SECTION 5

GEOTECHNICAL ENGINEERING

Table of Contents

5.1 INTRODUCTION ......................................................................................................... 1
  5.1.1 GENERAL .......................................................................................................... 1
  5.1.2 INVESTIGATION AND DESIGN .............................................................................. 1
    5.1.2.1 Subsurface Investigation ................................................................................. 1
    5.1.2.2 Laboratory Testing ........................................................................................... 2
    5.1.2.3 Foundation Recommendations ....................................................................... 2
  5.1.3 RESPONSIBILITY ................................................................................................ 2
    5.1.3.1 Engineer .......................................................................................................... 2
    5.1.3.2 Authority .......................................................................................................... 3

5.2 GEOTECHNICAL INVESTIGATION ........................................................................... 3
  5.2.1 PRELIMINARY INVESTIGATION ............................................................................ 3
  5.2.2 SUBSURFACE INVESTIGATION FOR DESIGN ......................................................... 4
    5.2.2.1 Boring Program ............................................................................................... 4
    5.2.2.2 Testing Program ............................................................................................ 10
  5.2.3 TEST BORING CONTRACT ................................................................................ 12
    5.2.3.1 General .......................................................................................................... 12
    5.2.3.2 Plans .............................................................................................................. 12
    5.2.3.3 Specifications ................................................................................................ 13
    5.2.3.4 Contract Award .............................................................................................. 13
    5.2.3.5 Inspection ...................................................................................................... 14
    5.2.3.6 Geotechnical Engineering Report ................................................................. 20

APPENDIX A  SAMPLE BORING SPECIFICATIONS ......................................................... 28
APPENDIX B  BURMISTER SOIL IDENTIFICATION SYSTEM .......................................... 72
APPENDIX C  BORING INSPECTOR’S MANUAL .............................................................. 81
APPENDIX D  LABORATORY TESTING FOR SOILS ........................................................ 95

List of Exhibits

<table>
<thead>
<tr>
<th>Exhibit</th>
<th>Description</th>
<th>Page No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhibit 5 - 1</td>
<td>Boring Log</td>
<td>16</td>
</tr>
<tr>
<td>Exhibit 5 - 2</td>
<td>Sample Boring Log</td>
<td>18</td>
</tr>
<tr>
<td>Exhibit 5 - 3</td>
<td>Foundation Recommendation Summary</td>
<td>27</td>
</tr>
</tbody>
</table>
SECTION 5
GEOTECHNICAL ENGINEERING

5.1 INTRODUCTION

5.1.1 General

The performance of engineering works (buildings, bridges, embankments, dams, etc.) is affected, to a major degree, by the performance of their foundations. It, therefore, becomes very important that the behavior of the materials on which the foundation is to be placed be investigated very thoroughly. Adequate knowledge of the behavior of the foundation conditions leads to a greater degree of confidence in design with consequent savings in cost.

This Section is to provide all Engineers with an outline of the work and methods expected that relate to geotechnical investigations, preparation of plans and specifications and construction monitoring.

The use of this Section is intended to provide a uniform approach to the geotechnical aspects of Authority projects and the presentation in contract plans and specifications. It also provides an outline of the required documentation of foundation design and related decisions.

5.1.2 Investigation and Design

5.1.2.1 Subsurface Investigation

Knowledge of the subsurface soils is essential for good foundation design. To obtain this information, it is necessary to conduct subsurface investigations. Methods usually utilized include borings (with dry, undisturbed core samples), seismic, electrical resistivity and other geophysical methods.

The subsurface investigation program should be geared toward obtaining all the relevant information without excessive costs. Prior knowledge of the surface conditions and the geology of the area are very helpful in achieving this result. Undisturbed samples should be scheduled so that the behavior of the soils can be studied through laboratory testing.

Site-specific seismic in-situ tests are used as part of a comprehensive geotechnical investigation. Crosshole Seismic Surveys are used as site-specific tests to obtain in-situ properties of soil and rock strata. The survey yields valuable information as to the strength and cohesiveness of the underlying soil and bedrock, information that is critical to any engineering endeavor. Crosshole Seismic Surveys measure the time for horizontally traveling compressional (P) and shear (S) waves to travel from a source hole to a receiver hole.
5.1.2.2 Laboratory Testing

The purpose of the laboratory program is to ascertain the in-situ properties of the soils and to study their behavior under conditions expected in design. It, therefore, is necessary that the Geotechnical Engineer be familiar enough with the project to simulate these conditions during the testing program. It is not the amount of data obtained that leads to a good design, but the accuracy and relevancy of the data.

5.1.2.3 Foundation Recommendations

The end result of the subsurface investigation and laboratory testing programs is a satisfactory and economical foundation. The Geotechnical Engineer must take into consideration all relevant aspects of the structure (e.g. type, function, aesthetics, etc.), and the allowable tolerances within which the structure will function satisfactorily, in arriving at the type of foundation.

The type of study involved in the soils and foundation design depends on the subsurface conditions. A competent foundation soil, such as dense sand, may require minimal effort in arriving at a foundation recommendation, and may permit a simple conventional foundation. On the other hand, a poor foundation soil, such as soft organic clay, will involve very complex soil analyses and foundation treatment.

5.1.3 Responsibility

5.1.3.1 Engineer

If required by the terms of the Order for Professional Services (OPS) with the Authority, the Engineer will prepare Plans and Specifications for a Boring Contract, invite bids from selected Contractors, receive and evaluate the bids and award the Contract after receiving the Authority’s approval of the bids. The Engineer will keep a complete record of all quantities, prepare interim and final estimates for payment to the Contractor and, upon completion, provide the Authority’s Project Manager with a complete accounting of the Boring Contract, together with an “as-built” set of the Contract Plans showing all the borings taken with their exact locations, and a complete set of boring logs as shown in Exhibit 5-1. Additionally, field boring logs shall be submitted on a weekly basis.

During the boring operations, the Engineer will stake out the location of each boring in the field, and obtain ground level elevations at each boring location. As work progresses and information on the subsurface conditions is obtained, the Engineer may wish to take additional borings or rearrange the locations of existing borings to obtain complete information of local problem areas. The Engineer will staff the job with experienced inspectors who will carefully inspect the work and keep complete logs of all the borings. Upon completion of the Contract, these logs will be incorporated into the construction contract plans. Sample boring log information sheets are shown in Subsection 5.2.3.5 (Exhibits 5-1 and 5-2).
The Engineer will prepare or arrange for the preparation of a laboratory testing program, if necessary, to obtain soil characteristics needed for design. The Engineer will select a laboratory to conduct the testing program, and will supervise the program to ensure that all the necessary geotechnical data is obtained. If the cost of the testing program is reimbursable to the Engineer, the Authority's approval of the laboratory must also be obtained. The Engineer will keep a complete record of all tests, prepare interim and final estimates for payment to the laboratory, and if required, submit a final accounting to the Authority upon completion of the testing program.

The results of the soil investigation and soil testing programs will be interpreted and analyzed by the Engineer, and these results will be utilized in making the foundation recommendations for structures and earthworks.

5.1.3.2 Authority

If required by the terms of the OPS, the Authority’s Engineering Department will review the Boring Contract Plans, Specifications and all proposals for compliance with its standards, prior to the Engineer inviting bids, and will advise the Engineer of changes which are deemed necessary. The Authority’s Project Manager will coordinate all work with adjacent projects.

After the bids have been received and checked by the Engineer, the Engineer shall make the award based on the lowest acceptable bid. The Authority’s Engineering Department will review the bids together with the Engineer’s recommendation, and will advise the Engineer whether the award should be made.

The Authority’s Engineering Department will review the soil testing program and will decide the acceptability of the laboratory.

The Authority’s Engineering Department will review the Engineer’s foundation recommendations and any soils design computations or procedures necessary to make the recommendations.

5.2 GEOTECHNICAL INVESTIGATION

The following is a brief outline of the necessary steps in such an investigation and some suggested possible subsurface investigation methods that might be used.

5.2.1 Preliminary Investigation

Prior to beginning the plan layout of the borings, the Geotechnical Engineer shall investigate all possible sources of existing information to inform themselves of the geology of the area and the nature of the soils. References shall include geology maps or papers, existing boring logs and foundations plans, soil and foundation reports, agricultural soil maps, borings made for previous construction nearby and Photogeologic Interpretation.
reports. Field reconnaissance of the proposed corridor and discussions with local residents sometimes may provide invaluable information not found in standard references. “The Geologic Map of New Jersey by Lewis and Kummel” is the standard reference geology map of New Jersey. Preliminary engineering soils information including engineering soil maps, by county, can be obtained from the Rutgers University publications entitled, “Engineering Soil Survey of New Jersey”. The United States Department of Agriculture, Soil Conservation Service also publishes soil maps which are useful when evaluating the upper layers of soil.

Normally the next step will be to proceed with the planning of the required additional subsurface investigations needed for design. However, there may be a few cases where additional preliminary information will be necessary for conceptual decisions to be made prior to design. A preliminary test boring program or other type of geophysical or photogeologic investigation should then be developed, approved by the Authority and implemented.

5.2.2 Subsurface Investigation for Design

This subsurface investigation program should provide all the subsurface information necessary for the design, preparation of plans and specifications, and for the construction of the proposed project. This program should include all necessary field in-situ and laboratory undisturbed testing. Appendix A contains more information in preparing Boring Specifications.

5.2.2.1 Boring Program

1. Layout

After having gained a preliminary knowledge of the geology and surface soils in the area, the Geotechnical Engineer should now be in a position to make a boring layout plan that will provide the maximum amount of information at the least possible cost. The size of the project and the type of foundation conditions expected will dictate the size of the investigation program.

The location and spacing of borings have not been standardized; therefore, the Geotechnical Engineer must use their own judgment in determining the location and spacing of the borings for the project. In general, if the subsurface profile is expected to be uniform, the spacing between borings can be large. On the other hand, if erratic soil layers or non-uniform conditions are expected, the spacing is reduced in an attempt to map the non-uniform conditions.

As a guide, it is suggested that the boring layout be separated into: (a) roadways, (b) bridges, (c) Retaining Walls and (d) Sign Structures.

a. Roadways - Roadway borings are generally 3-1/2” cased hole borings spaced approximately 100’ to 400’ apart along the centerline of roadways, with the smaller spacing used for poor foundation conditions such as deep layers of soft clays or non-
uniform conditions where lenses of soft clay are found in layers of sand. Average embankment widths may require only one boring per cross section, while very wide areas such as approaches to toll plazas, etc., may require two or three borings per cross section.

Larger diameter cased holes (4" or 6") are specified where undisturbed samples are needed for laboratory testing, or where in-situ shear tests are required. This occurs generally in areas of soft clays where undisturbed samples are needed for consolidation, strength or permeability testing.

In marshes or swamps, continuous sampling borings are specified at closer spacing to delineate the bottom of the organic deposits. In rock cuts, cores are required for the full depth of the cut to determine the type and quality of the rock. The rock cores are generally spaced 200 feet apart.

b. Bridges - At the time the Boring Contract is being prepared, the bridge plans may not be sufficiently advanced to determine the locations of the foundation units. The Geotechnical Engineer, in consultation with the bridge engineer, will need to consider all possible alternative designs and take sufficient borings to cover all possible alternatives. It is better to take a few extra borings at this time rather than to have to get additional borings later. If this condition does arise, it is to be brought to the attention of the Authority’s Project Manager at the time the Contract is being reviewed.

One boring is to be scheduled at each end of a foundation unit to ensure that there is not great variation in the subsurface profile across the length of the unit. Generally 3-1/2” cased hole borings, with ordinary dry samples, are specified, except in the event where clay layers are encountered. In this case, larger diameter holes are to be scheduled to obtain undisturbed samples for laboratory testing and special foundation analysis.

c. Retaining Walls - A minimum of two borings are to be scheduled for each retaining wall. For retaining walls more than 100 feet in length, borings shall be spaced every 100 to 200 feet with locations alternating from in front of the wall to behind the wall. For anchored walls, additional borings in the anchorage zone shall be spaced every 100 to 200 feet. For soil-nailed walls, additional borings at a distance of 1.0 to 1.5 times the height of the wall behind the wall shall be spaced at 100 to 200 feet.

The layout for noise walls, privacy walls, or solid face type fencing shall follow the same layout as for retaining walls.
The cost of a retaining wall is greatly dependent on the availability of the required type of fill materials. Therefore, investigations shall consider potential borrow sites within the contract limits that meet the requirements for wall select backfill.

d. Sign Structures - A minimum of one boring is to be scheduled per foundation unit.

The layout for High-Mast Lighting shall follow the same layout as for sign structures.

2. Depth Criteria

The depth to which borings are to be taken for embankment areas is a function of the embankment height, as well as of the type of foundation soil. If the foundation soil is granular, the borings are generally taken to about 30 to 40 feet in depth or until the standard penetration is 20 blows per 6” or greater, for a minimum thickness of 20 feet, whichever is deeper. For embankments over 20 feet in height, the depth of the borings is increased to about 50 to 60 feet in depth, or until the standard penetration is 20 blows per 6” or greater for a minimum thickness of 20 feet, whichever is deeper. A few borings are to be taken deeper, either to a minimum depth of 100 feet or to rock, to investigate the possible existence of soft clay layers at lower elevations.

For the case of structure foundations on embankments, the depth of the borings, in granular soil, shall be a minimum of 60 feet or until the standard penetration is 20 blows per 6” or greater for a minimum thickness of 20 feet, whichever is deeper. For the case of structure foundations below existing ground, the above criteria shall apply below the bottom of footing elevation. At least two borings per structure shall be taken to a minimum of 100 feet or to rock, to investigate the possible existence of soft clay layers at lower elevations.

If the foundation soil is clay or silt, the borings shall be taken to a minimum depth where the proposed imposed stresses do not exceed ten percent of the existing overburden stress. A rough calculation shall be made of the proposed foundation stresses to determine this depth. At least one boring should be taken to rock or deep enough to obtain information for deep foundation design.

For deep foundations in soil, depth of exploration should extend below the anticipated pile or shaft tip elevation a minimum of 20 feet, or a minimum of two times the maximum pile group dimension, whichever is deeper. All borings should extend through unsuitable strata such as unconsolidated fill, peat, highly organic materials, soft fine-grained soils, and loose coarse-grained soils to reach hard or dense materials.
For piles bearing on rock, a minimum of 10 feet of rock core shall be obtained at each exploration point location to verify that the boring has not terminated on a boulder.

For shafts supported on or extending into rock, a minimum of 10 feet of rock core, or a length of rock core equal to at least three times the shaft diameter for isolated shafts or two times the maximum shaft group dimension, or whichever is greater, shall be extended below the anticipated shaft tip elevation to determine the physical characteristics of rock within the zone of foundation influence.

For retaining walls, depth of exploration should extend below where the stress increase due to the estimated foundation load is less than 10 percent of the existing effective overburden stress at that depth and be between 1 to 2 times the wall depth. Exploration depth should be great enough to fully penetrate soft highly compressible soils or soft fine grained soils, and extend into competent material of suitable bearing capacity.

For roadways in cut areas, the borings are taken to a minimum depth of 15 feet below the proposed profile grade. If poor foundation soils are encountered at this depth, the criteria for embankments shall also apply. The ground water level in these areas is very important and shall be carefully measured. It is recommended that observation wells be installed in selected boring holes to permit ground water readings over an extended period of time.

3. Borings

Methods commonly used to advance borings include wash borings, rotary drilling, auger drilling and probes. The Authority recommends the wash boring method, preferably with casing, and the rotary drilling method for drilling mud or hollow stem augers for the full depth of the hole. The use of drilling mud without casing will be allowed only in exceptional circumstances where a continuous and deep clay layer is encountered, and ground water readings are not critical. The approval of the Authority's Engineering Department is required prior to allowing the use of this method. The process of advancing a hole by the wash boring method can be found in most standard soil mechanics references, and will not be elaborated upon here.

Bore holes are to be grouted up after completion in accordance with New Jersey Department of Environmental Protection requirements.

4. Sampling
Type of sampling equipment along with their advantages and disadvantages are fully discussed in most standard references, and the various manufacturers’ catalogues.

The Geotechnical Engineer shall specify, in the Boring Contract, the type of sampling equipment most suitable for recovering the type of materials expected to be encountered. If there is a possibility that a special type of sampling equipment may be needed, this provision should be included in the contract with a minimal proposal quantity, so as to avoid having to negotiate a price for its use during the boring operation.

Ordinary dry samples for identification purposes shall be obtained by using the split spoon sampler with the standard penetration test on the spoon. Undisturbed samples may be obtained using the thin walled tube sampler, the piston samples or the Dennison sampler. Rock cores are obtained using the swivel type, double tube core barrel or the N&N Drilling Supply Core barrel part no. 39-108. Special types of sampling devices are available for extraordinary conditions and these should be investigated whenever the need arises. The Burmister Method of Soil Identification as outlined in Appendix B shall be used.

The details governing each type of sampler and the methods for using them to recover samples shall be stated in the Contract Specifications so that the Contractor is fully aware of their responsibilities when submitting their bid. Refer to Boring Inspector’s Manual in Appendix C for additional information.

5. Ground Water

Ground water levels shall be measured in each bore hole during the boring program. It is recommended that the ground water level be measured each morning before beginning work in a hole, and twenty-four hours after the hole is completed and the casing withdrawn. At selected locations, especially in cut sections, a perforated plastic pipe, referred to as an observation well, shall be inserted into the hole to keep it open, and the water level measured each day by the Engineer until it stabilizes. The method of installing the observation wells shall be described in the Contract Specifications and a typical detail shown on the Contract Plans. Refer to Appendix A - Subsection 2.14 for additional direction on the installation and handling of observation wells.

Also, where there is open, running or intermittent water at potential sites for structures and walls, the water shall be tested for pH, chlorides, sulfates and other aggressive chemical content.

6. In-Situ Shear Tests
As both strength and sensitivity may be altered during boring, sampling, and handling in the laboratory, it may be necessary, in the case of soft and sensitive clays and silts, to obtain in-situ shear strength values to compare with those obtained from laboratory testing. The in-situ vane shear test has been developed for this purpose, and is performed in conjunction with the boring program. The description of the test and the method of evaluating it may be obtained from most standard references. The method of performing the test shall be described in the Contract Specifications.

7. Geophysical Methods

In some instances, where large areas need to be investigated for specific information, geophysical methods may provide the information more rapidly and at less cost. Examples are the location of the surface of rock under shallow overburden in deep rock cut areas or the location of firm bottom in marshy areas. Most manufacturers now make portable seismic and electrical receptivity instruments that can be used for these purposes. Whenever the need arises for this kind of survey, it is recommended that these methods be given consideration.

8. Crosshole Seismic Tests

For certain bridge sizes, site-specific seismic in-situ tests shall be performed. They shall be performed in accordance with ASTM D 4428 / D4428 M-00 “Standard Test Methods for Crosshole Seismic Testing.” The three borehole method shall be used. An inclinometer survey shall be performed in the boreholes prior to performing the test. The size of the borehole to be used shall be coordinated with the testing company to ensure compatibility with their testing equipment. The Engineer may present other test methods they deem appropriate. The Authority’s Engineering Department will review the test and if acceptable will approve its use by the Engineer.

9. Cost Estimate

Each boring program must be accompanied by an Engineer’s cost estimate if the cost of the borings is reimbursable, stating the various items proposed, the estimated quantities, the unit cost, and the total amount. In addition to the normal boring items, the Authority includes a separate lump sum item to cover the Contractor’s cost for Mobilization. Whenever borings are to be taken on or adjacent to existing Authority roadways, definite procedures must be followed regarding lane or shoulder closings, signing, etc. The Authority also provides a lump sum item, Maintenance and Protection of Traffic, to cover these costs. A contingency amount to cover unusual developments shall also be added into the cost estimate. It is anticipated that most of the
work will involve 3-1/2” diameter holes utilizing Standard Penetration Testing.

The following list of Boring Contract Items has been approved by the Authority. (See sample “Scheduled Items of Work” in Appendix A). Special Items shall be added as required:

a. 3-1/2” Dia. Cased Hole Borings for Soil Sampling – Linear Feet
b. 4” Dia. Cased Hole Borings for Soil Sampling – Linear Feet
c. 1-1/8” Dia. (AX) Core Borings in Rock – Linear Feet
d. 2-1/8” Dia. (NX) Core Borings in Rock – Linear Feet
e. 1-3/8” Dia. Ordinary Dry Samples - Each
f. 1-7/8” Dia. Undisturbed Dry Samples - Each
g. 2-7/8” Dia. Undisturbed Dry Samples - Each
h. 3-3/8” Dia. Undisturbed Dry Samples - Each
i. 2-13/16” Dia. Undisturbed Dry Samples - Each
j. 2” Dia. In-Place Vane Shear Tests - Each
k. 3” Dia. In-Place Vane Shear Test - Each
l. Observation Wells - Each
m. Mobilization and Demobilization - Lump Sum
n. Maintenance and Protection of Traffic - Lump Sum

5.2.2.2 Testing Program

1. Laboratory Selection

Laboratory undisturbed tests and special exploration methods such as pressuremeter, cone penetrometer, seismic reflection, etc. require special training to perform and therefore will be contracted for on a negotiated basis with an approved contractor. The selection of a laboratory to perform the soil testing involves several factors. When the proposed testing program is extensive and complex, it is necessary to request engineering proposals from two or three reputable laboratories and make the selection based on these engineering proposals. An inspection of the laboratory facilities and an investigation into the availability of the personnel and equipment shall be conducted prior to making the selection. The testing laboratory must provide evidence of AASHTO or ASTM certification.

Most testing programs are not very extensive and do not require complex testing equipment. The selection, therefore, usually can be made on the basis of knowledge of the past performance of the laboratory on similar projects. The Engineer shall always obtain assurance from the potentially acceptable laboratory that the required equipment and personnel will be available during the testing period, thus enabling the completion of the testing program within the allotted time.

After the Engineer has made the tentative selection, and has discussed the proposed tests in detail with the laboratory, the Engineer shall obtain a unit price proposal stating the test
procedure for each test in detail, and any extra charges involved. With this in hand, the Engineer shall prepare a cost estimate on which the ceiling cost for laboratory testing will be based.

If the cost of the laboratory testing is non-reimbursable, the Engineer shall proceed with the testing program. If, however, the cost of the laboratory testing is reimbursable to the Engineer, a request for approval of the laboratory, the testing program and the estimated cost shall be submitted to the Authority’s Project Manager at least one month prior to the date of beginning the testing program. The request shall also include a brief summary of similar projects the laboratory has successfully completed in the past. Upon receipt of the Authority’s approval, the Engineer will notify the laboratory to proceed with the testing program. No work shall be done by the laboratory until two weeks after the Authority’s formal approval has been obtained.

2. Type of Tests

A list of soil test standards is provided in Appendix D. It is recommended that this list be adhered to in making up the testing program, except in cases where the need for a special test exists. In this case, the reason for the special test and a detailed test procedure shall be submitted to the Authority’s Project Manager prior to including it in the testing program.

The tests and the testing procedures shall simulate, insofar as is practical, actual conditions that may be encountered during and after construction. In this manner the test results will be expected to be more representative of field conditions.

3. Test Results

A preliminary summary of the test results shall be submitted to the Authority’s Project Manager within two weeks after the completion of the testing program, if required. This summary shall state the types and number of each type of test performed, with the results obtained from each test. Tables and/or plotted information shall accompany this summary.

Within a month after the completion of the testing program a full report shall be submitted to the Authority’s Project Manager. This report shall contain the final results of the testing program, and the resulting soil parameters for use in design. A discussion on the use of these soil parameters in design shall also be included.

4. Cost

If the cost of the testing program is reimbursable to the Engineer, a complete record of the program cost shall be submitted to the Authority’s Project Manager at the conclusion of the testing program. This record shall include the types and number of each
type of test performed by the laboratory and the unit price of each
type of test. The extension of these numbers, plus any extra
costs, comprises the total cost of the program and this total shall
be within the ceiling cost previously submitted to the Authority. If
an overrun of the ceiling cost is anticipated during the testing
program, the Authority’s Project Manager shall be notified well in
advance and approval obtained before the remaining tests are
performed.

5.2.3 Test Boring Contract

Most subsurface investigations for design will involve a significant number of
test borings. Normally the test boring work is contracted out on the basis of
bids. The Engineer should prepare all proposed test boring contracts in
accordance with Section 5 (Geotechnical) of the Design Manual.

5.2.3.1 General

The Authority recognizes that a Project may be divided into several
construction contracts for ease of construction. However, the
Authority prefers that the Engineer prepare one boring contract and
one testing contract for the entire Project. If the Engineer desires to
have more than one boring contract and more than one testing
contract, written justification shall be provided to the Authority’s
Project Manager outlining the reason(s) why more than one contract
is recommended and the associated benefits to the Authority.

The Boring Contract for the entire Project, unless the Authority directs
otherwise, is to be completed to ready-to-advertise status and
submitted to the Authority’s Project Manager no later than with the
Phase “A” submittal for review, as discussed below. Any subsequent
revisions to the preliminary plans, due to later phase reviews will be
reflected as a Change of Plan to the Boring Contract.

Payment for the boring work completed is to be based on monthly
estimates and to be for 90 percent of the contract items completed
plus up to 50 percent of the mobilization. The test boring contract is
to be between the Engineer and the boring contractor. If it appears
that the boring contract cost will exceed the boring contract bid,
permission should be obtained prior to exceeding the bid amount.

5.2.3.2 Plans

The Engineer is to submit a preliminary boring location plan either
with the 1”=200’ scale roadway schematics, or after the 1”=200’ scale
schematics are approved, but no later than one month prior to the
Phase “A” submittal for review by the Authority’s Engineering
Department. This will be reviewed and returned to the Engineer for
preparation of a 1”=30’ or 1”=50’ scale boring location plan. This
boring location plan shall be submitted to the Authority’s Project
Manager in sufficient time for it to be reviewed by the Authority’s
Engineering Department and returned to the Engineer before the
Phase “A” submittal. The Engineer shall use this 1”=30’ or 1”=50’
scale boring location plan only for field stake out purposes. This plan shall be accompanied by a list of the borings, showing the station and offset, type and estimated depth of each boring.

Shortly after the Phase “A” submittal, the Authority’s Project Manager will notify the Engineer of any changes to be made on the 1”=200’ scale boring location plan. After these changes have been made, the Engineer will be notified to invite bids for the Boring Contract. The 1”=200’ scale boring location plan shall be part of the Contract documents.

Also submitted with the plans shall be the Engineer’s cost estimate and a list of not less than three qualified bidders from who bids are to be invited. The Authority reserves the right to add or delete from this list as it deems to be in its best interest.

5.2.3.3 Specifications

Preliminary specifications for the Boring Contract shall be submitted to the Authority with the 1”=200’ scale boring location plans. These specifications shall be as complete as possible to minimize changes in the final submission. A sample guide specification for test boring contracts is provided in Appendix A. The proposed test boring contract should be structured so that adjustments in the boring work can be made as the results of the borings are received.

The Authority’s Engineering Department will review these specifications and return them to be finalized and resubmitted with the 1”=30’ or 1”=50’ scale boring location plans, in a form ready for invitation of bids.

5.2.3.4 Contract Award

The Authority’s Engineering Department will review the final plans and specifications concurrently with the Phase “A” review, and after having determined that they are in order, the Authority’s Project Manager will notify the Engineer to proceed with the invitation of bids from the approved list of bidders. The Engineer will invite bids by sending a complete set of Contract Documents to each of the approved bidders, allowing at least two weeks for the receipt of bids. In the event that Authority action is necessary for awarding the Contract, the date for receipt of bids will be set by the Authority.

Bids will be received by the Engineer at their office and will be publicly opened and read at the date and time set by the Authority. The Authority may arrange to have a representative present at the time of opening of bids. All of the proposal guarantee checks will be held until the Engineer has checked the bids for accuracy and compliance with the Specifications. After the bids are checked, the Engineer will return the proposal guarantee checks to all the bidders except the lowest and second lowest bidders. These will be held until the lowest
bidder has executed the contract, at which time the remaining two proposal guarantee checks will be returned.

The Engineer will formally notify the Authority’s Project Manager of the results of the bidding and recommend the disposition of the Contract. The Authority will review the results of the bidding and the Engineer’s recommendation and decide the action that shall be taken. The Authority’s Project Manager will formally notify the Engineer of the action taken, and if favorable, the Engineer will advise the lowest bidder to obtain the documents required to execute the Contract. In no event shall the Contract be executed or work begun until the mandatory two week Governor’s review period has elapsed.

When the Contract Agreement, the Contract Bond and all the required Insurance Certificates have been submitted by the lowest bidder, properly signed and executed, the Engineer will sign the Contract Agreement and notify the Contractor to proceed with the work. At the same time, the remaining proposal guarantee checks of the lowest and second lowest bidders shall be returned.

5.2.3.5 Inspection

It is the Engineer’s responsibility to provide field monitoring of the boring contract. Borings will be staked out in accordance with the contract plans and obtain ground elevations at each location. The ground elevations shall be read to the nearest one-tenth of a foot.

The Engineer shall provide trained and experienced boring inspectors to monitor the boring operations and prepare boring logs. The Boring Inspectors will be under the supervision of a licensed Geotechnical Engineer who will make periodic visits to the project site during the course of the boring work. Each boring rig shall have the full time attention of one Inspector who will keep a complete record of the entire operations of that rig. In the event that two rigs are close enough for the Inspector to easily walk from one to the other, one Inspector may cover these two rigs. The Inspectors shall make their own measurements of the length of the casing driven into the ground, not relying on the so called standard length which varies from one piece to the next. They shall measure accurately the depth to the top of each sample, keep a record of the penetration resistance of the sampler or the pressure used to push the thin-walled samplers into the ground, and also record any unusual observations.

The Inspector shall identify the samples recovered with the split spoon sampler and observe the jarring and labeling of representative samples for future identification checking or index testing. The jars shall be kept in a safe place away from open sunlight. The soil description to be used by the Boring Inspectors is the Burmister Soil Identification System (Ref. 2) which is noted in Appendix B. Undisturbed samples shall be properly sealed in accordance with the Specifications, by the driller in the presence of the Inspector, and
placed in the required sample tube container. The Inspector shall keep them safely, guarding them against sunlight, impact or vibration, and carefully transport them to the laboratory.

The Inspector shall verify that ground water levels are taken at each hole by the driller. Ground water levels shall be taken each morning before work begins at a hole, on completion of the boring after removal of the casing, and twenty-four hours later.

The Inspector shall assure that all borings are grouted up at the completion of the borings.

A Boring Inspectors Manual is provided in Appendix C. The boring log forms to be used are given in Exhibit 5 - 1. A sample boring log is given in Exhibit 5 - 2.

At the conclusion of the boring program, the Engineer shall prepare a revised list of borings showing the “as-built” boring station and offset, actual type and depth of each boring (the Engineer shall maintain a record of boring coordinates). This revised list is to be utilized in locating the borings on the construction contract plans.

The Inspector’s field boring logs shall be edited by the Geotechnical Engineer for consistency and completeness. A layout of the boring logs applicable to each construction contract shall be made on standard size sheets and incorporated in the construction plans as reference drawings.

It is the Engineer’s responsibility to provide storage for the samples obtained during the boring program. All samples shall be carefully stored so that they are readily available until such time as all borings and testing contracts are completed and all claims satisfactorily settled. When the Engineer no longer has need for the samples and cores, the Authority’s Project Manager will be contacted for direction on the disposition of the samples.
EXHIBIT 5 - 1
BORING LOG

ENGINEERING FIRM

BORING NO. BF-1
SHEET NO. 1 OF 2

<PROJECT TITLE, MUNICIPALITY>

(Engineer)

(Contractor)

<table>
<thead>
<tr>
<th>Contract No.</th>
<th>Purpose</th>
<th>Structure No.</th>
<th>Location</th>
<th>ROADWAY</th>
<th>STA.</th>
<th>OFF.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rig No.</td>
<td>2</td>
<td>Type</td>
<td>CME 55</td>
<td>Driller</td>
<td>Helper</td>
<td></td>
</tr>
<tr>
<td>DATE</td>
<td>5/26/05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME STARTED</td>
<td>10:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME FINISHED</td>
<td>2:30 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEATHER</td>
<td>50° Cloudy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEPTH REACHED</td>
<td>39.0'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GROUND ELEVATION 593.68 M.L.W. ELEVATION ZERO OF BORING LOG ELEVATION GROUND WATER

PAY QUANTITIES

<table>
<thead>
<tr>
<th>LINEAL FEET OF BORING</th>
<th>SAMPLES</th>
<th>LIN. FT. OF ROCK CORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2 in</td>
<td>3 in</td>
<td>4 in</td>
</tr>
<tr>
<td>ITEM</td>
<td>ITEM</td>
<td>ITEM</td>
</tr>
</tbody>
</table>

Drilling Mud
Ordinary Dry Samples O.D. | 2 in | I.D. | 1-7 | 140 lbs | 30 in |
Undisturbed Samples Type | Length | O.D. | I.D. |

GROUND WATER READINGS

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>DEPTH</th>
</tr>
</thead>
</table>

GENERAL REMARKS: Boring located @ center of Rte. 46 west bound right lane @ 15± ft. south-southwest of original location.

The subsurface information shown hereon was obtained for NJTA design and estimate purposes. It is made available to authorized users only that may have access to the same information available to the State. It is presented in good faith, but is not intended as a substitute for investigations, interpretation or judgment of such authorized users.

INSPECTOR RESIDENT ENGINEER
### BORING LOG

**Boring No. BF-1**

**<PROJECT TITLE, MUNICIPALITY>**

**Sheet No. 2 of 2**

<table>
<thead>
<tr>
<th>Elev. (ft)</th>
<th>Blows on Casin</th>
<th>Blows on Spoon for 6-in Penetration</th>
<th>Depth ft</th>
<th>Log No.</th>
<th>Material &amp; Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>593.68</td>
<td>43</td>
<td>0.5 - 2</td>
<td></td>
<td>S-1</td>
<td>6&quot; asphalt, Dk. Br. c-f SAND, tr. Silt, Some c-f Gravel Rec.: 9%</td>
</tr>
<tr>
<td>591.68</td>
<td>36</td>
<td>100/1&quot;</td>
<td></td>
<td>C-1</td>
<td>2.5 ft. Auger refusal Rec.: 8&quot; Color mix Blue/ Lt. Gr./Pink Cobbles and Boulders, Sand Screams RQD: 0%</td>
</tr>
<tr>
<td>589.68</td>
<td>50/3&quot;</td>
<td>4 - 4.3</td>
<td></td>
<td>C-2</td>
<td>No Recovery Rec.: 0&quot; Color mix Blue/ Lt. Gr./Pink Boulders, RQD: 8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C-3</td>
<td>Color mix Blue/ Lt. Gr. Cobbles and Boulders, RQD: 10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C-4</td>
<td>Color mix Blue/ Lt. Gr. Cobbles RQD: 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C-5</td>
<td>Color mix Blue/ Lt. Gr./Pink Cobbles RQD: 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C-6</td>
<td>Color mix Blue/White/ Lt. Gr./Pink Cobbles RQD: 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C-7</td>
<td>Color mix Blue/ Lt. Gr./Pink Cobbles and Boulders, RQD: 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C-8</td>
<td>Color mix Blue/White/ Lt. Gr./Pink Cobbles RQD: 0% Hit Sand layer at 36.5</td>
</tr>
<tr>
<td>554.60</td>
<td></td>
<td>END</td>
<td></td>
<td>END</td>
<td>End of Boring @ 39.0'</td>
</tr>
</tbody>
</table>

End of Boring @ 39.0'
EXHIBIT 5 - 2
SAMPLE BORING LOG

ENGINEERING FIRM

BORING NO. _______
BORINGS FOR
<PROJECT TITLE, MUNICIPALITY>

(Engineer)

(Contractor)

Contract No. _______ Purpose _______ Structure No. _______
Location _______ ROADWAY _______ STA. _______ OFF. _______

<table>
<thead>
<tr>
<th>Rig No.</th>
<th>Type</th>
<th>Driller</th>
<th>Helper</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME STARTED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME FINISHED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEATHER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEPTH REACHED</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GROUND ELEVATION _______ M.L.W. ELEVATION _______
ZERO OF BORING LOG _______ ELEVATION GROUND WATER _______

<table>
<thead>
<tr>
<th>PAY QUANTITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINEAL FEET OF BORING</td>
</tr>
<tr>
<td>2-½ in</td>
</tr>
<tr>
<td>ITEM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit Weight</th>
<th>Size</th>
<th>Weight of Hammer</th>
<th>Average Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling Mud</td>
<td>Ordinary Dry Samples O.D.</td>
<td>I.D.</td>
<td>lbs</td>
</tr>
<tr>
<td>Undisturbed Samples</td>
<td>Type</td>
<td>Length</td>
<td>O.D.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUND WATER READINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
</tr>
<tr>
<td>------</td>
</tr>
</tbody>
</table>

GENERAL REMARKS:

The subsurface information shown hereon was obtained for NJTA design and estimate purposes. It is made available to authorized users only that may have access to the same information available to the State. It is presented in good faith, but is not intended as a substitute for investigations, interpretation or judgment of such authorized users.

INSPECTOR ________________  RESIDENT ENGINEER ________________
<table>
<thead>
<tr>
<th>CONTRACT NO.</th>
<th>ROADWAY</th>
<th>STA. OFF.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Boring Log**

Boring No. [Blank]

<PROJECT TITLE, MUNICIPALITY> Sheet No. 2 of 2

<table>
<thead>
<tr>
<th>Elev. Blows (ft)</th>
<th>Blows on Spoon for 6-in Penetration</th>
<th>Sample Log</th>
<th>Material &amp; Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. 0.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**End of Boring**

End of Boring 8
5.2.3.6 Geotechnical Engineering Report

When developing submissions, the Engineer is expected to use objective engineering judgment and avoid performing analyses which proves what is already known or documented.

1. Design Memoranda - Preliminary Engineering

The purpose of the Design Memoranda is to provide statements and remedies for specific geotechnical issues identified on the project in sufficient detail to enable the preliminary engineering to advance.

The Scope of Work of the Design Memoranda is as follows:

Prepare a separate Design Memorandum for each identified issue. Issues may include:

a. Geotechnical Treatments for Unusual Soils or Geologic Conditions
b. Preliminary Cut and Fill Slope recommendations
c. Environmental Mitigation
d. Other Special Design Treatments

Design Memoranda deliverables include the following:

At a minimum, in each Design Memorandum:

a. State the Geotechnical issue and identify as either Simple or Complex
b. Provide Geotechnical Recommendations to address the issue
c. Explain the Alternatives that were considered
d. Provide a concise technical account (include such items as test borings, analysis, calculations, etc.) that supports the Geotechnical Treatment.

2. Meetings

Meetings will be held to discuss geotechnical issues, determine which issues warrant design memoranda, review design memoranda and other geotechnical recommendations, and coordinate with the other disciplines on the Design Team.

The meeting agenda, time, date and place will be made by mutual agreement with the project team consisting of the Authority’s Project Manager and the Engineer. Certain meetings will occur during the Preliminary Engineering and include:

a. Reconnaissance Plan
b. Drilling (Pre-bid, Startup and other, if needed)
c. Design Memos
d. Other Geotechnical Issues

The purpose and objective of the Structure Foundation Geotechnical Engineering Report is to provide the structure design, the parameters used to develop the design and the basis for the parameters used in the design of the structure.

Structure Foundation Geotechnical Engineering Report

The foundation report submission consists of foundation plans and geotechnical report.

The process from collection of field data to foundation approval can be expedited through the use of three major steps:

a. Collection and submission of data:
Upon completion of the boring and testing programs, submit draft versions of the as-drilled boring location plan, typed engineer's boring logs, and relevant boring profiles. Submit a summary of soil, rock and water testing performed, along with the raw test data. Reference the date of the boring and testing program approval, and note any major discrepancies. Also submit other significant subsurface information to be considered during foundation analysis. This information will receive a preliminary QA review for format, content and completeness.

b. Discussion of foundations and analyses to be performed:
After submission of the data and prior to formal evaluation of foundation alternatives, a discussion will be held to review the data. Parties to the discussion will be the Authority's Engineering Department and the Engineer. As a result of this discussion, foundation alternatives will be identified for further evaluation, including cost comparisons, as warranted. The requirement for detailed analysis of various foundation alternatives will not be warranted if the outcome is predictable from review of the basic data.

These further alternative analyses will be summarized in a table or matrix, and submitted for concurrence. Informal discussions will arrive at a consensus as to the foundation type(s) and the general substance of the geotechnical foundation recommendations.

c. Draft and final SFGER submission:
At a minimum, the following items should be covered in the report:

i. INTRODUCTION - Include project location, structure description, and site description. This should be a brief
overview discussion, of not more than three paragraphs. Provide the general conditions, features, and any relevant items of note.

ii. RECOMMENDATIONS - This is a concise summary of the geotechnical foundation recommendations, including the summary table required shown in Exhibit 5-3, a list of applicable special provisions and construction details, a list of the foundation notes to appear on the bridge plans, and design guidance (including geotechnical parameters) for the structural engineer. Place the table at the front of the text for this chapter; not at the end of the report. In order to expedite the design, use the Authority’s Construction Standards and Specifications as a basis for recommendations. Discuss deviations with the Authority’s Project Manager prior to making formal revisions. Minimize geotechnical analysis where standardized details and specifications are applicable.

iii. SPECIAL CONCERNS - Provide a paragraph on any special geotechnical concerns identified. This may include stability, settlement, or other concerns.

iv. FOUNDATION ALTERNATIVES - Provide a concise summary of the alternatives considered at each substructure site, and the reasons for selecting or rejecting each alternative. Reference supporting documents, calculations, and meeting minutes where alternatives were discussed. Provide these documents in appendices. Maintain coordination with the Authority’s Project Manager during analyses. Perform technical and economic comparisons for the various options considered only when approved. During the analysis and design process, identify the basis for using any value, parameter, or procedure (for example is the value based on test results, reference material and/or engineering judgment). Included shall be a discussion of retaining wall selection. Considerations shall include the selection of wall type, the physical and chemical characteristics of the in situ soil, ground water, flood and tidal levels at the site. Consideration of alternate/proprietary retaining walls (mechanically stabilized embankment and prefabricated modular walls) shall also be included where applicable.

v. SUBSURFACE CONDITIONS AT SUBSTRUCTURE UNITS - This should concisely summarize the engineer's interpretation of the data and understanding of conditions at each substructure. Soil, rock, and water conditions should be addressed. Provide one paragraph for each substructure unit.

vi. SITE EXPLORATION AND TESTING - Provide a two-paragraph summary of the boring and testing program, referencing the boring logs and test results.

vii. APPENDICES - Provide the following appendices to the report:
a) draft special provisions and construction details  
b) test boring logs  
c) foundation plan  
d) laboratory test results  
e) subsurface profiles  
f) geotechnical analyses  
g) cost comparisons (if needed)  
h) relevant correspondence

The most important parts of the geotechnical report are the RECOMMENDATIONS and APPENDICES subparts a, b and c. These will be the basis for the preparation of the foundation elements of the structure plans. The report itself should be kept to a minimum by avoiding repetitive text while still providing appropriate documentation to support the recommendations.

The submission can be made in one or two volumes, depending on its overall size. If a two volume submission is made, include text and Appendices A, B and C in the first volume. The remaining Appendices may be in a second volume.

The foundation report submission will be modified in response to comments on the draft submission. Modifications can be made through submission of individual pages or report sections, for approval. After approval of modifications is received, provide a complete final foundation submission, including a letter.

The deliverable includes the two foundation submission components that include foundation plans and geotechnical report. The deliverable is submitted in a draft and a final document. The draft submission is reviewed and comments are provided. The final submission addresses the comments and serves as the final Structure Foundation Geotechnical Engineering Report for the structure being addressed in the project.


The RGER is intended to present recommendations addressing the subsurface conditions identified in investigations which will impact the design and construction of the roadway and its associated structures.

The process from collection of field data to RGER approval can be expedited through the use of three major steps:

a. Collection and submission of data:
Upon completion of the boring and testing programs, submit draft versions of the as-drilled boring location plan, typed engineer's boring logs, and relevant boring profiles. Submit a summary of soil, rock and water testing performed, along with
the raw test data. Reference the date of the boring and testing program approval, and note any major discrepancies. Also submit other significant subsurface information to be considered during geotechnical analysis. Include a paragraph that summaries the Geotechnical information and any readily identifiable geotechnical problems or concerns. This information will receive a preliminary QA review for format, content and completeness.

b. Discussion of findings and analyses to be performed:
After submission of the data and prior to formal evaluation of geotechnical results, a discussion will be held to review the data. Parties to the discussion will be the Authority’s Engineering Department and the Engineer. As a result of this discussion, geotechnical concerns will be identified for further evaluation. The requirement for detailed analysis of geotechnical information will not be warranted if the outcome is predictable from review of the basic data.

Informal discussions will arrive at a consensus as to the geotechnical concerns and the general substance of the geotechnical recommendations. The Geotechnical Engineer will prepare and distribute minutes of these discussions. These meetings outcome and issues for further analyses will be summarized in a table or matrix, and submitted with the meeting minutes.

c. Draft and final RGER submission:
The submission is expected to include the report, geotechnical treatment plan, subsurface profile plans, and details and special provisions for construction.

The report itself should be kept to a minimum by avoiding repetitive text while still providing appropriate documentation to support the recommendations. Incorporate figures and tables within the body of the report, not at the end.

At a minimum, the following items are to be provided in the report:

i. INTRODUCTION – Include project location and description – This should be a brief overview discussion, of not more than three paragraphs. Provide the general conditions, features, and any relevant items of note.

ii. RECOMMENDATIONS – This is a concise summary of the geotechnical recommendations, referencing the Geotechnical Treatment Plan including a list of applicable special provisions and construction details, a list of the construction notes to appear on the plans, and design
guidance (including geotechnical parameters) for the engineer. In order to expedite the design, use the Authority’s Construction Standards and Specifications as a basis for recommendations. Discuss deviations with the Authority’s Project Manager prior to making formal revisions.

The recommendations section shall address, as applicable:

a) Embankment Construction  
b) Cut Construction  
c) Use of On-Site Materials  
d) Transition Zones and Subgrade Construction  
e) Pavement Design Parameters  
f) Special Treatments Not Listed Above  
g) Instrumentation for Construction Control

iii. ANALYSIS OF DATA AND CONCLUSIONS – (prepare this chapter to generally parallel Recommendations as previously outlined on a section-by-section basis.) This is an analysis of the field and laboratory data and assessment of the site conditions, subsurface investigations and laboratory findings. The analysis and interpretation must support the conclusions. Minimize geotechnical analysis where standardized details and specifications are applicable. During the analysis and design process, identify the basis for using any value, parameter, or procedure (for example is the value based on test results, reference material and/or engineering judgment).

The conclusions are to be developed from the analysis. The conclusions shall be concise, specific and supporting of each recommendation. Do not repeat recommendations in this chapter.

iv. SOIL, ROCK AN HYDROLOGIC SETTING – Provide a concise, integrated summary of findings of the subsurface investigation, field reconnaissance, test drilling and laboratory testing, as they relate to proposed roadway construction. The section will include:

a) Regional Physiography and Topography  
b) Soils -Provide a concise written overview of soil types and identify problem soils  
c) Geology - Provide summary table and show key stratigraphic units on Reconnaissance Map  
d) Hydrology - Include surface drainage and groundwater  
e) Environmental Impacts -include hazardous waste or potentially contaminated media sites; wetlands, streams and water wells; and oil and gas wells
v. **GEOTECHNICAL INVESTIGATIONS** - Provide a very brief summary for each boring and testing program conducted for the project. Reference the boring logs and test results.

vi. **REFERENCES** – Provide documents used to prepare report.

vii. **APPENDICES** - Provide the following appendices to the report:
   a) Geotechnical Treatment Plan
   b) Draft Special Provisions and Details
   c) Subsurface Profile
   d) Plan of borings, notes and reconnaissance mapping
   e) Test Boring Records
   f) Laboratory Test Results
   g) Calculations
   h) Relevant Correspondence

Provide unique page numbers for all sheets within each Appendix. Additional Appendices may be provided for photographs or other relevant materials.

For Tables, provide only those tables that are needed during the natural course of design development. Do not develop tables simply to meet any perceived RGER submission requirement.

Organize calculations with a table of contents. Include a cover sheet containing a list of persons whose initials appear on the calculations, with a statement prepared, signed and sealed by a Professional Engineer, registered in the State of New Jersey, that all calculations are checked.

The RGER submission can be made in one or more volumes, depending on its overall size. If a multi-volume submission is made, provide the report text and Appendix A, B, and C as the first volume.

The RGER will be modified in response to comments on the Draft RGER submission. Modifications can be made through submission of individual pages or report sections, for approval. After approval of modifications is received, provide a complete final RGER submission.

5. **Additional Meetings**

The purpose of the meetings is to discuss the plan review, geotechnical issues and geotechnical recommendations. The objective of the meetings is to establish that the geotechnical recommendations and geotechnical issues have been adequately addressed in the design plans so the project can be advanced.
# EXHIBIT 5-3
## FOUNDATION RECOMMENDATION SUMMARY

NEW JERSEY TURNPIKE AUTHORITY  
JOHN DOE ASSOCIATES  
Consulting Engineers

<table>
<thead>
<tr>
<th>SECTION NO.</th>
<th>CONTRACT NO.</th>
</tr>
</thead>
</table>

### STRUCTURE FOUNDATION RECOMMENDATION

Structure No.  Job No.  By  Date  

Location  

Roadway  Over-Under  

Lower Rdway.  in-on  

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Soil Bearing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Piles/Drilled Shaft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Design Load</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tip Elev.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Design Load Tons</td>
</tr>
</tbody>
</table>

Remarks:  

* Water Elev. - Indicates Water Table except for borings located in water it indicates Mean Low Water for area.

Design Load - for AASHO Group I Loading.

Form N23-A - Rev. 2007
APPENDIX A
Sample Boring Specifications
INVITATION FOR PROPOSALS

Proposals are invited for Contract No. __________________________ which involves the taking of borings for the __________________ project name of the New Jersey Turnpike Authority in _______________ County, New Jersey.

The principal items of work are as follows:

Proposals will be received at the office of ________ engineer’s __________ address __________________ until ________ time & date ________ at which time and place said proposals will be publicly opened and read.

Contract documents may be examined during office hours on or after ________ time & date ________ at the office of __________ engineer’s office ________.

Note: Asterisk denotes location where information concerning the specific project is to be inserted.
BORING CONTRACT NO. C -

* * * * * * *

PROPOSAL

To _______ engineer ________

The undersigned hereby declares that ________ carefully examined the Invitation for Proposals, Specifications, Plans, Contract Agreement and Contract Bond for the Project named above; that ________ personally inspected the actual location of work; and that ________ will contract to carry out and complete the Project as specified at the price per unit of measure bid for each scheduled item stated in the Scheduled Items of Work to follow.

It is understood that the Total Price stated by the undersigned in the following Scheduled Items of Work is based on the estimated quantities shown for each item of work and will control in awarding the Contract. It is further understood that the quantities stated in said schedule for the various items are estimates only and may be increased or decreased during the progress of the work, as provided in the Specifications.
## SCHEDULED ITEMS OF WORK

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Description</th>
<th>Approximate Quantity</th>
<th>Unit Price</th>
<th>Amount Dollars</th>
<th>Amount Cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mobilization</td>
<td>---</td>
<td>Lump Sum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td>Lin. Ft., 2-1/2” Dia. Cased Holes for Soil Sampling</td>
<td></td>
<td>Per Linear Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3)</td>
<td>Lin. Ft., 2-1/2” Dia. Cased Holes for Soil Sampling on water</td>
<td></td>
<td>Per Linear Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4)</td>
<td>Lin. Ft., 4” Dia. Cased Holes for Soil Sampling</td>
<td></td>
<td>Per Linear Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5)</td>
<td>Each, 1-3/8” Dia. Ordinary Dry Samples</td>
<td></td>
<td>Each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6)</td>
<td>Each, 2-7/8” Dia. Undisturbed Dry Samples</td>
<td></td>
<td>Each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Quantity</td>
<td>Item with Written Unit Price</td>
<td>Unit Price</td>
<td>Amount</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
<td>------------------------------</td>
<td>------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>7)</td>
<td>Each, 2” or 3” Dia. In-Place Vane Shear Tests</td>
<td>____________________________</td>
<td>Dollars Cents</td>
<td>Dollars Cents</td>
<td></td>
</tr>
<tr>
<td>8)</td>
<td>Lin. Ft., 1-5/8” Dia. Core Borings in Rock</td>
<td>____________________________</td>
<td>Per Linear Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9)</td>
<td>Lin. Ft., 2-1/8” Dia. Core Borings in Rock</td>
<td>____________________________</td>
<td>Per Linear Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10)</td>
<td>Lin. Ft., Observation Wells</td>
<td>____________________________</td>
<td>Per Linear Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11)</td>
<td>Maintenance and Protection of Traffic</td>
<td>Lump sum of</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Price $__________
Acknowledgement is hereby made of the following Addenda received since the issuance of the Plans and Specifications:


Accompanying this Proposal is a certified check or bid bond made payable to _______ in the amount of not less than five percent of the Total Price bid, which the undersigned agrees is to be forfeited as liquidated damages, and not as a penalty, if the Contract is awarded to the undersigned and the undersigned shall fail to execute and deliver the Contract Agreement and the Contract Bond and furnish satisfactory evidence of all required insurance coverage, all within the stipulated time; otherwise, the check will be returned to the undersigned.

(an Individual)

The undersigned is (a Partnership) under the laws of the State (a Corporation)
of _____________________________________________________________ having its principal office at _____________________________________________________________.

Name of Firm Bidder:

__________________________________________________________

Address of Firm:

__________________________________________________________

__________________________________________________________

Witness or Attest: Bidder’s Signature: ______________________

__________________________ Title:

__________________________ Date Signed: ________________, 20__

(Corporate Seal)
BORING CONTRACT NO. ______________
* * * * * * * * *

CONTRACT AGREEMENT

THIS AGREEMENT, made this ___________ day of __________________ in the year of our Lord Two Thousand and__________________________ between ___________ (engineer), party of the first part, hereinafter called the Engineer, ____________________________________________, party of the second part, hereinafter called the Contractor.

WITNESSETH, that the said Contractor, for and in consideration of the payments hereinafter specified and agreed to be made by the Engineer, hereby covenants and agrees to furnish and deliver all materials necessary, and to perform all the work required to be performed, including all work incidental thereto, for the making of boring for ___________________________________________ and to complete this Contract in strict and entire conformity with the attached Specifications and accompanying boring location Plans, which said Plans and Specifications and other Contract documents are hereby made a part of this agreement as fully and with the same effect as if the same had been set forth at length in the body of this Agreement.

The Contractor agrees to make payment of all proper charges for labor and materials required in the aforementioned work, and to defend, indemnify and save harmless the Engineer, the New Jersey Turnpike Authority, their officers, employees, agents and servants, and each and every one of them, against and from all suits and costs of every name and description, and from all damages to which the said parties may be put, by reason of injury to the person or property of others resulting from the performance of said work, or through the negligence of the Contractor, or through any improper or defective machinery, implements or appliances used by the Contractor in the aforesaid work, or through any act or omission on the part of the Contractor, or his agent or agents, employees or servants.

It is also agreed and understood that the acceptance of the final payment by the Contractor shall be considered as a release in full of all claims against the Engineer, the New Jersey Turnpike Authority or any of their officers, employees, agents and servants, arising out of, or by reason of, the work done and materials furnished under this Contract.

In consideration of the premises, the Engineer hereby agrees to pay to the Contractor for the said work, when fully completed, the sum of ____________________________ Dollars and ______________________ Cents ($_____________________________)

(Estimated), payments to be made at the bid prices specified in the Contractor’s Proposal, as provided in the Specifications and upon presentation of the proper certificates of the Engineer and upon the terms set forth in the Specifications. It is understood that the amount to be paid shall be the total based on the unit prices contained in said Proposal and made a part of this Contract, for the work actually done rather than the estimated total Price hereinaabove specified which is based upon estimated quantities.

This Contract is to be binding upon the Engineer and his successor or successors, and upon the Contractor and its executors, administrators, successor or successors, and is voidable.
and may be terminated by the Engineer if the provisions of the Specifications relative thereto are not complied with.

IN WITNESS WHEREOF, the parties hereto have duly executed this agreement the day and year first above written.

Witness:

____________________________________

By: _________________________________
Title: ________________________________

(ENGINEER)

CONTRACTOR:

______________________________
Name of Firm

______________________________
Address

Witness or Attest:

____________________________________

By: _________________________________
Title: ________________________________

(Corporate Seal)
BORING CONTRACT NO. __________
* * * * * * * * * * *

CONTRACT BOND

KNOW ALL MEN BY THESE PRESENTS that we, the undersigned,
_______________________________________________________ as PRINCIPAL, and
_____________________________________________________________ a Corporation
organized and existing under the laws of the State of _________________ and
duly authorized to do business in the State of New Jersey, as SURETY, are hereby held and
firmly bound unto
______________________________(engineer)________________________________
their successor or successors, in the penal sum of ______________________________
Dollars and Cents ($_______________________________), for the payment of which well
and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors,
administrators, successors and assigns.

Signed this ______________________ day of ____________________________,
A.D. two thousand and_________________________

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH that whereas the above
named Principal is about to enter into a contract with ___________engineer_________
their successor or successors, which said contract, for the making of borings for
____________________________ is hereby made a part of this bond as if set forth herein
at length.

NOW, THEREFORE, if the said Principal shall well and faithfully do and perform the
things agreed by __________________ to be done and performed according to the terms of
the said Contract, or any changes or modifications therein made as therein provided, and
shall pay all lawful claims and judgments of subcontractors, materialmen, laborers, persons,
firms or corporations, for labor performed or materials, provisions, or other supplies, or
teams, fuels, oils, implements or machinery furnished, used or consumed in the carrying
forward, performing or completing of said Contract, we agreeing and assenting that this
undertaking shall be for the benefit of any subcontractor, materialmen, laborer, person, firm
or corporation having a just claim, or judgment against the Principal, as well as for the
obligee herein, and shall defend, indemnify and save harmless the party of the first part
mentioned in the Contract aforesaid, the New Jersey Turnpike Authority, their employees,
agents and servants, and each and every one of them against and from all suits and costs
of every kind and description, and from all damages to which the said parties or any of their
officers, agents, or servants may be put by reason of injury to the person or property of
others resulting from the performances of said work or through the negligence of said party
of the second part to said Contract, or through any improper or defective machinery,
implements or appliances used by the said party of the second part in the aforesaid work or
through any act or omission on the part of the said party of the second part, or his agents,
employees or servants, and shall further defend, indemnify and save harmless the party of
the first part mentioned in the Contract aforesaid, the New Jersey Turnpike Authority, their
officers, employees, agents and servants, from all suits and actions of any kind or character
whatsoever which may be brought or instituted by any subcontractor, materialman or laborer
who has performed work or furnished materials in or about the work required to be done
pursuant to the said Contract, or by or on account of any claims or amount recovered for
any infringement of patent, trademark or copyright; then this obligation shall be void;
otherwise, the same shall remain in full force and effect, it being expressly understood and agreed that the liability of the Surety for any and all claims and judgments hereunder shall in no event exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that no modifications or omissions, or additions in or to the terms of the said Contract, or in or to the Plans or Specifications therefor, shall in anywise affect the obligations of said Surety on its bond.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers the day and year first set forth above.

PRINCIPAL:

________________________________________
Name of Firm

________________________________________
Address

Witness or Attest:
By: ______________________________________

________________________________________
Title:

SURETY:

________________________________________
Name of Firm

________________________________________
Address

Witness or Attest:
By: ______________________________________

________________________________________
Title:
(Contract Title)
BORING CONTRACT NO. C-_______
* * * * * * *

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1 - General Provisions</td>
<td>5 - 39</td>
</tr>
<tr>
<td>Section 2 - Special Provisions</td>
<td>5 - 59</td>
</tr>
</tbody>
</table>
SECTION 1 — GENERAL PROVISIONS

1.1. Definitions

Whenever in this contract the following terms, or pronouns in place of them, are used, their intent and meaning shall be interpreted as follows:

ENGINEER: Designer

INSPECTOR: Authorized representative of the Engineer, assigned to inspection of work and materials.

CONTRACT: The agreement covering the performance of the Project, hereinafter defined, and payments thereof, including the Invitation for Proposals, executed Proposal, executed Contract Agreement, executed Contract Bond, Specifications, Plans, Addenda if issued, and supplementary agreements which may be entered into, all of which documents are to be treated as one instrument as if set forth at length in the form of Contract Agreement.

PROJECT: The entire work to be performed within the limits specified for the Contract.

PLANS: Drawings or reproductions thereof, furnished by the Engineer, pertaining to the Project.

SPECIFICATIONS: This document of Specifications, and any Addenda that may be issued relating thereto.

PROPOSAL: The prepared form furnished by the Engineer, properly filled in and executed and submitted as a bid for the performance of the Project.

BIDDER: An individual, partnership or corporation, acting directly or through a duly authorized representative, legally submitting a Proposal.

CONTRACTOR: Party of the second part to this Contract, acting directly or through agents or employees, and primarily liable for the acceptable performance of the Project and for the payment of all debts pertaining to the Project.

SURETY: The corporate body which is bound with and for the Contractor, and which engages to be responsible for their acceptable performance of the Project and for the payment of all debts pertaining to the Project.

ADDENDA: Written interpretations or revisions of any of the Contract documents mailed or otherwise delivered to Bidders prior to the opening of bids.

AUTHORITY: The New Jersey Turnpike Authority.

1.2. Invitation to Bid

In accordance with the Invitation for Proposals, proposals will be received for the performance of the project, the designation of which is stated in the Invitation for Proposals. Bids are requested on the items stated in the form of Proposal for the Contract. The prices bid shall cover all costs of any nature, incident to and growing out of the work. In explanation, but not in limitation thereof, these costs shall include the cost of all work, labor, material, equipment, transportation and all else necessary to perform and complete the Project in the manner and within the time required, all incidental expenses in connection therewith, and any additional expenses for unforeseen difficulties encountered and for settlement of damages.
Before submitting their Proposal, the Bidder shall be familiar with the Plans, Specifications and other documents that will form parts of the Contract, shall have investigated in detail the site of the Project and shall have made such examination thereof as may be necessary to satisfy himself in regard to the character and amount of work involved. He shall have satisfied himself also that he can secure the necessary labor and equipment to perform and complete the Project in the manner and within the time required.

1.3. Proposal

Proposals shall be submitted on the form of Proposal attached hereto, properly filled out in ink and executed. The Bidder shall state in the form of Proposal the price per unit of measure, or lump sum price, in figures and words, for each scheduled item of work, for which he will agree to carry out the work, as well as the Total Price for the performance of the Project, as determined by multiplying each estimated quantity by the price per unit of measure bid therefore, and adding together the resulting amounts and any lump sum prices required. For the purpose of comparison of bids received, the Total Price, correctly computed, stated in the Proposal will be considered to be the amount bid for the Contract and award will be made on that Total Price.

Where there is a discrepancy in any item between the unit or lump sum price written in figures and that written in words, the written words will govern.

If, during the tabulation of bids, the Total Price on any Proposal is found to be incorrectly computed, the Engineer reserves the right to make such changes as are necessary in the extended Amounts and Total Price on the basis of the unit and lump sum prices given in words and the Approximate Quantities stated for the scheduled items therein.

Conditions, limitations or provisions attached by the Bidder to the Proposal may cause its rejection; however, the Engineer reserves the right to waive any and all informalities of submitting the Proposal and/or Proposal Guaranty.

When the Proposal is made by an individual, their post office address shall be stated, and they shall sign the Proposal; when made by a partnership, its name and post office address shall be stated, and the Proposal shall be signed by one or more of the partners; when made by a corporation, its name and principal post office address shall be stated, and the Proposal shall be signed by an authorized officer of the corporation. Before award is made to a Bidder not a resident of the State of New Jersey, such Bidder shall designate a proper agent in the State of New Jersey on whom service can be made in the event of litigation.

1.4. Estimate of Quantities

The estimated quantities of the several scheduled items of work involved in the performance of the Project and stated in the form of Proposal are to be used for comparison of Proposals received. The actual quantities may be greater or less than those stated. Payment will be made only for the actual quantity of authorized work done under each scheduled item.

1.5. Proposal Guaranty

Each Proposal must be accompanied by a Proposal Guaranty in the form of a certified check or bid bond, made payable to __________(engineer)__________ in the amount of not less than 5 percent of the Total Price bid.
1.6. Submitting Proposal

The Proposal submitted by a Bidder shall be enclosed in a sealed envelope together with the Proposal Guaranty described above, and shall bear on the outside the name and address of the Bidder and the designation of the Project and Contract. If mailed, this envelope shall be inserted in an outer mailing envelope marked, “PROPOSAL” and addressed to______________________.

Proposals will be received at the place and until the time stated in the Invitation for Proposals.

1.7. Withdrawing Proposals

A Proposal, after being submitted, may be withdrawn when request therefor is made in writing by the Bidder before the time designated for opening the bids in the Invitation for Proposals.

1.8. Award of Contract

The Contract will be awarded or Proposals rejected within ten days from the date of opening of Proposals.

Award of the Contract, if made, will be to the lowest Bidder whose Proposal complies in all respects with the requirements stated herein.

Award of the Contract will be subject to the approval of the Authority.

The Engineer reserves the right to reject any or all Proposals if the prices are obviously unbalanced, if competition apparently has been suppressed, or if it is deemed advisable to do so in the interests of the Authority.

The award shall not be binding upon the Engineer until the Contract has been executed by the Engineer, nor shall any work be performed on account of the proposed Contract until the Contract Agreement and Contract bond have been fully executed and delivered, together with satisfactory evidence of all required insurance coverage.

1.9. Return of Proposal Guaranties

All certified checks submitted as Proposal Guaranties will be returned immediately after the Proposals have been opened, read and tabulated, except those of the two Bidders who have bid the lowest Total Prices and whose Proposals and other documents submitted therewith comply in all respects with the requirements stated herein. The certified checks submitted as Proposal Guaranties of these Bidders will be returned when the Contract is executed or, if not executed, when the matter has been disposed of by the Engineer, except, however, when the Proposal Guaranty has been forfeited as liquidated damages in accordance with the provisions of the Proposal.

1.10. Contract Bond

The Bidder to whom the Contract has been awarded shall furnish and deliver, within seven (7) calendar days of the date of written notice of award, a Contract Bond, issued by a Surety satisfactory to the Engineer, on the standard form attached hereto.

The bond shall be for a sum of not less than the Total Price bid for the Contract and shall be maintained by the Contractor until the final payment is made, and in the event of insolvency of the Surety, the Contractor shall forthwith furnish and maintain, as above provided, other Surety satisfactory to the Engineer.
1.11. Execution of Contract

The Bidder to whom the Contract is awarded shall, within seven calendar days of the date of written notice of award, execute and deliver to the Engineer the Contract Agreement and Contract Bond and furnish satisfactory evidence of all the required insurance coverage, and proof satisfactory to the Engineer of the authority of the person or persons executing the Contract Agreement and the Contract Bond on behalf of the Bidder. The above documents shall be furnished, executed and delivered before the Contract will be executed by the Engineer.

1.12. Failure to Execute Contract

Failure upon the part of a Bidder, to whom the Contract has been awarded, to execute and deliver the Contract Agreement and the Contract Bond and to furnish satisfactory evidence of all required insurance coverage, in the manner and within the time provided, shall be just cause for annulment of the award. It is understood and agreed by said Bidder that if the award is annulled for the above reasons, the Proposal Guaranty shall, as stated in the Proposal, become the property of the Engineer, not as a penalty but as liquidated damages.

1.13. Subletting and Assigning Contract

The Contractor shall not sell, transfer, assign or otherwise dispose of the Contract to any third party. The Contractor shall not sublet any part of the work to be performed under this Contract without the previous written consent of the Engineer.

1.14. Work to be Performed

It is the intent of this Contract to secure complete, accurate and reliable information on subsoil, rock and foundation conditions, secure proper samples of soils and rock, and obtain ground water elevations, at the locations indicated on the Plans or as directed by the Engineer.

The work under this Contract comprises the performance and completion of the project within the prescribed limits, including the furnishing of all materials, equipment, transportation, labor and all else necessary therefore and incidental thereto, all in accordance with the Plans and Specifications.

1.15. Examination of the Site

It is the obligation of each Bidder to visit the sites of the various borings required to be made under this Contract and ascertain for themselves all the facts concerning the conditions to be encountered in the course of this Project, before preparing and submitting their Proposal.

1.16. Available Information

It is the obligation of each Bidder to make their own investigations of subsurface conditions prior to submitting their Proposal.

The locations of borings taken in ________________________________ in the vicinity of ________________________________ are shown on the Plans. The logs of these borings are available for examination by Bidders at the office of the Engineer at ________________________________.

The above data is offered for the information of prospective Bidders and no representation whatsoever is made as to the nature of the materials and conditions that may
be encountered in the boring operations under this Contract. The Bidder shall assume full responsibility for any interpretation he may make of the above data.

The Contractor shall make diligent inquiry as to the availability of records of any other previous borings and excavations, if any, taken in the vicinity of the work. The Contractor shall establish an independent conclusion as to the completeness and accuracy of all available information.

1.17. **Working Site**

Borings will be required to be taken adjacent to roadways and shoulders in use by the public, adjacent to bridge structures, in marshlands, on railroad property, on private property, and in other areas within the Project limits.

The Contractor shall be responsible for providing access to and from all boring sites.

In advance of the boring contract, the Engineer shall have sent to each property owner, within the proposed right of way, introductory letters apprising the owners that the Authority’s personnel and contractors may be performing work on their property. These letters do not constitute a request for a right of entry to the property. It is the responsibility of the Contractor to secure, at their own expense, the owner’s permission before entering onto the property. The Contractor shall ascertain from the Engineer whether these letters have been sent before requesting such permission.

The Engineer will provide a list of all known property owners.

Temporary crossings of railroad property will not be permitted without written permission from the railroad company. The Engineer will offer all possible assistance to the Contractor in securing permission to enter upon such private property for their work. The Contractor shall at all times carry out their operations so as not to inconvenience residents at or near the working area. The Contractor shall make clear to all of their personnel the importance of proper public relations.

In gaining access to and from boring sites along roadways, the Contractor shall observe all applicable traffic regulations regarding the movements of their vehicles, equipment and personnel. Vehicles shall travel on roadways only in the direction of normal traffic flow and at no time shall they cross the traffic stream.

Permission to work on the railroad property should be obtained by the Contractor.

The Engineer will provide location plans to submit with the Contractor’s application and permit fees where applicable.

The Contractor will be responsible for the securing of wash water supply and for the proper disposition of its discharge at all boring locations.

The location of all stationary and mobile equipment shall be subject to the approval of the Engineer.

The Contractor may occupy during their operations only those portions of public places at the boring locations for which they have obtained the required permission, subject to the approval of the Engineer.

1.18. **Jurisdiction and Authority of the State Police**

Traffic on Authority facilities is under the direct supervision and control of the New Jersey State Police who will enforce all statutory laws including the Authority’s established “Regulations Relating to the Control of Traffic on the New Jersey Turnpike and Garden State Parkway”, as they pertain to the Contractor as well as to the traveling public. A copy
of the Regulations will be included with the Contract documents; additional copies will be issued upon request. The Contractor shall become familiar with and adhere strictly to the requirements of these Regulations and to the requirements of the Specifications.

If the State Police should observe any hazardous condition connected with or related to the Contractor’s operations, or of any violation of the Authority Regulations, they will so notify the Contractor and all work related to such hazardous condition or violation shall immediately be stopped and prompt remedial action shall be taken by the Contractor, to the satisfaction of the Traffic Engineer, before such work is resumed. All cost incurred as a result of discontinuing the work, and of all remedial action required, shall be borne entirely by the Contractor without recourse against the Authority.

1.19. Traffic Permit

The Contractor shall not commence work under this Contract, which would require occupation of or entry upon any Authority facility until he/she has been issued a Traffic Permit.

At least ten working days prior to the time the Contractor intends to occupy any portion of Authority facilities or intends to start any operations affecting Authority Traffic, and from time to time thereafter as directed by the Engineer, the Contractor shall apply for a traffic permit and submit complete details of the methods he/she intends to employ for the safe restriction to the movement of traffic required for their operations. These methods will be reviewed by the Engineer and when satisfactory, approved. Methods not approved will be returned for revision and shall be resubmitted for final review. Approval by the Engineer will be in the form of a Traffic Permit issued to the Contractor by the Traffic Engineer through the Engineer. No operations will be performed by the Contractor within 30 feet of a traveled lane until a Traffic Permit has been issued.

The Contractor’s methods submitted for approval shall include complete information, the data and/or sketches covering the following:

1. The nature and location of the work.
2. The proposed obstructions or other hazards to traffic, including all operations within 30 feet of a traveled lane.
3. The length of time during which it is anticipated that hazards or obstructions to traffic will exist.
4. The means proposed by the Contractor for the protection of the public and their own personnel and equipment, including layouts and schedules showing the anticipated lane and shoulder closings, truck protection of traffic, and anticipated dates and rates of work.
5. The names and the day and night telephone numbers of the Contractor’s Superintendents assigned to the project.

When work is not progressing in accordance with the Traffic Permit and when directed by the Engineer, the Contractor shall revise the details of their plan of operations and resubmit them for approval. Such revisions, when approved by the Engineer, will form the basis of an Addendum to the Traffic Permit. Work affected by the revisions shall not be undertaken until an Addendum to the Traffic Permit has been issued.

If the approved methods of operations or revisions thereto, submitted by the Contractor for a Traffic Permit are not strictly adhered to by the Contractor, the Engineer shall have the right to revoke the permit, and when so revoked, all work which, in the opinion
of the Engineer, will affect the maintenance and protection of traffic, shall be summarily discontinued. The Permit will not be renewed and such work shall not be resumed until the Engineer is assured and satisfied that the Contractor will perform the work in conformity with the approved methods of operations. The Contractor shall have no claim against the Authority or Engineer for losses or delays caused by the revocation of the Permit.

1.20. Maintenance and Protection of Traffic

When any portion of the work under this Contract requires one or more toll lane(s) and/or one or more shoulder of an Authority roadway be closed, such closings shall be made only at the times, to the limits, and in the manner that the movement of traffic by the closings will be at a minimum, and that all traffic moving on portions of the roadway not closed will be able to flow smoothly, and will be protected from all hazards attendant on the Contractor’s operations because of the closings, all in accordance with the requirements of the Plans and Specifications.

The Contractor is advised that Authority facilities are in continuous operation 24 hours a day, 7 days a week, and that the work under this Contract has been planned to cause no interference or as little interference to traffic as possible. The Contractor shall, therefore, plan their operations to permit the continuous flow of traffic along the roadways.

It is the intent of the Contract to limit toll lane and shoulder closings to an absolute minimum and that work requiring closings be carried out in an expeditious manner.

The work for maintenance and protection of traffic is a joint Contractor and Authority effort and consists in general of furnishing and/or placing traffic protection devices for closing lanes and shoulders; furnishing personnel immediately and solely employed for the maintenance of the devices and protection of the traveling public; the transportation of devices to and from the site of the Project; placing or installing the devices; moving devices from one position to another as required; all in accordance with the Traffic Permit, the Plans and the General and Special Provisions of the Contract.

No signs except traffic protection signs and traffic direction signs specified or as directed by the Engineer shall be erected by the Contractor or their subcontractors on or near the Authority right of way.

The safety measures outlined and prescribed shall be considered elementary only and not necessarily sufficient in every instance to guarantee the protection of the traveling public. Compliance with the safety measures and precautions prescribed in the Specifications and on the Plans shall not relieve the Contractor of responsibility for taking all necessary measures to protect and safeguard the public, nor relieve him/her of responsibility for the installation of adequate safety measures and for the protection of the traveling public and their own personnel on Authority roadways and premises, shall rest with the Contractor. The cost of safety measures for which payment is not specifically provided under scheduled items in the Proposal, shall be included in the prices bid for the various items scheduled in the Proposal.

1.20.1. Lane and Shoulder Closings

(a). Condition and Situation Requirements

The Contractor’s personnel, vehicles or equipment shall not occupy any part of a toll lane, through lane, ramp, or shoulder until the lane or shoulder has been closed.

The Contractor’s personnel, vehicles or equipment shall not occupy any area within 30 feet from the outside edge of a shoulder where there is no guardrail
until the shoulder has been closed. The storage of materials and equipment will be permitted within the Authority right of way only at specific locations to be designated by the Engineer which shall be not less than 30 feet from outside edge of shoulder or behind guardrail.

Whenever any equipment occupying a shoulder or through lane and not behind barrier curb will be within 3 feet of a traveled lane or will come within three feet when operated (such as a tractor, or a crane swinging), the lane adjacent to the shoulder shall also be closed.

Materials or equipment shall not be stored in a closed lane or shoulder unless protected by barrier curb.

(b). Times for Closings

Because of heavy traffic during morning and evening commuter rush hours, on weekends, over holidays, and during the summer vacation periods (between Memorial Day and Labor Day) the times or hours when a toll lane or lanes may be closed and work requiring toll lane closings may be performed, are limited.

Toll Lane Closings Permitted. Toll lanes may be closed, and work requiring toll lanes to be closed may be performed only during the times prescribed in the Special Provisions of the Contract.

Shoulder Closings Permitted. Shoulder closings by use of cones, as necessitated by work in progress, will be permitted at any time except that simultaneous closing of both the right and left shoulder of a roadway will not be permitted.

Work requiring the use of barrier curb shall be completed at the earliest time so that prompt removal of the curb can be accomplished.

Emergency Closings. When it becomes necessary, in the opinion of the Chief Engineer, to make prompt repairs to work in progress or to other facilities that are damaged, the lanes will be closed. In such event the Contractor shall provide all the materials and manpower necessary, and shall work continuously on a 24 hour per day basis to complete the emergency repairs and again make all lanes available to use by public traffic. Compensation for emergency repairs of damage beyond the Contractor’s control will be paid on a cost-plus basis as specified in the New Jersey Turnpike Authority’s Standard Specifications or on such other basis as agreed upon by the Contractor and the Engineer. All costs incurred as a result of emergency repairs of damage caused solely by the Contractor’s procedures shall be borne entirely by the Contractor.

(c). Number and Length

During permissible lane closing hours, not more than one toll lane in a toll plaza roadway may be closed at any one time in any one work area unless multiple toll lane closings are specifically permitted in the Special Provisions of the Contract.

All shoulder closings shall be of the shortest overall length necessary to protect traffic from a hazardous condition. It is essential that as much shoulder as possible be kept open for use by disabled vehicles.
(d). **Methods**

Toll lanes and shoulders shall be closed in accordance with the Specifications and with the typical closing procedure and traffic protection devices shown on the New Jersey Turnpike Authority Standard Drawings.

The Contractor shall give the Engineer 48 hours prior notice of the time he/she wishes to place or remove any toll lane closing.

The traffic protection devices (cones and/or pylons) for closing a toll lane or shoulder shall always be set up progressively in the direction of traffic from a truck equipped with not less than two approved six inch diameter flashing vehicle lights to warn traffic, and with the truck traveling in the lane or shoulder to be closed, after first having stationed a uniformed flagman toward traffic. The protection devices shall always be removed in the reverse order by the truck backing up in the closed toll lane or shoulder after first having stationed a uniformed flagman toward traffic.

The Contractor’s personnel shall, while working on foot, wear a sleeveless vest the same as that specified below to be worn by flagmen.

1.20.2. **Movement of Contractor’s Vehicles, Equipment and Personnel**

(a). **General**

Pedestrians are not allowed on Authority roadways at any time; the Contractor’s employees shall not walk across any Authority roadway, nor walk along any Authority roadway except within areas coned off or otherwise closed to the traveling public.

The Contractor shall be responsible for transporting all of their personnel, in accordance with N.J.S.A. 39.4-69-Riding on Part Not Intended for Passengers Prohibited, to and from enclosed or closed-off work areas. Personal vehicles will not be permitted to park anywhere within Authority or private properties except in areas designated by the Engineer. Whenever the Contractor’s vehicles operate on any Authority roadway or ramp pavement which is open to traffic, travel shall always be with and not across or against traffic.

Whenever the Contractor intends to transport oversize or slow moving equipment, or any equipment whose movement may be disruptive to the traveling public, on Authority roadways open to the public, he/she shall first notify the Engineer or their duly authorized representative at least 24 hours in advance of the intended move and the Engineer will establish the time and the route to be taken. At least two approved flashing vehicle lights shall be mounted on all slow moving vehicles.

Vehicles shall enter and leave work areas in a manner which will not be hazardous to or interfere with traffic. When a flagman is not on duty, during permissible times for lane closings or shoulder closings, automobiles operated solely for the transportation of supervisory personnel, flagmen, or approved inspectors will be allowed access to the work site provided such vehicles are operated in a safe manner.

Vehicles shall not park or stop in roadways or on shoulders except within areas of toll lanes or shoulders coned off or otherwise closed to the traveling public.
Unless otherwise specified the Contractor’s vehicles will not be permitted to use Z-turns, median U-turns, grade separated U-turns, or make U-turns across the median or in any Toll Plaza area. Any vehicle making an illegal turn will be subject to a summons by the State Police.

Where, in the opinion of the Engineer, the security of the Authority roadways might become endangered by an operation of the contractor, their subcontractors or suppliers which would permit unauthorized entry to or exit from Authority property, the Contractor shall take immediate measures to restore the security of the Authority right of way.

(b). Vehicle Access to Work Areas

Contractor’s vehicles entering or leaving a work area via the Authority roadways shall be operated in a safe manner without creating any hazard or danger to the traveling public. They shall leave and enter the traffic stream at designated points, as shown on the Plans, or as specified herein, or as directed by the Engineer.

Delivery of materials or personnel and movement of vehicles and equipment, into and out of a work area via the Authority roadways shall be made only during the times for closings prescribed above.

Traffic Protection Devices

Whenever the Contractor’s work requires closing of any toll lane or shoulder, the Authority will furnish, at no cost to the Contractor certain traffic protection devices required for the Project. These devices will be identified and listed in the Special Provisions of the Contract.

Payment for Work Specified Under this Article

Unless otherwise specified herein and/or in the Special Provisions of the Contract, no specific payment will be made for any work or expense in connection with the maintenance and protection of traffic, but all costs thereof shall be included in the Total Price bid for the Contract, as scheduled in the Proposal.

Railroad Traffic. Attention is hereby directed to the fact that work under this Contract will be performed on the property of and adjacent to the tracks and other facilities of the __________ Railroad Company.

Railroad traffic shall be maintained without interference or interruption at all times. The Contractor shall carry on their work and perform his operations with due regard to the maintenance and protection of railroad property and facilities.

The Contractor shall safeguard the tracks, traffic and appurtenances of the railroad. He/She shall determine and comply with the regulations of the railroad relative to the work, and shall keep the tracks clear of obstructions.

Whenever, in the opinion of the railroad, the work may affect the safety of the railroad’s facilities and/or the movement of trains, the Contractor shall first submit the manner and method of performing such work to the Chief Engineer of the railroad for their approval, and such work shall not begin without said approval. Any approval by the railroad shall not relieve the Contractor from any responsibility or liability for the acts or omissions of the Contractor, their servants, agents, employees or subcontractors.

If the Contractor desires, in the prosecution of their work, to cross the railroad’s right of way at other than an established public crossing, he/she shall make his own
arrangements with the railroad for doing so and will bear any expense imposed upon
him/her by the railroad for flagging, protection or other costs. Prior to starting work, he/she
shall inform the Engineer of the arrangements he/she has made with the railroad in this
matter.

Regular operating speed will be maintained by the trains of the railroad, and no slow
orders will be issued unless, in the opinion of the railroad, the Contractor’s operations
adjacent to or over the tracks warrant the issuance of such orders.

The Contractor shall conduct their work and handle their equipment and materials so
that no part of any equipment shall foul the operated track without the written permission of
the Chief Engineer of the railroad. Any equipment shall be considered to be fouling the
track when located in such position that the collapse of same, with or without load, brings
the equipment within the fouling limit. The track is considered to be fouled when any object
is brought to a point less than 12 feet from the near rail.

Equipment of the Contractor to be used adjacent to tracks shall be in first class
condition so as to fully prevent failures that might cause delay in the operation of trains or
damage to railroad facilities. Their materials or equipment shall not be placed or stored on
railroad property without first obtaining permission from the railroad, and such permission
will be on the condition that the railroad company will not be liable for damage to such
materials and equipment from any cause. The Contractor may be ordered to remove stored
materials and equipment at any time solely at their own expense.

It is hereby understood and agreed that in all matters affecting the safety of railroad
traffic, the Chief Engineer of the railroad, or their duly authorized representative, shall have
final authority.

The Contractor shall give written notice to the Chief Engineer of the railroad at least
ten days prior to the commencement of any work on or adjacent to the railroad’s right of
way, in order that necessary arrangements may be made by the railroad to properly protect
railroad traffic.

The Contractor shall assume liability for any and all damage to their work,
employees, servants, equipment and materials caused by railroad traffic or operations.

The Contractor shall keep the tracks adjacent to the boring sites clear of all refuse
and debris that may accumulate from their operations and shall leave the railroad property in
the condition existing before the start of their operations.

The Contractor shall bear the cost of any approved changes in railroad facilities
which are made for their convenience in the conduct of their work.

If deemed necessary by the railroad, an inspector or an engineer may be assigned to
the Project during the time the Contractor is performing the work on or adjacent to railroad
property. Furthermore, when in the opinion of the railroad, the work may cause a hazard to
the safe and continuous operation of trains, the railroad will furnish and place at the site of
the work, as it may deem necessary, trainmen, watchmen, flagmen or other protective
services and devices during the hours a hazard may occur. The providing of such trainmen,
watchmen or flagmen, and the taking of any other precautionary measure shall not release
the Contractor or discharge him/her of any responsibility or liability for the acts or omissions
of the Contractor, his servants, agents, employees or subcontractors, and such trainmen,
watchmen, flagmen or other railroad employees furnished by the railroad shall be
considered as employees of the Contractor.
If, during the carrying out of the work covered by this Contract, the tracks or other facilities of the railroad are endangered, the Contractor shall immediately do such work as directed by the Engineer to restore safety, all at the Contractor’s own expense, and upon failure of the Contractor to carry out such orders immediately, the railroad company may take whatever steps are necessary to restore safe conditions. The cost and expense to the railroad company of restoring safe conditions or of any damage to the railroad company’s trains, tracks or other facilities caused by the Contractor’s operations, shall be considered a charge against the Contractor and shall be paid for by him/her, or may be deducted from any monies due or that may become due him/her under this Contract.

The cost and expense to the railroad of all inspectors, engineers, track supervisors, conductors, trainmen, watchmen, flagmen or other railroad employees, required and placed at the site of the work by the railroad, shall be paid for by the Contractor. It is a requirement of this Contract that the Contractor shall reimburse the railroad promptly for all cost of such engineering and protective services when bills for the same are presented to the Contractor and final payment to the Contractor under this Contract will not be made until he/she has complied with these provisions.

Bidders shall investigate and determine for themselves:

(a). The number and classifications of railroad employees that the railroad may require, their wage rates and contingent costs and expenses including, but not necessarily limited to, Railroad Retirement Taxes, Unemployment Insurance, vacation allowances, expenses allowed railroad employees in the performance of their duties and transportation of railroad employees to and from the site of the work.

(b). The costs of conforming to the rules and regulations of the railroad as they may affect the methods and costs of the Contractor’s operations. Bidders shall base their bids upon their own conclusions and estimates of the costs of maintaining and protecting railroad facilities and traffic as specified.

If the railroad company should so request, the Contractor shall also enter into a separate agreement with the railroad company for the work to be done on its property, which agreement may embody all of the terms, conditions and requirements relating to the protection of the railroad company and its tenants, and of the operations and property of the railroad, as set forth in this and other Articles of these Specifications.

No separate payment will be made for the maintenance and protection of railroad traffic as herein described and in accordance with the rules and regulations of the railroad, but all costs thereof, including the cost of protective services, shall be included in the prices bid for the various items scheduled in the Proposal.

Marine Traffic. All operations or movement of equipment in the _________________ shall be conducted so as not to interfere with free navigation of the waterway. The present navigable widths and depths shall not be impaired, and any falsework, mooring piles, casing pipe or other obstructions placed in the waterway shall be completely removed upon completion of the work or removed down to such depths as may be approved by the regulating Federal and State agencies having jurisdiction of the waterway.

The cost of such maintenance and protection of navigation, including temporary work and its removal which may be required by the regulating Federal and State agencies, shall be included in the prices bid for the various items scheduled in the Proposal.
1.21. **Superintendents and Workmen**

The Contractor shall attend to the work personally, or through a competent, English-speaking superintendent on the Project, authorized to receive and carry out instructions. The superintendent shall not be a driller attached to any particular boring rig but shall be free to move from boring to boring as necessary. The workmen shall be competent and shall perform their work in a neat and workmanlike manner. Any man not properly qualified for their work or who is doing it in an unsatisfactory manner or contrary to the Specifications or the Engineer’s instructions, or who is disorderly, shall be discharged, if so requested by the Engineer, and shall not be employed again on the Project except with the approval of the Engineer. The superintendents and the number of workmen shall be sufficient, in the opinion of the Engineer, to insure the completion of the Project within the time stipulated therefor.

1.22. **Equipment**

The Contractor shall provide at all times at least four entirely independent drilling rigs and crews.

All plant, equipment and methods to be used shall be approved by the Engineer before the work is begun. However, approval of the equipment shall not be construed as including approval of the performance thereof. Additional equipment shall be provided when ordered by the Engineer in order to perform the work satisfactorily according to the Specifications.

For use in connection with borings in tidal water, the Contractor shall provide, at no additional cost to the Engineer, a suitable tide gage with clearly painted horizontal lines (black on white background) for each tenth of a foot and numerals at every foot mark, and of sufficient length to be clearly visible above high tide when driven firmly into the riverbed near the shoreline. The Engineer will place the tide gage and will advise the Contractor of the actual elevations to which the numerals have been set.

1.23. **Inspection of Work**

The work required under this Contract shall be performed under the general monitoring and to the satisfaction of the Engineer. The work will be inspected by the Engineer or their Inspector for strict compliance with the requirements of the Specifications. The Engineer will interpret the Specifications and will decide all questions in connection therewith. Upon request of the Contractor, the Engineer will confirm in writing any oral order, direction or requirement.

No boring shall begin except in the presence of the Engineer or their Inspector. The presence of the Engineer shall not relieve the Contractor or their agents of any responsibility for the proper execution of the work.

The Engineer will keep logs of the borings to determine that the required information is being obtained, keep a record of the work done, and verify that the samples and cores are properly taken, boxed and stored in a suitable place or shipped to the designated location.

1.24. **Personal Liability**

In carrying out the provisions of the Contract or in exercising any power or authority granted them by their position, there shall be no liability upon the Inspectors or other authorized representatives of the Engineer, either personally or as employees of the Engineer, it being understood that in such matters they act as agents and representatives of the Engineer.
1.25. Damage Claims

The Contractor shall defend, indemnify and save harmless the Engineer, the New Jersey Turnpike Authority, their officers, agents and servants and each and every one of them against and from all suits and costs of every kind and description and from all damages to which the Engineer, the New Jersey Turnpike Authority or any of their officers, agents or servants may be subjected by reason of injury to the person or property of others resulting from the performance of the Project, or through the negligence of the Contractor, or through any improper or defective machinery, implements or appliances used by the Contractor in the Project, or through any act or omission on the part of the Contractor or their agents, employees or servants; and they shall further defend, indemnify and save harmless the Engineer, the New Jersey Turnpike Authority, their officers, agents and servants from all suits, and actions of any kind or character whatsoever which may be brought or instituted by any subcontractor, materialman or laborer who has performed work or furnished materials in or about the Project, or by or on account of any claims or amount recovered for any infringement of patent, trademark or copyright. The cost thereof shall be included in the prices bid for the various scheduled items in the Proposal. So much money due to the Contractor under and by virtue of the Contract as shall be considered necessary by the Engineer, may be retained by the Engineer and held until such suits, actions, claims or amounts shall have been settled, and suitable evidence to that effect furnished to the Engineer.

The Contractor and those personnel who will be working on railroad property may be required to sign releases on forms to be furnished by the railroad, prior to entering upon railroad property.

Any separate agreement with a railroad company which the Contractor may be required to enter for the performance of work on railroad property will provide that the Contractor indemnify and save harmless the railroad company, its tenants, and each and every one of them from or against any loss of life or injury to persons, or loss of or damage to property growing out of or resulting from operations of the Contractor, howsoever such loss, injury or damage may be caused, and whether or not by reason of negligence of the railroad company or its tenants.

1.26. Laws

The Contractor shall observe and comply with all Federal and State laws and New Jersey Turnpike Authority Regulations and local ordinances that affect those engaged or employed on the Project, the materials or equipment used, or the conduct of the work.

In the hiring of laborers, workmen and mechanics for the performance of work under this Contract or any subcontract hereunder, no Contractor, nor any person acting on behalf of such Contractor or subcontractor, shall, by reason of race, creed or color, discriminate against any person who is qualified and available to perform the work to which the employment relates.

No Contractor, subcontractor, nor any person on their behalf, shall in any manner, discriminate against or intimidate any employee hired for the performance of work under this Contract on account of race, creed or color. All people employed by the Contractor on this project are subject to the prevailing New Jersey wage rates.

1.27. Drilling Permit

The Contractor shall procure a drilling permit prior to the start of any boring work from the Division of Water Resources, New Jersey Department of Environmental Protection.
1.28. Permits and Licenses

The Contractor shall procure all required permits and licenses, pay all charges and fees therefore, and shall give all notices necessary and incident to the due and lawful prosecution of the Project.

The Contractor shall furnish at their own expense the water supply necessary for carrying out the work, and shall secure all permits and licenses required to maintain such supply.

The cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

1.29. Public Utilities and Property Damage

The Plans indicate the locations of some subsurface structures within the vicinity of the proposed borings. The Contractor shall not proceed with their work at any one boring location until he/she has made diligent inquiry at the office of the Engineer, utilities and private companies and municipal authorities, to determine the existence and exact locations of subsurface structures. The Contractor shall also comply with the State’s Underground Facility Protection Act and notify the State’s One Call System before performing any work. The Contractor shall exercise extreme care in accurately locating all utilities and in carrying out their operations, and shall be solely responsible for any damages caused to utilities and to the facilities affected by such utility damage, whether such utilities are shown on any available plan or not.

The Contractor shall fill all holes caused by their operations and shall take every precaution against injuring paving, utilities, or private or public property, and shall promptly repair, at their own expense and to the satisfaction of the Engineer and the owners, any damage to such paving, utilities and property caused by their operations. This shall also include sodding of any areas where the grass is damaged.

Upon completion of the Contractor's operations at each site, they shall remove their equipment therefore, including pulling all casing and shall clear the area of all debris and restore it to the condition existing before the start of their operations.

1.30. Insurance

Contractor shall provide insurance as set forth in this Paragraph 1.30. With respect to the Authority’s Owner Controlled Insurance Program, Contractor shall be considered an “Excluded Party” as defined in the Consultants Order for Professional Services (OPS).

The Contract will not be executed by the Engineer until the Contractor has provided insurance of such character and in such amounts as will provide adequate protection for the Engineer, the Authority, their officers, representatives and employees, and for the Contractor against all liabilities, damages and accidents, and the Contractor shall maintain such insurance or equivalent protection in force during the life of the Contract, except as hereinafter specified.

The Contractor shall furnish the Engineer with satisfactory proof of carriage of the prescribed insurance (as specified herein below); however, the Engineer’s approval of insurance furnished by the Contractor, or their failure to disapprove such insurance, shall not relieve the Contractor of full responsibility for liability, damages and accidents as set forth elsewhere herein.

The minimum amounts of insurance to be carried by the Contractor shall be as follows:
(a). Contractor’s Bodily Injury and Property Damage Liability Insurance, including Contingent Liability Insurance and Contractual Liability Insurance:

1. One person in any one accident, $500,000
2. Two or more persons in any one accident, $1,000,000
3. Property damage in any one accident, $500,000 with aggregate property damage policy limit of, $1,000,000.

Property damage liability insurance policies shall contain a provision or endorsement providing insurance protection against property damage, including loss of use, caused by explosion and collapse, and against interference with existing underground and overhead pipes, cables, ducts and other such facilities, whether or not such facilities appear on available plans and whether or not accurately located on such plans.

The contractual liability insurance policy shall contain an endorsement attesting to the Contractor’s contractual responsibilities to defend, indemnify and save harmless the Engineer, the New Jersey Turnpike Authority, their officers, employees, agents and servants, from all suits, costs and damages, all as more fully set forth in Article 1.25, “Damage Claims”, of these Specifications.

(b). Automobile and Truck Liability Insurance (including coverage for Contractor’s automotive equipment):

1. One person in any one accident, $500,000.00
2. Two or more persons in any one accident, $1,000,000.00
3. Property damage in any one accident, $500,000.00

(c). Workman Compensation Insurance - Statutory

(d). For all work to be performed on or adjacent to property of the _________ Railroad _________, the Contractor shall carry the following Railroad Protective Bodily Injury and Property Damage Liability Insurance, reciting as named insured the _______________ Railroad its successor or successors:

1. One person in any one accident, (amount)
2. Two or more persons in any one accident, (amount)
3. Property damage in any one accident, (amount) with aggregate property damage policy limit of, (amount)

Policies required under subparagraphs (a) and (d) of this Article shall contain an endorsement evidencing that any damages resulting from an act or omission of watchmen, flagmen or similar employees furnished by the railroad by reason of the operations of the Contractor or their subcontractors, shall be deemed a part of the operations of the Contractor or subcontractors and are covered by insurance under said policies.

The policy required under subparagraph (d) of this Article shall also contain an endorsement in accordance with the provisions of the United States Department of Commerce, Bureau of Public Roads Memorandum issued August 9, 1955.

The Railroad Protective Insurance policy shall also contain an endorsement evidencing that the railroad is protected against any damages arising from injury to officers
and employees of the Contractor or subcontractors, and to officers, employees, agents or representatives of the Engineer or the New Jersey Turnpike Authority while on the premises of the railroad.

If any part of the work is sublet, all the above insurance coverage shall also be provided by or on behalf of each subcontractor.

Satisfactory evidence, in triplicate, of all required insurance coverage, including special endorsements, shall be forwarded to the Engineer for approval within seven calendar days after the date of written notice of award of Contract. All insurance coverage must be approved by the Engineer before the Contract will be executed by the Engineer.

As soon as possible after award of Contract, the original of the Railroad Protective Insurance policy, with the necessary endorsement or endorsements attached, shall be furnished in the first instance to the Engineer for review and processing to the railroad company. Such policy shall be approved by the railroad company before the Contractor or subcontractors will be permitted to enter upon railroad right of way.

All policies required above shall include an endorsement requiring ten days prior written notice to the Engineer before any change or cancellation is made effective.

The policy required under subparagraph (d) above shall include an endorsement requiring ten days prior notice to ______________________________ Railroad before any change or cancellation is made effective.

The Railroad Protective Insurance policy shall be maintained until all work on railroad property is completed. All other policies required under this Contract shall be maintained until completion of all work.

As an alternate to the Contractor’s furnishing a separate policy for the Railroad Protective Insurance, the railroad company may wish to extend its present protective insurance policy to cover the Contractor’s operations on railroad property. If this alternate arrangement is proposed by the railroad company, the Contractor shall comply with this request and shall reimburse the company for the benefit of such extended coverage on the basis of the company’s established fees therefore.

No separate payment will be made for the cost of the insurance herein specified but the Contractor shall include the cost of such insurance in the prices bid for the various items scheduled in the Proposal.

1.31. Commencement and Prosecution of Work

The Contractor shall have a complete crew or crews and fully-equipped rig or rigs actually at work upon the site within three calendar days from the date of written notice to proceed.

The Contractor shall notify the Engineer of their intention to start work or to add extra crews and rigs at least two calendar days in advance of such work.

The sequence in which the individual borings are to be made shall be as directed by the Engineer. The Engineer reserves the right to order the borings made at such locations and in such sequence as will provide the maximum amount of preliminary information as the work progresses.

The Contractor shall so conduct the work as to give the Engineer every facility to obtain their own records, including ground water level and note every detail of the work and to obtain a correct record of the material passed through.
Each boring shall be sunk and drilled entirely by a single crew.

No drilling shall be done on Sundays, nor before sunrise or after sunset on Mondays to Saturdays, inclusive, except with the express approval of the Engineer.

No materials or plant used in the making of any borings shall be removed until the Engineer has given permission therefore.

1.32. Sealing of Bore Holes

At the completion of each boring or abandoned boring, the holes are to be sealed in accordance with New Jersey Department of Environmental Protection requirements.

For borings located in sanitary landfills, grouting for backfilling will be done from the bottom of the boring up to the top of natural ground. The portion of the boring within the sanitary landfill material is not to be grouted, but just backfilled with drill cuttings or dirt.

1.33. Time of Completion

All boring work in the field shall be completed within ___ calendar days from the date of written notice to proceed.

The last shipment of soil and rock samples and the boring records hereinafter specified shall be delivered to the Engineer within ten calendar days after the completion of all field work.

1.34. Unavoidable Delays

If, for any reason beyond the control of the Contractor, the work be delayed, the Contractor shall have no right to nor shall he/she make any claim whatsoever for damages or additional compensation by reason of the delay, but he/she may, at the discretion of the Engineer, be granted an extension of time.

1.35. Failure to Complete on Time

If the Contractor fails to complete the boring work in the field, fully, entirely and in accordance with the provisions of this Contract, within the time stated above or within such further time as may have been granted in accordance with the provisions of the Contract, then the Contractor shall and hereby does agree to pay to the Engineer for each and every calendar day that he/she is in default on time to complete the boring work in the field, the amount of $_____, which said amount per day is agreed upon by the parties hereto to be liquidated damages and not a penalty.

The Engineer shall recover such liquidated damages by deducting the amount thereof out of any monies due or that may become due the Contractor and, if said monies be insufficient to cover said damages, then the Contractor or their Surety shall pay the amount due.

1.36. Change of Plans

It is understood and agreed that the Engineer reserves the right to order changes in the amount of work to be done within the general scope of the Contract so as to increase or decrease the quantities given in the Proposal, without change in the original Contract unit prices, provided, however, that such changes do not result in a sum total increase or decrease of more than fifty (50) percent of the original Total Price.

In the event the changes exceed this amount, payment for all work performed up to one hundred fifty (150) percent of the original Total Price (based on original Contract unit prices) will be made at the original Contract unit prices therefore, and payment for all work
performed beyond that will be made on the basis of modified unit prices negotiated between the Contractor and the Engineer for that portion of the work.

In the event the changes reduce the total amount of work to less than 50 percent of the original Project (based on original Contract unit prices), payment for all work performed will be made on the basis of modified unit prices negotiated between the Contractor and the Engineer.

If the Contractor and Engineer cannot reach agreement during negotiations for modified unit prices, as provided above, compensation for such work will be determined on the basis of actual cost to which 15 percent will be added.

1.37. Payment

Payment will be made for the actual quantity of authorized work done under each item scheduled in the Proposal at the respective unit prices bid therefore.

Monthly certificates will be prepared by the Engineer showing the approximate quantities of work completed during the month and the value of such work based on Contract unit prices. Partial payments for this work will be made to the Contractor based on the value stated on such certificates, except that 10 percent will be retained by the Engineer as security for the fulfillment of the entire Contract by the Contractor until the completion of the Project.

If at any time there should be evidence of any lien or claim for which, if established, the Engineer, the Authority might become liable and which is chargeable to the Contractor, the Engineer shall have the right to retain out of any payment then due or thereafter to become due, an amount sufficient to completely indemnify the Engineer, and the Authority against such lien or claim.

When the Project is completed and accepted by the Engineer, including the delivery by the Contractor of the last shipment of soil and rock samples and the prescribed boring records hereinafter specified, a final certificate of cost of the Project will be made by the Engineer, based on the actual quantities of authorized work done under each item scheduled in the Proposal and under supplementary agreements, if any, at the unit price or prices stipulated therein, and when this final certificate is approved, the money due the Contractor for the performance of the Project as determined by said final certificate, after deduction of any previous payments that may have been made as provided above, will be paid the Contractor, provided, however, that before such final payment is made, there shall be no outstanding claims against the Contractor, the Engineer, the New Jersey Turnpike Authority, and all obligations incurred by the Contractor and by their subcontractors in carrying out the Project shall have been satisfied.

Before final payment will be made, the Contractor shall execute and deliver a release in the following form:

“This is to certify that all just liens, claims and demands for labor, materials and rental of equipment, arising out of the prosecution of the work under Boring Contract No. C-________________________, are fully satisfied, and that all of the work is fully released from liens, claims and demands, whether just or otherwise.

In consideration of the final payment on said Contract, we hereby release ________ (engineer) ________ and the New Jersey Turnpike Authority, their officers, employees, agents and servants, from all claims, demands and liability of whatsoever nature from anything done or furnished or in any manner growing out of the doing of the work under
this Contract, including any and all extra or reduction orders issued thereunder and any agreements supplementary thereto."

The above release shall be signed and sealed by an officer or partner representing the Contractor, whose signature and authority to sign shall be certified by a notary public, or in the case of a corporation, by the corporation secretary.

Upon receipt of this release and the satisfying of all other obligations under this Contract, a final payment will be made to the Contractor for the entire work, making deductions for all previous payments.
SECTION 2 - SPECIAL PROVISIONS

2.1. General Description

This Contract comprises the taking of borings __________________________
________________________________________________________________________
________________________________________________________________________.

The purpose of the borings is to secure information regarding subsurface conditions
which will be used as required for the studies of highway construction and foundations for
bridges and other structures involved in ____________________________________.

2.2. Plans

The accompanying _____ plan sheets, numbered _____ to _____ inclusive, and entitled
“___________________________________________________”, form a part of these
Contract documents.

2.3. Types of Borings

This Contract provides for the making of casing borings in material other than rock
(including obtaining samples therefrom), performing in-place shear tests of subsoils, taking
retractable plug borings in soft soils, and drilling core borings in rock.

Casing borings shall be made in two sizes of casing, namely 2 1/2-inch pipe and 4-
inch pipe. In general, 1-3/8 inches of ordinary dry samples and 2 inches undisturbed dry
samples will be required in 2 1/2-inch casing borings, and 1-3/8 inches of ordinary dry
samples, 3-3/8 inches of undisturbed dry samples and 2- or 3-inch in-place vane shear tests
will be required in 4-inch casing borings.

Retractable plug borings shall be capable of retaining continuous soil samples 1 inch
in diameter.

Core samples secured from borings in ledge or bedrock shall be 1 5/8- inch diameter
generally taken in 2 1/2-inch casing borings.

The Plans indicate the type and size of boring expected to be made at each
proposed location; however, the Engineer reserves the right to change the type or size of
any boring sufficiently in advance of the start of any operations at each boring location.

2.4. Number and Locations of Borings

The contemplated number and approximate locations of the borings to be taken
under this Contract are shown on the Plans. The actual number of borings and the exact
location and ground elevation of each boring will be determined by the Engineer. The
Engineer will locate all borings in the field for the Contractor.

Since the number, types and sizes of borings are subject to change in the field, the
quantities of the various scheduled items of work stated in the Proposal, may be
substantially increased or decreased as directed by the Engineer as the work progresses,
without change in the unit prices bid by the Contractor for any of the scheduled items in the
Proposal, except as provided in Article 1.36 of these Specifications.

2.5. Depth of Borings

All borings are to be carried to the depths ordered by the Engineer. In general, 2 ½-
inches casing borings shall be carried into firm bearing material or to rock, and when ordered
by the Engineer, the boring continued into rock with 1-inch core borings for a minimum
depth of five feet. Four inch casing borings are to be made primarily to sample all soft or highly compressible strata and shall generally be carried slightly below the lowest known soft or highly compressible stratum when soil sampling but may be of more shallow depths when driven exclusively for in-place shear testing of the soils.

In general, borings should be carried into rock under structures and under embankments. Borings should be through varved clays.

2.6. Driving of Casings

Casings shall be extra strong steel pipe or flush-coupled casing with nominal inside diameter of 2 ½-inches or 4-inch, as required.

Casings shall be sunk vertically through earth and other materials, including boulders and rock veins, to rock, or if not to rock, to such depth below ground as the Engineer may direct. They shall be driven down without washing to the depth at which a sample is to be taken or shear test performed, after which the material shall be cleaned out to the bottom of the casing and the sample or shear test vane driven or pushed below the bottom of the cleaned casing. After sampling and/or shear testing, casing driving shall be resumed.

The use of water for cleaning out the casing between sample elevations will be required. The Contractor shall make suitable arrangements satisfactory to the Engineer and other interested parties, for the procuring and disposition of washwater.

The weight of hammer to be used in driving the casing shall be 300 pounds with a 24-inch height of free fall. The hammer shall be raised by means of a rope having one end wrapped (not more than three loops) around a winch head. A continuous record of the blows per foot required for the driving of the casing shall be kept by the driller except when the casing is being driven exclusively for performing in-place shear tests.

Simultaneous washing and driving of the casing will not be permitted except in the case of difficult driving which in the opinion of the Engineer requires the use of water. Where such use of water is permitted, a record must be kept by the Inspector and the driller of the elevations between which simultaneous washing and driving occurred.

In some cases of very difficult driving, and where the characteristics of the soil are suitable, the Engineer may give permission to discontinue driving the casing and proceed with the boring by means of wash rods with a chopping bit to the elevations at which samples are to be taken. This procedure shall be noted in the Inspector’s and driller’s boring record. Should there be any indication of the sides of the hole collapsing, thus blocking normal progress of the boring; driving of the casing shall be resumed as described above.

The Contractor must assume the risk of encountering boulders, rock veins or other obstacles and must drive the casing through or past such obstacles, using special devices for shattering boulders if necessary. If the Contractor abandons such boring before adequate information is obtained and starts another boring adjacent to it in preference to driving through or past the obstacle, or because of a shattered or misaligned casing, no payment will be made for the work done on the abandoned boring.

Where approved by the Engineer, blasting with small charges of dynamite will be permitted for the removal of small boulders or other obstructions which cannot be conveniently removed otherwise. Such blasting will be approved by the Engineer only where it is definitely known that there are no subsurface or surface structures in the vicinity that may be affected.
At borings being made exclusively for shear testing, the casing may be eliminated where the entire depth of hole will not exceed 6 feet and provided the hole may be suitably formed by other means and maintained clear at all times.

In certain instances where a 4-inch casing has already been driven to and slightly below soft or unstable strata, the Engineer may order that the boring be continued below the bottom of the 4-inch casing with a 2 1/2-inch casing. In such cases, the 4-inch casing shall first be cleaned out to the bottom of the casing, and the 2 1/2-inch casing inserted therein to the bottom of the hole. Driving of the 2 1/2-inch casing and sampling of materials below the bottom of the 4-inch casing shall then proceed as specified herein for the usual type of casing boring.

If the Contractor elects to use drilling mud as a means of advancing the hole in lieu of driving casing, the Contractor may proceed by this method using a suitable drilling fluid to prevent the collapse of the walls of the hole. The hole shall be maintained of sufficient size to permit proper sampling. The sampling equipment and the method and frequency of sampling shall be as specified below for cased holes. If the Contractor cannot maintain the hole clear and of sufficient size by this method, he/she shall return to the use of cased holes as above described.

The use of Hollow-Stem Auger Casing is considered a satisfactory alternate method for advancing the hole to obtain dry samples, undisturbed samples, and rock cores, in lieu of driving casing, in strata relatively free of cobbles and boulders. The sampling equipment and the method and frequency of sampling shall be as specified below for cased holes. This method of drilling shall be considered satisfactory for undisturbed sample borings provided the inside diameter of the auger stem is of such size as to permit the recovery of 3-inch diameter undisturbed samples.

In the use of this method, cuttings from the auger, relative resistance to penetration and general feel and performance of the drill shall be observed for detection of changes of material encountered. Sampling shall be performed by withdrawing the plug point through the auger stem, inserting the sampling tube through the auger stem, driving or pressing the sample below the auger bit, withdrawing the sampler, replacing the plug point, and advancing the auger to the next sample depth.

2.7. Frequency of Sampling and Testing

Samples shall be taken and shear tests performed at elevations designated by the Engineer. In the absence of any specific direction, sampling and shear testing shall be governed by the following:

In casing borings, samples shall be taken at every change in soil formation (indicated by an abrupt change in the driving resistance of the casing), and between the elevations of such soil changes, at intervals not exceeding 5 feet. Undisturbed dry samples shall generally be taken in soft strata, ordinary dry samples in firmer material. A sample shall always be taken in the first 5 feet of each boring; samples obtained by means of the casing alone will not be acceptable. In some cases of thinly stratified formations, it may be necessary to take continuous samples in order to establish all the various changes in the soil profile.

In casings driven exclusively for in-place shear testing, samples shall not be taken, but tests shall be made every 15 inches throughout the depth of the soft strata as ordered by the Engineer, beginning at a point approximately 3 feet from the ground surface but at least below any firm overburden.
Where shear tests are ordered by the Engineer in casing borings driven primarily for securing soil samples, they shall generally be taken in pairs 15 inches apart below the bottom of an undisturbed dry sample.

Retractable plug samples shall be taken continuously, generally in 3-foot runs, for the entire depth of the boring, beginning at the ground surface.

Rock cores shall be taken continuously, generally in 5-foot runs, for the depth into rock ordered by the Engineer.

2.8. Ordinary Dry Samples

Ordinary dry samples shall be taken with a split-barrel sampler. In both sizes of casing, the sampler to be used shall have an inside diameter of 1-3/8 inches, an outside diameter of 2 inches, and a length of split tube section of 24 inches. No sampler shall be used that does not contain a ball valve.

Ordinary dry samples shall be obtained by driving the sampler 2 feet into the material below the bottom of the cleaned casing. If a sample is not obtained in these 2 feet of penetration, the sampler shall be driven again for an additional foot of penetration. Should the material be so incohesive that this second attempt fails to secure a sample, a flapper valve shall be inserted in the shoe of the sampler and the sampler driven an additional foot. Should this last procedure fail to secure a sample, an auger or sandtrap shall be used until the required sample is obtained.

Should the Contractor in securing samples fail to provide the proper types of samplers, valves, traps and other special sampling devices, and the samples thus obtained are deemed improper and unsuitable by the Engineer, such samples will not be accepted nor measured for payment.

Samplers shall not be driven more than 3 feet below the bottom of casing. Where continuous sampling is ordered, driving of the casing shall be resumed before the bottom of sampler penetrates beyond this 3-foot limit.

A record of the number of blows required to drive the sampler for each 6 inches of penetration will be kept by the driller. A description of the sample obtained for each foot of penetration, unless otherwise directed by the Engineer, shall be preserved in a jar as specified below. To facilitate determination of the relative resistances of the various strata, the sampler shall always be driven with a 140-pound hammer with a height of free fall of 30 inches. The hammer shall be raised by means of a rope having one end wrapped (not more than three loops) around a winch head.

All ordinary dry samples, immediately upon removal from the sampler, shall be placed and tightly sealed in wide-mouthed, clear glass jars about 5 inches in height and 2-1/4 inches minimum opening, with screw caps. Each sample shall be of sufficient size to fill the jar and shall be placed in the jar carefully and in its correct position so as to represent as nearly as possible its natural condition. Each jar shall be clearly labeled showing the name of the Project, boring number, sample number, elevations between which the sample was taken, number of blows on sampler for each 6 inches, and classification of material. The boring number and sample number shall also be marked on each jar cap.

If two or more materials are encountered in a sampler, separate jars shall be used for each material. The letters “A”, “B”, etc., shall be added to the sample number on each such jar to designate the different materials.
The Contractor shall provide the sample containers keeping a sufficient supply on hand to prevent any delay in the work. He shall carefully preserve these samples and deliver them to the Engineer as hereinafter specified.

2.9. **Undisturbed Dry samples**

Undisturbed dry samples will be required at selected locations in strata of soft clay, organic silt, meadow mat and other highly compressible materials. The object of these samples is to obtain specimens of the soil formation which have been subjected to a minimum of disturbance and which represent as truly as may be obtained the actual condition of the soil in its natural state.

In silts and soft clays free from obstructions and containing little or no granular material, the thin-wall “Shelby tube” sampler shall be used. Where the material is too soft to be recovered with the “Shelby tube” sampler, the stationary piston type sampler shall be used. For both types of samplers, the tube shall be at least 24 inches long and shall have an inside diameter of 2-7/8 inches.

When ready to take an undisturbed dry sample, all loose and disturbed material shall be removed by washing to the bottom of the casing except that final cleaning of a four-inch casing shall be done with an M.P.F.M. clean-out jet auger having an outside diameter of 3" (NN Drilling Supply’s Part No. 71789 or approved equal). Cleaning out with the auger shall be done in such a manner that the soil immediately below the bottom of casing shall be as nearly undisturbed as possible.

The sampler shall then be lowered slowly to the bottom of the casing, and pressed either manually or by hydraulic jack, if necessary, into the soil a distance sufficient to fill the sampler to within three or four inches of its capacity. In no case shall the sampler be driven with a hammer; however, the sampler may be forced downward under the weight of the hammer. The sampler shall be pushed or jacked downward into the soil at a rate of 20 or 25 inches in approximately five seconds, as this is about the rate at which water can be vented through the ball valve without creating excessive pressure on the top of the sample.

When using the piston type sampler, the sampler, with the piston set flush with the cutting edge at the bottom, shall be carefully lowered to rest on the soil at the bottom of the cleaned casing. The rod supporting the piston shall then be clamped to the top of the casing so as to be immovable, after which the sampling tube shall be forced down as previously described to the proper depth. Then, the two rods shall be locked together at the top and the entire assembly slowly withdrawn from the hole.

After the sampler (either type) has been carefully removed from the hole, the tube section containing the soil sample shall be detached. The ends of the sample shall be carefully squared up not less than one-half inch back of each end, and the end spaces of the tube shall be completely filled with hot “Petrowax A”, as manufactured by the Gulf Oil Company, or approved equal. The tubes shall then be closed at both ends with snug fitting metal or plastic caps which shall be secured in place with masking tape, after which the ends of the tube shall be dipped in hot “Petrowax A”, or approved equal, to provide airtight seals.

Samplers shall not be pressed more than three feet below the bottom of casing. Where continuous sampling is ordered, driving of the casing shall be resumed before the bottom of the sampler penetrates beyond this three-foot limit.
Undisturbed dry samples shall be clearly labeled showing the name of the Project, boring number, sample number, depths between which the sample was taken and the top of the sample tube. Special care shall be taken to indicate the top end of the sample tube.

The Contractor shall provide the sample tube containers. He shall carefully preserve these samples and deliver them to the Inspector as hereinafter specified. Extreme care must be taken in handling undisturbed samples to avoid shock or jarring which may affect the character of the sample.

2.10. **In-Place Vane Shear Tests**

Vane shear tests shall be performed directly in strata of soft soils encountered in boring operations in order to determine the shearing resistances of various saturated fine-grained material.

The test consists basically of sinking a four-bladed vane in the undisturbed soil beneath a casing and rotating the vane through the soil by means of a turning apparatus mounted on the top of casing above ground. The torsional force required to rotate the vane and cause a cylindrical surface in the soil to fail, is read on a gage attached to the turning mechanism; which readings can be converted to shearing resistance.

Vanes shall be of two sizes; two inches in diameter by four inches in length and three inches in diameter by six inches in length. Unless specifically directed by the Engineer to use the two-inch diameter vane; the three-inch diameter vane shall be used for shear testing.

The calibrated torque assembly for rotating the vane and measuring the turning force shall be equal to NN Drilling Supply’s Part No. 10136, complete with base plate. A conversion chart shall be provided to enable the Inspector or driller to convert the gage readings to shear strength.

The vane shall be connected to the torque assembly by means of coupled rods. Whenever a casing is being used, at least one ball bearing guide shall be mounted on the rod shaft to fit snugly against the inside of the casing. The casing may be eliminated when the depth of hole does not exceed six feet.

When ready to perform a shear test, the casing shall be washed clean to the bottom of the casing. The vane and rod shaft shall be inserted in the casing until the vane reaches the bottom of the casing. If the test is being performed in a boring being made primarily for soil sampling, the test will generally be ordered after the securing of the undisturbed dry sample; in these instances, the vane is to be lowered to the deepest point penetrated by the sampler.

The vane shall then be slowly pressed, not driven, into the undisturbed soil beneath the bottom of the hole for a distance of 15 inches.

The torque assembly shall be mounted on the rod shaft and casing and braced against any possible accidental rotation of the casing or assembly during the test.

The crank shall be turned slightly to remove any slack or play, and the initial gage reading recorded. The crank shall then be turned at a uniform rate corresponding to a one-degree rotation of the vane in ten seconds. Gage readings shall be recorded by the driller every five degrees of vane rotation, and also at the point of maximum torque. The crank shall continue to be turned (and not stopped) while taking the readings. Vane rotation and gage readings shall continue until the second reading beyond the maximum reading (to ensure that the maximum is not a false peak of resistance) is taken. For each reading, the driller shall record the angle of rotation, the gage reading and the converted value of shear resistance.
strength. Each data sheet shall be identified as to Project, boring number, station, offset, ground line elevation, vane size, and elevation of the bottom of the vane at time of shear test.

A second shear test may be performed directly below the first test without advancing the casing. The vane shall be pressed into the undisturbed soil for another distance of 15 inches and the operation repeated. Before a third test is performed, the casing shall be driven to the bottom of vane penetration and all materials therein removed by washing, in order that the vane should not project below the cleaned casing for a distance greater than 30 inches. Where tests are made directly below the elevation reached by an undisturbed dry sampler, the vane may be sunk below such elevation a maximum distance of 30 inches.

Each sample tube shall be labeled to indicate the Project, boring number, station, offset, ground line elevation, the sample run from which it was obtained, and its proper location within each run, by numbering the tubes consecutively starting from the top of each sample run. After capping avoid excessive exposure to sunshine or freezing temperatures, excessive vibrations, shock or other adverse conditions.

2.11. Core Borings in Rock

The drilling shall be done with standard core drilling machinery of the rotary type with either screw or hydraulic feed, actuated by an internal combustion engine and equipped with a double-tube core barrel and a diamond bit, capable of producing cores with a minimum diameter of 1-5/8 inches or 2-1/8 inches.

Before starting the core bit in the hole, a chopping bit shall be used to break up all disintegrated rock and the casing seated firmly on hard rock by driving and washing out.

The core bit shall be started in the hole and drilled for a maximum depth of 5 feet. The drill shall then be withdrawn and the core removed from the barrel, labeled and stored as hereinafter specified. Drilling shall be continued in runs not exceeding 5 feet until the total depth required by the Engineer has been reached. If the core bit should become blocked by a piece of broken core, the barrel shall be retrieved and cleaned before continuing the drilling.

The Contractor shall exercise due care to obtain satisfactory cores from all materials of a character that would ordinarily produce satisfactory rock cores under the operation of a standard type of core drill.

It is important that the percentage of recovery of the cores shall be as large as possible and the Contractor shall regulate the speed of their drill and remove the core as frequently as directed in order to maintain a maximum percentage of recovery, special care being taken where the character of rock being penetrated is uncertain. If the appliances on any machine are not such as will give, in the opinion of the Engineer, a reasonable amount of core recovery, the Contractor shall furnish such appliances or equipment as will be satisfactory.

2.12. Packing and Delivery of Samples

Ordinary dry samples are to be packed in pasteboard cartons with the sample jars in upright position. The two adjacent sides of each box shall be clearly marked with the name of the Project, boring number, and sample numbers contained.

Undisturbed dry samples are to be carefully packed in wooden boxes, with each sample surrounded by soft packing to prevent vibration in delivery. Each box shall be clearly marked with the name of the Project, boring number, and sample numbers contained.
The rock samples shall be placed in wooden boxes in the order in which they were taken. These boxes shall be about 4 or 5 feet long, containing only one layer, capable of holding approximately 25 feet of core, and substantially made of one-half inch lumber. Each box shall have a hinged lid with hasp and staple for locking, and carrying handles at the ends. Each row of cores shall be separated from the adjacent row by a one-quarter inch wood strip. Cores from each run shall be separated from those of the next run by a wooden block nailed into place. If cores from more than one boring are placed in the same box, two wooden blocks shall be nailed between adjacent borings. On each of these two blocks, the boring number referring to the adjacent cores shall be marked. The lid of each box shall be clearly marked with the name of the Project, boring number(s), the run numbers, and the elevations between which each run contained therein was taken. Cores secured from drilling boulders shall be marked and placed in core boxes. No core drilling shall begin without having core boxes at hand at the boring site.

Upon the completion of each boring, all undisturbed dry samples and retractable plug samples, properly boxed, shall be furnished to the Inspector at the site.

Upon completion of all borings, all ordinary dry samples and rock samples, properly boxed, shall be delivered to _______________________________________________.

No separate payment will be made for the packing and delivery of samples as specified, but the cost thereof shall be included in the prices bid for the various scheduled items in the Proposal.

2.13. Boring Records

During the progress of each boring, the Contractor shall keep a continuous and accurate log of the materials encountered and a complete record of the operations involved, which shall include at least the following data:

**General**
- Project Name
- Date
- Engineer, Contractor and Inspector
- Location and identifying number and type of boring and reference to survey data.

**Ground elevation or bed of waterway or marsh water, at boring. Elevation of ground water table or surface of waterway or marsh water at the beginning of boring operations (if visible), each morning before starting work while the boring is in progress, at the completion of the boring, and 24 hours after the boring is completed.**

**Casing Borings (primarily for soil sampling)**
- Diameter and description of casing (when used).
- Weight and drop of hammer and number of blows used to drive the casing to each successive foot of elevation.
- Elevation of top of each different material penetrated.
- Depth or elevation of the bottom of sampler at start of driving or pushing for each sample.
- Depth of elevation to which the sampler was driven or pressed.
Elevation of bottom of boring.
Weight and drop of hammer and number of blows used to drive the ordinary dry sampler for each 6 inches of sample.
Length of sample obtained.
Distance from the bottom of the sampler to the lower end of the sample, when the sampler is not filled to the bottom, and any other circumstances of obtaining the sample.
Stratum represented by the sample.
Soil represented by the sample.
Soil shall be described in accordance with the following classifications:
   a. Kind: Topsoil, fill, loam, silt, clay, sand, gravel, etc.
   b. Color: Light, dark, blue, red, etc.
   c. Moisture: Dry, moist, wet, very wet, etc.
   d. Consistency: Soft, loose, medium, compact, stiff, hard, etc.

In-Place Vane Shear Tests
Diameter and length of vane used.
Elevation of bottom of vane at time of test.
Angle of rotation, gage reading of torque, and converted shear strength for each reading of each test.

Core Borings
Elevation of bottom of casing when seated on bedrock.
Type of core drill, including size of core.
Length of core recovered for each length drilled, with resulting percentage of recovery.
Elevation of each change in type of bedrock.
Elevation of bottom of hole.
Rate at which each section was cored in minutes per foot.
The bedrock shall be described in accordance with the following classifications:
   a. Type: Shale, schist, slate, limestone, granite, sandstone, etc.
   b. Condition: Broken, fissured, laminated, solid, etc.
   c. Hardness: Soft, medium, hard, very hard, etc.

The driller’s logs of all borings, containing the information specified above, shall be transferred onto the Contractor’s standard log forms, at least 8½” x 11”. The necessary data shall be recorded on the forms in ink or pencil or may be typewritten.

No separate payment will be made for preparing such boring records, but the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.
2.14. Observation Wells

Observation wells, consisting of plastic pipe, shall be installed in borings designated by the Engineer. Borings in which observation wells are to be installed will be determined as the work proceeds. Notice to install an observation well will be given prior to the time of completion of the selected borings. The well shall be installed immediately after completion of the boring.

Pipe for observation wells shall be rigid plastic or PVC, Schedule 40 minimum, 1¼” I.D., as approved by the Engineer. The installation shall be protected in a manner acceptable to the Engineer, so that water and debris cannot enter the boring hole or the plastic pipe from the surface. Surface seal details are shown at the end of these Specifications in Diagram 1.

The plastic pipe shall be drilled with two 1/8 inch diameter perforations 1 foot 0 inch on centers for the full length of the tubing. The holes in the pipe shall be drilled methods which will produce an inside wall, free from all obstructions which would interfere with the observation of the water level. The pipe is to be made of straight sections, connected with external couplings and shall be of sufficient strength to prevent pipe twisting, kinking, or collapsing. The perforated plastic shall be installed before the casing is withdrawn and shall extend to the depth directed by the Engineer. The installation shall be protected in such a manner, acceptable to the Engineer, so water and debris cannot enter the boring hole or the plastic pipe from the surface. The ground water elevation at these wells is to be measured by the Engineer 24 hours after installation and daily thereafter until the ground water elevation has stabilized or as determined by the Engineer. The bottom of the pipe shall be closed by a suitable plastic or rubber plug, or cap. The assembled pipe shall be lowered into the cased boring, and the casing withdrawn from the hole. The pipe shall be kept centered in the boring while the casing is withdrawn.

2.15. Measurement and Payment

Payment for Mobilization will be made at the lump sum price bid for the item MOBILIZATION in the Proposal, which price shall include the cost of mobilizing equipment, materials and personnel for the Project, setting up and dismantling at each boring site, transporting between sites, demobilization upon completion of all field work, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

The quantities of various sizes of Cased Holes for Soil Sampling for which payment will be made, will be the total depth of each size of this type of boring actually made primarily for soil sampling, either by the use of casing or by drilling mud, and accepted by the Engineer, measured from the surface of existing ground or Mean Low Water in waterways, whichever is higher, to the bottom of the hole, or to ledge or bedrock, determined from the measurements taken by the Engineer, which measurements shall be accepted by the Contractor as final and conclusive. When the casing is not driven to rock, the bottom of the hole shall include the depth of the last soil sample obtained below the casing. Bedrock shall be considered as ledge rock in places into which casing cannot be driven because of its degree of hardness. Rock so disintegrated or decayed that casing can be driven into it, shall not be considered as rock.

Where the driving of a 4-inch casing is ordered discontinued and the boring is continued with a 2 1/2-inch casing below, the quantity of 4-inch Diameter Cased Holes for Soil Sampling to be measured for payment at that location will be the length extending from the surface of existing ground or Mean Low Water in waterways, whichever is higher, to the
bottom of the 4-inch casing, and the quantity of 2 1/2-inch Diameter Cased Holes for Soil Sampling at that location will be the length extending from the bottom of the 4-inch casing to the bottom of the hole. No separate payment will be made for furnishing, placing and removing the length of 2 1/2-inch casing within the 4-inch casing, but the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

Payment for the various sizes of Cased Holes for Soil Sampling will be made for the quantity of each size as above determined, measured in linear feet, at the prices per linear foot bid for the Items 2-1/2” DIA. CASED HOLES FOR SOIL SAMPLING and 4” DIA. CASED HOLES FOR SOIL SAMPLING in the Proposal, which prices shall include the cost of locating utilities, furnishing and sinking the casing, removing and disposing of the casing after the boring is completed, the use of drilling mud if approved by the Authority, filling the holes, all labor, materials, tools, equipment and all else necessary therefore, and all other work in connection therewith and incidental thereto, exclusive of sampling.

The quantities of Ordinary Dry Samples and of Undisturbed Dry Samples, for which payment will be made, will be the total number of each type and size of sample actually obtained, accepted by the Engineer, and delivered in accordance with the Specifications. In the case of continuous sampling, each 2-foot sample obtained will be measured as an individual sample.

Payment for Ordinary Dry Samples and for Undisturbed Dry Samples will be made for the quantity of each type and size as above determined at the prices each bid for the Items 1-3/8” DIA. ORDINARY DRY SAMPLES, 2” DIA. ORDINARY DRY SAMPLES and 3-3/8” DIA. UNDISTURBED DRY SAMPLES, respectively, in the Proposal, which prices shall include the cost of taking the samples, furnishing jars, tube containers, cartons and boxes, delivering the samples, all labor, materials, tools, equipment and all else necessary therefore, and all other work in connection therewith and incidental thereto.

The quantity of 2-inch or 3-inch Diameter In-Place Vane Shear Tests for which payment will be made, will be the total number of tests actually performed and accepted, using either size of vane.

Payment for 2-inch or 3-inch Dia. In-Place vane Shear Tests will be made for the quantity as above determined at the price each bid for the Item 2” or 3” DIA. IN-PLACE VANE SHEAR TESTS in the Proposal, which price shall include the cost of sinking the vane shaft, rotating the vane, recording the gage readings, converting the readings to shear strengths, all materials, labor, equipment and all else necessary therefore, and all other work in connection therewith and incidental thereto.

The quantity of 1-inch Dia. Retractable Plug borings with Samples for which payment will be made, will be the total depth of this type of boring actually made, and accepted by the Engineer, measured from the surface of existing ground or Mean Low Water in waterways, whichever is higher, to the bottom of the hole, determined from the measurements taken by the Engineer, which measurements shall be accepted by the Contractor as final and conclusive.

Payment for 1-inch Dia. Retractable Plug Borings with Samples will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item 1” DIA. RETRACTABLE PLUG BORINGS with samples in the Proposal, which price shall include the cost of furnishing the equipment, advancing the sampler, securing the samples, delivering the samples in sample tubes, all labor, material, tools, equipment and all else necessary therefore, and all other work in connection therewith or incidental thereto.
The quantities of 1 5/8-inch and 2 1/8-inch Diameter Core Borings in Rock for which payment will be made, will be the total depth of each type actually drilled in ledge or bedrock, measured from the bottom of casing to the bottom of the hole, and the total depth drilled through boulders and rock veins 6 inches or more in thickness, provided the casing is driven below the bottom depth of such boulders and rock veins.

Payment for 1 5/8-inch and 2 1/8-inch Diameter Core Borings in Rock will be made for the quantity as above determined, measured in linear feet, at the price per linear foot of each type bid for the Items 1-5/8” DIA. CORE BORINGS IN ROCK and 2 1/8 DIA. CORE BORINGS IN ROCK in the Proposal, which prices shall include the cost of providing the proper equipment, securing the rock core samples, furnishing the core boxes, delivering the samples, all materials, labor, equipment and all else necessary therefore, and all other work in connection therewith and incidental thereto.

The quantity of observation wells for which payment will be made will be the total length of observation well casing measured from the cap to the tip of each installed in accordance with the plans and specifications and accepted by the Engineer.

Payment for observation wells will be made for the quantity as above determined, measured in linear feet, at the price bid for the item OBSERVATION WELLS in the Proposal, which price shall include the cost of all the materials, the installing of the observation well, placing the backfill, seals, labor, equipment and all else necessary therefore, and all other work in connection therewith and incidental thereto except for the drilling of the hole into which the piezometer or observation well is to be placed.

There shall be no duplication of payment for footage of Cased Holes for Soil Sampling and Core Borings in Rock.

No payment for sinking casing and taking samples therefrom will be made if the boring hole is abandoned or lost before completion, unless and solely to the extent that the Engineer believes that the sinking of the casing and taking of samples are of sufficient benefit to warrant payment for such work at scheduled prices.

The Contractor is hereby advised that final payment under this Contract will not be made until the boring records have been completed and delivered, together with all remaining soil and rock samples, to the Engineer as specified elsewhere herein.
APPENDIX B
Burmister Soil Identification System
BURMISTER SOIL IDENTIFICATION SYSTEM

IDENTIFICATION OF SOILS

A. Object

In all soil work, an important factor is to be able to recognize the soil materials that are being used, and to be able to accurately describe them. Included herein is the Burmister System for identification of soils that is to be used by the Engineer. It provides a concise and accurate description of the soil, yet is simple enough to determine the soil components by visual identification.

This system provides a description of the granular materials, Silt, Sand and Gravel, that is based upon particle size. The description of cohesive soils is based upon the plasticity. The criteria for soil identification using this system are noted later with examples.

B. Burmister Soil Identification System

Following in outline form, are the criteria for the identification of soils. Figure B1 summarizes this system and Figure B2 shows the standard semi-log graph used for graphic presentation of soils identifications. The plot gives the Percentage Finer by Weight vs. Grain Size in Millimeters. Beneath the graph are the particle size limits of the soil components used for the identification system.

1. Particle Size Limits for Soil Components.
   (a) Cobbles and Boulders - Greater than 3 inch diameter (76.2MM)
   (b) Gravel - 3 inch diameter (76.2MM) to No. 10 sieve (2.0MM)
   (c) Sand - No. 10 Sieve (2.0MM) to No. 200 Sieve (0.074MM)
   (d) Silt - Material passing the No. 200 Sieve (0.074MM) of a non-plastic nature
   (e) Clay - Material passing the No. 200 Sieve (0.074MM) of plastic nature
   (f) Miscellaneous - Materials such as mica, shells, organic silt, peat, decomposed bedrock in place, etc. These materials are described per se, without regard to grain size.

2. Particle Size Limits for Granular Soil Functions.

The above mentioned constituents in Categories b, c and d are further sub-divided into coarse, medium and fine components.

Following is a list of the component parts of the above mentioned constituents and their size limits:
   (a) Gravel - Coarse - Less than 3 inches (76.2MM) Greater than 1 inch (25.4MM)
       Medium - Less than 1 inch (25.4MM) Greater than 3/8 inch (9.52MM)
       Fine - Less than 3/8 inch (9.52MM) Greater than No. 10 Sieve (2.0MM)
   (b) Sand - Coarse - Less than No. 10 Sieve (2.0MM) Greater than No. 30 Sieve (0.59MM)
Medium - Less than No. 30 Sieve (0.59MM) Greater than 60 Sieve (0.25MM)
Fine - Less than No. 60 Sieve (0.59MM) Greater than No. 200 Sieve (0.074MM)

(c) Silt - Coarse - Material passing the No. 200 Sieve that is free draining in character
Fine - Material passing the No. 200 Sieve that is slow draining in character

The predominant fraction of any constituent can be noted by a plus sign. For example:
Mainly coarse Gravel = “Coarse + to fine Gravel” or
Mainly fine Sand = “Medium to fine + Sand”

3. Quantitative Description of Granular Components.

Soils that are essentially granular in character are identified by the classification system outlined above and are described on this basis and by the percentages by weight of each component part. Descriptive adjectives therefore precede the name of the soil component, which cover a rather narrow range of percentages of that component, by weight. Following is a list of descriptive adjectives and the percentage range of the total soil sample that they represent.

- a. Not described Less than 1%
- b. Trace 1-10%
- c. Little 10-20%
- d. Some 30-35%
- e. And 35-50%

4. Description of Granular Soil.

The major constituent of the soil sample is written in upper case letters. The minor components are written, along with their descriptive adjectives in lower case letters. Commas separate the various components. The color of the soil precedes the description.

Example: A soil sample is composed of the following percentages by weight of the various components.

- Gravel (Medium and Fine only) 25%
- Sand (Coarse, Medium & Fine Combined) 70%
- Silt (Coarse & Fine Combined) 5%

The soil color is brown.

The written description of the soil is as follows:

“Brown coarse to fine SAND, some medium to fine Gravel, trace Silt”
5. Description of Cohesive Soil.

For soils that are essentially cohesive in character, the clay-silt fraction is described on the basis of plasticity, since silt and clay in intimate combination cannot be easily separated. The soil is described then, on the basis of its plasticity index, which is a function of the types of clay minerals present, and of the clay-silt ratio. Following is a list of terms used to describe the clay-silt fraction of a soil, along with its range of plasticity indices.

<table>
<thead>
<tr>
<th>Description</th>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt</td>
<td>0</td>
</tr>
<tr>
<td>Clayey Silt</td>
<td>1 -5</td>
</tr>
<tr>
<td>Silt &amp; Clay</td>
<td>5 -10</td>
</tr>
<tr>
<td>Clay &amp; Silt</td>
<td>10 -20</td>
</tr>
<tr>
<td>Silty Clay</td>
<td>20 - 40</td>
</tr>
<tr>
<td>Clay</td>
<td>Greater than 40</td>
</tr>
<tr>
<td>Organic Clayey Silt,</td>
<td>An organic soil,</td>
</tr>
<tr>
<td>Organic Silt &amp; Clay, etc.</td>
<td>usually black in color.</td>
</tr>
</tbody>
</table>

The description, based on plasticity index, is the same as for ordinary clays and silts.

Example: A soil sample contains the following percentage by weight of these soil components:

- Gray Gravel 15% (fine Gravel only)
- Gray Sand 30% (all components)
- Gray Silt-Clay 50% (Plasticity Index of 15)
- Shell Material 5%

The above soil sample is described as follows:

“Gray CLAY & SILT, some coarse to fine Sand, little fine Gravel, trace Shells.”

6. Shorthand - For Field Use Only

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Clay</td>
</tr>
<tr>
<td>$</td>
<td>Silt</td>
</tr>
<tr>
<td>S</td>
<td>Sand</td>
</tr>
<tr>
<td>G</td>
<td>Gravel</td>
</tr>
<tr>
<td>O$</td>
<td>Organic Silt</td>
</tr>
<tr>
<td>c</td>
<td>Coarse</td>
</tr>
<tr>
<td>m</td>
<td>Medium</td>
</tr>
</tbody>
</table>
C. Visual Identification of Soils.

To facilitate visual identifications of soils in the field, the following methods are recommended. The use of these methods will provide easy and accurate identifications of soils with a little practice.

The best approach is to identify each sample by following a series of steps, as outlined below:

1. **Color**
   
   Determine the color or colors if the sample is mottled.

2. **Gravel Content**
   
   Determine the percent of the total sample that is gravel by separating out the gravel and estimating by eye. Allowance should be made for fine gravel that was missed when picking over the sample.

3. **Gravel Gradation**
   
   The size of the largest piece of gravel should be determined. Use an average dimension, not the maximum dimension. Estimate by eye the predominant size. If there is a predominant size, note with a plus sign as shown in Section 2.

4. **Sand Content**
   
   After separating the gravel, take a pinch of the remaining soil and rub it between the fingers and thumb. The presence of coarse and medium sand can be noted by a gritty feeling. By rubbing in the palm of the hand with a finger, the soil can be dried. The sand grains can then be distinguished and the percentage of sand in the Sand-Silt-Clay portion of the sample noted. This percentage should be corrected for the whole sample, to include the gravel, as illustrated below.
   
   Gravel separated out: 30%
   
   Remaining Sand-Silt-Clay portion of sample: 70%
   
   Sand content of Sand-Silt-Clay portion of sample: 50%
   
   Sand content of whole sample = 50 x 70 = 35%

5. **Sand Gradation**
   
   By drying a pinch of the sample in the palm of the hand as previously noted, the gradation of the sample can be determined. An easy way to distinguish between fine Sand and Silt is that the individual grains of the Sand can be distinguished by eye whereas the individual grains of Silt cannot.
6. **Silt-Clay Content**

Moisten a 1/2 inch diameter ball made from the Sand-Silt-Clay portion of the sample. Shake this ball in the palm of the hand and notice if moisture appears on the surface of the ball. If moisture appears, no clay is present; if no moisture appears, there is clay in the sample. If moisture appears on the surface of the ball, gently squeeze the ball between the forefinger and the thumb till the moisture disappears, then release. If moisture reappears, the sample is coarse Silt; if no moisture appears, or appears very slowly the sample is coarse and fine Silt.

For soils that contain both Silt and Clay, or Clay only, the plasticity index can be estimated by a rather simple test. A 1/2 inch diameter ball of the soil is made. The consistency or strength of the ball is brought to that of modeling clay by drying or adding moisture to the ball of soil. A piece of the ball is then rolled into a thread on a flat surface, and the diameter at which the thread crumbles indicates the Clay-Silt content, as noted below:

<table>
<thead>
<tr>
<th>Thread Diameter</th>
<th>Plasticity Index</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>¼&quot;</td>
<td>0</td>
<td>SILT</td>
</tr>
<tr>
<td>¼&quot;</td>
<td>1- 5</td>
<td>Clayey SILT</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>5-10</td>
<td>SILT &amp; CLAY</td>
</tr>
<tr>
<td>1/16&quot;</td>
<td>10 - 20</td>
<td>CLAY &amp; SILT</td>
</tr>
<tr>
<td>1/32&quot;</td>
<td>20 - 40</td>
<td>Silty CLAY</td>
</tr>
<tr>
<td>1/64&quot;</td>
<td>40</td>
<td>CLAY</td>
</tr>
</tbody>
</table>

It is helpful to have a 1/2 inch diameter ball of modeling clay available when performing the test. By squeezing the clay in one hand, and the soil in the other with the index finger and thumb, a good check on the consistency can be made by comparison.

7. Another test to help determine the soil plasticity is the resistance of a piece of dried soil to crushing by finger pressure. A soil specimen is molded to the consistency of putty, adding water if necessary. The moist pat of soil is allowed to dry (in oven, sun, or air) and is then crumbled between the fingers. Soils with slight dry strength crumble readily with very little finger pressure. Silt soils have almost no dry strength. Organic soils and clayey silt soils of low plasticity have slight dry strength. Soils of medium dry strength require considerable finger pressure to powder the sample. Silt and clay and clay and silt soils exhibit medium dry strength. Soils with high dry strength can be broken but cannot be powdered by finger pressure. High dry strength is indicative of silty clay or clay soils as well as some organic clays of high plasticity.

An additional aid in classifying soil types that consist of various components of sand, silt and clay is the sedimentation test in a glass jar or test tube. The various percentages of the components are estimated from the sedimentation test which is performed as follows:

A small quantity of soil is placed in the bottom one-half or one-quarter of a test tube or jar such that it is compact without any large air spaces. The height of sample is then noted. A supply of water is then added to the
test tube and the test tube is vigorously shaken until the soil sample is entirely in suspension. All sand particles should settle out of the suspension within 30 seconds after the shaking has stopped. The silt particles will settle out of the suspension within 30 minutes after the shaking has stopped. The relative depth of sand and silt to the original depth of sample will provide for an estimate of the percentage of sand and silt in the total sample. The clay will still be all in suspension at the end of 30 minutes and it may take up to 24 hours for all the clay to settle out. Therefore, there is no advantage in performing the test more than 30 minutes.
1. SOIL MATERIAL Composition, Gradation, and Plasticity Characteristics

   a) Soil Components and Soil Fractions

<table>
<thead>
<tr>
<th>Sieve</th>
<th>3&quot;</th>
<th>1&quot;</th>
<th>3/8&quot;</th>
<th>2 mm</th>
<th>No. 10</th>
<th>No. 30</th>
<th>No. 60</th>
<th>No. 200</th>
<th>0.076 mm</th>
<th>0.02 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granular Component Fractions</td>
<td>GRAVEL</td>
<td>coarse</td>
<td>medium</td>
<td>fine</td>
<td>coarse</td>
<td>medium</td>
<td>fine</td>
<td>coarse</td>
<td>fine</td>
<td></td>
</tr>
<tr>
<td>Clay Soil Components</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   b) Identifying Terms for Granular Soils Composition and Proportion Terms for Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Proportion Terms</th>
<th>Defining Range of Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Components- GRAVEL, SAND, SILT (all Uppercase)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor Components-</td>
<td>Gravel</td>
<td>and</td>
</tr>
<tr>
<td>Sand</td>
<td>some</td>
<td>20 to 35%</td>
</tr>
<tr>
<td>Silt</td>
<td>little</td>
<td>10 to 20%</td>
</tr>
<tr>
<td>Trace</td>
<td>1 to 10%</td>
<td></td>
</tr>
</tbody>
</table>

   Gradation Terms for Granular Soils

<table>
<thead>
<tr>
<th>Gradation Terms for Granular Soils</th>
<th>ORGANIC SOILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>coarse to fine all fractions more than 10%</td>
<td>Plasticity Basis, as</td>
</tr>
<tr>
<td>coarse to medium fine less than 10%</td>
<td>Organic SILT, H. PI</td>
</tr>
<tr>
<td>medium to fine coarse less than 10%</td>
<td>Organic SILT, L. PI</td>
</tr>
<tr>
<td>fine coarse and fine less than 10%</td>
<td></td>
</tr>
<tr>
<td>Fine coarse and medium less than 10%</td>
<td></td>
</tr>
</tbody>
</table>

   PLUS or MINUS signs used to indicate upper or lower limits.

   c) Identifying Terms for CLAY SOILS. Plasticity Basis for Combined Silt and Clay Components, Expressing the Relative Dominance of Clay

<table>
<thead>
<tr>
<th>Overall Plasticity</th>
<th>Plasticity Index</th>
<th>Principal Component</th>
<th>Minor Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Plastic</td>
<td>0</td>
<td>SILT</td>
<td>Silt</td>
</tr>
<tr>
<td>Slight</td>
<td>1 to 5</td>
<td>Clayey SILT</td>
<td>Clayey Silt</td>
</tr>
<tr>
<td>Low</td>
<td>5 to 10</td>
<td>SILT &amp; CLAY</td>
<td>Silt &amp; Clay</td>
</tr>
<tr>
<td>Medium</td>
<td>10 to 20</td>
<td>CLAY &amp; SILT</td>
<td>Clay &amp; Silt</td>
</tr>
<tr>
<td>High</td>
<td>20 to 40</td>
<td>Silty CLAY</td>
<td></td>
</tr>
<tr>
<td>Very High</td>
<td>more than 40</td>
<td>CLAY</td>
<td></td>
</tr>
</tbody>
</table>

   Example: Soil 60% coarse to fine Sand, 25% medium to fine Gravel, 15% Clayey Silt and color-brown.
   Identification: Br. coarse to fine SAND, some medium to fine Gravel, little Clayey Silt.

## FIGURE B2
STANDARD SEMI-LOG GRAPH

### Particle Size Distribution Report

<table>
<thead>
<tr>
<th>GRAIN SIZE - mm</th>
<th>% Cobble</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>% Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coarse</td>
<td>Fine</td>
<td>Coarse</td>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>PERCENT FINER</th>
<th>SPEC. PERCENT</th>
<th>PASS? (X=NO)</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(no specification provided)

**Atterberg Limits**

- **PL**
- **LL**
- **PI**

**Coefficients**

- **D_0.5**
- **D_10**
- **D_90**

**Classification**

- AASHTO=

**Remarks**

**Date:**

---

**Engineering Firm**

Client:

Project:

Project No:

Plate
APPENDIX C
Boring Inspector’s Manual
BORING INSPECTOR’S MANUAL

INTRODUCTION

This publication provides a guide to boring inspection, preparation of boring logs, sample preservation and compilation of boring contract records. Soil identification is covered in Appendix B and should be utilized in the preparation of boring logs.

ORGANIZATION

All borings are to be performed under the supervision of a Boring Inspector located in the field with the boring equipment. The Boring Inspector is to be under the supervision of a Geotechnical Engineer who will make periodic visits to the boring work.

Prior to initiating any field exploration, the Boring Inspectors and the Drilling Superintendent must be thoroughly briefed relative to anticipated subsurface conditions, boring locations, boring numbering, boring depth criteria, sampling procedures, boring access and other provisions required of the field exploration. Such information and instruction shall be covered in the boring contract plans and specifications and by a meeting with the Geotechnical Engineer.

The Geotechnical Engineer shall be contacted by telephone daily, or as directed, during the course of the investigation. These reports are to document conditions encountered and to check on possible changes in the boring program and sampling procedures. No boring rig should be allowed to demobilize or otherwise leave the site without the Geotechnical Engineer’s knowledge. In the event that the Geotechnical Engineer is unavailable for a decision, which cannot be made by the Boring Inspector, then the person next in command above the Geotechnical Engineer who is associated with the project should be consulted.

BORING RECORDS

The boring log is the basis for every foundation analysis and it is, therefore, important that a complete and accurate record of all aspects of the subsurface exploration be maintained. The following items should be carefully observed and recorded on the field boring log.

1. Dates and times of beginning and completion of work.
2. Identifying number and location of test boring.
3. Ground surface and elevation at the boring and source of reference.
4. Diameter and description of casing.
5. Total length of each size of casing.
6. Length of casing extending below ground surface at the completion of the boring.
7. Weight, number of blows, and the length of drop of hammer used to drive the casing each successive foot.
8. Water level observation with remarks on possible tidal variations. (All measurements from original ground surface.)
9. Depth to top of each different material penetrated.
10. Depth to the bottom of sampler at start of driving for each sample and depth to which the sampler was driven.
11. Sampler type and dimensions.
12. Weight of hammer and the length of drop used to drive the split spoon sampler and the number of blows required to drive the sampler, measured in 6-inch intervals, throughout its full depth of penetration.

13. Methods and forces used to push sampler tube when not driven.


15. Loss or gain of drilling fluid or mud.

16. Any sudden dropping of drill rods or other abnormal behavior.

17. An accurate record of any change in the original boring location.

18. Identification of the subsoils and bedrock including color, moisture, structure, condition, etc.

19. Type of drilling operation used to advance hole.

20. Comparative resistance to drilling.

21. Any loss of drilling water or drilling mud.

On the field boring log form all data on the drilling and sampling should be noted along with the identification of the soil samples obtained and soil strata changes. It is best to include too much information rather than too little. A sample boring log is attached that provides guidance, (see Figure C1). The Geotechnical Engineer should be consulted to be sure sufficient information is provided on the boring logs.

In addition to the foregoing, it is important that a site reconnaissance be made. Any conditions which may affect design considerations or construction should be noted and logged into the Daily Field Inspection Report and verbally reported to the Geotechnical Engineer. Examples might be: the presence of buildings or old foundations left over from demolition; man made or sanitary landfills; indications of sinkholes, depressions or open caves; existing rock outcrops; surface drainage; etc. Careful documentation throughout the field operations is critical.

Daily Field Inspection Reports should include, in chronological order, the following:

1. Job number, name, location, date, weather conditions, client, owner and contractor representatives.

2. Arrival and departure of all personnel involved.

3. Record all delay and down-times, their causes and eventual conclusion.

4. Summaries of any discussions, conversations and meetings relevant to the project work including any instructions and change orders.

5. Summarize all work, progress for the day. Include, whenever possible, a location diagram of work areas for that day.

6. Record all contacts made, the names of the parties contacted, and who they represent.

7. Tabulate daily pertinent data such as water level readings, boring footage (rock and soil), and footage for observation well installation, etc.

8. Document all equipment used and maintain an accurate record of all expenses incurred.
A sample of a Daily Field Inspectors Report (Subsurface Exploration Report) is attached for guidance; see Figure C2.

Following is a list of necessary equipment and supplies to be used by the Boring Inspector.

1. Clip board.
2. Boring plans and Specifications
3. Boring log forms.
4. Daily report and other type of forms.
5. 6-foot Folding Engineers ruler.
6. Pocket knife.
7. Optional equipment:
   100-foot Measuring tape
   Pocket penetrometer
   Hand level
   Flagging tape
   Indelible black ink marker pen

Conversations with local residents may provide additional useful historical data relevant to the site. However, extreme caution should be used when discussing a client’s project with outsiders. If questioned only state the general nature of the project. Any extra information provided may be misconstrued or misused in such a manner so as to create adverse publicity. For this reason discussions and information pertaining to the project should not be given to anyone except the client’s authorized representative.

Generally the driller should be the man best able to detect changes in strata and drilling resistance during the course of drilling. There should, therefore, be a close liaison between the driller and the Boring Inspector at all times. Where changes in strata are indicated by the driller in between scheduled sampling intervals, samples should be taken at the strata change wherever such is feasible.

There are a number of abbreviations and terms that are useful in preparing boring logs that may be utilized. Abbreviations for soil identifications should only be used when lack of space prohibits their being written out in full

**STANDARD ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Soil Identification</th>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel</td>
<td>G</td>
<td>Silty Clay</td>
</tr>
<tr>
<td>Sand</td>
<td>S</td>
<td>Clay</td>
</tr>
<tr>
<td>Silt</td>
<td>$</td>
<td>Peat</td>
</tr>
<tr>
<td>Clayey Silt</td>
<td>Cy$</td>
<td>fine</td>
</tr>
<tr>
<td>Silt &amp; Clay</td>
<td>$&amp;C</td>
<td>medium</td>
</tr>
<tr>
<td>Clay &amp; Silt</td>
<td>C&amp;$</td>
<td>coarse</td>
</tr>
</tbody>
</table>

Color
light gray LtGr tan Tn
gray Gr yellow Yl
dark gray DkGr green Grn
black Bk blue Bl
brown Br red Rd

Samplers
Split spoon SS Diamond core size BX, NX
Shelby Tube ST Torvane Tv
Piston Sampler PS Field Vane Fv
Denison Sampler DS Pocket penetrometer Pp

Modifications
organic org seam, seams sm, sms
calcareous calc streaks stks
ferrous fer nodules nod
lignitic lig laminated lam
very v slickensided sls
slightly sl interbedded intbdd
at @ intermixed intmx
with w/

TERMS CHARACTERIZING SOIL STRUCTURE
Slickensided - surfaces that are slick and glossy in appearance or polished.
Fissured - an extensive crack or cracks.
Sensitive strength - pertaining to cohesive soils that are subject to appreciable loss of strength when remolded.
Varved - alternating thin layers of silt (or fine sand) and clay.
Laminated - composed of thin layers and texture, 1 cm or less, in thickness.
Interlayered - composed of alternate layers of different soil types.
Parting - a very thin layer one or two grains thick.
Calcareous - containing appreciable quantities of calcium carbonate.

DRY SAMPLE BORINGS
The borings are to be advanced using ordinary boring techniques. Cased holes shall use driven casings not less than 2W in diameter to the extent needed to maintain an open hole without loss of ground. Cleaning out the hole, where casing is used, or advancing the hole, if casing is not needed, shall not be done by washing through a sampling spoon or open-
ended drill rod unless prior approval is obtained from the Resident Geotechnical Engineer. The use of rotary drilling techniques with weighted drilling mud, hollow stem augers or other methods to advance and maintain a stabilized hole may be permitted depending upon field conditions and the design of the drilling program. Any changes in the drilling program should have the approval of the Resident Geotechnical Engineer. Casing, where used, shall be driven down without washing in stages of not more than five feet, after which the material shall be cleaned out to the depth of the bottom of the casing. At every change in soil formation and at vertical intervals not to exceed five feet, hole advancement should be stopped, the loose material should be removed from the hole and an ordinary dry sample of the material should be taken. These samples should be taken in accordance with the provisions of the Standard Penetration Test. The samples should be removed from the hole in an unwashed condition in such a manner as to provide a true sample of the soil formation from which they are recovered. Requirements of the Standard Penetration Test (ASTM D1586) specifications for the sampler and guidelines for soil sampling are as follows:

1. A two-inch O.D. split-barrel sampler similar to Ackers’ Sampler No. 22017-9 may be used, provided a M1 I.D, open split-barrel at least 26-inches long is incorporated in the sampler. The beveled edge of the drive should be maintained in good condition and if excessively worn, should be reshaped to the satisfaction of the Engineer. The drive shoe of the sampler should be replaced, if damaged, in such a manner as to cause projections within the interior surface of the shoe.

2. Under no circumstances should samples be recovered by driving the casing as a sampling barrel. All samples should be obtained by driving the split barrel sampler in undisturbed ground beneath the bottom of the casing. Samples should be recovered at every change in soil formation and at vertical intervals not to exceed 5 feet.

3. After cleaning the hole of all loose material, the sampling barrel should be driven by a free-falling drop weight weighing 140 pounds and falling 30 inches. The sampler should be driven using Standard A rods connected between the sampler and drive head unless use of other equipment is approved by the project engineer.

4. In all soils requiring less than 100 blows per foot of penetration, the sampling barrel should be driven 24 inches with the number of blows for each 6 inches of penetration observed and recorded.

5. In extremely hard materials requiring over 100 blows per foot, the blows for smaller amounts of penetration may be observed and recorded with special note of the amount of penetration actually obtained. Refusal may be considered to be greater than 100 blows per 2 to 3 inches.

6. When a casing is used, particular care should be taken to remove all soil to the bottom of the casing before sampling. Particular care also must be exercised to maintain the hole full of water during all operations preceding sampling, such as during removal of wash pipe and wash bit and assembly and insertion of sampling barrel. The driller should provide positive inflow of water at the top of the casing during removal of drill rods or wash pipe.

Immediately upon removal from the hole the split barrel sampler should be split open to provide for visual inspection of the intact sample by the Boring Inspector. Samples should then be tightly sealed in screw-top glass jars or bottles at least 3-1/2 inches high, approximately 1-1/2 inch inside diameter at the mouth, and with inside diameter of the jar no more than ¼-inch larger than that at the mouth. The jars shall be provided with metal screw caps containing a rubber or waxed-paper gasket. Each sample container shall be labeled to
show plainly the project number, the boring number, the depth at which the sample was taken, and the number of blows for penetration of the sampler for each 6 inches of penetration should be noted in the correct location on the boring log. Samples shall be placed in the jars in the condition in which they are removed from the split barrel sampler without squeezing, mashing or otherwise excessively distorting the sample. The driller shall, at their expense, provide such containers, keeping a sufficient supply on hand to prevent any delay in the work. Samples which have been recovered and preserved should be numbered consecutively; i.e. S1, S2, etc. If the sample from the split barrel is divided into subsamples because of material change, then the sample designation number will be followed by a letter designation assigned alphabetically from top to bottom; i.e. S1A, S1B, etc. If no sample is recovered it will be designated by an “NR” and no sample number assigned. No jar need be placed in the jar box to show N position. The outer portion of the recovered soil samples should be scraped free of drilling mud for more accurate identification.

CONTINUOUS SAMPLING
Continuous sampling in certain borings or through certain soil strata may be requested by the Resident Geotechnical Engineer based upon information disclosed by the borings. Continuous sampling shall mean the securing of successive samples in sampling devices without intervening drilling or washing except for cleanout operations, as specified.

UNDISTURBED SAMPLE BORINGS
At the request of the Resident Geotechnical Engineer, or their representative, the driller may be required to take samples in a three-inch O.D. open-type “Shelby” tube undisturbed sample with sample tubes 30 inches long and provided with a positive ball check valve in its head. For obtaining undisturbed samples, the casing shall be at least 3½” in diameter. Undisturbed samples are normally required in soft clay or organic soils. Such samples shall be obtained by pushing or jacking the sampler into undisturbed soil at the bottom of the hole. Wherever possible, the equipment for advancing the sampler shall measure the force required to penetrate the soil. The Boring Inspector shall record the force required to penetrate the soil. The Boring Inspector shall record this force, depth of penetration and length of sample recovered. These samples shall be sealed in the tubes in which they are obtained and carefully labeled to show location and depth of sample (i.e.: S1, S2, ST3, S4). When there are problems with obtaining undisturbed samples using Shelby tubes, then undisturbed soil samples shall be recovered by means of special piston-type samplers.

When ready to take Shelby or piston-type samples, all loose and disturbed materials shall be removed to the bottom of the casing or of the open hole. This final cleaning should be accomplished with a device in which washwater is fully deflected in an upward direction. No washing with downward directed jets should be permitted within four inches of the intended top of the undisturbed sample unless otherwise directed by the Resident Geotechnical Engineer or their representative. Cleaning out of the last four inches of the intended top of the sample should be accomplished with shield jet auger such as a “Clean-Out Jet Auger”, (Ackers Catalogue 320396 for 3” pipe or 320397 for 4” pipe), or equivalent device subject to the approval of the project engineer. Cleaning out should be done in such a manner that the soil immediately below the bottom of the casing is as nearly undisturbed as possible. The sampling device connected to the drilling rod should then be lowered slowly to the bottom of the hole and the sampler forced into the soil for a distance of not less than 24 inches or more than 27 inches.

In the operation of securing the undisturbed samples, the samplers should be forced into the soil at a rate of four to five inches per second. The samplers should be pushed or jacked
downward, and not to be driven unless the character of the soil is such that driving with the hammer is absolutely necessary and is approved by the project engineer.

The sampler with its contained soil sample should be rotated, and then carefully removed from the hole. The thin-walled tube containing the sample should be detached from the driving head. A portion of the undisturbed sample should always be carefully removed from both ends of a tube (a minimum of ½” thickness) and squared and preserved whether the sample is sealed in the tube or extruded in the field and preserved in cartons. The removed samples from the top and tip of the tube should then be described on the boring log. At the request of the Resident Geotechnical Engineer, it may be necessary to perform Pocket Penetrometer and field Torvane tests on the bottom of the recovered undisturbed sample. It may, however, be necessary, if requested by the Resident Geotechnical Engineer, to extrude the samples in the field and preserve them in quart cartons; when samples are handled in this manner, extra time and care must be taken.

If the soil sample is not extruded, the ends of the tube are wiped clean and the end spaces filled with hot paraffin or hot melted beeswax. The ends of the tube should then be sealed with snug-fitting metal or plastic caps and secured in place with friction tape, after which the ends of the tube should be dipped in hot paraffin/beeswax to provide airtight seals.

Undisturbed soil samples should be clearly and permanently marked on the tube to show the project contract number, the number of the hole, the sample number, the depth from which the sample was taken, the measured recovery, and the top and bottom of the tube, and any other information which may be helpful in determining subsurface conditions. Whenever possible, a measurement of the force required to push the undisturbed sampler tube into the soil should be obtained and recorded.

Undisturbed samples, designated by a “U” and “Shelby Tubes” designated by “ST” should be numbered according to their occurrence in the boring sequence: i.e., S1, S2, U3, S4, ST5, S6, S6A, etc. Undisturbed samples should be handled and transported in a cushioned rack with the top of the sample always upright. It should be delivered to the laboratory with extreme care in order to minimize disturbance effects which may render laboratory test results useless.

During the winter months, precautions must be taken to prevent undisturbed samples from freezing during handling and shipping; if allowed to freeze, the samples will be worthless for strength or consolidation testing.

Tubes for undisturbed samples are to be provided by the driller, and should be of steel, seamless brass or hard aluminum. Sample tubes should have a machine-prepared sharp cutting edge with a flat bevel to the outside wall of the tube. The cutting edge shall be drawn in to provide an inside clearance beyond the cutting edge of 0.015”± 0.005”.

When recovery of samples by use of Shelby tubes is poor, then undisturbed soil samples are to be recovered by means of a thin-wall piston-type sampling device, similar to Acker’s No. 22041- 7 in which piston rods extend to the ground surface, or a self-contained hydraulically-operated piston sampler, such as the “Osterberg” sampler, or a casing-actuated piston sampler, such as the “Hong” sampler. The sampler selected should be designed to utilize sample tubes with a three-inch outside diameter. When samplers, utilizing piston rods extending to the ground surface, are used, positive locking of the piston rods with respect to the surface of the ground must be provided to prevent upward or downward motion of the piston during the advance of the sampling tube and the piston rods must be positively locked to the drill pipe at the surface during removal of the sampler for the depth to which it penetrated undisturbed soil. If the piston rods are locked to the mast of a
truck-mounted drill rig, the rig should be blocked and anchored to the ground in such a manner as to prevent motion of the rig during the sampling operations.

If specifically approved in advance by the Resident Geotechnical Engineer, samples may be recovered in hard soils by an open-type, thin-wall sampling device, similar to Acker’s No. 22012-14 or No. 22058-4.

In very soft soils, a weighted drilling mud may be required, whether or not casing is used, in order to maintain a pressure on the soil as nearly equal as possible to that existing before the drilling operations.

Under certain conditions, continuous sampling with three-inch diameter “Shelby” tubes may be required in cohesionless materials encountered in 3 ½” undisturbed sample borings.

BORING TERMINATION

In general, a specific completion depth, or depth criterion should be assigned to each boring location for the design of the drilling program. Unless otherwise instructed by the Resident Geotechnical Engineer, it is expected that the design completion depth will be adhered to. Because the sample depths are generally at five-foot intervals and the completion depths are generally in multiples of five feet (i.e. 25, 30, 40, 65 feet, etc.), the last sample should begin before and terminate at the design completion depth. Similarly with rock coring, the last run does not have to be a complete five-foot run, but may be stopped early at the design completion depth.

There are occasions when borings might not be terminated at the designated completion depths. Such occasions might be:

1. The boring is in soft clays or organic silts or some compressible stratum;
2. Sampling blow counts have been decreasing significantly or are very low to begin with (i.e. fewer than 10 to 20 blows per foot);
3. A void is encountered just before or at the design completion depth;
4. Unanticipated subsurface conditions have been encountered;
5. Minimum criteria for terminating a boring as established by the Resident Geotechnical Engineer have not been met (i.e. blow count, core recovery, R.Q.D., particular stratum, etc.)

Before proceeding further with the boring, the Boring Inspector should consult with the Resident Geotechnical Engineer for further instructions. If the Resident Geotechnical Engineer is unavailable, then consult the person next above in the chain of command, such as another engineer, the project manager or principal-in-charge.

ABANDONED BORINGS

Borings should not be abandoned before reaching the final depth ordered except with the approval of the Geotechnical Engineer or their representative. No payment will be made for borings abandoned by reason of an accident or negligence attributable to the driller.

Borings abandoned before reaching the required depth, due to an obstruction or other reasonable cause not permitting completion of the boring by standard procedures, shall be replaced by a supplementary boring adjacent to the original one and carried to the required depth. Penetration to the bottom depth of the abandoned boring may be made by any means selected by the driller and approved by the Boring Inspector unless payment is being rendered for the overlapped portion of the bore hole, in which case standard drilling procedures should be used. Samples to be taken in the supplementary boring should
commence from the last sampling elevation at which the original boring was abandoned in the manner specified for the original boring. This will establish a sampling continuity between the two borings.

Only under special circumstances when the bore hole is abandoned for reasons acceptable to the Geotechnical Engineer, or their representative, will payment be made as stated in the Contract, provided that the driller presents soil samples and records as specified and a report documenting the obstruction which necessitated terminating and relocating of the boring.

GROUNDWATER LEVEL OBSERVATIONS

Groundwater levels should be recorded when first encountered during drilling, at the start of work each morning for borings in progress and at the completion of each boring. Groundwater levels should also be recorded at the end of the field exploration project. The date and approximated time after boring completion should also be recorded for each water level reading. All water level observations should be summarized on the boring logs in the spaces provided. Observations should be made of ground water levels at the start of each day and in all completed holes. Any unusual water conditions and gain or loss of water in boring operations should be recorded completely in the boring logs. Whenever required by the Geotechnical Engineer, bore holes should be bailed for observations of groundwater conditions. When the open hole drilling method is used, and natural or commercial drilling mud utilized to stabilize the hole, the hole may have to be flushed thoroughly with clean water at the completion of the boring for the purpose of observing groundwater levels.

Groundwater level observations can be made in an open hole by filling the hole with clean water to a point above the natural groundwater level and observing the drop in the level of water in the hole. This may be followed by bailing the hole to a point below the natural groundwater level and observing the rise in the level of water in the hole. All individual measurements of the water level in holes should state the time elapsed since the last filling or bailing of the hole.

INSTALLATION OF STAND-PIPE OBSERVATION WELLS

Stand-pipe observation wells provide long term ground water observation and are often required by the Contract plans and specifications. Upon reaching the completion depth of a boring it may be part of the drilling program that an observation well be installed. In borings advanced with casing or hollow-stem augers, the well pipe, usually 1 inch to 2 inch diameter PVC pipe, may be inserted with its screen tip into the casing or hollow stem augers prior to their being withdrawn. If no screen is provided, the bottom pipe end should be sealed with a cap and a series of slots may be drilled or sawed to create the screen tip. In the event that the grain size gradation of the stratum into which the well tip screen has been placed, is finer than the screen opening size, then the screen should be packed with graded granular material to avoid plugging of the screen. Once the well has been installed, it should be backflushed with clean water to clear the screen. Upon removal of casing or augers and completion of backfilling, it may be desirable to again backflush by applying a slightly increased hydrostatic pressure and monitoring its drop to assure the screen is still open. When drilling with mud, those borings which require observation wells should be drilled with biodegradable mud if possible. If no biodegradable mud is available, then the hole should be thoroughly backflushed after the pipe and screen have been installed and tested, after backfilling. When non-biodegradable muds are used, boring wall permeability may be obstructed and may result in unreliable water level readings. No observation well installed using a non-biodegradable mud should be accepted unless the driller demonstrates that the well is in working order or unless directed by the Geotechnical Engineer.
CLEAN UP
Upon completion of the work the driller should remove their rigs, all equipment, unused material and soil removed from the holes and leave the site in a clean condition satisfactory to the owner and Consulting Engineer.

The driller should cut off, below ground surface, or remove all casing. All holes remaining inside buildings or in public roadways should be plugged at the top with concrete. All bore holes must be filled in or plugged before leaving a job unless otherwise directed by the Boring Inspector. Drilling mud shall be hosed off or disposed of beyond developed areas wherever feasible and in a legal and environmentally approved manner.

ROCK CORING AND FIELD LOGGING

In general when a blow count of 100/3” or greater has been recorded and it has been determined that bedrock has been encountered, and not a boulder or very dense soils, then it may be feasible to core. The decision to core is not to be determined by the results of the Standard Penetration Test alone, but may be used as an indication that coring is possible.
Knowledge of local geologic conditions, known or anticipated, and soil samples recovered, must be considered in any decision as to whether to begin coring. Once the driller is set up to core, the Boring Inspector should document the following information on the boring log:

1. Type of core barrel, diameter (ID), drill bit type and condition (which should be good);
2. Note any circulating fluid losses, depth and time of occurrence and any actions or reasons resulting in loss of core;
3. The starting and completion depth (to the nearest tenth of a foot) of each run, with no core run length to exceed 5.0 feet unless approved by the Geotechnical Engineer;
4. The core run designation (i.e. C, C2, etc.) and the recovery;
5. The type of rock recovered, color, the core recovery, R.Q.D. (Rock Quality Designation) and any other related information.

In addition to the above, the Boring Inspector should insure that:

1. Casing has been driven to and sealed into bedrock;
2. Coring equipment used is of a type that would maintain continuous contact between the core bit and the rock being drilled.

Each core should be packed in well constructed wooden boxes, provided by the boring contractor at their expense, with dividing strips to hold the cores in position and in the order in which they were recovered from each hole. Core boxes should be marked on the inside and the outside with the project job number, recovery, R.Q.D., and the depths from which the cores were recovered so that they may be easily identified. Wooden blocks should be placed in the box to separate the core runs and should be marked to identify the core depth. When the core recovered is fragmented, all pieces of a size less than the core diameter should be put in plastic bags and placed in the core box in its appropriate position within that core run.
FIGURE C1
BORING LOG

ENGINEERING FIRM

BORING NO. BF-1
BORINGS FOR
PROJECT TITLE, MUNICIPALITY

(Engineer)

(Contractor)

<table>
<thead>
<tr>
<th>Contract No.</th>
<th>Purpose</th>
<th>Structure No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>ROADWAY STA. OFF.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rig No. 2 Type</th>
<th>Driller Helper</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE 5/26/05 Type CME 55</td>
<td>Driller Helper</td>
</tr>
</tbody>
</table>

| TIME STARTED TIME FINISHED WEATHER DEPTH REACHED |
| 10:00 AM 2:30 AM 50' Cloudy 39.0' |

GROUND ELEVATION 593.68 M.L.W. ELEVATION ZERO OF BORING LOG ______________________ ELEVATION GROUND WATER ______________________

| PAY QUANTITIES |
| LINEAL FEET OF BORING | SAMPLES | LIN. FT. OF ROCK CORE |
| 2-½ in 3 in 4 in | ORD. DRY UNDIST. DRY | 1-3/8 1-5/8 2-1/8 |

| ITEM ITEM ITEM ITEM ITEM ITEM ITEM ITEM ITEM |
| Unit Weight Size Weight of Hammer Average Fall |
| Drilling Mud Ordinary Dry Samples O.D. 2 in I.D. 1-7 | 140 lbs 30 in |
| Undisturbed Samples Type Length O.D. I.D. |

| GROUND WATER READINGS |
| DATE TIME DEPTH |
| ____________  | ____________ | ____________ |

GENERAL REMARKS: Boring located @ center of Rte. 46 west bound right lane @ 15± ft. south-southwest of original location.

The subsurface information shown hereon was obtained for NJTA design and estimate purposes. It is made available to authorized users only that may have access to the same information available to the State. It is presented in good faith, but is not intended as a substitute for investigations, interpretation or judgment of such authorized users.

INSPECTOR RESIDENT ENGINEER
### BORING LOG

**Boring No.: BF-1**

<table>
<thead>
<tr>
<th>CONTRACT NO.</th>
<th>ROADWAY</th>
<th>STA.</th>
<th>OFF.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elev. (ft)</th>
<th>Blows on Casin</th>
<th>Blows on Spoon for 6-in Penetration</th>
<th>Sample No.</th>
<th>Depth ft</th>
<th>Lo ft</th>
<th>Material &amp; Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>593.68</td>
<td>43</td>
<td>36</td>
<td>S-1</td>
<td>0.5 - 2</td>
<td></td>
<td>6&quot; asphalt, Dk. Br. c-f SAND, tr. Silt, Some c-Gravel</td>
</tr>
<tr>
<td>591.68</td>
<td>17</td>
<td>11</td>
<td>S-2</td>
<td>2 - 4</td>
<td></td>
<td>Br. c-f SAND, tr. Silt, little c-m Gravel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-1</td>
<td>2.5 - 4</td>
<td></td>
<td>2.5 ft. Auger refusal</td>
</tr>
<tr>
<td>589.68</td>
<td>50/3&quot;</td>
<td></td>
<td>S-3</td>
<td>4 - 4.3</td>
<td></td>
<td>Color mix Blue/ Lt. Gr./Pink Cobbles and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-2</td>
<td>4 - 9</td>
<td></td>
<td>Boulders, Sand Screams</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>REC : 36%, RQD : 8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-3</td>
<td>9 - 14</td>
<td></td>
<td>Color mix Blue/ Lt. Gr. Cobbles and Boulders</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>REC : 30%, RQD : 10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-4</td>
<td>16 - 19</td>
<td></td>
<td>Color mix Blue/ Lt. Gr. Cobbles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>REC : 12%, RQD : 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-5</td>
<td>19 - 24</td>
<td></td>
<td>Color mix Blue/ Lt. Gr./Pink Cobbles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>REC : 32%, RQD : 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-6</td>
<td>24 - 29</td>
<td></td>
<td>Color mix Blue/White/ Lt. Gr./Pink Cobbles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>REC : 32%, RQD : 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-7</td>
<td>29 - 34</td>
<td></td>
<td>Color mix Blue/ Lt. Gr./Pink Cobbles and Boulders</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>REC : 36%, RQD : 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-8</td>
<td>34 - 39</td>
<td></td>
<td>Color mix Blue/White/ Lt. Gr./Pink Cobbles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>REC : 6%, RQD : 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hit Sand layer at 36.5</td>
</tr>
<tr>
<td>554.68</td>
<td></td>
<td></td>
<td>EN D</td>
<td></td>
<td></td>
<td>End of Boring @ 39.0'</td>
</tr>
</tbody>
</table>

MAY 2007

5 - 93
FIGURE C2
DAILY FIELD INSPECTORS REPORT

<table>
<thead>
<tr>
<th>ONSULTANT</th>
<th>SUBSURFACE EXPLORATION REPORT</th>
<th>Date</th>
<th>Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Report No. | Page
---|---

<table>
<thead>
<tr>
<th>Project</th>
<th>Job No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exploration Contractor

Weather

<table>
<thead>
<tr>
<th>EQUIPMENT ON JOB</th>
<th>WATER AND/OR EQUIPMENT TRUCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.</td>
<td>TYPE</td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BORING INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BORING NO.</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Visitors Representing

<table>
<thead>
<tr>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Received by Date Witness

MAY 2007 5 - 94
APPENDIX D
Laboratory Testing for Soils
### LABORATORY TESTING FOR SOILS

<table>
<thead>
<tr>
<th>Tests</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Identification Tests:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>A. Mechanical Analysis</strong></td>
<td></td>
</tr>
<tr>
<td>1. Sieve Analysis (with grain size curve)</td>
<td>ASTM D 422</td>
</tr>
<tr>
<td>2. Percent passing #200 Sieve</td>
<td>ASTM D 1140</td>
</tr>
<tr>
<td>3. Hydrometer Analysis including Specific Gravity (with grain size curve)</td>
<td>ASTM D 422</td>
</tr>
<tr>
<td><strong>B. Index Properties</strong></td>
<td></td>
</tr>
<tr>
<td>1. Preparation of Sample for Testing: Wet Preparation</td>
<td>ASTM D 2217</td>
</tr>
<tr>
<td>2. Liquid Limit - with flow curve</td>
<td>ASTM D 4318</td>
</tr>
<tr>
<td>3. Plastic Limit</td>
<td>ASTM D 4318</td>
</tr>
<tr>
<td>4. Shrinkage Limit</td>
<td>ASTM D 427</td>
</tr>
<tr>
<td><strong>C. Specific Gravity</strong></td>
<td>ASTM D 854</td>
</tr>
<tr>
<td><strong>D. Water Content Determination</strong></td>
<td>ASTM D 2216</td>
</tr>
<tr>
<td><strong>E. Maximum &amp; Minimum Density of Granular Soil (Dry State)</strong></td>
<td>ASTM D 4253 /</td>
</tr>
<tr>
<td><strong>F. Visual identification and classification of Jar Samples</strong></td>
<td>Ref. D.1</td>
</tr>
<tr>
<td><strong>G. Visual identification and log of undisturbed tube samples - including opening of tubes</strong></td>
<td>Ref. D.1</td>
</tr>
<tr>
<td><strong>H. Natural Dry Density and Water Content Determination of Shelby Tube Samples</strong></td>
<td>Ref. D.2</td>
</tr>
<tr>
<td><strong>II. Permeability Tests:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>A. Permeability of granular Soils (Constant Head)</strong></td>
<td>ASTM D 2434</td>
</tr>
<tr>
<td><strong>B. Permeability of undisturbed sample in 2.5 inch Dia. consolidation apparatus with a maximum pore water back pressure of 60 psi, reporting permeability (K20), natural water content and dry density.</strong></td>
<td>Ref. D.2</td>
</tr>
<tr>
<td><strong>III. Strength Tests:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>A. Unconfined compression test on undisturbed soil sample, including maximum stress and strain at failure, visual identification, initial water content, dry density, stress-strain curve and failure sketch. Minimum rate of strain 1% per minute.</strong></td>
<td>ASTM D 2166</td>
</tr>
<tr>
<td><strong>B. Direct Shear Test (Consolidated-Quick) on undisturbed soil sample for each normal load, including trimming, visual identification and consolidation of sample, initial and final</strong></td>
<td>ASTM D 3080</td>
</tr>
</tbody>
</table>

**Reference:**

- ASTM D 422
- ASTM D 1140
- ASTM D 422
- ASTM D 2217
- ASTM D 4318
- ASTM D 4318
- ASTM D 427
- ASTM D 854
- ASTM D 2216
- ASTM D 4253
- ASTM D 4254
- Ref. D.1
- Ref. D.1
- Ref. D.2
- ASTM D 2434
- Ref. D.2
- ASTM D 2166
- ASTM D 3080
- Ref. D.2
water contents, dry density and stress-strain curve. Rate of shear one-half percent per minute.

C. Triaxial Compression Test for 2.8 inch Dia. or 1.4 inch Dia. undisturbed or remolded soil sample.

1. Unconsolidated-Undrained for each lateral pressure ASTM D 2850 including visual identification initial water content, dry density, stress-strain curve and failure sketch. Minimum rate of strain 1 percent per minute.

2. Consolidated-Undrained for each lateral pressure at ASTM D 2850/ maximum of 24 hour consolidation, with or without back pressure including visual identification, initial and final water contents, dry density, stress-strain curve and failure sketch. Minimum rate of strain 1 percent per minute.

3. Consolidated Drained for each lateral pressure at maximum of 24 hour consolidation, with or without back pressure including visual identification, initial and final water contents, dry density, stress-strain curve and failure sketch. Minimum rate of strain 1 percent per minute.

D. Test Method for Consolidated Undrained Direct Simple Shear Testing of Cohesive Soils ASTM D 6528

IV. Consolidation Tests:

A. Consolidation test for 2.5 inch and not less than 0.75 inch high sample on undisturbed sample. For one load cycle and each load increment imposed for a maximum of 24 hours, and unloading to zero, including preparation, initial and final water contents, dry density, void ratio/log pressure curve or unit strain/log pressure curve. ASTM D 2435

B. Each unloading/reloading cycle consisting of two decrements and two increments. Ref. D.4

C. For each additional day required for consolidation to define secondary consolidation. Ref. D.4

D. For permeability test Ref. D.4

V. Compaction Test:

A. Moisture/Density Relations of Soils using 10 pound Rammer 1557 / and 18 inch Drop including sample preparation and moisture T180 density curve (modified Proctor). AASHTO

B. Standard Method of Test for California Bearing Ratio (CBR) ASTM D 1883 / with Stress Penetration Curve (cylinder soaked up to 3 days) AASHTO
T193
including required sample preparation and compaction either
(a) or (b) above. Moisture Density relations determined by
ASTM D 1557/AASHTO T-180.

VI. pH Test:
A. Test Method for pH of Soils ASTM D 4972
B. Test Method for pH of Peat Materials ASTM D 2976

VII. Organic Content Test:
A. Test Method for Organic Content of Peat Samples by Dry Mass ASTM D 1997

VIII. Tests on Rock Samples:
A. Test for Triaxial Compressive Strength of Undrained Rock Core ASTM D 7012
   Specimens without Pore Pressure Measurements (Method A)
B. Elastic Moduli of Undrained Rock Core Specimens in Triaxial ASTM D 7012
   Compression without Pore Pressure Measurements Specimens (Method B)
C. Test Method for Unconfined Compressive Strength Testing of ASTM D 7012
   Intact Rock Core Specimens (Method C)
D. Test for Elastic Moduli of Intact Rock Core Specimens in ASTM D 7012
   Uniaxial Compression (Method D)
E. Determination of the Point Load Strength Index of Rock ASTM D 5731

REFERENCES
D.1 Burmister, D. M. PRINCIPLES AND TECHNIQUES OF SOIL IDENTIFICATION.
D.3 Bishol, A. W. and Henkel, D. J. THE MEASUREMENT OF SOIL PROPERTIES IN
   THE TRIAXIAL TEST. 2nd Ed. Edward Arnold Ltd.
D.4 Burmister, D. M. THE APPLICATION OF CONTROLLED TEST METHODS IN
   CONSOLIDATION TESTING. ASTM Symposium of Consolidation Testing of Soils,