# ECS Southeast, LLP

## Preliminary Geotechnical Engineering Report

## Farm Tract in Beaufort

Route 70 near Cedar Avenue
Beaufort, North Carolina

ECS Project Number # 22:26486

March 23, 2018

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Nicole Frazier
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Norcross, GA 30093

ECS Project No. 22:26486

Reference: Preliminary Geotechnical Engineering Report
**Farm Tract in Beaufort – Route 70 near Cedar Avenue**
Beaufort, Carteret County, North Carolina

Dear Ms. Frazier:

ECS Southeast, LLP (ECS) has completed the subsurface exploration and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our Proposal No. 22:22352 dated March 14, 2018. This report presents our understanding of the geotechnical aspects of the project along with, the results of the field exploration conducted, and our preliminary design and construction recommendations.

It has been our pleasure to be of service to Pruitt Health during the design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase, and during the construction phase operations as well to verify the assumptions of subsurface conditions made for this report. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

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NORTH CAROLINA PROFESSIONAL SEAL 033751 ENGINEER WINSLOW E. GOINS
3/23/18

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## EXECUTIVE SUMMARY

The following summarizes the main findings of the exploration, particularly those that may have a cost impact on the planned development. Further, our principal foundation recommendations are summarized. Information gleaned from the executive summary should not be utilized in lieu of reading the entire geotechnical report.

- The geotechnical exploration performed for the planned development included ten (10) electronic cone penetration test (CPT) soundings to termination/refusal depths ranging from approximately 30 feet to 50 feet.

- The soundings generally encountered coastal plain soils consisting of Silty and Clean SAND (SM, SP) with layers of Sandy SILT (ML), Silty CLAY (CL-ML) and Lean CLAY (CL).

- Undercutting will be required to the indicated estimated depths at the following locations:
  - 3 to 5 feet in the vicinity of S-2, S-3, S-8, and S-10
  - 2 feet in the vicinity of S-7

- The proposed building can be supported with a shallow foundation having an allowable bearing pressure of 2,000 psf.

- Based on the results of the CPT soundings and our evaluation of the site, the site shall be assigned a seismic class “D”.

- Relatively shallow groundwater was encountered approximately 2.1 to 2.8 feet below existing grades at the site. Depending on design grades, temporary construction dewatering operations may be required to facilitate subsurface construction.

# 1.0 INTRODUCTION

## 1.1 GENERAL

ECS' understanding of this project is based on information provided by Charles Cullipher, PE of the Cullipher Group, PA (TCG) via email on 3/12/18, and a telephone discussion with Mr. Cullipher on 3/7/18. The site is located on an approximately 14 acre plat that is located northeast of the intersection of Route 70 and Cedar Avenue in Beaufort, Carteret County, North Carolina. The project will consist of a single story structure ranging in size from 50,000 to 75,000 square feet constructed on a portion of the site, and several configurations are being considered. Structural loading information was not available at the time of this report.

This report contains the results of our subsurface explorations, site characterization, engineering analyses, and recommendations for the design of the proposed construction.

## 1.2 SCOPE OF SERVICES

To obtain the necessary geotechnical information required for design of the proposed development, a total of ten (10) CPT soundings were performed. All CPT soundings were advanced to approximately 30 feet beneath existing grades except for S-5; which was advanced to approximately 50 feet beneath the ground surface. Shear wave velocity tests were performed in sounding S-5 for seismic site classification and liquefaction potential.

This report discusses our exploratory and testing procedures, presents our findings and evaluations and includes the following:

- A brief review and description of our field test procedures and the results of testing conducted;
- A review of surface topographical features and site conditions;
- A review of area and site geologic conditions;
- A review of subsurface soil stratigraphy with pertinent available physical properties;
- Preliminary foundation recommendations;
  - Allowable bearing pressure;
  - Settlement estimates (total and differential);
- Site development recommendations;
- Suitability of soils for use as fill material;
- Pavement design recommendations;
- Discussion of groundwater impact;
- Compaction recommendations;
- Special conditions encountered;
- Seismic site classification and liquefaction potential;
- Site vicinity map;
- Exploration location plan; and
- CPT sounding logs.

## 1.3 AUTHORIZATION

Our services were provided in accordance with our Proposal No. 22.22352, dated 3/14/18, as authorized by Pruitt Health on 3/15/18, and is subject to the Terms and Conditions of Service outlined in our proposal.

# 2.0 PROJECT INFORMATION

## 2.1 PROJECT LOCATION

The site is located on a +/- 14 acre plat that east of Route 70 and northeast of the intersection of Route 70 and Cedar Avenue in Beaufort, Carteret County, North Carolina. Figure 2.1.1 below shows an aerial image of the site.


**Figure 2.1.1 Site Location**

## 2.2 CURRENT SITE CONDITIONS

At the time of our site visit, the entire site consisted of flat, open farm field with ditch lines around the perimeter and two ditches running approximately north-south. The average site elevation is approximately 5.5 feet (Per TCG).

## 2.3 PROPOSED CONSTRUCTION

The project will consist of a single story structure ranging in size from 50,000 to 75,000 square feet constructed on a portion of the site, and several configurations are being considered including locating the structure on the north or south portion of the tract with the option to expand in the opposite direction in the future.

### 2.3.1 Site Civil Features

- Grading for stormwater ponds, roadways and building pads
- Cuts and fills less than 5 feet (assumed)

### 2.3.2 Structural Information/Loads

The following information explains our assumed structural loads for the purpose of the recommendations made in this report:

**Table 2.3.2.1 Design Values**

| SUBJECT | DESIGN INFORMATION / EXPECTATIONS |
|---|---|
| Usage | Occupancy Category I, II or III |
| Column Loads | 100 |
| Wall Loads | Up to 5 kips/ft |
| Finish Floor Elevation | ±3.5 feet of existing grade (assumed) |

# 3.0 FIELD EXPLORATION

## 3.1 FIELD EXPLORATION PROGRAM

The field exploration was planned with the objective of characterizing the project site in general geotechnical and geological terms and to evaluate subsequent field data to assist in the determination of geotechnical recommendations.

### 3.1.1 Cone Penetrometer Soundings

The subsurface conditions were explored by advancing ten (10) electronic cone penetration test (CPT) soundings across the site. All CPT soundings were advanced to approximately 30 feet beneath existing grades except for S-5; which was advanced to approximately 50 feet beneath the ground surface.

Sounding locations were located in the field by an ECS representative using a hand held GPS unit and referencing existing site features. The approximate as-drilled sounding location is shown on the Exploration Location Diagram in Appendix A.

The CPT soundings were conducted in general accordance with ASTM D 5778. The cone used in the soundings has a tip area of 10 $cm^2$ and a sleeve area of 150 $cm^2$. The CPT soundings recorded tip resistance and sleeve friction measurements to assist in determining pertinent index and engineering properties of the site soils. The ratio of the sleeve friction to tip resistance is then used to aid in assessing the soil types through which the tip is advanced. The results of the CPT soundings are presented in Appendix B.

Within sounding S-5, seismic tests were performed at approximately three foot intervals to refusal to measure the shear wave velocity ($v_s$) of the subsurface materials to aid in assessing the dynamic response properties of the site subsurface materials. The seismic shear waves are generated by making impact with a 20-pound sledgehammer onto a steel beam. The impacts are initiated on the right and left sides of the CPT rig and the corresponding wave traces recorded on an oscilloscope are analyzed to determine the shear wave velocity of the tested material. The waves are measured with three geophones that are installed in the cone. The results of the CPT soundings are presented in Appendix B.

## 3.2 REGIONAL/SITE GEOLOGY

The site is located in the Coastal Plain Physiographic Province of North Carolina. The Coastal Plain is composed of seven terraces, each representing a former level of the Atlantic Ocean. Soils in this area generally consist of sedimentary materials transported from other areas by the ocean or rivers. These deposits vary in thickness from a thin veneer along the western edge of the region to more than 10,000 feet near the coast. The sedimentary deposits of the Coastal Plain rest upon consolidated rocks similar to those underlying the Piedmont and Mountain Physiographic Provinces. In general, shallow unconfined groundwater movement within the overlying soils is largely controlled by topographic gradients. Recharge occurs primarily by infiltration along higher elevations and typically discharges into streams or other surface water bodies. The elevation of the shallow water table is transient and can vary greatly with seasonal fluctuations in precipitation.

Based on the U.S. Geological Survey[1,2] the proposed construction site consists of Undivided Surficial Deposits (Quaternary). Soils typically contain sand, clay, gravel, and peat deposited in marine, fluvial, eolian, and lacustrine environments. An overview of the general site geology is illustrated in Figure 3.2.1 below.


**Figure 3.2.1**

Geologic map for Figure 3.2.1 obtained from The North Carolina Dept. of Environment, Health, and Natural Resources, Division of Land Resources, NC Geological Survey, in cooperation with the NC Center for Geographic Information and Analysis, 1998, Geology - North Carolina (1:250,000), coverage data file geol250 and Google Earth.

[1] The North Carolina Dept. of Environment, Health, and Natural Resources, Division of Land Resources, NC Geological Survey, in cooperation with the NC Center for Geographic Information and Analysis, 1998, Geology - North Carolina (1:250,000), coverage data file geol250. The data represents the digital equivalent of the official State Geology map (1:500,000 scale), but was digitized from (1:250,000 scale) base maps.

[2] Rhodes, Thomas S., and Conrad, Stephen G., 1985, Geologic Map of North Carolina: Department of Natural Resources and Community Development, Division of Land Resources, and the NC Geological Survey, 1:500,000-scale, compiled by Brown, Philip M., et al, and Parker, John M. III, and in association with the State Geologic Map Advisory Committee.

### 3.3 SUBSURFACE CHARACTERIZATION

The subsurface conditions encountered were generally consistent with published geological mapping. The following sections provide generalized characterizations of the soil encountered during our subsurface exploration. For subsurface information at a specific location, refer to the CPT Sounding Logs in Appendix B.

**Table 3.3.1 Subsurface Stratigraphy**

| Approximate Depth Range (ft) | Stratum | Description | Ranges of N*-Values(1) blows per foot (bpf) |
|---|---|---|---|
| 0-0.5 | N/A | Soundings performed throughout contained an observed thickness of topsoil. Deeper topsoil or organic laden soils are most likely present in wet, poorly drained areas and potentially unexplored areas of the site. | N/A |
| 0.5-5 | I | Very soft to soft, lean Clay (CL), interbedded layers of sandy silt/silty sand (SM), moist to saturated. Encountered at S-1 through S-3, S-5, S-7 through S-10. Thickness varied from approximately 0' to 5'. | 1-4 |
| 0.5-18 | II | Loose to medium dense, Silty and Clean SAND (SM, SP) with interbedded layers up to 2' thick of Sandy SILT (ML) and Silty Clay (CL-ML), Moist to Saturated. Thickness varied from approximately 11' to 20'. | 6 to 33 |
| 18-27 | III | Very soft to very stiff, silty Clay (CL-ML), occasional interbedded layers of sandy silt/silty sand, saturated. Thickness varied from approximately 4' to 11', S-10 terminated in this stratum. | 3 to 8 |
| 27-50 | IV | Loose to very dense (typically medium dense), Silty and Clean SAND (SM, SP) with interbedded layers up to 2' thick of Sandy SILT (ML) and Silty Clay (CL-ML), Moist to Saturated. All soundings terminated in this stratum except S-10. | 6 to 50+ |

Notes: (1) Equivalent Corrected Standard Penetration Test Resistances

### 3.4 GROUNDWATER OBSERVATIONS

Porewater pressure measurements were made at the sounding locations during exploration as noted on the CPT sounding logs in Appendix B. The apparent groundwater depths were observed at the time of drilling to range from approximately 2.1 to 2.8 feet below ground surface.

The highest groundwater observations are normally encountered in the late winter and early spring. Variations in the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors not immediately apparent at the time of this exploration. If long term water levels are crucial to the development of this site, it would be prudent to verify water levels with the use of perforated pipes or piezometers.

# 4.0 DESIGN RECOMMENDATIONS

## 4.1 BUILDING DESIGN

The following sections provide recommendations for foundation design.

### 4.1.1 Foundations

**Shallow Foundations:** Provided that the subgrades are prepared as discussed herein, the proposed structures can be supported by conventional shallow foundations. The design of the foundation shall utilize the following parameters:

**Table 4.1.1.1 Foundation Design**

| Design Parameter | Column Footing | Wall Footing |
|---|---|---|
| Net Allowable Bearing Pressure[1] | 2,000 psf | 2,000 psf |
| Acceptable Bearing Soil Material | Stratum I or approved structural fill | Stratum I or approved structural fill |
| Minimum Width | 30 inches | 18 inches |
| Minimum Footing Embedment Depth (below slab or finished grade) | 12 inches | 12 inches |
| Estimated Total Settlement | 1 inch | 1 inch |
| Estimated Differential Settlement | Less than 0.5 inches | Less than 0.5 inches |

1. Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.

It will be important to have the geotechnical engineer of record observe the foundation subgrade prior to placing foundation concrete; to confirm the bearing soils are what was anticipated. If soft or unsuitable soils are observed at the footing bearing elevations, the unsuitable soils should be undercut and removed. Any undercut should be backfilled with approved structural fill up to the original design bottom of footing elevation; the original footing shall be constructed on top of the structural fill. The depth and lateral extent of the undercut should be determined in the field during undercutting operation. An ECS representative must be on site during the undercut and backfill of the areas in order to provide a report stating that the repairs were in accordance with our recommendations.

### 4.1.2 Floor Slabs

Based on the information provided by TCG, floor slabs will bear on +/- 3.5 feet of compacted structural fill. Provided the subgrade preparation and structural fill compaction recommendations of this report are followed, this material is likely suitable for the support of a slab-on-grade.

**Subgrade Modulus:** Provided the Subgrade Preparations and Earthwork Operations Sections of this report are followed, the slab may be designed assuming a modulus of subgrade reaction, k of 150 pci (lbs/cu. inch). The modulus of subgrade reaction value is based on a 1 ft by 1 ft plate load test basis.

**Slab Isolation:** Ground-supported slabs should be isolated from the foundations and foundation-supported elements of the structure so that differential movement between the foundations and slab will not induce excessive shear and bending stresses in the floor slab. Where the structural configuration prevents the use of a free-floating slab, the slab should be designed with suitable reinforcement and load transfer devices to preclude overstressing of the slab. Maximum differential settlement of soils supporting interior slabs is anticipated to be less than 0.5 inches in 50 feet.

### 4.1.3 Seismic Design Considerations

**Seismic Site Classification:** The International Building Code (IBC) 2009 requires site classification for seismic design based on the upper 100 feet of a soil profile. Three methods are utilized in classifying sites, namely the shear wave velocity ($v_s$) method; the unconfined compressive strength ($s_u$) method; and the Standard Penetration Resistance (N-value) method. The first method (shear wave velocity) was used in classifying this site.

The results of the shear wave velocity profiles are contained in Appendix B. The seismic site class definitions for the weighted average of shear wave velocity or SPT N-value in the upper 100 feet of the soil profile are shown in the following table:

**Table 4.1.3.1: Seismic Site Classification**

| Site Class | Soil Profile Name | Shear Wave Velocity, Vs, (ft./s) | N value (bpf) |
|---|---|---|---|
| A | Hard Rock | Vs > 5,000 fps | N/A |
| B | Rock | 2,500 < Vs ≤ 5,000 fps | N/A |
| C | Very dense soil and soft rock | 1,200 < Vs ≤ 2,500 fps | >50 |
| D | Stiff Soil Profile | 600 ≤ Vs ≤ 1,200 fps | 15 to 60 |
| E | Soft Soil Profile | Vs < 600 fps | <15 |

The North Carolina Building Code (2009 International Building Code with North Carolina Amendments) requires that a seismic Site Class be assigned for new structures. The seismic Site Class for the site was determined by calculating a weighted average of the shear velocities of the overburden to the depth of rock/refusal. The CPT test data indicates that the existing natural, overburden soils at the site have shear velocities ranging from approximately 427 ft/sec to 1,396 ft/sec. The method for determining the weighted average value is presented in Section 1613.5.5 of the IBC 2009. The weighted average value for the site is 770 ft/sec. Based on the results of the CPT soundings and our evaluation of the site, the site shall be assigned a seismic class “D”.

**Liquefaction:** The potential for liquefaction at the site is considered low based upon the CPT results and the liquefaction index procedure developed by Iwasaki (1982). Based on our CPT results and our evaluation using a site peak ground acceleration of 0.062, an earthquake event with a magnitude of 7.3 and procedures developed by Robertson (2009) and Boulanger & Idriss (2014), the liquefaction induced settlement at the subject site is estimated to be less than 1 inch.

**Ground Motion Parameters:** In addition to the seismic site classification noted above, ECS has determined the design spectral response acceleration parameters following the IBC 2009 methodology The Mapped Reponses were estimated from the free U.S. Seismic Design Maps Application available from the USGS website. The design responses for the short (0.2 sec, $S_{DS}$) and 1-second period ($S_{D1}$) are noted in bold at the far right end of the following table.

**Table 4.1.3.2: Ground Motion Parameters (IBC 2009 Method)**

| Period (sec) | Mapped Spectral Response Accelerations (g) | | Values of Site Coefficient for Site Class | | Maximum Spectral Response Acceleration Adjusted for Site Class (g) | | Design Spectral Response Acceleration (g) | |
|---|---|---|---|---|---|---|---|---|
| Reference | Figures 1613.5 (1) & (2) | | Tables 1613.5.3 (1) & (2) | | Eqs. 16-37 & 16-38 | | Eqs. 16-39 & 16-40 | |
| 0.2 | $S_S$ | 0.146 | $F_a$ | 1.600 | $S_{MS}=F_aS_s$ | 0.233 | $S_{DS}=2/3\ S_{MS}$ | 0.155 |
| 1.0 | $S_1$ | 0.061 | $F_v$ | 2.400 | $S_{M1}=F_vS_1$ | 0.146 | $S_{D1}=2/3\ S_{M1}$ | 0.097 |

The Site Class definition should not be confused with the Seismic Design Category designation, which the Structural Engineer typically assesses. If a higher site classification is beneficial to the project, ECS would be pleased to discuss additional testing capabilities in this regard.

## 5.0 SITE CONSTRUCTION RECOMMENDATIONS

### 5.1 SUBGRADE PREPARATION

#### 5.1.1 Stripping and Grubbing

It should be noted that the natural geology of the site has been modified in the past; therefore potential unsuitable material may be present on the site. The subgrade preparation should consist of stripping all vegetation, rootmat, topsoil, existing fill, and any other soft or unsuitable materials from the 10-foot expanded building area and 5-foot expanded pavement areas. ECS should be called on to verify that topsoil and unsuitable surficial materials have been completely removed prior to the placement of structural fill or construction of the building and pavement areas.

### 5.1.2 Proofrolling

After removing all unsuitable surface materials, cutting to the proposed grade, and prior to the placement of any structural fill or other construction materials, the exposed subgrade should be examined by the geotechnical engineer or authorized representative. Based on the results of subsurface explorations, it is expected that undercutting shall be required to remove unsuitable soft soils to the estimated depths and at the following locations:

- 3 to 5 feet in the vicinity of S-2, S-3, S-8, and S-10
- 2 feet in the vicinity of S-7

The exposed subgrade should be thoroughly proofrolled with previously approved construction equipment having a minimum axle load of 10 tons (e.g. fully loaded tandem-axle dump truck). The areas subject to proofrolling should be traversed by the equipment in two perpendicular (orthogonal) directions with overlapping passes of the vehicle under the observation of the geotechnical engineer or authorized representative. This procedure is intended to assist in identifying any localized yielding materials. In the event that unstable or “pumping” subgrade is identified by the proofrolling, those areas should be marked for repair prior to the placement of any subsequent structural fill or other construction materials. Methods of repair of unstable subgrade, such as undercutting or moisture conditioning or chemical stabilization, should be discussed with the geotechnical engineer to determine the appropriate procedure with regard to the existing conditions causing the instability. Test pits may be excavated to explore the shallow subsurface materials in the area of the instability to help in determined the cause of the observed unstable materials and to assist in the evaluation of the appropriate remedial action to stabilize the subgrade.

### 5.1.3 Site Temporary Dewatering

**Subsurface Water:** Due to the relatively shallow groundwater conditions observed during this exploration, temporary construction dewatering may be necessary to facilitate efficient below-grade construction. Dewatering operations for the majority of the site can be handled by the use of conventional submersible pumps directly in the excavation or temporary trenches or French drains consisting of free draining granular stone wrapped in filter fabric to direct the flow of water and to remove water from the excavation. If temporary sump pits are used, we recommend they be established at an elevation 3 to 5 feet below the bottom of the excavation subgrade or bottom of footing. A perforated 55 gallon drum or other temporary structure could be used to house the pump. We recommend continuous dewatering of the excavations using electric pumps or manned gasoline pumps be used during construction.

## 5.2 EARTHWORK OPERATIONS

### 5.2.1 Structural Fill Materials

**Product Submittals:** Prior to placement of structural fill, representative bulk samples (about 50 pounds) of on-site and off-site borrow should be submitted to ECS for laboratory testing, which will include Atterberg limits, natural moisture content, grain-size distribution, and moisture-density relationships for compaction. Imported materials should be tested prior to being hauled to the site to determine if they meet project specifications.

**Satisfactory Structural Fill Materials:** Materials satisfactory for use as structural fill should consist of inorganic soils classified as SM, SC, SW, SP, GW, GP, GM, and GC, or a combination of these group symbols, per ASTM D 2487. Natural fine-grained soils classified as clays or silts (CL, ML) should generally not be considered for use as engineered fill, but may be evaluated by the geotechnical engineer to determine their suitability at the contractor's request. The materials should be free of organic matter, debris, and should contain no particle sizes greater than 4 inches in the largest dimension. Open graded materials, such as gravels (GW and GP), which contain void space in their mass should not be used in structural fills unless properly encapsulated with filter fabric. Suitable structural fill material should have the index properties shown in Table 5.2.1.1.

**Table 5.2.1.1 Structural Fill Index Properties**

| Location with Respect to Final Grade | LL | PI | Max % Fines Passing # 200 Sieve |
|---|---|---|---|
| Building Area | 35 max | 9 max | 20 |
| Pavement Area | 35 max | 9 max | 20 |

**Unsatisfactory Materials:** Materials that should not be used as engineered fill include topsoil, organic materials (OH, OL), and high plasticity clays and silts (CH, MH). Such materials removed during grading operations should be either stockpiled for later use in landscape fills, or placed in approved on or off-site disposal areas.

**On-Site Borrow Suitability:** Near surface SANDS (SM, SP) with a fines content less than 20 percent should be suitable for re-use as structural fill. Moisture conditioning should be anticipated for the soils to achieve the optimum moisture content for fill placement.

### 5.2.2 Compaction

**Structural Fill Compaction:** Structural fill within the expanded building, pavement, and embankment limits should be placed in maximum 8-inch loose lifts, moisture conditioned as necessary to within -3 and +3 % of the soil's optimum moisture content, and be compacted with suitable equipment to a dry density of at least 98% of the standard Proctor maximum dry density (ASTM D698). Beyond these areas, compaction of at least 95% should be achieved. ECS should be called on to document that proper fill compaction has been achieved.

**Fill Compaction Control:** The expanded limits of the proposed construction areas should be well defined, including the limits of the fill zones for the proposed construction area, at the time of fill placement. Grade controls should be maintained throughout the filling operations. All filling operations should be observed on a full-time basis by a qualified representative of the construction testing laboratory to determine that the minimum compaction requirements are being achieved. Field density testing of fills will be performed at the frequencies shown in Table 5.2.2.1, but not less than 1 test per lift.

**Table 5.2.2.1 Frequency of Compaction Tests in Fill Areas**

| Location | Frequency of Tests |
|---|---|
| Building Area | 1 test per 2,500 sq. ft. |
| Utility Trenches | 1 test per 200 sq. ft. |
| Pavement Areas | 1 test per 10,000 sq. ft. |

**Compaction Equipment:** Compaction equipment suitable to the soil type being compacted should be used to compact the subgrades and fill materials. Sheepsfoot compaction equipment should be suitable for the fine-grained soils (Clays and Silts). A vibratory steel drum roller should be used for compaction of coarse-grained soils (Sands) as well as for sealing compacted surfaces.

**Fill Placement Considerations:** Fill materials should not be placed on frozen soils, on frost-heaved soils, and/or on excessively wet soils. Borrow fill materials should not contain frozen materials at the time of placement, and all frozen or frost-heaved soils should be removed prior to placement of structural fill or other fill soils and aggregates. Excessively wet soils or aggregates should be scarified, aerated, and moisture conditioned.

At the end of each work day, all fill areas should be graded to facilitate drainage of any precipitation and the surface should be sealed by use of a smooth-drum roller to limit infiltration of surface water. During placement and compaction of new fill at the beginning of each workday, the Contractor may need to scarify existing subgrades to a depth on the order of 4 inches so that a weak plane will not be formed between the new fill and the existing subgrade soils.

Drying and compaction of wet soils is typically difficult during the cold, winter months. Accordingly, earthwork should be performed during the warmer, drier times of the year, if practical. Proper drainage should be maintained during the earthwork phases of construction to prevent ponding of water which has a tendency to degrade subgrade soils.

Where fill materials will be placed to widen existing embankment fills, or placed up against sloping ground, the soil subgrade should be scarified and the new fill benched or keyed into the existing material. Fill material should be placed in horizontal lifts. In confined areas such as utility trenches, portable compaction equipment and thin lifts of 3 inches to 4 inches may be required to achieve specified degrees of compaction.

We recommend that the grading contractor have equipment on site during earthwork for both drying and wetting fill soils. We do not anticipate significant problems in controlling moisture within the fill during dry weather, but moisture control may be difficult during winter months or extended periods of rain. The control of moisture content of higher plasticity soils is difficult when these soils become wet. Further, such soils are easily degraded by construction traffic when the moisture content is elevated.

### 5.3 FOUNDATION AND SLAB OBSERVATIONS

**Protection of Foundation Excavations:** Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open for too long a time. Therefore, foundation concrete should be placed the same day that excavations are made. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, a 2 to 3-inch thick “mud mat” of “lean” concrete should be placed on the bearing soils before the placement of reinforcing steel.

**Footing Subgrade Observations:** The preparation of fill subgrades, as well as proposed building subgrades, should be observed on a full-time basis by ECS personnel. These observations should be performed by an experienced geotechnical engineer or qualified person to ensure that unsuitable materials have been removed and that the prepared subgrade meets project requirements for support of the proposed construction and/or fills.

It will be important to have the geotechnical engineer of record observe the foundation subgrade prior to placing foundation concrete; to confirm the bearing soils are what was anticipated. If soft or unsuitable soils are observed at the footing bearing elevations, the unsuitable soils should be undercut and removed. Any undercut should be backfilled with approved structural fill up to the original design bottom of footing elevation; the original footing shall be constructed on top of the structural fill. The depth and lateral extent of the undercut should be determined in the field during undercutting operation. An ECS representative must be on site during the undercut and backfill of the areas in order to provide a report stating that the repairs were in accordance with our recommendations.

### 5.4 GENERAL CONSTRUCTION CONSIDERATIONS

**Moisture Conditioning:** During the cooler and wetter periods of the year, delays and additional costs should be anticipated. At these times, reduction of soil moisture may need to be accomplished by a combination of mechanical manipulation and the use of chemical additives, such as lime or cement, in order to lower moisture contents to levels appropriate for compaction. Alternatively, during the drier times of the year, such as the summer months, moisture may need to be added to the soil to provide adequate moisture for successful compaction according to the project requirements.

**Subgrade Protection:** Measures should also be taken to limit site disturbance, especially from rubber-tired heavy construction equipment, and to control and remove surface water from development areas. It would be advisable to designate a haul road and construction staging area to limit the areas of disturbance and to prevent construction traffic from excessively degrading sensitive subgrade soils and existing pavement areas. Haul roads and construction staging areas could be covered with excess depths of aggregate to protect those subgrades. The aggregate can later be removed and used in pavement areas.

**Surface Drainage:** Surface drainage conditions should be properly maintained. Surface water should be directed away from the construction area, and the work area should be sloped away from the construction area at a gradient of 1 percent or greater to reduce the potential of ponding water and the subsequent saturation of the surface soils. At the end of each work day, the subgrade soils should be sealed by rolling the surface with a smooth drum roller to minimize infiltration of surface water.

**Excavation Safety:** Cuts or excavations associated with utility excavations may require forming or bracing, slope flattening, or other physical measures to control sloughing and/or prevent slope failures. Contractors should be familiar with applicable OSHA codes to ensure that adequate protection of the excavations and trench walls is provided.

**Excavation Considerations:** Based on the results of the soundings, we expect that the natural Coastal Plain soils encountered on this site can be excavated with conventional earth moving equipment such as loaders, bulldozers, rubber tired backhoes, etc.

The site soils are OSHA Type C soils for the purpose of temporary excavation support. Excavations should be constructed in compliance with current OSHA standards for excavation and trenching safety. Excavations should be observed by a “competent person,” as defined by OSHA, who should evaluate the specific soil type and other conditions, which may control the excavation side slopes or the need for shoring or bracing. Regardless, site safety shall be the sole responsibility of the contractor and their subcontractors. Exposed earth slopes shall be protected during periods of inclement weather.

**Erosion Control:** The surface soils may be erodible. Therefore, the contractor should provide and maintain good site drainage during earthwork operations to maintain the integrity of the surface soils. All erosion and sedimentation controls should be in accordance with sound engineering practices and local requirements.

## 6.0 CLOSING

ECS has prepared this report of findings, evaluations, and recommendations to guide geotechnical-related design and construction aspects of the project.

The description of the proposed project is based on information provided to ECS by TCG. If any of this information is inaccurate, either due to our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted immediately so that we can review the report in light of the changes and provide additional or alternate recommendations as may be required to reflect the proposed construction.

We recommend that ECS be allowed to review the project's plans and specifications pertaining to our work so that we may ascertain consistency of those plans/specifications with the intent of the geotechnical report.

Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of and integral to the geotechnical design recommendation. We recommend that the owner retain these quality assurance services and that ECS be allowed to continue our involvement throughout these critical phases of construction to provide general consultation as issues arise. ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

# APPENDIX A – Drawings & Reports

Site Location Diagram
Exploration Location Diagram

SITE LOCATION DIAGRAM

Farm Tract Preliminary Geotechnical Project

Beaufort, North Carolina


REFERENCE N/A.:

ENGINEER WEG

DRAFTING JDG

SCALE NTS

PROJECT NO. 22-26486

SHEET 1 of 2

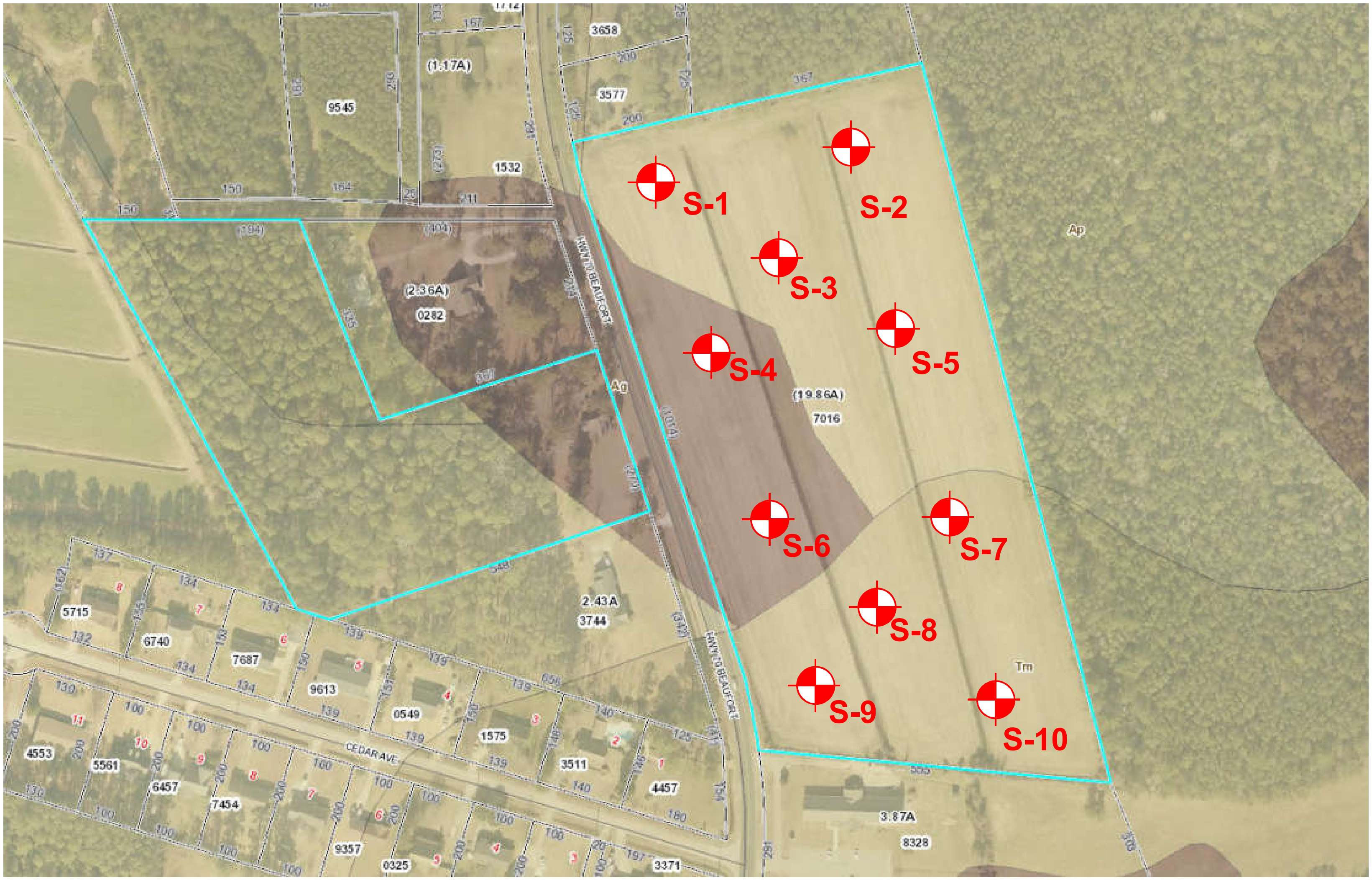
DATE 03/22/2018

# EXPLORATION LOCATION DIAGRAM

## Farm Tract Preliminary Geotechnical Project

Beaufort, North Carolina

| | |
|---|---|
| REFERENCE | N/A.: |
| ENGINEER | WEG |
| DRAFTING | JDG |
| SCALE | NTS |
| PROJECT NO. | 22-26486 |
| SHEET | 2 of 2 |
| DATE | 03/22/2018 |



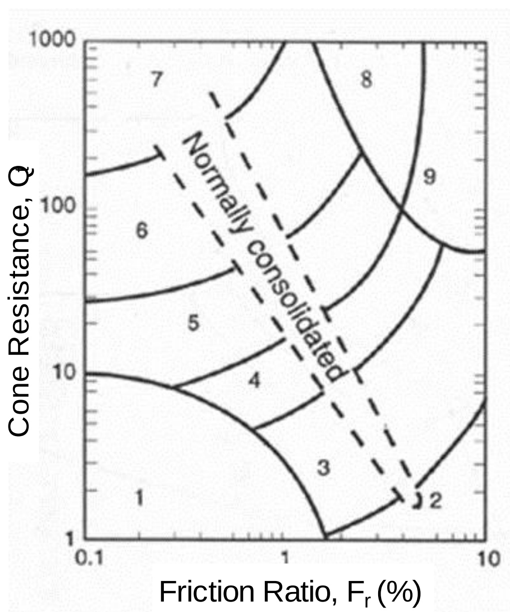

**DENOTES APPROXIMATE LOCATION OF CPT SOUNDING**

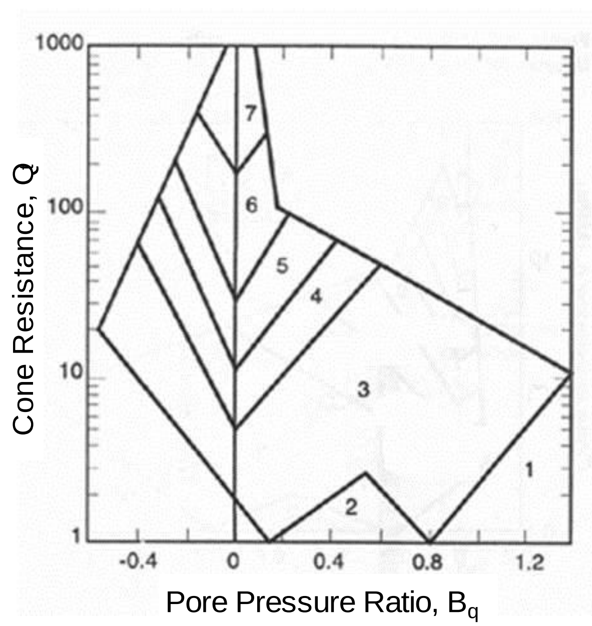
# APPENDIX B – Field Operations

Reference Notes for Sounding Logs
CPT Sounding Logs S-1 through S-10 (S-5 includes Shear Wave Velocity Profile)

**REFERENCE NOTES FOR CONE PENETRATION TEST (CPT) SOUNDINGS**

In the CPT sounding procedure (ASTM-D-5778), an electronically instrumented cone penetrometer is hydraulically advanced through soil to measure point resistance ($q_c$), pore water pressure ($u_2$), and sleeve friction ($f_s$). These values are recorded continuously as the cone is pushed to the desired depth. CPT data is corrected for depth and used to estimate soil classifications and intrinsic soil parameters such as angle of internal friction, preconsolidation pressure, and undrained shear strength. The graphs below represent one of the accepted methods of CPT soil behavior classification (Robertson, 1990).




1. Sensitive, Fine Grained
2. Organic Soils-Peats
3. Clays; Clay to Silty Clay
4. Clayey Silt to Silty Clay
5. Silty Sand to Sandy Silt
6. Clean Sands to Silty Sands
7. Gravelly Sand to Sand
8. Very Stiff Sand to Clayey Sand
9. Very Stiff Fine Grained

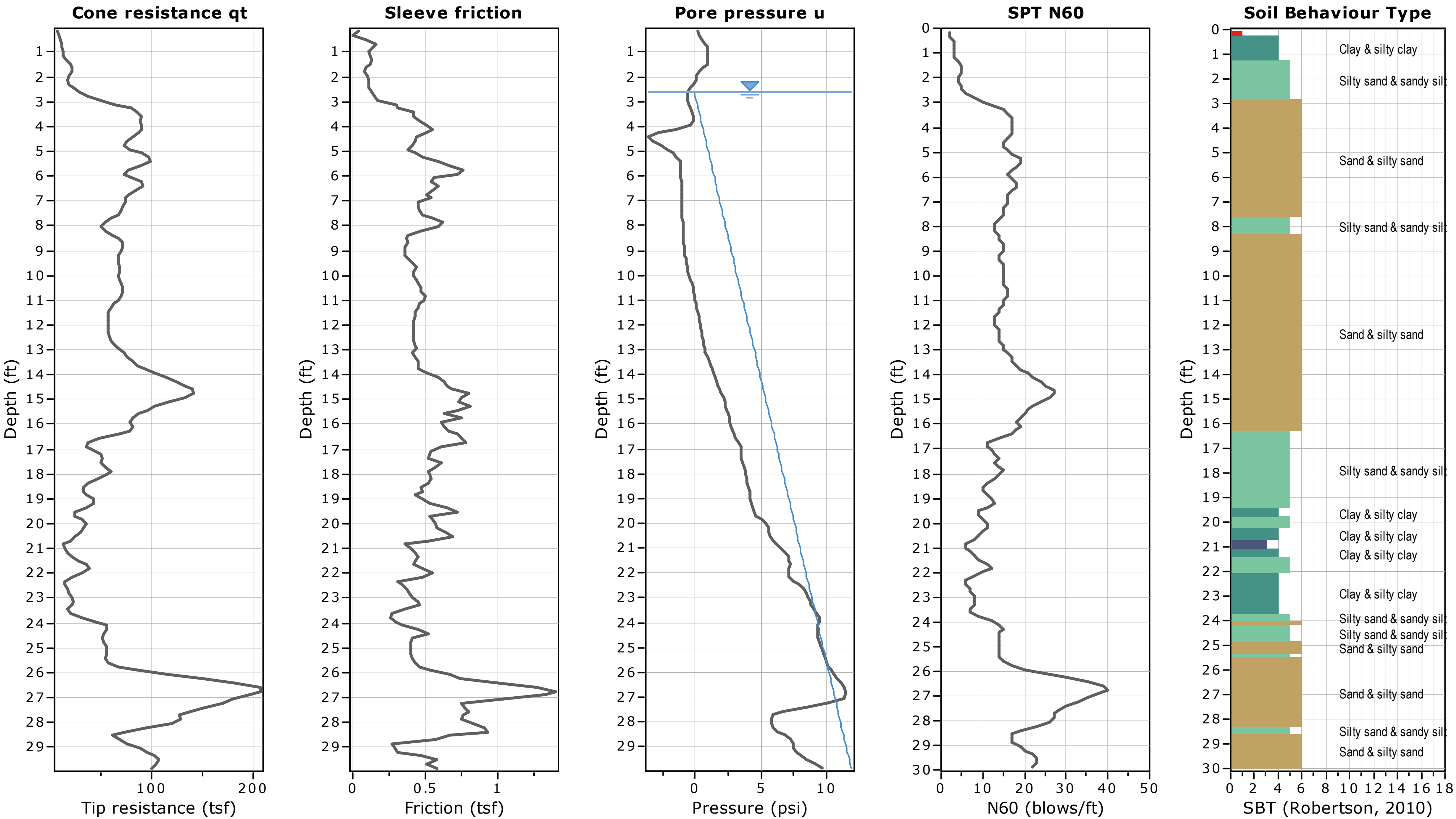
The following table presents a correlation of corrected cone tip resistance ($q_c$) to soil consistency or relative density:

| SAND | | SILT/CLAY | |
|---|---|---|---|
| **Corrected Cone Tip Resistance ($q_c$) (tsf)** | **Relative Density** | **Corrected Cone Tip Resistance ($q_c$) (tsf)** | **Relative Density** |
| <20 | Very Loose | <5 | Very Soft |
| 20-40 | Loose | 5-10 | Soft |
| 40-120 | Medium Dense | 10-15 | Firm |
| | | 15-30 | Stiff |
| 120-200 | Dense | 30-45 | Very Stiff |
| >200 | Very Dense | 45-60 | Hard |
| | | >60 | Very Hard |

**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

**CPT: S-1**
Total depth: 29.86 ft, Date: 3/21/2018
Cone Operator: Cory Robison

**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**
**Location:** **Beaufort, Carteret County, North Carolina**



**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

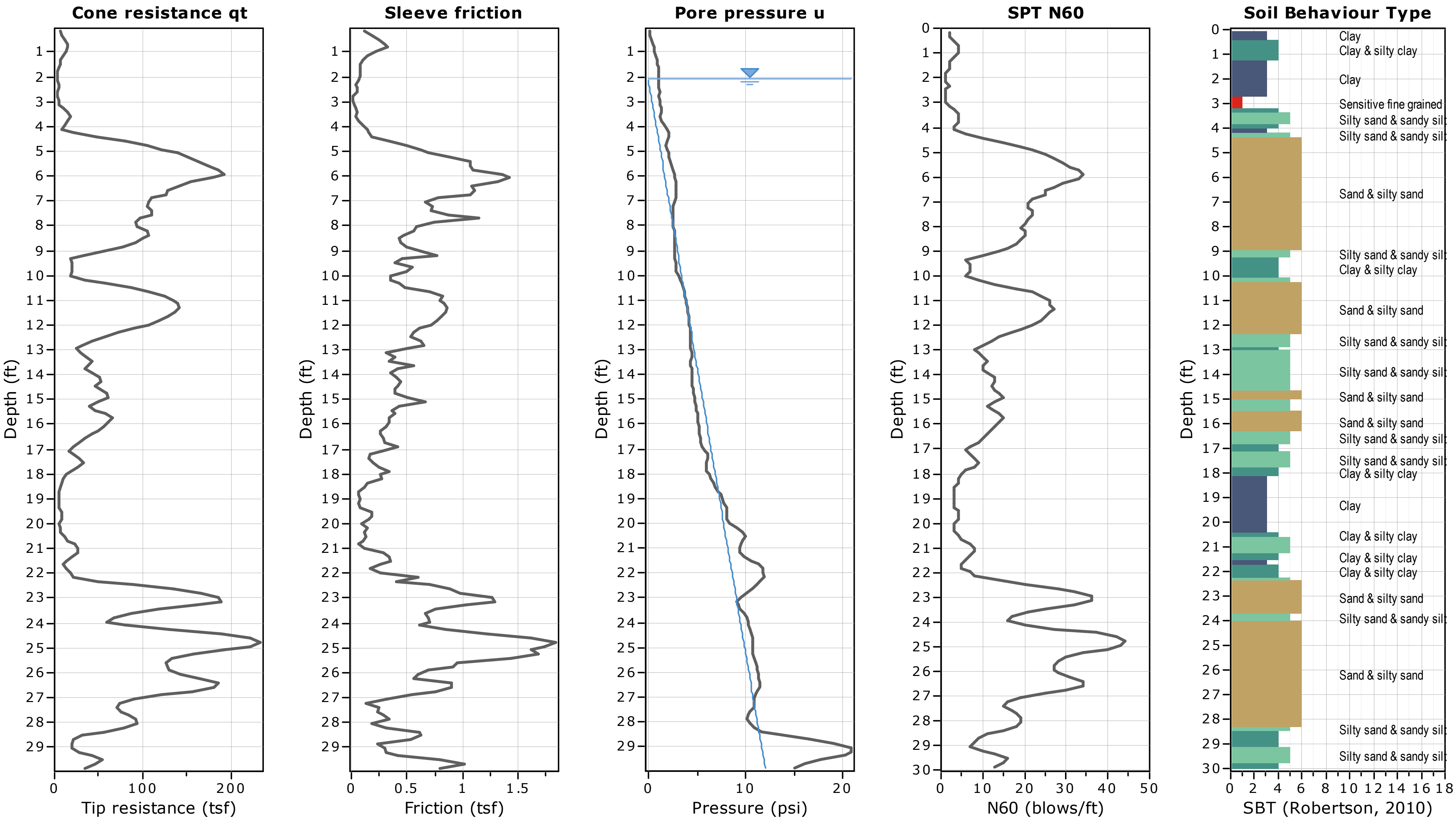
**CPT: S-2**

Total depth: 29.86 ft, Date: 3/21/2018

Cone Operator: Cory Robison

**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**

**Location:** **Beaufort, Carteret County, North Carolina**



**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

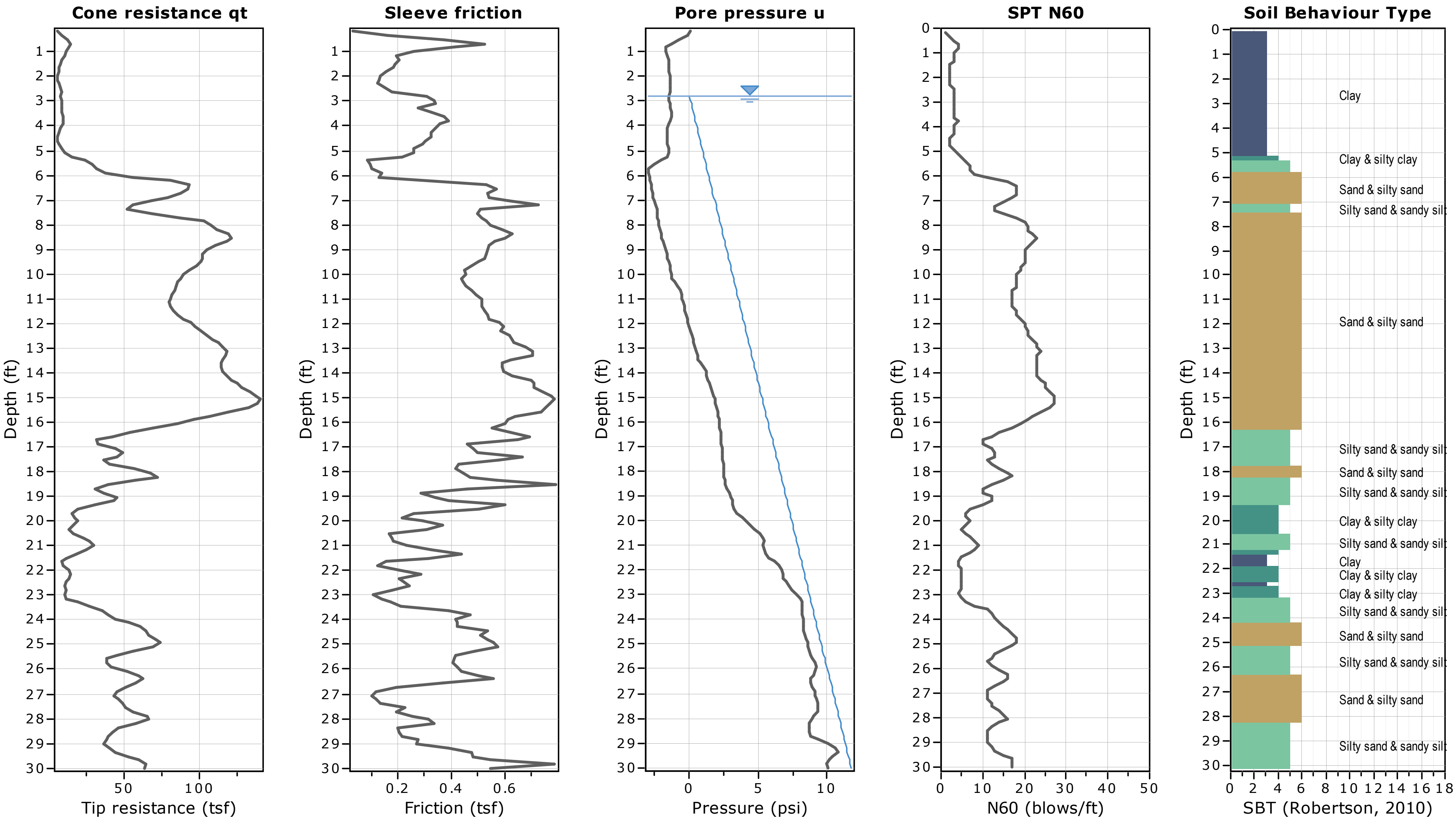
**CPT: S-3**

**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**

**Location:** **Beaufort, Carteret County, North Carolina**

Total depth: 30.02 ft, Date: 3/21/2018

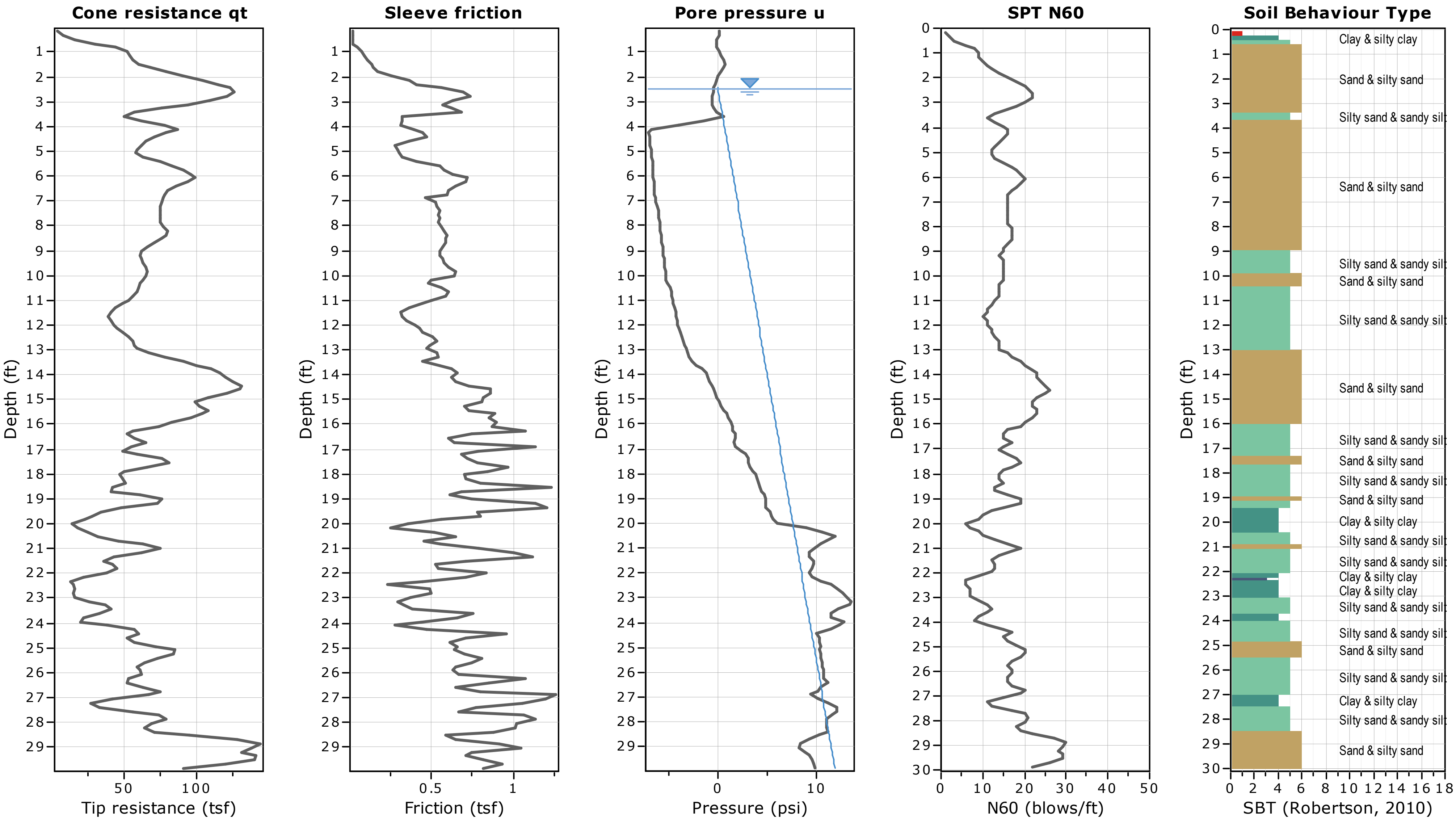
Cone Operator: Cory Robison



**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

**CPT: S-4**
Total depth: 29.86 ft, Date: 3/21/2018
Cone Operator: Cory Robison

**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**
**Location:** **Beaufort, Carteret County, North Carolina**

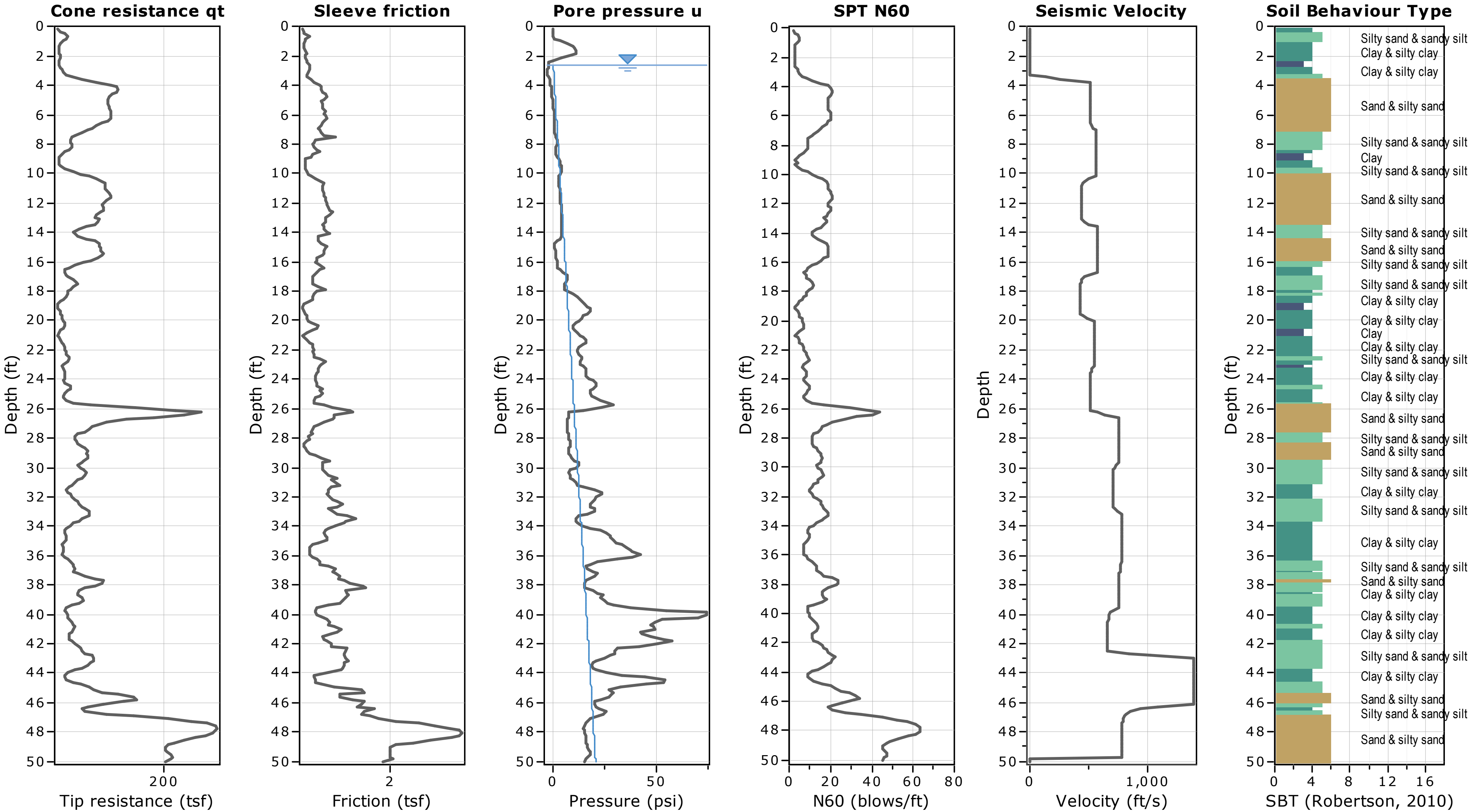


**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

**CPT: S-5**

**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**
**Location:** **Beaufort, Carteret County, North Carolina**

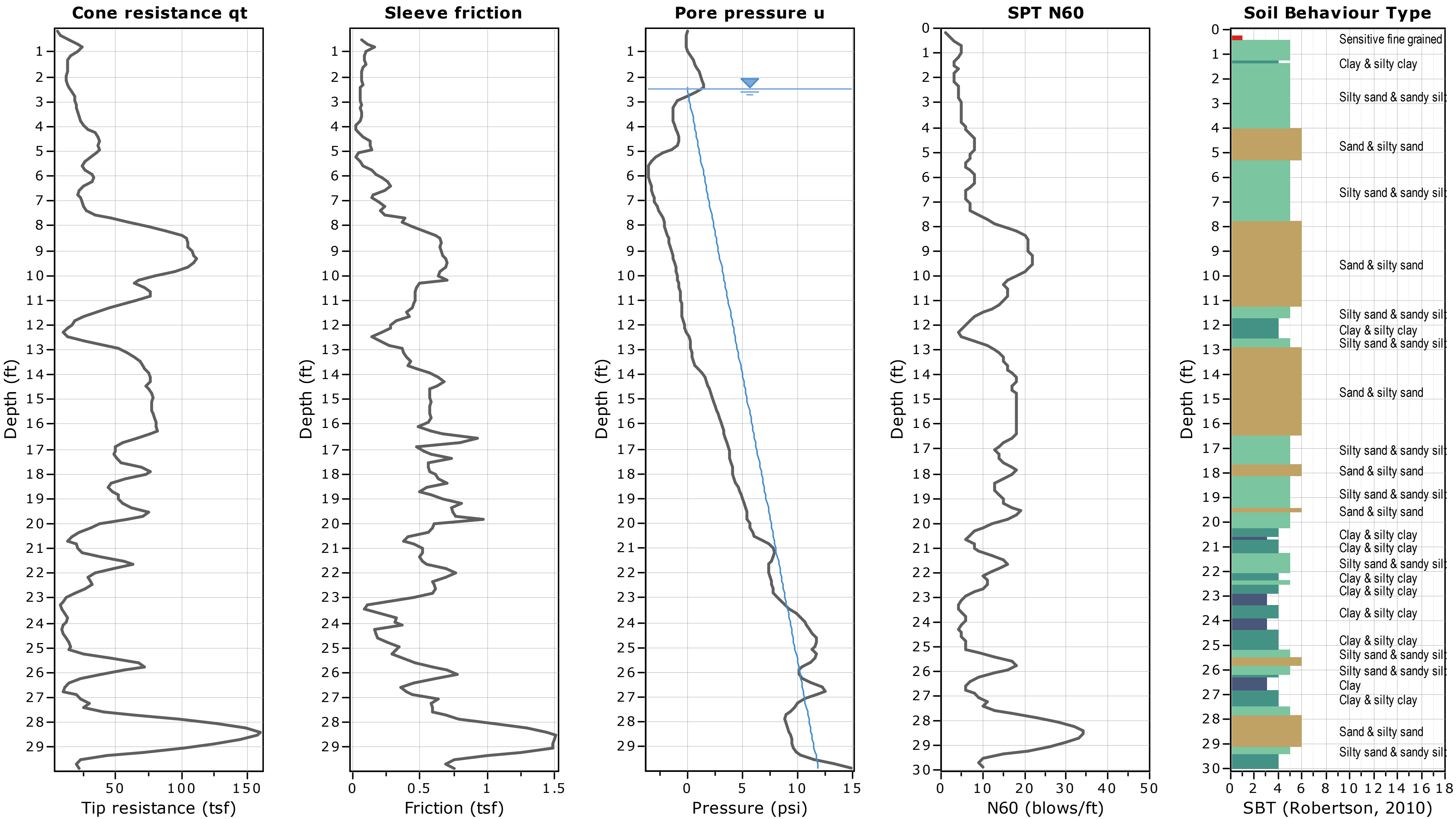
Total depth: 50.03 ft, Date: 3/21/2018
Cone Operator: Cory Robison



**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

**CPT: S-6**
Total depth: 29.86 ft, Date: 3/21/2018
Cone Operator: Cory Robison

**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**
**Location:** **Beaufort, Carteret County, North Carolina**



ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

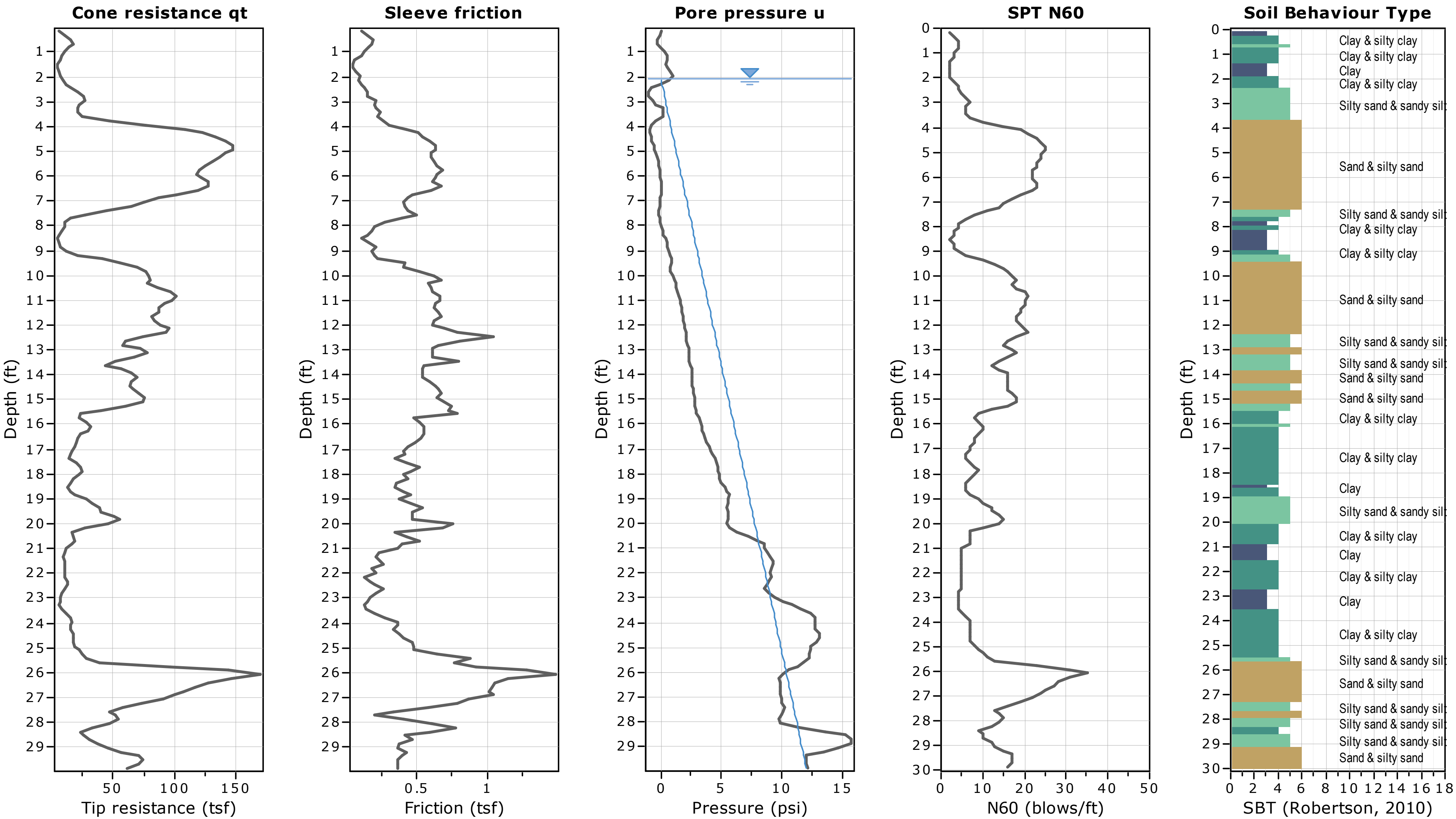
**CPT: S-7**

Total depth: 29.86 ft, Date: 3/21/2018

Cone Operator: Cory Robison

**Project:** Farm Tract - Preliminary Geotechnical Evaluation

**Location:** Beaufort, Carteret County, North Carolina



**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

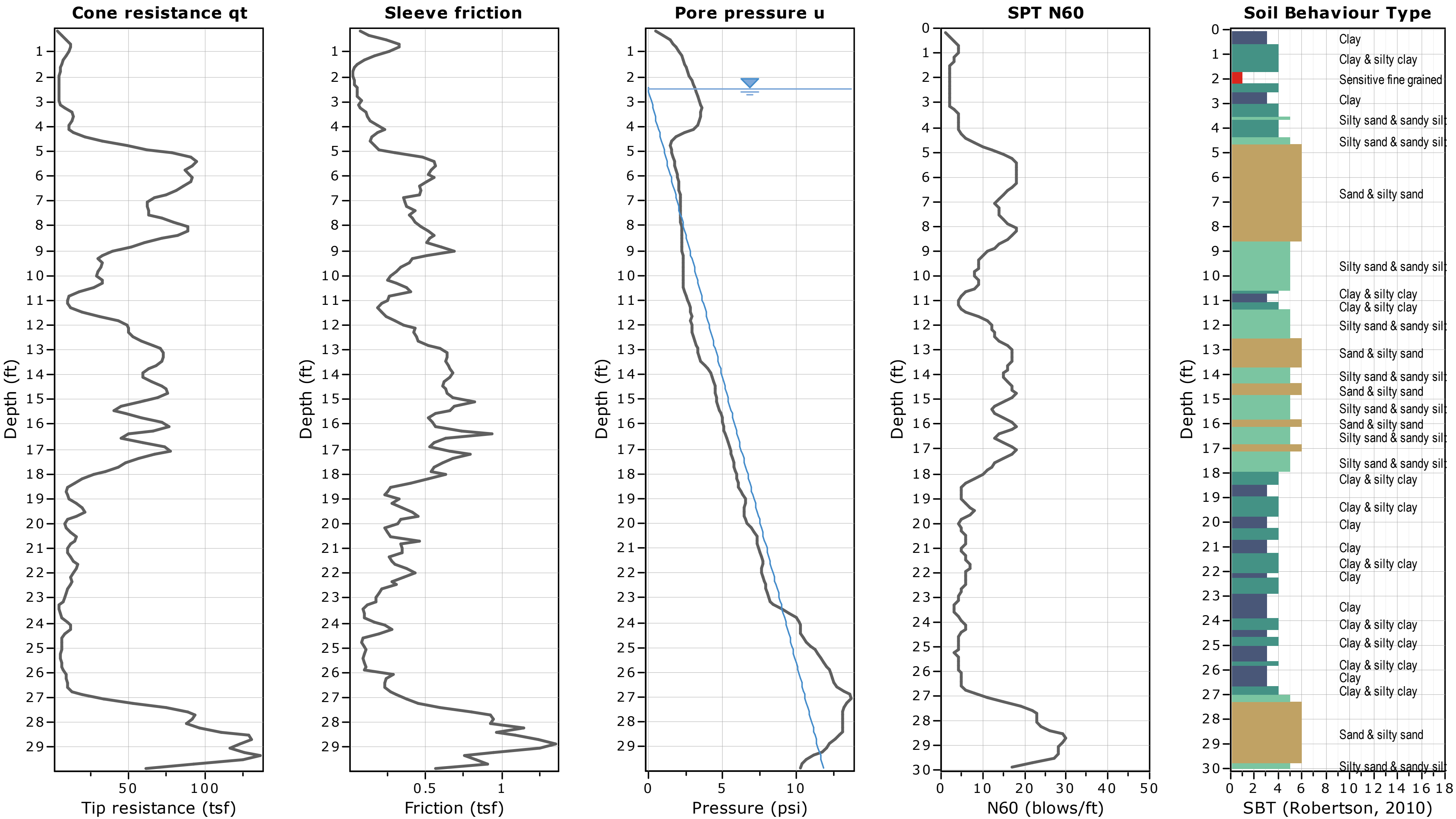
**CPT: S-8**

Total depth: 29.86 ft, Date: 3/21/2018

Cone Operator: Cory Robison

**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**

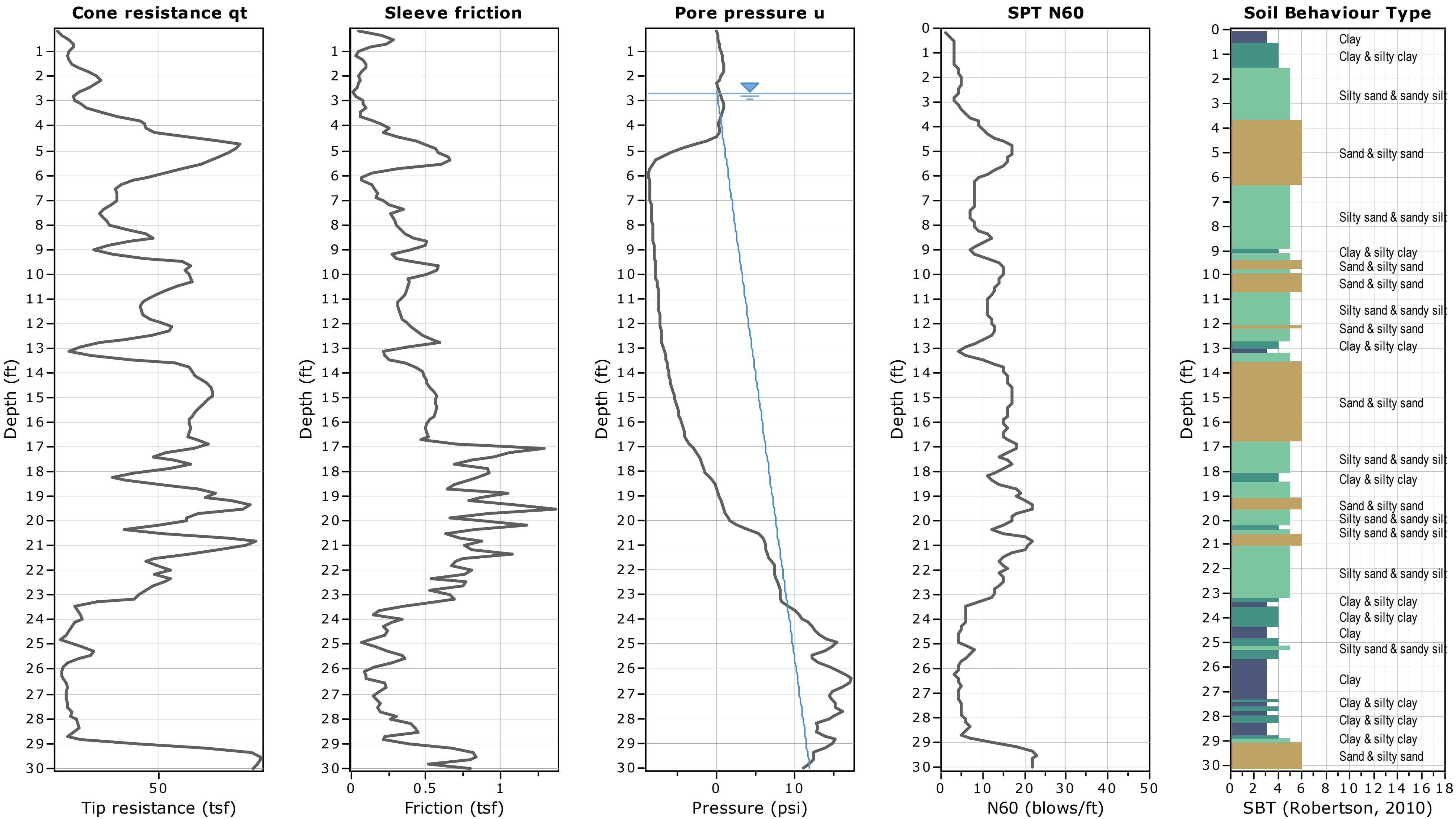
**Location:** **Beaufort, Carteret County, North Carolina**



**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

**CPT: S-9**
Total depth: 30.02 ft, Date: 3/21/2018
Cone Operator: Cory Robison

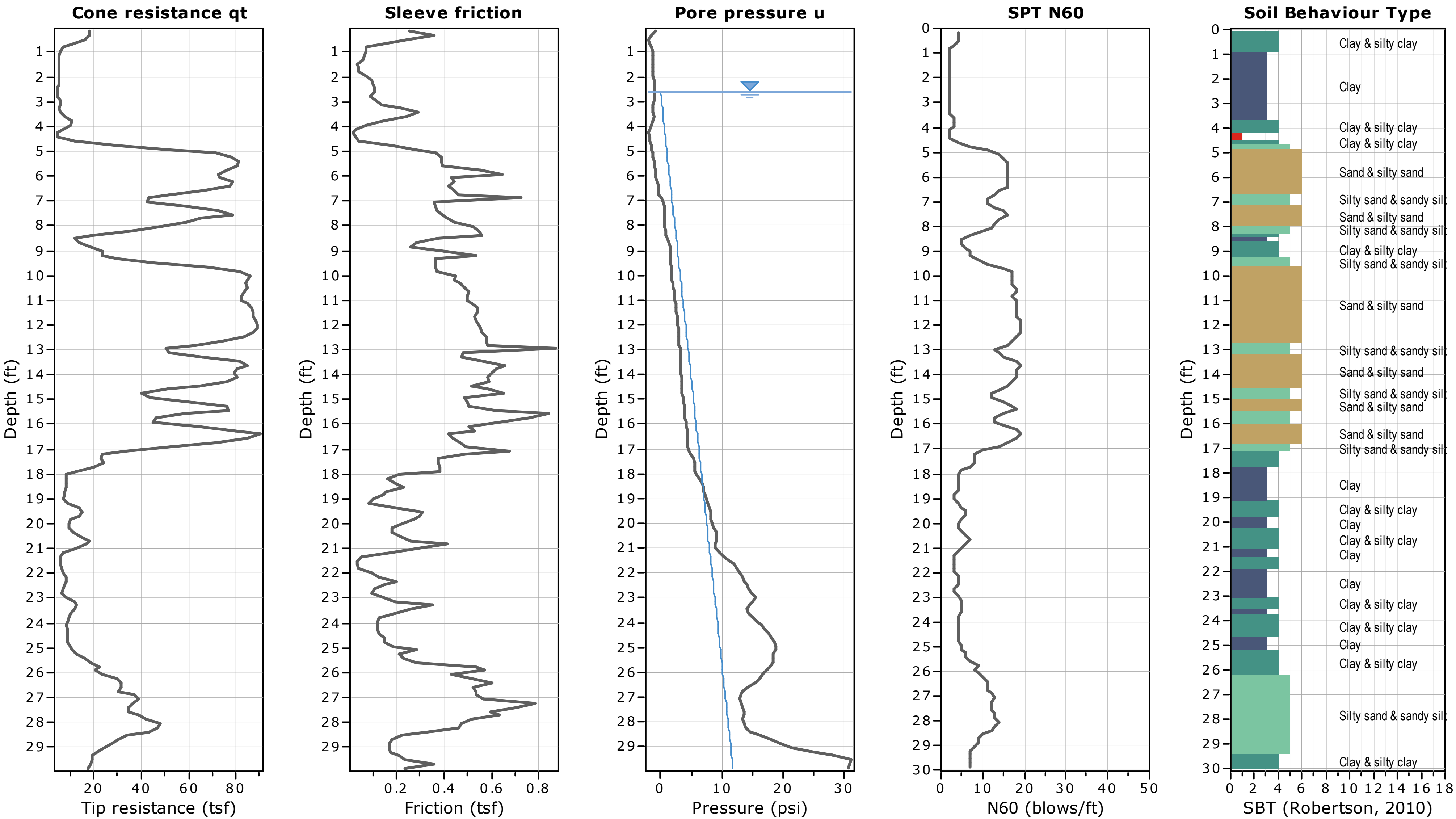
**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**
**Location:** **Beaufort, Carteret County, North Carolina**



**ECS Southeast, LLP**
6714 Netherlands Drive
Wilmington, NC 28405
ECS Project # 22-26486

**CPT: S-10**
Total depth: 29.86 ft, Date: 3/21/2018
Cone Operator: Cory Robison

**Project:** **Farm Tract - Preliminary Geotechnical Evaluation**
**Location:** **Beaufort, Carteret County, North Carolina**



# APPENDIX C – Supplemental Report Documents

ASFE Document

# Important Information About Your

# Geotechnical Engineering Report

*Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes*

*The following information is provided to help you manage your risks.*

## Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one - not even you* - should apply the report for any purpose or project except the one originally contemplated.

## Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

## A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from alight industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes - even minor ones - and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

## Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

## Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ-sometimes significantly from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

## A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

## A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

## Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

## Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

## Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

## Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

## Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the express purpose of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in-this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

## Rely on Your ASFE-Member Geotechnical Engineer For Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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Telephone:' 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org