Geotechnical Engineering Report
Multi-function Building
Savannah River Site, SC
April 9, 2018
Terracon Project No. 73185045

Prepared for:
USDA Forest Service – Savannah River
New Ellenton, SC

Prepared by:
Terracon Consultants, Inc.
Columbia, South Carolina
April 9, 2018

USDA Forest Service – Savannah River
P. O. Box 700
New Ellenton, SC 29809

Attn: Mr. Eugene Whatley
P: (803) 725 0310

Re: Geotechnical Engineering Report
Multi-function Building
Whiskey Road
Savannah River Site, SC
Terracon Project No. 73185045

Dear Mr. Whatley:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P73185045, dated March 9, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

Rajshekhar Sarkar
Geotechnical Staff Engineer

Signature

Phillip A. Morrison, P.E.
Geotechnical Department Manager
SC Registration No. 17275

Signature
REPORT TOPICS

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Note: This report was originally delivered in a web-based format. Orange Bold text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS (Boring Logs and Laboratory Data)
SUPPORTING INFORMATION (General Notes and Unified Soil Classification System)
INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed multi-function building to be located at Whiskey Road in Savannah River Site, SC. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification

The geotechnical engineering scope of services for this project included the advancement of 3 test borings to depths ranging from approximately 15 to 50 feet below existing ground surface (bgs).

Maps showing the site and boring locations are shown in the Site Location and Exploration Plan sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in the Exploration Results section of this report.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parcel Information</td>
<td>The project is located at Whiskey Road in Savannah River Site, SC.</td>
</tr>
<tr>
<td></td>
<td>The site covers about 2 acres.</td>
</tr>
<tr>
<td></td>
<td>The approximate site center is Lat. 33.36118, Long. -81.68399.</td>
</tr>
</tbody>
</table>
Geotechnical Engineering Report
Multi-function Building ■ Savannah River Site, SC
April 9, 2018 ■ Terracon Project No. 73185045

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing Improvements</strong></td>
<td>The site is currently a yard area adjacent to two mobile office trailers. Based on a review of historic aerial photographs, the proposed building area also was the site of a mobile structure.</td>
</tr>
<tr>
<td><strong>Current Ground Cover</strong></td>
<td>Grass</td>
</tr>
<tr>
<td><strong>Existing Topography</strong></td>
<td>The building area is generally flat with surface elevations between 383 and 382 feet.</td>
</tr>
<tr>
<td><strong>Existing utilities</strong></td>
<td>Overhead power and underground water, power and sewer lines were noted in the proposed construction area.</td>
</tr>
<tr>
<td><strong>Geology</strong></td>
<td>The site is located in the upper Coastal Plain physiographic province of South Carolina. The Coastal Plain is a wedge-shaped cross-section of water and wind deposited soil. Its thickness ranges from a featheredge at the surface contact of the Piedmont (Fall Line) to several thousand feet at the present day coastline. The sediments range in age from the Cretaceous and Tertiary periods at the contact with the bedrock to the recent period at the present coastline. The sediments include clays, silts, sands, and gravels, as well as organics.</td>
</tr>
</tbody>
</table>

**PROJECT DESCRIPTION**

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information Provided</strong></td>
<td>Plan Sheets C2 and P2.</td>
</tr>
<tr>
<td><strong>Proposed Structure</strong></td>
<td>A single-story structure with a footprint of about 2,000 square feet. The building will be slab-on-grade (non-basement).</td>
</tr>
<tr>
<td><strong>Building Construction</strong></td>
<td>Pre-engineered metal building.</td>
</tr>
<tr>
<td><strong>Finished Floor Elevation</strong></td>
<td>Not provided. Assumed to be at the approximate existing ground surface.</td>
</tr>
<tr>
<td><strong>Maximum Loads</strong></td>
<td>Structural loads were not provided. We have assumed the following:</td>
</tr>
<tr>
<td></td>
<td>■ Columns: 50 kips</td>
</tr>
<tr>
<td></td>
<td>■ Walls: 2 kips per linear foot (klf)</td>
</tr>
<tr>
<td></td>
<td>■ Slabs: 150 pounds per square foot (psf)</td>
</tr>
<tr>
<td><strong>Grading/Slopes</strong></td>
<td>We have assumed about 1 foot of cut and fill will be required to develop final grade.</td>
</tr>
<tr>
<td></td>
<td>Final slope angles of as steep as 3H:1V (Horizontal: Vertical) are expected.</td>
</tr>
</tbody>
</table>
GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The following table provides our geotechnical characterization.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options and pavement options. As noted in General Comments, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

<table>
<thead>
<tr>
<th>Description</th>
<th>Approximate Depth to Bottom of Stratum (feet)</th>
<th>Material Encountered</th>
<th>Consistency/Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>1 inch</td>
<td>Topsoil</td>
<td>N/A</td>
</tr>
<tr>
<td>Stratum 1</td>
<td>12</td>
<td>Silty sand</td>
<td>Medium dense to dense</td>
</tr>
<tr>
<td>Stratum 2</td>
<td>32(^1)</td>
<td>Clayey sand</td>
<td>Medium dense to dense</td>
</tr>
<tr>
<td>Stratum 3</td>
<td>50(^2)</td>
<td>Clay</td>
<td>Hard</td>
</tr>
</tbody>
</table>

1. Based on Boring B-3
2. Termination depth of Boring B-3.

Conditions encountered at each boring location are indicated on the individual boring logs shown in the Exploration Results section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.
Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in Exploration Results.

Groundwater was observed in Boring B-3 at a depth of 20 feet bgs at the time of field exploration. The shallower borings, Borings B-1 and B-2, were dry. Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The boring data indicates soil conditions that are generally compatible with the proposed development plan. Presuming the foundations are supported by native Coastal Plain soils represented by the soils or new engineered fill, the structure can be supported by conventional spread footings. The Shallow Foundations section addresses support of the building bearing on the native medium dense silty sands and engineered fill. The Floor Slabs section addresses slab-on-grade support of the building.

The General Comments section provides an understanding of the report limitations.

EARTHWORK

The following presents recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project. The recommendations presented for design and construction of earth-supported elements including foundations and slabs are contingent upon following the recommendations outlined in this section. All grading for each structure should incorporate the limits of the proposed structure plus a minimum of five feet beyond proposed perimeter building walls and any exterior columns.

Earthwork on the project should be observed and evaluated by qualified personnel. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.
Site Preparation

Topsoil and other unsuitable materials should be stripped and removed from the site. Though the topsoil thickness was about 1 inch at the boring locations, stripping depths between our boring locations and across the site could vary considerably. As such, we recommend actual stripping depths be evaluated by qualified personnel during construction to aid in preventing removal of excess material. The stripping should extend at least 5 feet beyond the construction limits. Stripped materials consisting of vegetation and organic materials should be wasted off site or used to vegetate landscaped areas of the site after completion of grading operations. After stripping the organic materials, the exposed subgrade should be observed by qualified personnel and any large concentrations of organics or root mat identified should be removed.

Special precautions should be made to locate all underground utilities. If the utilities will remain, the backfill should be evaluated for conformance to the structural fill recommendations presented below. If the utility will be removed or relocated, the corresponding fill should also be removed. Care should be given to locating and addressing these items during the site preparation phase of the project. If overlooked, they could be detrimental to the building’s long-term performance.

After stripping, the exposed subgrades in the at-grade areas and areas receiving fill should be proofrolled. Any cut areas should be proofrolled after they have been excavated to their proposed subgrade levels. Proofrolling should be performed with a heavily loaded tandem axle dump truck or with similar approved construction equipment under the observation of the Terracon geotechnical engineer. If conditions are found to be unstable, the subgrade should be undercut to soils that would provide a firm base for the compaction of the structural fill. The undercut soils should be replaced with compacted structural fill, placed as described in the following section of this report. Mass fill placement may commence after proofrolling has been successfully completed.

Fill Material Types

Earthen materials used for structural and general fill should meet the following material property requirements:

<table>
<thead>
<tr>
<th>Fill Type</th>
<th>USCS Classification</th>
<th>Acceptable Location For Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imported Structural Fill</td>
<td>SM and SC</td>
<td>All locations and elevations</td>
</tr>
<tr>
<td>On-Site Soils</td>
<td>SM</td>
<td>All locations and elevations</td>
</tr>
</tbody>
</table>

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.
Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill Lift Thickness</td>
<td>8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used. 4 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used.</td>
</tr>
<tr>
<td>Compaction Requirements</td>
<td>95% of the material’s standard Proctor maximum dry unit weight (ASTM D 698)</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>Within the range of -2 percent and +2 percent of the optimum moisture content as determined by the standard Proctor test at the time of placement and compaction</td>
</tr>
</tbody>
</table>

1. We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5 percent away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary as part of the structure’s maintenance program. Where paving or flatwork abuts the structure a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations, for the proposed structure, are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent
ponding of surface water on the prepared subgrades or in excavations. Water collecting over, or adjacent to, construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted, prior to floor slab construction.

Groundwater was encountered at a depth of 20 feet bgs in Boring B-3 at the time of field exploration. Groundwater related excavation issues are not expected at the site. However, the designers should consider the depth to groundwater when setting the utility inverts.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

**SHALLOW FOUNDATIONS**

If the site has been prepared in accordance with the requirements noted in *Earthwork*, the following design parameters are applicable for shallow foundations.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Net Allowable Bearing pressure</strong></td>
<td>3,000 psf (foundations bearing within structural fill) 3,000 psf (foundation bearing on undisturbed soils)</td>
</tr>
<tr>
<td><strong>Required Bearing Stratum</strong></td>
<td>12 inches</td>
</tr>
</tbody>
</table>
| **Minimum Foundation Dimensions**         | Columns: 24 inches  
Continuous: 18 inches |
<p>| <strong>Ultimate Passive Resistance</strong>           | 300 pcf                                         |
| (equivalent fluid pressures)              |                                                 |
| <strong>Ultimate Coefficient of Sliding Friction</strong> | 0.35                                              |
| <strong>Minimum Embedment below Finished Grade</strong>| 12 inches                                       |
| <strong>Estimated Total Settlement from Structural Loads</strong> | Less than about 1 inch                           |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Differential Settlement</td>
<td>$&lt;\frac{3}{4}$ inch</td>
</tr>
</tbody>
</table>

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions.
2. Values provided are for maximum loads noted in Project Description.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the Earthwork.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are as measured over a span of 50 feet.

Footings, foundations, and masonry walls should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings or other discontinuities in masonry walls is recommended.

**Foundation Construction Considerations**

As noted in Earthwork, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.
Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with structural fill placed, as recommended in the Earthwork section.

SEISMIC CONSIDERATIONS

<table>
<thead>
<tr>
<th>Code Used</th>
<th>Site Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 International Building Code (IBC) ¹</td>
<td>D²</td>
</tr>
</tbody>
</table>

1. In general accordance with the 2015 International Building Code which refers to ASCE7-10.
2. The 2015 International Building Code (IBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100-foot soil profile determination. Borings for the building extended to a maximum depth of approximately 50 feet and this seismic site class definition considers that similar consistency Coastal Plain soils continue below the maximum depth of the subsurface exploration. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration.
FLOOR SLABS

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior building floor system</td>
<td>Slab-on-grade concrete.</td>
</tr>
<tr>
<td>Floor slab support</td>
<td>Minimum 12 inches of approved on-site or imported soils placed and compacted in accordance with Earthwork section of this report.</td>
</tr>
<tr>
<td>Subbase</td>
<td>4-inch compacted layer of free draining, granular subbase material.</td>
</tr>
</tbody>
</table>

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

Finished subgrade within and for at least 10 feet beyond the floor slab should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.
GENERAL COMMENTS

As the project progresses, we address assumptions by incorporating information provided by the design team, if any. Revised project information that reflects actual conditions important to our services is reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for informational purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.
ATTACHMENTS
EXPLORATION AND TESTING PROCEDURES

Field Exploration

Three test borings were drilled at the site on April 4, 2018. The borings were drilled to depths ranging from approximately 15 to 50 feet (bgs) at the approximate locations shown on the attached Exploration Plan.

Boring Layout and Elevations: The borings were located in the field by using the proposed site plan and an aerial photograph of the site, and measuring from existing property lines. The ground surface elevations at the boring locations were interpolated from contour lines from the provided topographic plan and are shown on the boring logs. The boring locations shown on the Boring Location Plan and the ground surface elevations shown on the boring logs are approximate and should be considered accurate only to the degree implied by the method of location.

Subsurface Exploration Procedures: The borings were advanced with a truck-mounted CME-45C drill rig utilizing 2-1/4-inch inside diameter hollow-stem augers. Penetration resistance measurements were obtained by driving the split-spoon samplers into the subsurface materials with a 140-pound automatic hammer falling 30 inches. The penetration resistance value is a useful index in estimating the consistency or relative density of materials encountered. At selected intervals, samples of the subsurface materials were taken by driving split-spoon samplers.

A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

Representative disturbed soil samples were obtained from the borings and were placed in sealed containers and returned to our laboratory where our engineer visually reviewed and classified them. The purposes of this review were to check the drillers’ field classifications and visually estimate the soils’ relative constituents (sand, clay, etc.). The soil types and penetrometer values are shown on the boring logs. These records represent our interpretation of the field conditions based on the driller’s field logs and our engineer’s review of the soil samples. The lines designating the interfaces between various strata represent approximate boundaries only, as transitions between materials may be gradual.

Groundwater conditions were evaluated in each boring at the time of site exploration. After which, the borings were backfilled with the auger cuttings.
Our exploration services include storing the collected soil samples and making them available for inspection for 60 days from the report date. The samples will then be discarded unless requested otherwise.
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION PLAN
SRS - Multi-Purpose Building ■ Savannah River Site, SC
April 6, 2018 ■ Terracon Project No. 73185045
BORING LOCATION PLAN
SRS - Multi-Purpose Building ■ Savannah River Site, SC
April 6, 2018 ■ Terracon Project No. 73185045

LEGEND
BORING LOCATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

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AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS
EXPLORATION RESULTS
**BORING LOG NO. B-1**

**PROJECT:** SRS - Multi-Purpose Building  
**CLIENT:** USDA Forest Service - Savannah River  
**SITE:** Whiskey Road  
Savannah River Site, South Carolina

**LOCATION**  
See Exploration Plan  
Latitude: 33.3614° Longitude: -81.6836°

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### WATER LEVEL OBSERVATIONS

<table>
<thead>
<tr>
<th>Depth (Ft.)</th>
<th>Field Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-10-11</td>
<td>N=21</td>
</tr>
<tr>
<td>11-12-13</td>
<td>N=25</td>
</tr>
<tr>
<td>12-12-11</td>
<td>N=23</td>
</tr>
<tr>
<td>12-14-15</td>
<td>N=29</td>
</tr>
<tr>
<td>15-16-16</td>
<td>N=32</td>
</tr>
</tbody>
</table>

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### FIELD TEST RESULTS

**DEPTH**  
Approximate Surface Elev: 381 (FL) +/-

**ELEVATION (FL)**

---

**GRAPHIC LOG**

Hammer Type: Automatic  
Stratification lines are approximate. In-situ, the transition may be gradual.

---

**WATER LEVEL OBSERVATIONS**

No free water observed at end of drilling

---

**Notes:**

Advancement Method: 2-1/4" Hollow Stem Auger

Abandonment Method: Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).

See Supporting Information for explanation of symbols and abbreviations.

---

**Boring Terminated at 15 Feet**

---

**Driller:** S. Blair  
**Boring Started:** 04-05-2018  
**Boring Completed:** 04-05-2018  
**Drill Rig:** CME-45C  
**Project No.:** 73185045  
**Terraincon DATATEMPLATE.GDT**  
**4/9/18**

---

**521 Clemson Rd  
Columbia, SC**
### BORING LOG NO. B-2

**PROJECT:** SRS - Multi-Purpose Building  
**CLIENT:** USDA Forest Service - Savannah River  
**SITE:** Whiskey Road Savannah River Site, South Carolina

**LOCATION**  
See Exploration Plan  
Latitude: **33.3613°** Longitude: **-81.6836°**

**GRAPHIC LOG**  
Stratification lines are approximate. In-situ, the transition may be gradual.

**Hammer Type:** Automatic

---

**TOPSOIL** (1 inch)  
Silty Sand (SM), fine to medium grained, brown, medium dense

**CLAYEY SAND (SC)**, fine to medium grained, tan and brown, medium dense

**Boring Terminated at 15 Feet**

---

**ELEVATION (FL)**  
Approximate Surface Elev: **382 +/-**  
**DEPTH (FL)**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Sample Type</th>
<th>Field Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td></td>
<td>8-9-10 N=19</td>
</tr>
<tr>
<td>12.0</td>
<td></td>
<td>10-10-11 N=21</td>
</tr>
<tr>
<td>15.0</td>
<td></td>
<td>9-10-10 N=20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-13-13 N=26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13-14-15 N=29</td>
</tr>
</tbody>
</table>

---

**WATER LEVEL OBSERVATIONS**  
No free water observed at end of drilling

---

**Notes:**

- Advancement Method: **2-1/4" Hollow Stem Auger**
- Abandonment Method: Boring backfilled with auger cuttings upon completion.
- See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).
- See Supporting Information for explanation of symbols and abbreviations.

---

**Driller:** S. Blair  
**Boring Started:** 04-05-2018  
**Boring Completed:** 04-05-2018  
**Project No.:** 73185045
**BORING LOG NO. B-3**

**PROJECT:** SRS - Multi-Purpose Building

**SITE:** Whiskey Road
Savannah River Site, South Carolina

**CLIENT:** USDA Forest Service - Savannah River
New Ellenton, South Carolina

### GRAPHIC LOG

- **TOPSOIL (1 inch)**
  - **Silty Sand (SM),** fine to medium grained, brown, medium dense

- **Clayey Sand (SC),** fine to medium grained, brown and tan to reddish brown, medium dense to dense

- **Lean Clay (CL),** mottled (purple, red, pink), hard

---

**Boring Terminated at 50 Feet**

**Stratification lines are approximate. In-situ, the transition may be gradual.**

**Hammer Type:** Automatic

**Advancement Method:** 2-1/4" Hollow Stem Auger

**Abandonment Method:** Boring backfilled with auger cuttings upon completion.

**Notes:**

- **WATER LEVEL OBSERVATIONS**
  - **Depth (Ft.):** 5, 10, 15, 20, 25, 30, 35, 40, 45, 50
  - **Sample Type:** Field Test Results
  - **Field Test Results:**
    - 9-11-10
      - N=21
    - 10-11-11
      - N=22
    - 11-12-13
      - N=25
    - 10-11-11
      - N=22
    - 11-11-12
      - N=23
    - 15-17-17
      - N=34
    - 18-18-19
      - N=37
    - 18-18-17
      - N=35
    - 17-17-17
      - N=34
    - 18-20-22
      - N=42
    - 24-24-26
      - N=50

**Project Info:**

- **Whiskey Road                    Savannah River Site, South Carolina**
- **Driller:** S. Blair
- **Boring Completed:** 04-05-2018

---

**TERRACON DATATEMPLATE.GDT  4/9/18**

**Drill Rig:** CME-45C
**Driller:** S. Blair
**Project No.:** 73185045

---

**See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).**

**See Supporting Information for explanation of symbols and abbreviations.**

---

**TERRACON DATATEST.gdt  4/9/18**

**Drill Rig:** CME-45C
**Driller:** S. Blair
**Project No.:** 73185045

---
SUPPORTING INFORMATION
### General Notes

**Description of Symbols and Abbreviations**

SRS - Multi-Purpose Building  ■ Savannah River Site, South Carolina  
4/9/2018 ■ Terracon Project No. 73185045

#### Water Levels

- Water Initially Encountered
- Water Level After a Specified Period of Time
- Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

#### Descriptive Soil Classification

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

#### Location and Elevation Notes

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

#### Sampling

- Split Spoon

#### Field Tests

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Standard Penetration Test Resistance (Blows/Ft.)</td>
</tr>
<tr>
<td>HP</td>
<td>Hand Penetrometer</td>
</tr>
<tr>
<td>T</td>
<td>Torvane</td>
</tr>
<tr>
<td>DCP</td>
<td>Dynamic Cone Penetrometer</td>
</tr>
<tr>
<td>UC</td>
<td>Unconfined Compressive Strength</td>
</tr>
<tr>
<td>PID</td>
<td>Photo-Ionization Detector</td>
</tr>
<tr>
<td>OVA</td>
<td>Organic Vapor Analyzer</td>
</tr>
</tbody>
</table>

#### Strength Terms

<table>
<thead>
<tr>
<th>Descriptive Term (Consistency)</th>
<th>Standard Penetration or N-Value Blows/Ft.</th>
<th>Unconfined Compressive Strength Qu, (tsf)</th>
<th>Standard Penetration or N-Value Blows/Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>less than 0.25</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>Soft</td>
<td>0.25 to 0.50</td>
<td>2 - 4</td>
<td></td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>0.50 to 1.00</td>
<td>4 - 8</td>
<td></td>
</tr>
<tr>
<td>Stiff</td>
<td>1.00 to 2.00</td>
<td>8 - 15</td>
<td></td>
</tr>
<tr>
<td>Very Stiff</td>
<td>2.00 to 4.00</td>
<td>15 - 30</td>
<td></td>
</tr>
<tr>
<td>Hard</td>
<td>&gt; 4.00</td>
<td>&gt; 30</td>
<td></td>
</tr>
</tbody>
</table>

#### Grain Size Terminology

**Major Component of Sample**

- Boulders: Over 12 in. (300 mm)
- Cobbles: 12 in. to 3 in. (300mm to 75mm)
- Gravel: 3 in. to #4 sieve (75mm to 4.75 mm)
- Sand: #4 to #200 sieve (4.75mm to 0.075mm)
- Silt or Clay: Passing #200 sieve (0.075mm)

**Particle Size**

- Non-plastic
- Low
- Medium
- High

**Plasticity Description**

- Trace
- With
- Modifier

- <15
- 15-29
- >30

**Percent of Dry Weight**

- <5
- 5-12
- >12

**Descriptive Term(s) of other constituents**

- Trace
- With
- Modifier

**Relative Proportions of Sand and Gravel**

<table>
<thead>
<tr>
<th>Descriptive Term(s) of other constituents</th>
<th>Percent of Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt;15</td>
</tr>
<tr>
<td>With</td>
<td>15-29</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt;30</td>
</tr>
</tbody>
</table>

**Relative Proportions of Fines**

<table>
<thead>
<tr>
<th>Descriptive Term(s) of other constituents</th>
<th>Percent of Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt;5</td>
</tr>
<tr>
<td>With</td>
<td>5-12</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt;12</td>
</tr>
</tbody>
</table>

**Plasticity Index**

- 0
- 1 - 10
- 11 - 30
- > 30
### UNIFIED SOIL CLASSIFICATION SYSTEM

**Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests**

<table>
<thead>
<tr>
<th>Soil Classification</th>
<th>Group Symbol</th>
<th>Group Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravels:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 50% of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>coarse fraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>retained on No. 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sieve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean Gravels:</td>
<td>Cu ≥ 4 and 1 ≤ Cc ≤ 3</td>
<td>GW Well-graded gravel</td>
</tr>
<tr>
<td>Less than 5% fines</td>
<td>Cu &lt; 4 and/or 1 &gt; Cc &gt; 3</td>
<td>GP Poorly graded gravel</td>
</tr>
<tr>
<td>Gravels with Fines:</td>
<td>Fines classify as ML or MH</td>
<td>GM Silty gravel</td>
</tr>
<tr>
<td>More than 12% fines</td>
<td>Fines classify as CL or CH</td>
<td>GC Clayey gravel</td>
</tr>
<tr>
<td>Sands:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% or more of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>coarse fraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>passes No. 4 sieve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean Sands:</td>
<td>Cu ≥ 6 and 1 ≤ Cc ≤ 3</td>
<td>SW Well-graded sand</td>
</tr>
<tr>
<td>Less than 5% fines</td>
<td>Cu &lt; 6 and/or 1 &gt; Cc &gt; 3</td>
<td>SP Poorly graded sand</td>
</tr>
<tr>
<td>Sands with Fines:</td>
<td>Fines classify as ML or MH</td>
<td>SM Silty sand</td>
</tr>
<tr>
<td>More than 12% fines</td>
<td>Fines classify as CL or CH</td>
<td>SC Clayey sand</td>
</tr>
</tbody>
</table>

**Coarse-Grained Soils:**

- More than 50% retained on No. 200 sieve

**Sands:**

- 50% or more of coarse fraction

- More than 12% fines

**Fine-Grained Soils:**

- 50% or more passes the No. 200 sieve

**Silt and Clay:**

- Liquid limit less than 50

**Fine-Grained Soils:**

- 50% or more passes the No. 200 sieve

**Silt and Clay:**

- Liquid limit 50 or more

- More than 12% fines

- Inorganic:

  - PI > 7 and plots on or above “A” line
  - PI < 4 or plots below “A” line

- Organic:

  - Liquid limit - oven dried
  - Liquid limit - not dried

- Inorganic:

  - PI plots on or above “A” line
  - PI plots below “A” line

- Organic:

  - Liquid limit - oven dried
  - Liquid limit - not dried

**Silt and Clay:**

- Liquid limit 50 or more

- Inorganic:

  - PI > 7 and plots on or above “A” line
  - PI < 4 or plots below “A” line

- Organic:

  - Liquid limit - oven dried
  - Liquid limit - not dried

**Fine-Grained Soils:**

- 50% or more passes the No. 200 sieve

**Silt and Clay:**

- Liquid limit 50 or more

- More than 12% fines

- Inorganic:

  - PI > 7 and plots on or above “A” line
  - PI < 4 or plots below “A” line

- Organic:

  - Liquid limit - oven dried
  - Liquid limit - not dried

**Highly organic soils:**

- Primarily organic matter, dark in color, and organic odor

**For classification of fine-grained soils and fine-grained fraction of coarse-grained soils**

- Equation of “A” - line

  - Horizontal at PI=4 to LL=25.5.
  - then PI=0.73 (LL-20)

- Equation of “U” - line

  - Vertical at LL=16 to PI=7.
  - then PI=0.9 (LL-8)

**Plasticity Index (PI)**

<table>
<thead>
<tr>
<th>PI</th>
<th>CL, ML or OL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>CL - ML</td>
</tr>
<tr>
<td>5</td>
<td>CL - ML</td>
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<tr>
<td>10</td>
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<td>15</td>
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<td>55</td>
<td>CL, ML or OL</td>
</tr>
<tr>
<td>60</td>
<td>CL, ML or OL</td>
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**Liquid Limit (LL)**

<table>
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<th>ML or OL</th>
<th>MH or OH</th>
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