.0	8.5-10	1.0-2.5	23.5-25	33.5-35	1.0-3.0
SIEVE SIZE	ALL VALUES SHOWN ARE PERCENT PASSING THE SIEVE SIZE SHOWN						
3/8"	100		100		60		
#4	99.6	100	99.1	100	100	100	100
#10	98.7	100	96.7	100	100	99.4	100
#20	92.8	99.7	88.4	99.9	100	99.2	99.6
#40	60.8	94.4	71.0	91.6	99.3	98.9	95.3
#60	15.5	60.5	46.9	44.8	84.3	97.3	87.9
#100	3.6	9.7	12.0	10.2	18.8	63.5	75.6
#200	1.4	3.9	4.9	5.0	4.9	50.4	62.4

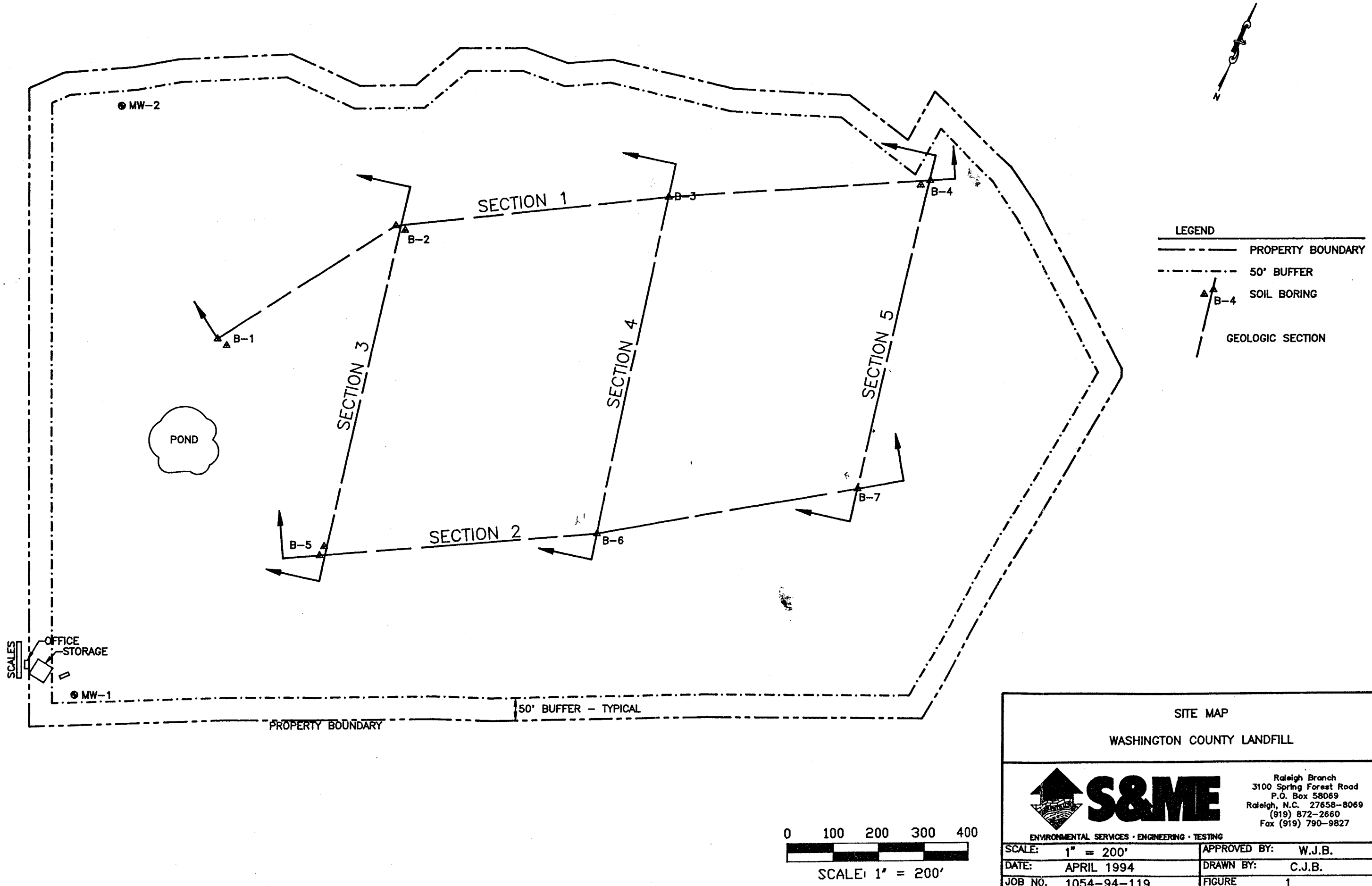
ATTERBERG LIMITS TESTS

BORING	B-2	B-3	B-6	B-6	UD
DEPTH	28.5-30.0	43.5-45	8.5-10.0	48.5-50	1.0-3.0
LIQUID LIMIT (LL)	33	61	105	28	40
PLASTICITY INDEX (PI)	1	29	70	12	22
SOIL CLASSIF.	SM	MH	CH	CL	CL

LABORATORY HYDRAULIC CONDUCTIVITY TEST

LABORATORY PERMEABILITY TEST - ASTM C-5084, Method C

BORING	DEPTH INTERVAL IN FEET	CALCULATED HYDRAULIC CONDUCTIVITY (K)	SOIL DESCRIPTION
Hand Auger #1 (UD)	1.0 - 3.0	5.0×10^{-6} CM/SEC	Dark Gray and Orange Sandy Clay
PHYSICAL PROPERTIES TESTS			
	Porosity	0.352	
	Specific Gravity	2.70	
	Moisture Content	18.6%	



SITE MAP

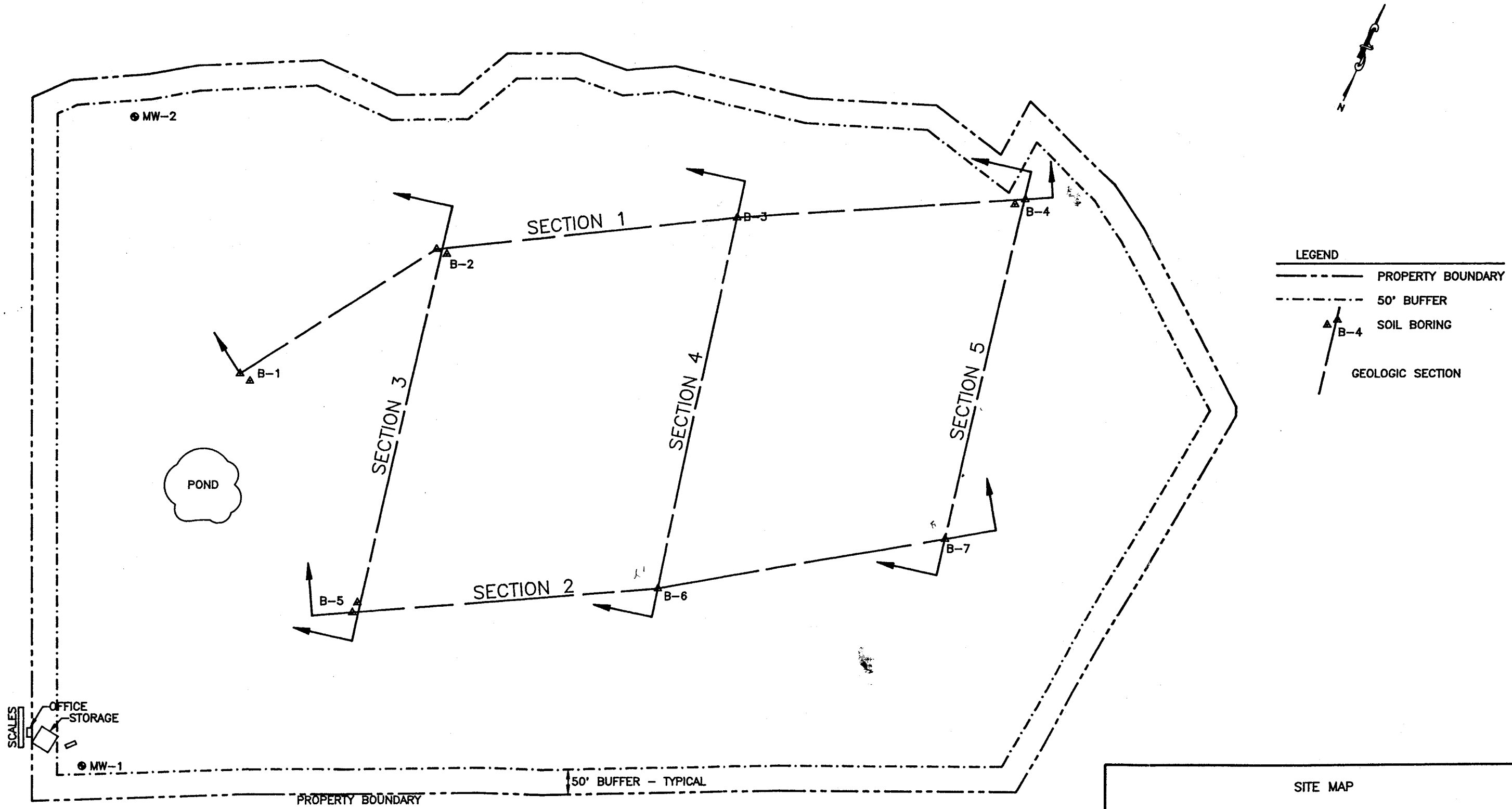
WASHINGTON COUNTY LANDFILL

S&ME

ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

Raleigh Branch
3100 Spring Forest Road
P.O. Box 58069
Raleigh, N.C. 27658-8069
(919) 872-2660
Fax (919) 790-9827

SCALE:	1" = 200'	APPROVED BY:	W.J.B.
DATE:	APRIL 1994	DRAWN BY:	C.J.B.
JOB NO.	1054-94-119	FIGURE	1



0 100 200 300 400

SCALE: 1" = 200'

SITE MAP

WASHINGTON COUNTY LANDFILL

S&ME

ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

Raleigh Branch
3100 Spring Forest Road
P.O. Box 58069
Raleigh, N.C. 27658-8069
(919) 872-2660
Fax (919) 790-9827

SCALE:	1" = 200'	APPROVED BY:	W.J.B.
DATE:	APRIL 1994	DRAWN BY:	C.J.B.
JOB NO.	1054-94-119	FIGURE	1

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

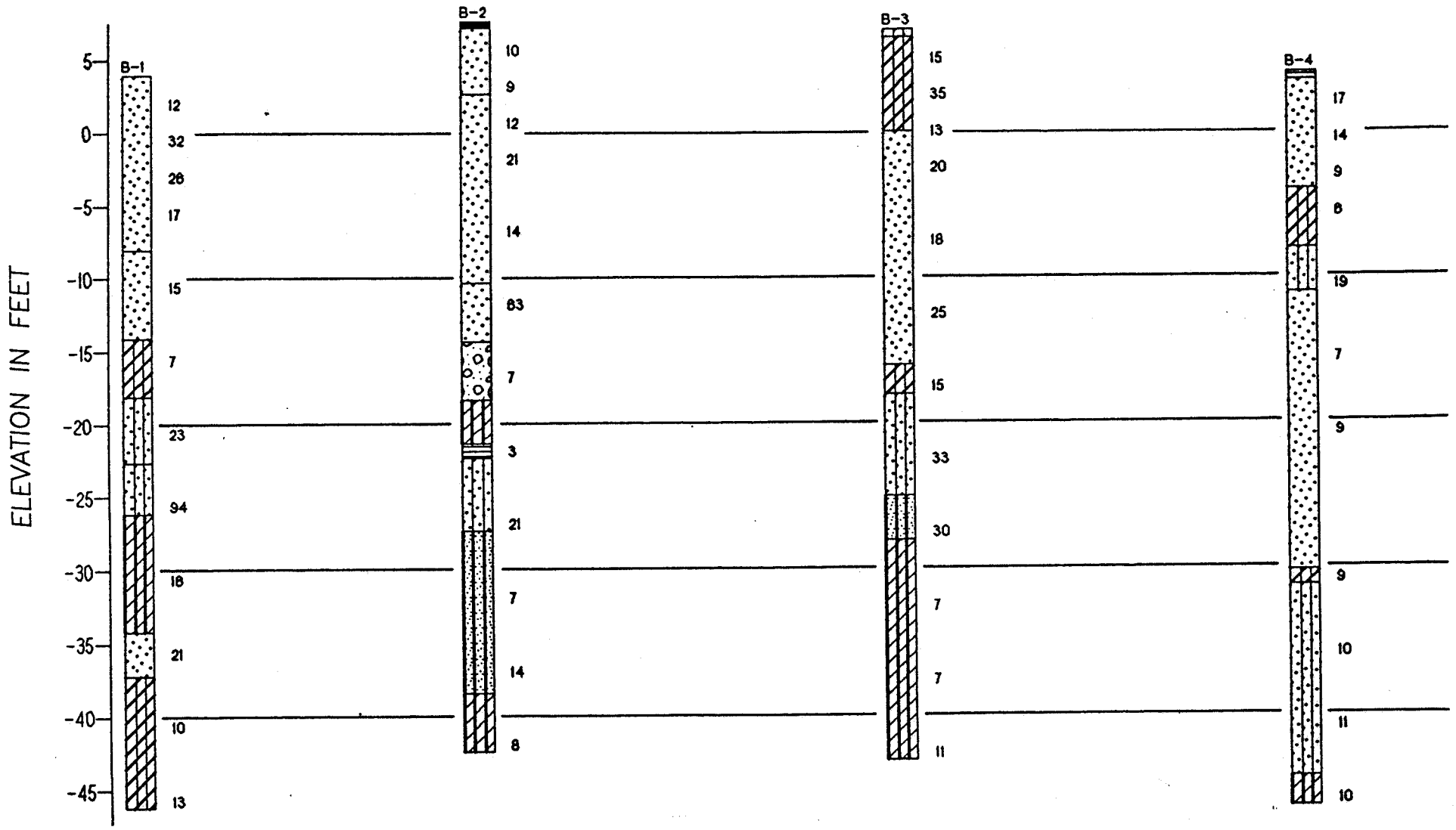
OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME

Environmental Services * Engineering * Testing

GEOLOGIC SECTION 1



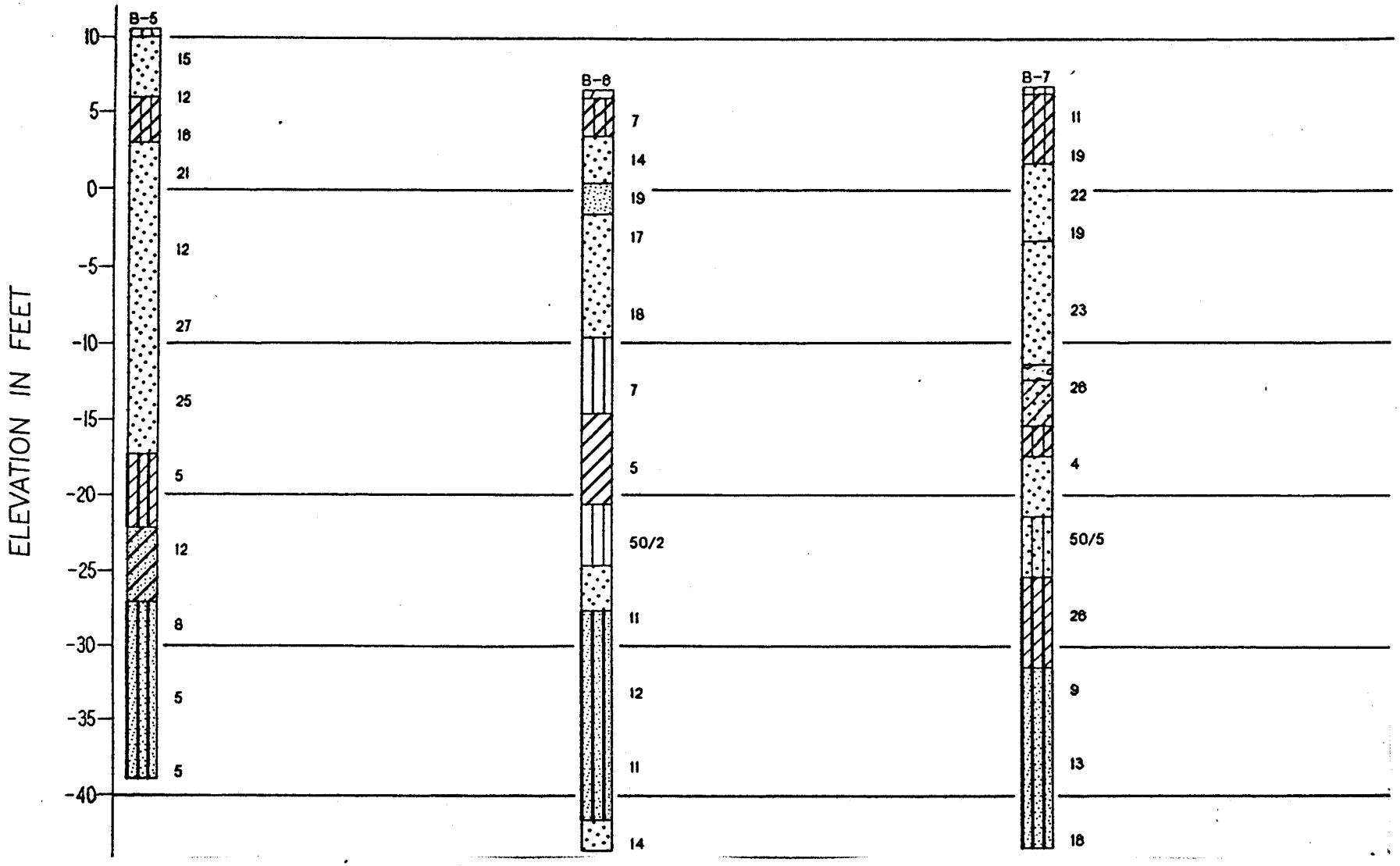
SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	2

GEOLOGIC SECTION 2



SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	3

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

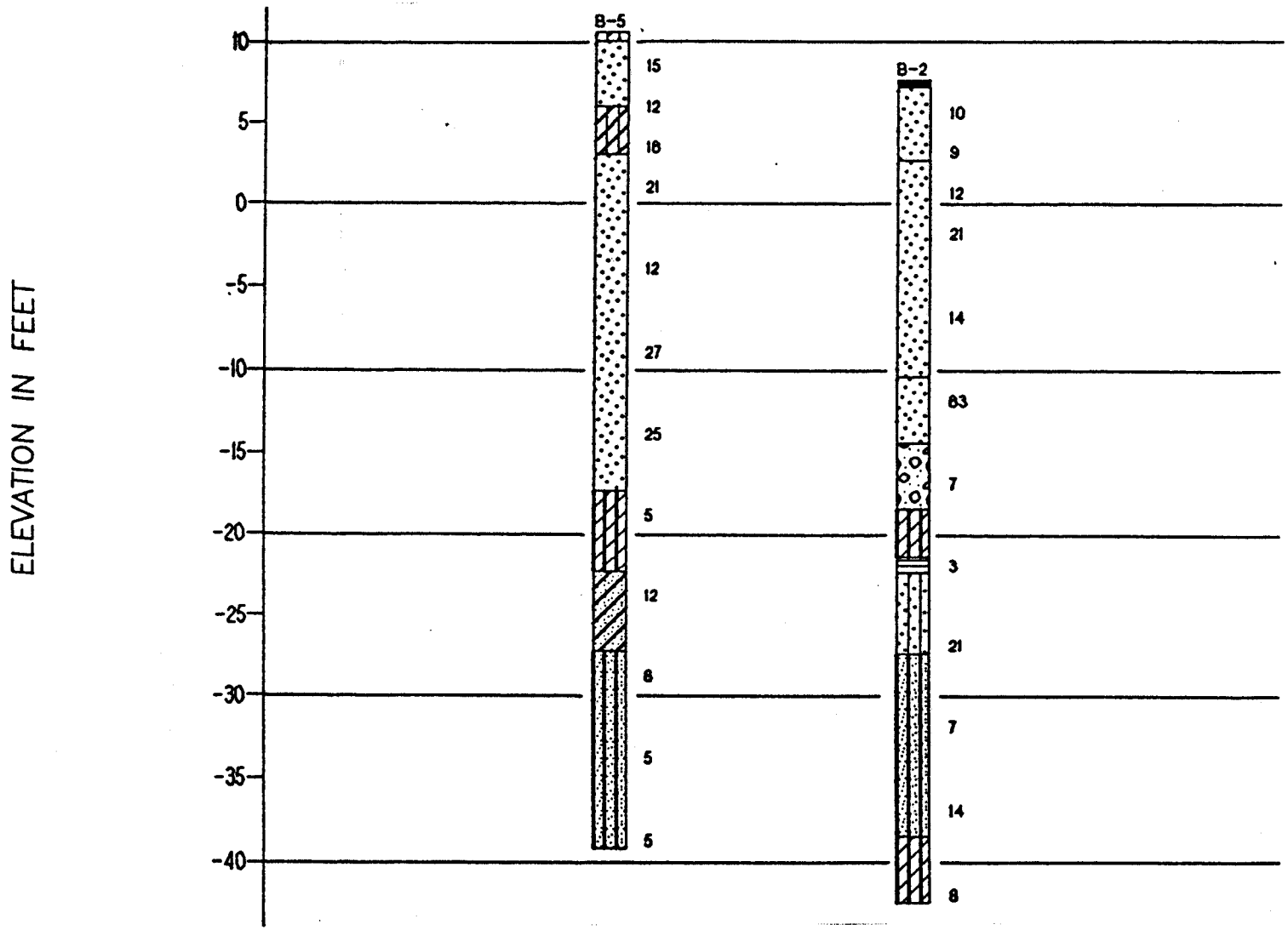
OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME

Environmental Services * Engineering * Testing

GEOLOGIC SECTION 3



SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	4

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

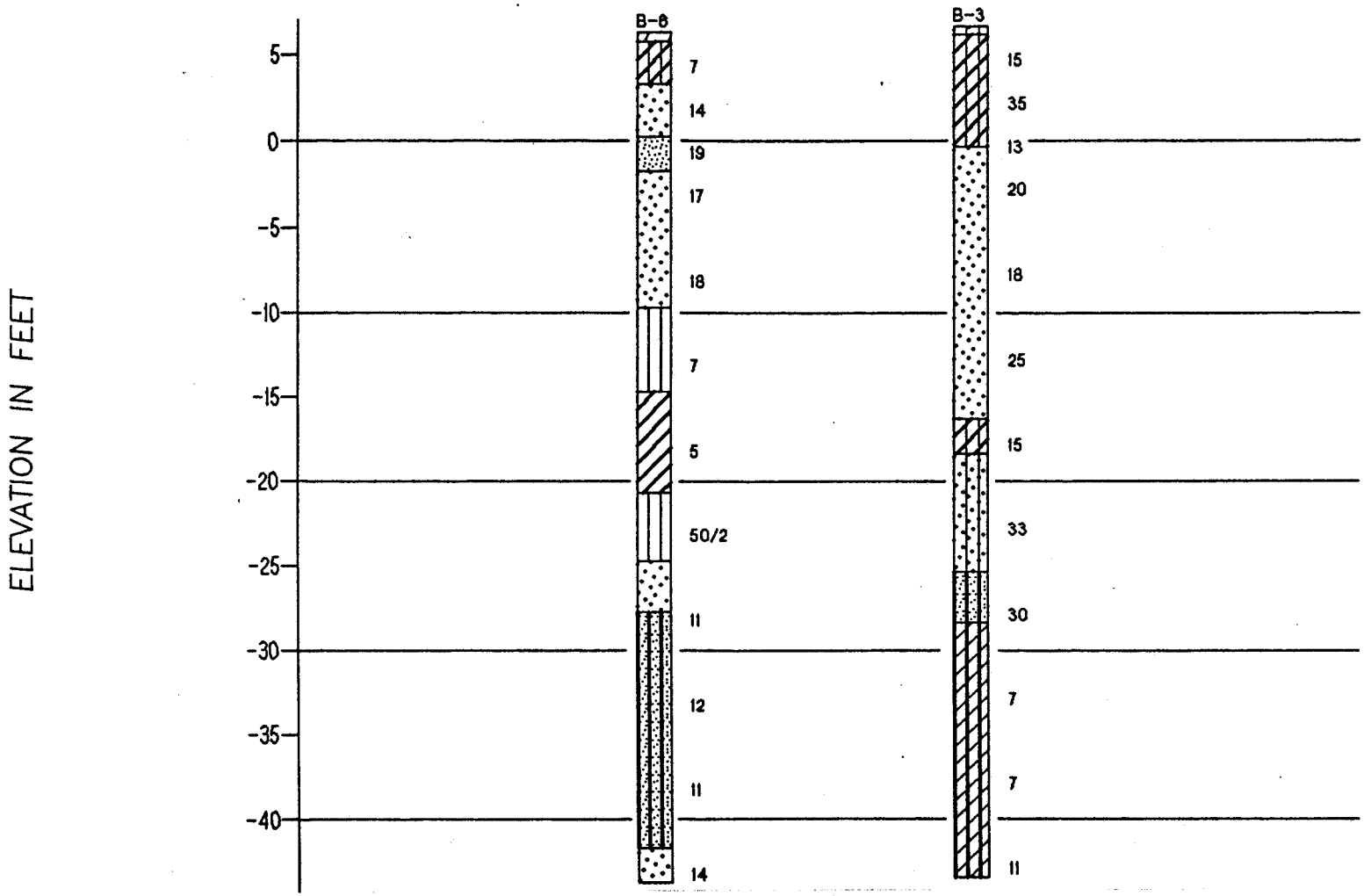
OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME

Environmental Services # Engineering # Testing

GEOLOGIC SECTION 4



SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	5

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Asphalt/Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Well Diagram Area)

- = Water Level At Termination Of Boring
- = Water Level Taken After 24 Hours
- = Loss Of Drilling Water
- HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance (SPR) - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

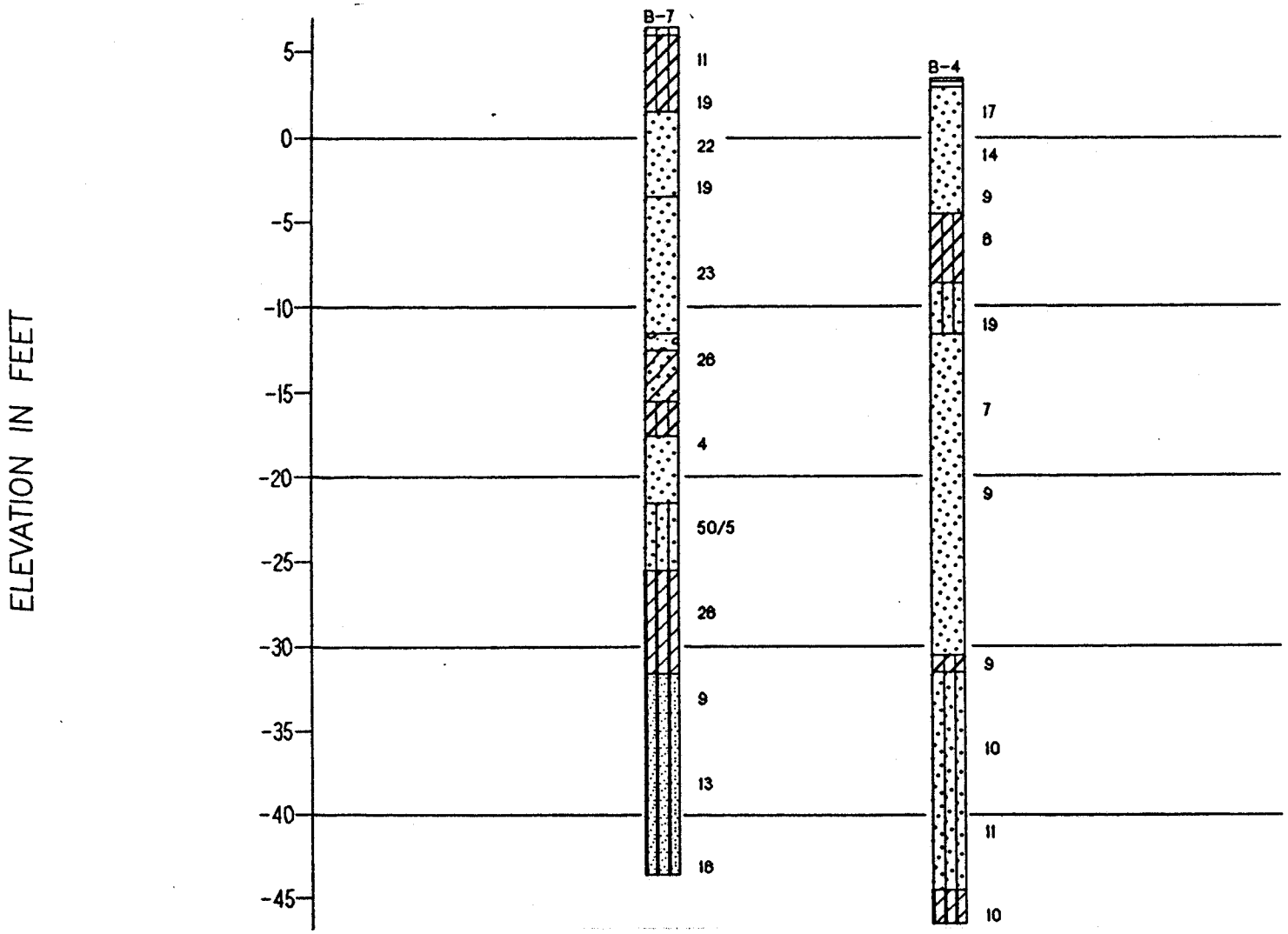
OVM - Organic Vapor Meter.

ELEVATION - Refers to Ground Surface at Location of Well

S&ME

Environmental Services * Engineering * Testing

GEOLOGIC SECTION 5

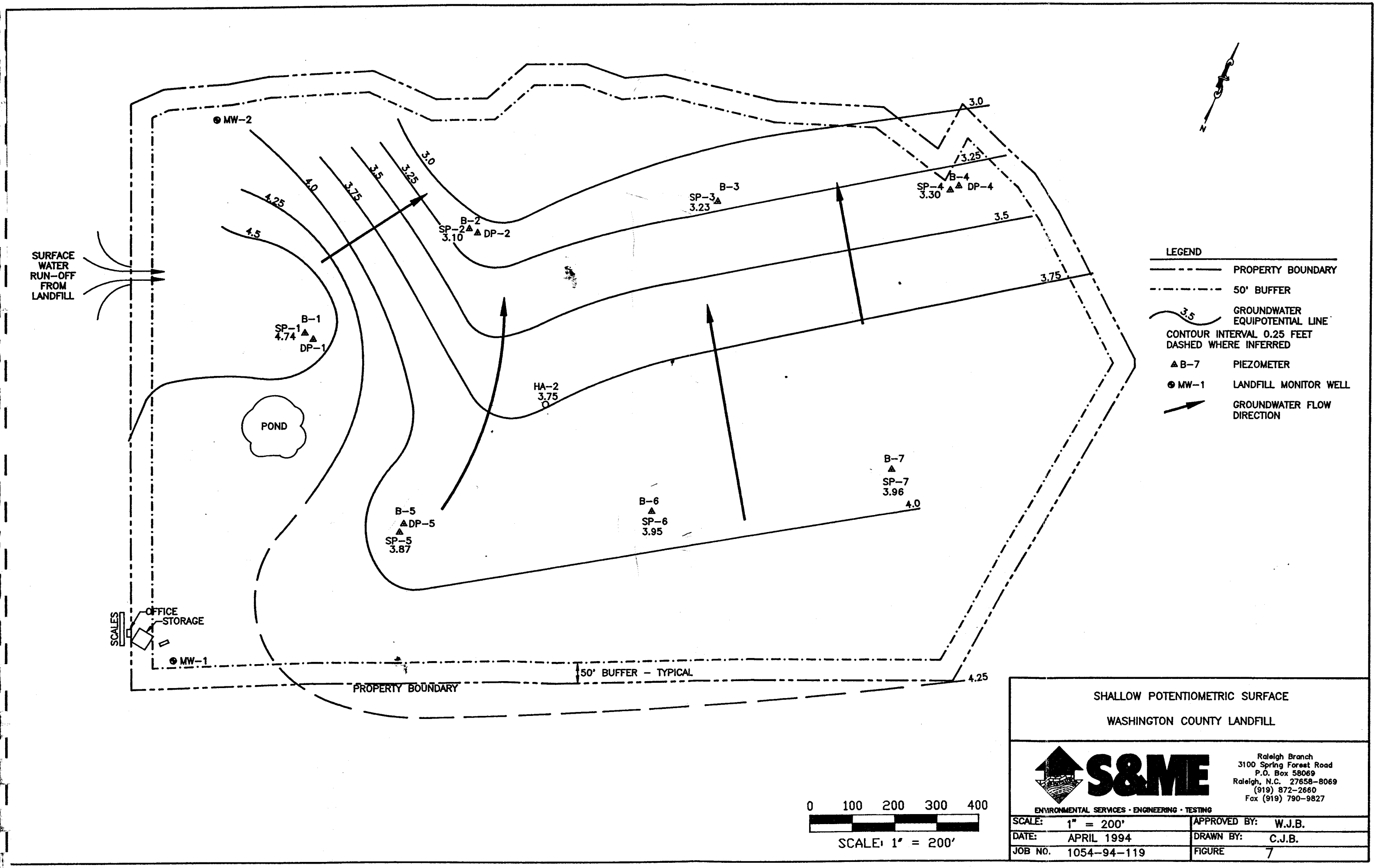


SEE ATTACHED SHEET FOR LEGEND

WASHINGTON COUNTY C & D LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

APPROVED BY:	W.J.B.
DRAWN BY:	T.R.P.
SCALE:	V: 1"=10' H: 1"=200'
JOB NO.	1054-94-119
FIGURE	6



SHALLOW POTENTIOMETRIC SURFACE

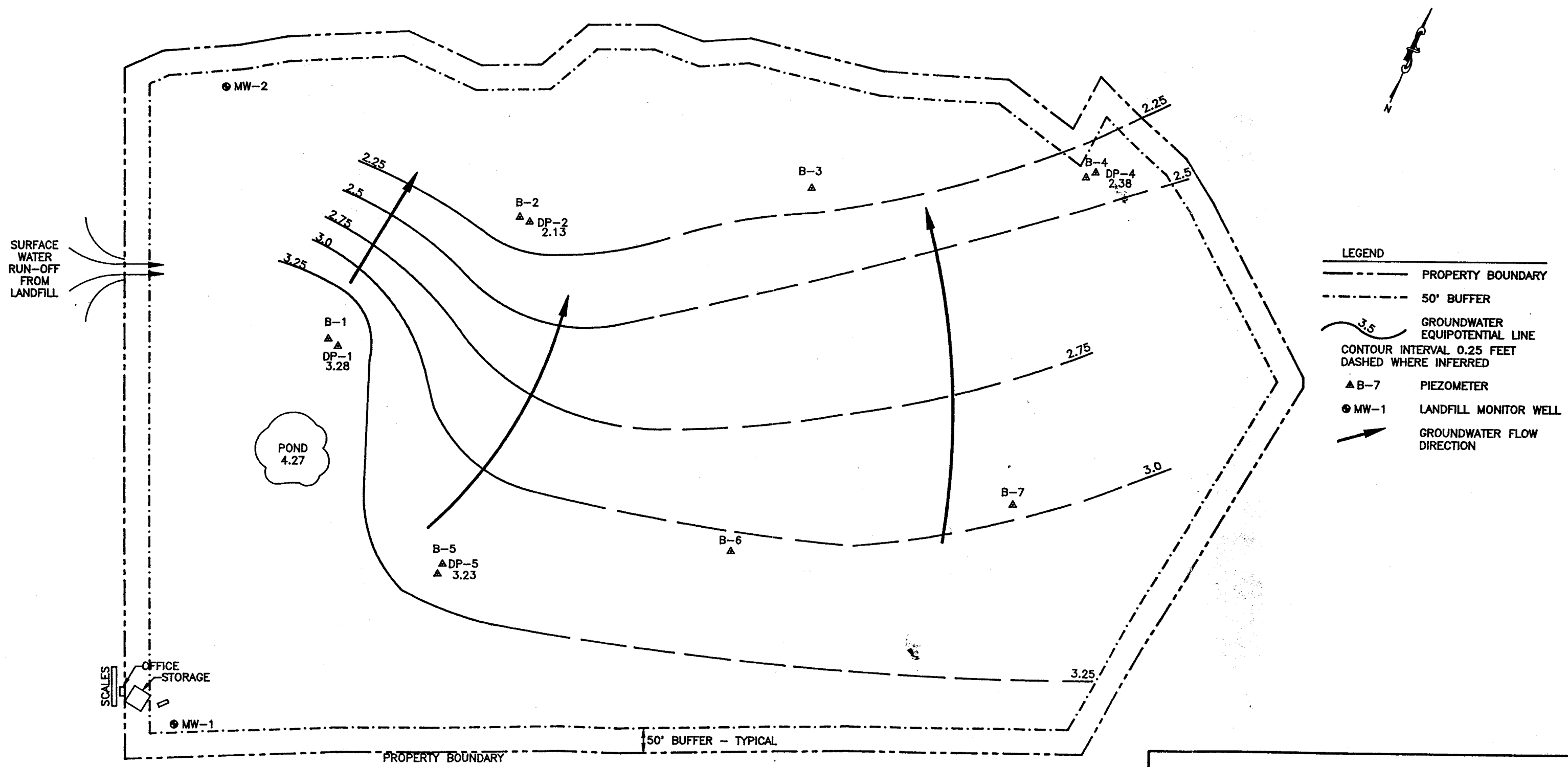
WASHINGTON COUNTY LANDFILL

S&ME

ENVIRONMENTAL SERVICES · ENGINEERING · TESTING

Raleigh Branch
3100 Spring Forest Road
P.O. Box 58069
Raleigh, N.C. 27658-8069
(919) 872-2660
Fax (919) 790-9827

SCALE:	1" = 200'	APPROVED BY:	W.J.B.
DATE:	APRIL 1994	DRAWN BY:	C.J.B.
JOB NO.	1054-94-119	FIGURE	7



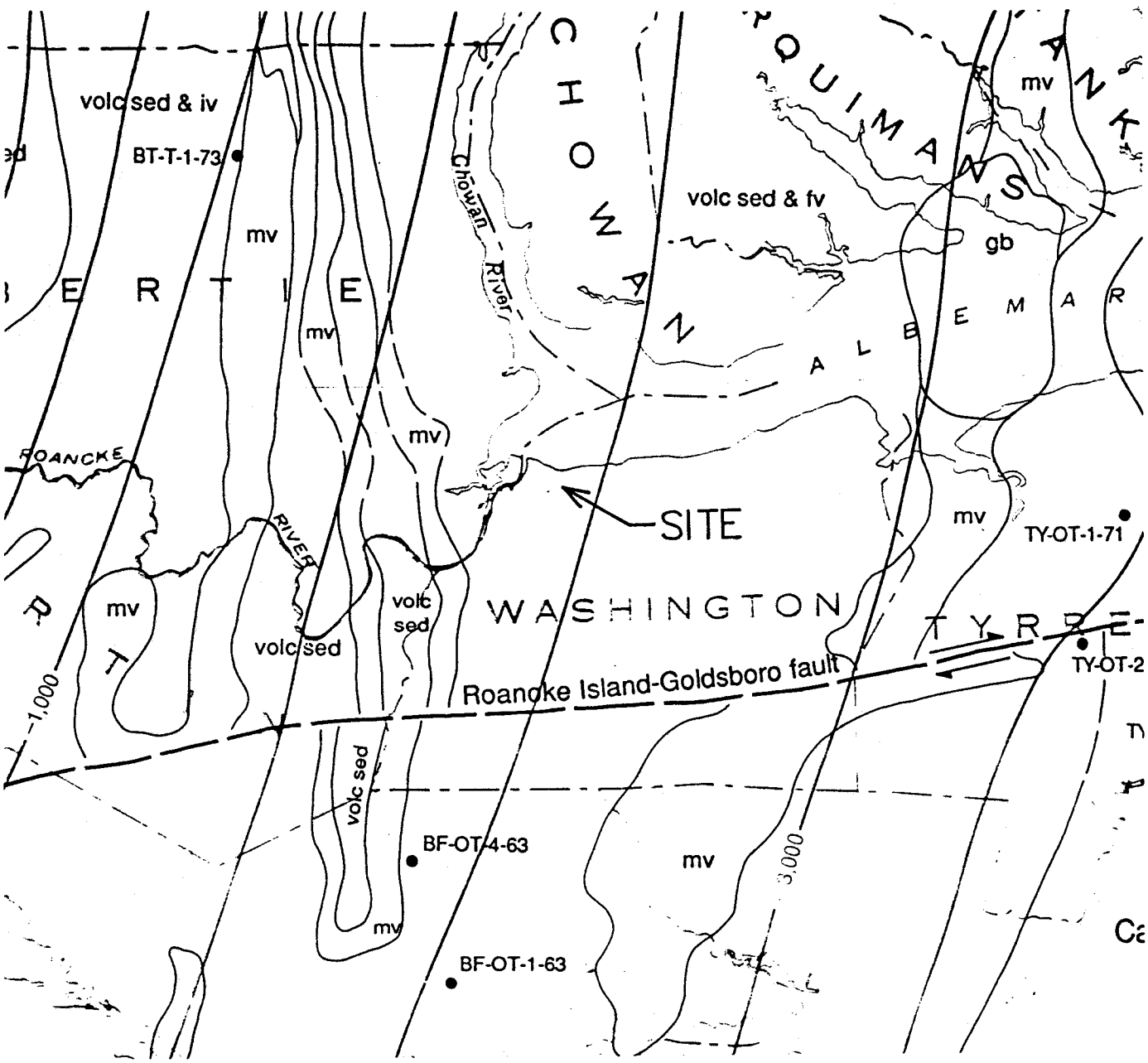
DEEP POTENTIOMETRIC SURFACE

WASHINGTON COUNTY LANDFILL

S&ME
ENVIRONMENTAL SERVICES · ENGINEERING · TESTING
Raleigh Branch
3100 Spring Forest Road
P.O. Box 58069
Raleigh, N.C. 27658-8069
(919) 872-2660
Fax (919) 790-9827

SCALE:	1" = 200'	APPROVED BY:	W.J.B.
DATE:	APRIL 1994	DRAWN BY:	C.J.B.
JOB NO.	1054-94-119	FIGURE	8

SOURCE: Geology of basement rocks beneath the North Carolina Coastal Plain
North Carolina Geological Survey Bulletin 95, 1993



LEGEND

Fault compiled from literature sources – arrows indicate direction of relative displacement

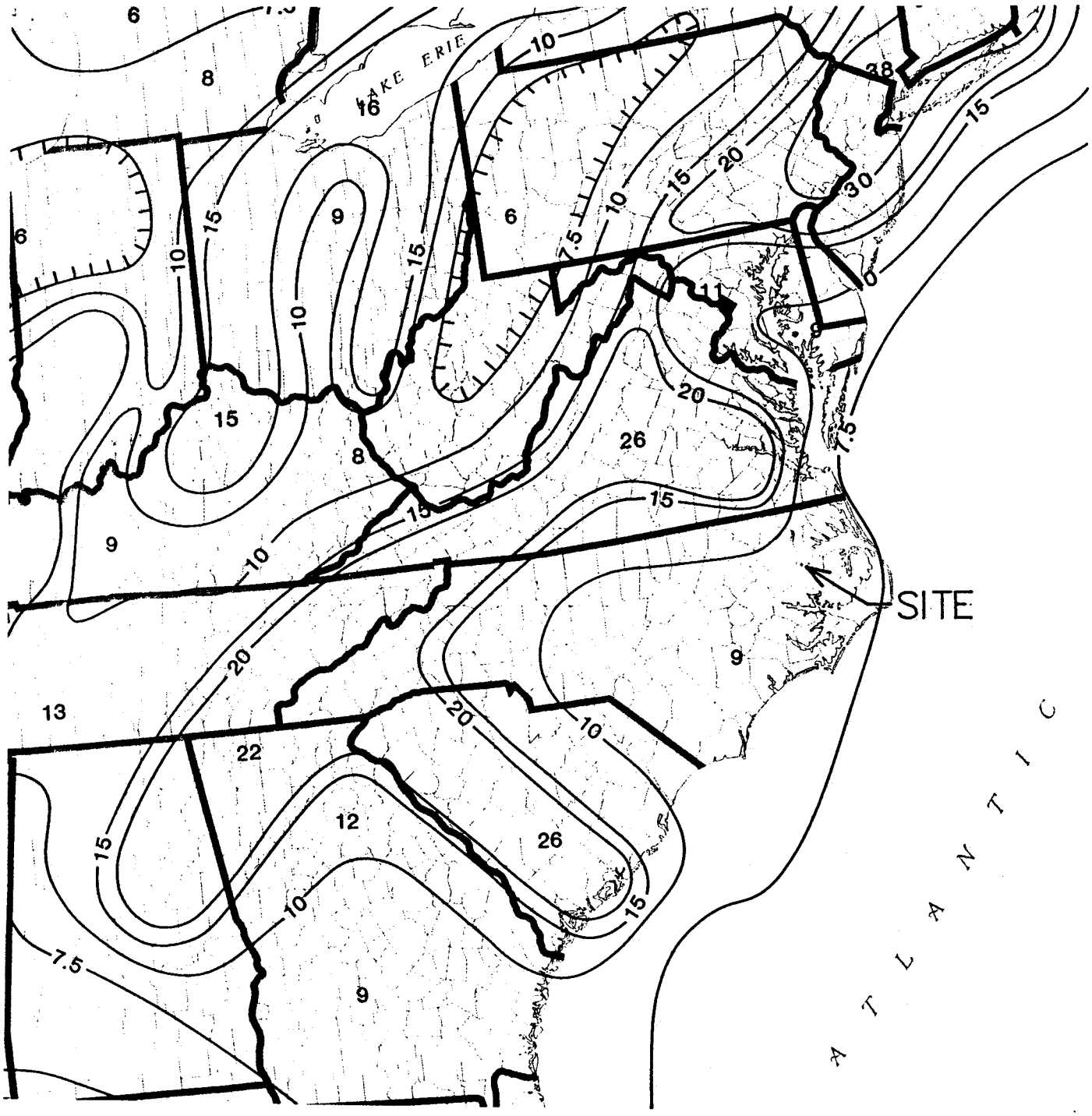
Inferred fault – arrows show direction of inferred relative displacement

Inferred thrust fault – saw teeth are on upper plate

200 Structure contour on basement surface in feet relative to mean level – the contour interval varies as follows:
From +200 feet to –1000 feet – 200–foot contour interval
From –1000 feet to –2000 feet – 500–foot contour interval
From –2000 feet to –10,000 feet – 1000–foot contour interval

FAULT MAP WASHINGTON COUNTY C & D LANDFILL	S&ME ENVIRONMENTAL SERVICES · ENGINEERING · TESTING	APPROVED BY: W.J.B. DRAWN BY: SCALE: 1 INCH=8 MILES Approx. JOB NO. 1054–94–119 FIGURE 9

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.

SEISMIC HAZARD MAP WASHINGTON COUNTY C & D LANDFILL	S&ME ENVIRONMENTAL SERVICES · ENGINEERING · TESTING	APPROVED BY: W.J.B. DRAWN BY: SCALE: 1:7,500,000 JOB NO. 1054-94-119 FIGURE 10

APPENDIX I
SOIL TEST BORING RECORDS

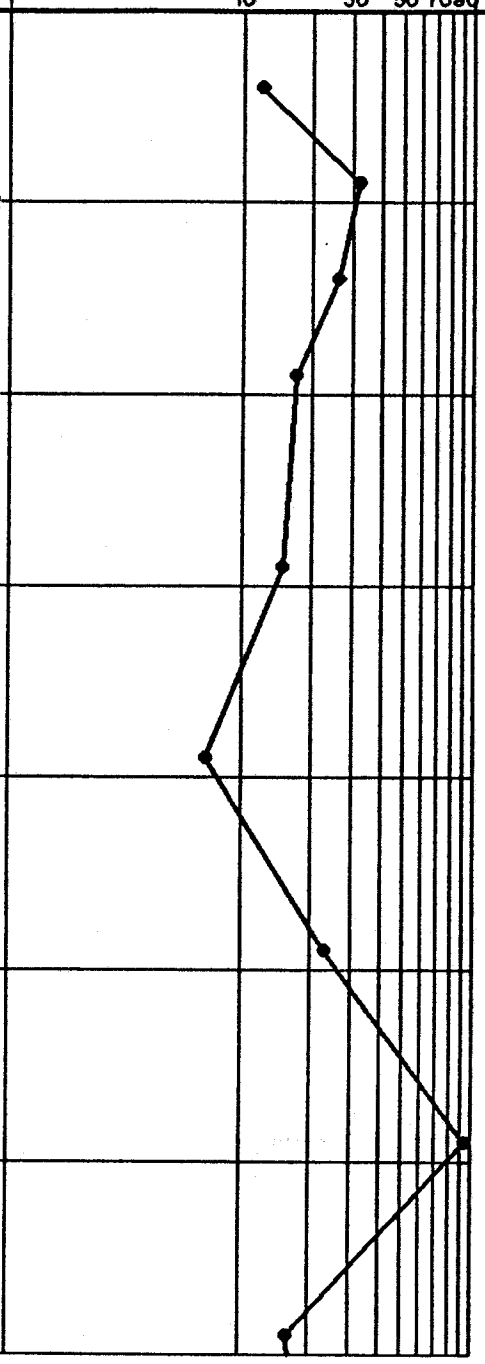
ABSTRACT

This appendix contains the Test Boring Records for borings B-1 through B-7. The location coordinates for each of these borings is shown on Table 1. The boring information is shown graphically on the Geologic Sections (Figures 2 through 6).

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-1
PROJECT NO.:	1054-94-119	ELEVATION:	3.8
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-18-94	WATER LEVEL:	0'-7"
DRILLING METHOD:	Hollow Stem Auger	DRILL RIG:	CME 450

NOTES:
Piezometer (DP-1) installed in boring at completion. Screen interval 40 to 50'. Shallow piezometer installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Medium Dense to Dense Tan to Light Brown Fine to Medium **SAND** (SP)					
5						-1.2	32
							28
10						-6.2	17
		Medium Dense Tan Medium to Coarse **SAND** (SP)					
15						-11.2	15
		Firm Gray Silty **CLAY** (CL)					
20						-16.2	7
		Medium Dense Gray Silty, Clayey Fine SAND with Fine Partially Decayed Organic Matter (SM)					
25						-21.2	23
		Very Dense Gray Silty Fine **SAND** (SM)					
30						-26.2	94
		Very Stiff Gray Fine Sandy Clayey **SILT** (ML)					
35						-31.2	16



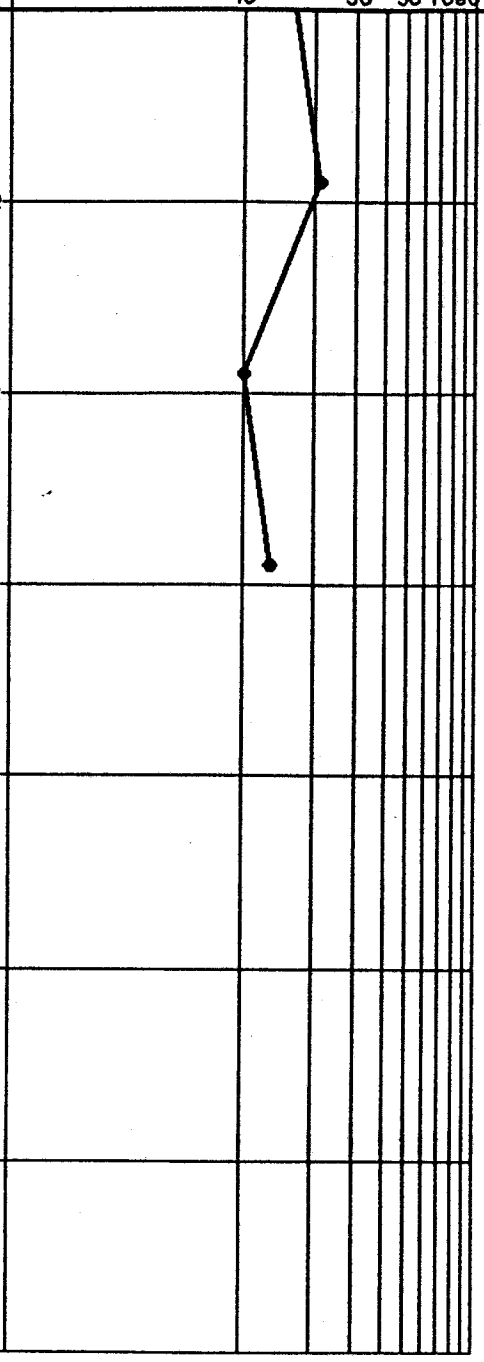
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-1
PROJECT NO.:	1054-94-119	ELEVATION:	3.8
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-18-94	WATER LEVEL:	0'-7"
DRILLING METHOD:	Hollow Stem Auger	DRILL RIG:	CME 450

NOTES:
Piezometer (DP-1) installed in boring at completion. Screen interval 40 to 50'. Shallow piezometer installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
40		Medium Dense Gray Brown Fine SAND (SP)				-36.2	21
45		Stiff Gray Fine Sandy Silty CLAY (CL)				-41.2	10
50		*Boring Terminated at 50.0'*				-46.2	13
55						-51.2	
60						-56.2	
65						-61.2	
70						-66.2	

Standard Penetration Test Data (Blows/ft)



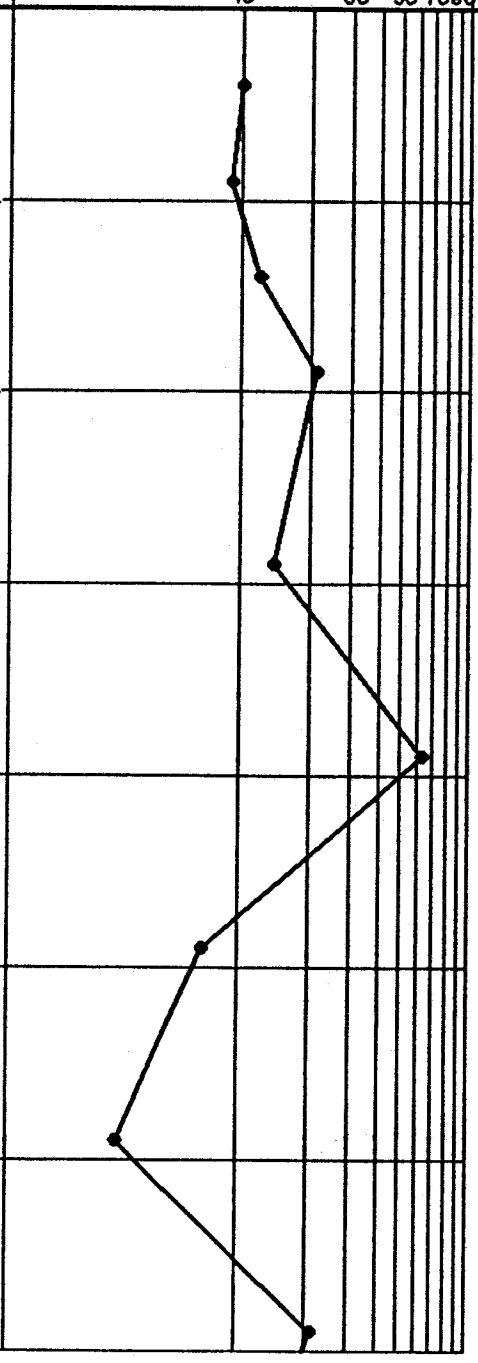
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-2
PROJECT NO.:	1054-94-119	ELEVATION:	7.4
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-27-94	WATER LEVEL:	6'-0"
DRILLING METHOD:	H.S.A./Wet Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-2) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	Soil Description	OVN (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
	Topsoil (SM)					
	Loose Tan to Light Brown Medium **SAND**					10
5	Medium Dense Tan to Light Brown Medium **SAND** (SP)				2.4	9
						12
10					-2.6	21
15					-7.6	14
20	Very Dense Tan Medium to Coarse **SAND** (SP)				-12.6	63
25	Loose Tan Coarse SAND and Small **GRAVEL** (SP-GP)				-17.6	7
	Soft Gray Fine Sandy Clayey **SILT** with Fine Decayed Organic Matter (ML-CL)					
30	Decayed Wood				-22.6	3
	Medium Dense Gray Silty Fine **SAND** with Fine Decayed Organic Matter (SM)					
35					-27.6	21

Standard Penetration Test Data (Blows/ft)



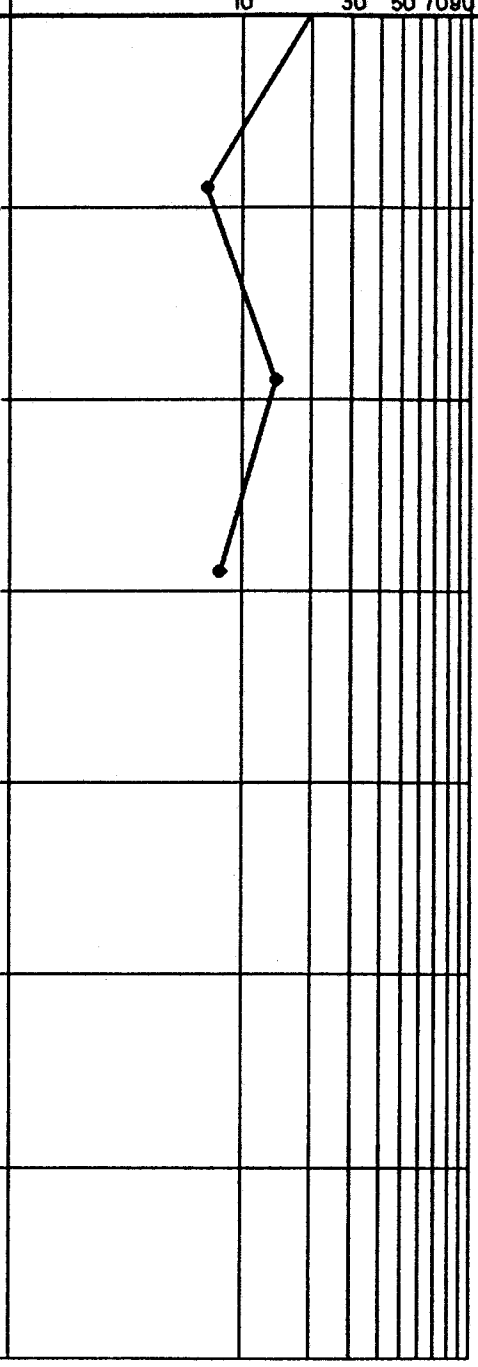
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-2
PROJECT NO.:	1054-94-119	ELEVATION:	7.4
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	1-27-94	WATER LEVEL:	6'-0"
DRILLING METHOD:	H.S.A./Wet Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer (DP-2) installed in boring at completion. Screen interval 40 to 50 feet. Shallow piezometer installed in offset boring. Screened at 10 to 20 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Firm to Stiff Gray Fine Sandy SILT with Fine Decayed Organic Matter (ML)					
40						-32.6	7
45						-37.6	14
		Firm Gray Clayey SILT, with Fine Decayed Organic Matter (ML-CL)					
50		*Boring Terminated at 50.0'*				-42.6	8
55						-47.6	
60						-52.6	
65						-57.6	
70						-62.6	

Standard Penetration Test Data (Blows/ft)



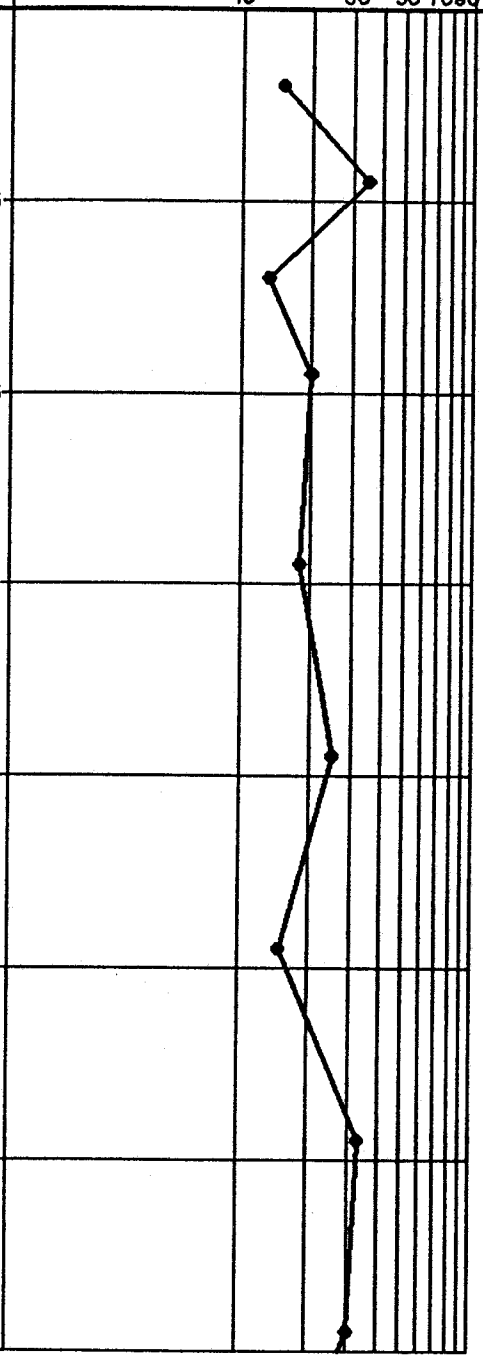
S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-3
PROJECT NO.:	1054-94-119	ELEVATION:	8.5
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-2-94	WATER LEVEL:	3' - 3"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer installed in off-set boring.
Screened at 15' to 25 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Topsoil (SM)					
		Stiff to Very Stiff Tan and Gray Fine Sandy Silty Clay, with Some Roots (CL)					15
5						1.5	35
							13
		Medium Dense Tan to Orange Brown Fine to Medium with Some Coarse SAND (SP)					
10						-3.5	20
15						-8.5	18
20						-13.5	25
		Stiff Gray Silty CLAY (CL)					
25						-18.5	15
		Dense Gray Silty Fine to Medium SAND, with Fine Organic Matter (SM)					
30						-23.5	33
		Very Stiff Gray Very Fine Sandy SILT, with Fine Organic Matter (ML)					
35						-28.5	30

Standard Penetration Test Data (Blows/ft)

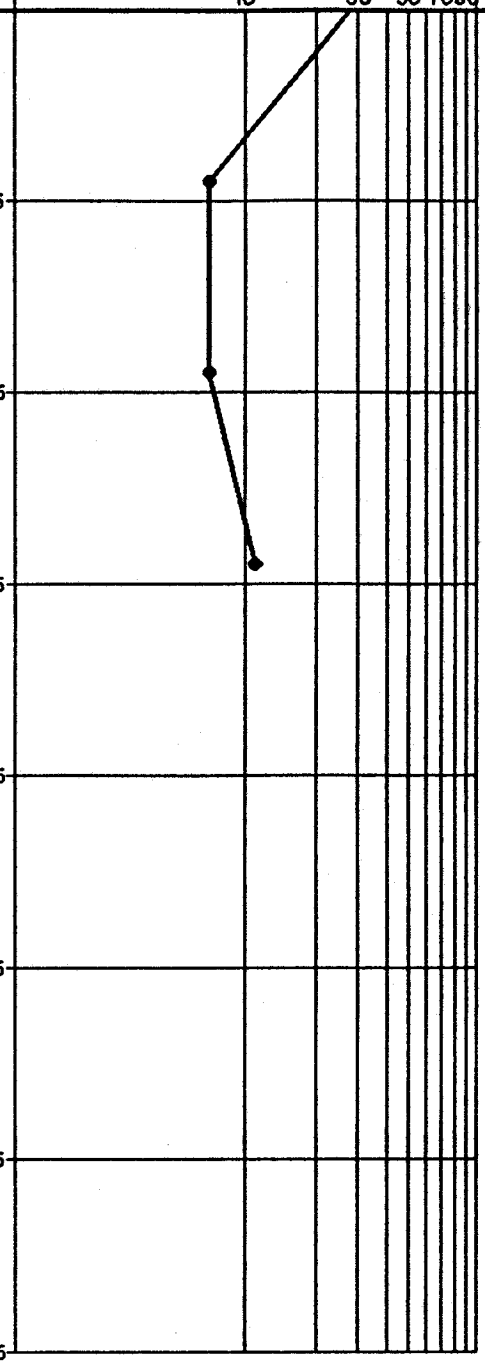


S&ME
Environmental Services
Engineering * Testing

PROJECT:	Washington County Landfill Washington Co., NC	TEST BORING RECORD	B-3
PROJECT NO.:	1054-94-119	ELEVATION:	6.5
LOGGED BY:	A. Hughes	BORING DEPTH:	50.0 FEET
DATE DRILLED:	2-2-94	WATER LEVEL:	3' - 3"
DRILLING METHOD:	H.S.A./Rotary	DRILL RIG:	CME - 450

NOTES:
Piezometer installed in off-set boring.
Screened at 15' to 25 feet.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
		Firm to Stiff Dark Gray Clayey SILT, with Trace of Fine Sand (MH)					
40						-33.5	7
45						-38.5	7
50						-43.5	11
		Boring Terminated at 50.0'					
55						-48.5	
60						-53.5	
65						-58.5	
70						-63.5	



S&ME
Environmental Services
Engineering * Testing