

## **Appendix R**

### **Soil Nail Wall Special Provision**

The following is the Special Provision for Soil Nail Wall design and construction.

September 22, 2009

## **PERMANENT SOIL NAILED RETAINING WALL**

### **Scope of Work**

The work covered under this SPECIAL PROVISION includes the furnishing of all materials, labor, tools equipment, and other incidental items for the designing, detailing, construction, and testing of permanent soil nailed retaining wall. The Contractor shall submit the proposed surface finish and provide a sample on-site for Department approval prior to wall construction.

The soil nailed retaining wall shall be constructed from the top down as the soil in front of the wall is removed and the nails are installed and grouted at each level. The exposed soil face shall be protected with a welded wire reinforced shotcrete facing. Drainage systems shall be installed prior to applying shotcrete. A structural cast-in-place or precast concrete facing with architectural finish shall be constructed and suitably attached to the soil nailed retaining structure. Attachment method for facing shall be designed by the Contractor and submitted to the Regional Production Group Structural and Geotechnical Design Engineer for review prior to installation. Where pre-cast concrete panels are attached to the soil nail walls, the panels have a similar finish to MSE Wall panels.

The soil nail walls addressed in this special provision are part of combination walls, with Mechanically Stabilized Earth (MSE) walls planned above the MSE walls. The design and construction of Soil Nail Walls shall be coordinated with the MSE Wall designer and installer.

### **Contractor Qualifications**

The Contractor or Subcontractor shall be experienced in the design and installation of permanent soil nailed retaining walls. His staff shall include at least one Registered Professional Engineer licensed in the State of South Carolina. The Contractor or Subcontractor shall have the following qualifications:

#### **I. Design:**

The designer shall have designed a minimum of three permanent soil nailed retaining walls in the past three years, with one permanent soil nailed retaining wall of at least 20 feet in height. The Design Engineer shall be available at any time during the life of the Contract to discuss the design of the soil nailed structure directly with the Department.

Design the soil nail walls in accordance with "FHWA Geotechnical Engineering Circular No. 7 - Soil Nail Walls Reference Manual" FHWA Publication No. FHWA-NHI-14-007.

#### **II. Construction:**

- (1) The Supervising Engineer shall have constructed a minimum of three permanent soil nailed retaining walls in three years, with one permanent soil nailed retaining wall of at least 20 feet in height.
- (2) The Foreman shall have constructed a minimum of three permanent soil nailed retaining walls in three years, with one permanent soil nailed retaining wall of at least 20 feet in height.
- (3) The Drill Operator shall have installed soil nails on a minimum of three permanent soil nailed retaining walls in three years, with one permanent soil nailed retaining wall of at least 20 feet in height.
- (4) Shotcrete Supervisor shall have supervised the application of shotcrete on projects of comparable nature or work for at least three years

- (5) Shotcreting Nozzle Operators shall have at least 1 year experience in the application of shotcrete on projects of comparable nature or work under the immediate supervisions of a foreman or instructor with at least 2 years of such experience.

### **General**

Unless otherwise specified, section references in this specification are to the South Carolina Department of Transportation Standard Specifications for Highway Construction, Edition of 2007.

The Contractor shall select the nail installation method and may increase the drill hole diameter or length, within the property constraints shown on the plans, to develop the required design loads. The Contractor will also be required to locate any underground utilities and adjust location of soil nails accordingly.

Soil nails shall maintain a minimum 6-inch vertical and horizontal clear distance between bridge piling as shown on existing bridge plans.

### **Materials**

- (1) *Steel Nails:* AASHTO M 31/ASTM A 615. Threaded, a minimum of 6 inches on the wall anchorage end, to allow proper attachment of bearing plate and nut. Threading may be continuous spiral deformed ribbing provided by the bar deformations (continuous thread bars) or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, provide the next-larger bar number designation from that shown on the Plans, at no additional cost.
- (2) *Corrosion Protection:* Provide Class A or Class B corrosion protection in accordance with FHWA Geotechnical Engineering Circular No. 7, corrosion protection shall consist of one of the following:
  - (a) Galvanizing: Galvanizing shall be done in accordance with AASHTO M 111/ASTM A 123 or AASHTO M 232/ASTM A 153 as applicable.
  - (b) All steel components shall be encapsulated in grout or shotcrete with 3" minimum cover.
- (3) *Steel Welded Wire Fabric:* Steel Welded Wire Fabric shall conform to the requirements of AASHTO M 55/ASTM A 185.
- (4) *Reinforcing Steel:* All steel used for reinforcement other than soil nails shall be ASTM A 706.
- (5) *Shotcrete Specifications:* This work consists of constructing one or more courses of shotcrete on a prepared surface. Refer to shotcrete specifications at the end of this section. The shotcrete will be a permanent facing and shall have a minimum of 6 inches thickness.
- (6) *Grout for Nails:* Provide neat cement or a sand/cement mixture with a minimum 3-day compressive strength of 1,500 psi and a minimum 28-day compressive strength of 3,000 psi, per AASHTO T 106/ASTM C 109 to be used in soil nail anchorage consisting of a pumpable mixture. Admixtures that control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to review and acceptance by the Engineer. Accelerators are not permitted. Expansive admixtures may only be added to grout used for filling sealed encapsulations. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations. No admixtures will be allowed that could have corrosive properties. The Contractor shall submit documentation to the Engineer showing that the admixtures used will not be detrimental to the nails.
- (7) *Fasteners and Attachment Devices:* Provide high strength nuts conforming to AASHTO M 291, Grade B, Hexagonal, or equivalent. Hexagonal nut shall be fitted with beveled washer or spherical seat to provide uniform bearing. Provide plates conforming to AASHTO M 183/ASTM A 36 or equivalent. Shear connector studs on bearing plates shall be in accordance with Section 709.2.2. Provide only plastic

centralizers of a minimum diameter of 1 in. smaller than the nominal diameter of the drill hole which permit free flow of grout.

- (8) *Centralizers:* Centralizers shall be manufactured from Schedule 40 PVC pipe securely attached to the soil nail. The centralizers shall be sized to position the soil nail within 1 inch of the center of the drill hole, sized to allow trimie pipe insertion to the bottom of the drill hole, and sized to allow grout to freely flow up the drill hole. Centralizers must be provided inside and outside of encapsulated nail assemblies and shall be spaced no further than 8 ft. apart. Centralizers shall also be located no further than 1.5 ft. from each end of the soil nails.
- (9) *Geocomposite Wall Drains:* Geocomposite wall drains shall consist of Ameridrain Sitedrain Sheet 90 by American Wick Drain, Inc. or equivalent.

### **Shotcrete Specifications**

#### **I. Materials**

- (1) Use the South Carolina Department of Transportation Standard Specifications for Highway Construction, Edition of 2007 for the following:
- (a) Air-entraining admixture, Section 701.2.5.1 (wet mix only)
  - (b) Chemical admixtures, Section 701.2.6 (wet mix only)
  - (c) Curing material, Section 702
  - (d) Cement, Section 701
  - (e) Pozzolans, Section 701
  - (f) Reinforcing steel, 703 (also see above)
- (2) Shotcrete Aggregate
- (a) For fine aggregate, furnish rounded particles conforming to AASHTO M 6 Class B including the reactive aggregate supplementary requirement, except as amended or supplemented by the following:  
  
Material passing 75- $\mu$ m sieve, AASHTO T 11/ASTM C 117: 3.0% max  
  
Sand equivalent value, AASHTO T 176: 75 min. referee method
  - (b) For coarse aggregate, conform to AASHTO M 80 Class B, except as amended or supplemented by the following:  
  
Los Angeles abrasion, AASHTO T 96/ASTM C 131: 40% max  
  
Combine the aggregates to meet the designated gradation in Table 1.



**Table 1: Shotcrete Gradation Limits for Combined Aggregates**

| Sieve Size | Percent by Mass Passing Designated Sieve (AASHTO T 27) |        |       |
|------------|--|--------|-------|
|            | Grading Designation                                    |        |       |
|            | A  | B      | C     |
| 19 mm      | 100  | 100    | 100   |
| 12.5 mm    | 100  | 100    | 80-95 |
| 9.5 mm     | 100  | 90-100 | 70-90 |
| 4.75 mm    | 95-100   | 70-85  | 50-70 |
| 2.4 mm     | 80-100   | 50-70  | 35-55 |
| 1.2 mm     | 50-85  | 35-55  | 20-40 |
| 600 µm     | 25-60  | 20-35  | 10-30 |
| 300 µm     | 10-30  | 8-20   | 5-17  |
| 150 µm     | 2-10   | 2-10   | 2-10  |

## II. Reinforcing

Contractor may elect to use deformed bar reinforcing steel in instead of welded wire reinforcement.

## III. General

Conform to the following:

- (1) ACI 506R Guide to Shotcrete
- (2) ACI 506.2 Specifications for Proportioning Application of Shotcrete
- (3) AASHTO C 311 Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Concrete
- (4) ASTM C 1077 Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

## IV. Preconstruction Submissions

- (1) Shotcrete material, equipment, preparation, and application. Submit the following to the Engineer for acceptance at least 30 days before placing shotcrete:
  - (a) Description of proposed equipment for mixing and applying shotcrete conforming to Section V. Include the manufacturer instructions, recommendations, literature, performance, and test data.
  - (b) Proposed shotcrete mix design conforming to Section VI with mix proportions.
  - (c) Representative samples of shotcrete material, if requested by the Engineer.
  - (d) Results of all shotcrete preconstruction testing conforming to Section VII.
  - (e) Proposed method for applying and curing shotcrete conforming to Sections VIII, IX, and X.
  - (f) Other information necessary to verify compliance with ACI 506.2.
  - (g) Certification that shotcrete conforms to the standards specified herein.
- (2) Submit the following to the Engineer for acceptance at least 30 days before placing shotcrete:
  - (a) *Project references:* Include project name, owner's name, and phone numbers for completed projects as described in "Contractor Qualifications" above.

- (b) *Nozzle Operator's experience and training;* For each nozzle operator, include shotcrete application experience on at least two projects of comparable nature and showing that they meet the qualifications described in "Contractor Qualifications" above.
- (c) *Shotcrete Supervisor experience:* Include direct shotcrete application experience on at least three comparable projects and showing that they meet the qualifications described in "Contractor Qualifications" above.
- (d) *Testing Laboratory certification;* Include documentation that the strength-testing laboratory complies with ASTM C 1077 and has the experience to perform the tests specified in this section. The testing laboratory shall be AASHTO accredited for ASTM C 1077 or demonstrate the ability to perform the requisite tests.

## V. Equipment

- (1) *Water Supply System:* For dry mix, provide a water storage tank at the job site. Provide a positive displacement pump with a regulating valve that is accurately controlled to provide water in the pressures and volumes recommended by the delivery machine manufacturer.
- (2) *Mixing:* Use equipment capable of handling and applying shotcrete containing the specified maximum size aggregate and admixtures. Provide an air hose and blowpipe to clear dust and rebound during shotcrete application.
- (3) *Air Supply System:* Use an air supply system capable of supplying the delivery machine and hose with air at the pressures and volumes recommended by the machine manufacturer. Do not use air supply systems that deliver oil-contaminated air or are incapable of maintaining constant pressure.
- (4) *Delivery Machine:* Use a delivery machine capable of supplying material to the delivery hose at a uniform rate. The ejection from the nozzle must adhere to the treated surface with minimum rebound and maximum density when the nozzle is held in the range of 3 to 6 ft from the target surface.

## VI. Composition (Shotcrete Mix Design)

- (1) Design and produce shotcrete mixtures conforming to Table 2 for the type of shotcrete specified. Use the amount of water required to produce shotcrete of suitable strength, consistency, quality, and uniformity with the minimum amount of rebound. Use the same material types and sources as submitted with the mix design in the field trials and production work.
  - (a) *Hydration stabilizing admixtures:* Hydration stabilizing admixtures may be used to extend the allowable delivery time for shotcrete. Dosage is based on the time needed to delay the initial set of the shotcrete for delivery and discharge on the job. Design shall include discharge time limit in the dosage submittal. Dosage required to stabilize shotcrete shall be determined using job site material and field trial mixtures. The extended-set admixture shall control the hydration of all cement minerals and gypsum. The maximum allowable design discharge time is 3.50 hours.
  - (b) If a hydration-stabilizing admixture is approved for use in the concrete mix, concrete shall be delivered and placed within the approved design discharge time limit. An approved and compatible hydration activator may be used at the discharge site to insure proper placement and testing.
  - (c) Dosage and type of extended-set admixture shall be included with proposed mix design. When requested, the admixture manufacturer shall provide the service of a qualified person to assist in establishing the proper dose of extended-set admixture and make dosage adjustments required to meet changing job site conditions.

**Table 2: Composition of Shotcrete**

| Type of Shotcrete Process | Minimum Cement Content | Maximum W/C <sup>(1)</sup> Ratio | Air Content Range (%) | Minimum 28-Day Compressive Strength <sup>(3)</sup> |
|---------------------------|------------------------|----------------------------------|-----------------------|--|
|                           | (lb/cy)                |                                  |                       | (psi)  |
| Wet                       | 550                    | 0.55                             | NA                    | 150  |
| Dry                       | 550                    | 0.50                             | NA                    | 150  |
| Wet (w/EA) <sup>(2)</sup> | 550                    | 0.45                             | 5 min                 | 150  |
| Dry (w/EA) <sup>(2)</sup> | 550                    | 0.45                             | 5 min                 | 150  |

Notes: (1) W/C = Water/Cement (by weight)

(2) EA = Entrained Air

(3) According to AASHTO T 23

## VII. Preconstruction Testing

Conduct preconstruction shotcrete field trials before starting shotcrete production. Allow the Engineer the opportunity to witness all phases of the preconstruction testing.

- (1) *Field Trials:* Construct wood forms at least 6 in. thick by 3 ft by 3 ft in size. Have each proposed nozzle operator make test panels on two vertical wood forms. Cure the test panels according to AASHTO T 23/ASTM C 31, without immersing the panels.
- (2) *Coring:* Drill six 3 in. diameter cores from each test panel according to AASHTO T 24/ASTM C 42. Trim the ends of the cores according to AASHTO T 24/ASTM C 42 to make cylinders at least 3 in. long. Test panel shall be allowed to cure in accordance with current AASHTO and ASTM standards prior to coring.
- (3) *Compressive Strength Testing:* Soak the cylinders in water for 40 hours immediately before testing. Test three cylinders from each test panel four days after field trial and test the remaining three cylinders 28 days after the field trial. Perform tests according to AASHTO T 23/ASTM C 31. All specified strength requirements shall be satisfied before the shotcrete mix design will be considered for acceptance.
- (4) *Mix Design Acceptance:* The Engineer will accept or reject the shotcrete mix design based on the results of the preconstruction field trials and testing. Before approving any changes to a previously accepted mix design, the Engineer may require additional preconstruction testing at no additional cost to the Department.

## VIII. Surface Preparation and Application of Shotcrete

- (1) *Surface Preparation:* Clean loose material, mud, rebound, and other foreign matter from all surfaces to receive shotcrete. Remove curing compound on previously placed shotcrete surfaces by sandblasting. Install approved depth gages to indicate the thickness of the shotcrete layers. Install depth gages on 6 ft centers longitudinally and transversely with no less than two gauges per increment of surface area to receive the shotcrete. Moisten all surfaces.
- (2) *Weather Limitations:* Place shotcrete when the ambient temperature is 41°F(5°C) or higher. Do not perform shotcrete operations during high wind and heavy rains.
- (3) *Shotcrete Application:*
  - (a) Do not apply shotcrete to frozen surfaces.
  - (b) Use acceptable nozzle operators who have fabricated acceptable test panels and have meet qualifications described above.
  - (c) Apply shotcrete within 45 minutes of adding cement to the mixture. Apply shotcrete at a temperature between 50°F(10°C) and 86°F(30°C).

- (d) Direct the shotcrete at right angles to the receiving surface except when shooting ground reinforcing bars. Apply shotcrete in a circular fashion to build up the required layer thickness. Apply shotcrete in a steady uninterrupted flow. If the flow becomes intermittent, direct the flow away from the work area until it becomes steady.
  - (e) Make the surface of each shotcrete layer uniform and free of sags, drips, or runs.
  - (f) Limit the layer thickness of each shotcrete application to 2 in. Thicker applications may be approved if the Contractor can demonstrate that no sloughing or sagging is occurring. If additional thickness is required, broom or scarify the applied surface and allow the layer to harden. Dampen the surface before applying an additional layer.
  - (g) Remove laitance, loose material, and rebound. Promptly removed rebound from the work area.
  - (h) Taper construction joints to a thin edge over a distance of at least 1 foot. Wet the joint surface before placing additional shotcrete on the joint. Do not use square construction joint.
- (4) *Production Summary:* Prepare and submit a summary of shotcrete production application for each shift. Furnish the summary to the Engineer within 24 hours. Include the following information in the report:
- (a) Quantity and location of shotcrete applied including sketches.
  - (b) Observations of success or problems of equipment operation, application, final product conditions, and any other relevant issues during production and application.
  - (c) Description of placement equipment.
  - (d) Batch number(s) if applicable.

## **IX. Quality Control Records**

Submit field quality control test reports within two working days of performing the tests. Include the following information in the reports:

- (a) Sample identification including mix design and test panel number and orientation.
- (b) Date and time of sample preparation including curing conditions and sample dimensions.
- (c) Date, time, and type of test.
- (d) Complete test results including load and deformation data during testing, sketch of sample before and after testing, and any unusual occurrences observed.
- (e) Names and signature of person performing the test.
- (f) Location of steel reinforcement, if used, covered by shotcrete.
- (g) Name of nozzle operator.

## **X. Protection and Curing**

Protect and cure the surface according to Section 702.4.4.2. Protect and maintain shotcrete at a temperature above 41°F (5°C) until shotcrete has achieved a minimum strength of 750 psi.

## **XI. Acceptance**

Material for concrete will be evaluated by visual inspection of the work, conformance testing and by certification for materials manufactured off-site. Compressive strength will be evaluated by conformance testing using Table 2 for specification limits. See Table 3 for minimum sampling and testing requirements and acceptance quality category.

**Table 3: Sampling and Testing of Shotcrete**

| Material or Product | Property or Characteristic | Category | Test Methods or Specifications                     | Frequency  | Sampling Point                          |
|---------------------|----------------------------|----------|--|--|---|
| Shotcrete           | Air content                | --       | AASHTO T 152/ASTM C 231 or AASHTO T 196/ASTM C 173 | 1 per load <sup>(1)</sup>  | Truck, mixer or agitator <sup>(2)</sup> |
|                     | Unit Mass                  | --       | AASHTO T 121/ASTM C 138                            | 1 per load <sup>(1)</sup>  | Truck, mixer or agitator <sup>(2)</sup> |
|                     | Compressive strength       | II       | AASHTO T 23/ASTM C 31                              | 1 set per 33 CY, but not less than 1 set each day <sup>(3)</sup> | Production test panels <sup>(3)</sup>   |

Notes: (1) When continuous mixing is used sample every 10 CY.  
(2) Sample according to AASHTO T 141/ASTM C 172  
(3) Prepare production test panels according to Section VII. Obtain two 3-in. diameter core specimens from each panel according to AASHTO T 24/ASTM C 42. A single compressive strength test result is the average result from two 3-in. diameter core specimens from the same test panel tested according to AASHTO T 23/ASTM C 31 at 28 days.

### **Submittals**

The Contractor shall also submit at least 30 days prior to beginning construction of soil nailed retaining wall the following:

- (1) Resumes of personnel described in “Contractor Qualifications” above. The resumes shall include project names, description, and owner contact information on the projects described in “Contractor Qualifications” above.
- (2) Design Calculations.
- (3) Construction Drawings.
- (4) Shop Drawings.
- (5) Construction procedures and detailed construction sequencing plans, including excavation sequence.
- (6) Test nail procedures.
- (7) Material and mill test certificates.
- (8) Mix designs.
- (9) Movement Monitoring Program with monument locations identified on Shop and Construction Drawings.
- (10) Any other details necessary for successful completion of this work.

The above submittals shall be prepared and sealed by the Design Engineer who must be registered as a Professional Engineer in the State of South Carolina. Design the soil nail walls in accordance with “FHWA Geotechnical Engineering Circular No. 7 - Soil Nail Walls Reference Manual” FHWA Publication No. FHWA-NHI-14-007.

The Contractor will be notified by the Resident Construction Engineer of acceptance or rejection of submissions within 21 days of receipt of each submission.

Work shall not be started and no materials shall be ordered until the all submissions have been approved in writing by the Engineer. If work is suspended due to the substitution of unqualified personnel, the Contractor shall be fully liable for additional costs resulting from the suspension of the work and no adjustments in contract time resulting from the suspension will be allowed.

The Department will be the sole judge of the adequacy of the information submitted. The review and acceptance of the final design plans, shop plans, and methods of construction by the Department shall not in any way relieve the Contractor of his responsibility for the successful completion of the work or the proper design of soil nailed retaining wall. Contractor delays due to untimely submissions and insufficient information shall not be considered as justification for time extensions.

### **Design Calculations**

The design calculations shall include, but not be limited to:

- (1) A written summary report which describes the overall soil nailed retaining wall design.
- (2) Applicable code requirements and design references.
- (3) Soil nailed retaining wall design cross-section(s) geometry including soil/rock strata and location, magnitude, and direction of design slope or external surcharge loads and piezometric levels.
- (4) Design criteria including soil/rock shear strengths (friction angle and cohesion), unit weights, and ground-grout pullout resistances and nail drillhole diameter assumptions for each soil/rock strata.
- (5) Partial safety factors/strength factors (for Service Load) used in the design of the pullout resistance, surcharges, soil/rock unit weights, nail head strengths, and steel, shotcrete, and concrete materials. Minimum required global stability soil factor of safety for SLD design or minimum required global stability soil resistance/ load ratio for LRFD design.
- (6) Seismic design acceleration coefficient
- (7) Design calculation sheets with project number, wall location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. Provide an index page with the design calculations.
- (8) Design notes including an explanation of any symbols and computer programs used in the design.
- (9) Soil nail wall final design cross-section(s) geometry including soil/rock strata and location, magnitude, and direction of slope or external surcharge loads and piezometric levels with slip critical surface shown along with a minimum calculated global stability soil factor of safety for SLD design or for minimum global stability soil resistance/load ratio for LRFD design and required nail lengths and strengths (nail bar sizes and grades) for each nail row.
- (10) Any other geotechnical parameters used in the design that are not mentioned above.
- (11) Any other necessary design calculations, such as for the connection of architectural facing to the soil nailed retaining wall and connections of soil nailed retaining wall and architectural facing around drainage facilities.

### **Construction**

- (1) *Excavation:* Excavation to be made to the limits and construction stages indicated on the plans. Excavation shall proceed in stages, exposing the minimum amount of soil or rock face which will allow the practical and expeditious application of the initial layer of shotcrete and the installation of soil nails while assuring stability of the excavated face and minimizing ground movements.

- (2) *Shotcreting:* After each stage cut, in anticipation of shotcreting, clean surfaces of all loose material, mud, rebound from previously placed shotcrete and other foreign material that will prevent bond of shotcrete. Dampen surface before shotcreting. Install permanent drainage as specified in the submitted plans. Connect drainage system at the bottom of the wall in such a manner as to carry the water away from the toe. Use weep holes, horizontal drains, or other methods to control seepage.

Control thickness, method of support, air pressure and water content of shotcrete to preclude sagging or sloughing off.

Shotcrete shall emerge from the nozzle in a steady uninterrupted flow.

- (3) *Attachment of Nail Head Bearing Plate and Nut:* Attach a bearing plate, washers, and nut to each nail head as shown on the plans. While the shotcrete construction facing is still plastic and before its initial set, uniformly seat the plate on the shotcrete by hand-wrench tightening the nut. Where uniform contact between the plate and the shotcrete cannot be provided, set the plate in a bed of grout. After grout has been set for 24 hours, hand-wrench tighten the nut. Ensure bearing plates with headed studs are located within the tolerances shown on the plans.

- (4) *Shotcrete Facing Tolerances:* Construction tolerances for the shotcrete facing from the plan location and plan dimensions are as follows:

- (a) Horizontal location of welded wire mesh and reinforcing bars: 0.4 in
- (b) Spacing between reinforcing bars: 1 in
- (c) Reinforcing lap, from specified dimension: 1 in
- (d) Complete thickness of shotcrete:
  - If troweled or screeded: 0.6 in
  - If left as shot: 1.2 in
- (e) Planeness of finish face surface-gap under 10 ft straightedge:
  - If troweled or screeded: 0.6 in
  - If left as shot: 1.2 in
- (f) Nail head bearing plate deviation from parallel to wall face: 10 degrees

- (5) *Nail Installation:* Drill holes for soil nails at the locations required in the submitted plans. Provide nail length and nail diameter necessary to develop load capacity to satisfy testing acceptance criteria for the design load required. Core drilling, rotary drilling, or auger drilling can be used. It shall be the Contractor's responsibility to choose drilling methods that will maintain open holes and do not promote mining and loosening of the soil at the perimeter of the drill hole or fracture soils with weak stratification planes by use of high flush volumes and pressures. At the ground surface the drill hole shall be located within 6 inches of the location shown on the submitted plans. At the point of entry the nail angle shall be within plus or minus 3 degrees of that shown on the approved plans. The nails shall not extend more than 24 feet measured horizontally from the face of the wall. Subsidence or physical damage by such operations shall be cause for immediate cessation of operations and repair at Contractor's expense.

Inject grout at the lowest point of the drill hole. Pump grout through grout tubes, casing, or drill rods such that the hole is filled to prevent air voids with grout progressively from the bottom to the top. Grout until the hole is completely filled with grout and clean grout is seen to run from the top of the hole.

Provide grouting equipment capable of continuous mixing and producing a grout free of lumps. Nails shall be placed in each drilled hole within 15 minutes of the grout injection.

Mortar packing and secondary grouting to the wall face shall be accomplished as soon as practical after nail installation.

Contractor shall immediately stop drilling and grout holes if existing bridge piling are encountered during drilling. RCE shall be immediately notified.

(6) *Nail Testing:*

- (a) *Equipment:* A dial gauge capable of measuring to 0.001 of-an-inch shall be used to measure movement. A hydraulic jack and gauge calibrated as a unit shall be used to apply the test load. The pressure gauge shall be graduated in 100 psi increments or less and used to measure the applied load. The test loads shall be applied incrementally.
- (b) *Verification Testing:* Install 1 nail per horizontal row but no more than 1 percent of the total number of nails as non-service nails for Verification Testing. Verification Testing shall be performed in accordance with Section 9.4.3 of FHWA Geotechnical Circular No. 7. The shop drawing submittal shall identify location of test nails, bond length, Verification Test Load (VTL), and detailed Verification Test Loading Schedule.

All nail test results shall be submitted to the Regional Production Group Structural and Geotechnical Engineer for review.

- (c) *Proof Testing:* Proof test a minimum of 5 percent of production nails in accordance with Section 9.4.4 of FHWA Geotechnical Circular No. 7. The shop drawing submittal shall identify Proof Test Load (PTL) and provide a detailed Proof Test Loading Schedule.

All nail test results shall be submitted to the Regional Production Group Structural Engineer for review.

- (d) *Acceptance Criteria:* The nail is deemed acceptable if:

- 1. No pullout occurs at loads less than 1.0 PTL or VTL.
- 2. The total soil nail movement ( $\Delta_{PTL}$  or  $\Delta_{VTL}$ ) measured at PTL or VTL is greater than 80 percent of the theoretical elastic elongation of the unbonded length, as defined below. Where:

$$\Delta_{PTL} > 0.8 \frac{PTL L_{UB}}{E A_t} \quad \text{and} \quad \Delta_{VTL} > 0.8 \frac{VTL L_{UB}}{E A_t}$$

- 3. The creep movement does not exceed the criteria presented in Section 9.4.5 of FHWA Geotechnical Circular No. 7

(7) *Construction Sequencing:* Follow closely the construction sequence on the approved plans.

- (8) *Storage and Handling:* Nails, cement, bars and drainage material shall be kept dry and stored in a protected location. Bars shall be placed on supports to prevent contact with ground. Replace any bars that exhibit abrasions, cuts, welds, weld splatter, corrosion, or pitting. Bars shall be replaced or repaired that exhibit damage to encapsulation or epoxy coating.

- (9) *Movement Monitoring:* Contractor shall establish a movement monitoring program. The monitoring program shall include the installation of horizontal and vertical survey monuments on the shotcrete facing. In addition to survey monuments on the shotcrete facing, the contractor shall establish vertical and horizontal monuments on existing pile footings. Monuments shall be measured daily during soil nail wall construction with the first measurement taken within 24 hours of placing the first lift of shotcrete. The contractor shall adhere to the following thresholds:



- a. Warning Threshold: The warning threshold occurs when the vertical or horizontal measured wall displacements exceed 0.5% of the wall height, or when pile footing displacement exceeds  $\frac{1}{2}$ ". When the warning threshold is reached, the contractor shall submit a remedial plan to demonstrate methods to reduce or eliminate additional wall deformations.
- b. Stop Work Threshold: The contractor shall stop work immediately if the vertical or horizontal wall displacements exceed 1.0% of the wall height, or when pile footing displacements exceed 1". The contractor shall submit a remedial action plan once the threshold is exceeded.

The contractor shall immediately notify the Regional Production Group Structural and Geotechnical Design Engineer if either threshold values are exceeded.

### **Shop Plans**

The shop plans shall include, but not be limited to:

- (1) A plan view of the wall identifying:
  - (a) A reference baseline and elevation datum.
  - (b) The offset from the construction centerline or baseline to the face of the wall at its base at all changes in horizontal alignment.
  - (c) Beginning and end of wall stations.
  - (d) Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures, or other potential interferences. The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the wall.
  - (e) Limit of longest nails.
  - (f) Subsurface investigation locations shown on a plan view of the wall alignment with appropriate reference baselines to fix the locations of the explorations relative to the wall.
- (2) An elevation view of the wall identifying:
  - (a) The elevation at the top of the wall, at all horizontal and vertical break points, and at least every 10 feet along the wall.
  - (b) Elevations at the finished grade at front of architectural finished face, at front face of soil nailed wall base and the top of the leveling pad for architectural faced wall, if split faced block or cast-in-place facing are used.
  - (c) Beginning and end of wall stations.
  - (d) The distance along face of wall to all steps in the wall base.
  - (e) Wall elevation view showing nail locations and elevations, vertical and horizontal nail spacing, the location of wall drainage elements, and the location of permanent facing expansion/contraction joints along the wall length (if applicable).
  - (f) Existing finished grade profiles both behind and in front of the wall.
- (3) Design parameters and applicable codes.
- (4) General notes for constructing the wall including construction sequencing or other special requirements.

- (5) Horizontal and vertical curve data affecting the wall and wall control points. Match lines or other details to relate wall stationing to centerline stationing.
- (6) A list of the quantities showing estimated surface area of wall face and other pay items.
- (7) Soil nailed wall typical sections staged excavation lift elevations, wall and excavation face batter, nail and spacing inclination, nail bar sizes, and corrosion protection details.
- (8) A typical detail of production and test nails defining nail length, minimum drill hole diameter, inclination, and test nail bonded and unbonded test lengths.
- (9) Details, dimensions, and schedule for all nails, reinforcing steel, wire mesh, bearing plates, headed studs, etc. and attachment devices of architectural facing.
- (10) Dimensions and schedules of all reinforcing steel including reinforcing bar bending details.
- (11) Details and dimensions for wall appurtenances such as barriers, coping, drainage gutters, fences.
- (12) Details for constructing wall around drainage facilities.
- (13) Details for terminating wall and adjacent slope construction.
- (14) Facing finishes, color and architectural treatment requirements for permanent wall facing elements.

### **Redesign**

If anchors fail during performance tests or proof tests, the Contractor shall modify the design or construction procedures, subject to review by the Department. These modifications may include reducing the soil nail load by increasing the number of nails, increasing the grout pressure, requiring post-grouting or increasing the bond length (within parameters of the plans). Any modification of design or construction procedure shall be at no cost to the Department. The redesigned anchors shall be installed and tested as previously defined at no cost to the Department. Those nails that fail the performance tests may be incorporated in the structure. The Contractor shall propose a reduced Design Load and retest as noted above. Acceptance of such anchors will be at the discretion of the Department.

### **Method of Measurement**

The quantities to be paid for shall be the total square feet of soil nailed wall with architectural face area completed and accepted.

**Appendix S**

**Cut Wall Design Memorandum and**

**Comments**

May 4, 2015  
Rev. June 26, 2015Mr. Rocque Kneece, PE  
CECS  
2000 Park Street  
Suite 201  
Columbia, SC 29201Reference: **Cut Walls at Various Locations**  
**I-85/385 Interchange Improvements**  
**Project ID: 0038111**  
**County: Greenville**  
**ECS Project No. 08-9283-B**

The I-85/385 Interchange improvement project incorporates In Situ Earth Retention Systems (ERSs), referred to herein "cut walls," at several locations across the project. The use and design of such walls is addressed in Chapter 18 of the SCDOT Geotechnical Design Manual. Chapter 18 references other chapters and sections of the GDM, as well as other Federal Highway Administration (FHWA) and AASHTO guidance documents. This memorandum identifies the cut wall locations, identifies maximum wall height, type of wall, anticipated design methodology, and applicable resistance factors. This memorandum does not provide a detailed analysis or evaluation of the various wall types.

**Cut Wall Locations**

Cut walls are currently planned at the following locations:

| Table 1 – Summary of Cut Walls |                       |                          |  |   |
|--------------------------------|-----------------------|--------------------------|--|---|
| Alignment                      | Station               | Maximum Wall Height (ft) | Proposed Wall Type                           | Nearest Borings   |
| I-385NB                        | 327+00 to 329+28 (Rt) | 6                        | Soldier Pile and Lagging                     | B-60, B-61, R385-24, R385-25  |
| I-385NBCD                      | 337+10 to 344+95 (Rt) | 12                       | Soldier Pile and Lagging                     | B-42, B-43, W385-1R-01, W385-1R-02, R11-28, R385-26, R385-27, R385-82, R385NBCD-83  |
| I-385NBCD <sup>(1)</sup>       | 358+95 to 361+07 (Rt) | 28                       | Anchored Soldier Pile Wall or Soil Nail Wall | B-3, W385-RN-03, W385-RN-04, W385-RN-07, W385-RS-02, W385-RS-03, W385-RS-05, R10-30 |

| Table 1 – Summary of Cut Walls(cont.) |   |    |   |   |
|---------------------------------------|---|----|---|---|
| I-385NBCD <sup>(2)</sup>              | 363+63 to 366+05 (Rt)                             | 15 | Mechanically Stabilized Earth Wall                                  | B-64, B-65, B04-SPT-01, B04-SPT-02, B04-DMT-01, B04-DMT-02, W385-2R-01, W385-2R-02  |
| I-385NBCD <sup>(2)</sup>              | 365+56 to 368+63 (Lt)                             | 20 | Mechanically Stabilized Earth Wall                                  | B-64, B-65, B-66, B04-SPT-01, B04-SPT-02, B04-DMT-01, B04-DMT-02, R8A-33, R8A-35, W385-2R-01, W385-2R-02, <b>W385-2R-03, W385-2R-04, W385-2L-01, W385-2L-02, W385-2L-03</b> |
| I-385SBCD <sup>(1)</sup>              | 116+99 to 133+09 (Rt)                             | 25 | Anchored Soldier Pile and Lagging and or Soil Nail Wall             | B-4, B-41, B-47, R10-29, R10-30, <b>W385-RS-01, W385-RS-02, W385-RS-03, W385-RS-04, W385-RS-05, W385-RS-06, W385-RS-07</b>  |
| Ramp 1A                               | Sta 49+50 to 54+00                                | 25 | MSE Wall, Soldier Pile and Lagging Wall or Reinforced Concrete Wall | <b>W1A-1R-01, W1A-1R-02, W1A-1R-03, W1A-1R-04, W1A-1R-05, W1A-1R-06</b>   |
| Ramp 2A <sup>(3)</sup>                | 105+48 to 114+71 (Rt)<br>Bridge 11 Abutment Walls | 20 | Combination Soil Nail/MSE Wall                                      | B11-SPT-01, B11-SPT-02, RCH-10, W2A-1R-01, W2A-1R-02, W2A-1R-03, W2A-1R-04, W2A-1R-05, W2A-1R-06,   |

| Table 1 – Summary of Cut Walls(cont.) |                  |   |                          |   |
|---------------------------------------|------------------|---|--------------------------|---|
| Ramp 3A                               | 328+13 to 446+72 | 9 | Soldier Pile and Lagging | B-44, B-45, R3A-46, <b>W385-4R-01, W385-4R-02, W385-4R-03, W385-4R-04, W385-4R-05, W385-4R-06, W385-4R-07</b> |
| Ramp 11                               | 50+00 to 51+42   | 5 | Soldier Pile and Lagging | B-62, <b>W385-1R-01, W385-1R-02</b>   |

Notes:

1. Proposed walls on I-385NBCD from 358+95 to 361+07 and I-385SBCDD from 116+99 to 122+09 are associated with Bridge 13 (Woodruff Road).
2. Proposed walls on I-385NBCD from 363+63 to 368+63 are associated with Bridge 4 approach embankments and were addressed in the Bridge 4 PBGER and will be further addressed in the final BGER.
3. Proposed walls on Ramp 2A from 105+58 to 114+71 common to Bridge 11 (Roper Mountain Road Bridge).
4. **BOLD** Final boring log not provided to ECS as of May 4, 2015, and cannot be transmitted with this memorandum.
5. *ITALIC* borings in vicinity of wall(s) that have not been drilled as of May 4, 2015.

**Cut Wall Evaluation**

Cut walls shall be evaluated in accordance with the requirements outlined in the SCDOT GDM; however, in several instances specific guidance regarding cantilever soldier pile and lagging walls, anchored soldier pile and lagging walls, and soil nail walls are not provided in the GDM. In these cases the SCDOT GDM refers to AASHTO and FHWA guidance. As such, this memorandum provides references for generally accepted design procedures for each type of wall.

**Soil Parameters**

Soil shear strength parameters for each cut wall shall be determined based on the nearest available subsurface information, laboratory testing, correlations and recommendations provided in Chapter 7 of the GDM and the Geotechnical Engineer's experience in the Geologic formation.

Active, Passive, and At-Rest earth pressure coefficients will be determined in accordance with Chapter 18.5.1 of the GDM. ECS recommends the following methods to derive lateral earth pressure coefficients:

- Rankine Active earth pressure coefficients are recommended for all cantilever soldier and pile lagging walls supporting roadways, embankments, or landscape areas.
- Rankine At-Rest pressure coefficients are recommended for all soldier pile and lagging walls situated near existing structures or in movement sensitive areas (i.e. where wall deflections of less than ½" are required).
- Rankine Passive earth pressure coefficients are recommended for all soldier pile and lagging walls with an embedment of less than 12 feet.
- Soldier pile and lagging walls with embedment of greater than 12 feet should use a passive pressure coefficient considering a log-spiral failure surface such as presented on Figures 16 and 17 in FHWA

Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchored Systems. Based on our experience and this method is generally accepted by the FHWA and provides a more realistic passive pressure distribution than Rankine parameters. Figures 16 and 17 are appended to this memorandum.

- Shear Strength Parameters and Lateral Earth Pressure coefficients used in Soil Nail Walls shall be independently evaluated and selected by the Soil Nail Wall Contractor/Designer.

#### Earth Pressure Distribution Diagrams

##### *Non-Gravity Cantilever Walls*

The SCDOT GDM does not provide specific guidance or requirements for establishing lateral earth pressure diagrams for cantilevered soldier pile and lagging walls or anchored walls, but rather refers to the AASHTO and FHWA guidance. As such, we recommend using the lateral earth pressure diagrams provided in Chapter 3.11.5.6 of the AASHTO LRFD Bridge Design Specifications (Figures 3.11.5.6-1 to 3.11.5.6-3) for permanent cantilever soldier pile and lagging walls. Those figures are attached to this memorandum for reference.

##### *Anchored Walls*

Careful selection of earth pressure diagrams is required for the design of anchored retaining walls. The appropriate earth pressure diagram must be selected on a case by case basis considering the number and type of anchors, soil types, and wall system. We recommend using the lateral earth pressure diagrams provided in Chapter 3.11.5.7 of the AASHTO LRFD Bridge Design Specifications (Figures 3.11.5.7.1-1 and 3.11.5.7.2b-1) for permanent anchored soldier pile and lagging walls. Those figures are attached to this memorandum for reference.

##### *Soil Nail Walls*

A lateral earth pressure diagram specific to soil nail wall is not required as part of design.

#### Geotechnical Resistance Factors

Flexible retaining walls (i.e. cantilever soldier pile and lagging walls or anchored soldier pile and lagging walls) shall be designed to meet the following minimum resistance factors for flexible retaining walls presented in SCDOT Bridge Design Memorandum – DM0310 and the resistance factors for cantilever retaining walls presented Table 9-8 of the GDM and represented as follows:

| <b>SCDOT Table 9-7, Resistance Factors for Flexible Retaining Walls</b> |            |                     |                |                      |
|---|------------|---------------------|----------------|----------------------|
| <b>Performance Limit</b>  |            | <b>Limit States</b> |                |                      |
|   |            | <b>Strength</b>     | <b>Service</b> | <b>Extreme Event</b> |
| Soil Bearing Resistance   |            | 0.65                | N/A            | 1.00                 |
| Sliding Frictional Resistance   |            | 1.00                | N/A            | 1.00                 |
| Lateral Displacement  |            | N/A                 | 1.00           | 1.00                 |
| Vertical Settlement   |            | N/A                 | 1.00           | 1.00                 |
| Global Stability Fill Walls   | ROC- I, II | N/A                 | 0.65           | 0.90                 |
|   | ROC= III   |                     | 0.75           | 1.00                 |
| Global Stability Cut Walls  | ROC- I, II | N/A                 | 0.60           | 0.90                 |
|   | ROC= III   |                     | 0.70           | 1.00                 |

| SCDOT Table 9-8, Resistance Factors for Cantilever Retaining Walls                 |                                 |                     |                     |                     |
|--|---------------------------------|---------------------|---------------------|---------------------|
| Performance Limit  |                                 | Limit States        |                     |                     |
|  |                                 | Strength            | Service             | Extreme Event       |
| Axial Compressive Resistance of Vertical Elements                                  |                                 | Section 9.4 Applies |                     |                     |
| Passive Resistance of Vertical Element   |                                 | 0.75                | N/A                 | 0.85                |
| Flexural Capacity of Vertical Element  |                                 | 0.90                | N/A                 | 0.90                |
| Tensile Anchor Resistance(1)   | Mild Steel (ASTM 615)           | N/A                 | 0.90 <sup>(1)</sup> | 0.90 <sup>(1)</sup> |
|  | High Strength Steel (ASTM A722) |                     | 0.8 <sup>(1)</sup>  | 0.80 <sup>(1)</sup> |
| Pullout Resistance of Anchors (2)  | Sands and Silts                 | N/A                 | 0.65 <sup>(2)</sup> | 0.90 <sup>(2)</sup> |
|  | Clay                            |                     | 0.70 <sup>(2)</sup> | 1.00 <sup>(2)</sup> |
|  | Rock                            |                     | 0.50 <sup>(2)</sup> | 1.00 <sup>(2)</sup> |
| Anchor Pullout Resistance Test (3)<br>(With proof test of every production anchor) |                                 | N/A                 | 1.00 <sup>(3)</sup> | 1.00 <sup>(3)</sup> |
| Lateral Displacement   |                                 | N/A                 | 1.00                | 1.00                |
| Vertical Settlement  |                                 | N/A                 | 1.00                | 1.00                |

1. Apply to maximum proof test load for the anchor. For mild steel apply resistance factor to  $F_y$ . For high-strength steel apply the resistance factor to guaranteed ultimate tensile strength.
2. Apply to presumptive ultimate unit bond stresses for preliminary design only. See AASHTO LRFD (C11.9.4.2) specifications for additional information.
3. Apply where proof tests are conducted on every production anchor to load of 1.0 or greater times the factored load on the anchor.

The SCDOT GDM does not provide specific resistance factors for soil nail wall design, but refers to FHWA guidance on these matters. We recommend establishing resistance factors for soil nail wall design based on FHWA guidelines presented in Table 6.3 of the FHWA "Soil Nail Walls Reference Manual" Publication No. FHAW-NHI-14-7, and summarized below. We have modified Table 6.3 to provide similar formatting to the GDM Presentation.

| Resistance Factors for Soil Nail Walls |                                 |              |         |               |
|--|---------------------------------|--------------|---------|---------------|
| Performance Limit                      |                                 | Limit States |         |               |
|  |                                 | Strength     | Service | Extreme Event |
| Overall Stability                      |                                 | 0.65         | N/A     | 0.90          |
| Basal Heave                            | Short Term                      | 0.65         | N/A     | N/A           |
|  | Long Term                       | 0.50         | N/A     | N/A           |
| Anchor Pull Out                        |                                 | N/A          | 0.65    | 0.65          |
| Tensile Anchor Resistance(1)           | Mild Steel (ASTM 615)           | N/A          | 0.75    | 0.75          |
|  | High Strength Steel (ASTM A722) |              | 0.65    | 0.65          |
| Facing Resistance                      | Flexural Resistance             | N/A          | 0.90    | 0.90          |
|  | Punching Shear                  |              | 0.90    | 0.90          |
|  | Headed Stud – A307              |              | 0.65    | 0.70          |
|  | Headed Stud – A325              |              | 0.75    | 0.80          |
| Lateral Sliding                        |                                 | N/A          | 0.90    | 1.00          |



#### Service Limit State Performance Limits

All cut walls shall be evaluated to the performance limit states outlined in SCDOT GDM Table 10-38 for Service Limit State and Table 10-43 in the Extreme Limit State. Tables 10-38 and 10-43 are appended to this memorandum.

#### Design Methodology and References

The SCDOT GDM does not provide specific design methodology for the evaluation of cut walls, but refers to guidance provided by AASHTO and FHWA. We recommend adopting the following AASHTO and FHWA guidelines for cut wall design in conjunction with performance and resistance factors outlined previously:

- Non-Gravity Cantilever Walls: AASHTO LRFD Bridge Design AASHTO LRFD Bridge Design Specifications Chapter 11.8.
- Anchored Walls: "FHWA Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchored Systems" FHWA Publication No. FHWA-IF-99-015
- Soil Nail Walls: "FHWA Geotechnical Engineering Circular No. 7 - Soil Nail Walls Reference Manual" FHWA Publication No. FHWA-NHI-14-007.

#### Closing

This memorandum provides design recommendations for cut walls. The geotechnical analysis of individual cut walls will be addressed individual BGER and RGER reports. Where requested by SCDOT, ECS will provide memorandums addressing specific locations in advance of the BGER and RGER. These locations include:

- I-385 NBCD approximate stations 337+00 to 346+00
- Ramp 2A sta. 110+00 to 114+00 (NB side of I-85 north of Bridge 11)
- Ramp 1A sta. 51+00 to 52+00 (SB side of I-85 south of Roper Mtn. Road).

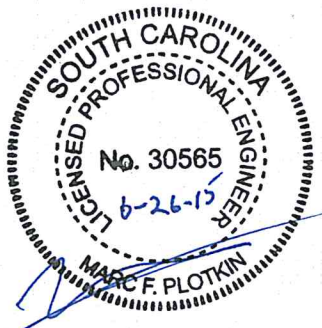
Please advise if you have questions, comments, or require further action on this matter at this time.

Respectfully,

ECS Carolinas, LLP



Marc F. Plotkin P.E.  
Principal Engineer  
S.C. Registration No. 030565



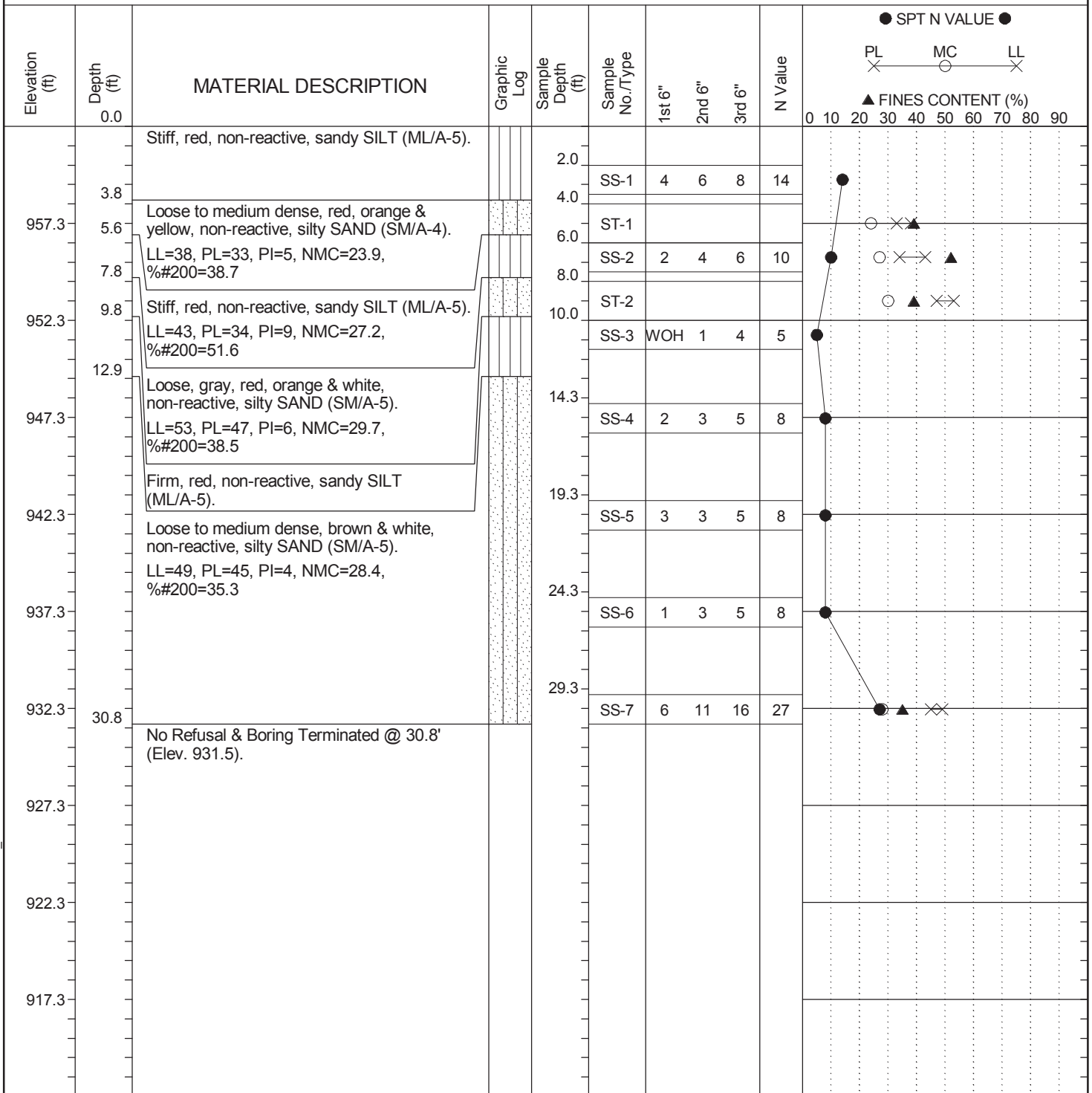
Richard L. Nance, P.E.  
Senior Principal Engineer, VP  
S.C. Registration No. 007332

Attachments: Boring Logs  
Laboratory Test Results – Triaxial Shear Only  
Plan and Profile Sheets (Excluded from Electronic Transmittal)  
AASHTO Figures 3.11.5.6-1 to 3.11.5.6-3, 3.11.5.7-1 and 3.11.5.7.2b-1  
SCDOT GDM Table 10-38, Cut ERS Performance Limits at SLS



# SCDOT Soil Test Boring Log

|                          |                                     |                       |            |                 |            |                 |            |
|--------------------------|-------------------------------------|-----------------------|------------|-----------------|------------|-----------------|------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |            | County:         | Greenville | Eng./Geo.:      | R. DeLost  |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |            |                 |            | Route:          |            |
| Boring No.:              | B-64                                | Boring Location:      | 55+93      | Offset:         | 76' Lt.    | Alignment:      | Ramp 8     |
| Elev.:                   | 962.3 ft                            | Latitude:             | 34.82456   | Longitude:      | 82.29118   | Date Started:   | 10/18/2012 |
| Total Depth:             | 30.8 ft                             | Soil Depth:           | 30.8 ft    | Core Depth:     | ft         | Date Completed: | 10/18/2012 |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |            | Liner Required: | Y (N)      | Liner Used:     | Y (N)      |
| Drill Machine:           | CME 45C                             | Drill Method:         | HSA        | Hammer Type:    | Automatic  | Energy Ratio:   | 82%        |
| Core Size:               | NA                                  | Driller:              | C. Banning | Groundwater:    | TOB        | 24HR            |            |

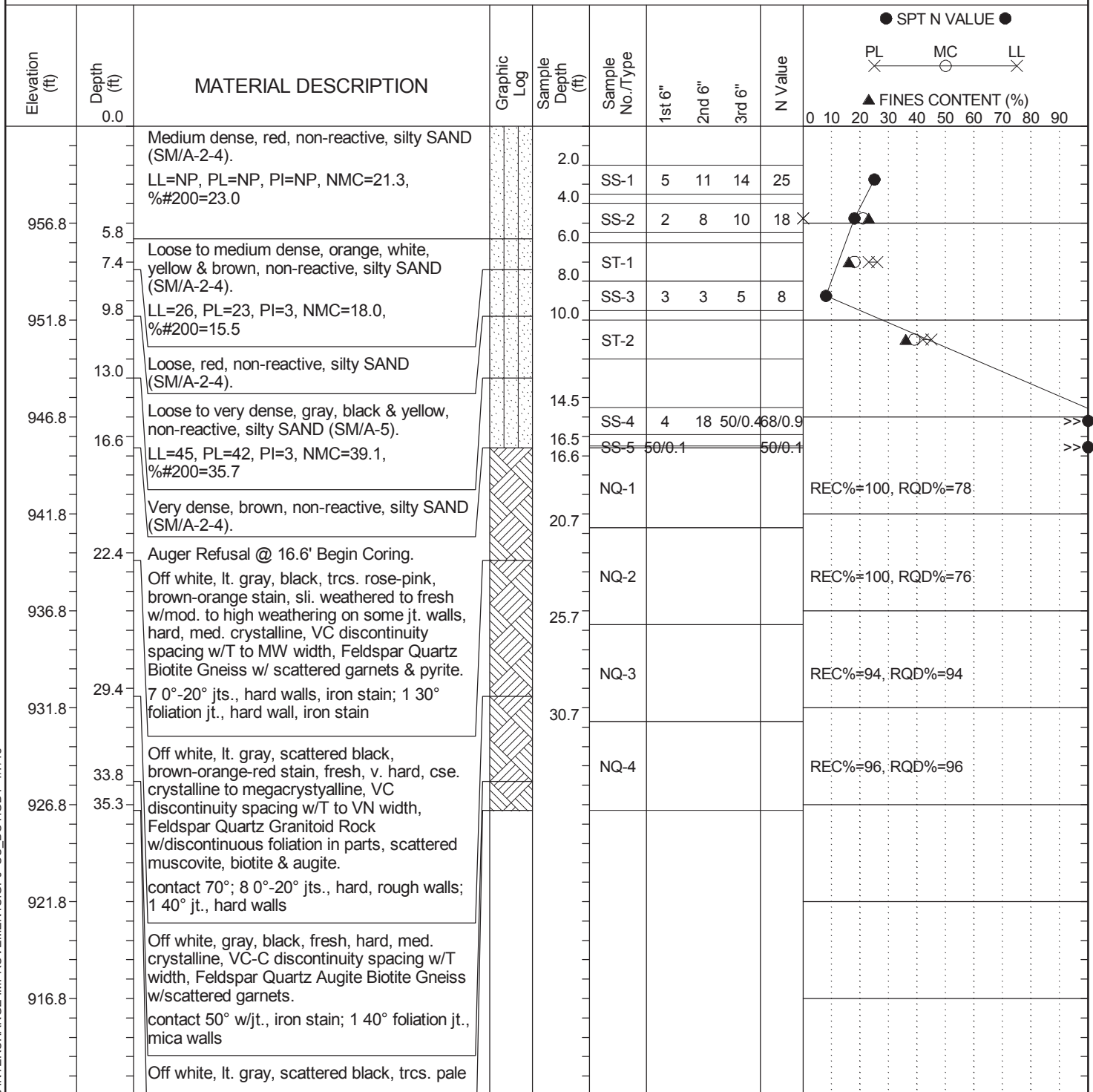


## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                                 |                                     |                              |            |                        |            |                        |              |
|---------------------------------|-------------------------------------|------------------------------|------------|------------------------|------------|------------------------|--------------|
| <b>File No.:</b>                | 23.038111                           | <b>Project No. (PIN):</b>    |            | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | S. Berry     |
| <b>Site Description:</b>        | I-85/I-385 Interchange Improvements |                              |            |                        |            | <b>Route:</b>          |              |
| <b>Boring No.:</b>              | B-65                                | <b>Boring Location:</b>      | 364+95     | <b>Offset:</b>         | 11' Rt.    | <b>Alignment:</b>      | I-385 NB C/D |
| <b>Elev.:</b>                   | 961.8 ft                            | <b>Latitude:</b>             | 34.82493   | <b>Longitude:</b>      | 82.29158   | <b>Date Started:</b>   | 10/9/2012    |
| <b>Total Depth:</b>             | 35.3 ft                             | <b>Soil Depth:</b>           | 16.6 ft    | <b>Core Depth:</b>     | 35.3 ft    | <b>Date Completed:</b> | 10/9/2012    |
| <b>Bore Hole Diameter (in):</b> | 4                                   | <b>Sampler Configuration</b> |            | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)        |
| <b>Drill Machine:</b>           | CME 45C                             | <b>Drill Method:</b>         | HSA        | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 82%          |
| <b>Core Size:</b>               | NQ2                                 | <b>Driller:</b>              | C. Banning | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |              |



## LEGEND

Continued Next Page

SC\_DOT I-85 I-385 INTERCHANGE IMPROVEMENTS.GPJ SC\_DOT.GDT 1/7/13

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                                 |           |                                     |            |                        |            |                        |              |
|---------------------------------|-----------|-------------------------------------|------------|------------------------|------------|------------------------|--------------|
| <b>File No.:</b>                | 23.038111 | <b>Project No. (PIN):</b>           |            | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | S. Berry     |
| <b>Site Description:</b>        |           | I-85/I-385 Interchange Improvements |            |                        |            | <b>Route:</b>          |              |
| <b>Boring No.:</b>              | B-65      | <b>Boring Location:</b>             | 364+95     | <b>Offset:</b>         | 11' Rt.    | <b>Alignment:</b>      | I-385 NB C/D |
| <b>Elev.:</b>                   | 961.8 ft  | <b>Latitude:</b>                    | 34.82493   | <b>Longitude:</b>      | 82.29158   | <b>Date Started:</b>   | 10/9/2012    |
| <b>Total Depth:</b>             | 35.3 ft   | <b>Soil Depth:</b>                  | 16.6 ft    | <b>Core Depth:</b>     | 35.3 ft    | <b>Date Completed:</b> | 10/9/2012    |
| <b>Bore Hole Diameter (in):</b> | 4         | <b>Sampler Configuration</b>        |            | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)        |
| <b>Drill Machine:</b>           | CME 45C   | <b>Drill Method:</b>                | HSA        | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 82%          |
| <b>Core Size:</b>               | NQ2       | <b>Driller:</b>                     | C. Banning | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |              |

| Elevation (ft) | Depth (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE ●</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%)</div> </div> |
|----------------|------------|--|-------------|-------------------|-----------------|--------|--------|--------|---------|---|
| 906.8          |            | green, fresh, v. hard, cse. crystalline to pegmatitic, Feldspar Quartz Granitoid Rock w/scattered muscovite, biotite & augite, trcs. garnets, no jts.. |             |                   |                 |        |        |        |         |   |
|                |            | Boring Terminated @ 35.3' (Elev. 926.5).   |             |                   |                 |        |        |        |         |   |
| 901.8          |            |  |             |                   |                 |        |        |        |         |   |
| 896.8          |            |  |             |                   |                 |        |        |        |         |   |
| 891.8          |            |  |             |                   |                 |        |        |        |         |   |
| 886.8          |            |  |             |                   |                 |        |        |        |         |   |
| 881.8          |            |  |             |                   |                 |        |        |        |         |   |
| 876.8          |            |  |             |                   |                 |        |        |        |         |   |
| 871.8          |            |  |             |                   |                 |        |        |        |         |   |
| 866.8          |            |  |             |                   |                 |        |        |        |         |   |

## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

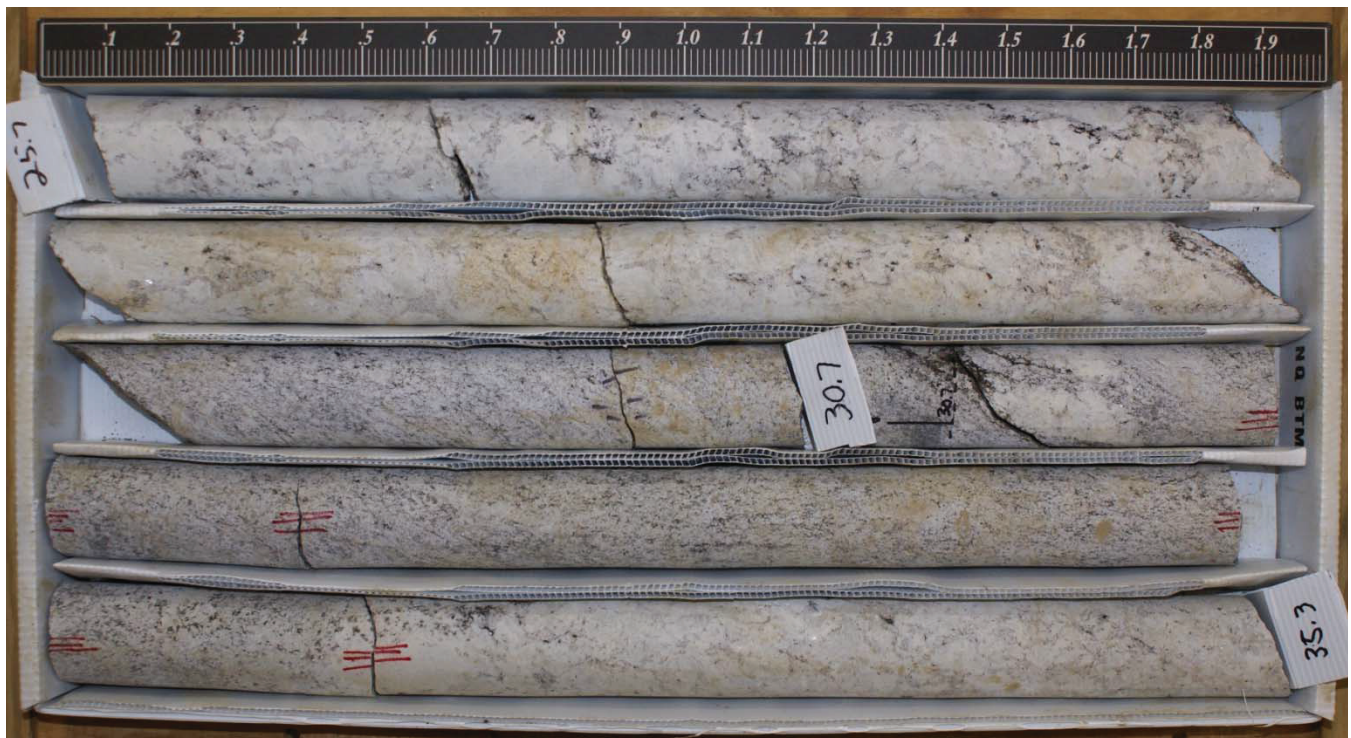


# CORE PHOTOGRAPHIC RECORD

## I-85 / I-385 Interchange Improvements



**B-65 Box 1 of 2**



**B-65 Box 2 of 2**

## Soil Test Boring Log

|                                 |                                   |                              |           |                        |            |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-----------|------------------------|------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009) | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | Phillip Mabry |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |           |                        |            | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B04-SPT-01                        | <b>Boring Location:</b>      | 57+42     | <b>Offset:</b>         | LT 30      | <b>Alignment:</b>      | Ramp 8        |
| <b>Elev.:</b>                   |                                   | <b>Latitude:</b>             |           | <b>Longitude:</b>      |            | <b>Date Started:</b>   | 11/12/2014    |
| <b>Total Depth:</b>             | 68.5 ft.                          | <b>Soil Depth:</b>           | 58.5 ft.  | <b>Core Depth:</b>     | 10 ft.     | <b>Date Completed:</b> | 11/13/2014    |
| <b>Bore Hole Diameter (in):</b> | 3-7/8"                            | <b>Sampler Configuration</b> |           | <b>Liner Required:</b> | No         | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR / RC   | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | SCI       | <b>Groundwater:</b>    | TOB NEWD   | <b>24 HR</b>           | 22.8 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | ● SPT N VALUE (blows / foot)<br>PL X — MC ○ — LL X<br>▲ FINES CONTENT (%) ▲<br>10 20 30 40 50 60 70 80 90 |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|---|
| 0.0        |                | Approximately 3 inches of topsoil.<br>Stiff, moist, reddish brown, with roots in the upper 3 inches and trace gravel, SANDY CLAY (CH)                                    |             | 0.0                | SS S-1          | 4      | 6      | 7      | 13      | ●   |
|            |                | Firm, moist, reddish brown, SANDY CLAY (CH, A-7-6(12)), LL=52 PL=22 PI=30 NMC=22.0 % <sub>#200</sub> =52.5   |             | 2.0                | SS S-2          | 2      | 3      | 2      | 5       | ●   |
|            |                | Very stiff   |             | 4.0                | SS S-3          | 4      | 9      | 10     | 19      | ●   |
| 5.0        |                | Medium dense, moist, reddish brown and light greenish gray, fine to medium grained, SILTY SAND (SM)  |             | 6.0                | SS S-4          | 3      | 6      | 8      | 14      | ●   |
|            |                | Medium dense, moist, yellowish brown and greenish gray, fine to medium grained, SILTY SAND (SM, A-7-5(6)), LL=54 PL=31 PI=23 NMC=28.3 % <sub>#200</sub> =43.7            |             | 8.0                | SS S-5          | 2      | 4      | 7      | 11      | ●   |
| 10.0       |                | Medium dense, moist, reddish brown, white and black, non reactive, fine to medium grained, SILTY SAND (SM, A-2-4(0)), LL=NP PL=NP PI=NP NMC=23.8 % <sub>#200</sub> =35.2 |             | 10.0               | SS S-6          | 3      | 4      | 7      | 11      | ●   |
|            |                | Medium dense, gray, green and black  |             | 13.5               | SS S-7          | 4      | 6      | 6      | 12      | ●   |
| 15.0       |                |  |             |                    |                 |        |        |        |         |   |
| 20.0       |                | Medium dense, moist, light green, white and black, fine to medium grained, SILTY SAND (SM, A-4(0)), LL=NP PL=NP PI=NP NMC=30.2 % <sub>#200</sub> =38.5                   |             | 18.5               | SS S-8          | 3      | 3      | 7      | 10      | ●   |
|            |                |  |             |                    |                 |        |        |        |         |   |
| 25.0       |                | Medium dense, light green, white, and tan, fine to coarse grained  |             | 23.5               | SS S-9          | 5      | 5      | 10     | 15      | ●   |

## LEGEND

## SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

## DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring

## Soil Test Boring Log

|                                 |                                   |                              |           |                        |            |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-----------|------------------------|------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009) | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | Phillip Mabry |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |           |                        |            | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B04-SPT-01                        | <b>Boring Location:</b>      | 57+42     | <b>Offset:</b>         | LT 30      | <b>Alignment:</b>      | Ramp 8        |
| <b>Elev.:</b>                   |                                   | <b>Latitude:</b>             |           | <b>Longitude:</b>      |            | <b>Date Started:</b>   | 11/12/2014    |
| <b>Total Depth:</b>             | 68.5 ft.                          | <b>Soil Depth:</b>           | 58.5 ft.  | <b>Core Depth:</b>     | 10 ft.     | <b>Date Completed:</b> | 11/13/2014    |
| <b>Bore Hole Diameter (in):</b> | 3-7/8"                            | <b>Sampler Configuration</b> |           | <b>Liner Required:</b> | No         | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR / RC   | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | SCI       | <b>Groundwater:</b>    | TOB NEWD   | <b>24 HR</b>           | 22.8 ft.      |

| Depth<br>(ft) | Elevation<br>(ft) | MATERIAL DESCRIPTION   | Graphic<br>Log | Sample<br>Depth<br>(ft.) | Sample<br>No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | ● SPT N VALUE<br>(blows / foot)<br>PL X MC O LL X<br>▲ FINES CONTENT (%) ▲<br>10 20 30 40 50 60 70 80 90 |
|---------------|-------------------|--|----------------|--------------------------|--------------------|--------|--------|--------|---------|--|
| 25.0          |                   |  |                |                          |                    |        |        |        |         |  |
| 30.0          |                   | Very dense, light green white, tan and black   |                | 28.5                     | SS<br>S-10         | 22     | 12     | 38     | 50      | ●  |
| 35.0          |                   | Medium dense, moist, light green, gray, and white,<br>fine to medium grained, SILTY SAND (SM, A-2-4(0)),<br>LL=NP PL=NP PI=NP NMC=29.4 % <sub>#200</sub> =24.9 |                | 33.5                     | SS<br>S-11         | 8      | 7      | 9      | 16      | ● ▲ ○  |
| 40.0          |                   | Medium dense, wet, white, tan and black, with friable<br>rock fragments  |                | 38.5                     | SS<br>S-12         | 6      | 8      | 9      | 17      | ●  |
| 45.0          |                   | Very dense   |                | 43.5                     | SS<br>S-13         | 50/1   | X      | X      | 50/1    | >> ●   |
| 50.0          |                   | Very dense, moist, light gray, green and white   |                | 48.5                     | SS<br>S-14         | 50/1   | X      | X      | 50/1    | >> ●   |

## LEGEND

## SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer

AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

## DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger

MR - Mud Rotary Wash  
RC - Rock Coring



## Soil Test Boring Log

|                                 |                                   |                              |           |                        |            |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-----------|------------------------|------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009) | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | Phillip Mabry |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |           |                        |            | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B04-SPT-01                        | <b>Boring Location:</b>      | 57+42     | <b>Offset:</b>         | LT 30      | <b>Alignment:</b>      | Ramp 8        |
| <b>Elev.:</b>                   |                                   | <b>Latitude:</b>             |           | <b>Longitude:</b>      |            | <b>Date Started:</b>   | 11/12/2014    |
| <b>Total Depth:</b>             | 68.5 ft.                          | <b>Soil Depth:</b>           | 58.5 ft.  | <b>Core Depth:</b>     | 10 ft.     | <b>Date Completed:</b> | 11/13/2014    |
| <b>Bore Hole Diameter (in):</b> | 3-7/8"                            | <b>Sampler Configuration</b> |           | <b>Liner Required:</b> | No         | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR / RC   | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | SCI       | <b>Groundwater:</b>    | TOB NEWD   | <b>24 HR</b>           | 22.8 ft.      |

| Depth<br>(ft) | Elevation<br>(ft) | MATERIAL DESCRIPTION   | Graphic<br>Log | Sample<br>Depth<br>(ft.) | Sample<br>No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | ● SPT N VALUE<br>(blows / foot)<br>PL X MC O LL X<br>▲ FINES CONTENT (%) ▲<br>10 20 30 40 50 60 70 80 90 |
|---------------|-------------------|--|----------------|--------------------------|--------------------|--------|--------|--------|---------|--|
| 50.0          |                   |  |                |                          |                    |        |        |        |         |  |
| 55.0          |                   | Very Dense, No Recovery  |                | 53.5                     | SS<br>S-15         | 50/0   | X      | X      | 50/0    | >>●  |
| 60.0          |                   | Began Rock Coring at 58.5 feet.<br>GRANITE, Igneous, grayish black to grayish orange pink, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, close to moderately spaced joints<br>RQD(%)=40.0 Rec(%)=94.7                                       |                | 58.5                     | RC<br>P-1          |        |        |        |         |  |
|               |                   | GRANITE, Igneous, grayish black to grayish orange pink, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, close to moderately spaced joints<br>RQD(%)=65.8 Rec(%)=100.0   |                | 61.0                     | RC<br>P-2          |        |        |        |         |  |
| 65.0          |                   | GRANITE, Igneous, grayish black to grayish orange pink, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, close to moderately spaced joints<br>RQD(%)=25.0 Rec(%)=100.0   |                | 63.5                     | RC<br>P-3          |        |        |        |         |  |
|               |                   | 10 degree joint, moderately open to wide, planar, slightly rough to smooth, with iron oxide surface stains   |                | 65.0                     | RC<br>P-4          |        |        |        |         |  |
|               |                   | GRANITE, Igneous, grayish black to grayish orange pink, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, 10 degree joint, moderately open to wide, planar, slightly rough to smooth, with iron oxide surface stains<br>RQD(%)=94.0 Rec(%)=94.3 |                |                          |                    |        |        |        |         |  |
|               |                   | 20 degree joint, moderately open to wide, planar, slightly rough to smooth, with iron oxide surface stains   |                |                          |                    |        |        |        |         |  |
|               |                   | 20 degree joint, moderately open to wide, planar, slightly rough to smooth, with iron oxide surface stains   |                |                          |                    |        |        |        |         |  |
|               |                   | Boring Terminated at 68.5 feet.  |                |                          |                    |        |        |        |         |  |

## LEGEND

## SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer

AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

## DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger

MR - Mud Rotary Wash  
RC - Rock Coring



## Soil Test Boring Log

|                          |                                   |                       |           |                 |            |                 |               |
|--------------------------|-----------------------------------|-----------------------|-----------|-----------------|------------|-----------------|---------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009) | County:         | Greenville | Eng./Geo.:      | Phillip Mabry |
| Site Description:        | I-85 and I-385 Interchange Design |                       |           |                 |            | Route:          | I-85 / I-385  |
| Boring No.:              | B04-SPT-02                        | Boring Location:      | 59+16     | Offset:         | LT 24      | Alignment:      | Ramp 8        |
| Elev.:                   |                                   | Latitude:             |           | Longitude:      |            | Date Started:   | 11/14/2014    |
| Total Depth:             | 33.5 ft.                          | Soil Depth:           | 10.0 ft.  | Core Depth:     | 22.5 ft.   | Date Completed: | 11/14/2014    |
| Bore Hole Diameter (in): | 3-7/8"                            | Sampler Configuration |           | Liner Required: | No         | Liner Used:     | NA            |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR / RC   | Hammer Type:    | Automatic  | Energy Ratio:   | 79%           |
| Core Size:               | NQ Wireline                       | Driller:              | SCI       | Groundwater:    | TOB NEWD   | 24 HR           | 3.3 ft.       |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <p>● SPT N VALUE (blows / foot)</p> <p>PL MC LL</p> <p>▲ FINES CONTENT (%) ▲</p> <p>10 20 30 40 50 60 70 80 90</p> </div> |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|---|
| 0.0        |                | Approximately 3 inches of topsoil.<br>Medium dense, moist, red and brown, fine to medium grained, with roots and trace gravel, SILTY SAND (SM, A-4(0)), LL=NP PL=NP PI=NP NMC=11.4<br>%#200=38.8<br>Medium dense   |             | 0.0                | SS S-1          | 4      | 5      | 8      | 13      | ●   |
|            |                |  |             | 2.0                | SS S-2          | 4      | 5      | 5      | 10      | ●   |
| 5.0        |                | Stiff, moist, reddish brown and gray, non reactive, SANDY CLAY (CL, A-6(6)), LL=31 PL=17 PI=14<br>NMC=26.9 %#200=63.8  |             | 4.0                | SS S-3          | 3      | 3      | 6      | 9       | ●   |
|            |                | Very hard, with 1" Rock Fragment   |             | 6.0                | SS S-4          | 50/1   | X      | X      | 50/1    | ●   |
|            |                | Very hard, with 1" Rock Fragment   |             | 8.0                | SS S-5          | 50/1   | X      | X      | 50/1    | ●   |
| 10.0       |                | Very hard, No Recovery<br>Began Rock Coring at 11.0 feet.  |             | 10.0               | SS S-6          | 50/0   | X      | X      | 50/0    | ●   |
|            |                | MARBLE, Metamorphic, grayish orange pink, calcite, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, moderately spaced joints RQD(%)=74.0 Rec(%)=74.0<br>10 degree joint, moderately open to wide, planar, slightly rough to smooth, with iron oxide surface stains |             | 11.0               | RC P-1          |        |        |        |         |   |
| 15.0       |                | MARBLE, Metamorphic, grayish orange pink, calcite, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, moderately spaced joints RQD(%)=100.0 Rec(%)=100.0   |             | 13.5               | RC P-2          |        |        |        |         |   |
|            |                | MARBLE, Metamorphic, grayish orange pink, calcite, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, moderately spaced joints RQD(%)=66.7 Rec(%)=66.7   |             | 17.8               | RC P-3          |        |        |        |         |   |
| 20.0       |                | MARBLE, Metamorphic, grayish orange pink, calcite, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, moderately spaced joints RQD(%)=100.0 Rec(%)=100.0   |             | 18.5               | RC P-4          |        |        |        |         |   |
| 25.0       |                | MARBLE, Metamorphic, grayish orange pink, calcite, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, moderately spaced joints   |             |                    |                 |        |        |        |         |   |

## LEGEND

## SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer

AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

## DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger

MR - Mud Rotary Wash  
RC - Rock Coring

# Soil Test Boring Log

|                                 |                                   |                              |           |                        |            |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-----------|------------------------|------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009) | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | Phillip Mabry |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |           |                        |            | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B04-SPT-02                        | <b>Boring Location:</b>      | 59+16     | <b>Offset:</b>         | LT 24      | <b>Alignment:</b>      | Ramp 8        |
| <b>Elev.:</b>                   |                                   | <b>Latitude:</b>             |           | <b>Longitude:</b>      |            | <b>Date Started:</b>   | 11/14/2014    |
| <b>Total Depth:</b>             | 33.5 ft.                          | <b>Soil Depth:</b>           | 10.0 ft.  | <b>Core Depth:</b>     | 22.5 ft.   | <b>Date Completed:</b> | 11/14/2014    |
| <b>Bore Hole Diameter (in):</b> | 3-7/8"                            | <b>Sampler Configuration</b> |           | <b>Liner Required:</b> | No         | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR / RC   | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | SCI       | <b>Groundwater:</b>    | TOB NEWD   | <b>24 HR</b>           | 3.3 ft.       |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 25.0       |                | RQD(%)=100.0 Rec(%)=100.0  |             | 23.5               | RC P-5          |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
| 30.0       |                | MARBLE, Metamorphic, grayish orange pink, calcite, quartz, feldspar and mica, fresh to slightly weathered, hard, strong to very strong, moderately spaced joints RQD(%)=100.0 Rec(%)=100.0 |             | 28.5               | RC P-6          |        |        |        |         |  |
|            |                | Boring Terminated at 33.5 feet.  |             |                    |                 |        |        |        |         |  |

## LEGEND

### SAMPLER TYPE

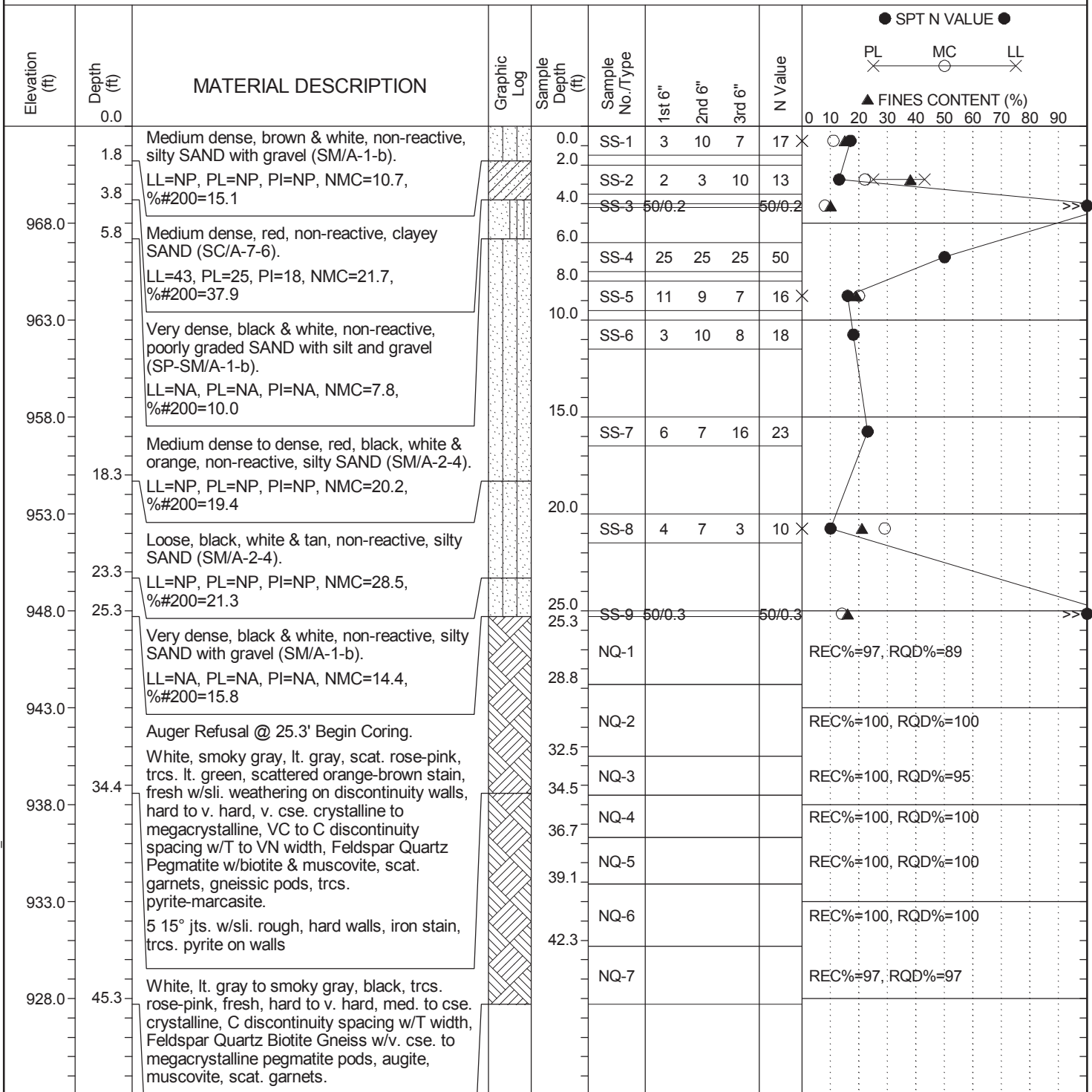
SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring

# SCDOT Soil Test Boring Log

|                          |                                     |                       |          |                 |            |                 |              |
|--------------------------|-------------------------------------|-----------------------|----------|-----------------|------------|-----------------|--------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |          | County:         | Greenville | Eng./Geo.:      | J. Patterson |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |          |                 |            | Route:          |              |
| Boring No.:              | B-4                                 | Boring Location:      | 114+01   | Offset:         | 56' Rt.    | Alignment:      | I-385 SB C/D |
| Elev.:                   | 973.0 ft                            | Latitude:             | 34.82426 | Longitude:      | 82.29235   | Date Started:   | 5/17/2012    |
| Total Depth:             | 45.3 ft                             | Soil Depth:           | 25.3 ft  | Core Depth:     | 45.3 ft    | Date Completed: | 5/18/2012    |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |          | Liner Required: | Y (N)      | Liner Used:     | Y (N)        |
| Drill Machine:           | CME 550                             | Drill Method:         | RC       | Hammer Type:    | Automatic  | Energy Ratio:   | 77%          |
| Core Size:               | NQ2                                 | Driller:              | SCI      | Groundwater:    | TOB        | 24HR            |              |



## LEGEND

Continued Next Page

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                                 |           |                                     |          |                        |            |                        |              |
|---------------------------------|-----------|-------------------------------------|----------|------------------------|------------|------------------------|--------------|
| <b>File No.:</b>                | 23.038111 | <b>Project No. (PIN):</b>           |          | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | J. Patterson |
| <b>Site Description:</b>        |           | I-85/I-385 Interchange Improvements |          |                        |            | <b>Route:</b>          |              |
| <b>Boring No.:</b>              | B-4       | <b>Boring Location:</b>             | 114+01   | <b>Offset:</b>         | 56' Rt.    | <b>Alignment:</b>      | I-385 SB C/D |
| <b>Elev.:</b>                   | 973.0 ft  | <b>Latitude:</b>                    | 34.82426 | <b>Longitude:</b>      | 82.29235   | <b>Date Started:</b>   | 5/17/2012    |
| <b>Total Depth:</b>             | 45.3 ft   | <b>Soil Depth:</b>                  | 25.3 ft  | <b>Core Depth:</b>     | 45.3 ft    | <b>Date Completed:</b> | 5/18/2012    |
| <b>Bore Hole Diameter (in):</b> | 4         | <b>Sampler Configuration</b>        |          | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)        |
| <b>Drill Machine:</b>           | CME 550   | <b>Drill Method:</b>                | RC       | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 77%          |
| <b>Core Size:</b>               | NQ2       | <b>Driller:</b>                     | SCI      | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |              |

| Elevation (ft) | Depth (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE ●</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%)</div> </div> |
|----------------|------------|---|-------------|-------------------|-----------------|--------|--------|--------|---------|---|
| 918.0          |            | 3 0°-15° jts. w/sli. rough, hard walls, faint iron stain; granitoid interval 37.5'-38.3'; foliation 80°-65° |             |                   |                 |        |        |        |         |   |
|                |            | Boring Terminated @ 45.3' (Elev. 927.7).  |             |                   |                 |        |        |        |         |   |
| 913.0          |            |   |             |                   |                 |        |        |        |         |   |
| 908.0          |            |   |             |                   |                 |        |        |        |         |   |
| 903.0          |            |   |             |                   |                 |        |        |        |         |   |
| 898.0          |            |   |             |                   |                 |        |        |        |         |   |
| 893.0          |            |   |             |                   |                 |        |        |        |         |   |
| 888.0          |            |   |             |                   |                 |        |        |        |         |   |
| 883.0          |            |   |             |                   |                 |        |        |        |         |   |
| 878.0          |            |   |             |                   |                 |        |        |        |         |   |

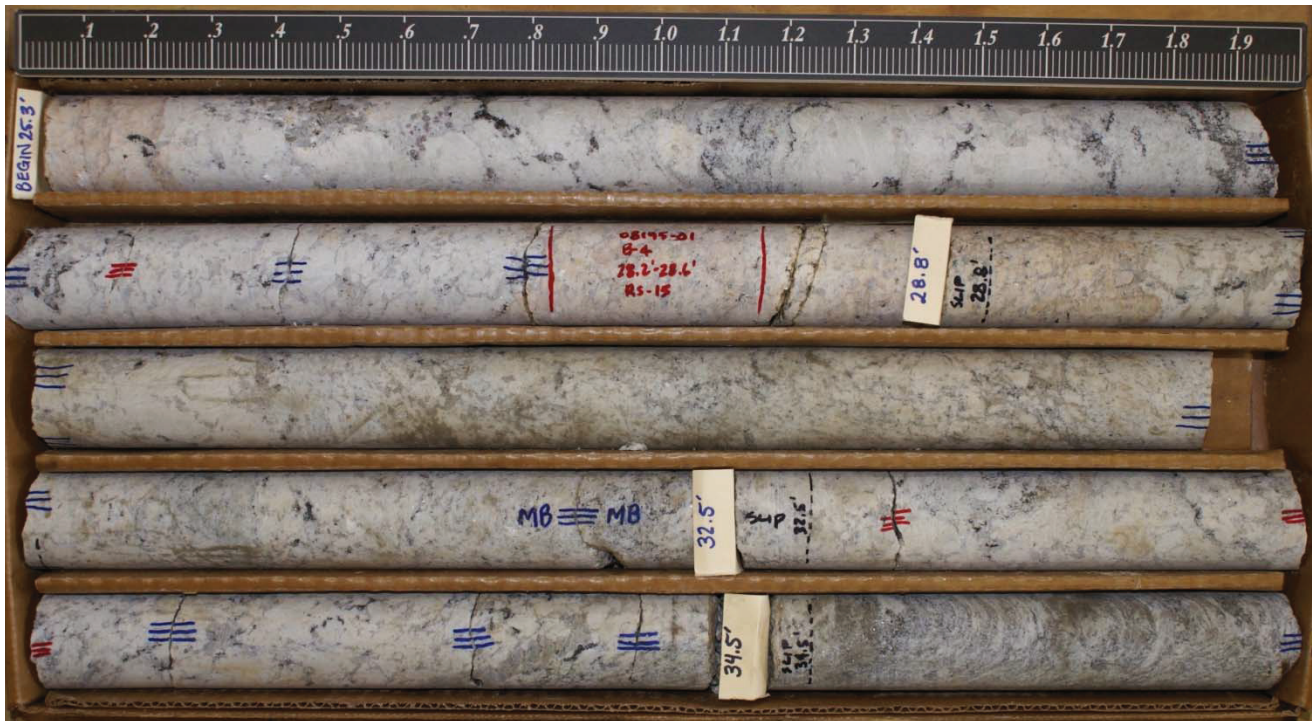
## LEGEND

| SAMPLER TYPE |                     | DRILLING METHOD |                            |
|--------------|---------------------|-----------------|----------------------------|
| SS           | - Split Spoon       | HSA             | - Hollow Stem Auger        |
| ST           | - Shelby Tube       | CFA             | - Continuous Flight Augers |
| AWG          | - Rock Core, 1-1/8" | DC              | - Driving Casing           |
| NQ           | - Rock Core, 1-7/8" | RW              | - Rotary Wash              |
| CU           | - Cuttings          | RC              | - Rock Core                |
| CT           | - Continuous Tube   |                 |                            |

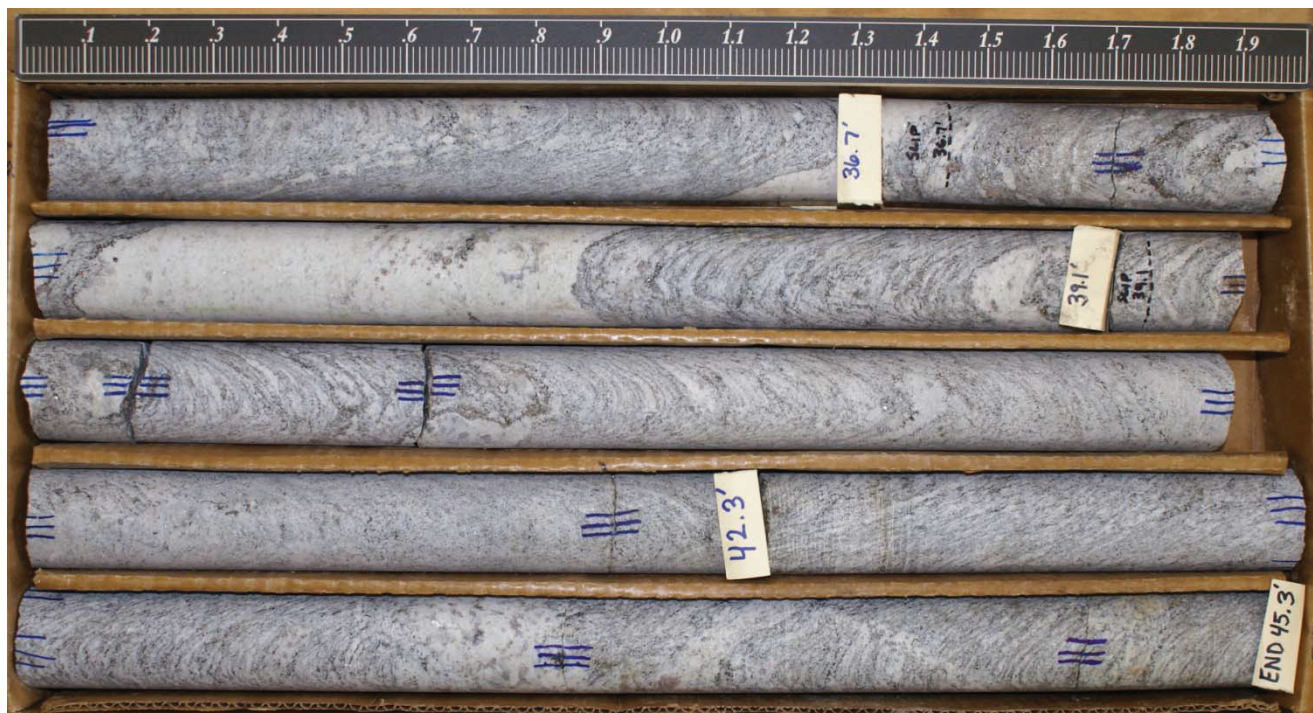


# CORE PHOTOGRAPHIC RECORD

## I-85 / I-385 Interchange Improvements



**B-4 Box 1 of 2**



**B-4 Box 2 of 2**





# Soil Test Boring Log

|                          |                                   |                       |             |                 |              |                 |               |
|--------------------------|-----------------------------------|-----------------------|-------------|-----------------|--------------|-----------------|---------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009)   | County:         | Greenville   | Eng./Geo.:      | Michael Davis |
| Site Description:        | I-85 and I-385 Interchange Design |                       |             |                 |              | Route:          | I-85 / I-385  |
| Boring No.:              | B11-SPT-01                        | Boring Location:      | 36+76       | Offset:         | LT 27        | Alignment:      | Roper         |
| Elev.:                   | 935.7 ft.                         | Latitude:             | 34.83779425 | Longitude:      | -82.28861805 | Date Started:   | 1/5/2015      |
| Total Depth:             | 98.0 ft.                          | Soil Depth:           | 75.0 ft.    | Core Depth:     | 23.0 ft.     | Date Completed: | 1/6/2015      |
| Bore Hole Diameter (in): | 3-7/8                             | Sampler Configuration |             | Liner Required: | No           | Liner Used:     | NA            |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR / RC     | Hammer Type:    | Automatic    | Energy Ratio:   | 88%           |
| Core Size:               | NQ Wireline                       | Driller:              | TE          | Groundwater:    | TOB 44.0 ft. | 24 HR           | 26.0 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 0.0        |                |  |             |                    |                 |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
|            | 935.0          | Approximately 6 inches of topsoil.<br>Firm, moist, brown, SILT with SAND (ML, A-4(0)),<br>FILL, LL=NP PL=NP PI=NP NMC=27.1 % <sub>#200</sub> =71.6                   |             | 0.0                | SS S-1          | 2      | 2      | 5      | 7       | ● ○ ▲  |
|            |                | Stiff, reddish brown, fine to medium grained, FILL   |             | 2.0                | SS S-2          | 4      | 6      | 6      | 12      | ● ○  |
| 5.0        |                | Loose, moist, brown, fine grained, SILTY SAND (SM, A-2), RESIDUUM  |             | 4.0                | SS S-3          | 3      | 5      | 5      | 10      | ● ○  |
|            | 930.0          | Medium dense, moist, brown and white, weakly reactive, fine to medium grained, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=34.9 % <sub>#200</sub> =45.8 |             | 6.0                | SS S-4          | 4      | 4      | 8      | 12      | ● ○ ▲  |
|            |                | Loose, brown and light brown, RESIDUUM   |             | 8.0                | SS S-5          | 2      | 5      | 5      | 10      | ● ○  |
| 10.0       |                | Medium dense, moist, brown, fine grained, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=44.7 % <sub>#200</sub> =43.3                                      |             | 10.0               | SS S-6          | 3      | 5      | 6      | 11      | ● ○ ▲  |
|            | 925.0          | Loose, moist, brown, white and tan, fine grained, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=31.3 % <sub>#200</sub> =31.7                            |             | 13.5               | SS S-7          | 3      | 3      | 5      | 8       | ● ○ ▲  |
| 15.0       |                | Medium dense, moist, brown, tan and white, RESIDUUM  |             | 18.5               | SS S-8          | 2      | 4      | 6      | 10      | ● ○  |
|            | 915.0          | Loose, RESIDUUM  |             | 23.5               | SS S-9          | 2      | 2      | 5      | 7       | ● ○  |
| 25.0       |                |  |             |                    |                 |        |        |        |         |  |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring



# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B11-SPT-01                        | <b>Boring Location:</b>      | 36+76       | <b>Offset:</b>         | LT 27        | <b>Alignment:</b>      | Roper         |
| <b>Elev.:</b>                   | 935.7 ft.                         | <b>Latitude:</b>             | 34.83779425 | <b>Longitude:</b>      | -82.28861805 | <b>Date Started:</b>   | 1/5/2015      |
| <b>Total Depth:</b>             | 98.0 ft.                          | <b>Soil Depth:</b>           | 75.0 ft.    | <b>Core Depth:</b>     | 23.0 ft.     | <b>Date Completed:</b> | 1/6/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR / RC     | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 88%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | TE          | <b>Groundwater:</b>    | TOB 44.0 ft. | <b>24 HR</b>           | 26.0 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 25.0       | 910.0          |  |             |                    |                 |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
| 30.0       | 905.0          | Medium dense, brown, black and tan, fine grained, RESIDUUM   |             | 28.5               | SS S-10         | 3      | 6      | 5      | 11      | ●  |
| 35.0       | 900.0          | Medium dense, moist, brown, tan, white and black, weakly reactive, fine to medium grained, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=32.8 % #200=30.4 |             | 33.5               | SS S-11         | 3      | 6      | 7      | 13      | ● ▲  |
| 40.0       | 895.0          | Medium dense, fine grained, RESIDUUM   |             | 38.5               | SS S-12         | 3      | 5      | 8      | 13      | ●  |
| 45.0       | 890.0          | Medium dense, tan, white and black, RESIDUUM   |             | 43.5               | SS S-13         | 4      | 5      | 8      | 13      | ●  |
| 50.0       |                | Medium dense, brown, tan, white and black, RESIDUUM  |             | 48.5               | SS S-14         | 6      | 7      | 10     | 17      | ●  |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

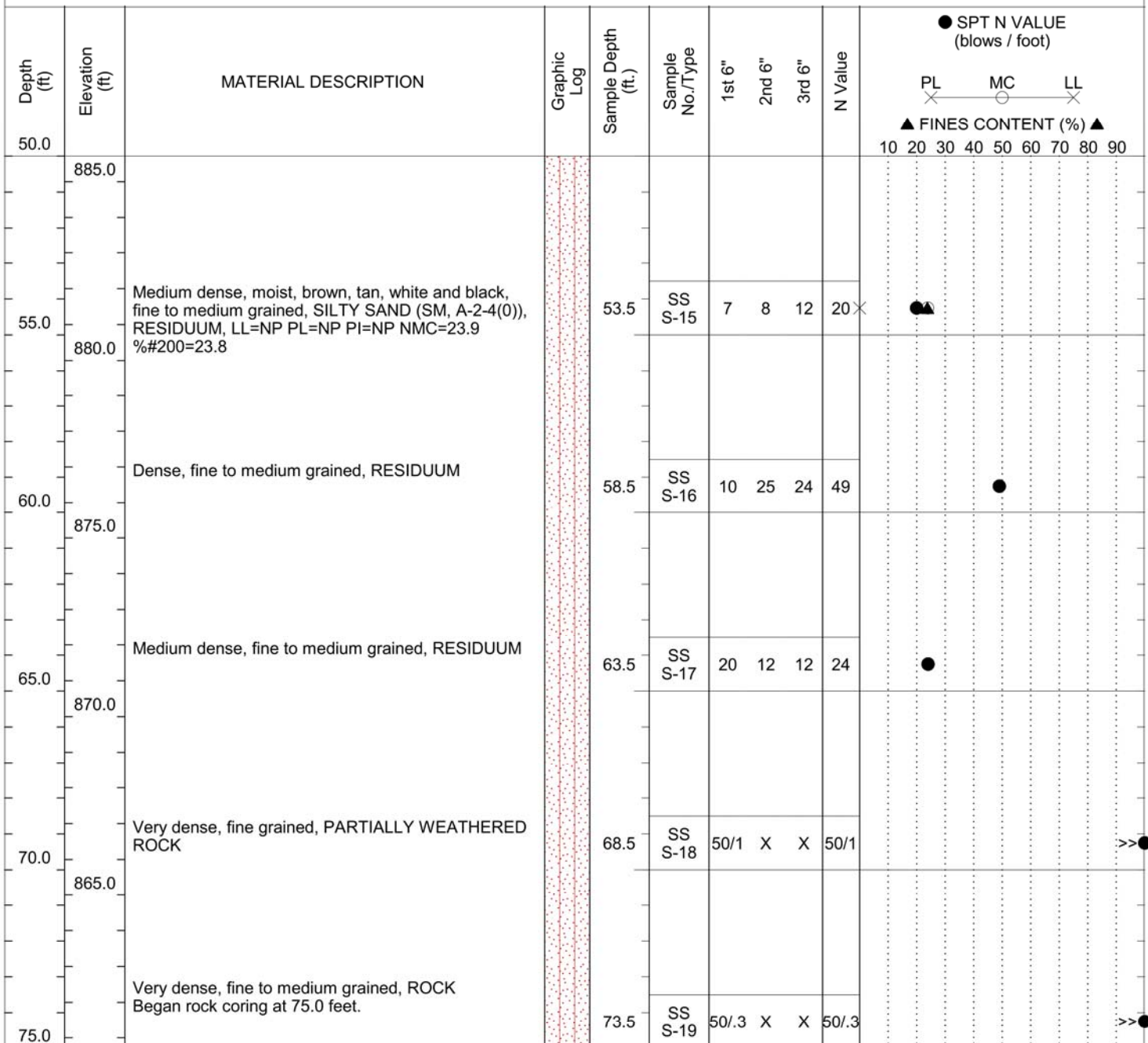
### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring



# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B11-SPT-01                        | <b>Boring Location:</b>      | 36+76       | <b>Offset:</b>         | LT 27        | <b>Alignment:</b>      | Roper         |
| <b>Elev.:</b>                   | 935.7 ft.                         | <b>Latitude:</b>             | 34.83779425 | <b>Longitude:</b>      | -82.28861805 | <b>Date Started:</b>   | 1/5/2015      |
| <b>Total Depth:</b>             | 98.0 ft.                          | <b>Soil Depth:</b>           | 75.0 ft.    | <b>Core Depth:</b>     | 23.0 ft.     | <b>Date Completed:</b> | 1/6/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR / RC     | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 88%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | TE          | <b>Groundwater:</b>    | TOB 44.0 ft. | <b>24 HR</b>           | 26.0 ft.      |



## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring





# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B11-SPT-01                        | <b>Boring Location:</b>      | 36+76       | <b>Offset:</b>         | LT 27        | <b>Alignment:</b>      | Roper         |
| <b>Elev.:</b>                   | 935.7 ft.                         | <b>Latitude:</b>             | 34.83779425 | <b>Longitude:</b>      | -82.28861805 | <b>Date Started:</b>   | 1/5/2015      |
| <b>Total Depth:</b>             | 98.0 ft.                          | <b>Soil Depth:</b>           | 75.0 ft.    | <b>Core Depth:</b>     | 23.0 ft.     | <b>Date Completed:</b> | 1/6/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR / RC     | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 88%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | TE          | <b>Groundwater:</b>    | TOB 44.0 ft. | <b>24 HR</b>           | 26.0 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|---|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 75.0       | 860.0          | Igneous, GRANITE, grayish black to grayish orange pink, quartz, feldspar and mica, fresh to slightly weathered, strong to very strong, with close to moderately spaced joints<br>RQD(%)=68.9 Rec(%)=85.8  |             | 75.0               | RC C-1          |        |        |        |         |  |
| 80.0       | 855.0          | Igneous, GRANITE, grayish black to grayish orange pink, quartz, feldspar, and mica, fresh to slightly weathered, strong to very strong, with close to moderately spaced joints<br>Horizontal joint, moderately open to wide, planar, slightly rough to smooth, with mica surface stains<br>2 - 10 degree joints (seperated approximately 2 inches), moderately open to wide, planar, slightly rough to smooth, with mica surface stains   |             | 78.0               | RC C-2          |        |        |        |         |  |
| 85.0       | 850.0          | Igneous, GRANITE, grayish black to grayish orange pink, quartz, feldspar, and mica, slightly to moderately weathered, strong to very strong with close to moderately spaced joints<br>RQD(%)=100.0 Rec(%)=100.0   |             | 83.0               | RC C-3          |        |        |        |         |  |
| 90.0       | 845.0          | Igneous, GRANITE, grayish black to grayish orange pink, quartz, feldspar and mica, slightly to moderately weathered, strong to very strong, with close to moderately spaced joints, horizontal joints, open to wide, planar, slightly rough to smooth, with mica surface stains<br>RQD(%)=86.0 Rec(%)=94.0  |             | 88.0               | RC C-4          |        |        |        |         |  |
| 95.0       | 840.0          | Igneous, GRANITE, grayish black to grayish orange pink, quartz, feldspar and mica, slightly to moderately weathered, strong to very strong with close to moderately spaced joints<br>RQD(%)=74.0 Rec(%)=92.0<br>20 degree joint, moderately open to wide, planar, slightly rough to smooth, with mica surface stains<br>15 degree joint moderately open to wide, planar, slightly rough to smooth, with mica surface stains<br>15 degree joint and 20 degree joint (seperated by approximately 3 inches), moderately open to wide, planar, slightly rough to smooth, with mica surface stains |             | 93.0               | RC C-5          |        |        |        |         |  |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
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GB - Grab Bag  
NQ - Rock Core

### DRILLING METHOD

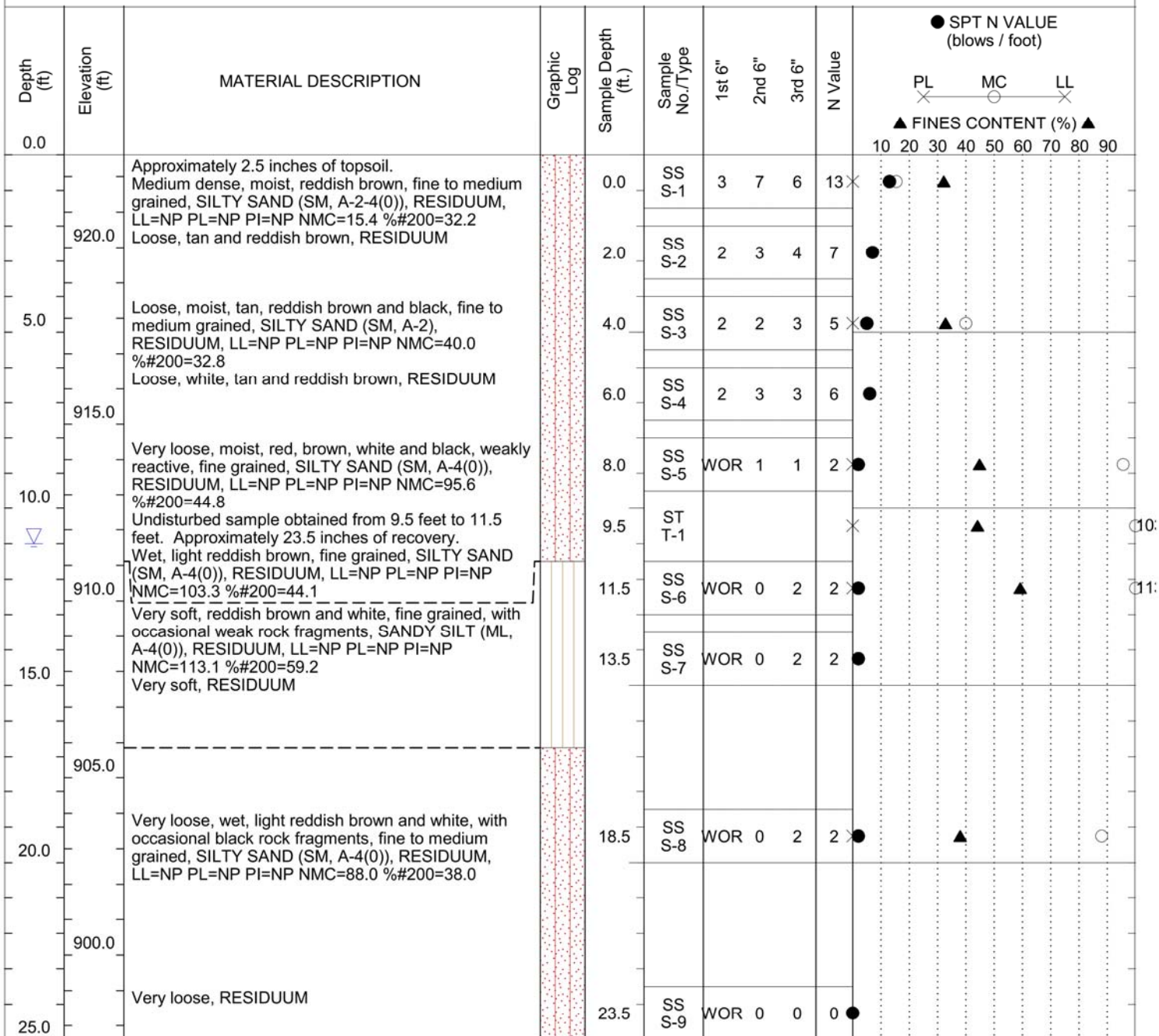
HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring





# Soil Test Boring Log

|                          |                                   |                       |             |                 |              |                 |               |
|--------------------------|-----------------------------------|-----------------------|-------------|-----------------|--------------|-----------------|---------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009)   | County:         | Greenville   | Eng./Geo.:      | Phillip Mabry |
| Site Description:        | I-85 and I-385 Interchange Design |                       |             |                 |              | Route:          | I-85 / I-385  |
| Boring No.:              | B11-SPT-02                        | Boring Location:      | 37+53       | Offset:         | LT 14        | Alignment:      | Roper         |
| Elev.:                   | 922.6 ft.                         | Latitude:             | 34.83793244 | Longitude:      | -82.28882109 | Date Started:   | 11/10/2014    |
| Total Depth:             | 73.6 ft.                          | Soil Depth:           | 68.6 ft.    | Core Depth:     | 0.0 ft.      | Date Completed: | 11/10/2014    |
| Bore Hole Diameter (in): | 3-7/8                             | Sampler Configuration |             | Liner Required: | No           | Liner Used:     | NA            |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR          | Hammer Type:    | Automatic    | Energy Ratio:   | 88%           |
| Core Size:               | NQ Wireline                       | Driller:              | TE          | Groundwater:    | TOB N.E.     | 24 HR           | 11.0 ft.      |



## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
AC - Auger Cuttings  
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### DRILLING METHOD

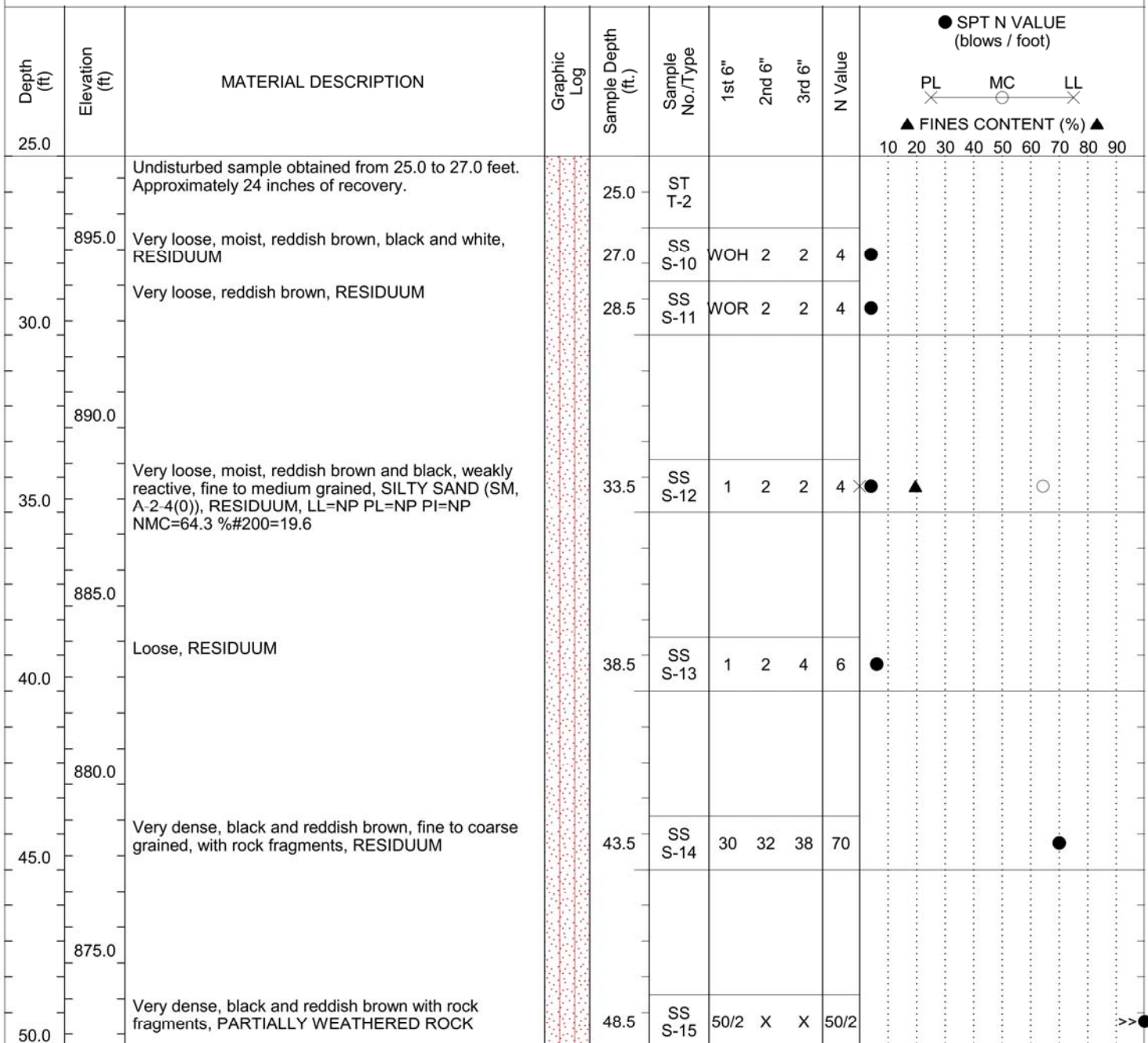
HSA - Hollow Stem Augers  
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HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring





# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Phillip Mabry |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B11-SPT-02                        | <b>Boring Location:</b>      | 37+53       | <b>Offset:</b>         | LT 14        | <b>Alignment:</b>      | Roper         |
| <b>Elev.:</b>                   | 922.6 ft.                         | <b>Latitude:</b>             | 34.83793244 | <b>Longitude:</b>      | -82.28882109 | <b>Date Started:</b>   | 11/10/2014    |
| <b>Total Depth:</b>             | 73.6 ft.                          | <b>Soil Depth:</b>           | 68.6 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 11/10/2014    |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 88%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | TE          | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 11.0 ft.      |



## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
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### DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
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RC - Rock Coring



# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Phillip Mabry |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | B11-SPT-02                        | <b>Boring Location:</b>      | 37+53       | <b>Offset:</b>         | LT 14        | <b>Alignment:</b>      | Roper         |
| <b>Elev.:</b>                   | 922.6 ft.                         | <b>Latitude:</b>             | 34.83793244 | <b>Longitude:</b>      | -82.28882109 | <b>Date Started:</b>   | 11/10/2014    |
| <b>Total Depth:</b>             | 73.6 ft.                          | <b>Soil Depth:</b>           | 68.6 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 11/10/2014    |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 88%           |
| <b>Core Size:</b>               | NQ Wireline                       | <b>Driller:</b>              | TE          | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 11.0 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|---|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 50.0       |                |   |             |                    |                 |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
| 55.0       | 870.0          | Very dense, black reddish brown and tan, with rock fragments, PARTIALLY WEATHERED ROCK                          |             | 53.5               | SS S-16         | 37     | 27     | 50/1   | 50/1    | >>●  |
| 60.0       | 865.0          | Very dense, red, brown, tan, black, white and light green, RESIDUUM   |             | 58.5               | SS S-17         | 41     | 32     | 37     | 69      | ●  |
| 65.0       | 860.0          | Very dense, black, reddish brown and tan, fine to medium grained, with rock fragments, PARTIALLY WEATHERED ROCK |             | 63.5               | SS S-18         | 50/2   | X      | X      | 50/2    | >>●  |
| 70.0       | 855.0          | Very dense, dark gray, ROCK   |             | 68.5               | SS S-19         | 50/1   | X      | X      | 50/1    | >>●  |
|            | 850.0          |   |             |                    |                 |        |        |        |         |  |
|            |                | Very dense, No Recovery, ROCK<br>Boring Terminated at 74.1 feet.  |             | 73.5               | SS S-20         | 50/1   | X      | X      | 50/1    | >>●  |

## LEGEND

### SAMPLER TYPE

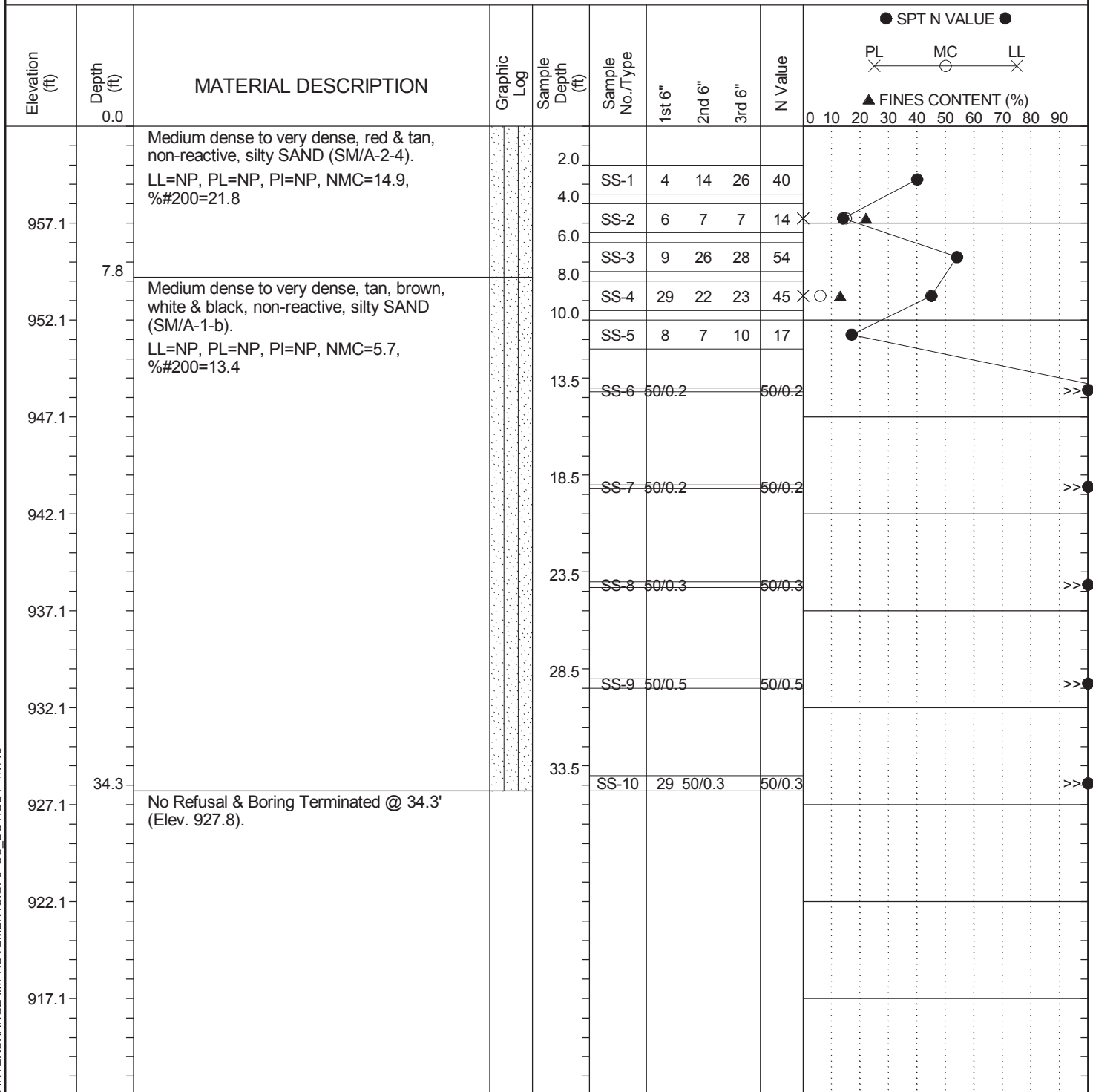
SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring

# SCDOT Soil Test Boring Log

|                          |                                     |                       |            |                 |            |                 |              |
|--------------------------|-------------------------------------|-----------------------|------------|-----------------|------------|-----------------|--------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |            | County:         | Greenville | Eng./Geo.:      | S. Berry     |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |            |                 |            | Route:          |              |
| Boring No.:              | B-41                                | Boring Location:      | 113+09     | Offset:         | 37' Lt.    | Alignment:      | I-385 SB C/D |
| Elev.:                   | 962.1 ft                            | Latitude:             | 34.82455   | Longitude:      | 82.2923    | Date Started:   | 10/7/2012    |
| Total Depth:             | 34.3 ft                             | Soil Depth:           | 34.3 ft    | Core Depth:     | ft         | Date Completed: | 10/7/2012    |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |            | Liner Required: | Y (N)      | Liner Used:     | Y (N)        |
| Drill Machine:           | CME 45C                             | Drill Method:         | HSA        | Hammer Type:    | Automatic  | Energy Ratio:   | 86%          |
| Core Size:               | NA                                  | Driller:              | M. Frazier | Groundwater:    | TOB        | 24HR            |              |

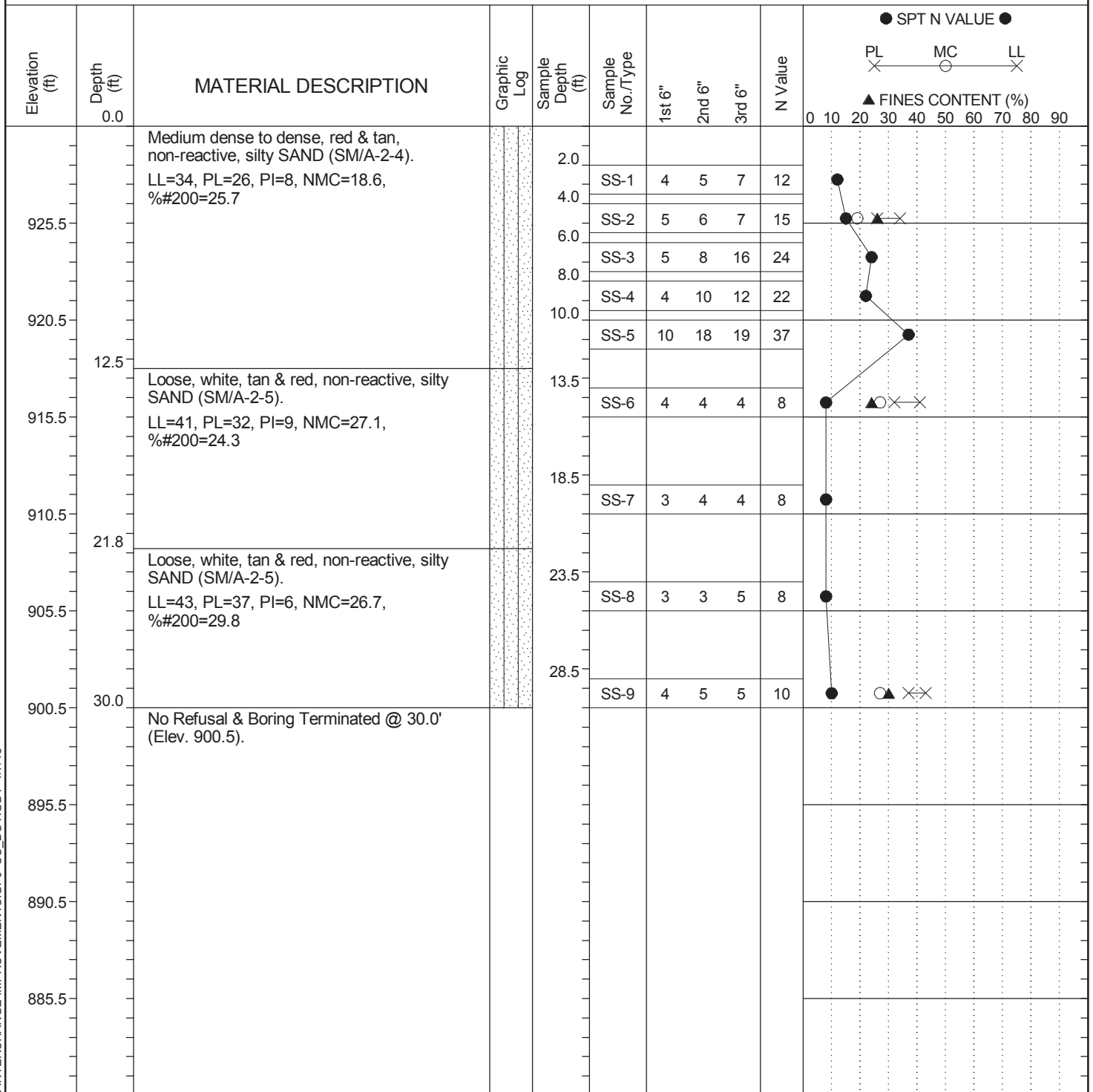


## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                                 |                                     |                              |            |                        |            |                        |              |
|---------------------------------|-------------------------------------|------------------------------|------------|------------------------|------------|------------------------|--------------|
| <b>File No.:</b>                | 23.038111                           | <b>Project No. (PIN):</b>    |            | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | S. Berry     |
| <b>Site Description:</b>        | I-85/I-385 Interchange Improvements |                              |            |                        |            | <b>Route:</b>          |              |
| <b>Boring No.:</b>              | B-42                                | <b>Boring Location:</b>      | 340+05     | <b>Offset:</b>         | 13' Rt.    | <b>Alignment:</b>      | I-385 NB C/D |
| <b>Elev.:</b>                   | 930.5 ft                            | <b>Latitude:</b>             | 34.81816   | <b>Longitude:</b>      | 82.29043   | <b>Date Started:</b>   | 10/8/2012    |
| <b>Total Depth:</b>             | 30 ft                               | <b>Soil Depth:</b>           | 30.0 ft    | <b>Core Depth:</b>     | ft         | <b>Date Completed:</b> | 10/8/2012    |
| <b>Bore Hole Diameter (in):</b> | 4                                   | <b>Sampler Configuration</b> |            | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)        |
| <b>Drill Machine:</b>           | CME 45C                             | <b>Drill Method:</b>         | HSA        | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 86%          |
| <b>Core Size:</b>               | NA                                  | <b>Driller:</b>              | M. Frazier | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |              |

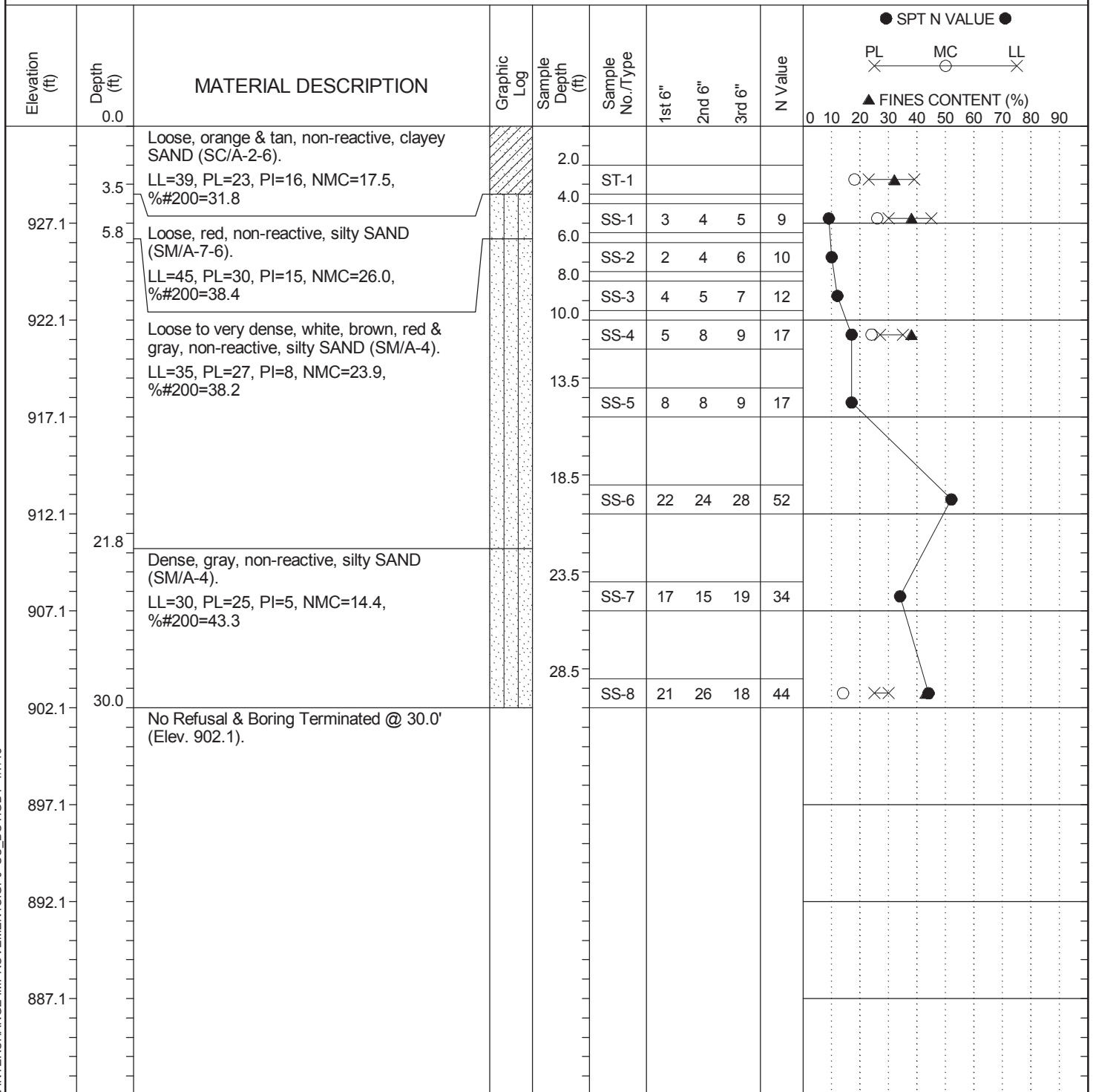


## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                          |                                     |                       |            |                 |            |                 |              |
|--------------------------|-------------------------------------|-----------------------|------------|-----------------|------------|-----------------|--------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |            | County:         | Greenville | Eng./Geo.:      | S. Berry     |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |            |                 |            | Route:          |              |
| Boring No.:              | B-43                                | Boring Location:      | 341+96     | Offset:         | 6' Lt.     | Alignment:      | I-385 NB C/D |
| Elev.:                   | 932.1 ft                            | Latitude:             | 34.81867   | Longitude:      | 82.29058   | Date Started:   | 10/9/2012    |
| Total Depth:             | 30 ft                               | Soil Depth:           | 30.0 ft    | Core Depth:     | ft         | Date Completed: | 10/9/2012    |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |            | Liner Required: | Y (N)      | Liner Used:     | Y (N)        |
| Drill Machine:           | CME 45C                             | Drill Method:         | HSA        | Hammer Type:    | Automatic  | Energy Ratio:   | 86%          |
| Core Size:               |                                     | Driller:              | M. Frazier | Groundwater:    | TOB        | 24HR            |              |



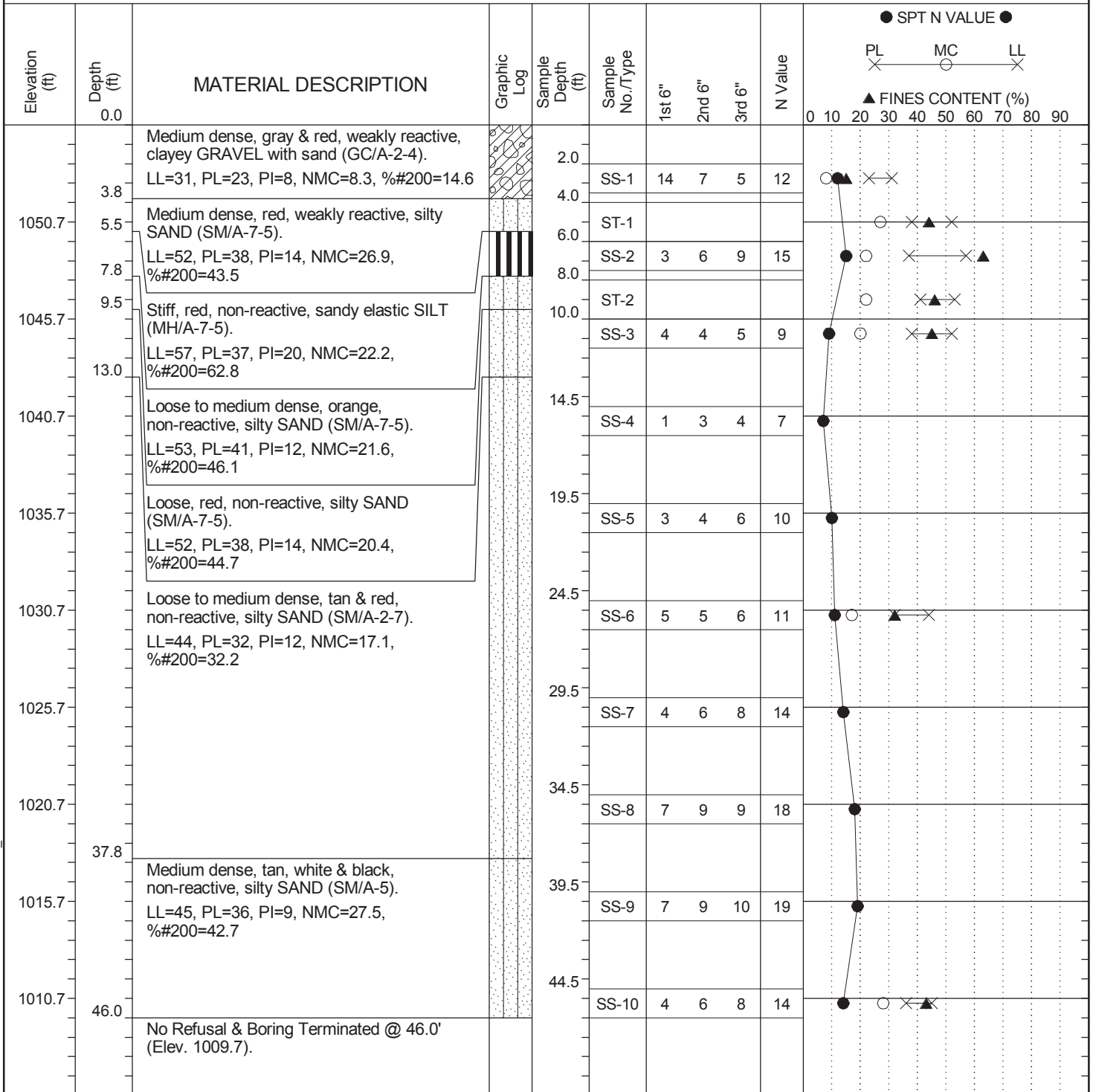
## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |



# SCDOT Soil Test Boring Log

|                          |                                     |                       |            |                 |            |                 |           |
|--------------------------|-------------------------------------|-----------------------|------------|-----------------|------------|-----------------|-----------|
| File No.:                | 23.038111                           | Project No. (PIN):    |            | County:         | Greenville | Eng./Geo.:      | S. Berry  |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |            |                 |            | Route:          |           |
| Boring No.:              | B-44                                | Boring Location:      | 431+86     | Offset:         | 135' Rt.   | Alignment:      | I-385     |
| Elev.:                   | 1055.7 ft                           | Latitude:             | 34.83648   | Longitude:      | 82.30706   | Date Started:   | 10/7/2012 |
| Total Depth:             | 46 ft                               | Soil Depth:           | 46.0 ft    | Core Depth:     | ft         | Date Completed: | 10/7/2012 |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |            | Liner Required: | Y (N)      | Liner Used:     | Y (N)     |
| Drill Machine:           | CME 45C                             | Drill Method:         | HSA        | Hammer Type:    | Automatic  | Energy Ratio:   | 82%       |
| Core Size:               | NA                                  | Driller:              | C. Banning | Groundwater:    | TOB        | 24HR            |           |

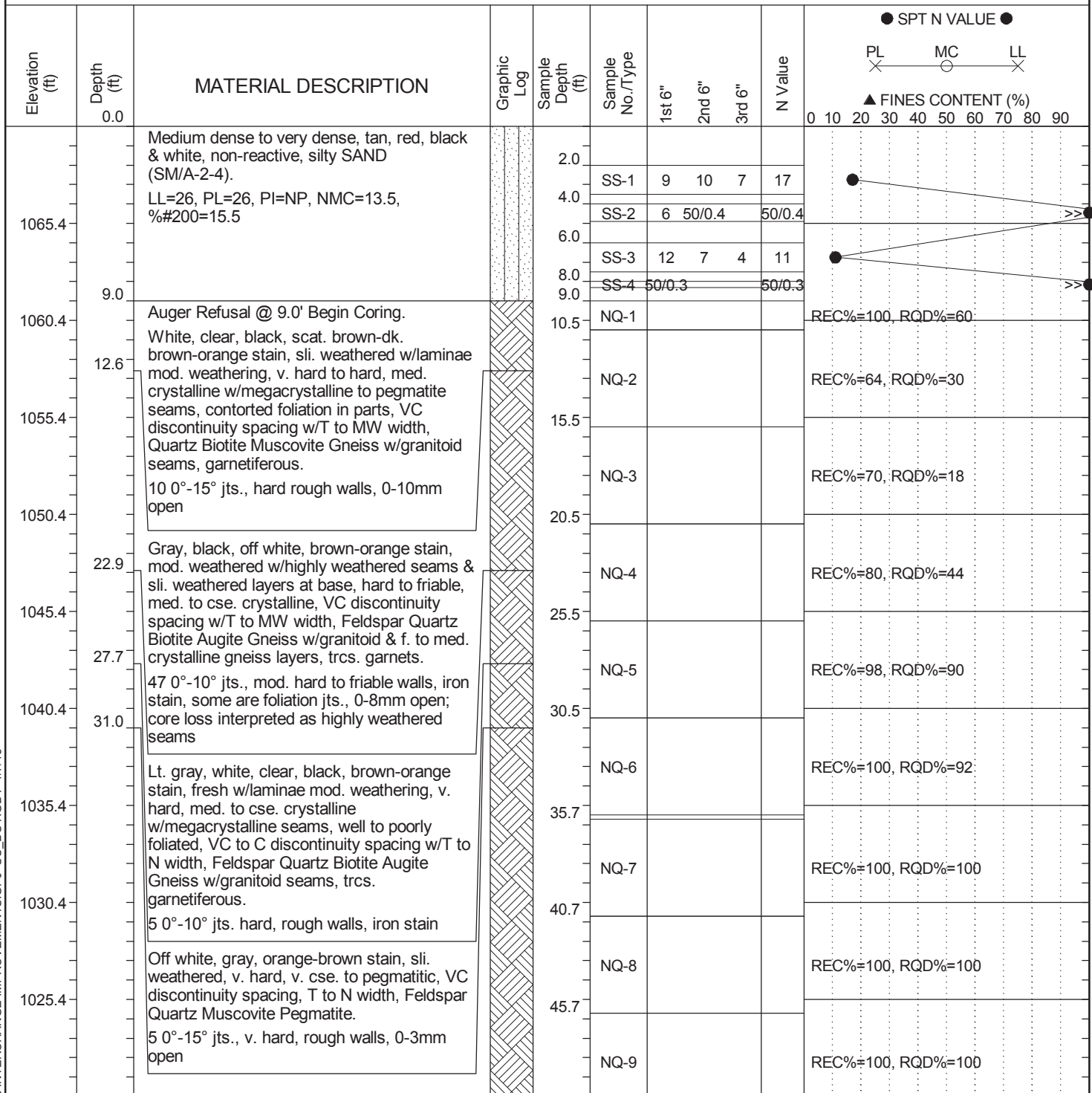


## LEGEND

| SAMPLER TYPE |                     | DRILLING METHOD |                            |
|--------------|---------------------|-----------------|----------------------------|
| SS           | - Split Spoon       | HSA             | - Hollow Stem Auger        |
| ST           | - Shelby Tube       | CFA             | - Continuous Flight Augers |
| AWG          | - Rock Core, 1-1/8" | DC              | - Driving Casing           |
| NQ           | - Rock Core, 1-7/8" | RW              | - Rotary Wash              |
| CU           | - Cuttings          | RC              | - Rock Core                |
| CT           | - Continuous Tube   |                 |                            |

# SCDOT Soil Test Boring Log

|                          |                                     |                       |            |                 |            |                 |            |
|--------------------------|-------------------------------------|-----------------------|------------|-----------------|------------|-----------------|------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |            | County:         | Greenville | Eng./Geo.:      | R. DeLost  |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |            |                 |            | Route:          |            |
| Boring No.:              | B-45                                | Boring Location:      | 439+42     | Offset:         | 136' Rt.   | Alignment:      | I-385      |
| Elev.:                   | 1070.4 ft                           | Latitude:             | 34.83741   | Longitude:      | 82.30931   | Date Started:   | 10/31/2012 |
| Total Depth:             | 55.7 ft                             | Soil Depth:           | 9 ft       | Core Depth:     | 55.7 ft    | Date Completed: | 11/1/2012  |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |            | Liner Required: | Y (N)      | Liner Used:     | Y (N)      |
| Drill Machine:           | CME 45C                             | Drill Method:         | HSA        | Hammer Type:    | Automatic  | Energy Ratio:   | 79%        |
| Core Size:               | NQ2                                 | Driller:              | F. Woodard | Groundwater:    | TOB        | 24HR            |            |



## LEGEND

Continued Next Page

SC\_DOT I-85 I-385 INTERCHANGE IMPROVEMENTS.GPJ SC\_DOT.GDT 1/7/13

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                                 |                                     |                              |            |                        |            |                        |            |
|---------------------------------|-------------------------------------|------------------------------|------------|------------------------|------------|------------------------|------------|
| <b>File No.:</b>                | 23.038111                           | <b>Project No. (PIN):</b>    |            | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | R. DeLost  |
| <b>Site Description:</b>        | I-85/I-385 Interchange Improvements |                              |            |                        |            | <b>Route:</b>          |            |
| <b>Boring No.:</b>              | B-45                                | <b>Boring Location:</b>      | 439+42     | <b>Offset:</b>         | 136' Rt.   | <b>Alignment:</b>      | I-385      |
| <b>Elev.:</b>                   | 1070.4 ft                           | <b>Latitude:</b>             | 34.83741   | <b>Longitude:</b>      | 82.30931   | <b>Date Started:</b>   | 10/31/2012 |
| <b>Total Depth:</b>             | 55.7 ft                             | <b>Soil Depth:</b>           | 9 ft       | <b>Core Depth:</b>     | 55.7 ft    | <b>Date Completed:</b> | 11/1/2012  |
| <b>Bore Hole Diameter (in):</b> | 4                                   | <b>Sampler Configuration</b> |            | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)      |
| <b>Drill Machine:</b>           | CME 45C                             | <b>Drill Method:</b>         | HSA        | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 79%        |
| <b>Core Size:</b>               | NQ2                                 | <b>Driller:</b>              | F. Woodard | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |            |

| Elevation (ft) | Depth (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE ●</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%)</div> <div>0 10 20 30 40 50 60 70 80 90</div> </div> |
|----------------|------------|---|-------------|-------------------|-----------------|--------|--------|--------|---------|---|
| 1015.4         | 55.7       | White, lt. gray, clear, black, brown-orange stain in upper part, fresh, v. hard, med. to cse. crystalline w/v. cse. crystalline seams & augen, well to poorly foliated, VC to C discontinuity spacing w/T width, Quartz Feldspar Biotite Gneiss w/granitoid augen & seams, garnetiferous in parts.<br>11 0°-10° jts.. hard, rough walls, some w/faint stain, tight; granitoid seams 42.3'-42.8' & 51.1'-51.8' |             | 50.7              | NQ-10           |        |        |        |         | <div>REC%=96, RQD%=96</div>   |
| 1010.4         |            | Boring Terminated @ 55.7' (Elev. 1014.7).   |             |                   |                 |        |        |        |         |   |
| 1005.4         |            |   |             |                   |                 |        |        |        |         |   |
| 1000.4         |            |   |             |                   |                 |        |        |        |         |   |
| 995.4          |            |   |             |                   |                 |        |        |        |         |   |
| 990.4          |            |   |             |                   |                 |        |        |        |         |   |
| 985.4          |            |   |             |                   |                 |        |        |        |         |   |
| 980.4          |            |   |             |                   |                 |        |        |        |         |   |
| 975.4          |            |   |             |                   |                 |        |        |        |         |   |

## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |



# CORE PHOTOGRAPHIC RECORD

## I-85 / I-385 Interchange Improvements



**B-45 Box 1 of 5**

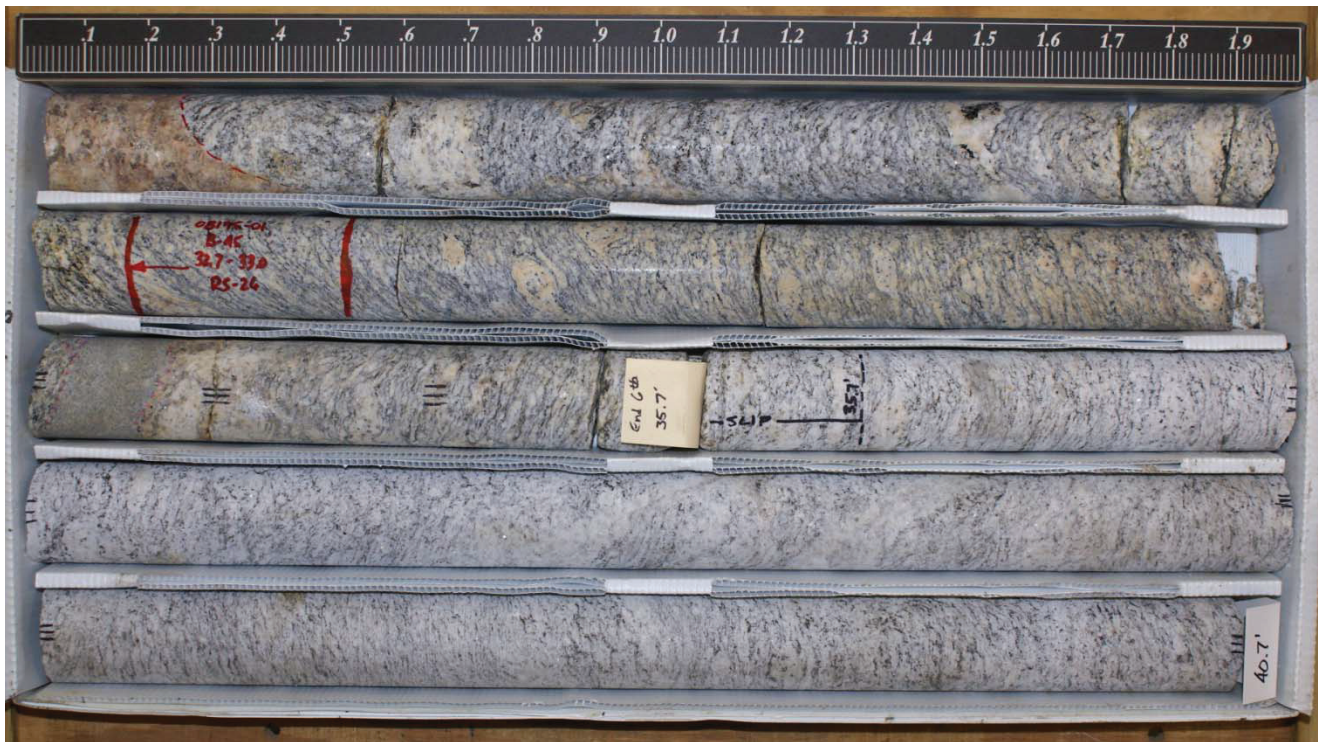


**B-45 Box 2 of 5**

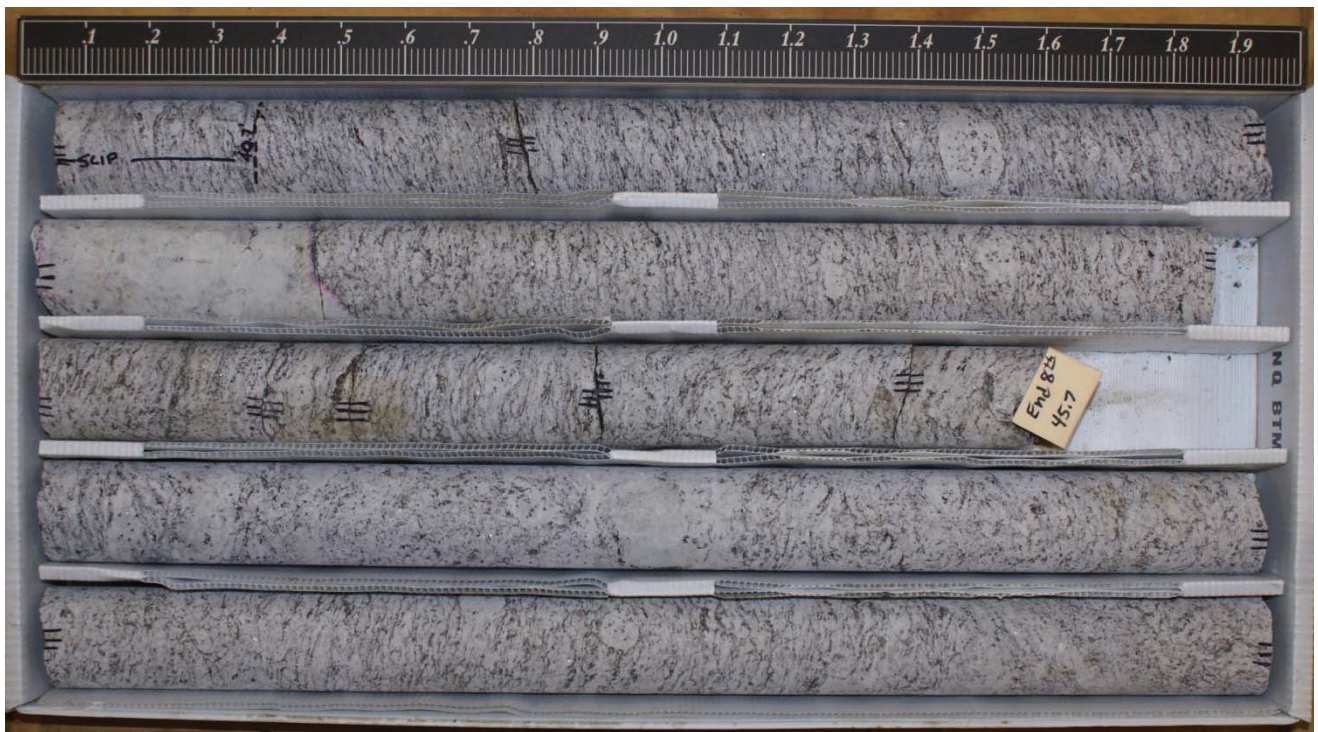


# CORE PHOTOGRAPHIC RECORD

## I-85 / I-385 Interchange Improvements



**B-45 Box 3 of 5**



**B-45 Box 4 of 5**



# CORE PHOTOGRAPHIC RECORD

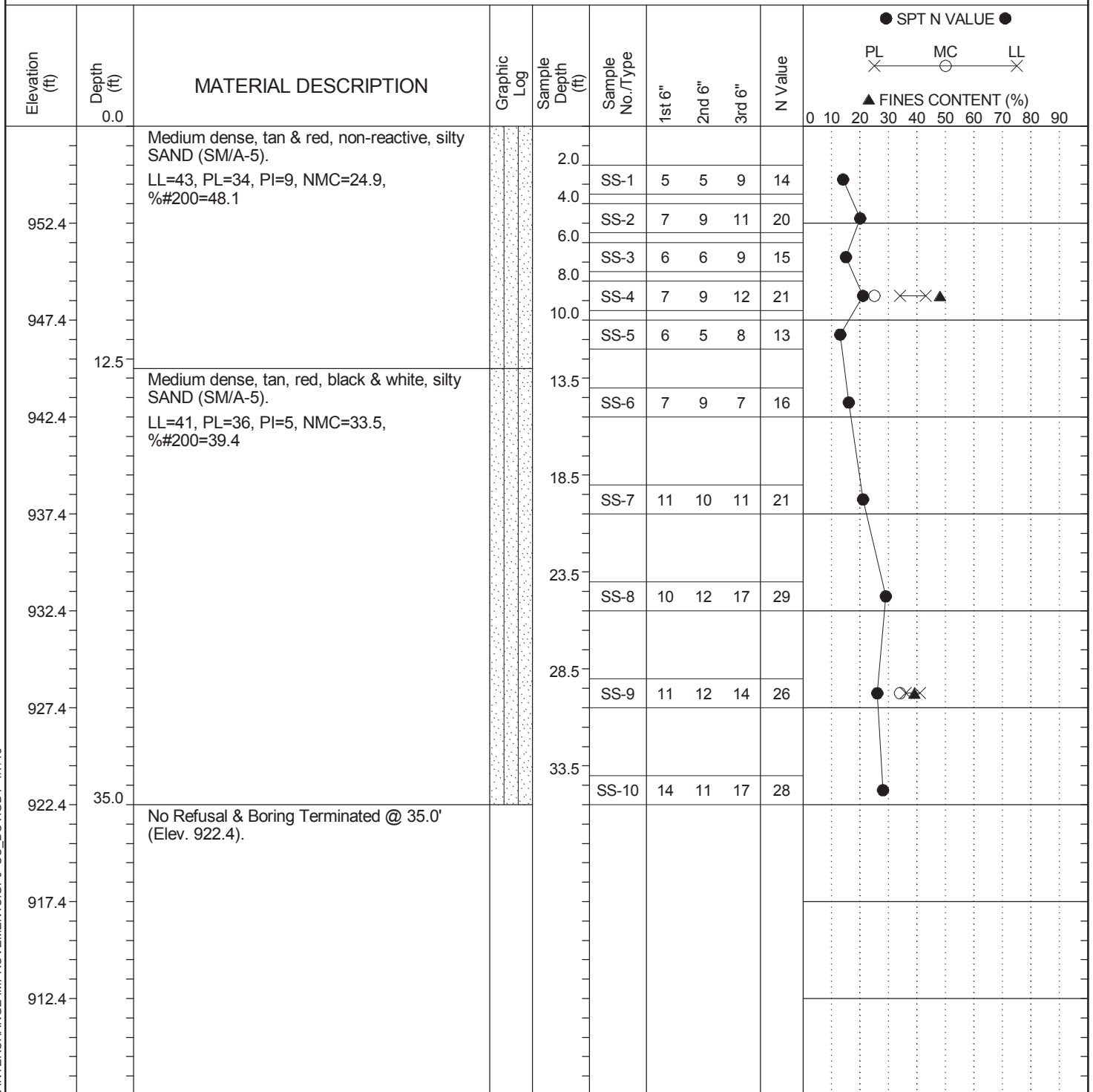
## I-85 / I-385 Interchange Improvements



**B-45 Box 5 of 5**

# SCDOT Soil Test Boring Log

|                          |                                     |                       |            |                 |            |                 |              |
|--------------------------|-------------------------------------|-----------------------|------------|-----------------|------------|-----------------|--------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |            | County:         | Greenville | Eng./Geo.:      | S. Berry     |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |            |                 |            | Route:          |              |
| Boring No.:              | B-47                                | Boring Location:      | 120+03     | Offset:         | 70' Rt.    | Alignment:      | I-385 SB C/D |
| Elev.:                   | 957.4 ft                            | Latitude:             | 34.82263   | Longitude:      | 82.29204   | Date Started:   | 10/7/2012    |
| Total Depth:             | 35 ft                               | Soil Depth:           | 35.0 ft    | Core Depth:     | ft         | Date Completed: | 10/7/2012    |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |            | Liner Required: | Y (N)      | Liner Used:     | Y (N)        |
| Drill Machine:           | CME 45C                             | Drill Method:         | HSA        | Hammer Type:    | Automatic  | Energy Ratio:   | 79%          |
| Core Size:               | NA                                  | Driller:              | C. Frazier | Groundwater:    | TOB        | 24HR            |              |



## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                                 |                                     |                              |            |                        |            |                        |           |
|---------------------------------|-------------------------------------|------------------------------|------------|------------------------|------------|------------------------|-----------|
| <b>File No.:</b>                | 23.038111                           | <b>Project No. (PIN):</b>    |            | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | S. Berry  |
| <b>Site Description:</b>        | I-85/I-385 Interchange Improvements |                              |            |                        |            | <b>Route:</b>          |           |
| <b>Boring No.:</b>              | B-60                                | <b>Boring Location:</b>      | 324+88     | <b>Offset:</b>         | 84' Lt.    | <b>Alignment:</b>      | I-385     |
| <b>Elev.:</b>                   | 913.7 ft                            | <b>Latitude:</b>             | 34.81406   | <b>Longitude:</b>      | 82.28929   | <b>Date Started:</b>   | 10/8/2012 |
| <b>Total Depth:</b>             | 9.5 ft                              | <b>Soil Depth:</b>           | 9.5 ft     | <b>Core Depth:</b>     | ft         | <b>Date Completed:</b> | 10/8/2012 |
| <b>Bore Hole Diameter (in):</b> | 4                                   | <b>Sampler Configuration</b> |            | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)     |
| <b>Drill Machine:</b>           | CME 45C                             | <b>Drill Method:</b>         | HSA        | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 86%       |
| <b>Core Size:</b>               | NA                                  | <b>Driller:</b>              | M. Frazier | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |           |

| Elevation (ft) | Depth (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> ● SPT N VALUE ● </div> <div> PL      MC      LL </div> <div> ▲ FINES CONTENT (%) </div> |
|----------------|------------|---|-------------|-------------------|-----------------|--------|--------|--------|---------|---|
| 908.7          | 0.0        | Loose, tan & white, non-reactive, silty SAND (SM/A-2-5).<br>LL=41, PL=36, PI=5, NMC=24.5, % <sub>#200</sub> =33.0 |             | 2.0               |                 |        |        |        |         |   |
|                |            |   |             | 4.0               | SS-1            | 3      | 5      | 3      | 8       |   |
|                |            |   |             | 6.0               | SS-2            | 4      | 4      | 4      | 8       |   |
|                |            |   |             | 8.0               | SS-3            | 3      | 3      | 4      | 7       |   |
| 903.7          | 9.5        | No Refusal & Boring Terminated @ 9.5' (Elev. 904.2).  |             |                   | SS-4            | 3      | 4      | 5      | 9       |   |
| 898.7          |            |   |             |                   |                 |        |        |        |         |   |
| 893.7          |            |   |             |                   |                 |        |        |        |         |   |
| 888.7          |            |   |             |                   |                 |        |        |        |         |   |
| 883.7          |            |   |             |                   |                 |        |        |        |         |   |
| 878.7          |            |   |             |                   |                 |        |        |        |         |   |
| 873.7          |            |   |             |                   |                 |        |        |        |         |   |
| 868.7          |            |   |             |                   |                 |        |        |        |         |   |

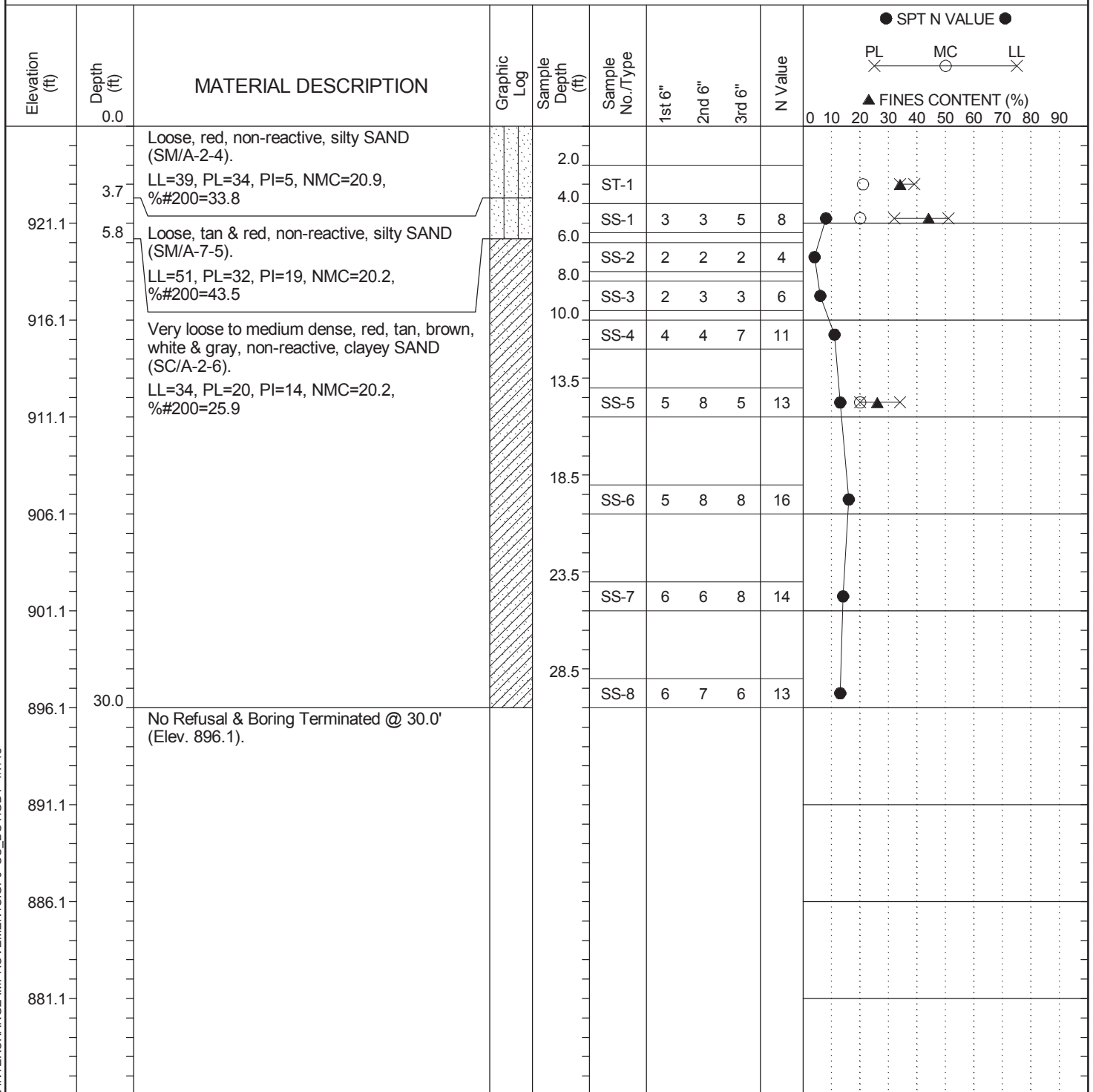
## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |



# SCDOT Soil Test Boring Log

|                          |                                     |                       |            |                 |            |                 |              |
|--------------------------|-------------------------------------|-----------------------|------------|-----------------|------------|-----------------|--------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |            | County:         | Greenville | Eng./Geo.:      | S. Berry     |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |            |                 |            | Route:          |              |
| Boring No.:              | B-61                                | Boring Location:      | 332+58     | Offset:         | 20' Rt.    | Alignment:      | I-385 NB C/D |
| Elev.:                   | 926.1 ft                            | Latitude:             | 34.81617   | Longitude:      | 82.28983   | Date Started:   | 10/9/2012    |
| Total Depth:             | 30 ft                               | Soil Depth:           | 30.0 ft    | Core Depth:     | ft         | Date Completed: | 10/9/2012    |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |            | Liner Required: | Y (N)      | Liner Used:     | Y (N)        |
| Drill Machine:           | CME 45C                             | Drill Method:         | HSA        | Hammer Type:    | Automatic  | Energy Ratio:   | 86%          |
| Core Size:               | NA                                  | Driller:              | M. Frazier | Groundwater:    | TOB        | 24HR            |              |



## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                                 |                                     |                              |            |                        |            |                        |              |
|---------------------------------|-------------------------------------|------------------------------|------------|------------------------|------------|------------------------|--------------|
| <b>File No.:</b>                | 23.038111                           | <b>Project No. (PIN):</b>    |            | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | S. Berry     |
| <b>Site Description:</b>        | I-85/I-385 Interchange Improvements |                              |            |                        |            | <b>Route:</b>          |              |
| <b>Boring No.:</b>              | B-62                                | <b>Boring Location:</b>      | 349+94     | <b>Offset:</b>         | 19' Lt.    | <b>Alignment:</b>      | I-385 NB C/D |
| <b>Elev.:</b>                   | 935.7 ft                            | <b>Latitude:</b>             | 34.82084   | <b>Longitude:</b>      | 82.29095   | <b>Date Started:</b>   | 10/8/2012    |
| <b>Total Depth:</b>             | 10 ft                               | <b>Soil Depth:</b>           | 10.0 ft    | <b>Core Depth:</b>     | ft         | <b>Date Completed:</b> | 10/8/2012    |
| <b>Bore Hole Diameter (in):</b> | 4                                   | <b>Sampler Configuration</b> |            | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)        |
| <b>Drill Machine:</b>           | CME 45C                             | <b>Drill Method:</b>         | HSA        | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 79%          |
| <b>Core Size:</b>               | NA                                  | <b>Driller:</b>              | C. Frazier | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |              |

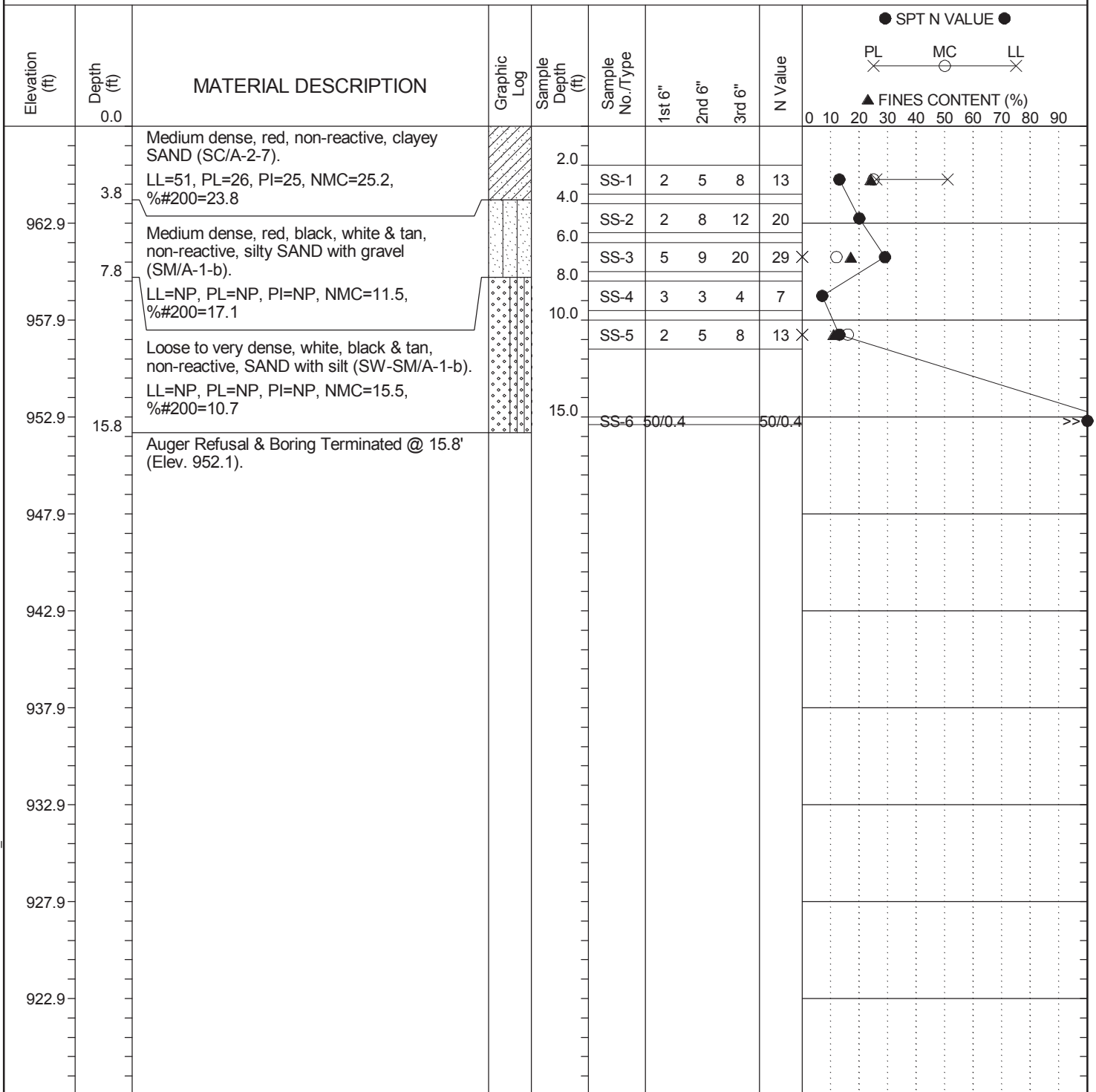
| Elevation (ft) | Depth (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> ● SPT N VALUE ● </div> <div> PL MC LL </div> <div> ▲ FINES CONTENT (%) </div> |
|----------------|------------|--|-------------|-------------------|-----------------|--------|--------|--------|---------|---|
| 930.7          | 0.0        | Stiff to very stiff, red, tan & brown, non-reactive, sandy SILT (ML/A-4).<br>LL=39, PL=31, PI=8, NMC=30.3, %200=70.1 |             | 1.0               | SS-1            | 6      | 5      | 8      | 13      |   |
|                |            |  |             | 3.5               | SS-2            | 7      | 7      | 10     | 17      |   |
|                |            |  |             | 6.0               | SS-3            | 7      | 9      | 4      | 13      |   |
| 925.7          | 10.0       | No Refusal & Boring Terminated @ 10.0' (Elev. 925.6).  |             | 8.5               | SS-4            | 8      | 9      | 13     | 22      |   |
| 920.7          |            |  |             |                   |                 |        |        |        |         |   |
| 915.7          |            |  |             |                   |                 |        |        |        |         |   |
| 910.7          |            |  |             |                   |                 |        |        |        |         |   |
| 905.7          |            |  |             |                   |                 |        |        |        |         |   |
| 900.7          |            |  |             |                   |                 |        |        |        |         |   |
| 895.7          |            |  |             |                   |                 |        |        |        |         |   |
| 890.7          |            |  |             |                   |                 |        |        |        |         |   |

## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                                 |                                     |                              |            |                        |            |                        |              |
|---------------------------------|-------------------------------------|------------------------------|------------|------------------------|------------|------------------------|--------------|
| <b>File No.:</b>                | 23.038111                           | <b>Project No. (PIN):</b>    |            | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | R. DeLost    |
| <b>Site Description:</b>        | I-85/I-385 Interchange Improvements |                              |            |                        |            | <b>Route:</b>          |              |
| <b>Boring No.:</b>              | B-66                                | <b>Boring Location:</b>      | 369+87     | <b>Offset:</b>         | 16' Lt.    | <b>Alignment:</b>      | I-385 NB C/D |
| <b>Elev.:</b>                   | 967.9 ft                            | <b>Latitude:</b>             | 34.82623   | <b>Longitude:</b>      | 82.292     | <b>Date Started:</b>   | 10/17/2012   |
| <b>Total Depth:</b>             | 15.8 ft                             | <b>Soil Depth:</b>           | 15.8 ft    | <b>Core Depth:</b>     | ft         | <b>Date Completed:</b> | 10/17/2012   |
| <b>Bore Hole Diameter (in):</b> | 4                                   | <b>Sampler Configuration</b> |            | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)        |
| <b>Drill Machine:</b>           | CME 45C                             | <b>Drill Method:</b>         | HSA        | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 79%          |
| <b>Core Size:</b>               | NA                                  | <b>Driller:</b>              | F. Woodard | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |              |

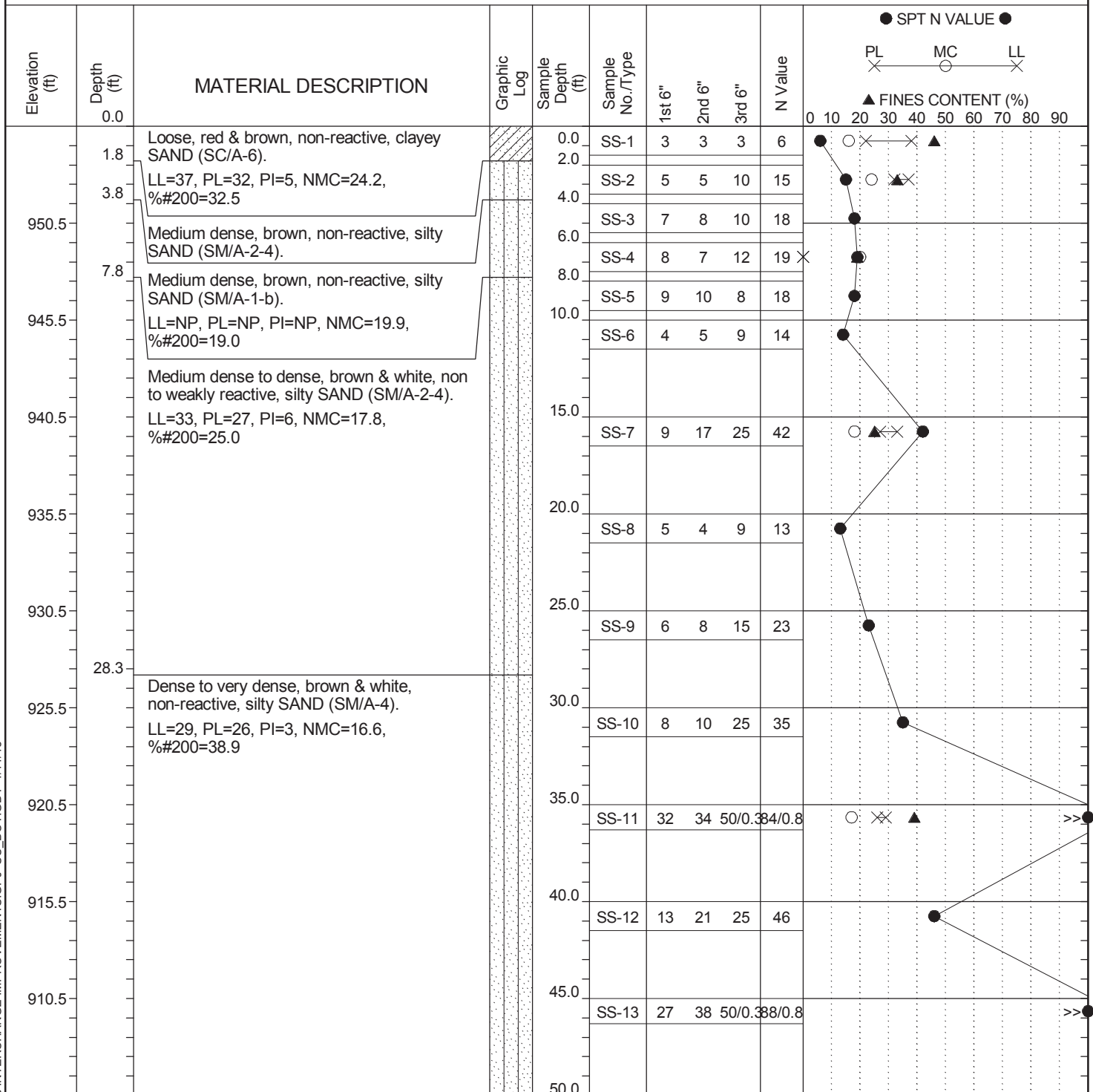


## LEGEND

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                          |                                     |                       |          |                 |            |                 |              |
|--------------------------|-------------------------------------|-----------------------|----------|-----------------|------------|-----------------|--------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |          | County:         | Greenville | Eng./Geo.:      | J. Patterson |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |          |                 |            | Route:          |              |
| Boring No.:              | B-3                                 | Boring Location:      | 359+28   | Offset:         | 18' Rt.    | Alignment:      | I-385 NB C/D |
| Elev.:                   | 955.5 ft                            | Latitude:             | 34.82341 | Longitude:      | 82.29118   | Date Started:   | 5/21/2012    |
| Total Depth:             | 100.3 ft                            | Soil Depth:           | 100.3 ft | Core Depth:     | 95.0 ft    | Date Completed: | 5/25/2012    |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |          | Liner Required: | Y (N)      | Liner Used:     | Y (N)        |
| Drill Machine:           | CME 550                             | Drill Method:         | RC       | Hammer Type:    | Automatic  | Energy Ratio:   | 77%          |
| Core Size:               | NQ2                                 | Driller:              | SCI      | Groundwater:    | TOB        | 24HR            |              |



LEGEND

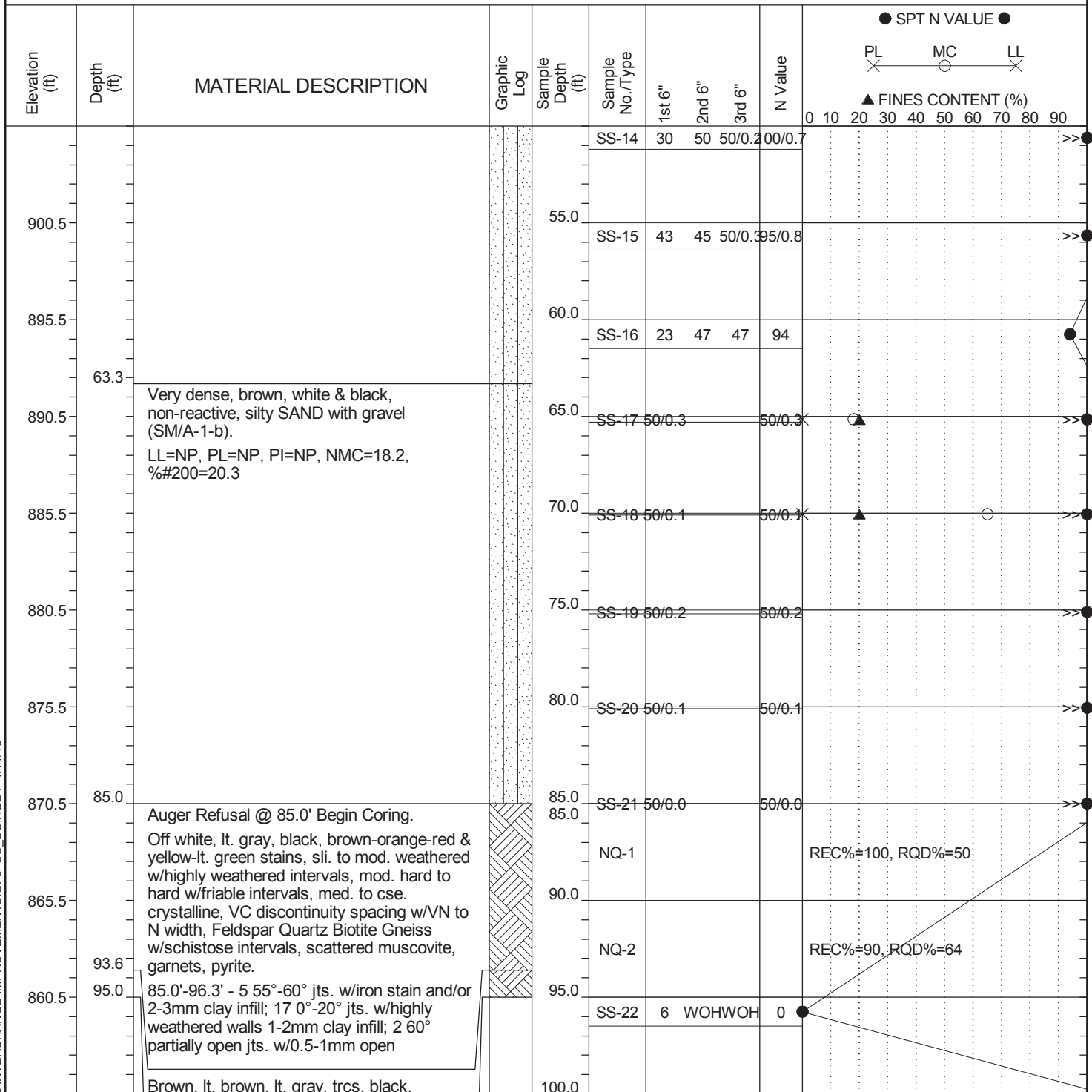
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SC\_DOT I-85 I-385 INTERCHANGE IMPROVEMENTS.GPJ SC\_DOT.GDT 1/11/13

| SAMPLER TYPE            |                        | DRILLING METHOD                |                  |
|-------------------------|------------------------|--------------------------------|------------------|
| SS - Split Spoon        | NQ - Rock Core, 1-7/8" | HSA - Hollow Stem Auger        | RW - Rotary Wash |
| ST - Shelby Tube        | CU - Cuttings          | CFA - Continuous Flight Augers | RC - Rock Core   |
| AWG - Rock Core, 1-1/8" | CT - Continuous Tube   | DC - Driving Casing            |                  |

# SCDOT Soil Test Boring Log

|                          |                                     |                       |          |                 |            |                 |              |
|--------------------------|-------------------------------------|-----------------------|----------|-----------------|------------|-----------------|--------------|
| File No.:                | 23.038111                           | Project No. (PIN):    |          | County:         | Greenville | Eng./Geo.:      | J. Patterson |
| Site Description:        | I-85/I-385 Interchange Improvements |                       |          |                 |            | Route:          |              |
| Boring No.:              | B-3                                 | Boring Location:      | 359+28   | Offset:         | 18' Rt.    | Alignment:      | I-385 NB C/D |
| Elev.:                   | 955.5 ft                            | Latitude:             | 34.82341 | Longitude:      | 82.29118   | Date Started:   | 5/21/2012    |
| Total Depth:             | 100.3 ft                            | Soil Depth:           | 100.3 ft | Core Depth:     | 95.0 ft    | Date Completed: | 5/25/2012    |
| Bore Hole Diameter (in): | 4                                   | Sampler Configuration |          | Liner Required: | Y (N)      | Liner Used:     | Y (N)        |
| Drill Machine:           | CME 550                             | Drill Method:         | RC       | Hammer Type:    | Automatic  | Energy Ratio:   | 77%          |
| Core Size:               | NQ2                                 | Driller:              | SCI      | Groundwater:    | TOB        | 24HR            |              |



LEGEND

Continued Next Page

# SCDOT Soil Test Boring Log

|                                 |           |                                     |          |                        |            |                        |              |
|---------------------------------|-----------|-------------------------------------|----------|------------------------|------------|------------------------|--------------|
| <b>File No.:</b>                | 23.038111 | <b>Project No. (PIN):</b>           |          | <b>County:</b>         | Greenville | <b>Eng./Geo.:</b>      | J. Patterson |
| <b>Site Description:</b>        |           | I-85/I-385 Interchange Improvements |          |                        |            | <b>Route:</b>          |              |
| <b>Boring No.:</b>              | B-3       | <b>Boring Location:</b>             | 359+28   | <b>Offset:</b>         | 18' Rt.    | <b>Alignment:</b>      | I-385 NB C/D |
| <b>Elev.:</b>                   | 955.5 ft  | <b>Latitude:</b>                    | 34.82341 | <b>Longitude:</b>      | 82.29118   | <b>Date Started:</b>   | 5/21/2012    |
| <b>Total Depth:</b>             | 100.3 ft  | <b>Soil Depth:</b>                  | 100.3 ft | <b>Core Depth:</b>     | 95.0 ft    | <b>Date Completed:</b> | 5/25/2012    |
| <b>Bore Hole Diameter (in):</b> | 4         | <b>Sampler Configuration</b>        |          | <b>Liner Required:</b> | Y (N)      | <b>Liner Used:</b>     | Y (N)        |
| <b>Drill Machine:</b>           | CME 550   | <b>Drill Method:</b>                | RC       | <b>Hammer Type:</b>    | Automatic  | <b>Energy Ratio:</b>   | 77%          |
| <b>Core Size:</b>               | NQ2       | <b>Driller:</b>                     | SCI      | <b>Groundwater:</b>    | TOB        | <b>24HR</b>            |              |

| Elevation (ft) | Depth (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE ●</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%)</div> </div> |
|----------------|------------|--|-------------|-------------------|-----------------|--------|--------|--------|---------|---|
| 850.5          | 100.3      | yellow-lt. green stain, widely scattered pink-rose & off white, highly weathered, mod. hard to friable, f. to med. crystalline w/cse. crystalline grains, VC discontinuity spacing, Biotite Feldspar Quartz Schist w/scattered muscovite & garnets.<br>93.6'-95.0' discontinuity pattern not apparent; interpreted core loss between 93.6' & 94.8'<br>Coring Terminated @ 95.0' Return to Auger & Sample.<br>SS-22 & SS-23 resulted in No Recovery<br>No Refusal & Boring Terminated @ 100.3' (Elev. 855.2). |             |                   | SS-23           | 50/0.3 |        |        | 50/0.3  |   |
| 845.5          |            |  |             |                   |                 |        |        |        |         |   |
| 840.5          |            |  |             |                   |                 |        |        |        |         |   |
| 835.5          |            |  |             |                   |                 |        |        |        |         |   |
| 830.5          |            |  |             |                   |                 |        |        |        |         |   |
| 825.5          |            |  |             |                   |                 |        |        |        |         |   |
| 820.5          |            |  |             |                   |                 |        |        |        |         |   |
| 815.5          |            |  |             |                   |                 |        |        |        |         |   |
| 810.5          |            |  |             |                   |                 |        |        |        |         |   |

## LEGEND

| SAMPLER TYPE |                     |                        | DRILLING METHOD |                            |
|--------------|---------------------|------------------------|-----------------|----------------------------|
| SS           | - Split Spoon       | NQ - Rock Core, 1-7/8" | HSA             | - Hollow Stem Auger        |
| ST           | - Shelby Tube       | CU - Cuttings          | CFA             | - Continuous Flight Augers |
| AWG          | - Rock Core, 1-1/8" | CT - Continuous Tube   | DC              | - Driving Casing           |
|              |                     |                        | RW              | - Rotary Wash              |
|              |                     |                        | RC              | - Rock Core                |

SC\_DOT I-85 I-385 INTERCHANGE IMPROVEMENTS.GPJ SC\_DOT.GDT 1/11/13



# CORE PHOTOGRAPHIC RECORD

## I-85 / I-385 Interchange Improvements



**B-3 Box 1 of 1**



# Soil Test Boring Log

|                          |                                   |                       |            |                 |              |                 |                |
|--------------------------|-----------------------------------|-----------------------|------------|-----------------|--------------|-----------------|----------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009)  | County:         | Greenville   | Eng./Geo.:      | Justin Fancher |
| Site Description:        | I-85 and I-385 Interchange Design |                       |            |                 |              | Route:          | I-85 / I-385   |
| Boring No.:              | RCH-10                            | Boring Location:      | 31+90      | Offset:         | LT 24        | Alignment:      | Chrome         |
| Elev.:                   | 953.0 ft.                         | Latitude:             | 34.8366439 | Longitude:      | -82.29041817 | Date Started:   | 1/25/2015      |
| Total Depth:             | 39.0 ft.                          | Soil Depth:           | 39.0 ft.   | Core Depth:     | 0.0 ft.      | Date Completed: | 1/25/2015      |
| Bore Hole Diameter (in): | 3-7/8                             | Sampler Configuration |            | Liner Required: | No           | Liner Used:     | NA             |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR         | Hammer Type:    | Automatic    | Energy Ratio:   | 79%            |
| Core Size:               | NA                                | Driller:              | SCI        | Groundwater:    | TOB 33.0 ft. | 24 HR           | 32.0 ft.       |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | SPT N VALUE (blows / foot) | PL | MC | LL | FINES CONTENT (%) |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|----------------------------|----|----|----|-------------------|
| 0.0        |                |  |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
|            |                | Approximately 5 inches of topsoil.   |             | 0.0                | SS S-1          | 1      | 1      | 2      | 3       | ●                          |    |    |    |                   |
|            |                | Very loose, moist, red and brown, fine to medium grained, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=22.2 % <sub>#200</sub> =45.1                      |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
|            | 950.0          | Very stiff, moist, red and light brown, SANDY ELASTIC SILT (MH, A-7-5(22)), RESIDUUM, LL=67 PL=37 PI=30 NMC=31.4 % <sub>#200</sub> =68.5                             |             | 2.0                | SS S-2          | 3      | 6      | 10     | 16      | ●                          | ○  | ×  |    | ▲                 |
| 5.0        |                | Dense, moist, red, fine grained, with mica, SILTY SAND (SM, A-2), RESIDUUM   |             | 4.0                | SS S-3          | 3      | 18     | 16     | 34      | ●                          |    |    |    |                   |
|            |                | Dense, moist, red, light brown and white, fine to medium grained, with mica, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=17.1 % <sub>#200</sub> =35.1 |             | 6.0                | SS S-4          | 11     | 18     | 18     | 36      | ○                          |    | ●  |    |                   |
|            | 945.0          | Dense, red and light brown, with mica, RESIDUUM  |             | 8.0                | SS S-5          | 9      | 21     | 20     | 41      | ●                          |    |    |    |                   |
| 10.0       |                | Medium dense, light brown and white, with mica, RESIDUUM   |             | 10.0               | SS S-6          | 5      | 7      | 9      | 16      | ●                          |    |    |    |                   |
|            | 940.0          | Medium dense, with mica, RESIDUUM  |             | 13.5               | SS S-7          | 3      | 7      | 8      | 15      | ●                          |    |    |    |                   |
| 15.0       |                |  |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
|            | 935.0          |  |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
| 20.0       |                | Medium dense, moist, white and light brown, fine to medium grained, with mica, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=25.6 % <sub>#200</sub> =36.8 |             | 18.5               | SS S-8          | 4      | 7      | 10     | 17      | ●                          | ○  |    | ▲  |                   |
|            | 930.0          |  |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
| 25.0       |                | Medium dense, with mica and trace gravel, RESIDUUM   |             | 23.5               | SS S-9          | 7      | 10     | 11     | 21      | ●                          |    |    |    |                   |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring



## Soil Test Boring Log

|                          |                                   |                       |            |                 |              |                 |                |
|--------------------------|-----------------------------------|-----------------------|------------|-----------------|--------------|-----------------|----------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009)  | County:         | Greenville   | Eng./Geo.:      | Justin Fancher |
| Site Description:        | I-85 and I-385 Interchange Design |                       |            |                 |              | Route:          | I-85 / I-385   |
| Boring No.:              | RCH-10                            | Boring Location:      | 31+90      | Offset:         | LT 24        | Alignment:      | Chrome         |
| Elev.:                   | 953.0 ft.                         | Latitude:             | 34.8366439 | Longitude:      | -82.29041817 | Date Started:   | 1/25/2015      |
| Total Depth:             | 39.0 ft.                          | Soil Depth:           | 39.0 ft.   | Core Depth:     | 0.0 ft.      | Date Completed: | 1/25/2015      |
| Bore Hole Diameter (in): | 3-7/8                             | Sampler Configuration |            | Liner Required: | No           | Liner Used:     | NA             |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR         | Hammer Type:    | Automatic    | Energy Ratio:   | 79%            |
| Core Size:               | NA                                | Driller:              | SCI        | Groundwater:    | TOB 33.0 ft. | 24 HR           | 32.0 ft.       |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | SPT N VALUE (blows / foot) | PL | MC | LL | FINES CONTENT (%) |
|------------|----------------|---|-------------|--------------------|-----------------|--------|--------|--------|---------|----------------------------|----|----|----|-------------------|
| 25.0       |                |   |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
|            | 925.0          |   |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
| 30.0       |                | Dense, with mica, RESIDUUM  |             | 28.5               | SS S-10         | 10     | 18     | 32     | 50      |                            |    |    |    |                   |
|            | 920.0          |   |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
| 35.0       |                | Very dense, wet, light brown, fine to medium grained, with mica, RESIDUUM |             | 33.5               | SS S-11         | 8      | 21     | 30     | 51      |                            |    |    |    |                   |
|            | 915.0          |   |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
|            |                | Very dense, with mica, PARTIALLY WEATHERED ROCK                           |             | 38.5               | SS S-12         | 48     | 50/4   | X      | 50/4    |                            |    |    |    |                   |
|            |                | Boring Terminated at 39.0 feet.   |             |                    |                 |        |        |        |         |                            |    |    |    |                   |

### LEGEND

#### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

#### DRILLING METHOD

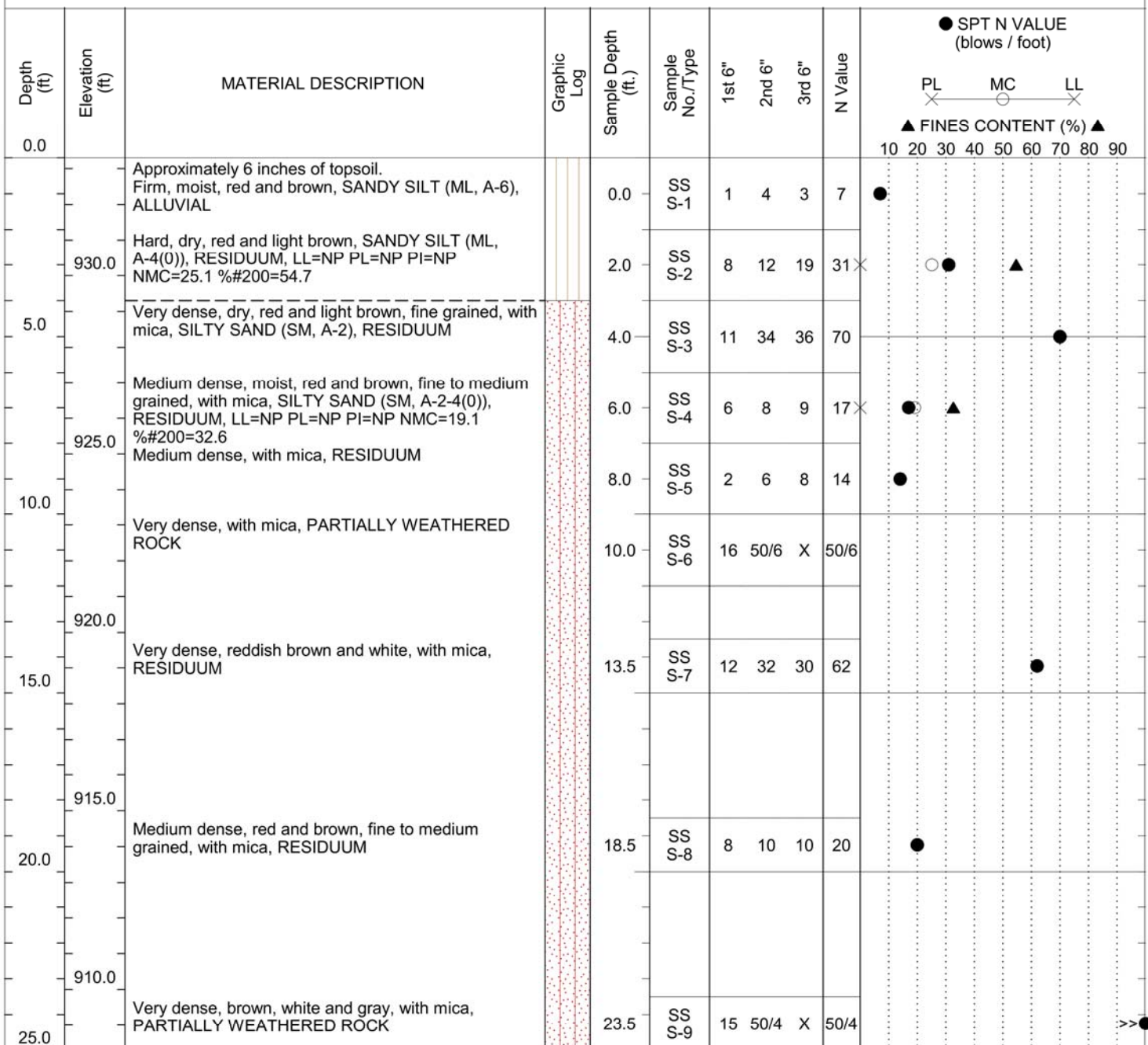
HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring





## Soil Test Boring Log

|                          |                                   |                       |             |                 |              |                 |                |
|--------------------------|-----------------------------------|-----------------------|-------------|-----------------|--------------|-----------------|----------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009)   | County:         | Greenville   | Eng./Geo.:      | Justin Fancher |
| Site Description:        | I-85 and I-385 Interchange Design |                       |             |                 |              | Route:          | I-85 / I-385   |
| Boring No.:              | W2A-1R-01                         | Boring Location:      | 107+12      | Offset:         | RT 19        | Alignment:      | I-85 NB / CD   |
| Elev.:                   | 933.3 ft.                         | Latitude:             | 34.83743071 | Longitude:      | -82.28930902 | Date Started:   | 3/29/2015      |
| Total Depth:             | 35.0 ft.                          | Soil Depth:           | 35.0 ft.    | Core Depth:     | 0.0 ft.      | Date Completed: | 3/29/2015      |
| Bore Hole Diameter (in): | 3-7/8                             | Sampler Configuration |             | Liner Required: | No           | Liner Used:     | NA             |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR          | Hammer Type:    | Automatic    | Energy Ratio:   | 79%            |
| Core Size:               | NA                                | Driller:              | SCI         | Groundwater:    | TOB N.E.     | 24 HR           | N.O.           |



### LEGEND

#### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

#### DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring



## Soil Test Boring Log

|                          |                                   |                       |             |                 |              |                 |                |
|--------------------------|-----------------------------------|-----------------------|-------------|-----------------|--------------|-----------------|----------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009)   | County:         | Greenville   | Eng./Geo.:      | Justin Fancher |
| Site Description:        | I-85 and I-385 Interchange Design |                       |             |                 |              | Route:          | I-85 / I-385   |
| Boring No.:              | W2A-1R-01                         | Boring Location:      | 107+12      | Offset:         | RT 19        | Alignment:      | I-85 NB / CD   |
| Elev.:                   | 933.3 ft.                         | Latitude:             | 34.83743071 | Longitude:      | -82.28930902 | Date Started:   | 3/29/2015      |
| Total Depth:             | 35.0 ft.                          | Soil Depth:           | 35.0 ft.    | Core Depth:     | 0.0 ft.      | Date Completed: | 3/29/2015      |
| Bore Hole Diameter (in): | 3-7/8                             | Sampler Configuration |             | Liner Required: | No           | Liner Used:     | NA             |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR          | Hammer Type:    | Automatic    | Energy Ratio:   | 79%            |
| Core Size:               | NA                                | Driller:              | SCI         | Groundwater:    | TOB N.E.     | 24 HR           | N.O.           |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION                                  | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | SPT N VALUE (blows / foot) | PL | MC | LL | FINES CONTENT (%) |
|------------|----------------|---|-------------|--------------------|-----------------|--------|--------|--------|---------|----------------------------|----|----|----|-------------------|
| 25.0       |                |   |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
| 30.0       | 905.0          | Very dense, white, red and brown, with mica, RESIDUUM |             | 28.5               | SS S-10         | 4      | 9      | 47     | 56      |                            |    |    |    |                   |
| 35.0       | 900.0          | Dense, reddish brown, with mica, RESIDUUM             |             | 33.5               | SS S-11         | 6      | 13     | 19     | 32      |                            |    |    |    |                   |
|            |                | Boring Terminated at 35.0 feet.                       |             |                    |                 |        |        |        |         |                            |    |    |    |                   |

### LEGEND

#### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

#### DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring



# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | W2A-1R-02                         | <b>Boring Location:</b>      | 107+99      | <b>Offset:</b>         | RT 42        | <b>Alignment:</b>      | I-85 NB / CD  |
| <b>Elev.:</b>                   | 934.2 ft.                         | <b>Latitude:</b>             | 34.83753079 | <b>Longitude:</b>      | -82.28903519 | <b>Date Started:</b>   | 1/4/2015      |
| <b>Total Depth:</b>             | 45.0 ft.                          | <b>Soil Depth:</b>           | 45.0 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 1/4/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NA                                | <b>Driller:</b>              | SCI         | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 17.0 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|---|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 0.0        |                | Approximately 6 inches of topsoil. Loose, wet, reddish brown, weakly reactive, fine to medium grained, CLAYEY SAND (SC, A-6(2)), FILL, LL=31 PL=14 PI=17 NMC=22.7 % <sub>#200</sub> =39.0 Loose, FILL |             | 0.0                | SS S-1          | 1      | 1      | 2      | 3       | ●  |
|            |                |   |             | 2.0                | SS S-2          | 2      | 3      | 5      | 8       | ●  |
| 5.0        | 930.0          | Medium dense, moist, fine grained, FILL   |             | 4.0                | SS S-3          | 3      | 7      | 9      | 16      | ●  |
|            |                | Medium dense, FILL  |             | 6.0                | SS S-4          | 2      | 4      | 7      | 11      | ●  |
|            |                |   |             | 8.0                | SS S-5          | 3      | 5      | 6      | 11      | ●  |
| 10.0       | 925.0          | Medium dense, moist, brown and white, fine to medium grained, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=27.1 % <sub>#200</sub> =48.9 Loose, brown and white, RESIDUUM                  |             | 10.0               | SS S-6          | 3      | 5      | 5      | 10      | ●  |
|            |                |   |             | 13.5               | SS S-7          | 3      | 7      | 10     | 17      | ●  |
| 15.0       | 920.0          | Medium dense, fine grained, with trace gravel, RESIDUUM   |             | 18.5               | SS S-8          | 3      | 5      | 7      | 12      | ●  |
| 20.0       | 915.0          | Medium dense, moist, brown and white, weakly reactive, fine to medium grained, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=37.0 % <sub>#200</sub> =39.2                                  |             |                    |                 |        |        |        |         |  |
| 25.0       | 910.0          | Loose, brown, black and white, RESIDUUM   |             | 23.5               | SS S-9          | 3      | 4      | 6      | 10      | ●  |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring





# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | W2A-1R-02                         | <b>Boring Location:</b>      | 107+99      | <b>Offset:</b>         | RT 42        | <b>Alignment:</b>      | I-85 NB / CD  |
| <b>Elev.:</b>                   | 934.2 ft.                         | <b>Latitude:</b>             | 34.83753079 | <b>Longitude:</b>      | -82.28903519 | <b>Date Started:</b>   | 1/4/2015      |
| <b>Total Depth:</b>             | 45.0 ft.                          | <b>Soil Depth:</b>           | 45.0 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 1/4/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NA                                | <b>Driller:</b>              | SCI         | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 17.0 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|---|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 25.0       |                |   |             |                    |                 |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
| 30.0       | 905.0          | Loose, brown and white, with trace gravel, RESIDUUM   |             | 28.5               | SS S-10         | 2      | 2      | 8      | 10      | ●  |
| 35.0       | 900.0          | Medium dense, moist, brown and white, fine to medium grained, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=38.3 % <sub>#200</sub> =35.1 |             | 33.5               | SS S-11         | 3      | 5      | 15     | 20      | ● ▲  |
| 40.0       | 895.0          | Dense, RESIDUUM   |             | 38.5               | SS S-12         | 9      | 12     | 23     | 35      | ●  |
| 45.0       | 890.0          | Medium dense, RESIDUUM  |             | 43.5               | SS S-13         | 9      | 10     | 15     | 25      | ●  |
|            |                | Boring Terminated at 45.0 feet.   |             |                    |                 |        |        |        |         |  |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

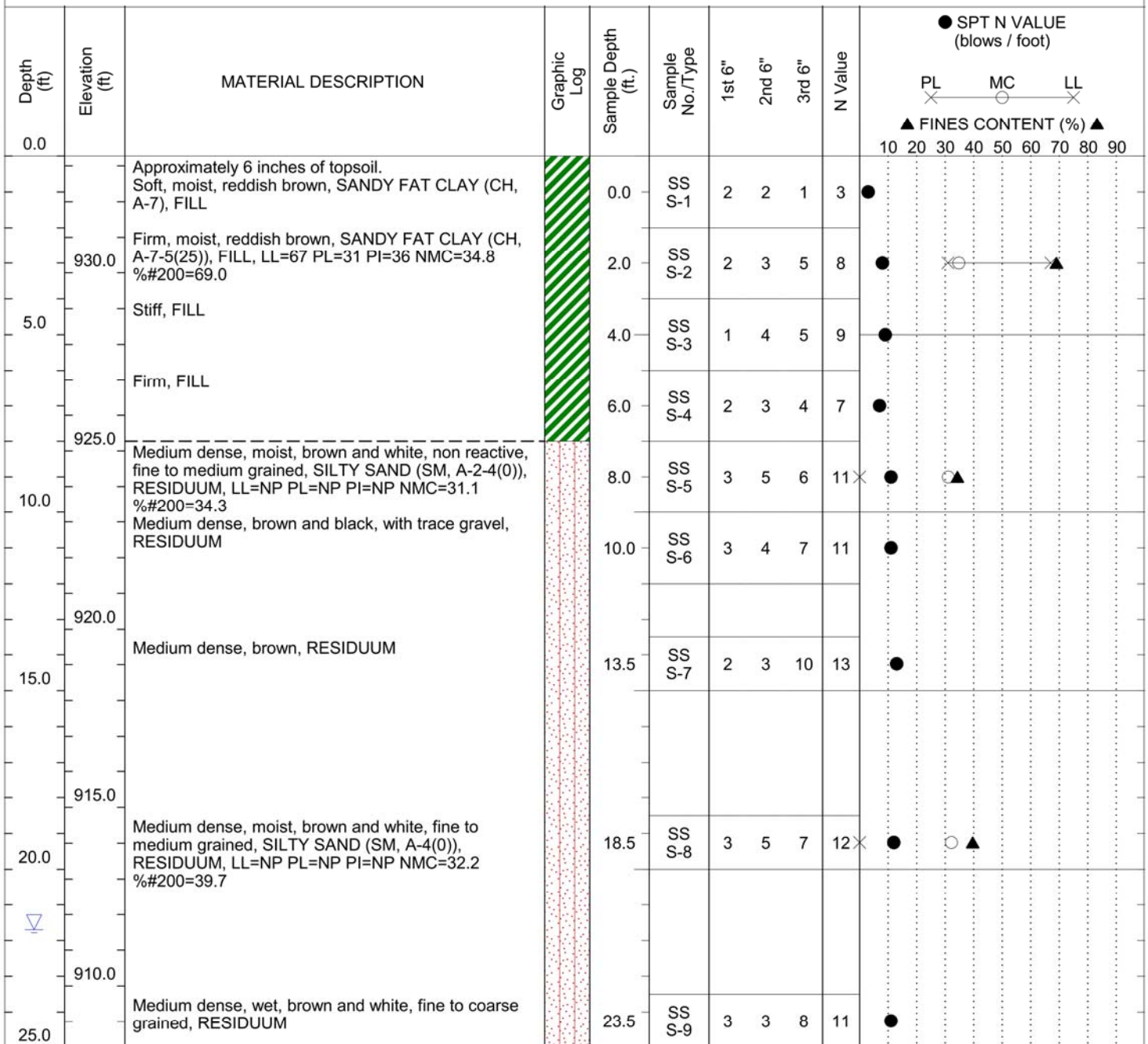
### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring



# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | W2A-1R-03                         | <b>Boring Location:</b>      | 108+66      | <b>Offset:</b>         | RT 37        | <b>Alignment:</b>      | I-85 NB / CD  |
| <b>Elev.:</b>                   | 933.3 ft.                         | <b>Latitude:</b>             | 34.83765748 | <b>Longitude:</b>      | -82.28887174 | <b>Date Started:</b>   | 1/4/2015      |
| <b>Total Depth:</b>             | 45.0 ft.                          | <b>Soil Depth:</b>           | 45.0 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 1/4/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NA                                | <b>Driller:</b>              | SCI         | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 21.7 ft.      |



## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring



## Soil Test Boring Log

|                          |                                   |                       |             |                 |              |                 |               |
|--------------------------|-----------------------------------|-----------------------|-------------|-----------------|--------------|-----------------|---------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009)   | County:         | Greenville   | Eng./Geo.:      | Michael Davis |
| Site Description:        | I-85 and I-385 Interchange Design |                       |             |                 |              | Route:          | I-85 / I-385  |
| Boring No.:              | W2A-1R-03                         | Boring Location:      | 108+66      | Offset:         | RT 37        | Alignment:      | I-85 NB / CD  |
| Elev.:                   | 933.3 ft.                         | Latitude:             | 34.83765748 | Longitude:      | -82.28887174 | Date Started:   | 1/4/2015      |
| Total Depth:             | 45.0 ft.                          | Soil Depth:           | 45.0 ft.    | Core Depth:     | 0.0 ft.      | Date Completed: | 1/4/2015      |
| Bore Hole Diameter (in): | 3-7/8                             | Sampler Configuration |             | Liner Required: | No           | Liner Used:     | NA            |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR          | Hammer Type:    | Automatic    | Energy Ratio:   | 79%           |
| Core Size:               | NA                                | Driller:              | SCI         | Groundwater:    | TOB N.E.     | 24 HR           | 21.7 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | SPT N VALUE (blows / foot) | PL | MC | LL | FINES CONTENT (%) |
|------------|----------------|---|-------------|--------------------|-----------------|--------|--------|--------|---------|----------------------------|----|----|----|-------------------|
| 25.0       |                |   |             |                    |                 |        |        |        |         |                            |    |    |    |                   |
| 30.0       | 905.0          | Medium dense, fine grained, RESIDUUM  |             | 28.5               | SS S-10         | 4      | 5      | 16     | 21      |                            |    |    |    |                   |
| 35.0       | 900.0          | Medium dense, moist, brown and black, RESIDUUM  |             | 33.5               | SS S-11         | 4      | 6      | 9      | 15      |                            |    |    |    |                   |
| 40.0       | 895.0          | Medium dense, wet, brown and white, fine to medium grained, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=32.6 % #200=32.6 |             | 38.5               | SS S-12         | 6      | 8      | 13     | 21      |                            |    |    |    |                   |
| 45.0       | 890.0          | Medium dense, moist, RESIDUUM   |             | 43.5               | SS S-13         | 4      | 5      | 9      | 14      |                            |    |    |    |                   |

Boring Terminated at 45.0 feet.

### LEGEND

#### SAMPLER TYPE

SS - Split Spoon  
ST - Shelby Tube  
DCP - Dynamic Cone Penetrometer  
AC - Auger Cuttings  
GB - Grab Bag  
NQ - Rock Core

#### DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger  
MR - Mud Rotary Wash  
RC - Rock Coring





# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | W2A-1R-04                         | <b>Boring Location:</b>      | 111+56      | <b>Offset:</b>         | RT 42        | <b>Alignment:</b>      | I-85 NB / CD  |
| <b>Elev.:</b>                   | 934.2 ft.                         | <b>Latitude:</b>             | 34.83814117 | <b>Longitude:</b>      | -82.28810367 | <b>Date Started:</b>   | 1/7/2015      |
| <b>Total Depth:</b>             | 45.0 ft.                          | <b>Soil Depth:</b>           | 45.0 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 1/7/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NA                                | <b>Driller:</b>              | SCI         | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 27.0 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 0.0        |                |  |             |                    |                 |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
|            |                | Approximately 3 inches of topsoil.<br>Firm, moist, reddish brown, with organics, SANDY ELASTIC SILT (MH, A-7), FILL                                |             | 0.0                | SS S-1          | 1      | 2      | 3      | 5       | ●  |
|            |                | Medium dense, moist, reddish brown, with mica, SANDY ELASTIC SILT (MH, A-7-5(17)), FILL, LL=67 PL=46 PI=21 NMC=34.1 % <sub>#200</sub> =68.3        |             | 2.0                | SS S-2          | 3      | 5      | 7      | 12      | ● ○ × ▲  |
| 5.0        | 930.0          | Stiff, moist, reddish brown, with mica, SANDY SILT (ML, A-4), FILL   |             | 4.0                | SS S-3          | 2      | 4      | 6      | 10      | ●  |
|            |                | Firm, moist, reddish brown, weakly reactive, with mica, SANDY SILT (ML, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=32.8 % <sub>#200</sub> =55.1      |             | 6.0                | SS S-4          | 2      | 5      | 5      | 10      | ● ○ ▲  |
|            | 925.0          | Firm, RESIDUUM   |             | 8.0                | SS S-5          | 3      | 3      | 4      | 7       | ●  |
| 10.0       |                | Firm, RESIDUUM   |             | 10.0               | SS S-6          | 3      | 3      | 4      | 7       | ●  |
|            |                |  |             |                    |                 |        |        |        |         |  |
| 15.0       | 920.0          | Loose, moist, reddish brown and tan, fine to medium grained, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=48.7 % <sub>#200</sub> =42.3 |             | 13.5               | SS S-7          | 2      | 3      | 4      | 7       | ● ○ ▲  |
|            |                |  |             |                    |                 |        |        |        |         |  |
| 20.0       | 915.0          | Loose, tan, white and brown, RESIDUUM  |             | 18.5               | SS S-8          | 1      | 3      | 6      | 9       | ●  |
|            |                |  |             |                    |                 |        |        |        |         |  |
| 25.0       | 910.0          | Very loose, moist, brown and tan, RESIDUUM   |             | 23.5               | SS S-9          | 2      | 1      | 3      | 4       | ●  |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring



# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | W2A-1R-04                         | <b>Boring Location:</b>      | 111+56      | <b>Offset:</b>         | RT 42        | <b>Alignment:</b>      | I-85 NB / CD  |
| <b>Elev.:</b>                   | 934.2 ft.                         | <b>Latitude:</b>             | 34.83814117 | <b>Longitude:</b>      | -82.28810367 | <b>Date Started:</b>   | 1/7/2015      |
| <b>Total Depth:</b>             | 45.0 ft.                          | <b>Soil Depth:</b>           | 45.0 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 1/7/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NA                                | <b>Driller:</b>              | SCI         | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 27.0 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 25.0       |                |  |             |                    |                 |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
| 30.0       | 905.0          | Very loose, brown, tan, white and black, with mica, RESIDUUM   |             | 28.5               | SS S-10         | 2      | 1      | 2      | 3 ●     |  |
| 35.0       | 900.0          | Loose, moist, brown, black and tan, fine to medium grained, with mica, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=52.9 % <sub>#200</sub> =31.5 |             | 33.5               | SS S-11         | 1      | 2      | 3      | 5 × ●   | ▲ ○  |
| 40.0       | 895.0          | Loose, RESIDUUM  |             | 38.5               | SS S-12         | 1      | 3      | 4      | 7 ●     |  |
| 45.0       | 890.0          | Medium dense, brown, fine grained, RESIDUUM  |             | 43.5               | SS S-13         | 3      | 7      | 10     | 17 ●    |  |
|            |                | Boring Terminated at 45.0 feet.  |             |                    |                 |        |        |        |         |  |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring



# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | W2A-1R-05                         | <b>Boring Location:</b>      | 111+65      | <b>Offset:</b>         | RT 44        | <b>Alignment:</b>      | I-85 NB / CD  |
| <b>Elev.:</b>                   | 935.1 ft.                         | <b>Latitude:</b>             | 34.83815224 | <b>Longitude:</b>      | -82.28807904 | <b>Date Started:</b>   | 1/6/2015      |
| <b>Total Depth:</b>             | 45.0 ft.                          | <b>Soil Depth:</b>           | 45.0 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 1/6/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NA                                | <b>Driller:</b>              | SCI         | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 26.0 ft.      |

| Depth<br>(ft) | Elevation<br>(ft) | MATERIAL DESCRIPTION  | Graphic<br>Log | Sample Depth<br>(ft.) | Sample<br>No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | ● SPT N VALUE<br>(blows / foot) | PL ○ MC × LL<br>▲ FINES CONTENT (%) ▲ |   |
|---------------|-------------------|---|----------------|-----------------------|--------------------|--------|--------|--------|---------|---------------------------------|---------------------------------------|---|
| 0.0           | 935.0             |   |                |                       |                    |        |        |        |         |                                 | 10 20 30 40 50 60 70 80 90            |   |
|               |                   | Approximately 6 inches of topsoil.<br>Soft, moist, reddish brown and dark brown, with organics, SANDY FAT CLAY (CH, A-7), FILL                                    |                | 0.0                   | SS S-1             | 2      | 1      | 2      | 3       | ●                               |                                       |   |
|               |                   | Stiff, moist, reddish brown and tan, SANDY FAT CLAY (CH, A-7-6(16)), FILL, LL=61 PL=29 PI=32 NMC=32.2 %200=57.3   |                | 2.0                   | SS S-2             | 3      | 5      | 6      | 11      | ●                               | ○                                     | ▲ |
| 5.0           | 930.0             | Firm, reddish brown, FILL   |                | 4.0                   | SS S-3             | 1      | 3      | 4      | 7       | ●                               |                                       |   |
|               |                   | Loose, moist, reddish brown, fine grained, with mica, SILTY SAND (SM, A-2), RESIDUUM  |                | 6.0                   | SS S-4             | 3      | 4      | 5      | 9       | ●                               |                                       |   |
| 10.0          | 925.0             | Loose, moist, reddish brown, weakly reactive, fine grained, with mica, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=31.1 %200=43.3<br>Loose, RESIDUUM |                | 8.0                   | SS S-5             | 1      | 4      | 5      | 9       | ●                               | ○                                     | ▲ |
|               |                   |   |                | 10.0                  | SS S-6             | 2      | 4      | 4      | 8       | ●                               |                                       |   |
| 15.0          | 920.0             | Medium dense, brown and black, fine to medium grained, RESIDUUM   |                | 13.5                  | SS S-7             | 3      | 5      | 8      | 13      | ●                               |                                       |   |
| 20.0          | 915.0             | Loose, moist, brown and black, fine grained, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=38.7 %200=41.8  |                | 18.5                  | SS S-8             | 2      | 3      | 4      | 7       | ●                               | ○                                     | ▲ |
|               |                   | Loose, brown, RESIDUUM  |                | 23.5                  | SS S-9             | 2      | 4      | 6      | 10      | ●                               |                                       |   |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring





| Depth<br>(ft) | Elevation<br>(ft) | MATERIAL DESCRIPTION   | Graphic<br>Log | Sample<br>Depth<br>(ft.) | Sample<br>No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div> <div>● SPT N VALUE<br/>(blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div> <div>▲ FINES CONTENT (%) ▲</div> </div> </div> </div> |
|---------------|-------------------|--|----------------|--------------------------|--------------------|--------|--------|--------|---------|--|
| 25.0          | 910.0             |  |                |                          |                    |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
| 25.0          | 910.0             |  |                |                          |                    |        |        |        |         |  |
| 30.0          | 905.0             | Loose, fine grained, RESIDUUM  |                | 28.5                     | SS<br>S-10         | 2      | 2      | 4      | 6       | ●  |
| 35.0          | 900.0             | Loose, moist, brown and black, fine to medium grained, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=52.9 % <sub>#200</sub> =23.0 |                | 33.5                     | SS<br>S-11         | 2      | 3      | 5      | 8       | × ● ▲ ○  |
| 40.0          | 895.0             | Loose, RESIDUUM  |                | 38.5                     | SS<br>S-12         | 2      | 3      | 5      | 8       | ●  |
| 45.0          |                   | Medium dense, RESIDUUM   |                | 43.5                     | SS<br>S-13         | 4      | 5      | 7      | 12      | ●  |
|               |                   | Boring Terminated at 45.0 feet.  |                |                          |                    |        |        |        |         |  |

## SAMPLER TYPE

## DRILLING METHOD

HSA - Hollow Stem Augers  
SSA - Solid Stem Augers  
HA - Hand Auger



# Soil Test Boring Log

|                          |                                   |                       |             |                 |              |                 |               |
|--------------------------|-----------------------------------|-----------------------|-------------|-----------------|--------------|-----------------|---------------|
| File No.:                | 23.038111                         | Project No. (PIN):    | IM23(009)   | County:         | Greenville   | Eng./Geo.:      | Michael Davis |
| Site Description:        | I-85 and I-385 Interchange Design |                       |             |                 |              | Route:          | I-85 / I-385  |
| Boring No.:              | W2A-1R-06                         | Boring Location:      | 113+70      | Offset:         | RT 36        | Alignment:      | I-85 NB / CD  |
| Elev.:                   | 916.4 ft.                         | Latitude:             | 34.83851329 | Longitude:      | -82.28755253 | Date Started:   | 1/7/2015      |
| Total Depth:             | 45.0 ft.                          | Soil Depth:           | 45.0 ft.    | Core Depth:     | 0.0 ft.      | Date Completed: | 1/7/2015      |
| Bore Hole Diameter (in): | 3-7/8                             | Sampler Configuration |             | Liner Required: | No           | Liner Used:     | NA            |
| Drill Machine:           | CME 550X                          | Drill Method:         | MR          | Hammer Type:    | Automatic    | Energy Ratio:   | 79%           |
| Core Size:               | NA                                | Driller:              | SCI         | Groundwater:    | TOB N.E.     | 24 HR           | 10.3 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION  | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|---|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 0.0        |                |   |             |                    |                 |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
|            | 915.0          | Approximately 3 inches of topsoil. Stiff, moist, reddish brown, with mica, SANDY FAT CLAY (CH, A-7-5(15)), FILL, LL=62 PL=31 PI=31 NMC=24.8 % <sub>#200</sub> =55.1             |             | 0.0                | SS S-1          | 2      | 5      | 5      | 10      | ● ○ × ▲ ×  |
|            |                | Medium dense, moist, reddish brown, with mica, SILTY SAND (SM, A-2), RESIDUUM   |             | 2.0                | SS S-2          | 5      | 7      | 7      | 14      | ● ○ ×  |
| 5.0        |                | Loose, moist, reddish brown, fine to medium grained, SILTY SAND (SM, A-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=33.1 % <sub>#200</sub> =44.5                                      |             | 4.0                | SS S-3          | 1      | 3      | 4      | 7 ×     | ● ○ × ▲  |
|            | 910.0          | Loose, brown, tan and white, RESIDUUM   |             | 6.0                | SS S-4          | 2      | 4      | 5      | 9       | ● ○ ×  |
|            |                | Loose, RESIDUUM   |             | 8.0                | SS S-5          | 2      | 4      | 3      | 7       | ● ○ ×  |
| 10.0       |                | Loose, moist, brown, tan and black, weakly reactive, fine to medium grained, with mica, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=40.1 % <sub>#200</sub> =29.9 |             | 10.0               | SS S-6          | 2      | 3      | 4      | 7 ×     | ● ○ × ▲  |
|            |                | Loose, brown, tan, white and black, RESIDUUM  |             | 13.5               | SS S-7          | 2      | 2      | 5      | 7       | ● ○ ×  |
| 15.0       |                |   |             |                    |                 |        |        |        |         |  |
|            | 900.0          |   |             |                    |                 |        |        |        |         |  |
| 20.0       |                | Loose, brown, tan and white, RESIDUUM   |             | 18.5               | SS S-8          | 2      | 3      | 6      | 9       | ● ○ ×  |
|            | 895.0          |   |             |                    |                 |        |        |        |         |  |
| 25.0       |                | Medium dense, moist, tan, white and brown, fine to medium grained, with mica, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP  |             | 23.5               | SS S-9          | 4      | 7      | 9      | 16 ×    | ● ○ × ▲  |

## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring



# Soil Test Boring Log

|                                 |                                   |                              |             |                        |              |                        |               |
|---------------------------------|-----------------------------------|------------------------------|-------------|------------------------|--------------|------------------------|---------------|
| <b>File No.:</b>                | 23.038111                         | <b>Project No. (PIN):</b>    | IM23(009)   | <b>County:</b>         | Greenville   | <b>Eng./Geo.:</b>      | Michael Davis |
| <b>Site Description:</b>        | I-85 and I-385 Interchange Design |                              |             |                        |              | <b>Route:</b>          | I-85 / I-385  |
| <b>Boring No.:</b>              | W2A-1R-06                         | <b>Boring Location:</b>      | 113+70      | <b>Offset:</b>         | RT 36        | <b>Alignment:</b>      | I-85 NB / CD  |
| <b>Elev.:</b>                   | 916.4 ft.                         | <b>Latitude:</b>             | 34.83851329 | <b>Longitude:</b>      | -82.28755253 | <b>Date Started:</b>   | 1/7/2015      |
| <b>Total Depth:</b>             | 45.0 ft.                          | <b>Soil Depth:</b>           | 45.0 ft.    | <b>Core Depth:</b>     | 0.0 ft.      | <b>Date Completed:</b> | 1/7/2015      |
| <b>Bore Hole Diameter (in):</b> | 3-7/8                             | <b>Sampler Configuration</b> |             | <b>Liner Required:</b> | No           | <b>Liner Used:</b>     | NA            |
| <b>Drill Machine:</b>           | CME 550X                          | <b>Drill Method:</b>         | MR          | <b>Hammer Type:</b>    | Automatic    | <b>Energy Ratio:</b>   | 79%           |
| <b>Core Size:</b>               | NA                                | <b>Driller:</b>              | SCI         | <b>Groundwater:</b>    | TOB N.E.     | <b>24 HR</b>           | 10.3 ft.      |

| Depth (ft) | Elevation (ft) | MATERIAL DESCRIPTION   | Graphic Log | Sample Depth (ft.) | Sample No./Type | 1st 6" | 2nd 6" | 3rd 6" | N Value | <div> <div>● SPT N VALUE (blows / foot)</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div>▲ FINES CONTENT (%) ▲</div> </div> |
|------------|----------------|--|-------------|--------------------|-----------------|--------|--------|--------|---------|--|
| 25.0       |                |  |             |                    |                 |        |        |        |         | 10 20 30 40 50 60 70 80 90   |
|            | 890.0          | NMC=27.1 % <sub>#200</sub> =31.7   |             |                    |                 |        |        |        |         |  |
|            |                | Medium dense, brown, white and black, RESIDUUM   |             | 28.5               | SS S-10         | 2      | 5      | 7      | 12      | ●  |
|            | 885.0          |  |             |                    |                 |        |        |        |         |  |
|            |                | Medium dense, tan, white and black, RESIDUUM   |             | 33.5               | SS S-11         | 4      | 7      | 9      | 16      | ●  |
|            | 880.0          |  |             |                    |                 |        |        |        |         |  |
|            |                | Medium dense, moist, brown, fine to medium grained, with mica, SILTY SAND (SM, A-2-4(0)), RESIDUUM, LL=NP PL=NP PI=NP NMC=37.2 % <sub>#200</sub> =24.1 |             | 38.5               | SS S-12         | 3      | 6      | 13     | 19      | ●▲○  |
|            | 875.0          |  |             |                    |                 |        |        |        |         |  |
|            |                | Dense, tan, black, and white, fine grained, with trace gravel, RESIDUUM  |             | 43.5               | SS S-13         | 4      | 12     | 23     | 35      | ●  |

|  |  |                                 |  |  |  |  |  |  |  |  |
|--|--|---------------------------------|--|--|--|--|--|--|--|--|
|  |  | Boring Terminated at 45.0 feet. |  |  |  |  |  |  |  |  |
|--|--|---------------------------------|--|--|--|--|--|--|--|--|

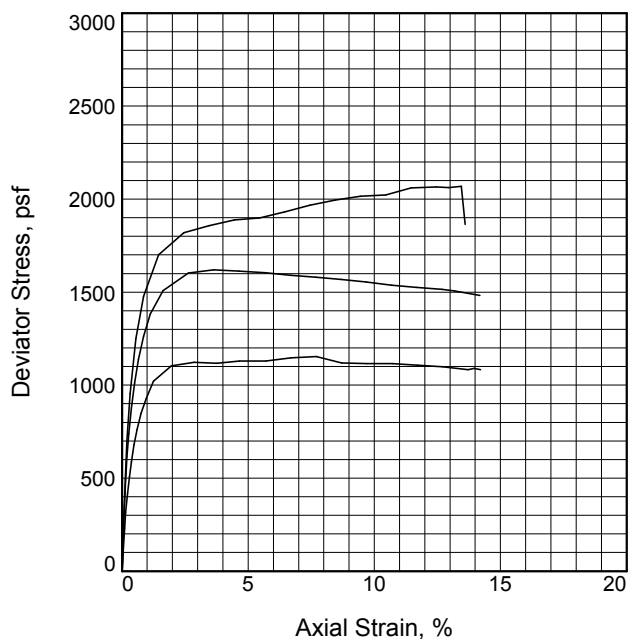
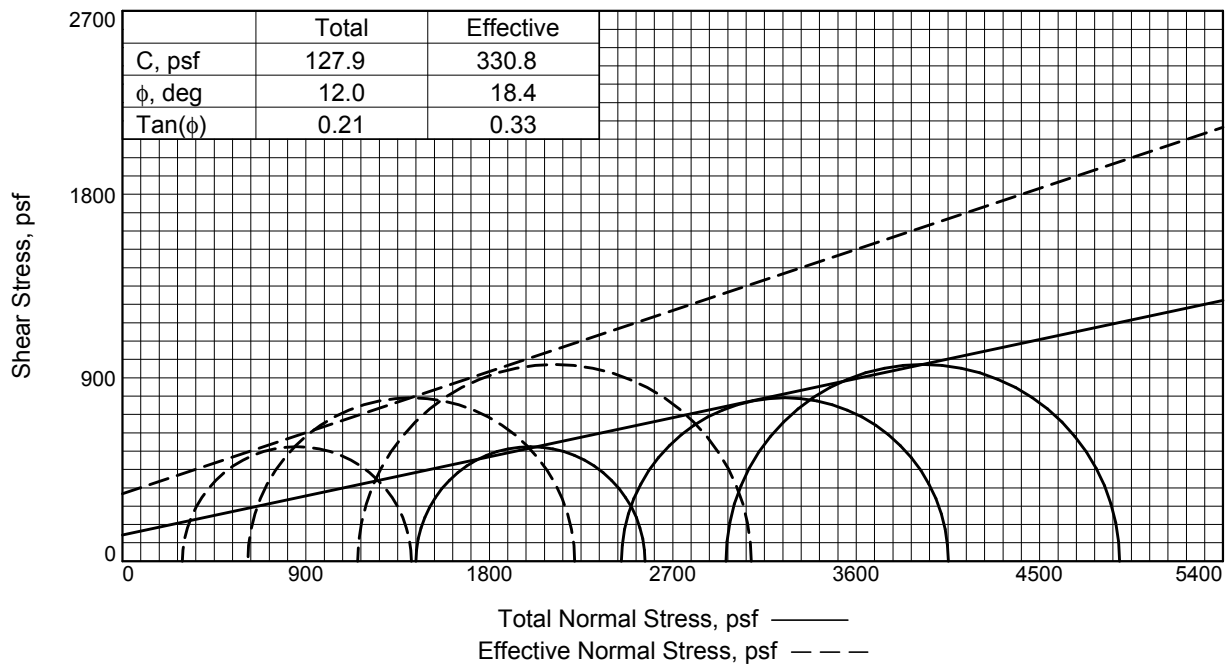
## LEGEND

### SAMPLER TYPE

SS - Split Spoon  
 ST - Shelby Tube  
 DCP - Dynamic Cone Penetrometer  
 AC - Auger Cuttings  
 GB - Grab Bag  
 NQ - Rock Core

### DRILLING METHOD

HSA - Hollow Stem Augers  
 SSA - Solid Stem Augers  
 HA - Hand Auger  
 MR - Mud Rotary Wash  
 RC - Rock Coring



| Specimen No.                  |                  | 1      | 2      | 3      |
|-------------------------------|------------------|--------|--------|--------|
| Initial                       | Water Content, % | 97.1   | 105.6  | 109.3  |
|                               | Dry Density, pcf | 46.6   | 44.6   | 43.5   |
|                               | Saturation, %    | 100.9  | 103.3  | 103.3  |
|                               | Void Ratio       | 2.5607 | 2.7203 | 2.8141 |
|                               | Diameter, in.    | 2.743  | 2.744  | 2.729  |
|                               | Height, in.      | 5.570  | 5.550  | 5.540  |
| At Test                       | Water Content, % | 106.2  | 97.4   | 86.5   |
|                               | Dry Density, pcf | 46.6   | 44.6   | 43.5   |
|                               | Saturation, %    | 110.3  | 95.3   | 81.8   |
|                               | Void Ratio       | 2.5607 | 2.7203 | 2.8141 |
|                               | Diameter, in.    | 2.743  | 2.744  | 2.729  |
|                               | Height, in.      | 5.570  | 5.550  | 5.540  |
| Strain at peak, %             |                  | 2.9    | 5.7    | 6.5    |
| Eff. Cell Pressure, psf       |                  | 1440.0 | 2448.0 | 2960.6 |
| Fail. Stress, psf             |                  | 1123.4 | 1603.9 | 1931.2 |
| Excess Pore Pr., psf          |                  | 1146.0 | 1833.2 | 1806.6 |
| Strain, %                     |                  | 2.9    | 5.7    | 6.5    |
| Ult. Stress, psf              |                  | 1123.4 | 1603.9 | 1931.2 |
| Excess Pore Pr., psf          |                  | 1146.0 | 1833.2 | 1806.6 |
| Strain, %                     |                  | 2.9    | 5.7    | 6.5    |
| $\bar{\sigma}_1$ Failure, psf |                  | 1417.4 | 2218.7 | 3085.2 |
| $\bar{\sigma}_3$ Failure, psf |                  | 294.0  | 614.8  | 1154.1 |

#### Type of Test:

CU with Pore Pressures

**Sample Type:** 3-in. Shelby Tube

**Description:**

LL= NP

PI= NP

**Assumed Specific Gravity=** 2.66

**Remarks:**

**Figure** \_\_\_\_\_

**Client:** CECS

**Project:** SCDOT I-85 & I-385 Interchange Modification

**Source of Sample:** B-11 SPT 02

**Depth:** 9.5

**Sample Number:** T-1

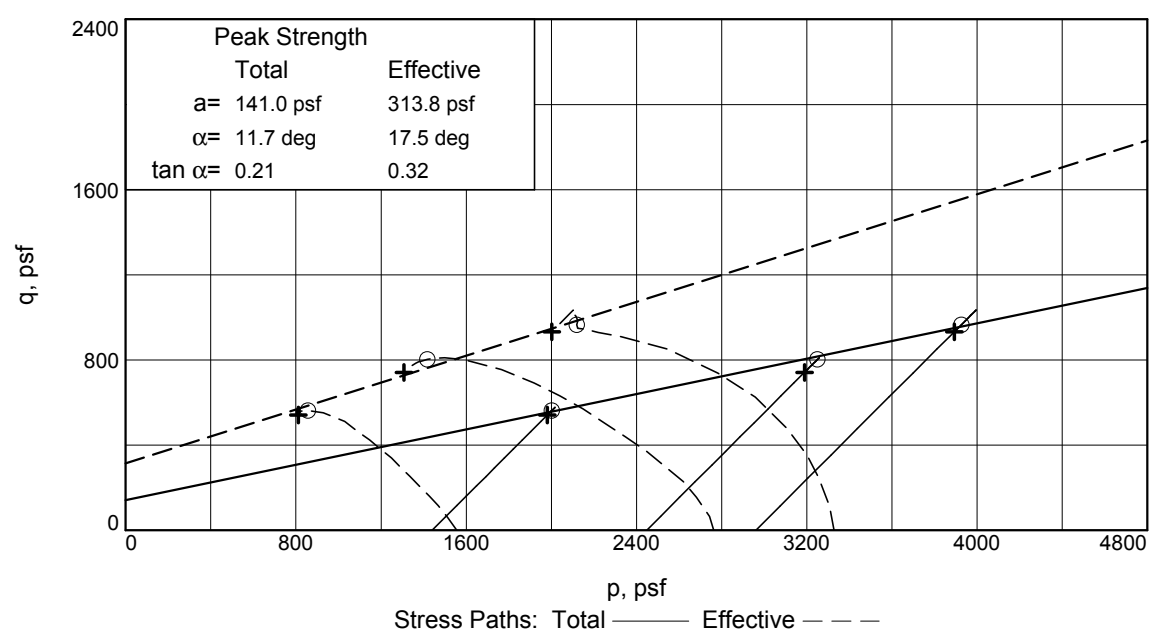
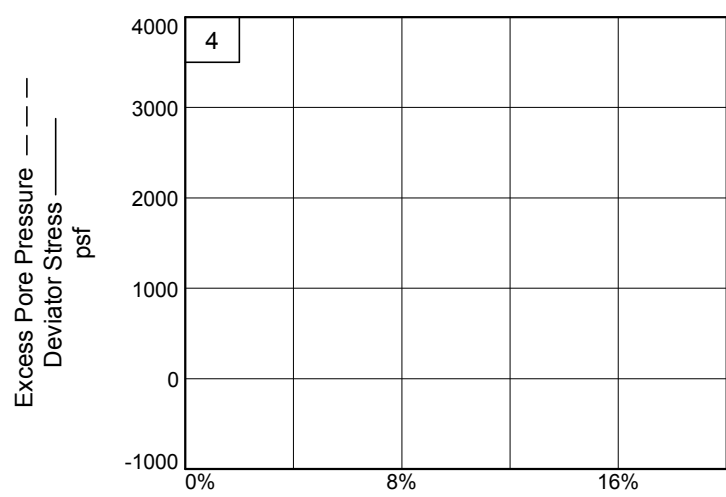
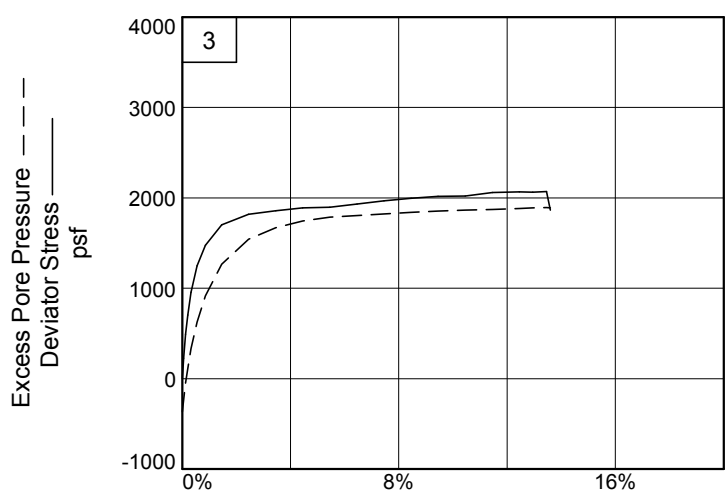
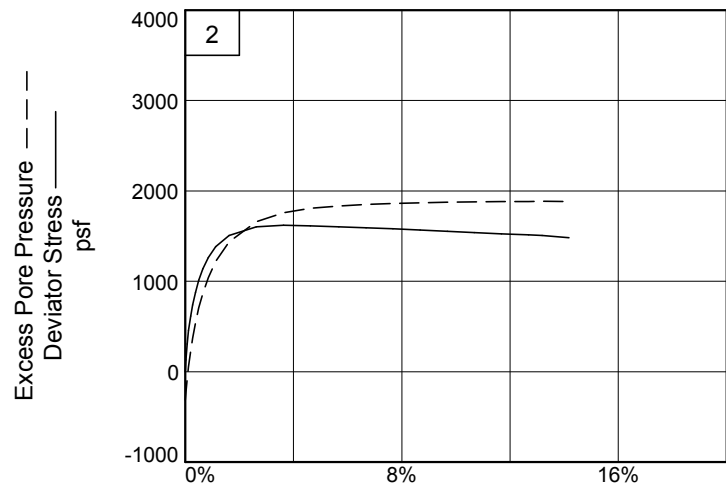
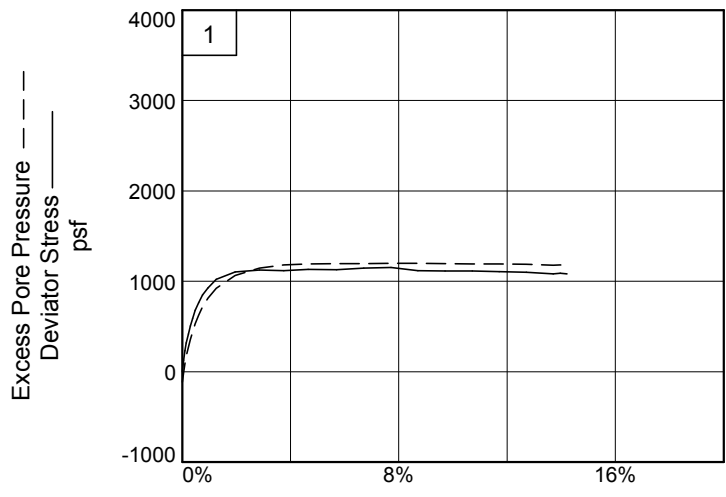
**Proj. No.:** 1411010276

**Date Sampled:** 12/04/14

TRIAXIAL SHEAR TEST REPORT

Thompson Engineering

Mobile, Alabama

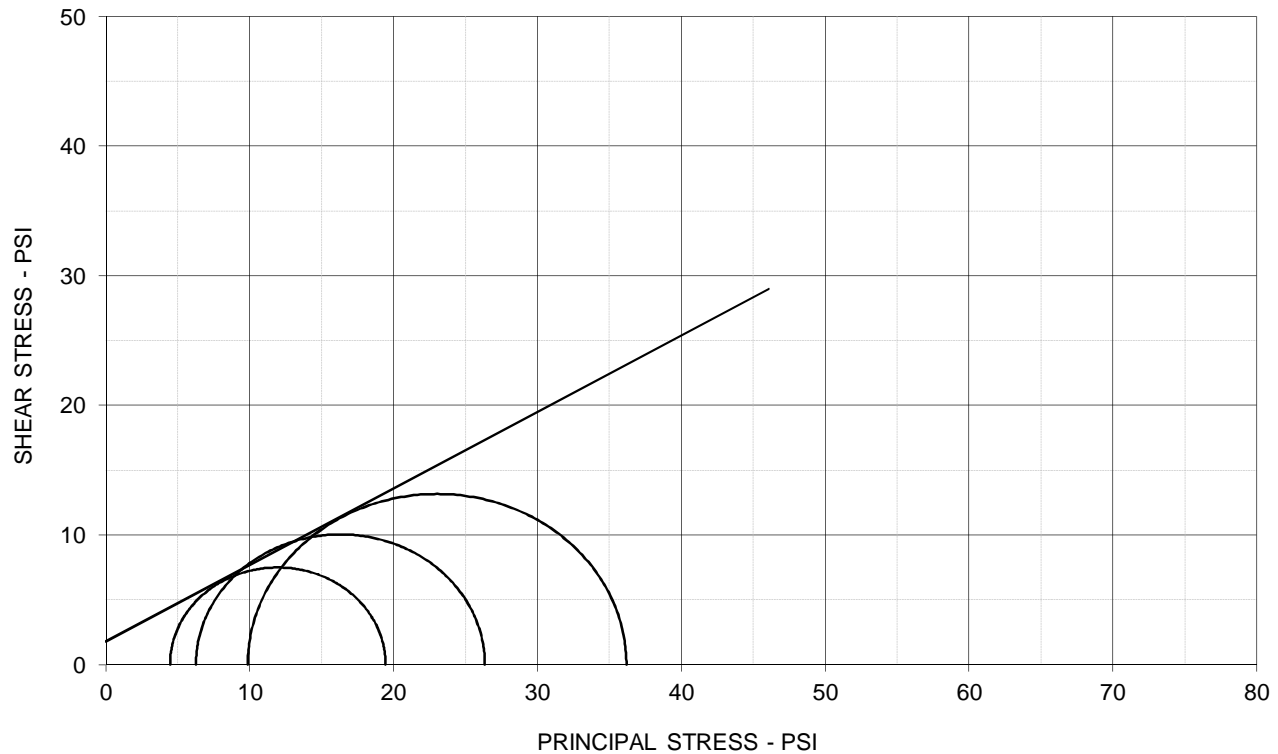




# TRIAXIAL SHEAR TEST REPORT



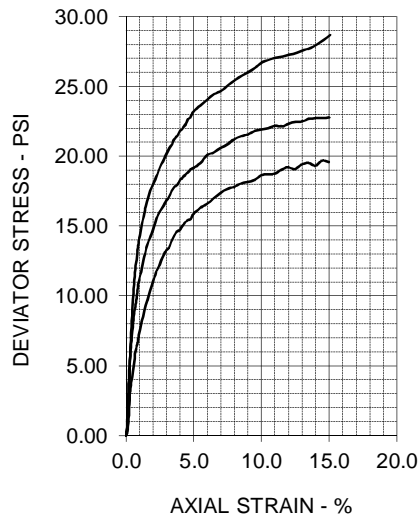
P.O. Box 5010, 51 Lost Mound Drive, Suite 135 Chattanooga, TN 37406



## EFFECTIVE STRESS PARAMETERS

$\phi' = 30.5 \text{ deg}$

$c' = 1.8 \text{ psi}$



### SPECIMEN NO.

1 2 3 4

#### INITIAL

|                      |      |      |      |
|----------------------|------|------|------|
| Moisture Content - % | 27.2 | 27.2 | 27.2 |
| Dry Density - pcf    | 90.3 | 90.3 | 90.3 |
| Diameter - inches    | 2.00 | 2.00 | 2.00 |
| Height - inches      | 4.00 | 4.00 | 4.00 |

#### AT TEST

|                             |         |         |         |
|-----------------------------|---------|---------|---------|
| Final Moisture - %          | 31.4    | 30.7    | 30.6    |
| Dry Density - pcf           | 90.3    | 90.8    | 91.5    |
| Calculated Diameter (in.)   | 1.97    | 1.97    | 1.99    |
| Height - inches             | 3.93    | 3.92    | 3.96    |
| Effect. Cell Pressure - psi | 5.0     | 10.0    | 20.0    |
| Failure Stress - psi        | 14.98   | 20.08   | 26.32   |
| Total Pore Pressure - psi   | 50.5    | 53.7    | 60.1    |
| Strain Rate - inches/min.   | 0.00040 | 0.00040 | 0.00040 |
| Failure Strain - %          | 4.2     | 6.0     | 9.5     |
| $\sigma_1'$ Failure - psi   | 19.45   | 26.35   | 36.19   |
| $\sigma_3'$ Failure - psi   | 4.47    | 6.27    | 9.87    |

## TEST DESCRIPTION

TYPE OF TEST & NO: CU with Pore Pressure  
 SAMPLE TYPE: Remolded  
 DESCRIPTION: Silty Sand (SM)  
 SAMPLE LOCATION: RRM-47 25-27 ft.  
 ASSUMED SPECIFIC GRAVITY: 2.7  
 LL: 49 PL: 46 PI: 3 Percent -200: 21.5  
 REMARKS: Specimens Remolded

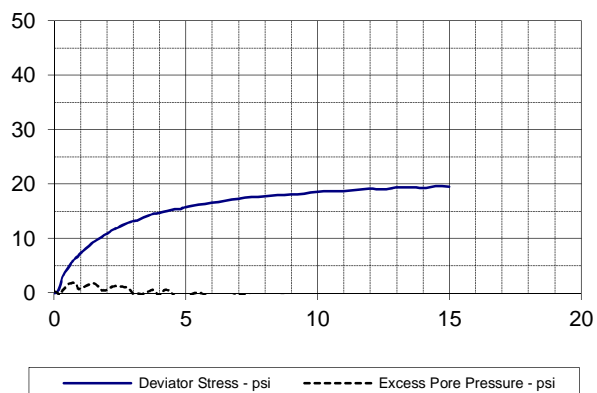
## PROJECT INFORMATION

PROJECT: I-85/I-385 Interchange Modifications  
 LOCATION: I-85/I-385 Interchange  
 PROJECT NO: E2156301  
 CLIENT: Thompson Engineering  
 DATE: 4/3/15

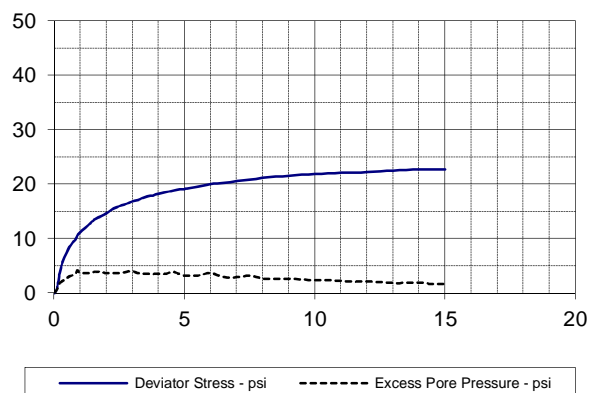
**TERRACON**



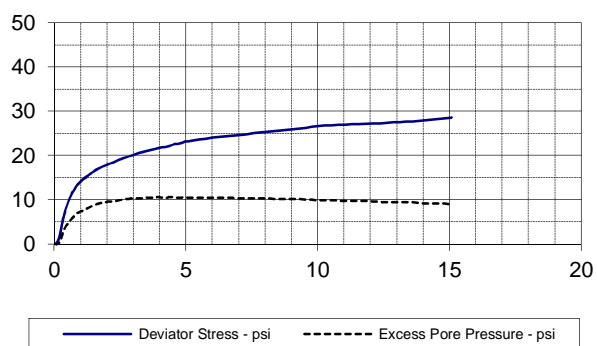
SPECIMEN NO. 1



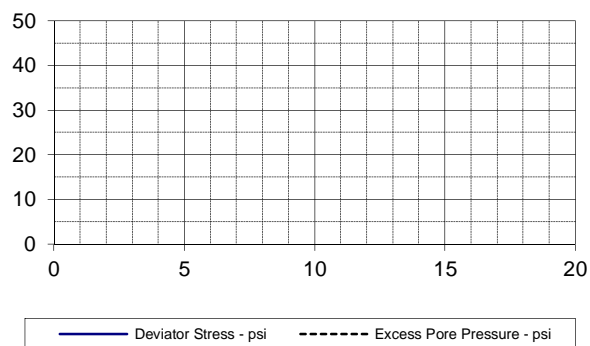
SPECIMEN NO. 2



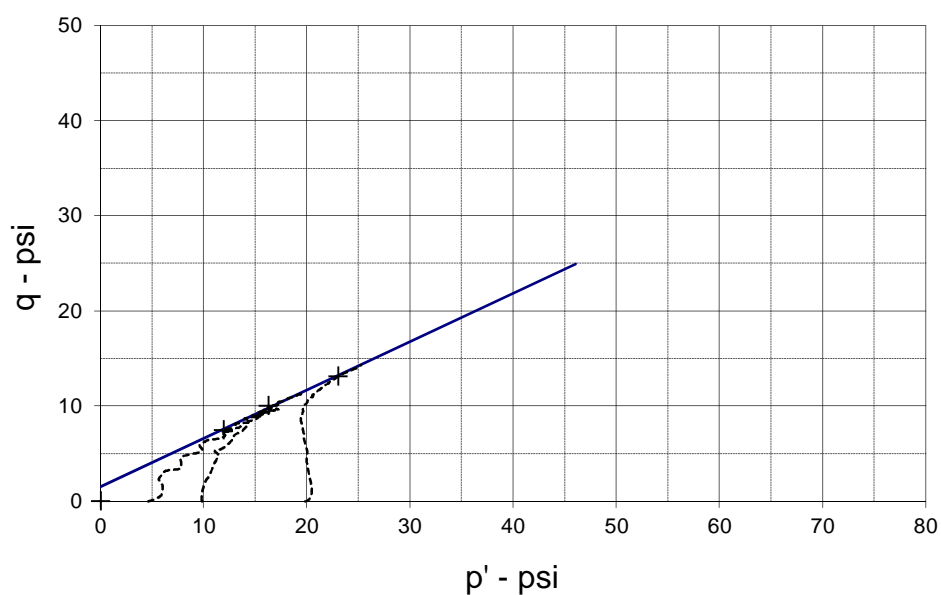
SPECIMEN NO. 3



SPECIMEN NO. 4



p - q DIAGRAM



EFFECTIVE STRESS PARAMETERS

 $R^2 = 1.00$  $\alpha$  (deg) = 26.9

a (psi) = 1.5

PROJECT: I-85/I-385 Interchange Modifications

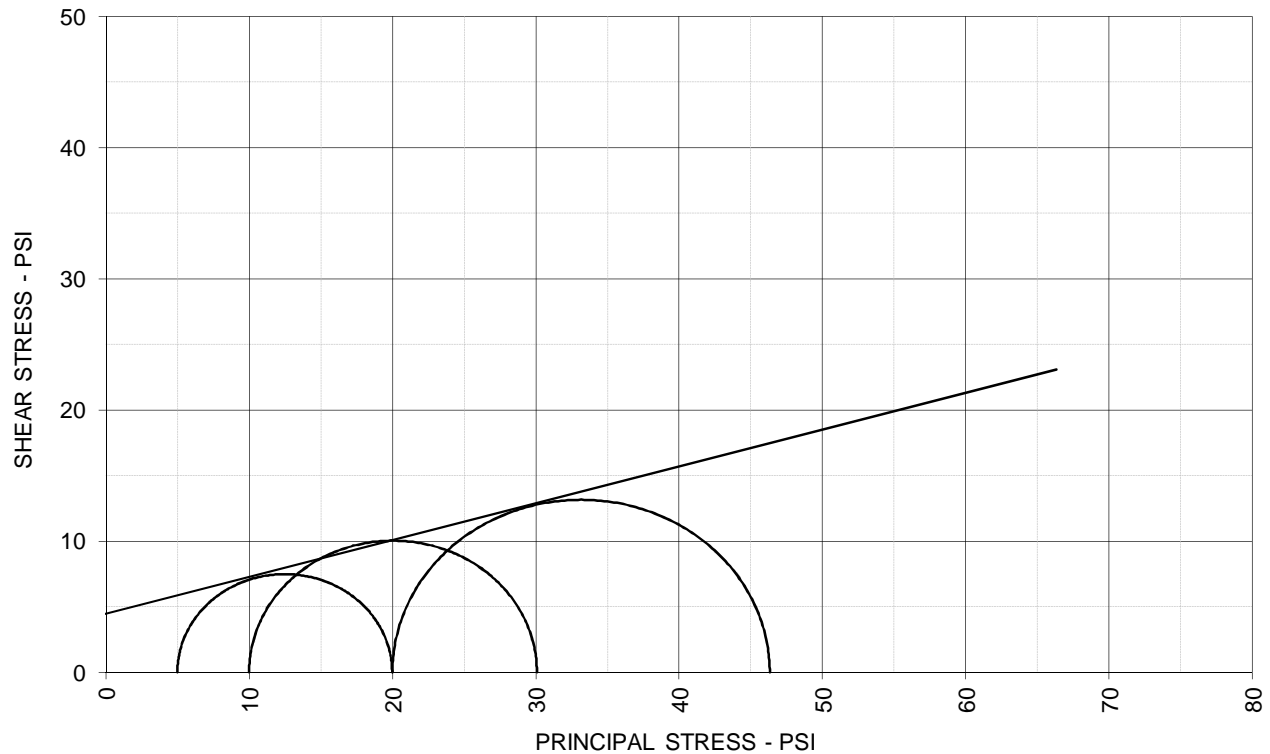
TYPE OF TEST &amp; NO: CU with Pore Pressure

PROJECT NO: E2156301

DESCRIPTION: Silty Sand (SM)

**TERRACON**

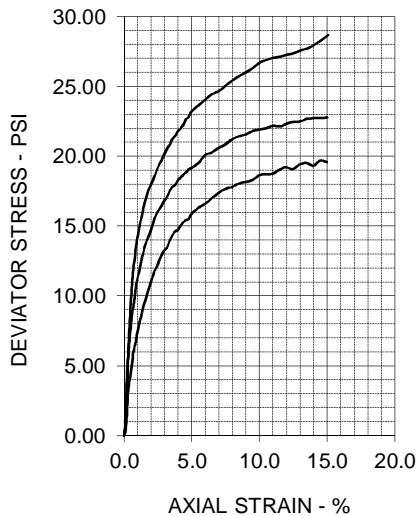
# TRIAXIAL SHEAR TEST REPORT



## TOTAL STRESS PARAMETERS

$\phi = 15.7 \text{ deg}$

$c = 4.5 \text{ psi}$



### SPECIMEN NO.

1 2 3 4

#### INITIAL

|                      |      |      |      |
|----------------------|------|------|------|
| Moisture Content - % | 27.2 | 27.2 | 27.2 |
| Dry Density - pcf    | 90.3 | 90.3 | 90.3 |
| Diameter - inches    | 2.00 | 2.00 | 2.00 |
| Height - inches      | 4.00 | 4.00 | 4.00 |

#### AT TEST

|                             |         |         |         |
|-----------------------------|---------|---------|---------|
| Final Moisture - %          | 31.4    | 30.7    | 30.6    |
| Dry Density - pcf           | 90.3    | 90.8    | 91.5    |
| Calculated Diameter (in.)   | 1.97    | 1.97    | 1.99    |
| Height - inches             | 3.93    | 3.92    | 3.96    |
| Effect. Cell Pressure - psi | 5.0     | 10.0    | 20.0    |
| Failure Stress - psi        | 14.98   | 20.08   | 26.32   |
| Total Pore Pressure - psi   | 50.5    | 53.7    | 60.1    |
| Strain Rate - inches/min.   | 0.00040 | 0.00040 | 0.00040 |
| Failure Strain - %          | 4.2     | 6.0     | 9.5     |
| $\sigma_1$ Failure - psi    | 19.98   | 30.08   | 46.32   |
| $\sigma_3$ Failure - psi    | 5.00    | 10.00   | 20.00   |

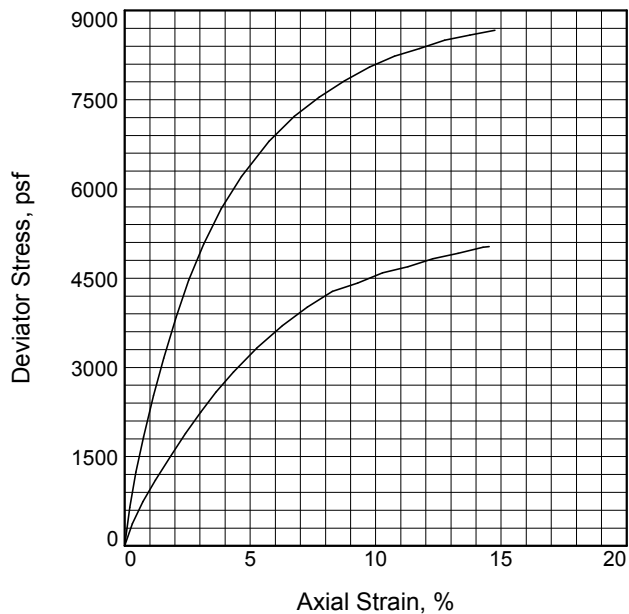
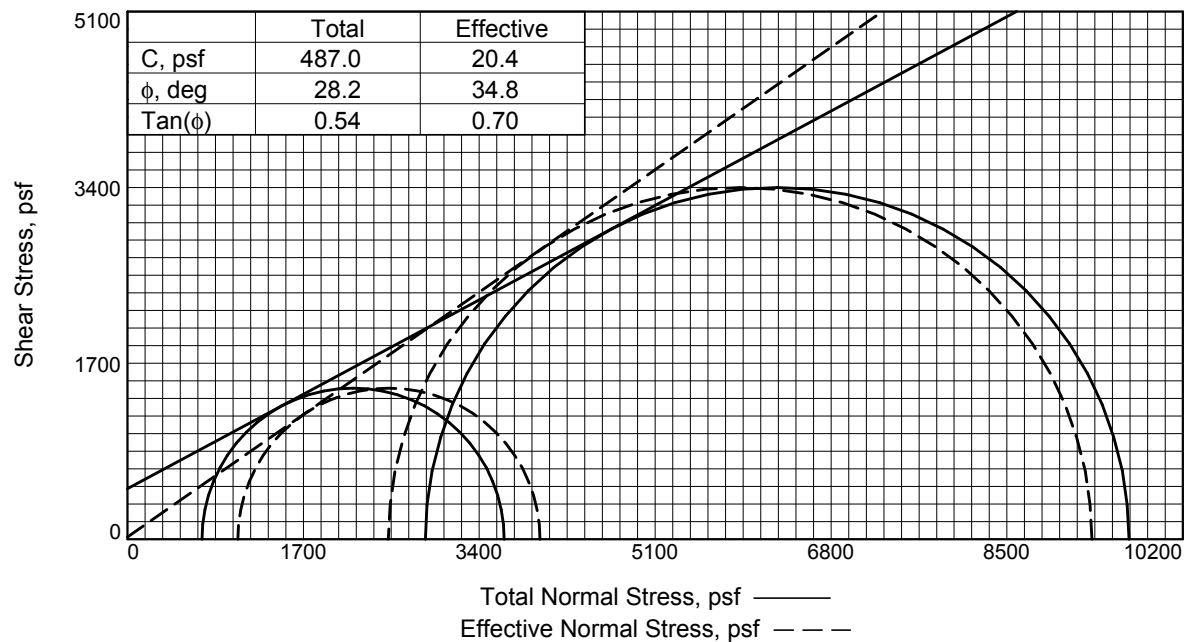
## TEST DESCRIPTION

TYPE OF TEST & NO: CU with Pore Pressure  
 SAMPLE TYPE: Remolded  
 DESCRIPTION: Silty Sand (SM)  
 SAMPLE LOCATION: RRM-47 25-27 ft.  
 ASSUMED SPECIFIC GRAVITY: 2.7  
 LL: 49 PL: 46 PI: 3 Percent -200: 21.5  
 REMARKS: Specimens Remolded

## PROJECT INFORMATION

PROJECT: I-85/I-385 Interchange Modifications  
 LOCATION: I-85/I-385 Interchange  
 PROJECT NO: E2156301  
 CLIENT: Thompson Engineering  
 DATE: 4/3/15

**TERRACON**



| Specimen No.                  |                  | 1      | 2      |
|-------------------------------|------------------|--------|--------|
| Initial                       | Water Content, % | 20.4   | 20.5   |
|                               | Dry Density, pcf | 107.8  | 103.2  |
|                               | Saturation, %    | 100.4  | 89.4   |
|                               | Void Ratio       | 0.5399 | 0.6090 |
|                               | Diameter, in.    | 2.771  | 2.777  |
|                               | Height, in.      | 5.120  | 5.520  |
| At Test                       | Water Content, % | 20.3   | 22.9   |
|                               | Dry Density, pcf | 107.8  | 103.2  |
|                               | Saturation, %    | 100.0  | 100.0  |
|                               | Void Ratio       | 0.5399 | 0.6090 |
|                               | Diameter, in.    | 2.771  | 2.777  |
|                               | Height, in.      | 5.120  | 5.520  |
| Strain at peak, %             |                  | 4.3    | 5.8    |
| Eff. Cell Pressure, psf       |                  | 720.0  | 2880.0 |
| Fail. Stress, psf             |                  | 2921.2 | 6799.1 |
| Excess Pore Pr., psf          |                  | -346.6 | 358.7  |
| Strain, %                     |                  | 4.3    | 5.8    |
| Ult. Stress, psf              |                  | 2921.2 | 6799.1 |
| Excess Pore Pr., psf          |                  | -346.6 | 358.7  |
| Strain, %                     |                  | 4.3    | 5.8    |
| $\bar{\sigma}_1$ Failure, psf |                  | 3987.9 | 9320.5 |
| $\bar{\sigma}_3$ Failure, psf |                  | 1066.6 | 2521.3 |

#### Type of Test:

CU with Pore Pressures

**Sample Type:** 3-in. Shelby Tube

**Description:**

LL= 32

PL= 27

PI= 5

**Assumed Specific Gravity=** 2.66

**Remarks:**

**Figure** \_\_\_\_\_

**Client:** CECS

**Project:** SCDOT I-85 & I-385 Interchange Modification

**Source of Sample:** W3A-1R-01

**Depth:** 12.0

**Sample Number:** T-1

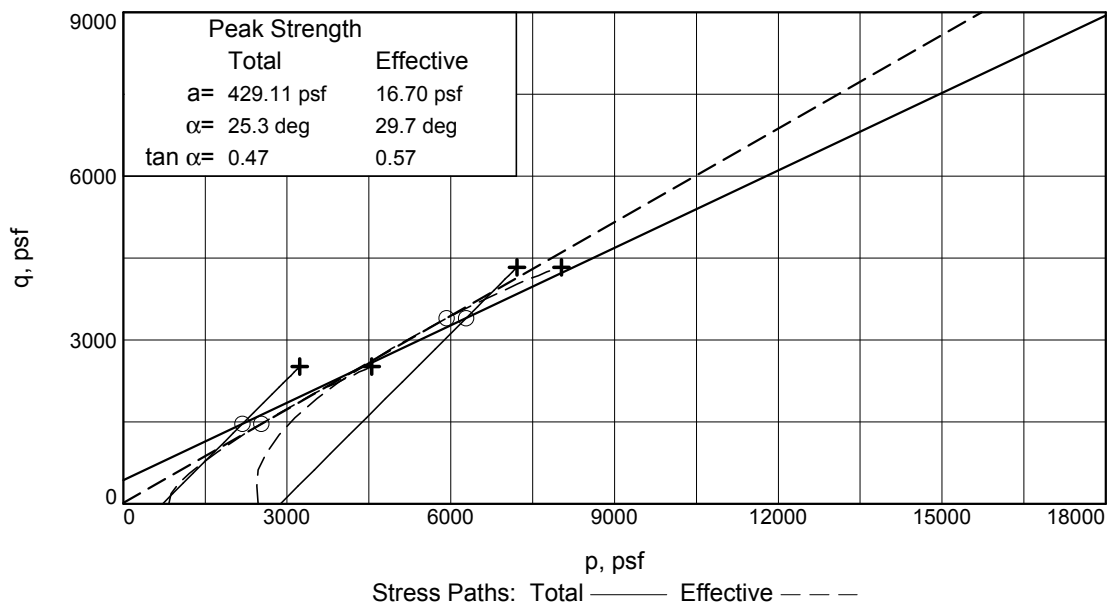
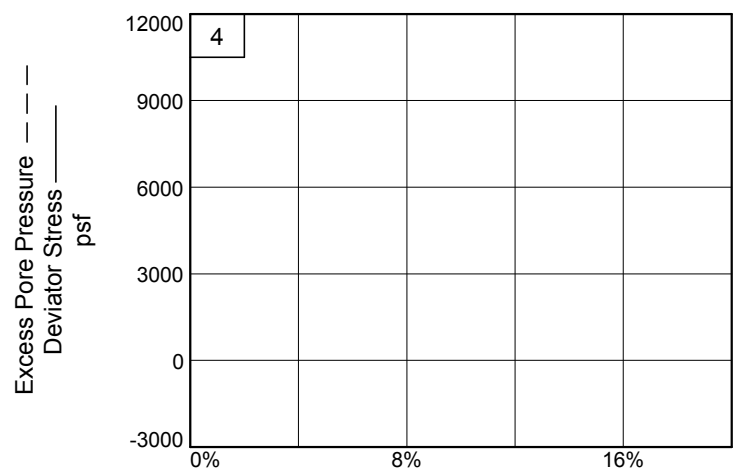
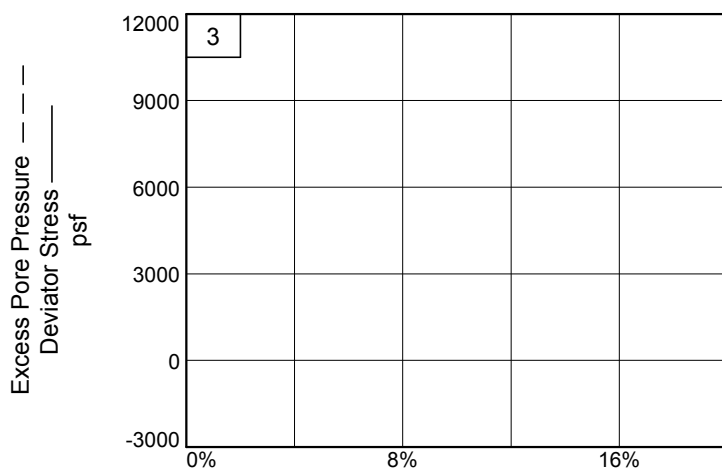
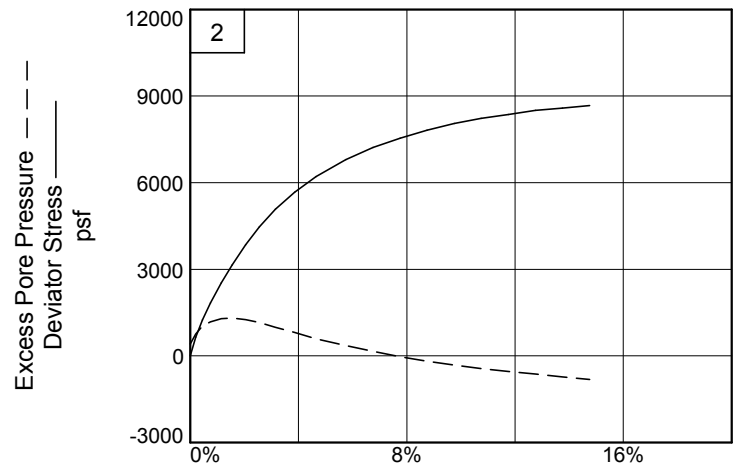
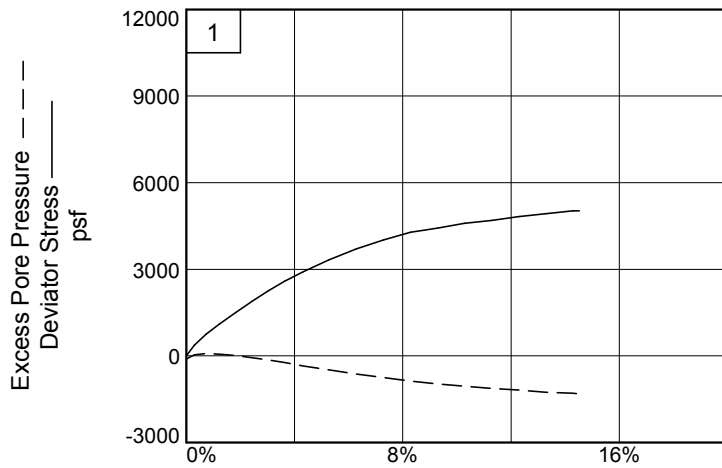
**Proj. No.:** 1411010276

**Date Sampled:** 1/22/15

TRIAXIAL SHEAR TEST REPORT

Thompson Engineering  
Mobile, Alabama

**Tested By:** B. Hak



**Client:** CECS

**Project:** SCDOT I-85 & I-385 Interchange Modification

**Source of Sample:** W3A-1R-01

**Depth:** 12.0

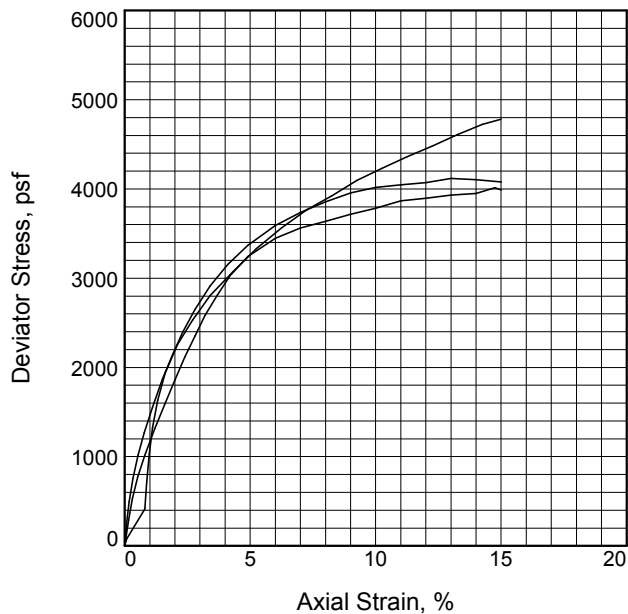
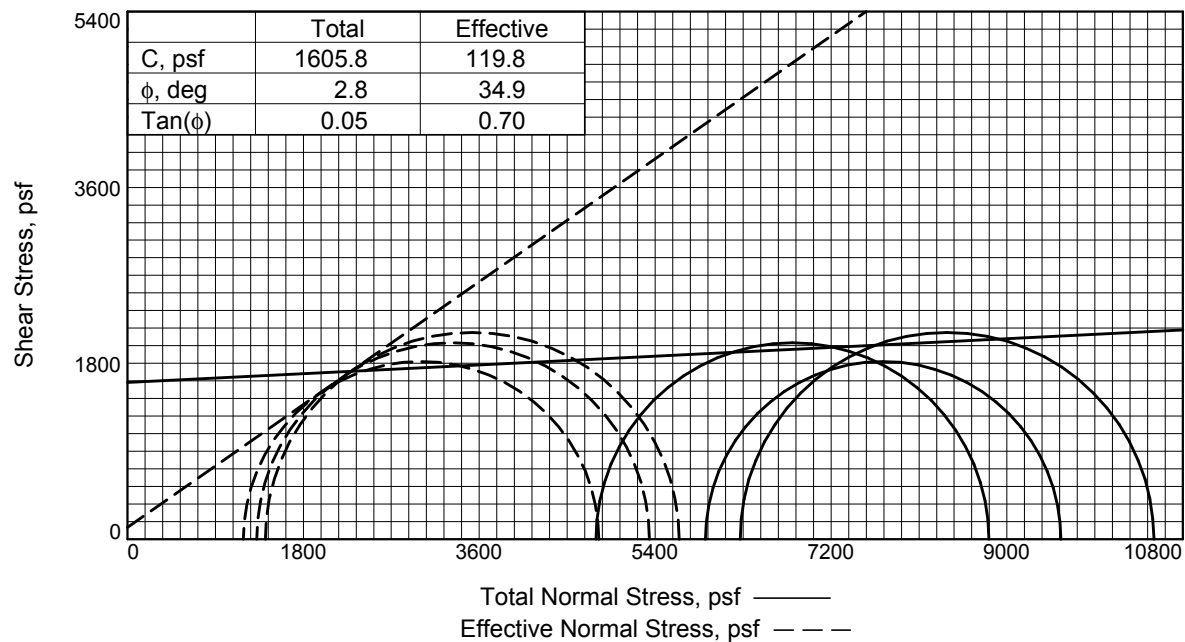
**Sample Number:** T-1

**Project No.:** 1411010276

**Figure** \_\_\_\_\_

**Thompson Engineering**

**Tested By:** B. Hak \_\_\_\_\_



| Specimen No.                  |                  | 1      | 2      | 3      |
|-------------------------------|------------------|--------|--------|--------|
| Initial                       | Water Content, % | 30.7   | 31.5   | 34.5   |
|                               | Dry Density, pcf | 85.6   | 87.1   | 88.1   |
|                               | Saturation, %    | 87.1   | 92.5   | 103.6  |
|                               | Void Ratio       | 0.9392 | 0.9069 | 0.8859 |
|                               | Diameter, in.    | 2.758  | 2.766  | 2.749  |
|                               | Height, in.      | 5.340  | 5.460  | 5.510  |
| At Test                       | Water Content, % | 35.3   | 34.1   | 33.3   |
|                               | Dry Density, pcf | 85.6   | 87.1   | 88.1   |
|                               | Saturation, %    | 100.0  | 100.0  | 100.0  |
|                               | Void Ratio       | 0.9392 | 0.9069 | 0.8859 |
|                               | Diameter, in.    | 2.758  | 2.766  | 2.749  |
|                               | Height, in.      | 5.340  | 5.460  | 5.510  |
| Strain at peak, %             |                  | 8.0    | 10.0   | 10.3   |
| Eff. Cell Pressure, psf       |                  | 5914.1 | 4795.2 | 6269.8 |
| Fail. Stress, psf             |                  | 3636.6 | 4019.3 | 4233.7 |
| Excess Pore Pr., psf          |                  | 4727.0 | 3473.0 | 4858.6 |
| Strain, %                     |                  | 8.0    | 10.0   | 10.3   |
| Ult. Stress, psf              |                  | 3636.6 | 4019.3 | 4233.7 |
| Excess Pore Pr., psf          |                  | 4727.0 | 3473.0 | 4858.6 |
| Strain, %                     |                  | 8.0    | 10.0   | 10.3   |
| $\bar{\sigma}_1$ Failure, psf |                  | 4823.6 | 5341.5 | 5644.8 |
| $\bar{\sigma}_3$ Failure, psf |                  | 1187.0 | 1322.2 | 1411.1 |

#### Type of Test:

CU with Pore Pressures

**Sample Type:** 3-in. Shelby Tube

**Description:**

LL= NP

PI= NP

**Assumed Specific Gravity=** 2.66

**Remarks:**

**Figure** \_\_\_\_\_

**Client:** CECS

**Project:** SCDOT I-85 & I-385 Interchange Modification

**Source of Sample:** WCR-1L-02

**Depth:** 15.0

**Sample Number:** T-1

**Proj. No.:** 1411010276

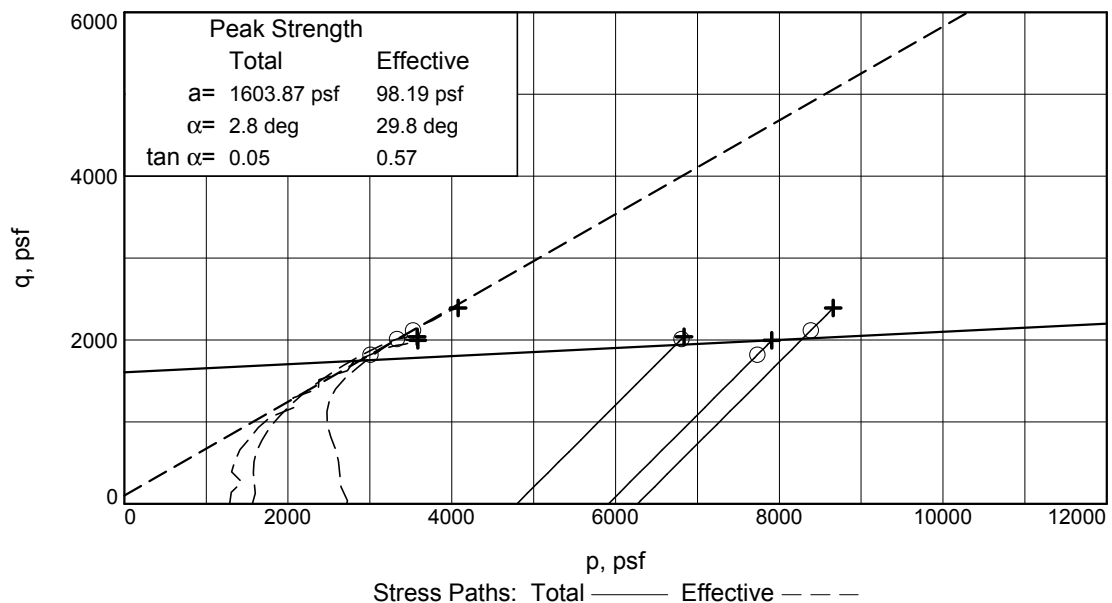
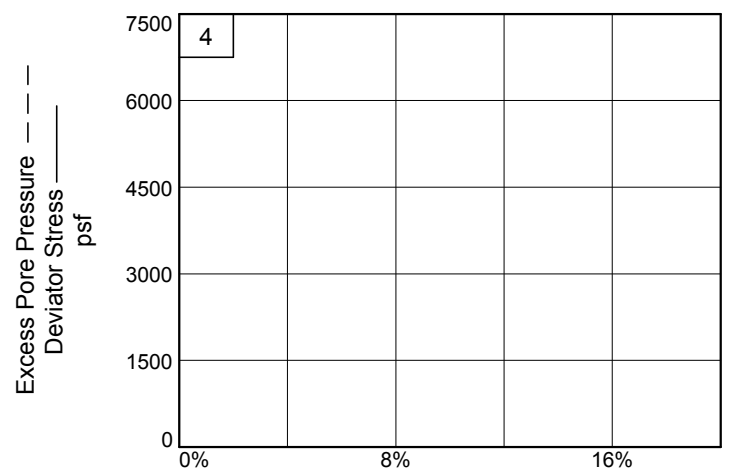
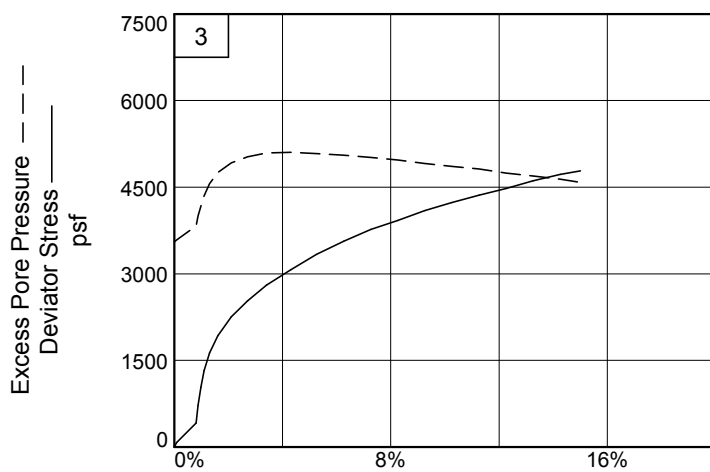
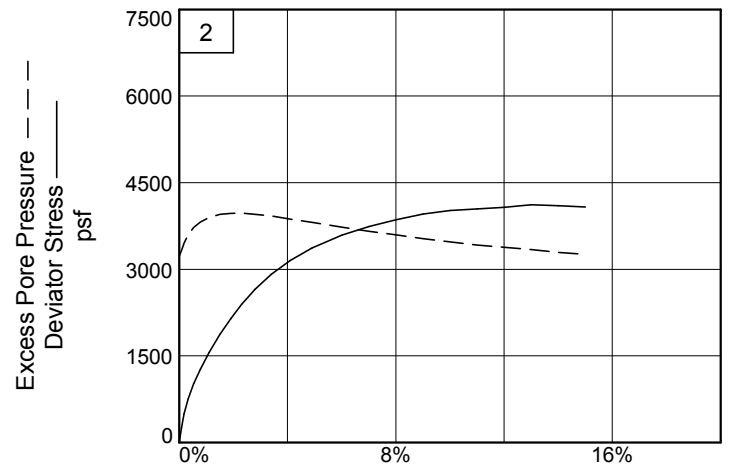
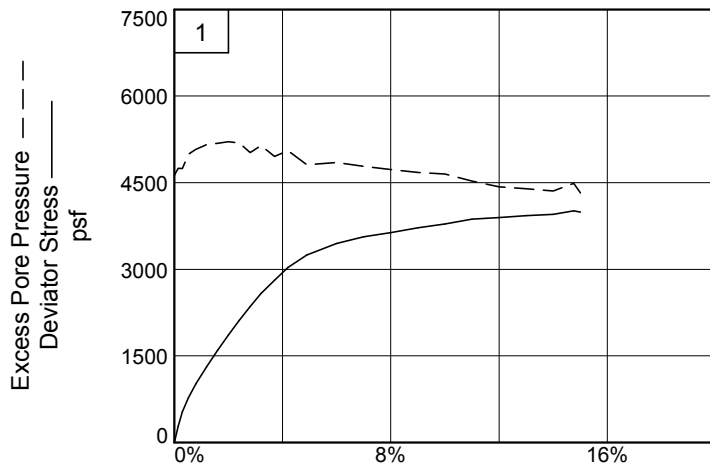
**Date Sampled:**

TRIAXIAL SHEAR TEST REPORT

Thompson Engineering  
Mobile, Alabama

**Tested By:** B. Hak





**Client:** CECS

**Project:** SCDOT I-85 & I-385 Interchange Modification

**Source of Sample:** WCR-1L-02

**Depth:** 15.0

**Sample Number:** T-1

**Project No.:** 1411010276

**Figure** \_\_\_\_\_

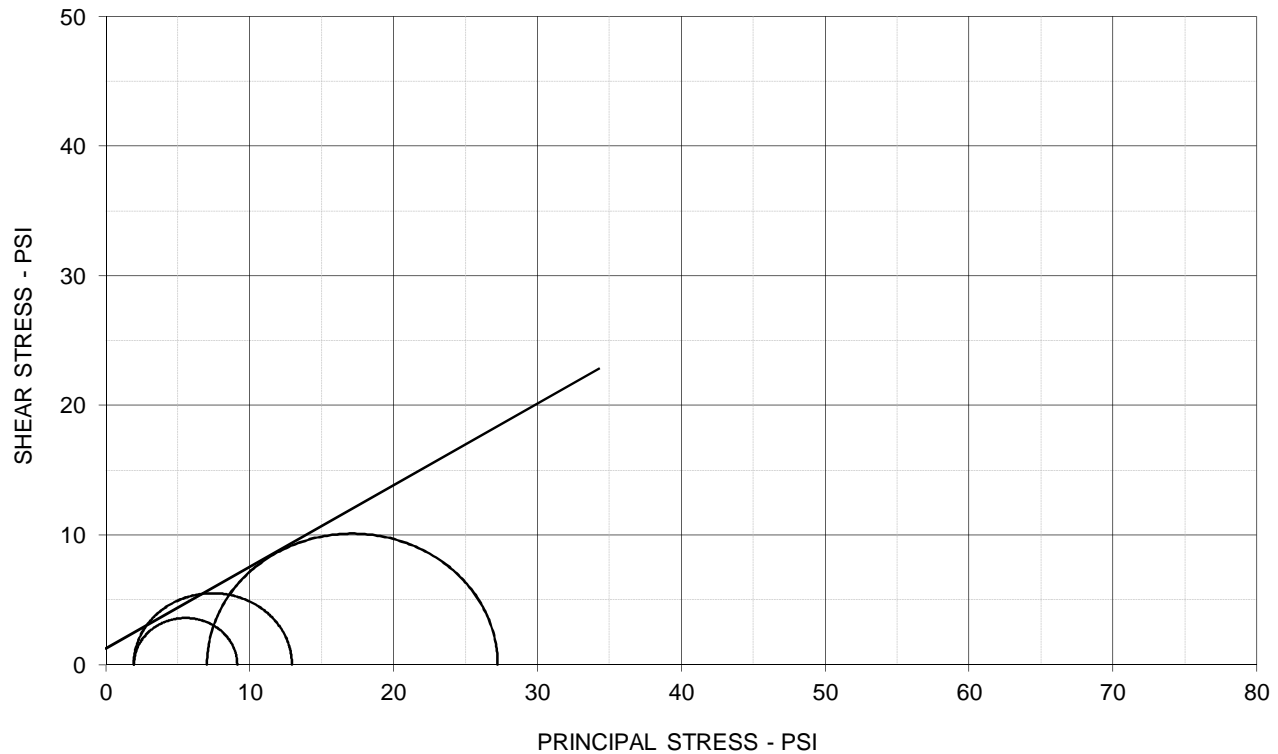
**Thompson Engineering**

**Tested By:** B. Hak

# TRIAXIAL SHEAR TEST REPORT

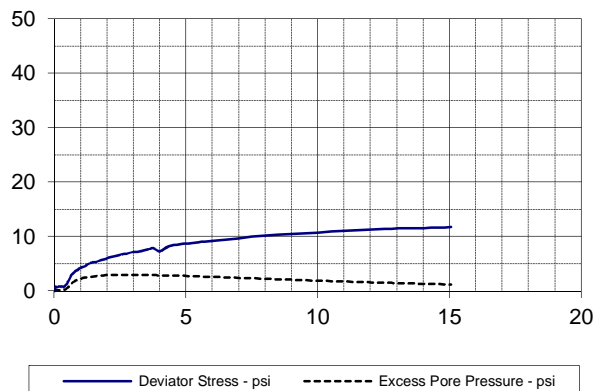


P.O. Box 5010, 51 Lost Mound Drive, Suite 135 Chattanooga, TN 37406

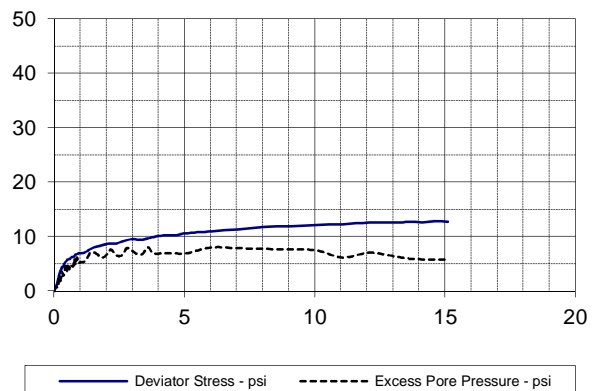


| EFFECTIVE STRESS PARAMETERS   |                           | $\phi' = 32.2 \text{ deg}$                    |      | $c' = 1.2 \text{ psi}$ |   |
|---|---------------------------|---|------|------------------------|---|
|   | SPECIMEN NO.              | 1   | 2    | 3                      | 4 |
|   | INITIAL                   |   |      |                        |   |
|   | Moisture Content - %      | 34.7  | 37.8 | 37.8                   |   |
|   | Dry Density - pcf         | 87.1  | 82.8 | 82.8                   |   |
|   | Diameter - inches         | 1.99  | 1.98 | 1.99                   |   |
|   | Height - inches           | 3.98  | 3.97 | 3.98                   |   |
|   | AT TEST                   |   |      |                        |   |
|   | Final Moisture - %        | 34.2  | 35.9 | 33.7                   |   |
|   | Dry Density - pcf         | 87.1  | 84.5 | 87.6                   |   |
|   | Calculated Diameter (in.) | 1.97  | 1.95 | 1.95                   |   |
| TEST DESCRIPTION  |                           | PROJECT INFORMATION                           |      |                        |   |
| TYPE OF TEST & NO: CU with Pore Pressure<br>SAMPLE TYPE: Shelby Tube<br>DESCRIPTION: Silty Sand (SM)<br>SAMPLE LOCATION: B06-SPT-12, T3, 35.0-37.0ft<br>ASSUMED SPECIFIC GRAVITY: 2.7<br>LL: 42    PL: 34    PI: 8    Percent -200: 44.0<br>REMARKS: Specimens trimmed to 2.0" in diameter. |                           | PROJECT: I-85/I-385 Interchange Modifications |      |                        |   |
|   |                           | LOCATION: I-85/I-385 Interchange              |      |                        |   |
|   |                           | PROJECT NO: E2156301                          |      |                        |   |
|   |                           | CLIENT: Thompson Engineering                  |      |                        |   |
|   |                           | DATE: 1/22/15                                 |      |                        |   |
|   |                           | TERRACON                                      |      |                        |   |

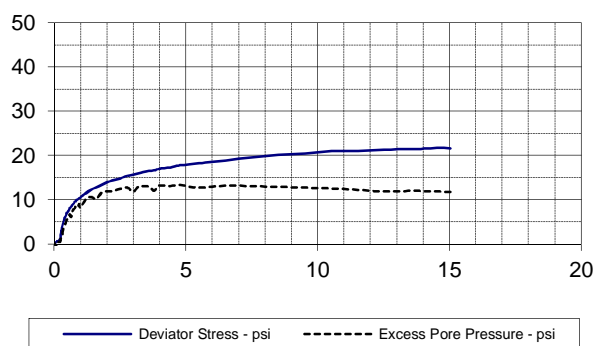
SPECIMEN NO. 1



SPECIMEN NO. 2



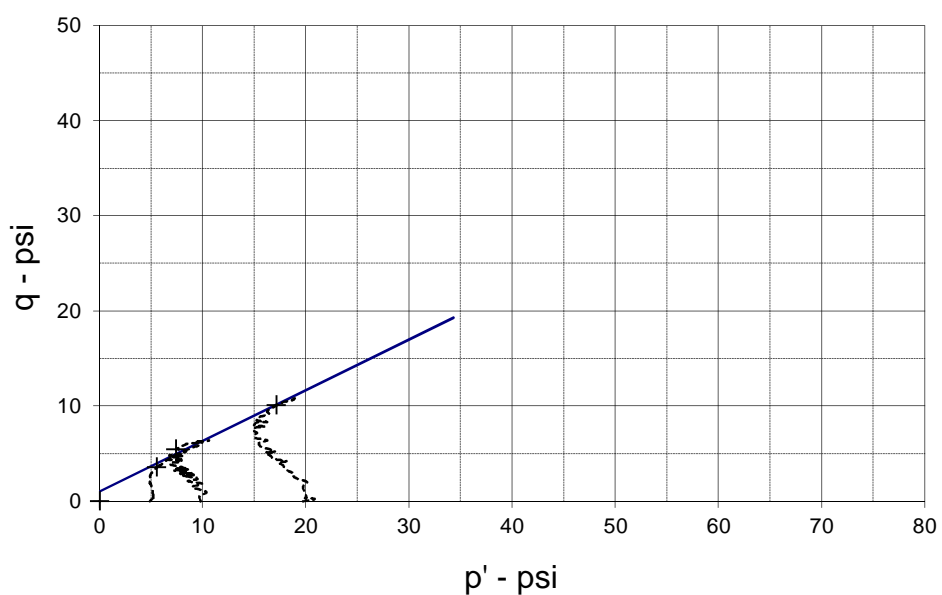
SPECIMEN NO. 3



SPECIMEN NO. 4



p - q DIAGRAM



EFFECTIVE STRESS PARAMETERS

 $R^2 = 0.99$  $\alpha$  (deg) = 28.1

a (psi) = 1.0

PROJECT: I-85/I-385 Interchange Modifications

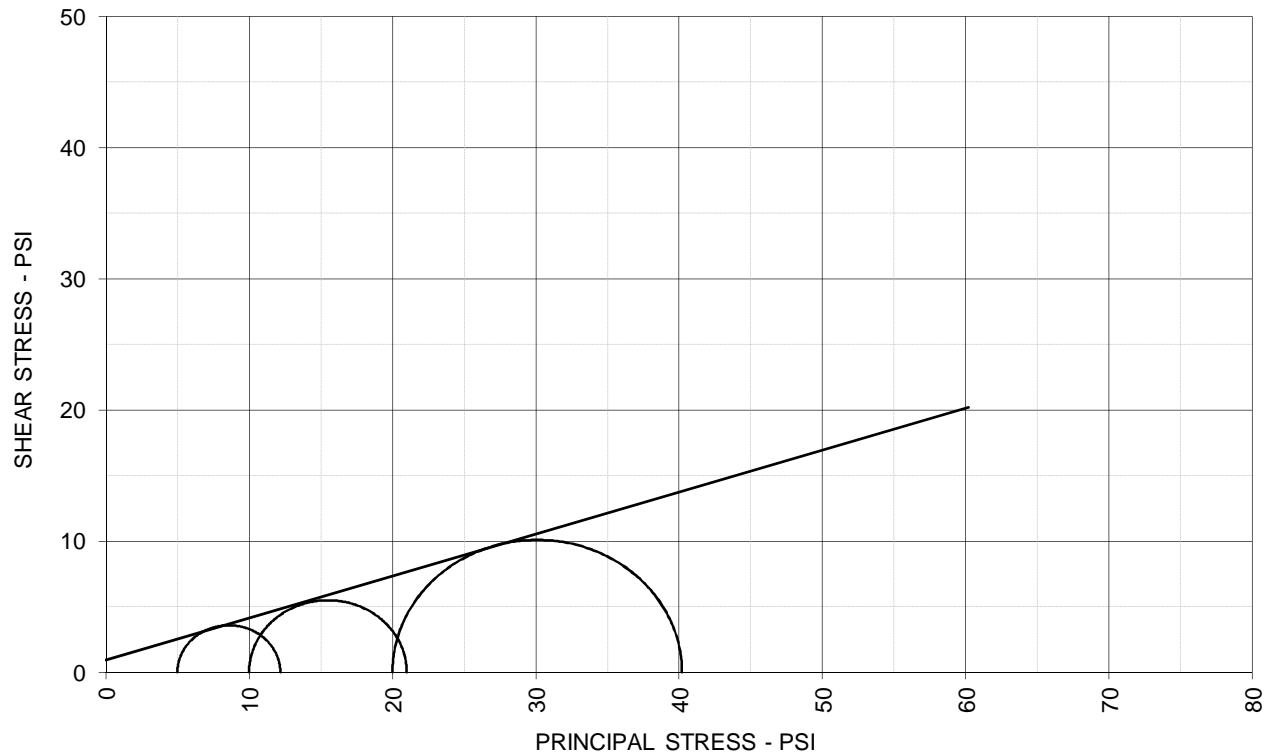
TYPE OF TEST &amp; NO: CU with Pore Pressure

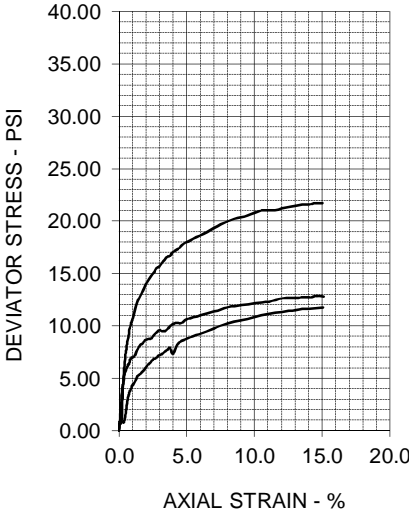
PROJECT NO: E2156301

DESCRIPTION: Silty Sand (SM)

**TERRACON**

# TRIAXIAL SHEAR TEST REPORT

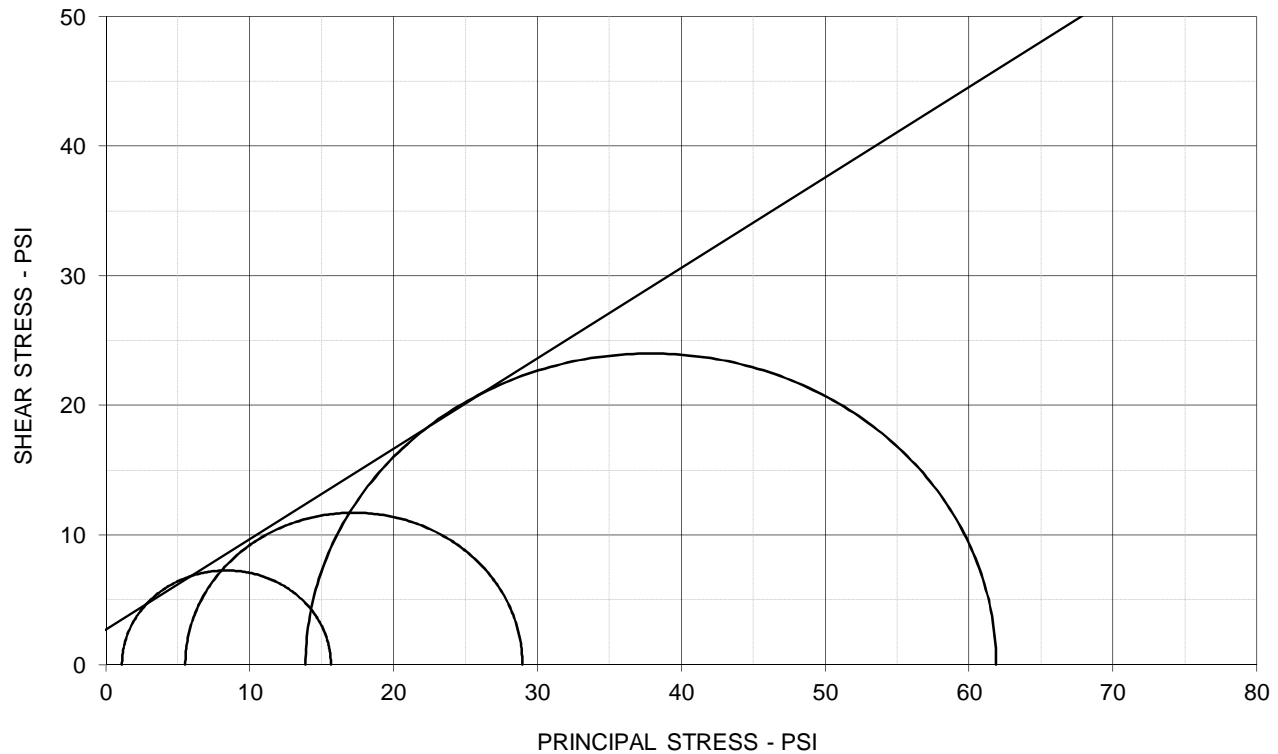


| TOTAL STRESS PARAMETERS   |                             | $\phi = 17.7 \text{ deg}$ |   | $c = 0.9 \text{ psi}$ |         |
|---|-----------------------------|---------------------------|---|-----------------------|---------|
|  | SPECIMEN NO.                |                           | 1   | 2                     | 3       |
|   | INITIAL                     |                           |   |                       |         |
|   | Moisture Content - %        |                           | 34.7  | 37.8                  | 37.8    |
|   | Dry Density - pcf           |                           | 87.1  | 82.8                  | 82.8    |
|   | Diameter - inches           |                           | 1.99  | 1.98                  | 1.99    |
|   | Height - inches             |                           | 3.98  | 3.97                  | 3.98    |
|   | AT TEST                     |                           |   |                       |         |
|   | Final Moisture - %          |                           | 34.2  | 35.9                  | 33.7    |
|   | Dry Density - pcf           |                           | 87.1  | 84.5                  | 87.6    |
|   | Calculated Diameter (in.)   |                           | 1.97  | 1.95                  | 1.95    |
|   | Height - inches             |                           | 3.93  | 3.89                  | 3.87    |
|   | Effect. Cell Pressure - psi |                           | 5.0   | 10.0                  | 20.0    |
|   | Failure Stress - psi        |                           | 7.18  | 11.00                 | 20.20   |
|   | Total Pore Pressure - psi   |                           | 53.0  | 58.1                  | 63.0    |
|   | Strain Rate - inches/min.   |                           | 0.00040                                       | 0.00040               | 0.00040 |
| Failure Strain - %  |                             | 2.9                       | 6.0   | 8.5                   |         |
| $\sigma_1$ Failure - psi  |                             | 12.18                     | 21.00   | 40.20                 |         |
| $\sigma_3$ Failure - psi  |                             | 5.00                      | 10.00   | 20.00                 |         |
| TEST DESCRIPTION  |                             |                           | PROJECT INFORMATION                           |                       |         |
| TYPE OF TEST & NO: CU with Pore Pressure  |                             |                           | PROJECT: I-85/I-385 Interchange Modifications |                       |         |
| SAMPLE TYPE: Shelby Tube  |                             |                           | LOCATION: I-85/I-385 Interchange              |                       |         |
| DESCRIPTION: Silty Sand (SM)  |                             |                           | PROJECT NO: E2156301                          |                       |         |
| SAMPLE LOCATION: B06-SPT-12, T3, 35.0-37.0ft  |                             |                           | CLIENT: Thompson Engineering                  |                       |         |
| ASSUMED SPECIFIC GRAVITY: 2.7   |                             |                           | DATE: 1/22/15                                 |                       |         |
| LL: 42      PL: 34      PI: 8      Percent -200: 44.0                               |                             |                           | TERRACON                                      |                       |         |
| REMARKS: Specimens trimmed to 2.0" in diameter.                                     |                             |                           |   |                       |         |

# TRIAXIAL SHEAR TEST REPORT



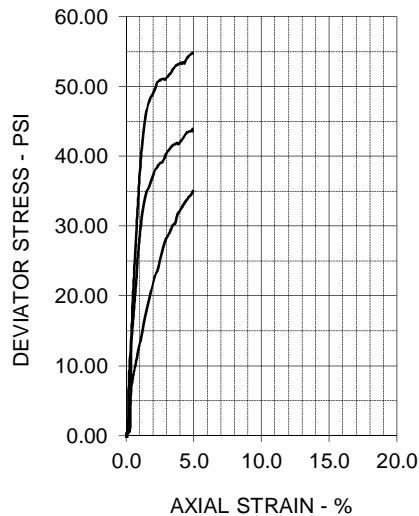
P.O. Box 5010, 51 Lost Mound Drive, Suite 135 Chattanooga, TN 37406



## EFFECTIVE STRESS PARAMETERS

$\phi' = 34.9 \text{ deg}$

$c' = 2.7 \text{ psi}$



### SPECIMEN NO.

1 2 3 4

#### INITIAL

|                      |       |       |       |
|----------------------|-------|-------|-------|
| Moisture Content - % | 20.1  | 20.1  | 20.1  |
| Dry Density - pcf    | 101.0 | 101.0 | 101.0 |
| Diameter - inches    | 2.02  | 2.02  | 2.02  |
| Height - inches      | 4.01  | 4.01  | 4.01  |

#### AT TEST

|                             |         |         |         |
|-----------------------------|---------|---------|---------|
| Final Moisture - %          |         |         | 23.5    |
| Dry Density - pcf           | 101.0   | 101.4   | 102.4   |
| Calculated Diameter (in.)   | 2.02    | 2.02    | 2.02    |
| Height - inches             | 4.01    | 4.01    | 4.02    |
| Effect. Cell Pressure - psi | 5.0     | 10.0    | 20.0    |
| Failure Stress - psi        | 14.52   | 23.43   | 48.00   |
| Total Pore Pressure - psi   | 53.9    | 54.5    | 56.1    |
| Strain Rate - inches/min.   | 0.00040 | 0.00040 | 0.00040 |
| Failure Strain - %          | 1.2     | 0.8     | 1.7     |
| $\sigma_1'$ Failure - psi   | 15.65   | 28.96   | 61.89   |
| $\sigma_3'$ Failure - psi   | 1.13    | 5.53    | 13.89   |

## TEST DESCRIPTION

TYPE OF TEST & NO: CU with Pore Pressure  
 SAMPLE TYPE: Shelby Tube  
 DESCRIPTION: Sandy Lean Clay (CL)  
 SAMPLE LOCATION: W1B-2R-03, T-1, 4.0-6.0ft  
 ASSUMED SPECIFIC GRAVITY: 2.7  
 LL: 43 PL: 23 PI: 20 Percent -200: 56.3  
 REMARKS: Multistage Triaxial

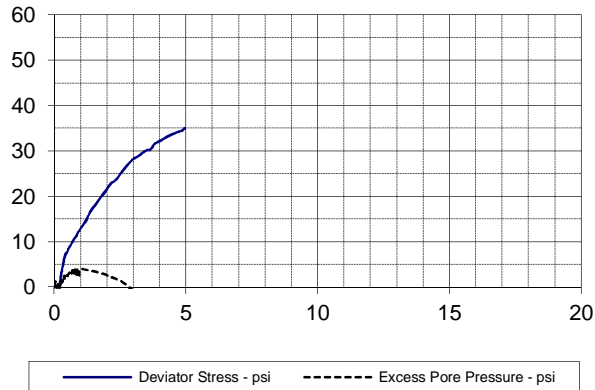
## PROJECT INFORMATION

PROJECT: I-85/I-385 Interchange Modifications  
 LOCATION: I-85/I-385 Interchange  
 PROJECT NO: E2156301  
 CLIENT: Thompson Engineering  
 DATE: 1/22/15

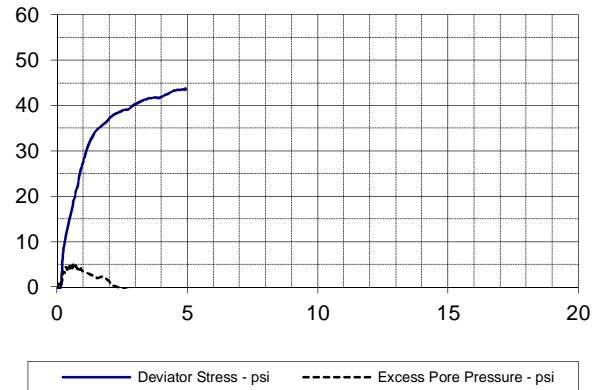
**TERRACON**



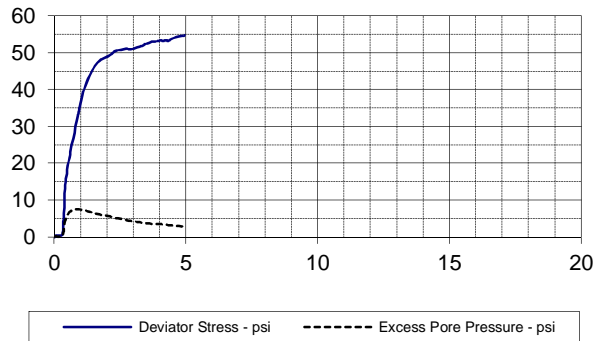
SPECIMEN NO. 1



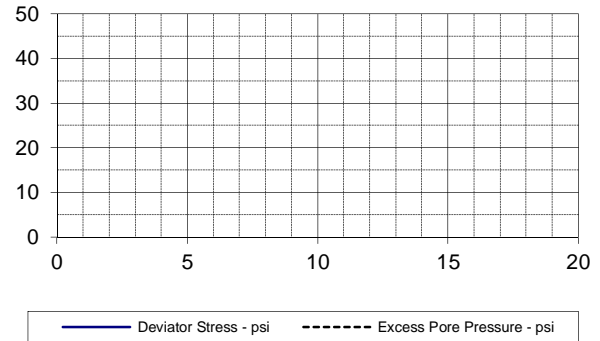
SPECIMEN NO. 2



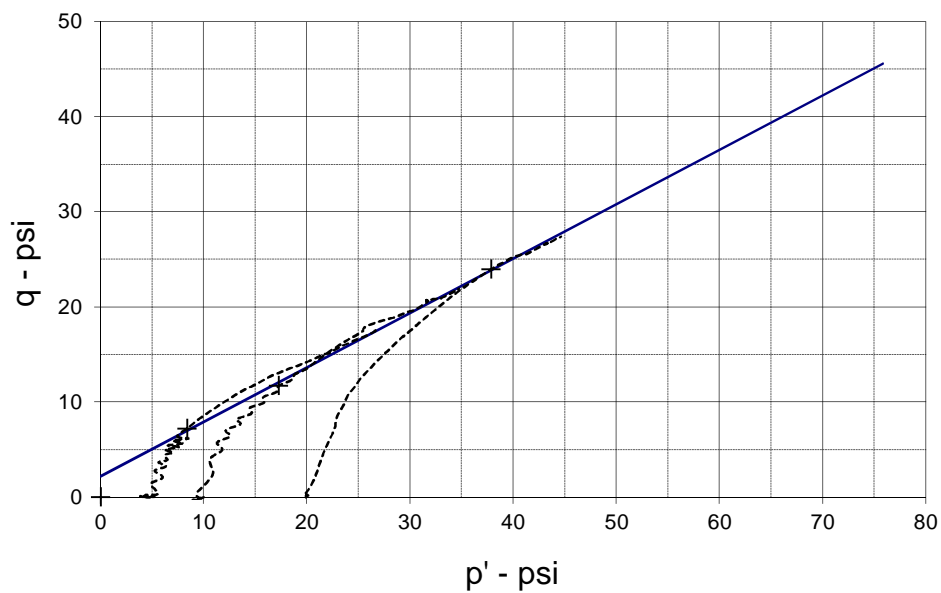
SPECIMEN NO. 3



SPECIMEN NO. 4



p - q DIAGRAM



EFFECTIVE STRESS PARAMETERS

 $R^2 = 1.00$  $\alpha$  (deg) = 29.8

a (psi) = 2.2

PROJECT: I-85/I-385 Interchange Modifications

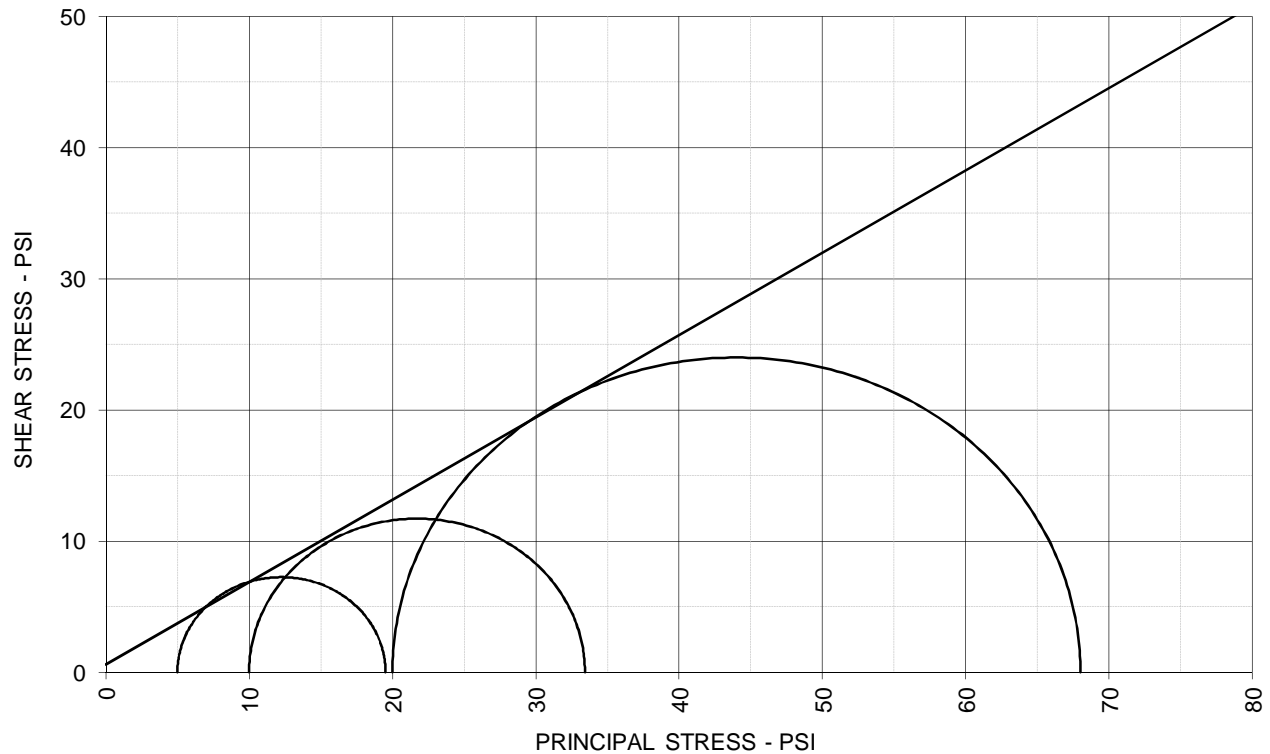
TYPE OF TEST &amp; NO: CU with Pore Pressure

PROJECT NO: E2156301

DESCRIPTION: Sandy Lean Clay (CL)

**TERRACON**

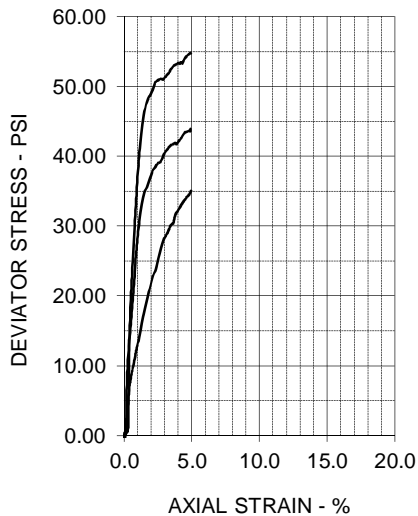
# TRIAXIAL SHEAR TEST REPORT



## TOTAL STRESS PARAMETERS

$\phi = 32.1 \text{ deg}$

$c = 0.6 \text{ psi}$



### SPECIMEN NO.

1 2 3 4

#### INITIAL

|                      |       |       |       |
|----------------------|-------|-------|-------|
| Moisture Content - % | 20.1  | 20.1  | 20.1  |
| Dry Density - pcf    | 101.0 | 101.0 | 101.0 |
| Diameter - inches    | 2.02  | 2.02  | 2.02  |
| Height - inches      | 4.01  | 4.01  | 4.01  |

#### AT TEST

|                             |         |         |         |
|-----------------------------|---------|---------|---------|
| Final Moisture - %          |         |         | 23.5    |
| Dry Density - pcf           | 101.0   | 101.4   | 102.4   |
| Calculated Diameter (in.)   | 2.02    | 2.02    | 2.02    |
| Height - inches             | 4.01    | 4.01    | 4.02    |
| Effect. Cell Pressure - psi | 5.0     | 10.0    | 20.0    |
| Failure Stress - psi        | 14.52   | 23.43   | 48.00   |
| Total Pore Pressure - psi   | 53.9    | 54.5    | 56.1    |
| Strain Rate - inches/min.   | 0.00040 | 0.00040 | 0.00040 |
| Failure Strain - %          | 1.2     | 0.8     | 1.7     |
| $\sigma_1$ Failure - psi    | 19.52   | 33.43   | 68.00   |
| $\sigma_3$ Failure - psi    | 5.00    | 10.00   | 20.00   |

## TEST DESCRIPTION

TYPE OF TEST & NO: CU with Pore Pressure  
 SAMPLE TYPE: Shelby Tube  
 DESCRIPTION: Sandy Lean Clay (CL)  
 SAMPLE LOCATION: W1B-2R-03, T-1, 4.0-6.0ft  
 ASSUMED SPECIFIC GRAVITY: 2.7  
 LL: 43 PL: 23 PI: 20 Percent -200: 56.3  
 REMARKS: Multistage Triaxial

## PROJECT INFORMATION

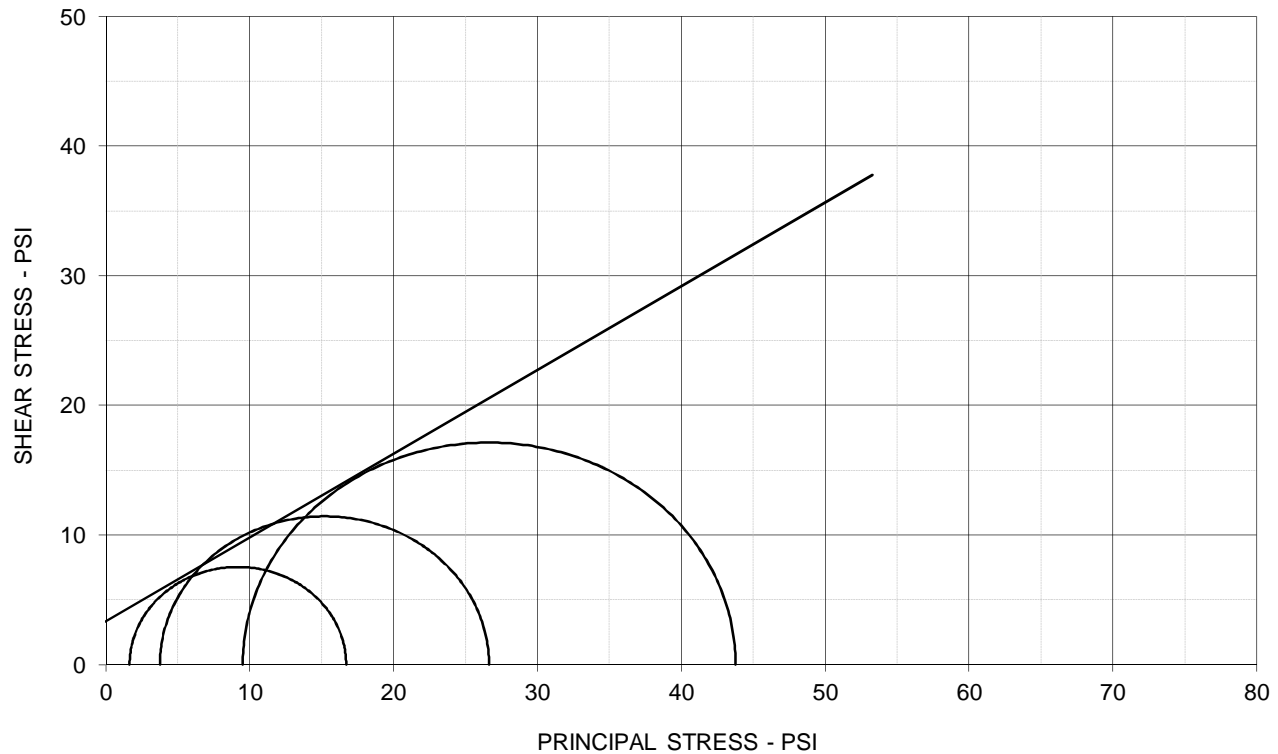
PROJECT: I-85/I-385 Interchange Modifications  
 LOCATION: I-85/I-385 Interchange  
 PROJECT NO: E2156301  
 CLIENT: Thompson Engineering  
 DATE: 1/22/15

**TERRACON**

# TRIAXIAL SHEAR TEST REPORT



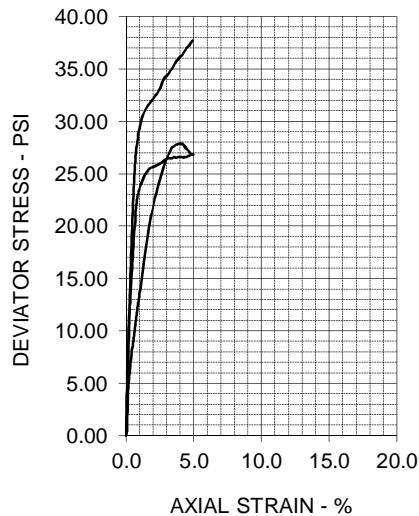
P.O. Box 5010, 51 Lost Mound Drive, Suite 135 Chattanooga, TN 37406



## EFFECTIVE STRESS PARAMETERS

$\phi' = 32.9 \text{ deg}$

$c' = 3.3 \text{ psi}$



### SPECIMEN NO.

1 2 3 4

### INITIAL

|                      |       |       |       |
|----------------------|-------|-------|-------|
| Moisture Content - % | 22.1  | 22.1  | 22.1  |
| Dry Density - pcf    | 106.4 | 106.4 | 106.4 |
| Diameter - inches    | 2.86  | 2.86  | 2.86  |
| Height - inches      | 5.72  | 5.72  | 5.72  |

### AT TEST

|                             |         |         |         |
|-----------------------------|---------|---------|---------|
| Final Moisture - %          |         |         | 20.7    |
| Dry Density - pcf           | 106.4   | 107.0   | 107.9   |
| Calculated Diameter (in.)   | 2.84    | 2.86    | 2.85    |
| Height - inches             | 5.67    | 5.72    | 5.71    |
| Effect. Cell Pressure - psi | 5.0     | 10.0    | 20.0    |
| Failure Stress - psi        | 15.05   | 22.87   | 34.25   |
| Total Pore Pressure - psi   | 53.3    | 56.2    | 60.5    |
| Strain Rate - inches/min.   | 0.00060 | 0.00060 | 0.00060 |
| Failure Strain - %          | 1.2     | 0.9     | 2.7     |
| $\sigma_1'$ Failure - psi   | 16.71   | 26.64   | 43.77   |
| $\sigma_3'$ Failure - psi   | 1.66    | 3.77    | 9.52    |

## TEST DESCRIPTION

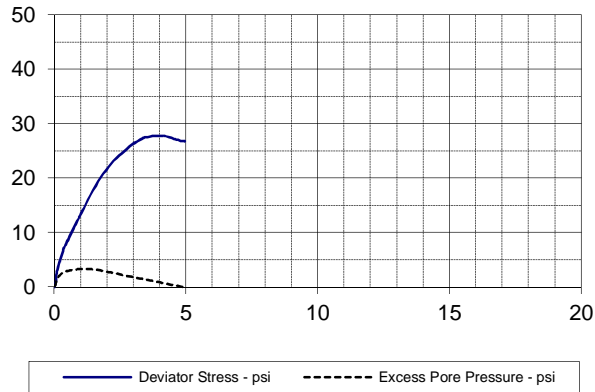
TYPE OF TEST & NO: CU with Pore Pressure  
 SAMPLE TYPE: Shelby Tube  
 DESCRIPTION: Silty Sand (SM)  
 SAMPLE LOCATION: W1B-2R-03, T-2, 15.0-17.0ft  
 ASSUMED SPECIFIC GRAVITY: 2.7  
 LL: 43 PL: 35 PI: 8 Percent -200: 21.9  
 REMARKS: Multistage Triaxial

## PROJECT INFORMATION

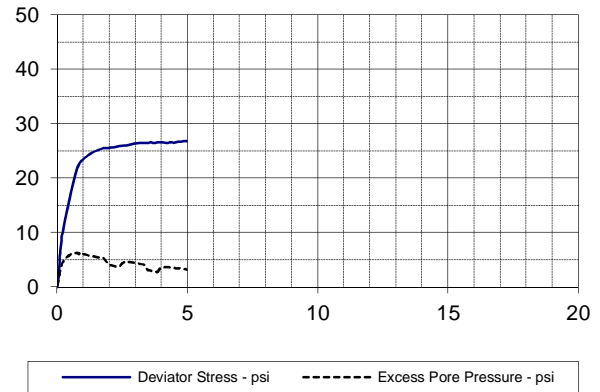
PROJECT: I-85/I-385 Interchange Modifications  
 LOCATION: I-85/I-385 Interchange  
 PROJECT NO: E2156301  
 CLIENT: Thompson Engineering  
 DATE: 1/22/15

**TERRACON**

SPECIMEN NO. 1



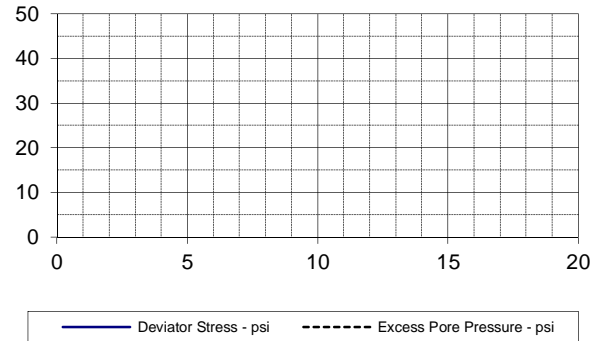
SPECIMEN NO. 2



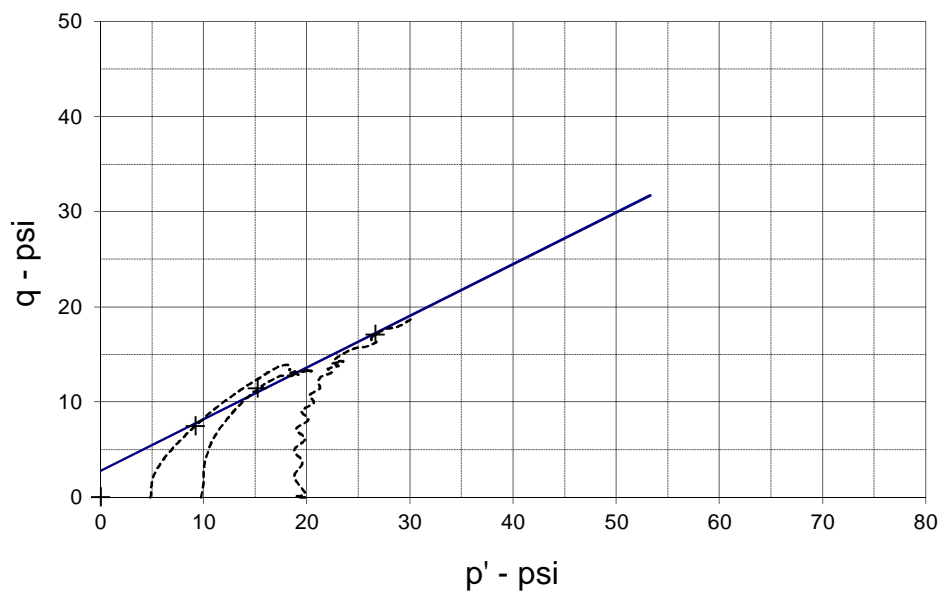
SPECIMEN NO. 3



SPECIMEN NO. 4



p - q DIAGRAM



EFFECTIVE STRESS PARAMETERS

 $R^2 = 1.00$  $\alpha$  (deg) = 28.5

a (psi) = 2.8

PROJECT: I-85/I-385 Interchange Modifications

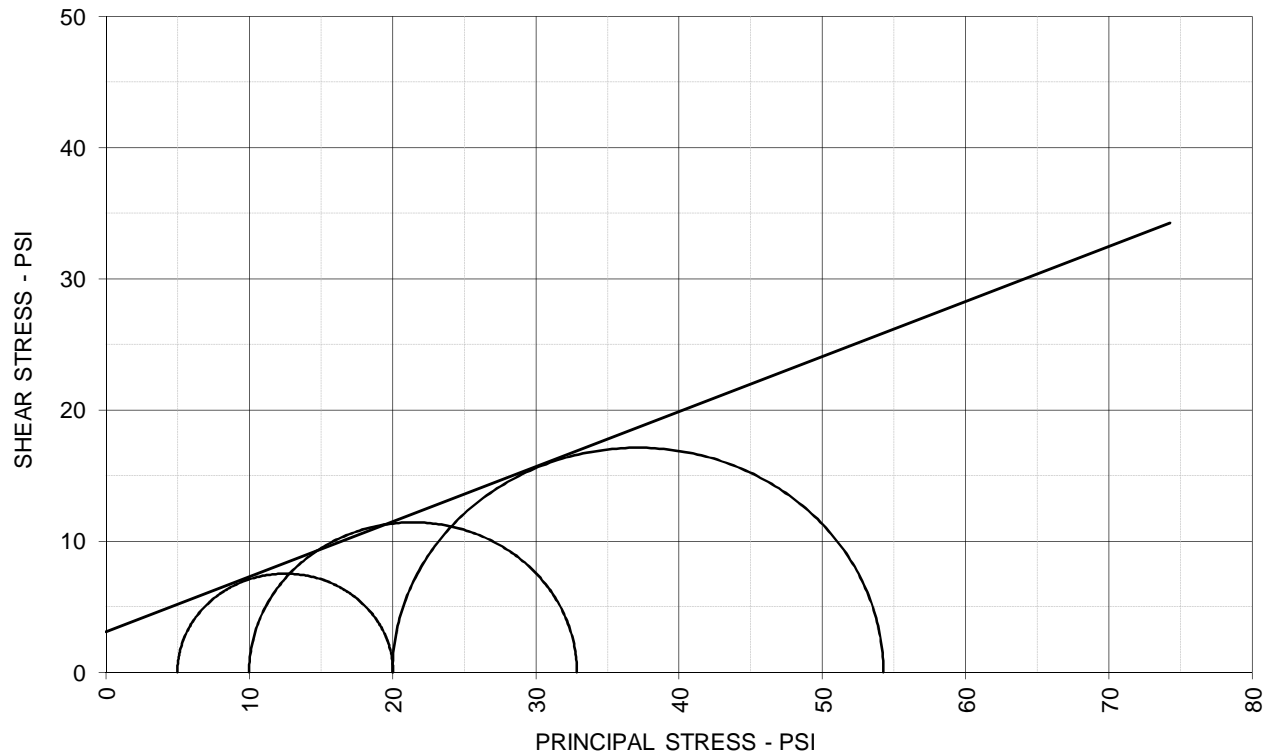
TYPE OF TEST &amp; NO: CU with Pore Pressure

PROJECT NO: E2156301

DESCRIPTION: Silty Sand (SM)

**TERRACON**

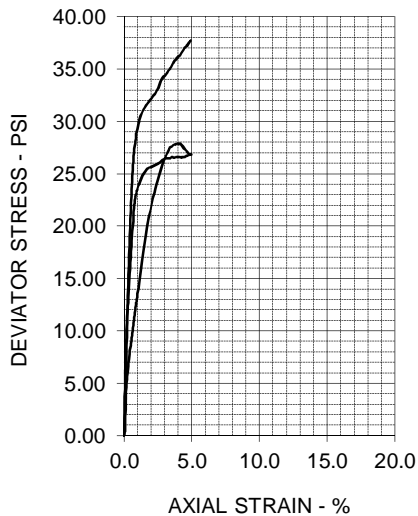
# TRIAXIAL SHEAR TEST REPORT



## TOTAL STRESS PARAMETERS

$\phi = 22.8 \text{ deg}$

$c = 3.1 \text{ psi}$



### SPECIMEN NO.

1

2

3

4

### INITIAL

Moisture Content - %

22.1

22.1

22.1

Dry Density - pcf

106.4

106.4

106.4

Diameter - inches

2.86

2.86

2.86

Height - inches

5.72

5.72

5.72

### AT TEST

Final Moisture - %

20.7

Dry Density - pcf

106.4

107.0

107.9

Calculated Diameter (in.)

2.84

2.86

2.85

Height - inches

5.67

5.72

5.71

Effect. Cell Pressure - psi

5.0

10.0

20.0

Failure Stress - psi

15.05

22.87

34.25

Total Pore Pressure - psi

53.3

56.2

60.5

Strain Rate - inches/min.

0.00060

0.00060

0.00060

Failure Strain - %

1.2

0.9

2.7

$\sigma_1$  Failure - psi

20.05

32.87

54.25

$\sigma_3$  Failure - psi

5.00

10.00

20.00

## TEST DESCRIPTION

TYPE OF TEST & NO: CU with Pore Pressure

SAMPLE TYPE: Shelby Tube

DESCRIPTION: Silty Sand (SM)

SAMPLE LOCATION: W1B-2R-03, T-2, 15.0-17.0ft

ASSUMED SPECIFIC GRAVITY: 2.7

LL: 43 PL: 35 PI: 8 Percent -200: 21.9

REMARKS: Multistage Triaxial

## PROJECT INFORMATION

PROJECT: I-85/I-385 Interchange Modifications

LOCATION: I-85/I-385 Interchange

PROJECT NO: E2156301

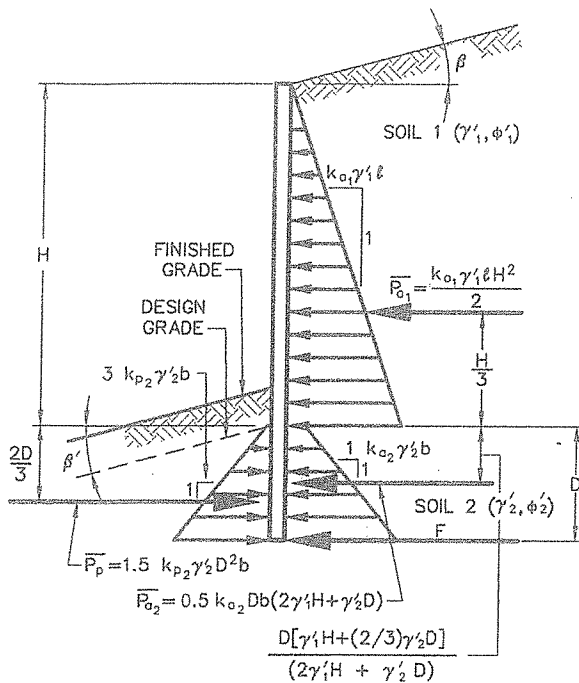
CLIENT: Thompson Engineering

DATE: 1/22/15

**TERRACON**

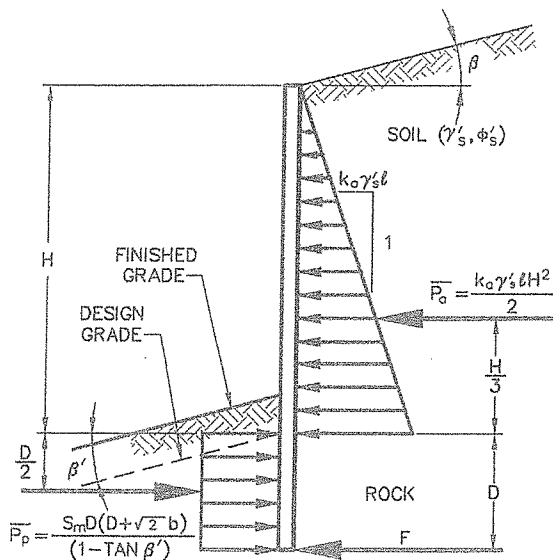


**Plan and Profile Sheets (Excluded from Electronic Transmittal)**



b = ACTUAL WIDTH OF EMBEDDED DISCRETE VERTICAL WALL ELEMENT BELOW DESIGN GRADE IN PLANE OF WALL (FT.).

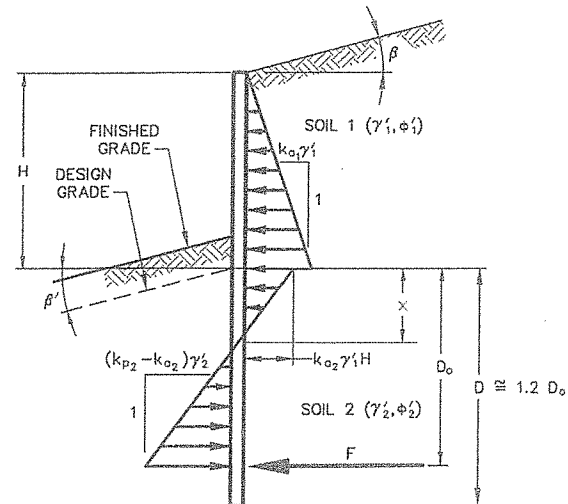
**Figure 3.11.5.6-1—Unfactored Simplified Earth Pressure Distributions for Permanent Nongravity Cantilevered Walls with Discrete Vertical Wall Elements Embedded in Granular Soil**



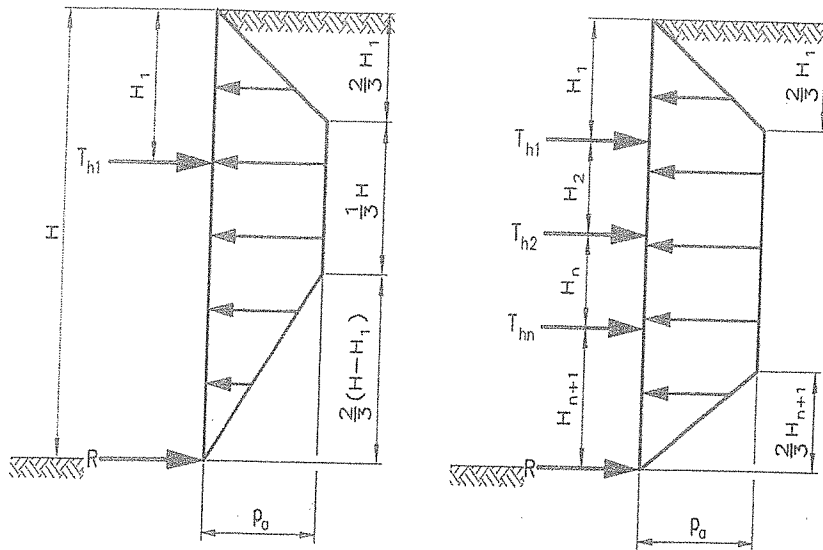
b = ACTUAL WIDTH OF EMBEDDED DISCRETE VERTICAL WALL ELEMENT BELOW DESIGN GRADE IN PLANE OF WALL (FT.).

**Figure 3.11.5.6-2—Unfactored Simplified Earth Pressure Distributions for Permanent Nongravity Cantilevered Walls with Discrete Vertical Wall Elements Embedded in Rock**

### SECTION 3: LOADS AND LOAD FACTORS



**Figure 3.11.5.6-3—Unfactored Simplified Earth Pressure Distributions for Permanent Nongravity Cantilevered Walls with Continuous Vertical Wall Elements Embedded in Granular Soil Modified after Teng (1962)**



(a) Wall with one level of ground anchors

(b) Walls with multiple levels of ground anchors

Figure 3.11.5.7.1-1—Apparent Earth Pressure Distributions for Anchored Walls Constructed from the Top Down in Cohesionless Soils

... from the excavation base up to a maximum value of  $B_e/\sqrt{2}$ , where  $B_e$  is the excavation width.

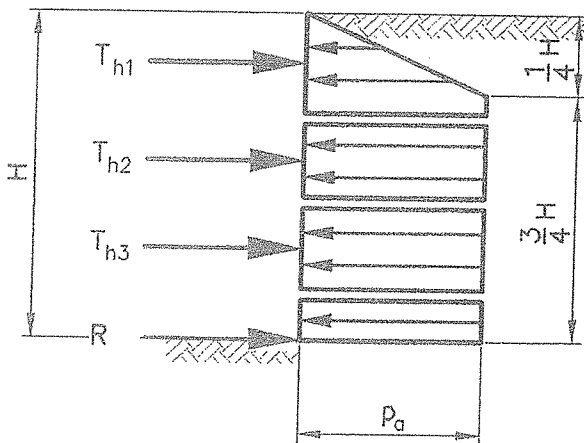


Figure 3.11.5.7.2b-1—Apparent Earth Pressure Distribution for Anchored Walls Constructed from the Top Down in Soft to Medium Stiff Cohesive Soils

Table 10-38, Cut ERS Performance Limits at SLS

| Deformation ID No.           |  | Service Limit State   |                           |                           |                           |
|------------------------------|--|---|---------------------------|---------------------------|---------------------------|
|                              |  | Performance Limit Description   |                           |                           |                           |
| Settlement<br>(Longitudinal) | RV-01  | Minimum Design Life (Years) <sup>(1)</sup>  |                           |                           |                           |
|                              |  | Maximum Vertical Settlement at any point on top of the wall profile grade over the design life of the ERS (Inches)  | 100                       | 100                       | 75                        |
|                              |  | Maximum Rate of Settlement per year after the ERS has been constructed (Inches per year)  | 8.00"                     | 8.00"                     | 8.00"                     |
|                              | RV-02  |   | 0.10                      | 0.10                      | 0.20                      |
| RV-03                        | Maximum Vertical Differential Settlement at Top of Wall Profile grade over the life of the structure. (Inches/50 feet of wall) |   |                           |                           |                           |
|                              | (Maximum settlement ratio indicated in parenthesis for informational purposes only)  | 1.50" (1/400)   | 2.00" (1/300)             | 3.00" (1/200)             |                           |
| Settlement<br>(Transverse)   | RV-04  | Maximum Vertical Differential Settlement Perpendicular to the wall facing profile over the design life of the structure. <sup>(2)</sup> (Inches/5 feet of wall) |                           |                           |                           |
|                              |  | Embedded Walls w/Anchors, In-Situ Reinforced Earth Walls  | 0.100 L <sub>Anchor</sub> | 0.100 L <sub>Anchor</sub> | 0.150 L <sub>Anchor</sub> |
| Lateral<br>Displacements     | RL-01  | Maximum Lateral Displacement at the top of the wall. <sup>(3)</sup> (Inches)  | 0.015 H <sub>Wall</sub>   | 0.015 H <sub>Wall</sub>   | 0.025 H <sub>Wall</sub>   |
|                              |  | Embedded Walls  | 0.035 H <sub>Wall</sub>   | 0.035 H <sub>Wall</sub>   | 0.045 H <sub>Wall</sub>   |
|                              | RL-02  | Maximum Differential Lateral Displacement longitudinally along the top of the wall. (Inches/50 feet of wall)  | 1.00"                     | 1.00"                     | 1.00"                     |
|                              | RL-03  | Maximum Angle of Rotation (θ) of the ERS Facing from the original constructed ERS facing after lateral displacements have occurred. (Degrees)                   | <1°                       | <1°                       | <1°                       |
|                              |  | Embedded Walls  | <2°                       | <2°                       | <2°                       |

<sup>(1)</sup> The Minimum Design Life for temporary structures that will be in service more than 3 years is 75 years. The Minimum Design Life for temporary earth retaining structures that will be in service for less than 3 years is 3 years.

<sup>(2)</sup> The soil anchor length (L<sub>Anchor</sub>) is measured in feet.

<sup>(3)</sup> The wall height (H<sub>Wall</sub>) is measured in feet.

Table 10-43, Cut ERS Performance Limits at EE I Limit State

| Deformation ID No.                 | Performance Limit Description   | ROC |                          |                          |
|------------------------------------|---|-----|--------------------------|--------------------------|
|                                    |   | I   | II                       | III                      |
| RV-03<br>(Longitudinal Settlement) | Maximum Vertical Differential Settlement at Top of Wall Profile grade over the life of the structure. (Inches/50 feet of wall)                                  | FEE | 1.50"<br>(1/400)         | 3.00"<br>(1/200)         |
|                                    | (Maximum settlement ratio indicated in parenthesis for informational purposes only)   | SEE | 3.00"<br>(1/200)         | 6.00"<br>(1/100)         |
| RV-04<br>(Transverse Settlement)   | Maximum Vertical Differential Settlement Perpendicular to the wall facing profile over the design life of the structure. <sup>(1)</sup> (Inches/5 feet of wall) | FEE | 0.100 L <sub>Reinf</sub> | 0.150 L <sub>Reinf</sub> |
|                                    | Embedded Walls w/Anchors, In-Situ Reinforced Earth Walls  | SEE | 0.200 L <sub>Reinf</sub> | 0.300 L <sub>Reinf</sub> |
| RL-01<br>(Lateral Displacements)   | Maximum Lateral Displacement at the top of the wall. <sup>(2)</sup> (Inches)  | FEE | 0.015 H <sub>Wall</sub>  | 0.025 H <sub>Wall</sub>  |
|                                    |   | SEE | 0.030 H <sub>Wall</sub>  | 0.050 H <sub>Wall</sub>  |
|                                    | Embedded Walls  | FEE | 0.035 H <sub>Wall</sub>  | 0.045 H <sub>Wall</sub>  |
|                                    |   | SEE | 0.070 H <sub>Wall</sub>  | 0.090 H <sub>Wall</sub>  |
| RL-02                              | Maximum Differential Lateral Displacement longitudinally along the top of the wall. (Inches/50 feet of wall)  | FEE | 1.00"                    | 1.00"                    |
|                                    | All Cut Earth Retaining Structures  | SEE | 2.00"                    | 2.00"                    |
| RL-03                              | Maximum Angle of Rotation ( $\theta$ ) of the ERS Facing from the original constructed ERS facing after lateral displacements have occurred. (Degrees)          | FEE | <1°                      | <1°                      |
|                                    |   | SEE | <2°                      | <2°                      |
|                                    | Embedded Walls  | FEE | <2°                      | <2°                      |
|                                    |   | SEE | <3°                      | <3°                      |

(1) The soil reinforcement length (L<sub>Reinf</sub>) is measured in feet.(2) The wall height (H<sub>Wall</sub>) is measured in feet.



## REVIEW COMMENTS

|                             |                                     |
|-----------------------------|-------------------------------------|
| <b>Project ID:</b>          |                                     |
| <b>County:</b>              | Greenville                          |
| <b>Project Description:</b> | I-85/I-385 Interchange Improvements |

|                   |  |
|-------------------|--|
| <b>Submittal:</b> | D-0021_Memos for MSEWs, Cut Walls, Cut & Fill Slopes |
| <b>Date:</b>      | May 15, 2015   |
| <b>Reviewers:</b> | SCDOT, FHWA, ICE & ICA                               |

| No.  | Reviewer | Dwg. No. | COMMENTS  | RESPONSES   | Status |
|--|----------|----------|---|---|--------|
| <b>GEOTECHNICAL &amp; STRUCTURAL</b>   |          |          |   |   |        |
| <b>Memorandum: MSE Walls with Heights exceeding 40 feet, dated May 5, 2015 &amp; rev. May 15, 2015 – Associated with Comment 1, D-0021 Geotech &amp; Structures Matrix</b> |          |          |   |   |        |
| 1  | MAH/DLC  | General  | Provide calculations for the sliding resistance check for the Strength and Extreme Event I limit states.  | Acknowledged. Calculations will be provided as part of the final BGER or RGER as appropriate.<br><br><i>Calculations provided in memorandum.</i>  | 4      |
| 2  | JCS/DLC  | General  | Provide estimated vertical and lateral displacements for the Service and Extreme Event I limit states.  | Settlement analysis will be included in the appropriate BGER or RGER. The analysis will consider performance limits provided in Chapter 10 of the GDM.<br><br><i>See response to comment 2.1.</i>       | 4      |
| 2.1  | MAH      | General  | Provide estimated vertical and lateral displacements for the Service and Extreme Event I limit states.  | Per discussions with SCDOT and ICA, total settlements are still under evaluation. Discussion added to memorandum regarding time rate (i.e. primary vs. secondary settlement) and lateral displacements. | 4      |
| 2.2  | DLC      | General  | <ul style="list-style-type: none"> <li>Please verify in the final roadway report that the correct performance limits are being referenced and used. Such as RL-01 for MSE walls is <math>0.035 \cdot H_{wall}</math>.</li> <li>Also, in the updated memos it is mentioned that Equation C-48 was used but C-47 was the actual one calculated and mentioned. In the final report, please review and ensure the correct equation is used for the type of reinforcement utilized.</li> <li>Lastly, in the final report, please include calculations for the vertical displacements.</li> </ul> | <i>No response required. Please address in final report.</i>  | 3      |
| 3  | JCS      | General  | Briefly discuss any construction techniques that will be required to achieve a positive batter/vertical wall once the entire wall has been constructed.   | Discussion will be incorporated into the final BGER or RGER as appropriate.<br><br><i>See response to comment 3.1</i>   | 4      |
| 3.1  | MAH      | General  | Briefly discuss any construction techniques that will be required to achieve a positive batter/vertical wall once the entire wall has been constructed.   | Brief discussion added to the memo regarding maintaining positive vertical displacement. Maintaining positive batter is an internal design question and should  | 4      |

## REVIEW COMMENTS

|                             |                                     |
|-----------------------------|-------------------------------------|
| <b>Project ID:</b>          |                                     |
| <b>County:</b>              | Greenville                          |
| <b>Project Description:</b> | I-85/I-385 Interchange Improvements |

|                   |  |
|-------------------|--|
| <b>Submittal:</b> | D-0021_Memos for MSEWs, Cut Walls, Cut & Fill Slopes |
| <b>Date:</b>      | May 15, 2015   |
| <b>Reviewers:</b> | SCDOT, FHWA, ICE & ICA                               |

| No. | Reviewer | Dwg. No. | COMMENTS  | RESPONSES  | Status |
|-----|----------|----------|---|--|--------|
|     |          |          |   | be addressed by the wall designer.   |        |
| 4   | JCS      | General  | Provide calculations and documentation for the required shear force needed in the timber piles used in global stability analyses.   | These numbers are preliminary and will be revised and presented in the final BGER or RGER if required as part of the final design.<br><br>See response to comment 4.1  | 4      |
| 4.1 | MAH      | General  | Since the potential for ground improvement using timber piles exists, provide calculations and documentation for the shear force needed in the timber piles used in the global stability analysis.  | Provided in memorandum.  | 4      |
| 5   | DLC      | General  | For all of the analysis, please include the output files from the analysis programs selected.   | Acknowledged, and will be provided in the final BGER or RGER.  | 3      |
| 6   | MAH/DLC  | Page 4   | Table 3 - Verify cohesion values used in slope stability analysis. Please provide evidence from laboratory shear strength testing (indicating which test) corresponds to the values used in the slope stability analysis model.   | Shear strength values are preliminary and will be revisited in the final BGER or RGER. Final reports will reference specific tests, where applicable or correlations provided in the GDM.<br><br>Shear strength values were adjusted and additional explanation is provided on method to select shear strength values. | 4      |
| 7   | DLC      | Page 4   | For the total stress condition assuming clayey soils, it appears that both effective and total stress parameters are being shown and used in the analysis. For example, soil layer 1 with a reported cohesion of 900 PSF with a friction angle of 24° is being shown. Please refer to Sections 7.10 and 7.11 in the GDM when estimating soil strength parameters. | See response to comment 6.   | 4      |
| 7.1 | DLC      | Page 4   | For comments 6 and 7, please verify that revising the soil parameters to something in accordance with the GDM for the various analyses (short term and long term) would not have any impact on the current ROW plans.   | At this location modifying shear strength parameters will not modify the current ROW plans.  | 4      |
| 8   | DLC      | Page 4   | In the final report, please include the third method for the slope stability analysis.  | Acknowledged<br><br>Incorporated into revised memorandum.  | 4      |

## REVIEW COMMENTS

|                             |                                     |
|-----------------------------|-------------------------------------|
| <b>Project ID:</b>          |                                     |
| <b>County:</b>              | Greenville                          |
| <b>Project Description:</b> | I-85/I-385 Interchange Improvements |

|                   |  |
|-------------------|--|
| <b>Submittal:</b> | D-0021_Memos for MSEWs, Cut Walls, Cut & Fill Slopes |
| <b>Date:</b>      | May 15, 2015   |
| <b>Reviewers:</b> | SCDOT, FHWA, ICE & ICA                               |

| No. | Reviewer | Dwg. No.      | COMMENTS   | RESPONSES  | Status |
|-----|----------|---------------|--|--|--------|
|     | DLC      | Page 4        | Please use the surcharge loads as recommended in the GDM 17.3.1 and 17.3.3.  | Acknowledged.<br><br>Incorporated into revised memorandum.   | 4      |
| 10  | MAH/DLC  | Page 4        | In future reports, revise "Reduction Factor" to "Resistance Factor".   | Acknowledged and will update in future reports.<br><br>Corrected in revised memorandum.  | 4      |
| 11  | DLC      | Page 4        | Please discuss the selection of the timber piles to help improve the slope stability of these proposed MSE walls. Were any other ground improvement methods reviewed and/or analyzed? If so, please include in the discussion. Also, provide any specifics on these preliminary timber piles (type, diameter, etc.) Please provide preliminary estimates on the station limits for the ground modification needed. | Timber piles are the contractor's preferred ground improvement/modification method. Other systems are possible (i.e. stone columns, hardened inclusions, etc). This analysis was intended to show the feasibility of constructing the wall, not the final analysis. Limits of ground improvement will be discussed in the final reports. | 3      |
| 12  | DLC      | Page 4        | In the final report and along the proposed MSE Wall, please verify if conflicting strap lengths occur for these very tall MSE walls with long straps. If a Back to Back wall scenario exists, please design these in accordance with FHWA-NHI-10-024.  | Acknowledged and will incorporate.   | 3      |
| 13  | MAH/DLC  | Page 5        | Verify calculation for determining $\alpha_w$ is correct.  | Calculation is incorrect and will be updated. The error provides a more conservative result (higher wave scattering coefficient).<br><br>Calculation is corrected in the revised memorandum.   | 4      |
| 14  | DLC      | Page 5        | It appears the boring selected for the liquefaction screening was not performed at this MSE wall area? Please explain.   | We provided this boring as a single example calculation. Screening was performed on all borings considered in this analysis. No SSL or Liquefaction potential was identified.  | 3      |
| 15  | MAH/DLC  | Pages 21 - 38 | It is difficult to determine which boring the samples were obtained from for the shear strength testing that was performed. Recommend showing the boring number, sample number, and depth of sample on each shear strength test record.  | Acknowledged. This will be corrected in final reports.   | 3      |
| 16  | DLC      | Pages 39 - 40 | Please review the liquefaction spreadsheet fines content calculation and compare with the GDM.   | In accordance with Section 13.11.2 (page 13-51) of the GDM, the fines content for SSL and Liquefaction are   | 3      |

## REVIEW COMMENTS

|                             |                                     |
|-----------------------------|-------------------------------------|
| <b>Project ID:</b>          |                                     |
| <b>County:</b>              | Greenville                          |
| <b>Project Description:</b> | I-85/I-385 Interchange Improvements |

|                   |  |
|-------------------|--|
| <b>Submittal:</b> | D-0021_Memos for MSEWs, Cut Walls, Cut & Fill Slopes |
| <b>Date:</b>      | May 15, 2015   |
| <b>Reviewers:</b> | SCDOT, FHWA, ICE & ICA                               |

| No.  | Reviewer | Dwg. No.      | COMMENTS   | RESPONSES  | Status |
|------|----------|---------------|--|--|--------|
|      |          |               |  | based on the soil fraction passing the No. 4 sieve.<br><br><i>See response to comment 16.1</i>   |        |
| 16.1 | DLC      | Pages 39-40   | Please review the liquefaction spreadsheet fines content calculation and compare with the GDM. Please review the GDM and the liquefaction literature referenced in the GDM for further clarification.            | We have modified based on subsequent discussions. It is our opinion that the text in the GDM is not clear in this regard. We would suggest SCDOT provide clarification in a design memorandum that the intent of the Fines Content revision is to exclude soil material greater than the No. 4 sieve from the Fines Content calculation, rather than defining as the "soil fraction passing in the No. 4 sieve". | 3      |
| 16.2 | DLC      | Pages 39-40   | In the final report, please include discussion on the selection of the KDR values used in the liquefaction analysis.   | <i>No response required. Please address in final report.</i>   | 3      |
| 17   | DLC      | Pages 41 - 47 | Please verify that the reported failure surfaces are the critical failure surfaces and are not being restricted by the search limits.  | Surfaces are not being restricted by search limits. Future analysis will be prepared in Slide by Rocscience versus SlopeW which will graphically demonstrate this.<br><br><i>Updated memorandum incorporates analysis in Slide and demonstrate failure surfaces are not restricted.</i>  | 4      |
| 18   | MAH      | Pages 48 - 54 | Are the bearing resistance calculations for the MSE Wall at End Bent 6 on Bridge 7 or for the MSE Wall parallel to Ramp 2B centerline at Station 39+50?  | Transverse to Bridge Centerline at End Bent 6 on Bridge 7.   | 4      |
| 19   | JCS      | Pages 50 & 51 | Does the bearing resistance calculation account for the wall bearing on a 2:1 slope? Section 10.6.3.1.2c should be used when determining the reduction in bearing resistance due to the wall bearing on a slope. | Calculations do not currently account for 2:1 slope. This will be updated in the final BGER or RGER.   | 4      |
| 19.1 | MAH      | Pages 50 & 51 | Provide estimated bearing resistance calculations for the wall that accounts for the wall bearing on top of a 2:1 slope.   | <i>External stability calculations are revised and included in the revised memorandum.</i>   | 4      |
| 20   | MAH      | Pages 50 & 51 | If the MSE Wall being analyzed is directly underneath the bridge abutment, there should be a magnitude for $V_2$ since 10 feet +/- of material will be present on top of the reinforced zone.                    | Acknowledged. MSE Wall height references from pavement surface to leveling pad. This is an incorrect measurement, but considered in this preliminary analysis to demonstrate wall feasibility.   | 3      |

## REVIEW COMMENTS

|                             |                                     |
|-----------------------------|-------------------------------------|
| <b>Project ID:</b>          |                                     |
| <b>County:</b>              | Greenville                          |
| <b>Project Description:</b> | I-85/I-385 Interchange Improvements |

|                   |  |
|-------------------|--|
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| <b>Date:</b>      | May 15, 2015   |
| <b>Reviewers:</b> | SCDOT, FHWA, ICE & ICA                               |

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| <b>Memorandum: Cut Walls at Various Locations, dated May 4, 2015 – Associated with Comment 2, D-0021 Geotech &amp; Structures Matrix</b> |          |              |   |   |        |
| 21   | JAC/DLC  | General      | Provide Special Provision that specifies the requirements for design, design submittals, materials, construction, quality control, and quality assurance for the Soil Nail walls.   | Acknowledged. Special provision will be incorporated into final BGER and RGER.  | 3      |
| 21.1   | JAC      |              | Soil Nail special provision should also be incorporated into the final plans for Bridge 11.   | <a href="#">Acknowledged and will be incorporated into revised BGER for Bridge 11.</a>                                  | 3      |
| 22   | DLC      | General      | Please verify that a separate memo for I-385 NBCD Station 337+00-346+00 and Ramp 1A Station 51+00-52+00 will be provided.   | Confirmed.  | 4      |
| 23   | JAC      | Page 2       | Ramp 1A: Verify that a soldier pile and lagging and a reinforced concrete wall are appropriate wall types at this location.   | Wall types are appropriate, and will be discussed in final BGER, RGER and memo referenced in Comment 22.                | 3      |
| 23.1   | JAC      | Page 2       | Verify sufficient R/W is provided for construction of all wall components. Based on the maximum wall height shown in the table and on the cross-sections, it appears that an anchored wall may be required for portions of the cut wall along Ramp 1A. If a reinforced concrete cantilever wall is used, verify the necessary footing can be accommodated and verify this wall type can be constructed as a cut wall within the R/W. If more than one wall type will be used, identify the approximate station ranges for each wall type and provide proposed details for interfacing the different wall types. | This comment is addressed in various memorandums. Refer to Ramp 1A memorandum for specific discussion at this location. | 3      |
| 23.2   | JAC      | Ramp 1A Memo | See additional comment 48.1.  | <a href="#">See response to comment 48.1</a>  | 3      |
| 24   | JAC      | Page 3       | Soil Parameters: Verify that active, passive, and at-rest earth pressure coefficients will be determined in accordance with Section 18.5 of the GDM.  | Confirmed.  | 4      |
| 25   | MAH/DLC  | Page 3       | Soil Parameters: Provide documentation for using Rankine passive earth pressure coefficients for embedment depths less than 12 feet and Coulomb passive earth pressure coefficients for embedment depths greater than 12 feet.  | Documentation will be provided if Coulomb passive pressure coefficients are recommended on individual walls.            | 4      |



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| 25.1 | MAH      | Page 3   | Provide documentation for where the 12-foot limit comes from.  | This intent of this section was to consider a log-spiral failure surface for deep embedment. Additional discussion is provided in the revised memorandum.  | 4      |
| 26   | JAC      | Page 4   | Anchored Walls: Verify figure number 3.11.5.7-1 from the AASHTO LRFD Bridge Design Specifications is the correct figure number.  | Confirmed, and figures are attached to memorandum.   | 4      |
| 26.1 | JAC      | Page 4   | Correct figure number is 3.11.5.7.1-1.   | Figure no is corrected in updated memo.  | 4      |
| 27   | JAC      | Page 4   | Soil Nail Walls: Wall designer shall provide lateral earth pressure diagram and design calculations as part of the shop plan submittal.  | Acknowledged.  | 4      |
| 28   | MAH      | Page 5   | Resistance Factors for Soil Nail Walls: Verify that the reported resistance factors for basal heave and headed stud are correct.   | Resistance factors for Basal Heave should be 0.65 and 0.5 for short term and long term conditions, respectively. Resistance factors for A307 studded heads should be 0.7 and 0.65 for static and seismic loading, respectively. Resistance factors for A325 studded heads should be 0.8 and 0.75 for static and seismic loading, respectively.<br><br>Updated in revised memorandum. | 3      |
| 28.1 | MAH      | Page 5   | Resistance Factors for Soil Nail Walls: Verify that the reported resistance factors for basal heave and headed stud are correct. According to Table 6.3 of GEC-007, short-term basal heave = 0.50, long-term basal heave = 0.40, static A307 headed stud = 0.70, static A325 headed stud = 0.80, seismic A307 headed stud = 0.65, and seismic A325 headed stud = 0.75. | See comment 34.1   | 3      |
| 29   | MAH      | Page 6   | Which performance limits are applicable for the Extreme Event I limit state?   | Extreme Event 1 performance should be evaluated in accordance with Table 10-43 of the GDM.<br><br>Updated in revised memorandum.   | 4      |
| 30   | MAH/DLC  | Page 6   | Design Methodology and References: Non-Gravity Cantilever Walls & Anchored Walls: Per Section 18.7 of the GDM, the design should be in accordance with the FHWA Earth  | Acknowledged.  | 3      |

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|  |          |          | Retaining Structures manual (FHWA-NHI-07-071, 2008).   |   |        |
| <b>Memorandum: Cut Walls Along Ramp 2A from Station 110+00 to 114+00, dated May 11, 2015– Associated with Comment 2, D-0021 Geo. &amp; Str. Matrix</b> |          |          |  |   |        |
| 31   | DLC      | General  | The name of the file provided references “2B”. Please update.  | Acknowledged and will correct.<br><b>Corrected in revised memorandum.</b>   | 4      |
| 32   | JAC      | Page 1   | Verify that the publication number for the FHWA “Soil Nail Walls Reference Manual” is correct.   | Acknowledged. The Publication No. is FHWA-NHI-14-007<br><b>Corrected in revised memorandum.</b>   | 4      |
| 33   | DLC      | Page 1   | Please provide more discussion on these preliminary soil nails chosen for this analysis (length, diameter, inclination, tensile capacity, plate capacity, bond strength, etc.)   | These items should be addressed and selected by the Soil Nail Wall designer. For the preliminary analysis ECS assumed a No. 7 Gr. 75 all thread bar, 4” diameter drill hole with a 7 psi ultimate bond.<br><b>Addressed in revised memorandum.</b>  | 4      |
| 34   | MAH      | Page 2   | Resistance Factors for Soil Nail Walls: Verify that the reported resistance factors for basal heave and headed stud are correct.   | Resistance factors for Basal Heave should be 0.65 and 0.5 for short term and long term conditions, respectively. Resistance factors for A307 studed heads should be 0.7 and 0.65 for static and seismic loading, respectively. Resistance factors for A325 studed heads should be 0.8 and 0.75 for static and seismic loading, respectively.<br><b>Corrected in revised memorandum.</b> | 3      |
| 34.1   | MAH, DLC | Page 2   | Resistance Factors for Soil Nail Walls: Verify that the reported resistance factors for basal heave and headed stud are correct. According to Table 6.3 of GEC-007, short-term basal heave = 0.50, long-term basal heave = 0.40, static A307 headed stud = 0.70, static A325 headed stud = 0.80, seismic A307 headed stud = 0.65, and seismic A325 headed stud = 0.75. | <b>Acknowledged. When revising the resistance factors we referenced Table 5.5 for basal heave which does not match the resistance factors in Table 6.3. For headed studs the resistance factors were reversed for static and seismic events. This will be corrected and updated in final BGER and RGER.</b>   | 3      |
| 35   | DLC      | Page 3   | For the total stress condition assuming clayey soils, it appears   | Acknowledged. Shear strength parameters will be   | 3      |

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|      |          |                       | that both effective and total stress parameters are being shown and used in the analysis. Please refer to Sections 7.10 and 7.11 in the GDM when estimating soil strength parameters.                 | updated in the BGER or RGER.<br><br>Shear strength values were adjusted and additional explanation is provided on method to select shear strength values.                 |        |
| 35.1 | DLC      | Page 3                | Please verify that revising the soil parameters to something in accordance with the GDM for the various analyses (short term and long term) would not have any impact on the current ROW plans.       | Modified parameters will not impact ROW plans. Changes in soil parameters can be offset by an increased soil nail density.  | 3      |
| 36   | MAH/DLC  | Page 4                | Verify that the proposed cut wall does not support highway or other infrastructure. Revise surcharge loading accordingly.   | Proposed wall does not support infrastructure at this location. Surcharge loads will be in accordance with GDM where infrastructure is present.                           | 4      |
| 37   | MAH/DLC  | Page 4                | In future reports, revise "Reduction Factor" to "Resistance Factor".  | Acknowledged.<br><br>Corrected in revised memorandum.   | 4      |
| 38   | MAH/DLC  | Page 4                | Verify calculation for determining $\alpha_w$ is correct.   | Calculation is incorrect and will be updated. The error provides a more conservative result (higher wave scattering coefficient).<br><br>Corrected in revised memorandum. | 4      |
| 39   | MAH      | Pages 14 - 22         | Verify that the station, offset, and alignment correctly correspond to each other on the boring logs.   | Will verify as part of final BGER and/or RGER.  | 3      |
| 40   | DLC      | Pages 41-42 and 44-45 | Please review the liquefaction spreadsheet fines content calculation and compare with the GDM.  | In accordance with Section 13.11.2 (page 13-51) of the GDM, the fines content for SSL and Liquefaction are based the soil fraction passing the No. 4 sieve.               | 3      |
| 40.1 | DLC      | Pages 41-42 and 44-45 | Please review the liquefaction spreadsheet fines content calculation and compare with the GDM. Please review the GDM and the liquefaction literature referenced in the GDM for further clarification. | See Item 16.1   | 3      |
| 41   | MAH      | Pages 23 - 40         | It is difficult to determine which boring the samples were obtained from for the shear strength testing that was performed. Recommend showing the boring number, sample                               | Acknowledged. Clarification will be provided in the final BGER or RGER.   | 3      |

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|   |          |  | number, and depth of sample on each shear strength test record.   |  |        |
| <b>Memoranda: MSE Walls with heights exceeding 40 feet, dated May 27 or 28, 2015 – Associated with Comment 1, D-0021 Geotech &amp; Structures Matrix</b>            |          |  |   |  |        |
| 42  | DLC      | General                                | Please provide preliminary settlement magnitude and time calculations for these very tall MSE walls. Even if provided in the bridge report, it would be helpful to have in these preliminary memos.   | Provided in revised memo. Refer to comment 2.1.  | 4      |
| 43  | DLC      | Ramp 1A<br>70+25 to<br>73+00           | It appears based on the strap lengths reported in this preliminary report that a back to back wall scenario will occur here. Please keep this in mind for the final design.   | Acknowledged and will be evaluated as part of the BGER.  | 3      |
| 44  | DLC      | Ramp 1A<br>Station<br>88+20            | Please provide the results of the analyses.   | In an attempt to limit the volume of analysis for this submittal, and based on previous discussions with SCDOT analysis was not completed on Ramp 1A as the geometry and soil conditions are similar to Ramp 2B Station 39+25 to 44+00 (common approach embankment for Bridges 5 and 7). Refer page 1 paragraphs 3 and 4 of memorandum for discussion. | 4      |
| 45  | DLC      | Ramp 4<br>Station<br>39+50 to<br>46+00 | Please verify the slope stability has accurately modeled the existing sloping ground line. Also, slope stability program indicated in the memo is incorrect.  | Ground surface is accurately modeled. Computer program information is corrected in the updated memorandum.   | 4      |
| <b>Memorandum: Cut Walls Along I-385 NBCD from Station 337+00 to 346+00, dated May 27, 2015 – Associated with Comment 2, D-0021 Geotech &amp; Structures Matrix</b> |          |  |   |  |        |
| 46  | JAC      | Page 3                                 | Shear Strength Parameters: Assumption that the wall is infinitely strong is not consistent with prior assumption of flexible wall type (page 2). The assumption of an infinitely strong wall is also not particularly realistic considering most wall types will permit or have some level of displacement and/or rotation over the design life. Use consistent and reasonable assumptions for all aspects of the analysis. | This is a modeling method when evaluating the performance of gravity walls or cantilever walls in a limit-equilibrium slope stability program (i.e. Slide or SlopeW). The infinitely strong material prevents failure surfaces from penetrating the face of the wall.  | 4      |
| 46.1  | JAC      |  | This modeling method for evaluating global stability is   | Acknowledged. The scope of this memorandum was   | 3      |

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|  |          |               | understood. The intent of this comment was to point out that checking global stability alone does not validate wall type selection. Cut wall anchorage may be controlled by the structural Strength or Service limit states and wall design should be coordinated with the structural engineer and/or wall designer. | limited to geotechnical concerns. Global stability will control influence on ROW. If a soldier pile and lagging wall vertical pile embedment can be modified to achieve internal wall stability. Pile embedment does not affect ROW. For a reinforced concrete wall, the wall foundation may be extended in either the heel or toe direction to overcome internal stability issues. Although extending the heel is more effective, extending the toe of the wall can provide the required resistance. Final wall selection will be coordinated with the structural engineer, but as discussed the internal stability will not affect ROW.   |        |
| 47   | MAH      | Pages 10 - 12 | Boring W385-1R-01 indicates that the silty sand is non-plastic. Provide laboratory tests that prove the non-plastic material encountered in Boring W385-1R-01 has at least 50 psf in cohesion and phi of 33 degrees (as modeled in the slope stability analysis).  | To date, two consolidated-undrained triaxial shear tests were performed on silty sand (SM) materials. Sample T-2 in Boring W1B-2R-03 and sample T-1 in W1B-2R-02. Those results showed effective cohesion values of 130 psf to 475 psf with drained friction angles of 33 to 39 degrees. Corresponding N-values (uncorrected) a above those samples ranged from 5 to 6. As the relative density (based on N-value) of the soil in boring W385-1R-01 is equal to or greater than the relative density of the triaxial test samples, the effective cohesion and friction angles used in the analysis are considered appropriate.<br><br>The compiled triaxial testing of all tests available to date is appended to the revised memorandum. | 4      |
| <b>Memorandum: Cut Walls Along Ramp 1A from Station 51+00 to 52+00, dated May 27, 2015 – Associated with Comment 2, D-0021 Geotech &amp; Structures Matrix</b> |          |               |  |   |        |
| 48   | JAC      | General       | Expand the scope of this Memorandum to include the full length of the cut wall. The section with the maximum wall height has not been addressed. Additionally, the potential need for an anchored wall along with possible impacts to R/W  | The memorandum title has not changed, but the document now includes the ramp from Sta. XX+00 to YY+00 excluding the portion of the ramp directly below Bridge 11.   | 3      |



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|      |          |                        | need to be addressed prior to completion of R/W plans.  |   |        |
| 48.1 | JAC      | Page 1 revised memo    | For the portion of cut wall just north of Bridge 11 (Ramp 1A stations 48+50 to 50+00) this memo suggests likely use of a soldier pile wall, while Bridge 11 final plans show a soil-nail wall in this area. Similarly, for the portion of cut wall just south of Bridge 11 (Ramp 1A stations 50+00 to 54+00), this memo identifies soldier pile and lagging as the preferred wall type, while Bridge 11 final plans show a soil-nail wall. How will a cut wall be constructed in these areas given the drainage pipes shown passing underneath the wall: 18" RCP near station 49+80 (on sheet D2 on the Roper/Chrome plans) and 36" RCP at station 51+00? Identify the stations on either side of the bridge in this area where the soil-nail wall terminates and another wall type starts. Wall type should be coordinated between the geotechnical, hydraulic, roadway, and structural designers. | <p>The wall between stations 49+70 and 50+71 will be soil-nailed and MSE combined. The walls up station and down station of this range will be pile and panel walls. At the location of the 18" RCP there is a difference of approximately 5' from pipe invert to finished grade on Ramp 1A. The 18" RCP travels approximately 50 feet behind the wall with a rise of approximately 5'. This assures that the pipe remains below the wall and out of the anchorage zone.</p> <p>The 36" RCP at approximate station 51+00 passes under the pile and panel wall with a difference of approximately 5' between pipe invert and the finished grade. This will sufficient depth for the pipe to pass under the wall.</p> | 3      |
| 49   | JAC      | General                | Revise this Memorandum to address the potential impacts of and to: the pond located behind the wall; the pond's "normal" drainage outfall; and the overflow from the pond spillway. How will the water from these three elements of the drainage system be addressed and how will it impact the wall design and construction?   | Refer to discussion provided in the revised global stability section memorandum.  | 4      |
| 49.1 | JAC      | Pages 2-3 revised memo | This memo addresses the way the pond affects groundwater in the geotechnical global stability analysis for this wall. Short term and long term effects of groundwater still needs to be considered in the structural design of the wall and any temporary shoring that may be necessary.  | Acknowledged. The scope of the memorandum was limited to geotechnical stability. The wall designer shall consider short term and long term effects when designing the wall.   | 3      |
| 50   | JAC      | Pages 1-2              | Based on the possible wall types shown in Table 1 in the Memorandum for Cut Walls at Various Locations (dated May 4, 2015), verify the assumption that the selected wall type will be a flexible wall.  | Verified, The wall will be designed as a flexible wall.   | 4      |
| 50.1 | JAC      |                        | A reinforced concrete gravity wall is not considered a flexible wall type and is listed as an option in Table 1 and page 1 of   | If a reinforced concrete wall is selected, the wall will be designed as a rigid wall and resistance factors from table  | 3      |

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|  |          |          | revised Ramp 1A memo.   | 9-6 in DM0310 will be considered in the internal design. The resistance factors for global stability of flexible and rigid walls are similar and do not modify or change the geotechnical assessment presented in the memorandum. |        |
| 51   | JAC      | Page 3   | Groundwater: Verify proposed method for conveying the normal outfall from pond and the pond's overflow spillway will not adversely impact the groundwater table and the wall design parameters.   | See comment 49.   | 4      |
| 52   | JAC      | Page 3   | Shear Strength Parameters: Assumption that the wall is infinitely strong is not consistent with prior assumption of flexible wall type (page 2). The assumption of an infinitely strong wall is also not particularly realistic considering most wall types will permit or have some level of displacement and/or rotation over the design life. Use consistent and reasonable assumptions for all aspects of the analysis. | See comment 46.   | 4      |
| 53   | JAC      | Page 3   | Static (Service Limit) Global Stability: Considering the detention pond behind the wall, the proposed wall does support other infrastructure and the potential hazards associated with wall failure or overtopping of the pond must be considered in determining loading conditions and resistance factors to be used in the analysis and design.   | Acknowledged.   | 4      |
| 54   | JAC      | Page 4   | Verify applicability of Table 5 to the wall type and location addressed by this Memorandum.   | Table 5 is applicable; however, the station and location is incorrect. This is corrected in the revised memorandum.   | 4      |
| <b>Memorandum: Cut Slopes, dated May 29, 2015 – Associated with Comment 25, D-0021 Geotech &amp; Structures Matrix</b> |          |          |   |   |        |
| 55   | MAH/DLC  |          | Provide the log for Boring R385-25A. B-55 was included but not discussed in the memo. Please include any laboratory results on samples from Boring R385-25A.  | B-55 should not have been included and has been removed from the revised memorandum. Available laboratory tests were provided. Additional laboratory information will be provided in the final RGER for the main interchange.     | 4      |
| 56   | MAH      |          | Provide proof that the material within the proposed 1.5:1 cut   | Soil properties have been and discussion is provided in   | 3      |

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|  |          |          | slope has a unit weight of 115 pcf, $\Phi = 36$ , and $c = 50$ psf.   | the revised memorandum.  |        |
| 56.1   | MAH      |          | The slope stability analysis provided in the memo dated May 29, 2015 used a unit weight of 115 pcf, $\Phi = 36$ , and $c = 50$ psf for the material within the proposed 1.5:1 cut slope. The slope stability analysis in the revised memo dated June 26, 2015 used a unit weight of 115 pcf, $\Phi = 33$ , and $c = 75$ psf for the material within the proposed 1.5:1 cut slope. If no additional subsurface data has been obtained during the time between memo submissions, why were the soil strength parameters changed? | The soil properties were revisited at this location as well as several others between the initial preliminary analysis and the resubmittal. After further review, we elected to reduce the drained friction angle but slightly increase the effective cohesion in the upper soil layer. Please note we also lowered the effective cohesion in the lower layer. An additional boring will be added in this area to confirm soil properties as part of the final analysis. | 3      |
| 57   | DLC      |          | What is the reason for using the cohesion of 250 PSF for the PWR in the short term and long term conditions.  | It is not practical to collect samples of PWR for shear strength testing. The 250 psf is based on ECS experience in the Piedmont. For slope stability analysis we model ESA=TSA for PWR. Alternatively, an undrained shear strength of 8,000 psf could be considered. However, due to revisions in the analysis,   | 3      |
| 58   | MAH      |          | Does the surcharge load of 140 psf take into account that a parking lot and 1-story building is present at the crest of the proposed slope?   | We consider 140 psf a representative surcharge load for the single story building near the slope.  | 4      |
| 59   | DLC      |          | For the final design, a minimum resistance factor of 0.70 is required instead of the 0.75 mentioned in the report.  | Acknowledged.  | 3      |
| <b>Memoranda: Fill Slopes, dated May 29, 2015 – Associated with Comment 26, D-0021 Geotech &amp; Structures Matrix</b> |          |          |   |  |        |
| 60   | MAH      |          | For final design, the analysis and design shall be modified to meet the Geogrid Soil Reinforcement Special Provision (found in the RFP).  | Acknowledged. Revised submittal includes Geogrid strengths consistent with the special provision.  | 3      |
| 61   | MAH      |          | For final design, the analysis and design shall meet the requirements of Appendix D of the GDM. Laboratory tests on proposed borrow material used as the reinforced backfill shall be submitted to the Department for review and approval.  | Acknowledged.  | 3      |
| 62   | MAH      |          | I-385 SBCE from Station 139+00 to 140+00: What is the estimated resistance factor of the existing slope between the   | Analysis is included in the revised memorandum.  | 4      |

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|     |          |          | offsets of 50-R and 85-R when the new 1:1 reinforced soil slope is in place?   |   |        |
| 63  | DLC      |          | Please explain the reasoning for using a cohesion value of 250 PSF for the PWR. The friction angle used for this material seems appropriate.   | See comment 57.   | 3      |
| 64  | MAH      |          | Ramp 8A at Station 12+50: Boring R8A-31 indicates that below elevation +963 the silty sand is non-plastic. Provide laboratory tests that prove the non-plastic material encountered in Boring R8A-31 has at least 50 psf in cohesion (as modeled in the slope stability analysis). | See comment 47.   | 4      |
| 65  | DLC      |          | In the MSE Wall memos, the embankment fill has a friction angle of 28°. For these fill slope memos, the embankment fill is using a friction angle of 29°. Please be consistent in the final design.  | The increased friction angle was required to achieve stability requirements. Shear strengths will be revisited during final design.   | 3      |
| 66  | DLC      |          | Provide estimated vertical settlements for the service limit state at these fill sections.   | Based on settlement analysis in other areas of the project, we anticipate settlements will be less than 6 to 9 inches. Settlement estimates will be provided in the RGER. Settlement will not affect the ROW. | 3      |

## **Appendix T**

### **Cut Walls - Ramp 1A from Station 51+00 to 52+00**



May 27, 2015  
Rev June 26, 2015

Mr. Rocque L. Kneece, P.E.  
Civil Engineering Consulting Services, Inc.  
2000 Park Street – Suite 201  
Columbia, SC 29201

**MEMORANDUM:** Cut Walls - Ramp 1A from Station 51+00 to 52+00  
Interstate 85/385 Interchange Improvements  
Federal Aid Project No. IM23(009)  
Project ID. 0038111  
CECS Project No. 4177A  
Greenville County, South Carolina  
ECS Project No. 08-9283

Dear Mr. Kneece,

The I-85/385 Interchange improvement project incorporates In Situ Earth Retention Systems (ERSs), referred to herein "cut walls," at several locations across the project. The use and design of such walls is addressed in Chapter 18 of the SCDOT Geotechnical Design Manual. Chapter 18 references other chapters and sections of the GDM, as well as other Federal Highway Administration (FHWA) and AASHTO guidance documents. This memorandum identifies the cut wall locations, identifies maximum wall height, type of wall, anticipated design methodology, and applicable resistance factors.

ECS recently transmitted a memorandum outlining the location of planned cut walls and geotechnical design recommendations based on the SCDOT GDM.

This memorandum specifically addresses Cut Walls on Ramp 1A from Station 48+50 to 54+00. This portion of the ramp passes beneath Bridge 11. Combination walls consisting of Mechanically Stabilized Earth (MSE) walls overlying Soil Nail Walls are planned beneath and directly adjacent to the Bridge. The portion of the wall beneath and adjacent to Bridge 11 is provided in the final BGER. The centerline of Bridge 11 is situated at about Ramp 1A Station 50+00. Walls to the north of the bridge (Sta 48+50 to 50+00) will most likely consist of soldier pile and lagging walls. The retaining wall south of the bridge (Sta. 50+00 to 54+00) will either consist of a cast-in-place reinforced concrete wall or a soldier pile and lagging wall. Although, soldier pile and lagging walls is currently the preferred option.

The entire subsurface exploration and laboratory testing program is not complete. This analysis is considered preliminary until completion of the entire subsurface exploration and laboratory testing program and the final wall type is selected. Once the remaining borings have been completed and advanced laboratory test data is provided, we will review the information and make any necessary revisions to this memorandum. The following sections discuss model development, shear strength parameters, seismic events and triggering evaluation and our conclusions.

The exposed wall height north of the bridge is about 12 feet. In this area the wall is located approximately 15 feet from the ROW. Based on the set back from ROW and exposed wall heights, the proposed wall in this area can be designed as a cantilever soldier pile and lagging wall without impacting the ROW. This portion of the wall will be address in the Main Interchange Final Roadway Geotechnical Engineering Report (RGER).

The exposed wall height south of the bridge is relatively short, with exposed heights ranging from 6 to 8 feet. However, this portion of the alignment is situated adjacent to an existing lake, and the SCDOT has requested a preliminary analysis to evaluate wall global stability and potential seepage issues.



In accordance with Section 8.9.2 of the GDM, the Roadway Structure Operational Classification (ROC) for embankments and roadway structures located within 150 feet of a bridge will be classified as ROC=I. The ROC=I classification applies to a portion of this wall as the structure is situated within 150 feet of Bridge 11 (Roper Mountain Road Bridge). For this preliminary analysis, the wall has only been evaluated as ROC-I; however, portions of the wall beyond the 150 foot limits should be designed as ROC-III.

For the purposes of this analysis we have assumed the wall will be designed by a structural engineer as a flexible wall. Table 9-7 of the SCDOT GDM provides resistance factors for the design of flexible walls.

| Table 1 - SCDOT Table 9-7, Resistance Factors for Flexible Retaining Walls |            |              |         |               |
|--|------------|--------------|---------|---------------|
| Performance Limit  |            | Limit States |         |               |
|  |            | Strength     | Service | Extreme Event |
| Soil Bearing Resistance  |            | 0.65         | N/A     | 1.00          |
| Sliding Frictional Resistance  |            | 1.00         | N/A     | 1.00          |
| Lateral Displacement   |            | N/A          | 1.00    | 1.00          |
| Vertical Settlement  |            | N/A          | 1.00    | 1.00          |
| Global Stability Fill Walls  | ROC- I, II | N/A          | 0.65    | 0.90          |
|  | ROC= III   |              | 0.75    | 1.00          |
| Global Stability Cut Walls   | ROC- I, II | N/A          | 0.60    | 0.90          |
|  | ROC= III   |              | 0.70    | 1.00          |

#### Global Stability Analysis

The global stability of the proposed cut wall was evaluated with the computer program Slide 6.0 by Rocscience Inc, 439 University Ave Ste 780, Toronto, Ontario M5G 1Y88, e-mail: [software@rocscience.com](mailto:software@rocscience.com), website: [www.rocscience.com](http://www.rocscience.com).

The preliminary global stability analysis was conducted in the transverse direction on Ramp 1A at Station 53+00 for the Service and for the Extreme Event I limit states. This location was selected as the critical section because it represents the maximum wall height with the shortest distance to the existing lake. A plan sheet showing the roadways and bridges near cross section locations is attached to this memorandum along with transverse cross sections provided by CECS.

#### Subsurface Information

There are several existing and proposed borings along Ramp 1A from Station 51+00 to 52+00, including W1A-1R-03 and W1A-1R-04. The completed (to date) boring logs are attached to this memorandum and summarized as follows:

Boring W1A-1R-03 encountered a 2 ft layer of soft sandy clay (fill), underlain by a 2 ft layer of medium dense silty sand (fill), underlain by a 6 ft layer of firm to very stiff elastic silt (fill), underlain by a 28.6 ft layer of a medium dense to very dense silty sand (residuum) that extends to boring termination depth of 38.6 ft. No rock coring was performed

Boring W1A-1R-04 encountered a 2 ft layer of soft sandy clay (fill), underlain by a 2 ft layer of loose silty sand (residuum), underlain by a 4 ft layer of firm sand silt, underlain by a 6 ft layer of soft to firm sandy elastic silt, underlain by a 3 ft layer of soft sandy silt, underlain by a 8 ft layer of loose to medium dense silty sand that extends to the boring termination depth of 25 ft. No rock coring was performed.

The soils were grouped into layers based on soil type, relative density and geologic origin. The following table presents the generalized subsurface profile considered in this preliminary analysis:

| Table 2 – Generalized Subsurface Profile |                  |                        |                   |                   |                |                    |          |
|--|------------------|------------------------|-------------------|-------------------|----------------|--------------------|----------|
| Layer No.                                | Elevation (feet) | Layer Thickness (feet) | N <sub>meas</sub> | N <sub>1.60</sub> | USCS Soil Type | Relative Density   | Comments |
| Sandy Clay                               | 934              | 4                      | 5                 | 8                 | CL             | Soft to Stiff      | Fill     |
| Elastic Silt                             | 930              | 13                     | 4                 | 5                 | MH             | Soft to Very Stiff | Fill     |
| Silty Sand                               | 917              | 10                     | 25                | 30                | SM             | Loose to Md. Dense | Residuum |

#### Groundwater

Groundwater was measured during drilling and 24 hours after drilling at borings W1A-1R-03 and W1A-1R-04 at depths ranging from 14.2 to 16.2 feet below ground surface. For the purpose of this preliminary analysis ECS considered a groundwater elevation of ranging from 910.8 to 915.1 feet. The groundwater elevation considered in this analysis will be revisited in the final analysis and once the remaining subsurface information is available.

Considering the maximum excavation to construct the proposed retaining wall will not extend below elevation 925 ft, groundwater is not anticipated to be a significant concern during wall construction.

#### Existing Lake Considerations

The groundwater elevation measured in the area of the wall ranged from about 910 to 915 feet (14 to 16 feet below ground surface), as just presented. The planned toe of wall elevation in the vicinity of the lake will only modify the ground surface elevation by a few feet (typically less than 3 feet). Due to the depth to ground water and the minor modifications to the ground surface, the construction of the proposed wall south of Bridge 11 will not impact the existing pond.

#### Laboratory Testing

Laboratory testing, including index testing (Atterberg Limits, grain size distribution, etc), was performed on select samples discussed in this memorandum. In addition, advanced laboratory testing including Consolidation testing, Unconfined Compression tests, triaxial shear (CU) tests, and Simple Direct Shear tests was performed on representative soil samples throughout the project. Representative Triaxial Shear (CU) tests were considered in selecting shear strength parameters in this preliminary analysis. The Triaxial Shear Test results were appended to our Memorandum regarding the Cut Wall on Ramp 2A from Station 110+00 to 114+00 dated May 11, 2015. The results are not attached to this memorandum for brevity, and are available upon request or in the referenced memorandum.

#### Shear Strength Parameters

Soil shear strength parameters were selected based on correlations provided in the SCDOT GDM, advanced laboratory testing, and our experience in the Piedmont geologic formation. More specifically, ECS considered the correlations in Chapter 7 of the SCDOT GDM in selecting drained friction angles for non-cohesive soils (SM, ML, etc) and for selecting undrained cohesion values for cohesive soils (SC, CL, CH or MH). The compiled advanced laboratory testing demonstrates a minimum of 50 psf of effective cohesion is a reasonable for Piedmont residual soils within the interchange. Table 3 summarizes the shear strength parameters selected for this preliminary analysis including both Effective Stress and Total Stress parameters.

| Table 3 – Summary of Shear Strength Parameters |                                     |                        |                                    |                       |
|--|-------------------------------------|------------------------|------------------------------------|-----------------------|
| Description                                    | Effective Stress                    |                        | Total Stress                       |                       |
|  | Friction Angle ( $\phi'$ ), degrees | Cohesion ( $c'$ ), psf | Friction Angle ( $\phi$ ), degrees | Cohesion ( $c$ ), psf |
| Sandy Clay                                     | 26                                  | 50                     | 0                                  | 500                   |
| Elastic Silt                                   | 28                                  | 50                     | 0                                  | 750                   |
| Silty Sand                                     | 34                                  | 50                     | 34                                 | 50                    |

The proposed retaining wall was defined as infinitely strong in order to prevent failure surfaces from passing through the wall face. The retaining wall was modeled as a 1 foot wide element extending 2 feet below the final ground surface elevation at the toe of the wall.

The strength parameters used in this analysis are conservative and will be revisited as part of the final analysis.

#### Static (Service Limit) Global Stability

The Service limit state was used to evaluate the static slope stability of the cut wall at station 112+50 the Bishop Simplified, Morgenstern-Price and Spencer methods of analyzing slope stability. The proposed cut wall does not support highway or other infrastructure.

Table 8-8 in the GDM does not provide specific guidance for surcharge loading of walls not supporting infrastructure. We considered a uniform surcharge of 140 psf (Load Factor,  $\gamma=1.0$ ) was used to simulate light vehicular or other pedestrian traffic that may approach the cut wall.

A long term groundwater elevation of 917 feet was modeled in the global stability analysis. We recognize that short term storm events may result in additional surface water in drainage ditches and pipes near the wall; however, these short term conditions will not globally impact the long term groundwater level in the vicinity of the wall.

Each cross section included Total Stress Analysis (TSA) and Effective Stress Analysis (ESA) to evaluate short term and long term loading conditions, respectively. The walls were evaluated to achieve a minimum Resistance Factor of 0.65 for all static loading condition. A wall is considered to meet stability requirements when the Demand to Capacity (D/C) ratio is less than the Resistance Factor. The performance requirements for MSE walls were further discussed in our previously referenced cut wall memorandum.

| Table 4 - Service Limit State Global Stability Summary |                       |                   |                      |                   |         |                          |
|--|-----------------------|-------------------|----------------------|-------------------|---------|--------------------------|
| Global Stability Location                              | Description           | Loading Condition | Demand/Capacity, D/C |                   |         | Performance Criteria Met |
|  |                       |                   | Bishop               | Morgenstern-Price | Spencer |                          |
| Sta. 53+00   | Typical Cross Section | ESA               | 0.53                 | 0.53              | 0.53    | YES                      |
|  |                       | TSA               | 0.27                 | 0.27              | 0.27    | YES                      |

#### Extreme Event (Seismic) Evaluation

The Extreme Event I limit state is used to evaluate the seismic global slope stability. The Seismic Site Class D and Peak Ground Acceleration of 0.20 were presented in the PRGER. Those reports deferred evaluating wave scattering and liquefaction triggering and shear strength loss (SSL) triggering events until additional subsurface information and groundwater measurements were available. Liquefaction Triggering, SSL Triggering, Wave Scattering and the results of our stability analysis are discussed in the following section.

#### Liquefaction and Shear Strength Loss Triggering

ECS evaluated the potential for liquefaction and SSL triggering events in accordance with Section 13.6 of the GDM for both the FEE and SEE seismic events. The analysis indicated that SSL and Liquefaction will not occur and minimum D/C is achieved in all cases. Since the analysis demonstrated SSL and Liquefaction will not occur, the global stability analysis considered fully mobilized undrained shear strengths (i.e. no shear strength loss). SSL and Liquefaction triggering calculations are available upon request.

### Seismic Global Stability

The Bishop Simplified and Spencer slope stability method was used to evaluate D/C ratio and slope performance for the seismic event. Section 17.3.3 of the GDM, a live load surcharge was not considered in the Extreme Event analysis, and a 140 psf surcharge load for pavement overlay was considered. Seismic loading was evaluated for Safety Evaluation Earthquake (SEE) with Total Stress shear strength parameters. The walls were evaluated to achieve a minimum Resistance Factor of 0.9 for the seismic loading condition. A wall is considered to meet stability requirements when the D/C ratio is less than the Resistance Factor. As presented below, the SEE evaluation demonstrated the minimum stability requirements can be met for the proposed site geometry, as such the FEE may be considered to meet stability requirements by inspection.

| Table 5 –Extreme Limit State Global Stability Summary |                       |                   |                      |                   |         |                          |
|---|-----------------------|-------------------|----------------------|-------------------|---------|--------------------------|
| Global Stability Location                             | Description           | Loading Condition | Demand/Capacity, D/C |                   |         | Performance Criteria Met |
|   |                       |                   | Bishop               | Morgenstern-Price | Spencer |                          |
| Sta. 53+00  | Typical Cross Section | TSA               | 0.55                 | 0.55              | 0.55    | YES                      |

### Summary

The analysis presented above demonstrates that the proposed cut walls can be designed to meet minimum SCDOT requirements for Global Stability. In addition, the groundwater measurements and estimated elevation indicate that groundwater will not be a significant issue during wall construction. As previously stated, the final wall type has not been selected (i.e. soldier pile and lagging wall or reinforced concrete gravity wall). Regardless, the demonstration that global stability requirements are achieved indicate that the proposed wall can be designed to meet other external wall stability requirements (i.e. direct sliding of a reinforced concrete wall) can be achieved.

We appreciate the opportunity to assist you during this phase of the project. If you have questions concerning this memorandum, please contact us.

Respectfully,

**ECS CAROLINAS, LLP**

Marc F. Plotkin, P.E.  
Principal Engineer  
SC Registration No. 30565

Richard L. Nance, P.E.  
Senior Principal Engineer/VP  
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Attachments: Plan Sheet  
Cross Sections  
Boring Logs W1A-1R-03 and W1A-1R-04  
Global Stability Analysis