

December 4, 2001

Greenville Utilities Engineering Center  
PO Box 1847  
Greenville, North Carolina 27825-1847

Attention: Mr. Edward C. Askew, CLGPO  
Director of Support Services

Subject: Geotechnical Engineering Report  
Greenville West and MacGregor Downs Substations  
Greenville, North Carolina  
Titan Project No. 019907-80

Dear Mr. Askew:

Titan Atlantic Group, Inc. (Titan) is pleased to present this geotechnical report for the proposed substations in Greenville, North Carolina. Our services were provided in accordance with Titan Proposal No. P-1-075-80 dated October 22, 2001. Findings, conclusions, and recommendations given in this report are subject to the limitations presented in the Appendix.

Please contact us if you have any questions or comments regarding this report. We are available to discuss our recommendations with you and to provide additional services as necessary during the final design and construction phases of this project. We have enjoyed assisting you and look forward to serving as your consultant on the remainder of this project and future projects.

Sincerely,

TITAN ATLANTIC GROUP, INC.

G. Ryan Bridger, E.I.  
Staff Geotechnical Professional

Carl F. Bonner, P.E.  
Greenville Office Manager  
Registered, North Carolina 16252

Reviewed by: Barney C. Hale, P.E.  
Vice President - Chief Engineer  
Registered, North Carolina 11285

C:\Titan\Projects\2001\80-n019907GreenvilleWestand MacGregor Downs Substations-Gville,NC\Cover Letter.doc

Attachments

*Greenville West and MacGregor Downs Substations  
Greenville, North Carolina*

*Titan Project No. 019907-80  
December 4, 2001*

## **1.0 PURPOSE OF GEOTECHNICAL STUDY**

The purpose of this geotechnical study was to explore the general subsurface conditions at the project site and to evaluate these conditions with respect to the design and construction of foundations for the project. Our scope of services included drilling soil test borings, performing engineering analyses, and preparing this report of our findings and recommendations.

## **2.0 PROJECT INFORMATION**

Mr. Edward Askew of Greenville Utilities Engineering Center provided project information to Titan. We understand that two substations are planned for a site in Greenville, North Carolina. The site is at the approximate location shown on Drawing No. 1 in the Appendix.

We received a site plan which shows the locations of existing site features, the proposed substations, and the boring locations from Booth and Associates, Inc. The project includes the construction of two substations side by side.

Design grades have not been provided. However, based on the existing topography and our experience with similar projects, we assume that cut and fill depths will be less than 2 to 3 feet.

## **3.0 SUBSURFACE EXPLORATION AND TESTING**

### **3.1 Field Exploration**

In order to explore the general subsurface conditions at the project site, Titan subcontracted Carolina Drilling to drill 10 soil test borings (B-1 through B-10 ) to a depth of 30 feet below existing grades. The borings were advanced at the approximate locations shown on Drawing No. 2 in the Appendix. The number of borings and their locations were selected by Greenville Utilities Engineering Center.

*Greenville West and MacGregor Downs Substations  
Greenville, North Carolina*

*Titan Project No. 019907-80  
December 4, 2001*

The borings were located in the field by Titan personnel by pacing distances and estimating right angles relative to existing site features. The soil test borings were performed by a trailer-mounted and track-mounted power drilling rig utilizing rotary wash drilling procedures. Standard Penetration Tests were performed in the soil test borings at 2.5 to 5.0 feet intervals in general accordance with ASTM D 1586. Titan personnel visually classified the split-spoon soil samples in general accordance with the Unified Soil Classification System.

Boring Logs are included in the Appendix of this report.

#### **4.0 SITE AND SUBSURFACE CONDITIONS**

##### 4.1 Site Description

The site is located on the north side of MacGregor Downs Road, west of the intersection of MacGregor Downs Road and B's Barbeque Road. The majority of the site is currently an overgrown abandoned cultivated field.

A drainage ditch is located along MacGregor Downs Road. No surface water was observed at the site at the time of our exploration.

##### 4.2 Regional Geology

The project site is located in the Coastal Plain Physiographic Province. The Coastal Plain consists mainly of marine sediments which were deposited during successive periods of fluctuating sea level and moving shoreline. The soils in this province are typical of those laid down in a shallow sloping sea bottom; sands, silts, and clays with irregular deposits of shells. Alluvial sands, silts, and clays are typically present near rivers and creeks.

*Greenville West and MacGregor Downs Substations  
Greenville, North Carolina*

*Titan Project No. 019907-80  
December 4, 2001*

According to the 1985 Geologic Map of North Carolina, the site overlies the Yorktown formation. This Tertiary marine formation consists primarily of fossiliferous clay with varying amounts of fine-grained sand and bluish-gray shell material commonly concentrated in lenses.

#### 4.3 Soil Conditions

A 10-inch-thick layer of cultivated soil was encountered at the ground surface in all of the borings. The cultivated soil is generally underlain by silty and clayey fine sand to a depth of 30 feet. These soils visually classify as SM and SC, respectively, in accordance with the Unified Soil Classification System. Standard penetration test values (N-values) range from 0 to 16 blows per foot (bpf) with an average of 6 bpf, indicating a very loose to medium dense relative density.

More detailed descriptions of the subsurface conditions encountered at each boring location are given on the boring logs in the Appendix. For example, Borings B-8 and B-9 encountered a layer of very soft to soft, high and low plasticity silt (MH and ML) at a depth of 12 to 22 feet below grade.

#### 4.4 Groundwater Conditions

Groundwater levels were measured in the open boreholes at the completion of drilling operations and after a stabilization period of approximately 9 days. Groundwater was measured at depths of 8.5 to 15.7 feet below existing grades.

Fluctuations in the groundwater table on the order of 1 to 2 feet are typical in the Coastal Plain, depending on variations in precipitation, evaporation, and surface water runoff. Seasonal high groundwater levels are expected to occur during or just after the typically wetter months of the year (November through April).

Greenville West and MacGregor Downs Substations  
Greenville, North Carolina

Titan Project No. 019907-80  
December 4, 2001

### 5.0 GEOTECHNICAL RECOMMENDATIONS

#### 5.1 Site Preparation

All cultivated soil, vegetation, debris, and other unsuitable material should be removed from the construction areas. We anticipate an average stripping depth of 8 inches to remove the cultivated soil. Cultivated soil may be re-used in areas to be landscaped.

ROLLING  
TAY NOT  
E REST  
METH  
INCE  
CRISTATIONS  
HOLD  
IT JUST  
BE  
DCP?

After stripping of cultivated soil is completed, the exposed subgrade soils in areas to receive fill or at the subgrade elevation in cut areas should be proofrolled to detect loose soils. Proofrolling should be performed with a moderately loaded dump truck or similar construction equipment. The geotechnical engineer's representative should observe this operation to aid in delineating unstable soil areas. Proofrolling should be performed after a suitable period of dry weather to avoid degrading an otherwise acceptable subgrade. Any soils which continue to rut or deflect excessively under the rolling operations should be undercut as directed by the geotechnical engineer and replaced with compacted fill material.

Based on the borings, we anticipate that undercutting of near-surface soils may be required in the vicinity of Boring B-4. However, localized undercutting of loose or soft soils may be necessary between the boring locations. Potential undercutting can be reduced if the site preparation work is performed during a period of dry weather.

#### 5.4 Earthwork

Structural fill and backfill placed at the site should consist of a low to moderate plasticity soil (liquid limit less than 50 and plasticity index less than 20) that is free of organic material or debris. Fill soils should classify as CL, ML, SM, or SC in accordance with the Unified Soil Classification System. Highly plastic clays and silts (CH, MH) should not be used as surface fill because they are very moisture sensitive and subject to shrinking or swelling with seasonal changes in moisture content.

*Greenville West and MacGregor Downs Substations  
Greenville, North Carolina*

*Titan Project No. 019907-80  
December 4, 2001*

With the exception of cultivated soil, occasional soft near-surface soils, and highly plastic clays, the on-site soils may be reused as structural fill, but they will require careful moisture control. Excess cultivated soil may be placed in areas to be landscaped.

Structural fill should be placed in 8- to 10-inch thick loose lifts at a moisture content within three percent of the optimum moisture content of the material as determined by ASTM D 698 (Standard Proctor). Each lift of fill should be uniformly compacted to a dry density of at least 95 percent of the maximum dry density of the material determined according to ASTM D 698 (Standard Proctor). The upper 18 inches in substations areas should be compacted to at least 98 percent of the standard Proctor maximum dry density.

The geotechnical engineer's representative should perform in-place field density tests to evaluate the compaction of the structural fill and backfill placed at the site. We recommend a testing frequency of one test per lift per 2,500 square feet of fill area within the footprints of the substations.

### 5.5 Foundations

We recommend that the proposed substations be supported on shallow foundations bearing on suitable natural soil or properly compacted fill. A net allowable bearing pressure of 2,000 pounds per square foot (psf) should be used for design of the footings. The net allowable bearing pressure is that pressure which may be transmitted to the soil in excess of the surrounding overburden pressure.

Shallow foundations should be designed to bear at least 12 inches below finished grades for frost protection and protective embedment.

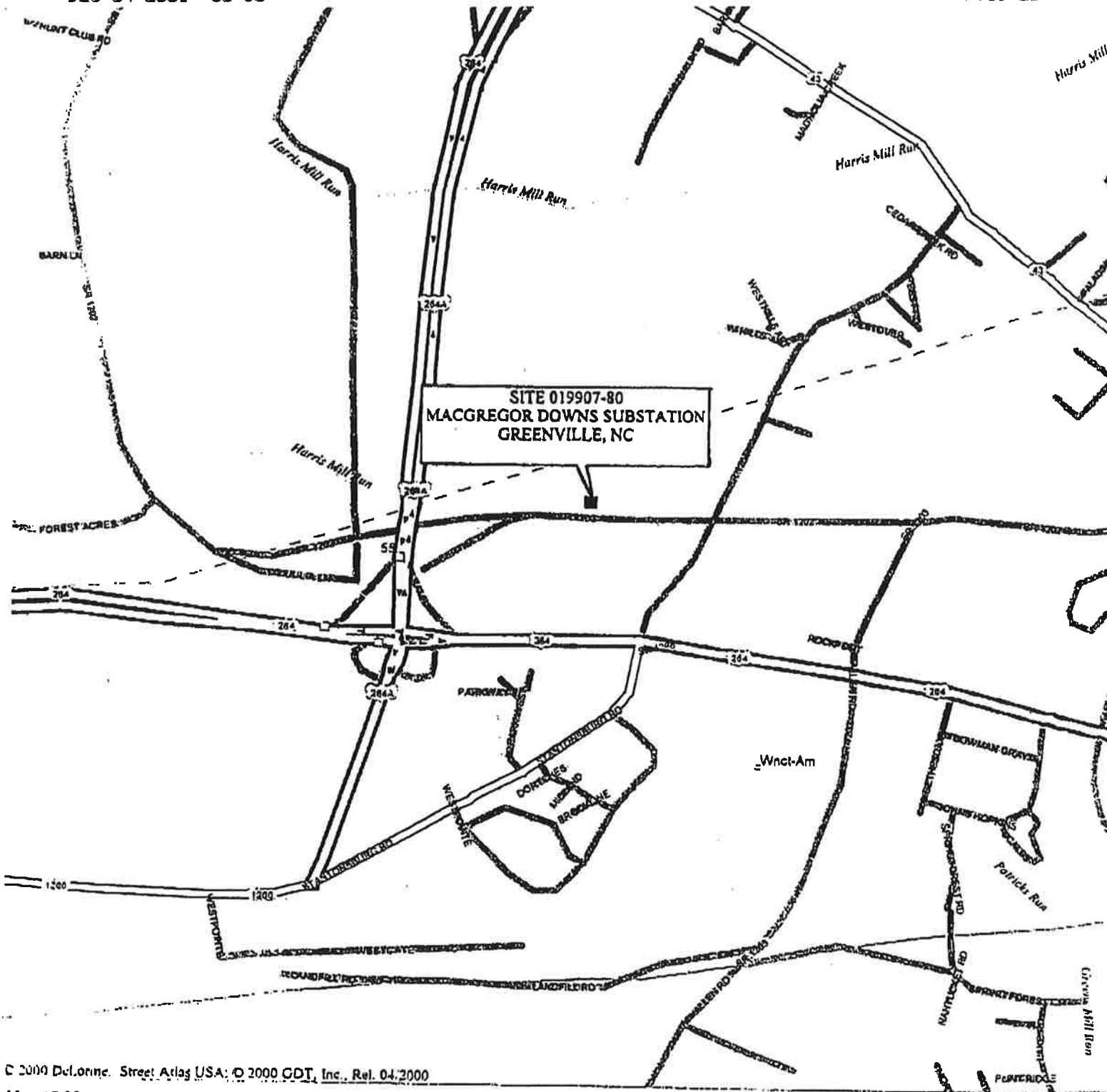
We estimate the total settlement for the substations will be less than 1-inch. Differential settlement should also be tolerable (less than about 1/2-inch).

*Greenville West and MacGregor Downs Substations  
Greenville, North Carolina*

*Titan Project No. 019907-80  
December 4, 2001*

We recommend that the footing excavations be observed by the geotechnical engineer's representative to verify that suitable soils are present at and below the proposed bearing elevation. If soft or unsuitable materials are encountered in the footing excavations, they should be undercut and replaced to the bottom of footing elevation with washed crushed stone (NCDOT No. 57 or 67). Based on the borings, we anticipate that undercutting of footings may be required in the vicinity of Boring B-4.

Prepared bearing surfaces for foundations should not be disturbed or left exposed during inclement weather. Saturation of the footing subgrade can cause a loss of strength and increased compressibility. If construction occurs during inclement weather, and concreting of foundations is not possible at the time they are excavated, a layer of lean concrete should be placed on exposed bearing surfaces for protection. Also, concrete should not be placed on frozen subgrades. The bottom of the foundation excavation should be clean and free of any loose soil, mud, or debris prior to placing concrete.



© 2000 DeLorme, Street Atlas USA; © 2000 GDT, Inc., Rel. 04/2000

Mag 15.00

Thu Nov 15 08:54 2001

Scale 1:18,750 (at center)

2000 Feet

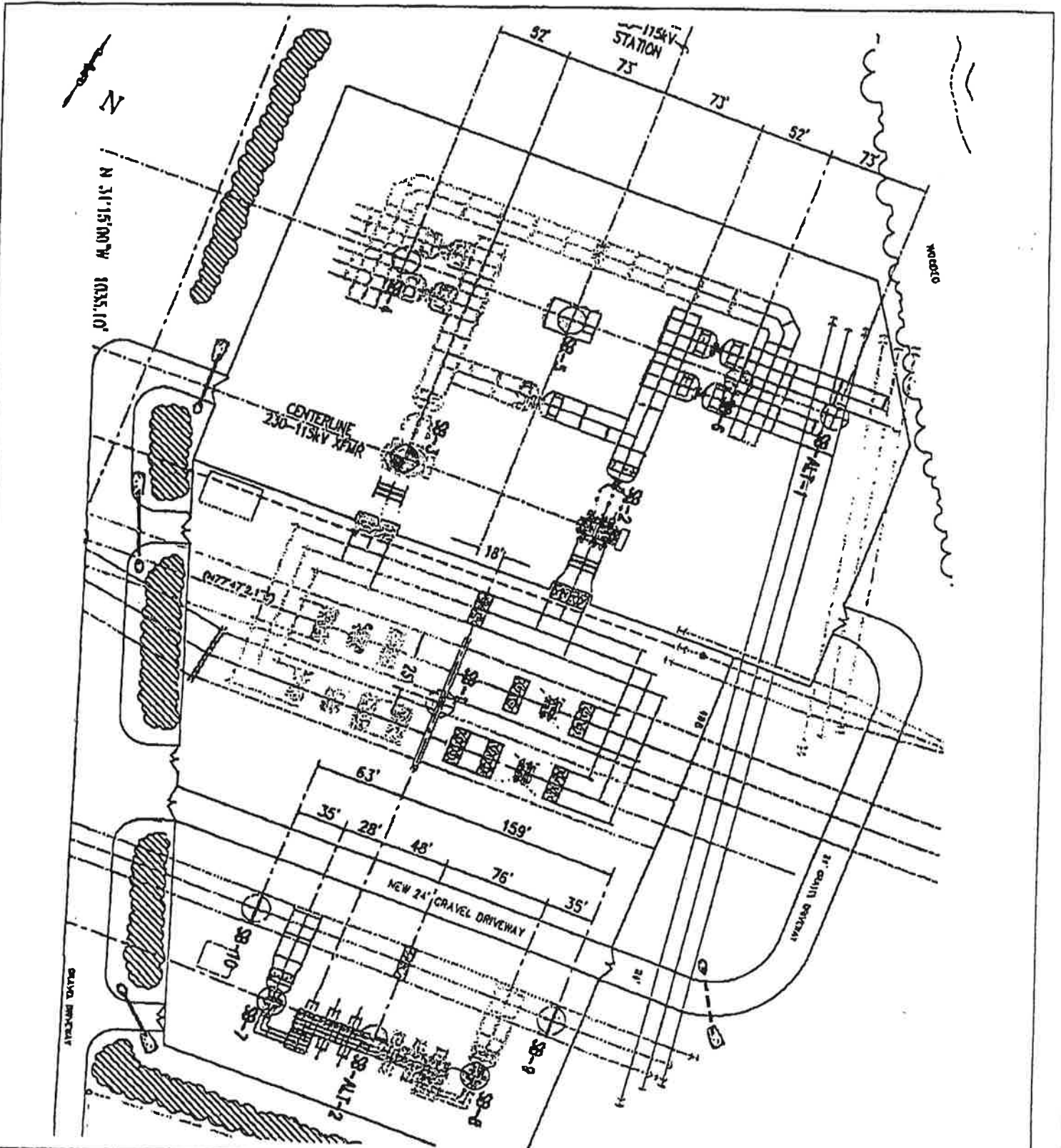
500 Meters

- Local Road
- US Highway
- Interstate/Limited Access
- Major Connector
- State Route
- Exit
- Utility/Pipe
- Railroad
- Point of Interest
- Land
- Water
- River/Canal
- Intermittent River



**SITE LOCATION PLAN**  
**MACGREGOR DOWNS**  
**SUBSTATION**  
**GREENVILLE, NC**  
**019907-80**  
**DRAWING NO. 1**



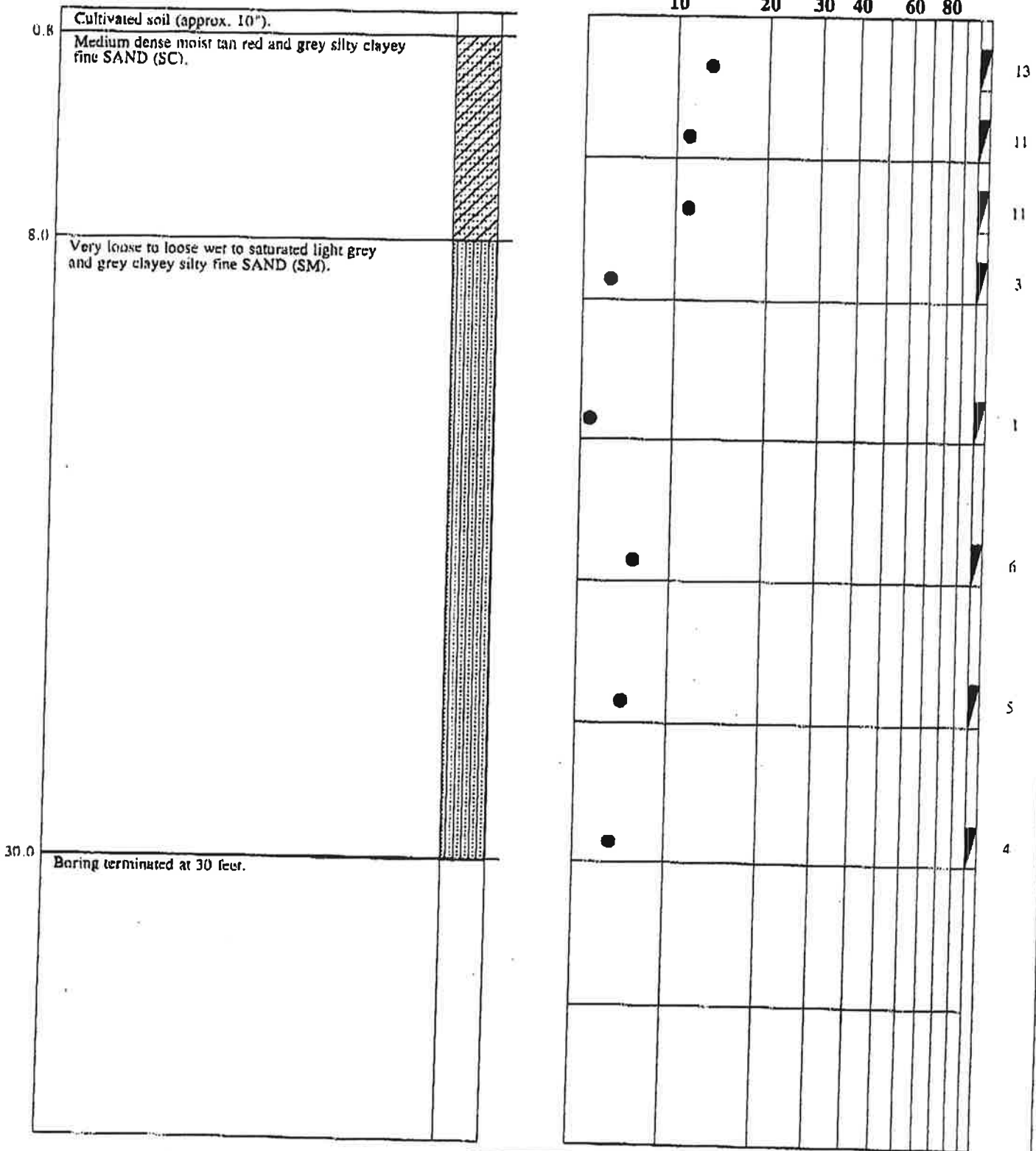


**TITAN Atlantic Group**  
 ENGINEERING ▲ CONSTRUCTION ▲ CONSULTING  
 111-C WEST FIRE TOWER ROAD  
 WINTERVILLE, NC 28580  
 PHONE: (252) 353-1800  
 FAX: (252) 353-0002

**BORING LOCATION PLAN  
 MACGREGOR DOWNS  
 SUBSTATIONS  
 GREENVILLE, NC  
 TITAN PROJ NO. 019908-80**

CHECK: CFB	DRAWN: GRB	DATE: 11/30/01	SCALE: 1"=100'	DWG. NO. 2
------------	------------	----------------	----------------	------------

(F I.)



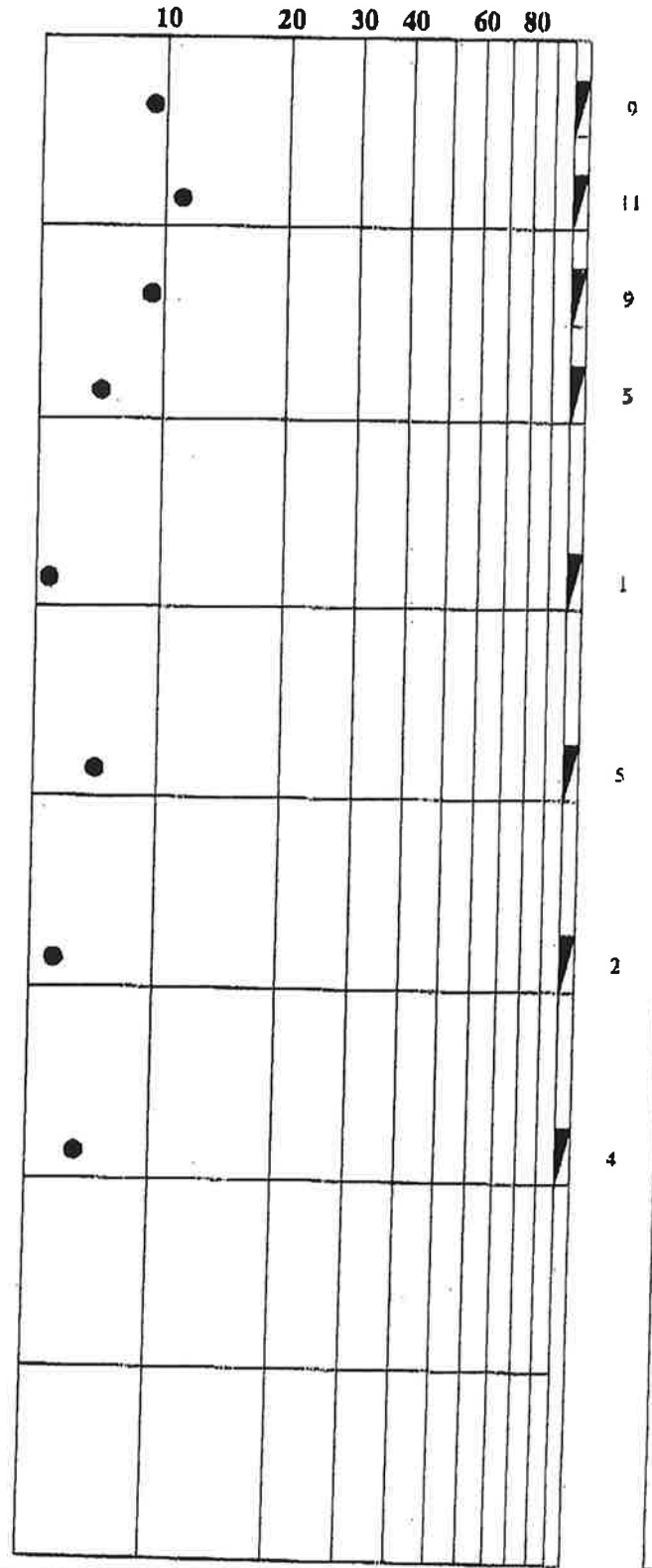
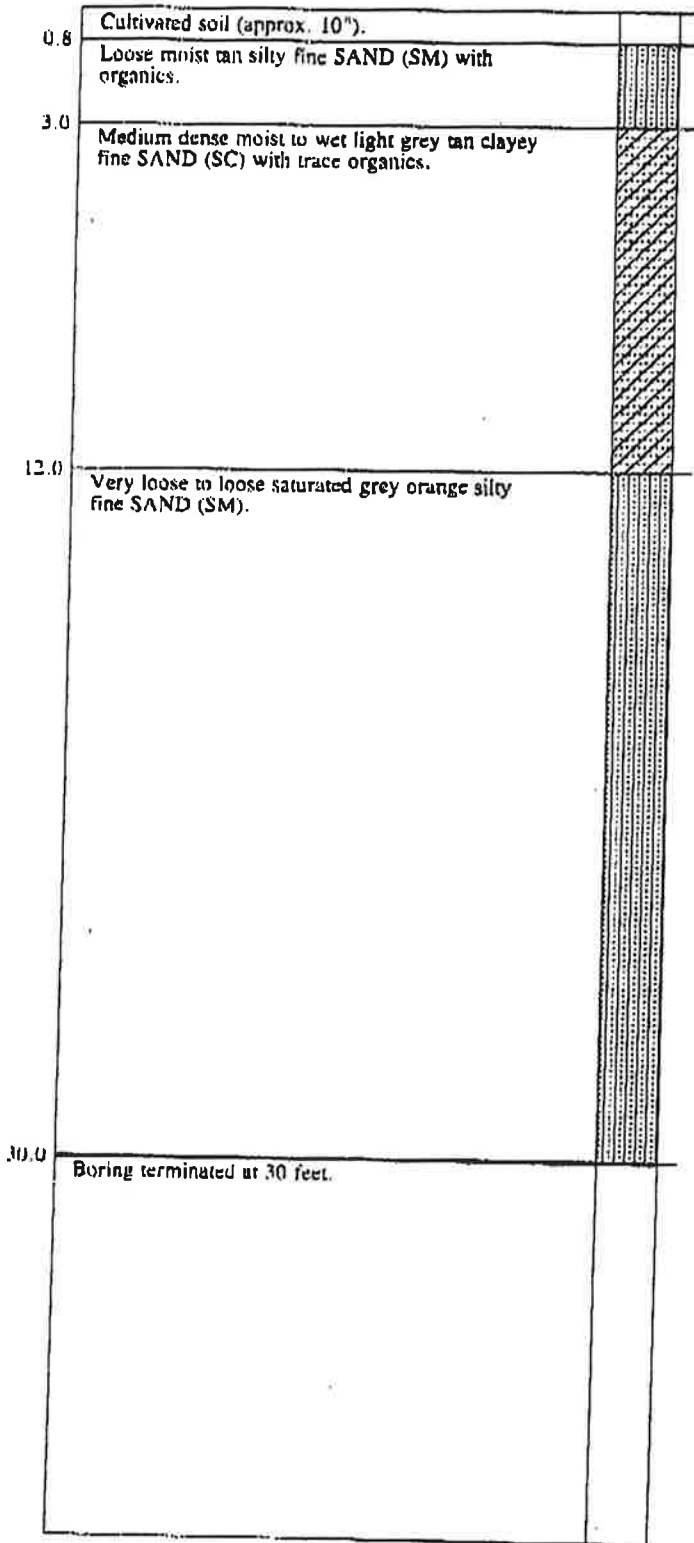
Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	12.0'	--	8 DAYS

<b>BORING LOG</b>	
<b>BORING NUMBER</b>	B-1
<b>DATE DRILLED</b>	11/12/01
<b>PROJECT NUMBER</b>	019907-80
<b>PROJECT</b>	MACGREGOR DOWNS SUBSTATIONS
<b>PAGE 1 OF 1</b>	
<b>TITAN ATLANTIC GROUP</b>	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

(P. 1. J)



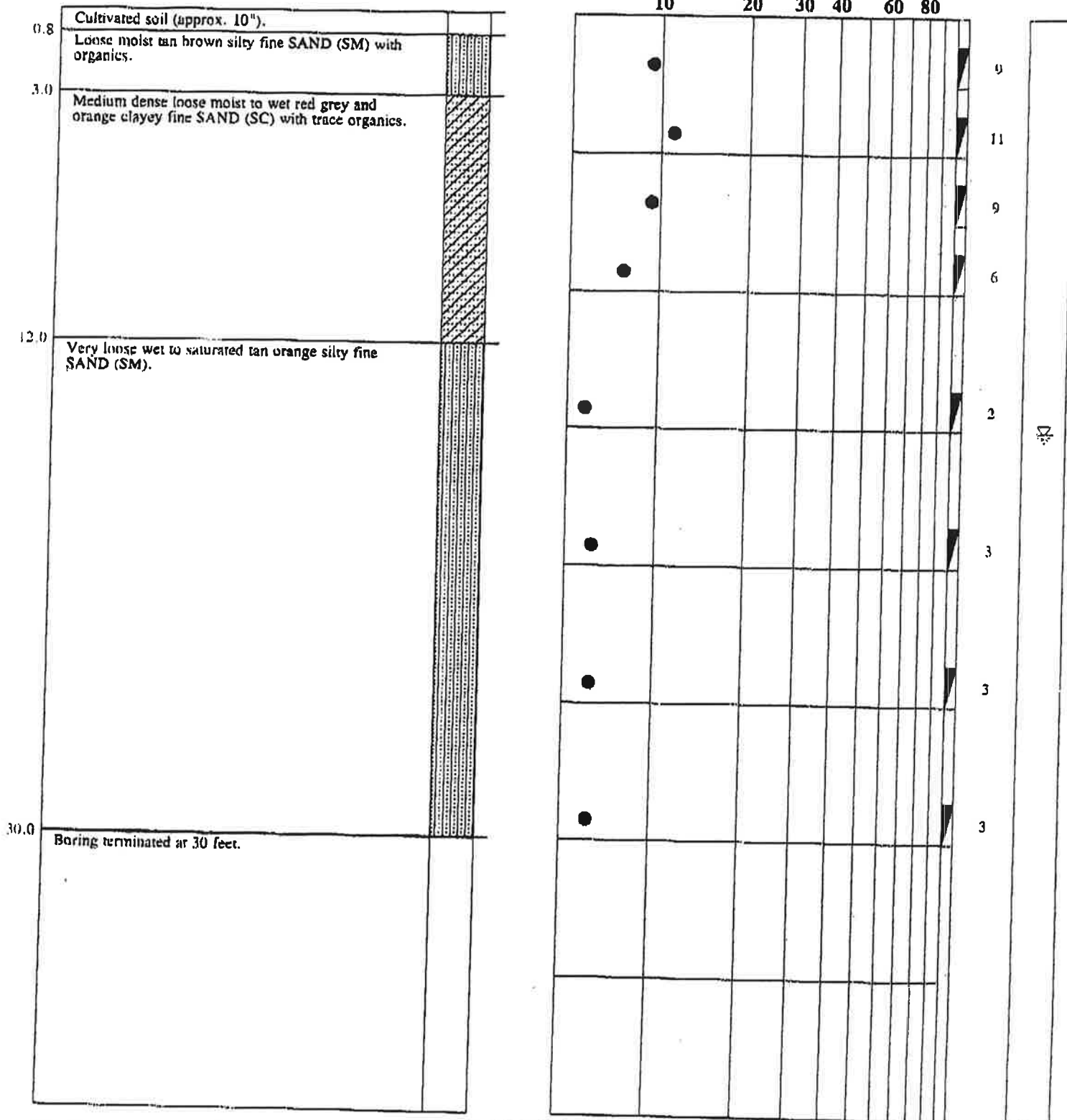
Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	14.0'	--	9 DAYS

BORING LOG	
BORING NUMBER	B-2
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	
<b>TITAN ATLANTIC GROUP</b>	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

(R1.J)



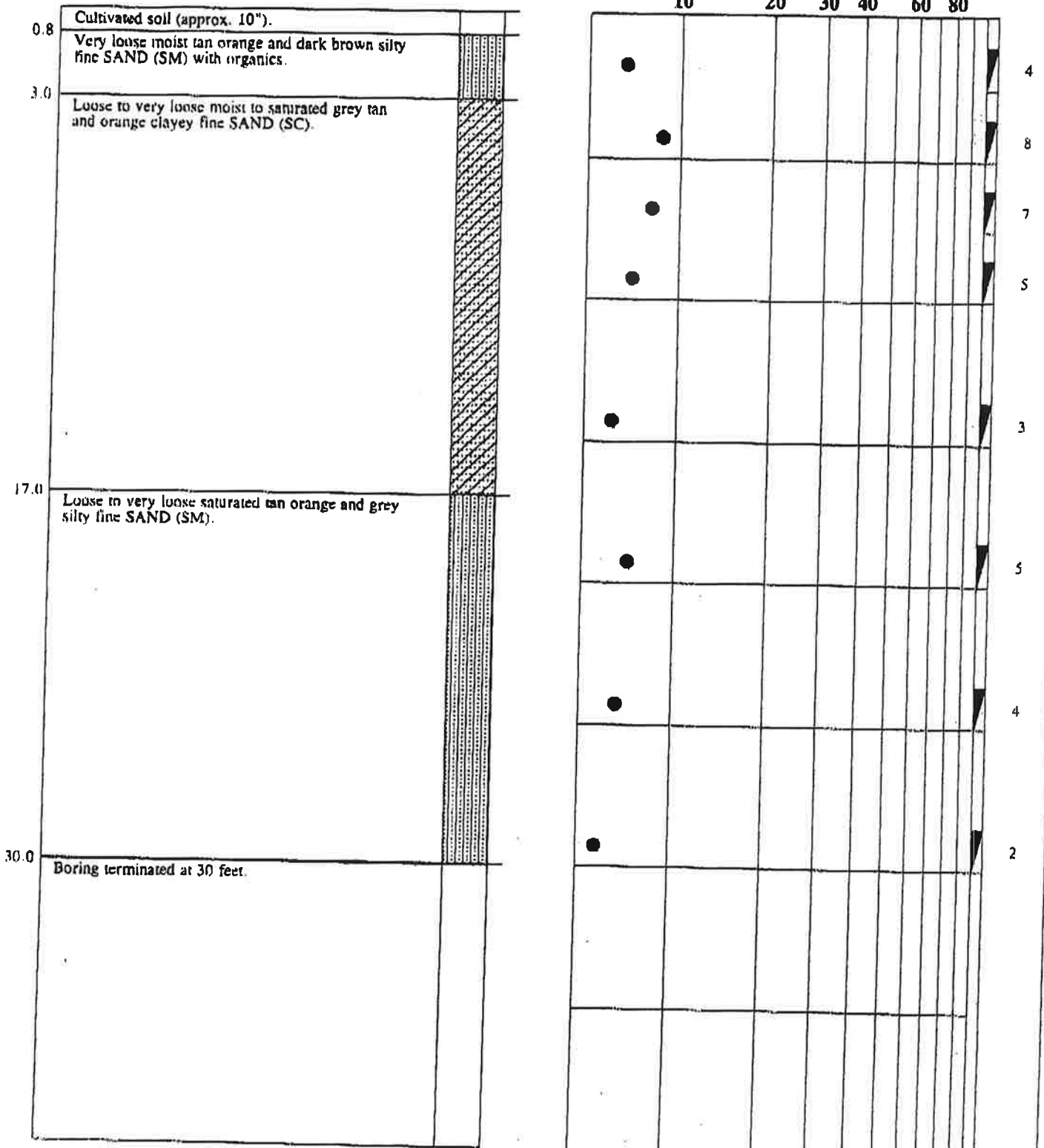
Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	15.0'	--	8 DAYS

BORING LOG	
BORING NUMBER	B-3
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	
<b>TITAN ATLANTIC GROUP</b>	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

(F1.)



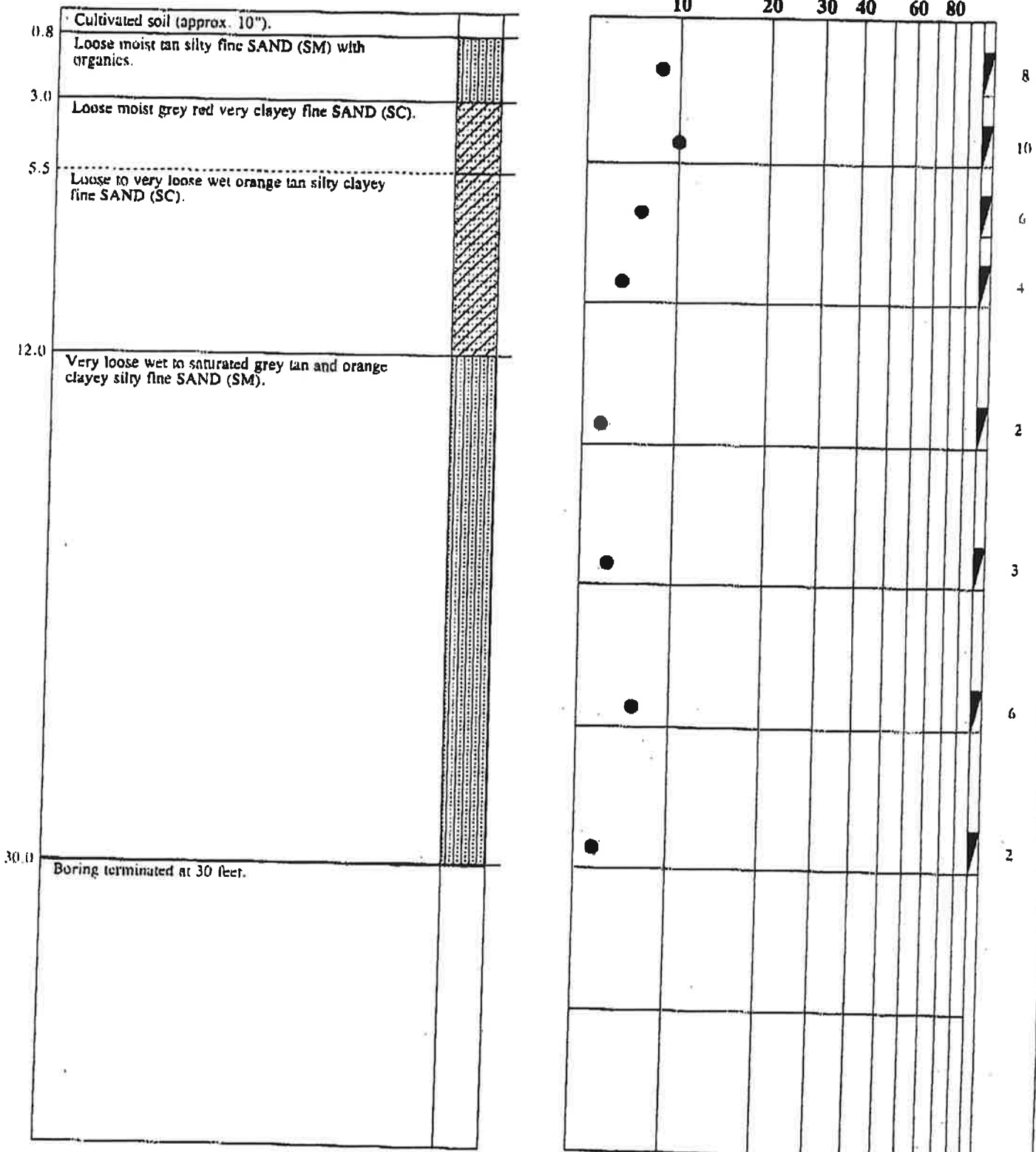
Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	15.7'	--	8 DAYS

<b>BORING LOG</b>	
<b>BORING NUMBER</b>	B-4
<b>DATE DRILLED</b>	11/12/01
<b>PROJECT NUMBER</b>	019907-80
<b>PROJECT</b>	MACGREGOR DOWNS SUBSTATIONS
<b>PAGE 1 OF 1</b>	
<b>TITAN ATLANTIC GROUP</b>	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

(F 1.)



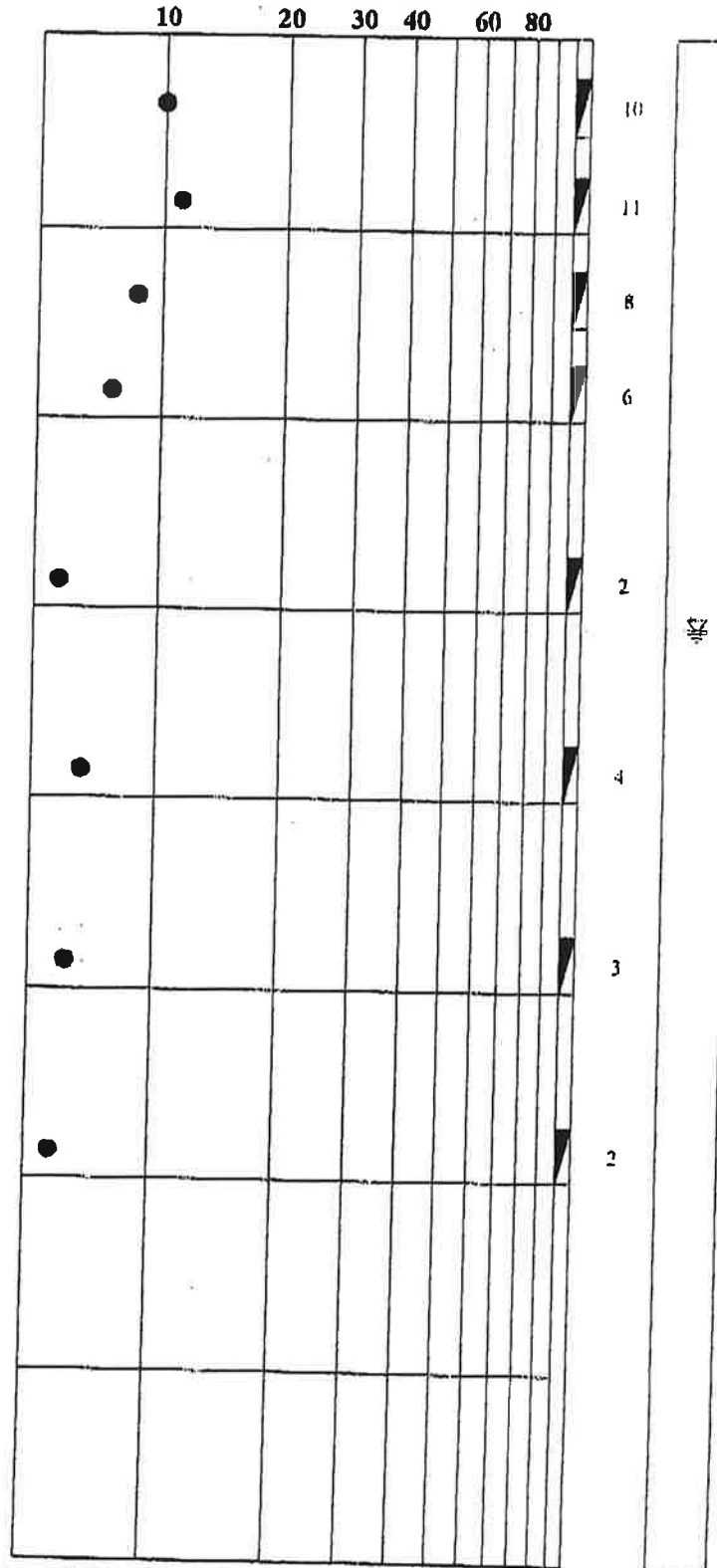
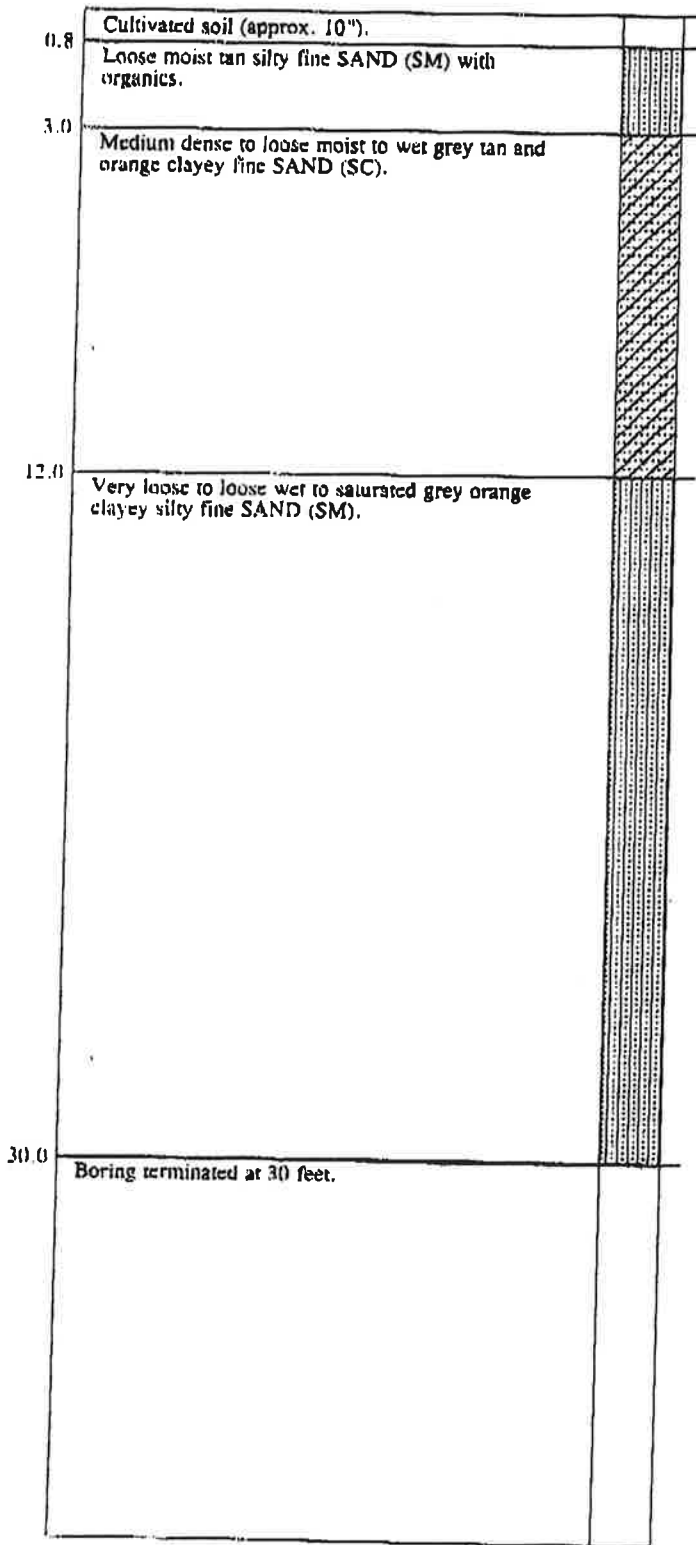
Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	15.5'	--	9 DAYS

<b>BORING LOG</b>	
<b>BORING NUMBER</b>	B-5
<b>DATE DRILLED</b>	11/12/01
<b>PROJECT NUMBER</b>	019907-80
<b>PROJECT</b>	MACGREGOR DOWNS SUBSTATIONS
<b>PAGE 1 OF 1</b>	
<b>TITAN ATLANTIC GROUP</b>	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

(FT.)



Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

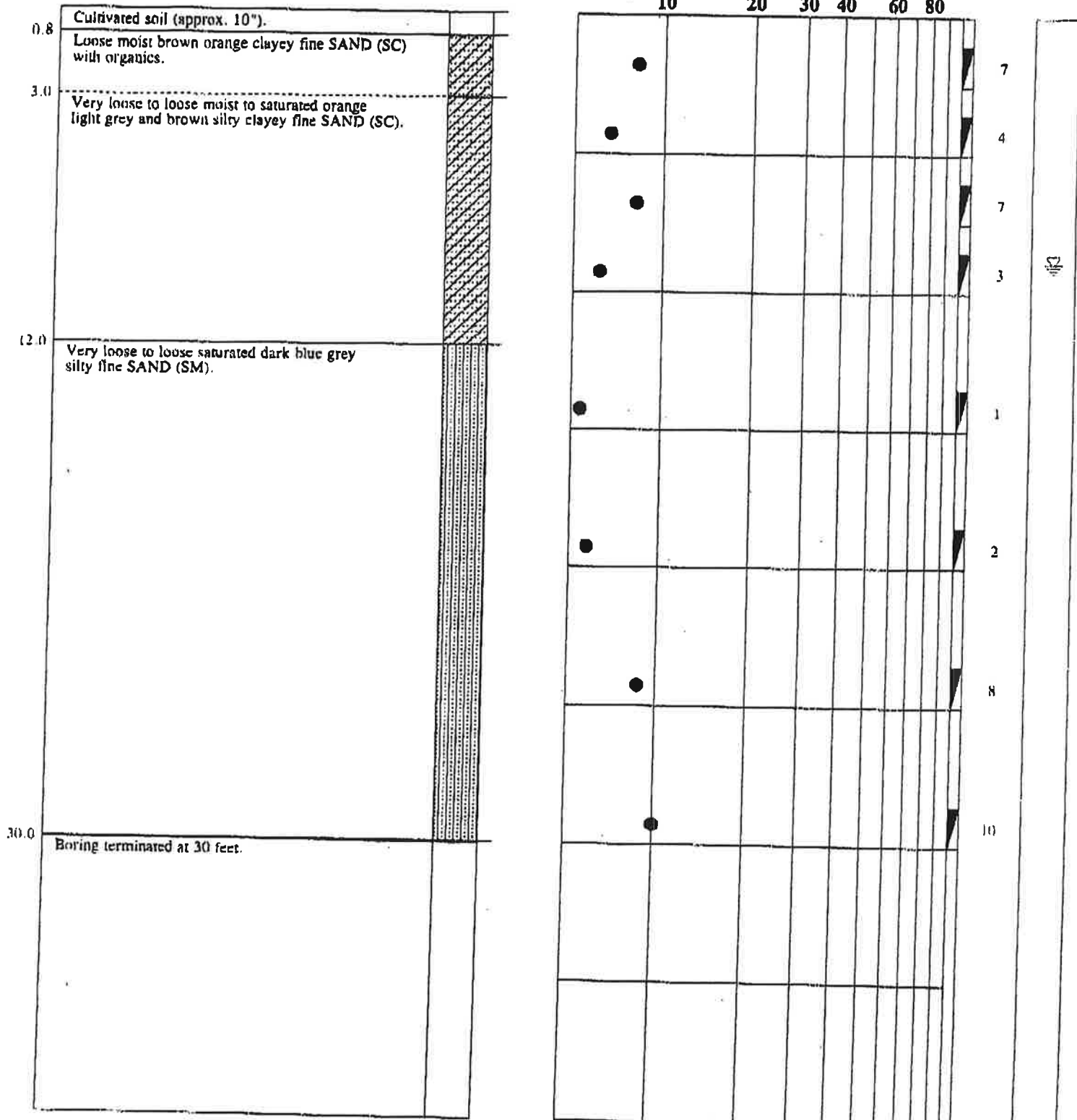
GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	15.4'	--	9 DAYS

BORING LOG	
BORING NUMBER	B-6
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	
TITAN ATLANTIC GROUP	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS



(FT.)



Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

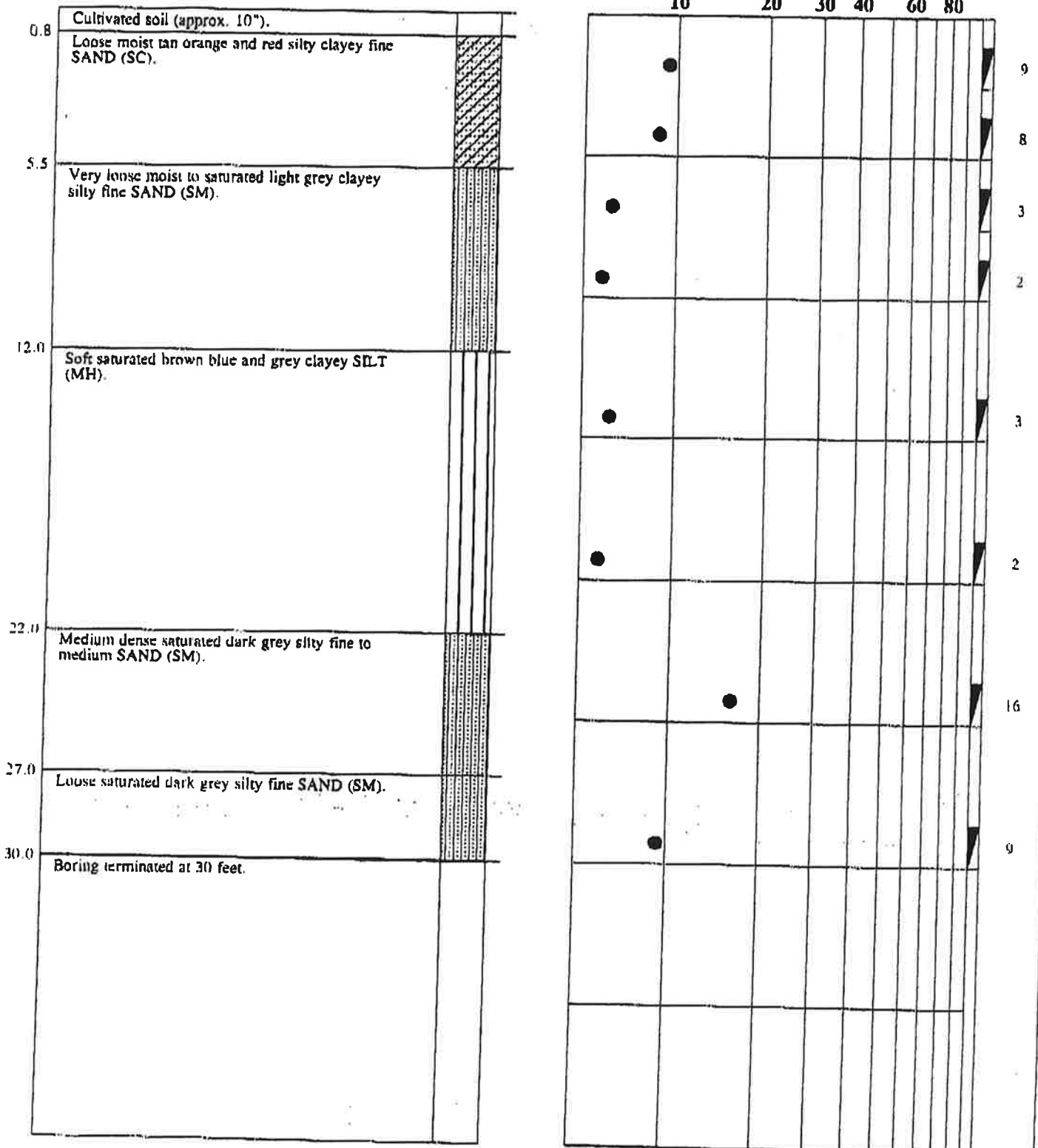
GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	8.9'	--	9 DAYS

BORING LOG	
BORING NUMBER	B-7
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	
<b>TITAN ATLANTIC GROUP</b>	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS



(F.T.)



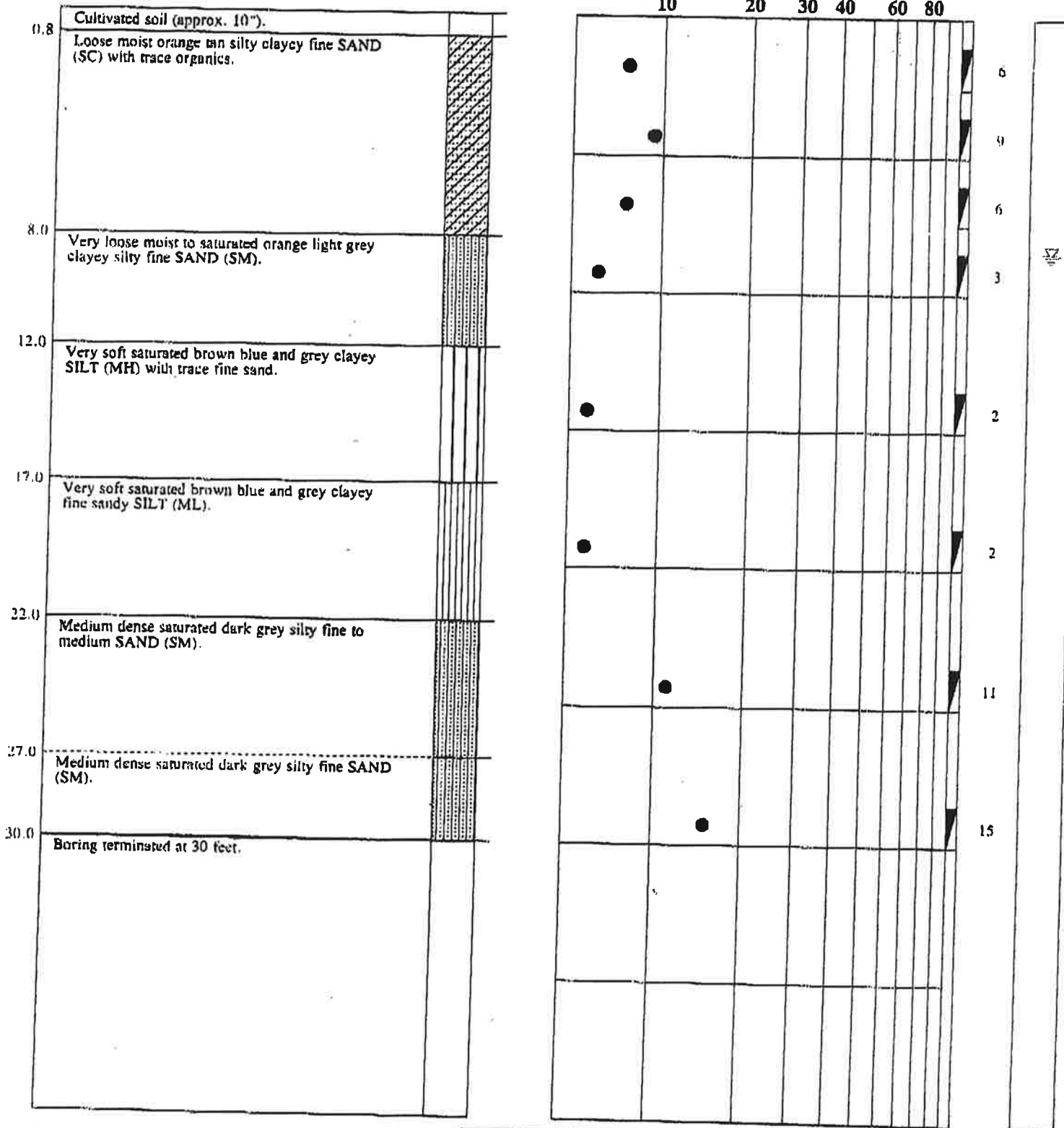
Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	8.5'	-	9 DAYS

<b>BORING LOG</b>	
<b>BORING NUMBER</b>	B-8
<b>DATE DRILLED</b>	11/12/01
<b>PROJECT NUMBER</b>	019907-80
<b>PROJECT</b>	MACGREGOR DOWNS SUBSTATIONS
<b>PAGE 1 OF 1</b>	
<b>TITAN ATLANTIC GROUP</b>	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

(R 1.)



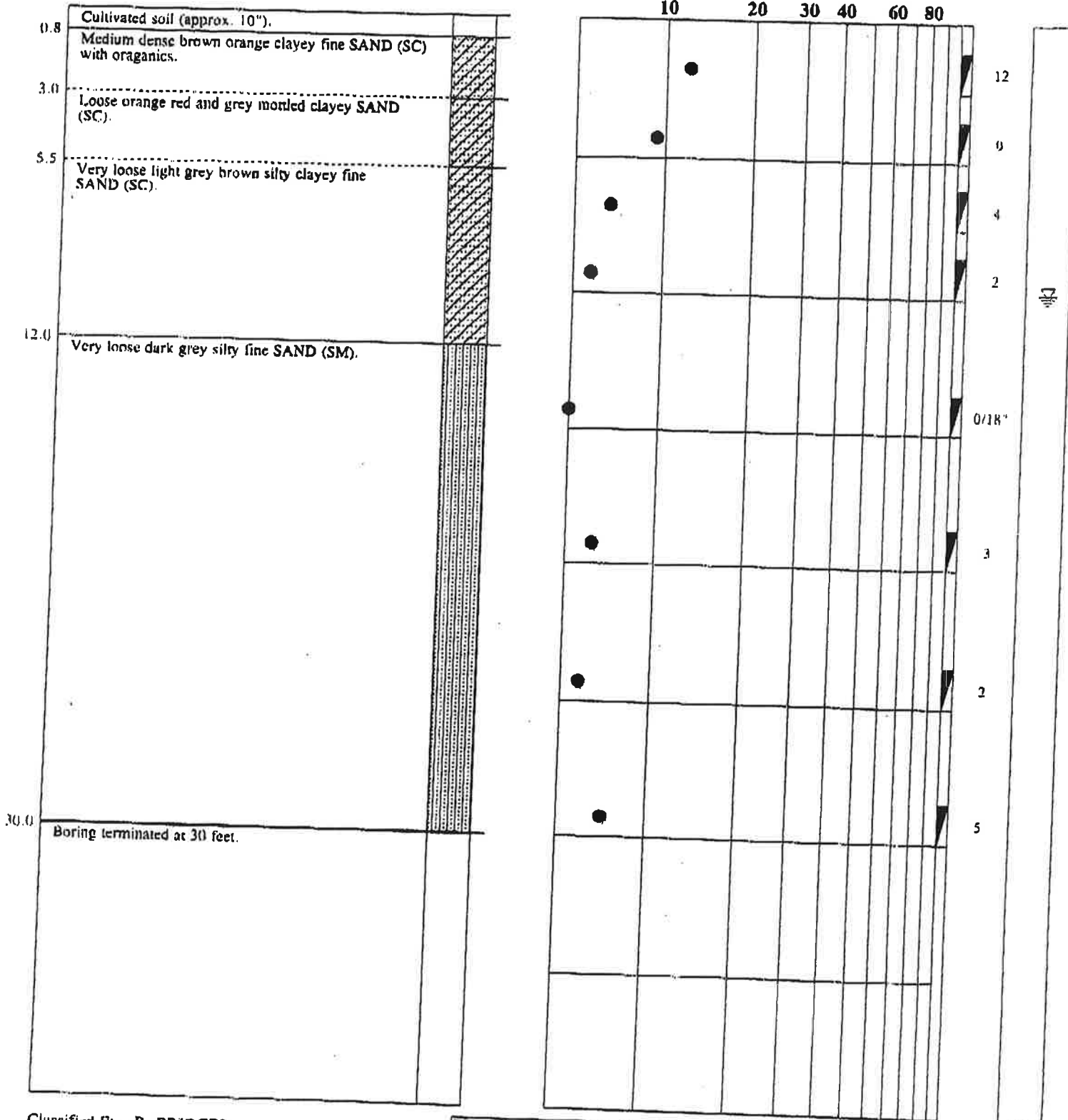
Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	8.5'	--	8 DAYS

BORING LOG	
<b>BORING NUMBER</b>	B-9
<b>DATE DRILLED</b>	11/12/01
<b>PROJECT NUMBER</b>	019907-80
<b>PROJECT</b>	MACGREGOR DOWNS SUBSTATIONS
<b>PAGE 1 OF 1</b>	
<b>TITAN ATLANTIC GROUP</b>	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

(F1.)



Classified By: R. BRIDGER  
 Driller: CAROLINA DRILLING  
 Drill Rig: CME 45  
 Boring Type: MUD ROTARY

GROUNDWATER READINGS				
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	9.8'	--	9 DAYS

**BORING LOG**

<b>BORING NUMBER</b>	B-10
<b>DATE DRILLED</b>	11/12/01
<b>PROJECT NUMBER</b>	019907-80
<b>PROJECT</b>	MACGREGOR DOWNS SUBSTATIONS
<b>PAGE 1 OF 1</b>	

**TITAN ATLANTIC GROUP**

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS