Express Oil Change

Geotechnical Engineering Report

Panama City Beach, Florida

July 12, 2024 | Terracon Project No. HF245054

Prepared for:

Express Oil Change & Tire Engineers
1880 Southpark Drive
Birmingham, Alabama 35244

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July 12, 2024

Express Oil Change & Tire Engineers
1880 Southpark Drive
Birmingham, Alabama 35244

Attn: Mr. Justin Duck – Senior Project Manager
P: (205) 397-1142
E: justin.duck@expressoil.com

Re: Geotechnical Engineering Report
Express Oil Change
2611 Thomas Drive
Panama City Beach, Florida
Terracon Project No. HF245054

Dear Mr. Duck:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. PHF245054 dated April 25, 2024. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, stormwater ponds, and pavements 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

ZACHARY LEE BRANNON
LICENSE
No 83652
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

08/20/2024

Joshua C.S. Rakestraw, EI
Staff Engineer

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Department Manager
Florida PE No. 83652

This document has been digitally signed and sealed by Zachary L. Brannon, PE on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed, and the signature must be verified on any electronic copies.

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Note: This report was originally delivered in a web-based format. **Blue 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**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed automotive maintenance facility to be located at 2611 Thomas Drive in Panama City Beach, Florida. The purpose of these services was to provide information and geotechnical engineering recommendations relative to the following:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Dewatering considerations
- Foundation design and construction
- Floor slab design and construction
- Lateral earth pressure
- Pavement design and construction
- Stormwater pond design parameters and considerations

The geotechnical engineering scope of services for this project initially included the advancement of seven standard penetration test (SPT) borings, two cone penetration test (CPT) Soundings, laboratory testing, engineering analysis, and preparation of this report. During this initial exploration, organic soils were observed beneath the building. As a result, we remobilized to perform a supplementary exploration with the intent of further characterizing and delineating the approximate horizontal and vertical extents of the organic soils.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and as a separate table in the **Exploration Results** section.

Project Description

Item	Description
Information Provided	Project information was provided through electronic mail correspondence initially received April 19, 2024. This information included a General requested Boring Layout and a legal description of the parcel.

Item	Description
Project Description	The project includes a new automotive maintenance facility including a single-story building, drive isles, and parking lots.
Proposed Structure	It is anticipated that the building will be single story steel-framed with load bearing masonry walls and soil-supported shallow foundations with slab-on-grade.
Maximum Loads	In the absence of information provided by the design team, we will use the following loads in estimating settlement based on our experience with similar projects. ▪ Columns: 50 kips ▪ Walls: 3 kips per linear foot (klf) ▪ Slabs: 100 pounds per square foot (psf)
Grading/Slopes	The finished floor elevation is expected to be about elevation EL16 feet. Based on the topography, we assume approximately 2 to 4 feet of cut (for stormwater) and up to 2 feet of fill will be required to develop final grade, excluding remedial grading requirements. Final slopes are assumed to have an inclination of 3H:1V (Horizontal: Vertical) or flatter.
Below-Grade Structures	We anticipate the structure may include subsurface pits constructed of cast-in-place concrete retaining walls and sublevel slabs estimated to extend about 6 feet below the finished floor elevation.
Free-Standing Retaining Walls	None indicated or anticipated.
Pavements	Traffic patterns, vehicle types, and a preferred pavement surfacing have not been identified to us. Both asphalt and concrete surfacing are common in the area for projects of this nature. In our pavement designs, we will assume a 20-year design life and normal vehicle/traffic patterns for this type of development.
Stormwater	A stormwater pond is planned for the southern portion of the site. Based on the preliminary site plan, we anticipate the depth to be on the order of about three feet below ground surface.

Terracon should be notified if any of the above information is inconsistent with the planned construction (e.g., maximum loads and limits of grading) as modifications to our recommendations may be necessary.

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.

Item	Description
Parcel Information	The project is located at 2611 Thomas Drive in Panama City Beach, Florida. See **Site Location** Total parcel area: 1.2 acres.
Existing Site Conditions	Based upon Google Earth Pro, we understand the site has been stripped of trees and vegetation sometime between May 2020 and December 2022. The ground cover at the site is now primarily low weeds and grass.
Existing Topography	The site is relatively flat with existing site elevations (EL) ranging from about EL12 to EL15 feet, based on Google Earth Pro.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

Geotechnical Characterization

Soil Conditions

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Sand**	Sand with trace to little silt
2	**Organic Soil**	Organic sand with peat and clay layers

The subsurface was generally characterized by loose to medium dense sands (Model Layer 1) to the maximum depth explored of about 47 feet below the existing ground surface (bgs). In the southern portion of the building footprint, a layer of highly organic soils was encountered at soil boring E-2 at a depth of approximately 12 feet-bgs and estimated to be approximately 6 feet thick. The discovery of this soil layer prompted additional exploration within the building footprint to delineate the horizontal and vertical extent of the layer. Six additional CPT soundings were performed within the building area, labeled DL-1 through DL-6. The organic soil layer was encountered at 5 of the 6 additional locations (DL-2 through DL-6) and at depths between about 8 to 15 feet bgs. The thickness and composition of the layer varied across the building footprint. In general, the loose/soft organic soil layer was observed with a thickness of about 1 foot to 3 feet and appears to be interbedded with layers of sand.

Groundwater

The groundwater levels observed during our exploration ranged from a depth of about 0.7 to 3.6 feet-bgs. The groundwater observations are illustrated on the **GeoModel** and annotated on the boring logs in **Exploration Results**.

Groundwater level fluctuations may occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. Long-term observations in piezometers or observation wells sealed from the influence of surface water are often required to define permanent groundwater levels. Therefore, groundwater levels during construction or at other times in the life of the structure may be different than the levels indicated on the boring logs, and the possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Geotechnical Overview

The site appears adaptable for the proposed construction based upon geotechnical conditions encountered in the exploration, provided that the recommendations provided in this report are implemented in the design and construction phases of this project. A layer of compressible soft/loose sandy organic soil, about 3 feet or less in thickness, was identified at a minimum depth of about 8 feet-bgs extending to a maximum depth of about 15 feet-bgs. Due to the presence of this compressible organic soil layer special foundation design and/or construction considerations will be required. We anticipate complete overexcavation and replacement of the organic soil layer is likely not cost effective due to the presence of shallow groundwater which would necessitate significant shoring or dewatering. Therefore, we have omitted any further discussion of this option.

Generally speaking, the risk of differential or excess settlement, due to the presence of this layer, may be realized from either loading foundations during construction or the mass earthwork grading of the site.

If not mitigated, conventional shallow foundations for the proposed building structure may be subject to total settlements more than 1-inch resulting from the compression of the organic soil layer. As such, we recommend one of the following options be implemented for the design and construction of the building:

A. Conduct a temporary surcharge program consisting of five feet of additional fill (above the planned FFE) in the building footprint with an estimated hold time of about 4 weeks. The planned stormwater pond is anticipated to be a suitable source of fill for the surcharge embankment. Surcharge settlement pins will be monitored twice per week for the duration of the hold period. Following completion of monitoring, the surcharge can be removed, and the building can be constructed with conventional shallow foundations.

B. Support the building on a deep foundation system, such as helical piers. Helical pier foundations are typically design by the contractors/installers to meet the specifications of the project. Based on the CPT soundings, we anticipate a suitable bearing layer between about 15 to 30 feet-bgs.

As provided by the project Civil Engineer, we expect that up to 1 to 2 feet of fill may be placed to establish the finished floor elevation of the proposed building. Based on the planned FFE within no more than 2 feet above existing site grades, we anticipate settlement from mass grading will be less than one inch and occur relatively rapidly during construction. <u>If the final FFE changes or the site is graded with more fill than noted above, additional design and construction considerations may be necessary for the support of the floor slab</u>.

Additional details for either a surcharge program or helical pier foundations has been provided in **Surcharge Monitoring** and **Helical Pile Foundation** sections, respectively.

The near surface soils at this site are considered suitable for reuse as structural fill. In order to improve the density of loose soils, we recommend densifying the near surface soils with overlapping passes of a vibratory drum roller and applying a surcharge to the building footprint. Site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

Our opinion of pavement section thickness design has been developed based on our understanding of the intended use, assumed traffic, and subgrade preparation recommended herein using methodology contained in ACI and AASHTO publications and adjusted with consideration to local practice. The **Pavements** section includes minimum pavement component thickness.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and engineered fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Furthermore, recommendations for a **Surcharge Program** have been provided herein. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, pavements, and stormwater parameters.

Site Preparation

General Site Drainage

Site drainage measures should be implemented prior to or concurrent with initial mass grading and may include excavation of perimeter ditches with supplemental lateral ditches extending into the site, as required. The ditches should be constructed and maintained to gravity drain throughout the site preparation process. Failure to protect the subgrade soils and control surface water runoff can significantly impact the earthwork construction schedule and result in unnecessary reworking of the subgrade.

The Contractor should be prepared to cope with shallow groundwater conditions present at this site, see **Groundwater Considerations**. Pumping equipment may be utilized if the collector ditch system cannot effectively gravity drain water away from the site, especially during the rainy season.

Stripping

Prior to placing fill, existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas.

Surficial Soil Densification (Subgrade Preparation)

Following clearing and grubbing, areas of mass "cut" earthwork should be established prior to densification and proofrolling. Throughout most of the project area, a veneer of sandy surficial soils (Model Layer 1) is present. Sandy soils typically respond well to mechanical densification using a heavy vibratory drum roller. This densification process, conducted prior to proofroll, will improve the uniformity of the subsurface, increase bearing capacity, and reduce settlement. The exposed sandy subgrade soils within 5 feet of the planned building and pavement areas should be compacted with at least eight overlapping passes of a vibratory drum roller with a static operating weight of at least 15,000 pounds and a drum diameter of at least 36 inches. The roller passes should be divided into an equal number of passes in perpendicular directions. An initial test strip should be conducted and evaluated by the Geotechnical Engineer. If pumping or instability occurs, the Geotechnical Engineer may require static compaction or other methods at the time of construction. A compaction criterion of about 95% of the native soil's maximum dry density (ASTM D1557) should be targeted to a depth of about 12 inches. The effectiveness of the densification will be dependent on the moisture content of the subsoils at the time of construction. Moisture conditioning of the soils will likely be required.

Proofrolling

Following the densification program and prior to any grading fill placement, the exposed subgrade soils should be proofrolled by the contractor and observed by Terracon personnel. Proofrolling may be accomplished using the previously described vibratory drum roller operating in static-only mode. Alternatively, heavy, rubber-tired construction equipment or a tandem-axle dump truck (loaded to a gross weight of at least 20 tons) may be used for this purpose. The proofroll vehicle should systematically traverse the entire project area with multiple overlapping passes. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Excessively wet or dry material should either be removed, or moisture conditioned and recompacted.

Surcharge Monitoring

In lieu of a deep foundation system, the site may be surcharged in order to induce settlement of the underlying organic layers prior to constructing the building.

Following site preparation measures, we recommend constructing a surcharge embankment consisting of about 5 feet of fill above the planned FFE. This surcharge should extend at least 5 feet outside of the building perimeter (tapering down to proposed grade at a 1V:1H) in the vicinity of soundings DL-1 through DL-6. The northern most section of the building may be omitted, as organic soils were not encountered north of sounding DL-1. A brief monitoring and 'hold' period of 4 weeks should be observed following placement of the surcharge and prior to placing the foundation concrete. The intent of this hold period will help to induce settlement of the deep-seated sandy organic zones and reduce the amount of differential settlement that may occur post construction.

A settlement monitoring program must be incorporated into the construction program to provide data regarding on-going settlement to determine when slab construction can commence. For this program, at least 3 settlement pins (e.g., 1-inch by 3 feet long rebar driven into pad) should be placed at the building pad location after completion of the fill placement. The pins should be monitored (surveyed) immediately after placement then at least twice per week for the perspective hold period to confirm that settlement has sufficiently dissipated. Ther results of the settlement monitoring period should be provided to Terracon each day. Construction of the foundations or slabs should not commence until approved in writing by the Geotechnical Engineer.

It should be noted that the time rate of settlement is a prediction and subject to variation due to inaccuracies inherent with the calculations and assumptions of material properties and drainage characteristics. Variation in the settlement duration should be anticipated.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures or pavements. General fill is material used to achieve grade outside of these areas.

Reuse of On-Site Soil: Excavated on-site soil is likely to be suitable for reuse as structural or general fill. Material property requirements for on-site soil for use as general fill and structural fill are noted in the table below:

Property	General and Structural Fill
Composition	Free of deleterious material
Maximum particle size	3 inches
Fines content	Less than 12% Passing No. 200 sieve
Plasticity	Non-plastic
GeoModel Layer Expected to be Suitable[1]	1

1. Based on subsurface exploration. Actual material suitability should be determined in the field at time of construction.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris.

Soil Type [1]	USCS Classification	Acceptable Parameters (for Structural Fill)
Granular	SP, SP-SM	Less than 12% passing No. 200 sieve

Soil Type [1]	USCS Classification	Acceptable Parameters (for Structural Fill)

1. Structural and general fill should consist of approved materials free of organic matter and debris. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site. Additional geotechnical consultation should be provided prior to use of uniformly graded gravel on the site.

Fill Placement and Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	▪ 12 inches or less in loose thickness when heavy, self-propelled compaction equipment is used ▪ 4 to 6 inches in loose thickness when lighter hand-guided equipment (e.g., jumping jack or plate compactor) is used	Same as structural fill
Minimum Compaction Requirements [1]	▪ 98% of max. in first 12 inches below foundations and within 1 foot beneath pavement base ▪ 95% of max. above foundations, below floor slabs, and more than 1 foot below finished pavement subgrade or foundations	92% of max.
Water Content Range [1,2]	Granular: -3% to +3% of optimum	As required to achieve min. compaction requirements

1. Maximum density and optimum water content as determined by the modified Proctor test (ASTM D1557).
2. Specifically, moisture levels should be achieved and maintained low enough to allow for satisfactory compaction to be achieved without pumping when using suitable vibration compaction equipment.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfills should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Flooding or jetting for placement and compaction of backfill is not recommended.

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% 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 have been completed, 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 grade-supported improvements such as floor slabs and pavements. 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 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.

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.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Groundwater Considerations

The Contractor should be prepared to implement a dewatering program for excavations made below existing site grades, such as those for installation of stormwater pipes or other utilities. Based on observations at our soil borings, it is anticipated that groundwater could be encountered in excavations on site, particularly in topographically lower areas of the site. Dewatering procedures used by the contractor will be dependent on a number of factors such as the areas and depths of excavations, prevalent groundwater conditions, and prevalent weather conditions at the time of construction.

Dewatering procedures employed should be capable of maintaining groundwater levels at least 2 feet below the lowest point of the excavation being dewatered, or as deep as required to achieve the required compaction or suitable subgrade conditions. In addition, the dewatering procedures should be maintained until all construction operations are above the groundwater levels that existed prior to dewatering, or until all structural bearing subgrades are adequately protected.

We expect that installation of deeper drainage pipes and drainage structures will require vacuum-type dewatering systems such as wellpoints or horizontal sock-type vacuum dewatering systems. Groundwater control in shallower excavations (e.g., spread footings) in sandy soils can typically be accomplished by excavating sumps in non-structural bearing areas of the excavation and pumping of the accumulated water from the sumps as needed to maintain a dry excavation.

To facilitate construction operations and aid long term performance of grade supported structures on the project site, additional measures may be necessary to manage the shallow groundwater conditions. Such measures may include, but may not be limited to, the following:

- The use of clean granular backfill materials, such as sands with less than 5% passing the No. 200 mesh sieve or No. 57 gradation crushed washed stone, to facilitate backfill operations near or below groundwater levels.
- The proper scheduling of construction operations to minimize the potential effects of groundwater conditions on excavation and construction operations. Such scheduling should be performed in a manner as to minimize the amount of time for which excavations are allowed to remain open and subgrades exposed, and to expedite the backfill or construction operations as quickly as is practical. Therefore, all materials and equipment required to perform any excavation or construction operations should be available and ready on the site prior to and at the time of the operations.
- The use of thin mats of lean concrete to help protect structural subgrades and to help minimize the effects of perched groundwater conditions on the subgrades. Such "mud mats" can be placed during and immediately following excavation operations, and will allow, with proper care and use, for backfill placement or other construction operations within the excavations at a later time.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements) as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. Where not specified by local ordinance, one density and water content test should be performed for every 75 linear feet of compacted utility trench backfill and a minimum of one test performed for every lift of compacted backfill.

In areas of foundation excavations, the prepared bearing subgrade should be tested for density and water content at a frequency of at least one test for every 100 square feet for footings (at least one per column) and at least one test per 50 feet for continuous strip footings. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in **Earthwork** and a success **Surcharge Monitoring** program has been completed in accordance with this report, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Allowable Net Bearing Pressure [1, 2]	2,500 pounds per square foot
Required Bearing Stratum	Compacted Structural Fill or approved in-situ soil
Minimum Foundation Dimensions	Isolated – 24 inches Continuous – 18 inches
Ultimate Passive Resistance[3] **(equivalent fluid pressures)**	300 pcf
Sliding Resistance [4]	0.40 ultimate coefficient of friction
Minimum Embedment below Finished Grade [5]	18 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch (following surcharge program)
Estimated Differential Settlement [2, 6]	About 1/2 of total settlement (following surcharge program)

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. 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. Assumes no hydrostatic pressure.

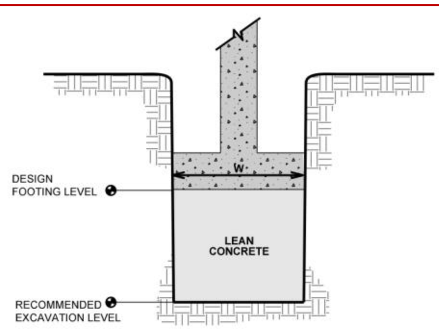
Item	Description

4. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations.
5. Embedment necessary to minimize the effects of seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
6. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 40 feet.

Foundation Construction Considerations

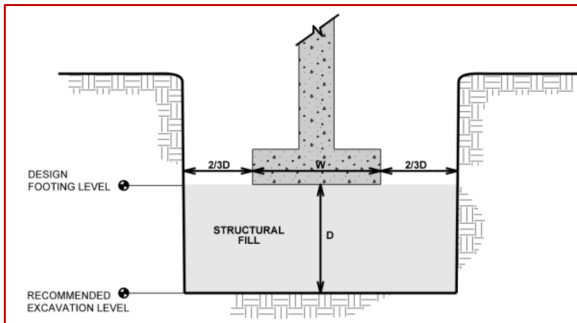
As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. 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 observed 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. The lean concrete and structural fill replacement zones are illustrated on the sketches below. Structural fill should consist of granular fill as described in **Earthwork**.



LEAN CONCRETE BACKFILL

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY



OVER-EXCAVATION / BACKFILL ZONE

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Helical Pile Foundations

Helical Pile Design

Helical compression piles are commonly used in underpinning applications but can also be used for new construction. These piles would be screwed beyond (below) the organic soil layer and into the medium dense sand layer which starts at depths varying from about 8 12 to 15 feet-bgs. Because the piles are "screwed" into the ground, nominal spoil removal is required. Each lead section of helical steel pile has a coupler device on the top end and an earth penetrating pilot on the bottom (below the lowest helix). The helices have typical diameters ranging from 6 to 14 inches with solid square stem widths or pipe shaft diameters ranging from 1-½ to 3-1/2 inches. The capacity of the helical piles would be developed primarily in end-bearing and pull-out (uplift) resistance in the medium dense sand layer. The design of the piles would need to consider lateral loading (since these elements do not generate much lateral load capacity due to their relatively small cross-section). In firm soils, the helical piles are typically installed using a hydraulic drive unit or torque head having a rated torque ranging from 3,000 to 15,000 ft-lbs. The piles can be installed on a batter, if desired.

Although helical piles are normally constructed of hot-dipped galvanized metal for corrosion resistance, selection of the pile type should consider the potential for corrosion. In highly corrosive environments, the piles can be painted with a protective coating, or cathodic protection may be necessary. We recommend that the helical pile manufacturer be contacted in regard to the potential for corrosion. Corrosion testing was not conducted as part of our scope of services, though is recommended if helical systems are desired. Terracon can perform this test upon request.

Since most helical pile installers perform their own pile capacity designs, we have provided recommended soil engineering properties in the table below. We recommend a minimum factor of safety of 2 be used for axial capacity of helical piles. The soil properties listed in the table can also be used for design of the helical piles to resist ground line shear and overturning moment loads. We recommend that the tabulated design parameters be used to determine required shaft and helix diameters and embedment depths.

Depth Range (ft)	Soil Type	LPile Soil Model	Undrained Cohesion, C_u (psf)	Friction Angle, ϕ (deg)	Effective Unit Weight, γ_{total} (pcf)	Lateral Subgrade Modulus, k (pci)
0 to 10	Medium dense fine Sand	Sand (Reese)	0	35	50	Default

10 to 15	Loose Organic Sand	Sand (Reese)	0	28	35	Default
15 to 35	Dense Fine Sand	Sand (Reese)	0	38	55	Default

We anticipate that the lateral resistance of the helical piles will be primarily generated in the loose to medium dense sands in the upper 5 to 10 feet of the pile. We further assume that lateral load resistances will be calculated using the program LPILE by ENSOFT. We have therefore provided soil parameters in the table above that are suitable for input into the LPILE program.

Due to the presence of organic soils at a typical depth range of 8 to 15 feet, we do not recommend a pile length of less than 18 feet below existing grade. Because typical pinned connections between pier shaft sections can result in some “play”, resulting in pile settlement during compression loading, we recommend that the pile sections be welded rather than pinned. Alternatively, a pile type that uses threaded type connections could be used, or the helical piles could be preloaded after installation using a hydraulic jack to take the “play” out of the connections.

We recommend a minimum center to center pile spacing of 3D, where D is the diameter of the leading plate. For compression applications, the uppermost helical plate should be embedded at least five diameters below the ground surface to create a deep foundation bearing condition. For tension applications, the uppermost helix plate should be installed to a depth of at least twelve diameters below the ground surface.

Multiple helices can be used in soil on a single pile to increase the pile capacity. If the helices are spaced at least 3 diameters apart (center to center) vertically, and the upper helix is located at least 5 helix diameters into the bearing stratum, then the total pile capacity is equal to the sum of the individual helix capacities.

Helical Pile Installation

The helical piers are installed manually or using a hydraulic torque head. Load testing of the piles in soils has shown a direct relationship between the installation torque and the pile ultimate compression capacity. The installation torque required is a function of the desired pile capacity. This relationship is defined by the following equation:

$$\mathbf{Q = K \times T}$$

Where: Q = Ultimate pile compression capacity (pounds)

K = Empirical torque correlation factor (typical range: 3 to 10, function of shaft diameter) (ft^{-1})

T = Final installation torque (ft-lbs)

Shear pins or calibrated hydraulic gauges are utilized to determine when the pile has reached the desired torque and ultimate capacity. The piles should be installed to bearing within the medium dense sand layer.

The actual pile embedment depth should be determined in the field based on observations during installation.

Helical Pier Installation Monitoring

We recommend that production helical pile installation be monitored by a senior engineering technician from this office on a full-time basis. The items that should be observed and documented by the technician include the following:

- Date and time of installation
- Type of installation equipment, including type of torque indicator or method utilized to determine installation torque
- Helical pile number and location
- Depth of bearing stratum and total embedment of helix into layer
- Identification of lead section and extension
- Number of helices used, diameter of each, and spacing between helices
- Inclination of helical pile
- Installation torque at 3-foot intervals
- Comments pertaining to delays during installation, obstructions, or other pertinent information

Helical Pile Load Test Recommendations

At least two full scale load tests should be conducted and observed by a representative of the geotechnical engineer. The load tests should be conducted in accordance with applicable ASTM standards.

Review of Contractor Submittals

We recommend that Terracon be permitted to review the proposed helical pile design and construction plans to confirm that acceptable soil engineering properties have been used in the analysis.

Floor Slabs

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

If the site grading plan or FFE differs from our assumptions, we should be notified to review and modify our recommendations for floor slabs.

Floor Slab Design Parameters

Item	Description
Floor Slab Support	Floor slabs should be constructed over a uniform and stable subgrade compacted to a depth of at least 12 inches. The subgrade should be constructed as described below: ▪ On-site sand soil (Model Layer 1) or imported sand meeting the requirements of Granular fill should be placed for the first 12 inches immediately below the slab. ▪ An optional 4-inch-thick base course meeting the material specifications of ACI 302 may be used. ▪ Subgrade should be compacted to recommendations outlined in **Earthwork**
Estimated Modulus of Subgrade Reaction [1]	200 pounds per square inch per inch (psi/in) for point loads

1. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

With proper compaction and moisture conditioning, native sand subgrades may be capable of supporting foot traffic from less-invasive slab construction methods. However, locally available fine to medium grained sands may be easily disturbed by exposure to construction equipment and excessive foot traffic, which should be minimized to the extent possible. On buildings where mixers, pumps, equipment, and personnel may be repeatedly traversing the prepared subgrade, we recommend placing a 4-inch-thick base course meeting the material specifications of ACI 302.

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, when the project includes humidity-controlled areas, 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 contraction 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 waterproof, 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

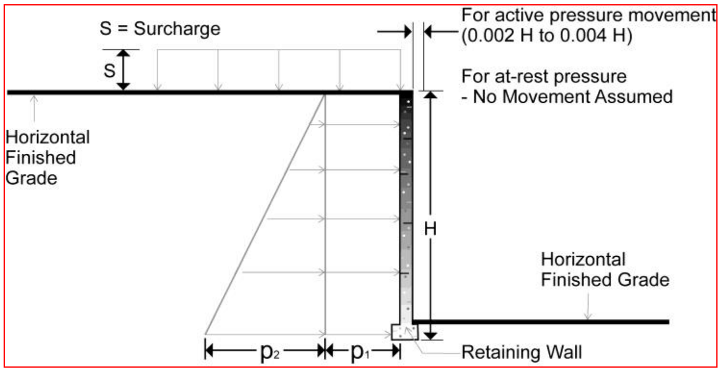
Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor 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 observe 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.

Below Grade Service Pits

Design Parameters

Structures with unbalanced backfill levels on opposite sides, such as service pits, should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained. The “at-rest” condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3] p_1 (psf)	Equivalent Fluid Pressures (psf) [2,4]	
			Unsaturated [5]	Submerged [5]
At-Rest (Ko)	0.50	(0.5)S	(55)H	(86)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance. Fat clay or other expansive soils should not be used as backfill behind the wall.
2. Uniform, horizontal backfill, with a maximum unit weight of 110 pcf for granular soils.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.

Footings, floor slabs or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

The lateral earth pressure recommendations given in this section are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls. These recommendations are not applicable to the design of modular block - geogrid reinforced backfill walls (also termed MSE walls). Recommendations covering these types of wall systems are beyond the scope of services for this assignment. However, we would be pleased to develop a proposal for evaluation and design of such wall systems upon request.

Considerations for Below-Grade Walls

Due to the shallow groundwater level at this site, a permanent dewatering system may be required. Furthermore, the service pit should be design with consideration to buoyant uplift forces from shallow groundwater. For this purpose, we recommend considering a seasonal high groundwater level of about 18 inches below the existing natural ground surface.

Pavements

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Pavement Subgrade Parameters

Based on our experience, an estimated subgrade resilient modulus of 9,000 pounds per square inch is common for the native soils. However, due to prevalent shallow groundwater, we have reduced the design resilient modulus for asphaltic concrete (AC) pavements to about 6,750 psi to in accordance with FDOT guidelines. A modulus of subgrade reaction of 200 pci was used for the portland cement concrete (PCC) pavement designs. The values were empirically derived based upon our experience with the native subgrade soils and our expectation of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**. A modulus of rupture of 550 psi was used in design for the concrete (based on correlations with a minimum 28-day compressive strength of 4,000 psi).

Design Traffic

In absence of traffic criteria provided to us by the design team, Terracon has assumed relatively normal commercial/retail traffic patterns for the size of the development. A 20-year design life was assumed in the development of the pavement section thickness. For asphalt pavements the anticipated traffic was converted into flexible AASHTO pavement 18-kip equivalent single axle loads (ESALs) for use in AC pavement thickness design as follows:

Flexible Pavement (AC) Traffic Level	Vehicles per day	Design ESALs (flexible)
Light Duty	▪ 500 Passenger Cars/Trucks	7,500
Medium Duty	▪ 500 Passenger Cars/Trucks ▪ 5 loaded Sem-tractor Trailers	100,000

PCC traffic level designs are based on the traffic categories and truck frequencies listed in ACI 330-21, Commercial Concrete Parking Lots and Site Paving Design and Construction Guide, and are summarized below:

Rigid Pavement (PCC) Traffic Level	ACI Traffic Category	Applicable Trucks per day
Light Duty	(A) Car parking and access lanes	1
Garbage Truck Lane	(E) Garbage or fire truck lane	1

Pavement Section Thicknesses

The following table provides our opinion of minimum thickness for AC sections:

Asphaltic Concrete Design

Layer	Thickness (inches)	
	Light Duty [1]	Medium Duty [1]
AC [2]	1.5	2.5
Aggregate Base [3]	6	8
Stabilized Subgrade (LBR 40)[4]	12	12

Asphaltic Concrete Design

Layer	Thickness (inches)	
	Light Duty [1]	Medium Duty [1]

1. See **Design Traffic** for more specifics regarding traffic assumptions.
2. All materials should meet the current Florida Department of Transportation (FDOT) Standard Specifications for Roadway and Bridge Construction.
3. FDOT Specification Sections 200, 204, and 911 or alternative approved by the Geotechnical Engineer.
4. Native soil blended with approved materials to achieve a limerock bearing ration of 40%. See **Subgrade Preparation**.

The following table provides our estimated minimum thickness of PCC pavements.

Portland Cement Concrete Design

Layer	Thickness (inches)		
	Light Duty [1]	Medium Duty	Garbage Truck
PCC [2]	5	5	6.5
Aggregate Subbase [3]	Optional	Optional	Optional
Prepared Subgrade[4]	12	12	12

1. See **Design Traffic** for more specifics regarding traffic classifications.
2. All materials should meet the current FDOT Standard Specifications for Roadway and Bridge Construction.
3. Optional layer for the purpose of maintaining uniform support during construction. FDOT Specification Section 204, Graded Aggregate Base (GAB), or crushed concrete. Limerock base should not be used beneath PCC pavements.
4. Native soil or structural fill compacted to at least 98% of the material's maximum dry density as determined by ASTM D1557. See **Subgrade Preparation**.

Subgrade Preparation

Site grading is typically accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to temporarily improve ride comfort. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

After densification, proofrolling, repairing deep subgrade deficiencies, and installation of underground utilities, the entire subgrade should be scarified (ripped) to a depth of at least 12 inches, recompacted, and tested as recommended in **Earthwork** to provide a uniform subgrade for pavement construction. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed (e.g., for excavation and installation of utilities), the subgrade should be reviewed by qualified personnel immediately prior to paving. The pavement subgrade should be in its finished form at the time of the final review.

In areas of Florida with easily disturbed near surface clean sandy soils, a stabilized subgrade course, about 12 inches thick, is often constructed by mixing approved materials with native soils and serves as a working platform to permit the efficient construction of the base material used in AC pavements. The stabilized subgrade is constructed with a target Limerock Bearing Ratio (LBR) of about 40%. The stabilized subgrade course should be constructed in accordance with FDOT Specification 160. Due to prevalent shallow groundwater level, imported sand-clay stabilization soils are not recommended.

AC Aggregate Base

Aggregate base for flexible pavements shall comply with FDOT Specification Sections 200, 204, and 911. Due to the shallow groundwater table, sand-clay base is not recommended. Aggregate base or pavement materials should not be placed when the surface is wet. Surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade.

PCC Subbase (Optional)

Considering the relatively light vehicular traffic, importing an aggregate subbase material for the sole purpose of improving subgrade support (increasing subgrade modulus) is not likely to be economically viable and is not considered necessary for the rigid pavements at this site. However, as described by ACI 330-21, an aggregate subbase layer may be prescribed for the following reasons:

- To provide a stiffer working platform during construction
- To reduce weather delays caused by weakened subgrade conditions
- To reduce susceptibility to pumping of fine-grained subgrade soil from slab joints.

Rigid pavements that are exposed to less than about 200 loaded trucks per day and low speeds are typically not considered susceptible to pumping.

Design and Construction Considerations

Asphaltic concrete pavements are most commonly used in the area for commercial site development. However, rigid concrete pavements are often used in drive through areas, truck lanes, or other areas exposed to turning/maneuvering vehicles. Furthermore, concrete is minimally affected by oil and gas leaks produced by vehicles.

Areas for parking of heavy vehicles, concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. Edge restraints (e.g., concrete curbs or aggregate shoulders) should be planned along curves and areas of maneuvering vehicles.

Where practical, we recommend early-entry cutting of crack-control joints in PCC pavements. Cutting of the concrete in its "green" state typically reduces the potential for micro-cracking of the pavements prior to the crack control joints being formed, compared to cutting the joints after the concrete has fully set. Micro-cracking of pavements may lead to crack formation in locations other than the sawed joints, and/or reduction of fatigue life of the pavement.

Proper joint spacing will be required to prevent excessive slab curling and shrinkage cracking. Joints should be sealed to prevent entry of foreign material and doweled where necessary for load transfer. PCC pavement details for joint spacing, joint reinforcement, and joint sealing should be prepared in accordance with ACI 330 and ACI 325.

Openings in pavements, such as decorative landscaped areas, are sources for water infiltration into surrounding pavement systems. Water can collect in the islands and migrate into the surrounding subgrade soils thereby degrading support of the pavement. Islands with raised concrete curbs, irrigated foliage, and low permeability near-surface soils are particular areas of concern. The civil design for the pavements with these conditions should include features to restrict or collect and discharge excess water from the islands. Examples of features are edge drains connected to the stormwater collection system, longitudinal subdrains, or other suitable outlets and impermeable barriers preventing lateral migration of water such as a cutoff wall installed to a depth below the pavement structure.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. Preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.

We understand a shallow stormwater retention system will be construction at this site. The stormwater pond bottom is expected to be on the order of about 3 feet below the existing site grades. The exploration encountered primarily clean sands which will be suitable for subterranean recovery of stormwater runoff, although groundwater levels could prohibit the function of a dry pond. A stormwater pond may be designed using the subsoil parameters outlined in the following subsection. These parameters are based on a conventional shallow dry retention pond. The Drainage Engineer should use the information provided in the following sections to evaluate the stormwater management facility, including a mounding analysis, with an appropriate factor of safety.

Stormwater

Infiltration Rate Testing

The field infiltration rate of water was measured using a Modified Phillip-Dunne (MPD) infiltrometer in order to calculate the in-situ hydraulic conductivity of the soils. One test was performed at the location shown on the **Exploration Plan** at a depth of about 2 feet-bgs. The test reports are provided in **Exploration Results** and summarized below:

Test Label	Nearby Boring	Depth (feet)	Saturated Hydraulic Conductivity, K_{sat} (in/hr)	USCS Classification
E-9	E-9	2	49.4	SP

Design Parameters

To aid in the evaluation of dry retention stormwater treatment and drainage, the table below summarizes recommended design parameters derived from the available data:

Recommended Stormwater Design Parameters	
Item	**Value** [1,2]
Estimated Seasonal High Groundwater Elevation[3]	EL 12.5 feet
Elevation of Estimated Effective Confining Layer	<EL -5 feet
Estimated Fillable Porosity	20 percent
Estimated Vertical Unsaturated Hydraulic Conductivity	26 ft/day
Estimated Vertical and Horizontal Saturated Hydraulic Conductivity	40 ft/day

1. Hydraulic conductivity values are based on the permeability tests performed locations noted and do not include the effects of groundwater mounding or a factor of safety.
2. Recommended maximum value per the Northwest Florida Water Management District.
3. Based on the topographic map provided to us.

The information provided in this table should be used in tandem with the lithology and groundwater conditions presented on the boring log reports at each site. Permeability values are unfactored, and we recommend applying a minimum factor of safety of 2 to these values for the design and recovery analysis of the proposed stormwater ponds. Due to the groundwater level, a groundwater mounding analysis should be performed by the Drainage Engineer.

Terracon requests the opportunity to review the design input parameters for stormwater analyses. Please contact us if there are any questions regarding the stormwater pond design parameters, changes in the location of planned stormwater improvements, or necessity for alternative stormwater treatment measures.

Construction Considerations

Soil densification that often occurs due to heavy construction equipment may reduce the drainage characteristics of the subsoils. Care should be taken to limit the amount of surface compaction and densification that occurs during construction. Low ground pressure tracked equipment should be considered where practical.

General Comments

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. 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 this 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 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 information 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.

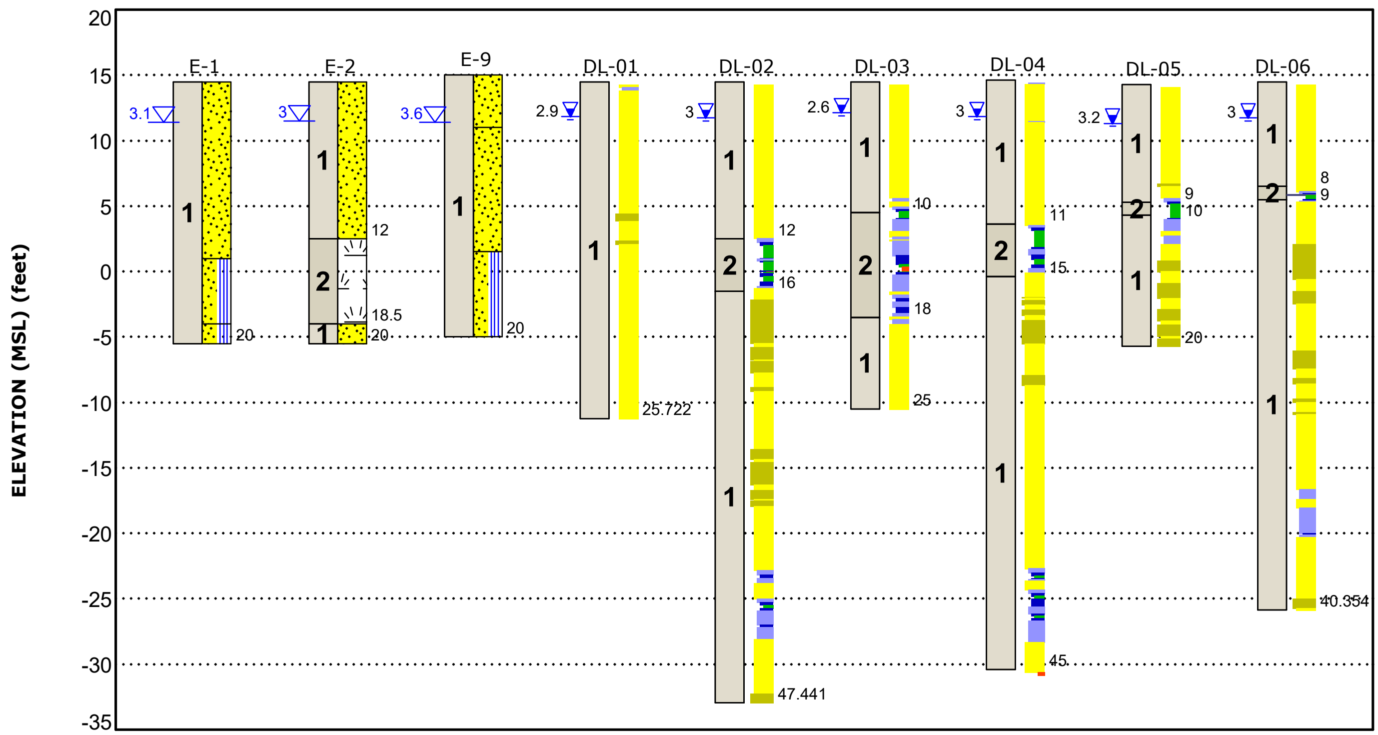
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation 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. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. 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.

Figures

Contents:

3559 Timberlane School Rd
Tallahassee, FL

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Sand	Sand with varying amounts of silt
2	Organic Soil	Organic sand with peat and clay layers

Legend

Poorly-graded Sand
Poorly-graded Sand with Silt
Peat

CPT Water Depth
First Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Locations	Exploration Type	Approximate Boring Depth (feet)	Location
2	SPT Boring	20	Proposed Building Footprint
6	CPT Sounding	20 to 48	
4	SPT Boring	10 to 15	Parking and drive area
2	CPT Sounding	10	Parking and drive area
1	SPT Boring	20	Proposed Stormwater Pond

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±20 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using a mud rotary drilling technique. In the mud rotary procedure, drilling fluid was circulated in the boreholes to stabilize the borehole walls and flush soil cuttings to the surface. Five samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon is recorded at an interval of 6 inches. The sum of blows in the second and third interval of a normal 18-inch or 24-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value (N). The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. For safety purposes, all borings were backfilled with auger cuttings after their completion.

Log Recording: The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Cone Penetration Test Soundings: Cone Penetration Test (CPT) soundings were performed using an electronic cone penetrometer. The penetrometer device includes a cone-tipped sounding unit attached to steel rods with flush joint couplings. The sounding unit has electronic strain gauges that measure point resistance and sleeve friction, a transducer that measures pore water pressure and an inclinometer that measures verticality of the sounding unit. The readings from the cone instruments are transmitted wirelessly, or electronically through a cable within the rods, to a computer at the surface that stores the data and provides real-time display of the cone results. A depth encoder device monitors penetration depth and speed as the rods are pushed slowly into the ground. The cone unit records the measured values at 2-cm intervals. No soil samples are gathered through this subsurface investigation technique.

CPT testing is conducted in general accordance with ASTM D5778, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils" and ASTM D7400-14, "Standard Test Methods for Downhole Seismic Testing". The CPT Sounding Logs provide detailed information on stratigraphy and a measure of the in-situ soil properties. The resistance to penetration can be correlated with soil strength, stiffness, and density properties, and soil types can be estimated.

Field Infiltration Rate Testing: A Modified Phillip-Dunne (MPD) infiltrometer was used to measure the field infiltration rate of water into the soil at designated locations. The tests were performed in general accordance with ASTM D8152 and at a depth of approximately 2 to 2.5 feet-bgs. An auger or shovel was used to excavate soils to the designated test depth. The MPD infiltrometer consists of a 10-centimeter inner-diameter cylinder with a beveled bottom edge (for inserting in the soil). The MPD infiltrometer is equipped with a digital pressure transducer to automatically record the water level within the cylinder at various intervals during the test. An initial volumetric moisture reading of the soil is recorded prior to starting the test. The device is inserted into the ground to a depth of about 5 centimeters, and the cylinder is filled with water. The infiltrated volume of water (by means of drop in head) is recorded versus time. After about three liters of water have passed through the device and into the soil, the test is concluded. A final measurement of soil moisture is recorded at completion. The saturated hydraulic conductivity is then calculated using the general procedures outlined in ASTM D8152. The test reports are included in **Exploration Results**.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Fines Content
- Organic Content

The laboratory testing program included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System. The estimated group symbol for the Unified Soil Classification System is shown on the boring log and a brief description of the Unified Soil Classification System is included in the supporting information section of this report. Laboratory test results have been tabulated in the Attachments and presented on the individual Boring Logs.

Photography Log

Site condition at E-6 facing east

Site condition at E-1 facing south

Site condition at E-6 facing north

Site condition at E-6 facing northwest

Site Location and Exploration Plans

Contents:

Note: All attachments are one page unless noted above.

Site Location

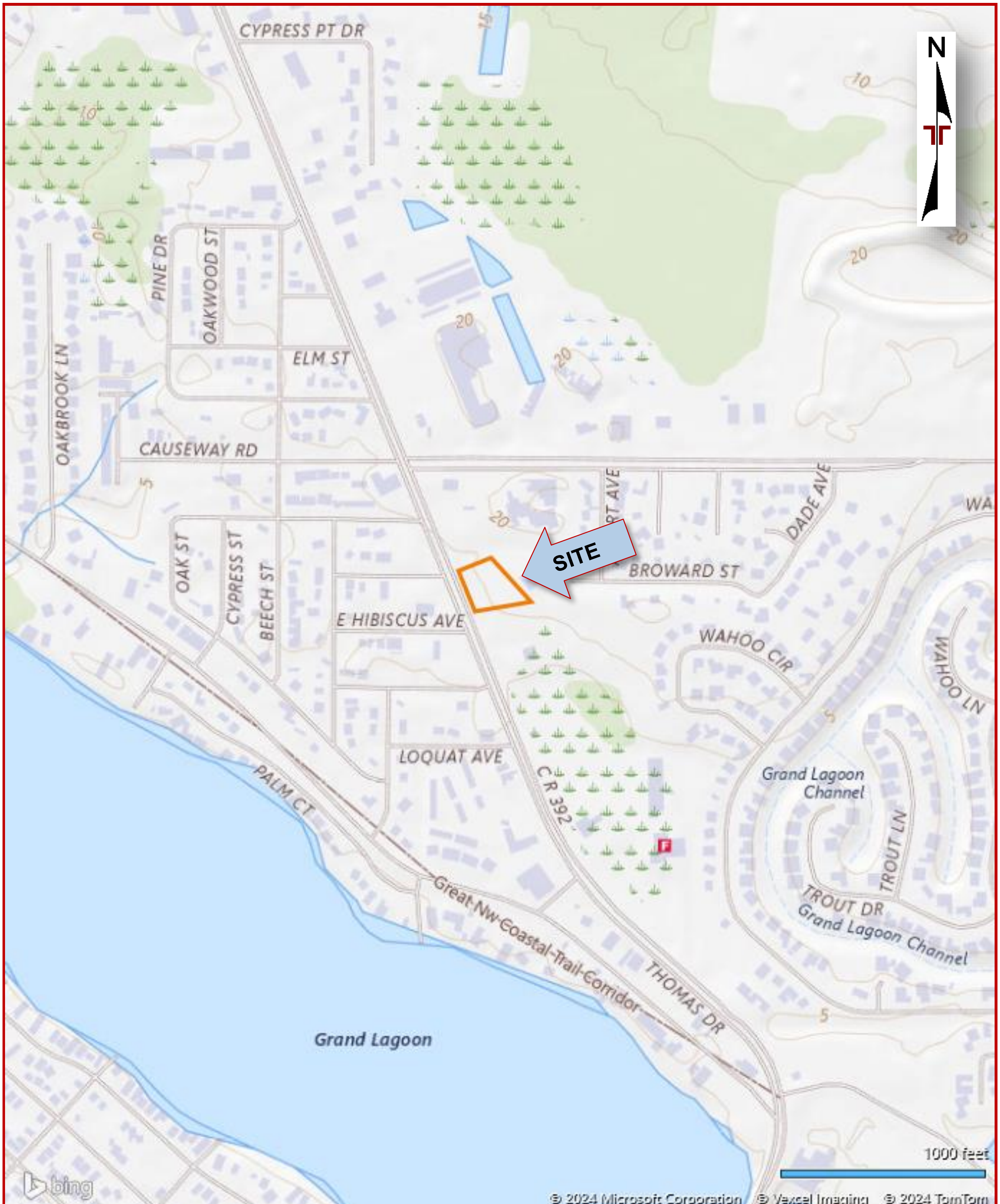


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

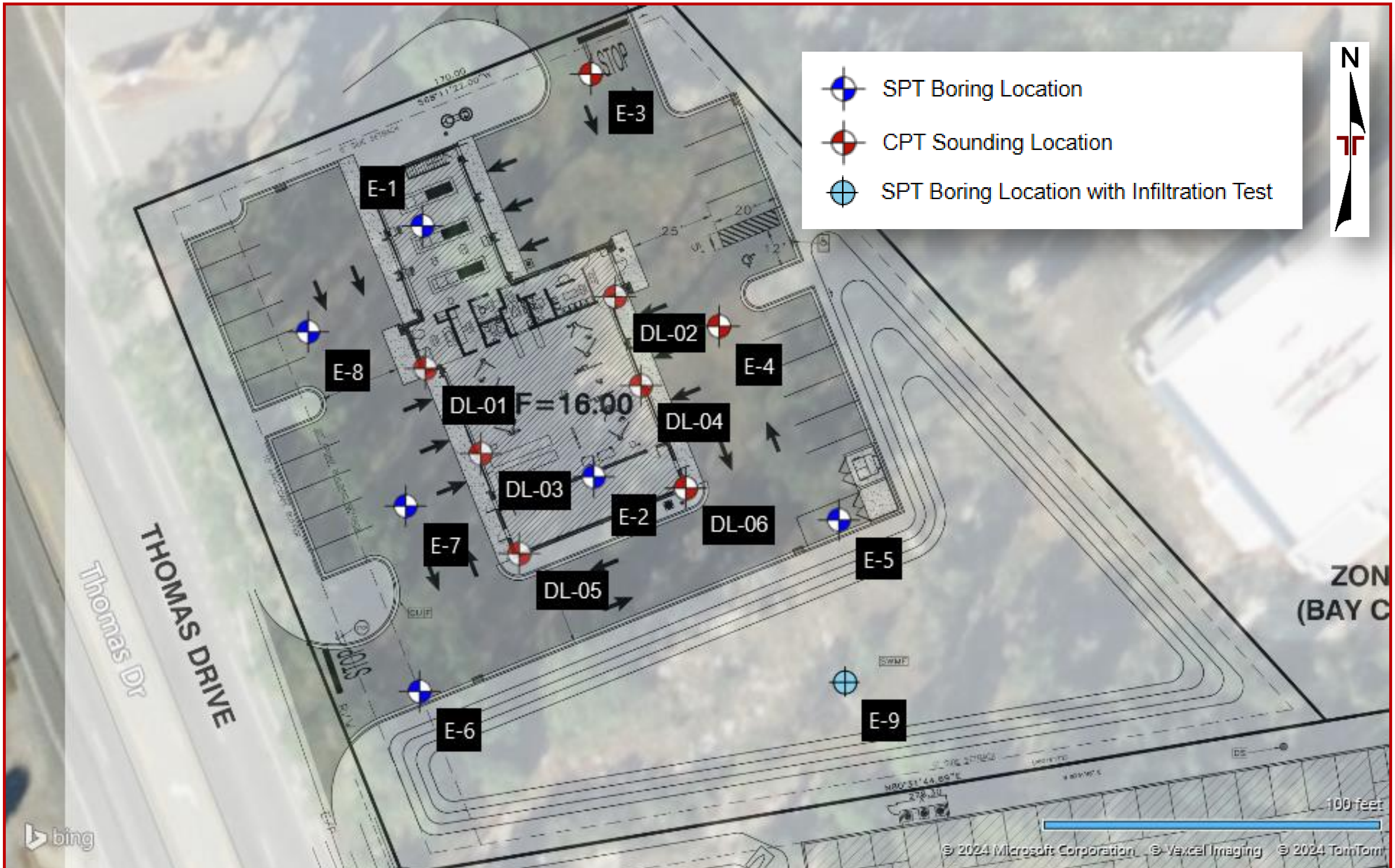


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless noted above.

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Boring Log No. E-1

Location: See Exploration Plan

Latitude: 30.1574° Longitude: -85.7521°

Elevation: 14.5 (Ft.) +/-

Model Layer	Depth (Ft.)	Material Description	Elevation	Water Level Observations	Field Test Results	Organic Content (%)	Water Content (%)	Percent Fines
1	0	**POORLY GRADED SAND (SP)**, fine grained, light gray, loose			WOH-1-2-2 N=3		6.4	1
		below 2 feet - tan		▽ (3.1 ft)	1-2-2-4 N=4			
		below 4 feet - white			1-2-3-5 N=5			
					WOH-1-2-3 N=3			
		below 8 feet - medium dense			2-4-6-8 N=10			
	13.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, brown, dense	1		7-12-15 N=27			
	18.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, dark brown, medium dense	-4		5-7-9 N=16			
	20.0	***Boring Terminated at 20 Feet***	-5.5					

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.

Elevation Reference: Elevations estimated from Google Earth Pro.

WOH = Weight of Hammer

Water Level Observations
▽ Groundwater encountered at 3.1 feet while drilling.

Drill Rig
Geoprobe 3126 GT

Hammer Type
Automatic

Driller
M. Castillo

Notes

Advancement Method
0 to 4 feet: Manual Auger
4 to 20 feet: Mud Rotary

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
M. Castillo

Boring Started
05-15-2024

Boring Completed
05-15-2024

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Boring Log No. E-2

Location: See Exploration Plan

Latitude: 30.1572° Longitude: -85.7519°

Elevation: 14.5 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Elevation	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Organic Content (%)	Water Content (%)	Percent Fines
1	SP	**POORLY GRADED SAND (SP)**, fine grained, light gray, loose				X	WOH-1-2-3 N=3			
		below 2 feet - tan			▽ (3 ft)	X	1-2-2-4 N=4		21.0	3
		below 4 feet - white		5		X	1-2-3-6 N=5			
						X	WOH-1-2-5 N=3			
						X	1-2-6-7 N=8			
		12.0	2.5	10						
2	PT	**PEAT (PT)**, dark brown, very soft				X	WOH/18" N<1	41.8	250.8	
		18.5	-4	15						
1	SP	**POORLY GRADED SAND (SP)**, fine grained, light gray, dense				X	8-15-17 N=32			
		20.0	-5.5	20						

Boring Terminated at 20 Feet

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.

Elevation Reference: Elevations estimated from Google Earth Pro.

WOH = Weight of Hammer

Water Level Observations
▽ Groundwater encountered at 3 feet while drilling.

Drill Rig
Geoprobe 3126 GT

Hammer Type
Automatic

Driller
M. Castillo

Notes

Advancement Method
0 to 4 feet: Manual Auger
4 to 20 feet: Mud Rotary

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
M. Castillo

Boring Started
05-15-2024

Boring Completed
05-15-2024

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Boring Log No. E-5

Location: See Exploration Plan

Latitude: 30.1572° Longitude: -85.7517°

Model Layer	Graphic Log	Depth (Ft.) / Description / Elevation: 15 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Organic Content (%)	Water Content (%)	Percent Fines
1		**POORLY GRADED SAND (SP)**, fine grained, light gray, loose			X	WOH-1-2-2 N=3		4.2	2
		below 2 feet - tan		▽	X	1-2-1-3 N=3			
		below 4 feet - white	5		X	1-2-3-3 N=5			
					X	1-2-3-4 N=5			
		10.0 ... 5	10		X	1-2-5-9 N=7			
		Boring Terminated at 10 Feet							

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.
Elevation Reference: Elevations estimated from Google Earth Pro.
WOH = Weight of Hammer

Water Level Observations
▽ Groundwater encountered at 3.1 feet while drilling.

Drill Rig
Geoprobe 3126 GT

Hammer Type
Automatic

Driller
M. Castillo

Notes

Advancement Method
0 to 4 feet: Manual Auger
4 to 10 feet: Mud Rotary

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
M. Castillo

Boring Started
05-16-2024

Boring Completed
05-16-2024

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Boring Log No. E-6

Location: See Exploration Plan

Latitude: 30.1570° Longitude: -85.7521°

Depth (Ft.) Elevation: 12 (Ft.) +/-

Model Layer	Depth (Ft.)	Description	Elevation	Water Level Observations	Field Test Results	Organic Content (%)	Water Content (%)	Percent Fines
1		**POORLY GRADED SAND (SP)**, fine grained, tan, loose		▽ (1 ft)	1-2-4-5 N=6			
		below 2 feet - white			1-2-3-4 N=5			
					WOH-1-2-3 N=3			
	6.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, few organics, fine grained, dark brown, loose	6		1-1-2-1 N=3		81.4	6
		below 8 feet - very loose			1-1-1-1 N=2	8.3	52.9	
	13.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, dark brown, medium dense	-1.5		7-9-11 N=20			
	15.0	***Boring Terminated at 15 Feet***	-3					

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.

Elevation Reference: Elevations estimated from Google Earth Pro.

WOH = Weight of Hammer

Water Level Observations
▽ Groundwater encountered at 1 foot while drilling.

Drill Rig
Geoprobe 3126 GT

Hammer Type
Automatic

Driller
M. Castillo

Notes

Advancement Method
0 to 4 feet: Manual Auger
4 to 15 feet: Mud Rotary

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
M. Castillo

Boring Started
05-16-2024

Boring Completed
05-16-2024

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Boring Log No. E-7

Location: See Exploration Plan

Latitude: 30.1572° Longitude: -85.7521°

Elevation: 13.5 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Description	Elevation	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Organic Content (%)	Water Content (%)	Percent Fines
1			**POORLY GRADED SAND (SP)**, fine grained, tan, loose			▽		2-3-3-3 N=6			
			below 2 feet - white					1-3-3-7 N=6		25.9	1
			below 4 feet - very loose		5			WOH-1/12"-3 N=1			
		6.0		7.5							
			POORLY GRADED SAND (SP), fine grained, white, medium dense					1-3-6-8 N=9			
								2-6-8-9 N=14			
		10.0		3.5	10						
			Boring Terminated at 10 Feet								

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.
Elevation Reference: Elevations estimated from Google Earth Pro.
WOH = Weight of Hammer

Water Level Observations
▽ Groundwater encountered at 0.7 feet while drilling.

Drill Rig
Geoprobe 3126 GT

Hammer Type
Automatic

Driller
M. Castillo

Notes

Advancement Method
0 to 4 feet: Manual Auger
4 to 10 feet: Mud Rotary

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
M. Castillo

Boring Started
05-16-2024

Boring Completed
05-16-2024

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Boring Log No. E-8

Location: See Exploration Plan

Latitude: 30.1573° Longitude: -85.7522°

Elevation: 13.5 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Description	Elevation	Water Level Observations	Sample Type	Field Test Results	Organic Content (%)	Water Content (%)	Percent Fines
1			**POORLY GRADED SAND (SP)**, fine grained, tan, very loose		▽		WOH/12"-1-1 N=1		29.1	3
		2.0	**POORLY GRADED SAND (SP)**, fine grained, white, loose	11.5			1-2-4-6 N=6			
			below 4 feet - medium dense				2-7-9-11 N=16			
							6-8-11-13 N=19			
							2-7-8-13 N=15			
		10.0	*Boring Terminated at 10 Feet*	3.5						

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.
Elevation Reference: Elevations estimated from Google Earth Pro.
WOH = Weight of Hammer

Water Level Observations
▽ Groundwater encountered at 0.7 feet while drilling.

Drill Rig
Geoprobe 3126 GT

Hammer Type
Automatic

Driller
M. Castillo

Notes

Advancement Method
0 to 2 feet: Manual Auger
2 to 10 feet: Mud Rotary

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
M. Castillo

Boring Started
05-16-2024

Boring Completed
05-16-2024

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Boring Log No. E-9

Location: See Exploration Plan

Latitude: 30.1570° Longitude: -85.7517°

Model Layer	Graphic Log	Depth (Ft.) / Material Description / Elevation: 15 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Organic Content (%)	Water Content (%)	Percent Fines
1		**POORLY GRADED SAND (SP)**, fine grained, light gray, very loose			X	WOH/12"-1-2 N=1			
		below 2 feet - brown and loose		▽	X	1-2-2-3 N=4		18.8	4
		4.0 — 11							
		POORLY GRADED SAND (SP), fine grained, white, loose	5		X	1-2-3-4 N=5		26.8	1
					X	1-3-4-5 N=7			
					X	1-3-5-6 N=8			
			10						
		13.5 — 1.5							
		POORLY GRADED SAND WITH SILT, fine grained, grayish brown, dense			X	9-12-16 N=28			
			15						
					X	4-10-14 N=24			
		20.0 — -5	20						
		Boring Terminated at 20 Feet							

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.
Elevation Reference: Elevations estimated from Google Earth Pro.
WOH = Weight of Hammer

Water Level Observations
▽ Groundwater encountered at 3.6 feet while drilling.

Drill Rig
Geoprobe 3126 GT

Hammer Type
Automatic

Driller
M. Castillo

Notes

Advancement Method
0 to 4 feet: Manual Auger
4 to 20 feet: Mud Rotary

Abandonment Method
Boring backfilled with auger cuttings and bentonite chips upon completion.

Logged by
M. Castillo

Boring Started
05-16-2024

Boring Completed
05-16-2024

Express Oil Change
2611 Thomas Drive | Panama City Beach, Florida
Terracon Project No. HF245054

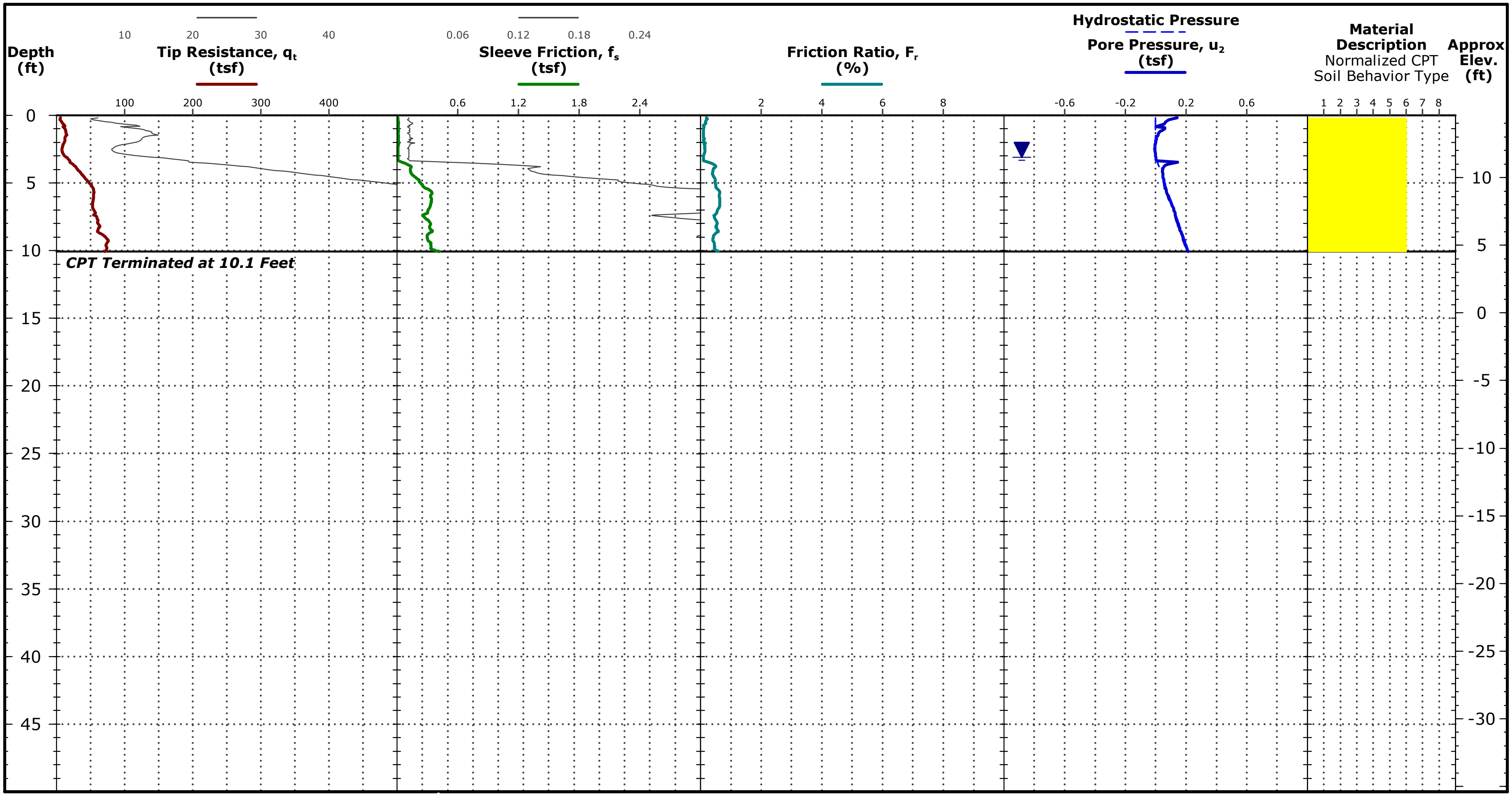
CPT Sounding ID E-3

3559 Timberlane School Rd
Tallahassee, FL

Latitude: 30.1575° Longitude: -85.7519°
North: 30.157527 East: -85.751912

Elevation: 14.6 (ft) +/-
Elevation Reference: Elevations estimated from Google Earth Pro.

CPT Started: 5/16/2024
CPT Completed: 5/16/2024



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.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe 3126 GT

Operator: M. Castillo

CPT sensor calibration reports available upon request

Probe No. 51022 with net area ratio of .845

Manufactured by Geoprobe- Calibrated 2/9/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

3.1 ft measured water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Express Oil Change
2611 Thomas Drive | Panama City Beach, Florida
Terracon Project No. HF245054

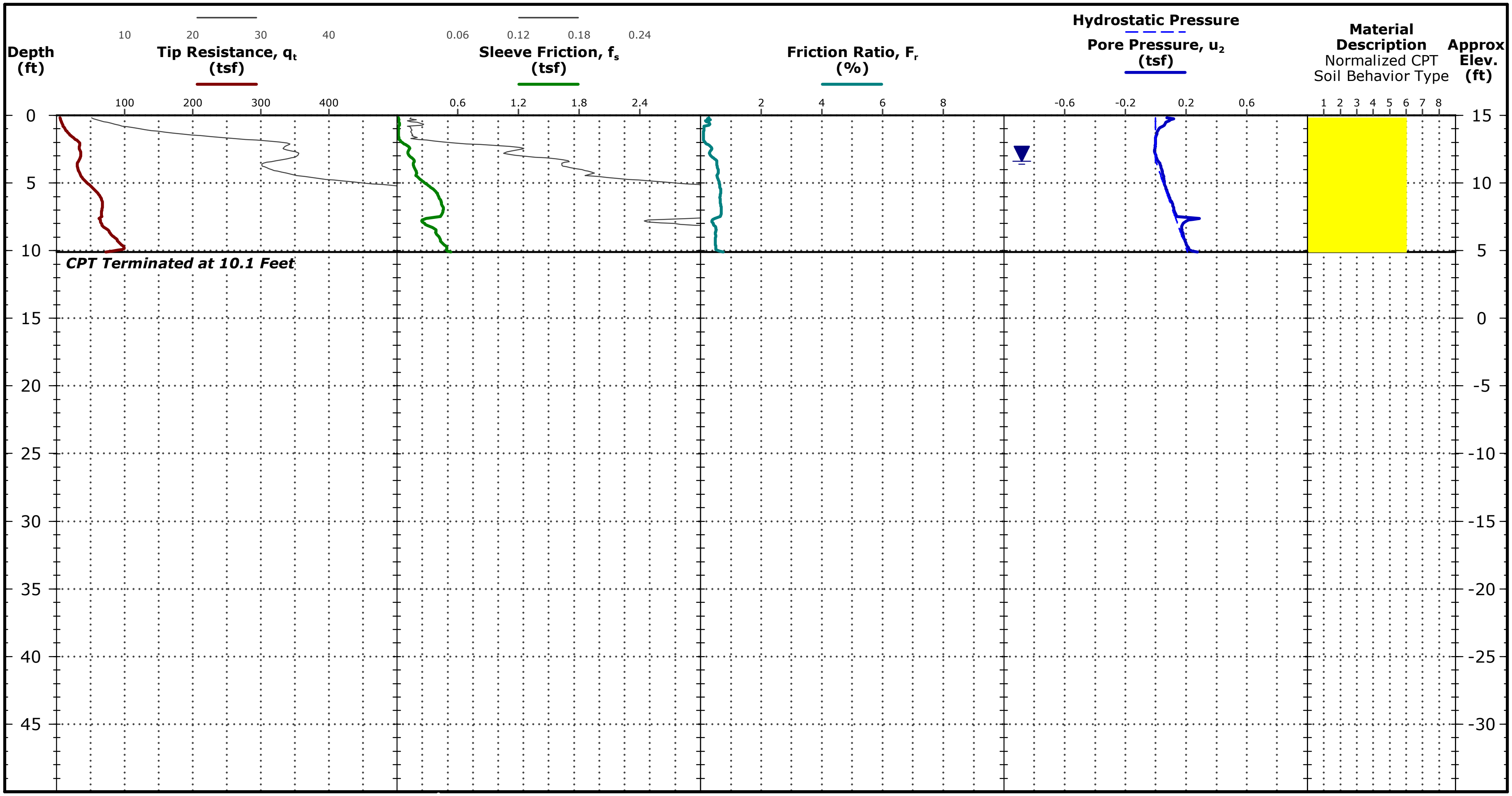
CPT Sounding ID E-4

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Latitude: 30.1573° Longitude: -85.7518°
North: 30.157323 East: -85.751792

Elevation: 15 (ft) +/-
Elevation Reference: Elevations estimated from Google Earth Pro.

CPT Started: 5/16/2024
CPT Completed: 5/16/2024



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.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe 3126 GT

Operator: M. Castillo

CPT sensor calibration reports available upon request

Probe No. 51022 with net area ratio of .845

Manufactured by Geoprobe- Calibrated 2/9/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

3.4 ft measured water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Express Oil Change
2611 Thomas Drive | Panama City Beach, Florida
Terracon Project No. HF245054

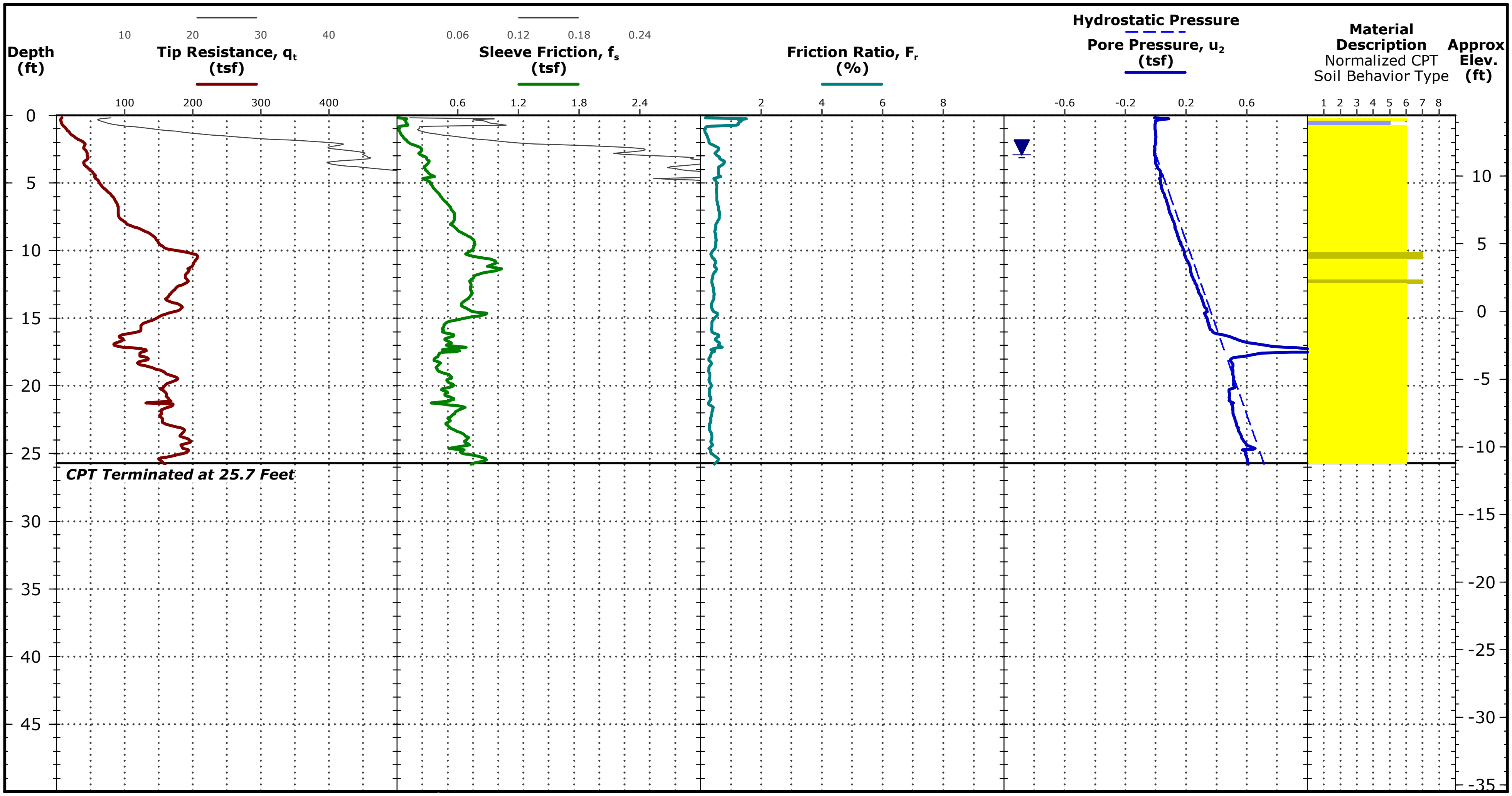
CPT Sounding ID DL-01

3559 Timberlane School Rd
Tallahassee, FL

Latitude: 30.1573° Longitude: -85.7521°
North: 30.157289 East: -85.752067

Elevation: 14.5 (ft) +/-
Elevation Reference: Elevations estimated from Google Earth Pro.

CPT Started: 6/27/2024
CPT Completed: 6/27/2024



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.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe 3126 GT

Operator: M. Castillo

CPT sensor calibration reports available upon request

Probe No. 51022 with net area ratio of .845

Manufactured by Geoprobe- Calibrated 2/9/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

2.9 ft measured water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Express Oil Change
2611 Thomas Drive | Panama City Beach, Florida
Terracon Project No. HF245054

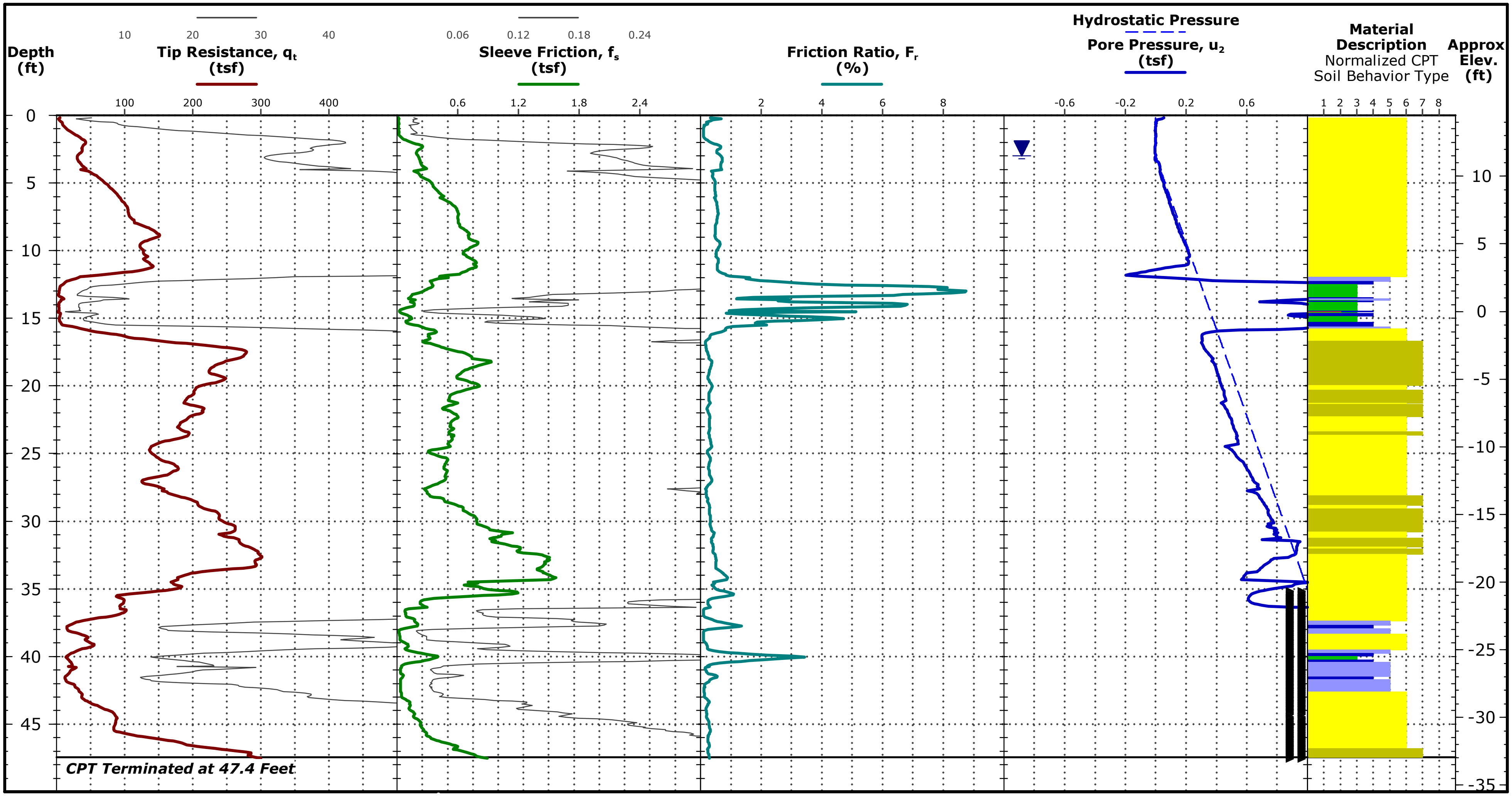
CPT Sounding ID DL-02

3559 Timberlane School Rd
Tallahassee, FL

Latitude: 30.1573° Longitude: -85.7519°
North: 30.157347 East: -85.751889

Elevation: 14.5 (ft) +/-
Elevation Reference: Elevations estimated from Google Earth Pro.

CPT Started: 6/27/2024
CPT Completed: 6/27/2024



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.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe 3126 GT
Operator: M. Castillo
CPT sensor calibration reports available upon request
Probe No. 51022 with net area ratio of .845
Manufactured by Geoprobe- Calibrated 2/9/2024
Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

3 ft measured water depth
(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Express Oil Change
2611 Thomas Drive | Panama City Beach, Florida
Terracon Project No. HF245054

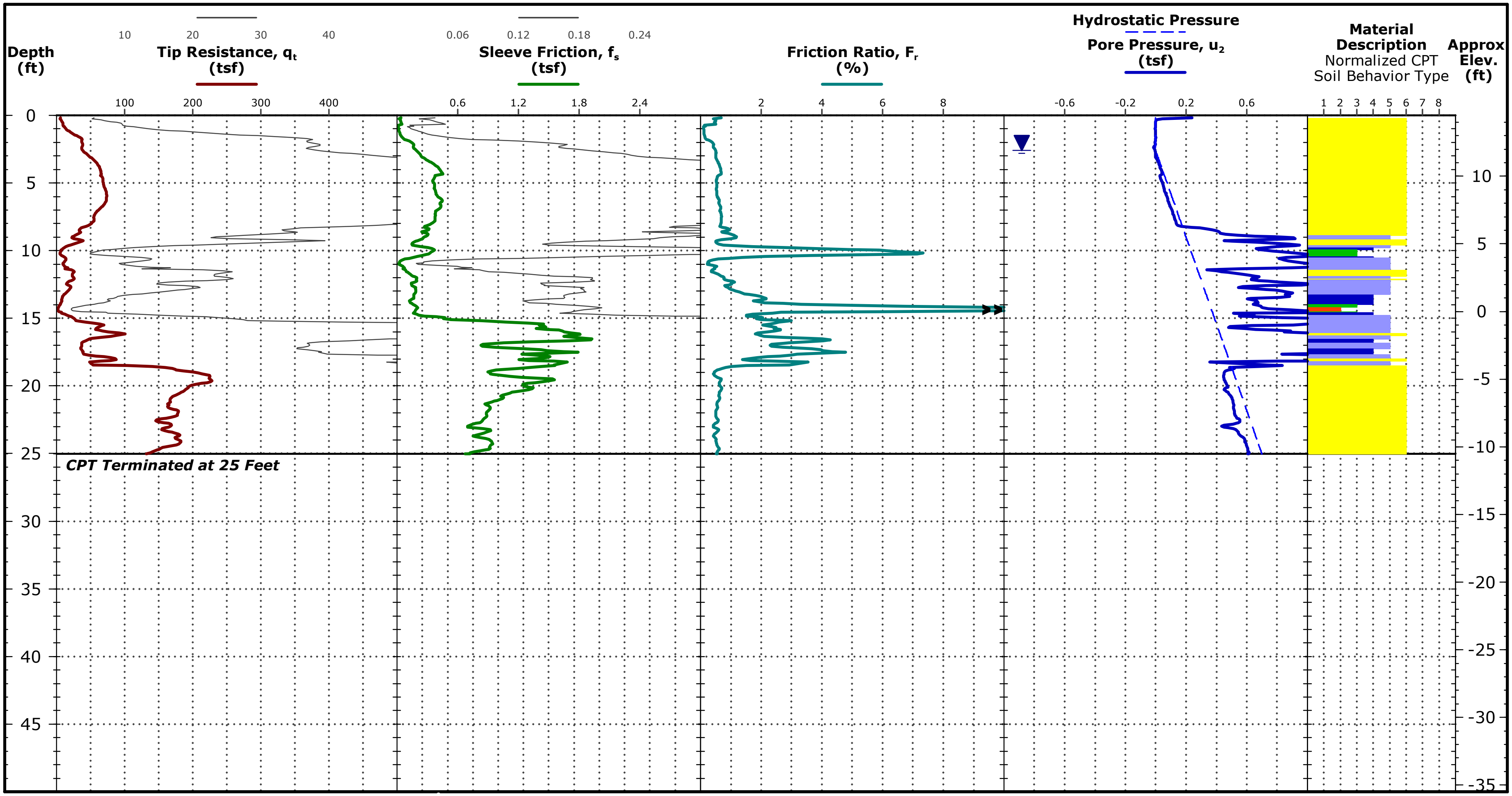
CPT Sounding ID DL-03

3559 Timberlane School Rd
Tallahassee, FL

Latitude: 30.1572° Longitude: -85.7520°
North: 30.15722 East: -85.752015

Elevation: 14.5 (ft) +/-
Elevation Reference: Elevations estimated from Google Earth Pro.

CPT Started: 6/27/2024
CPT Completed: 6/27/2024



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.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe 3126 GT

Operator: M. Castillo

CPT sensor calibration reports available upon request

Probe No. 51022 with net area ratio of .845

Manufactured by Geoprobe- Calibrated 2/9/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

2.6 ft measured water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Express Oil Change
2611 Thomas Drive | Panama City Beach, Florida
Terracon Project No. HF245054

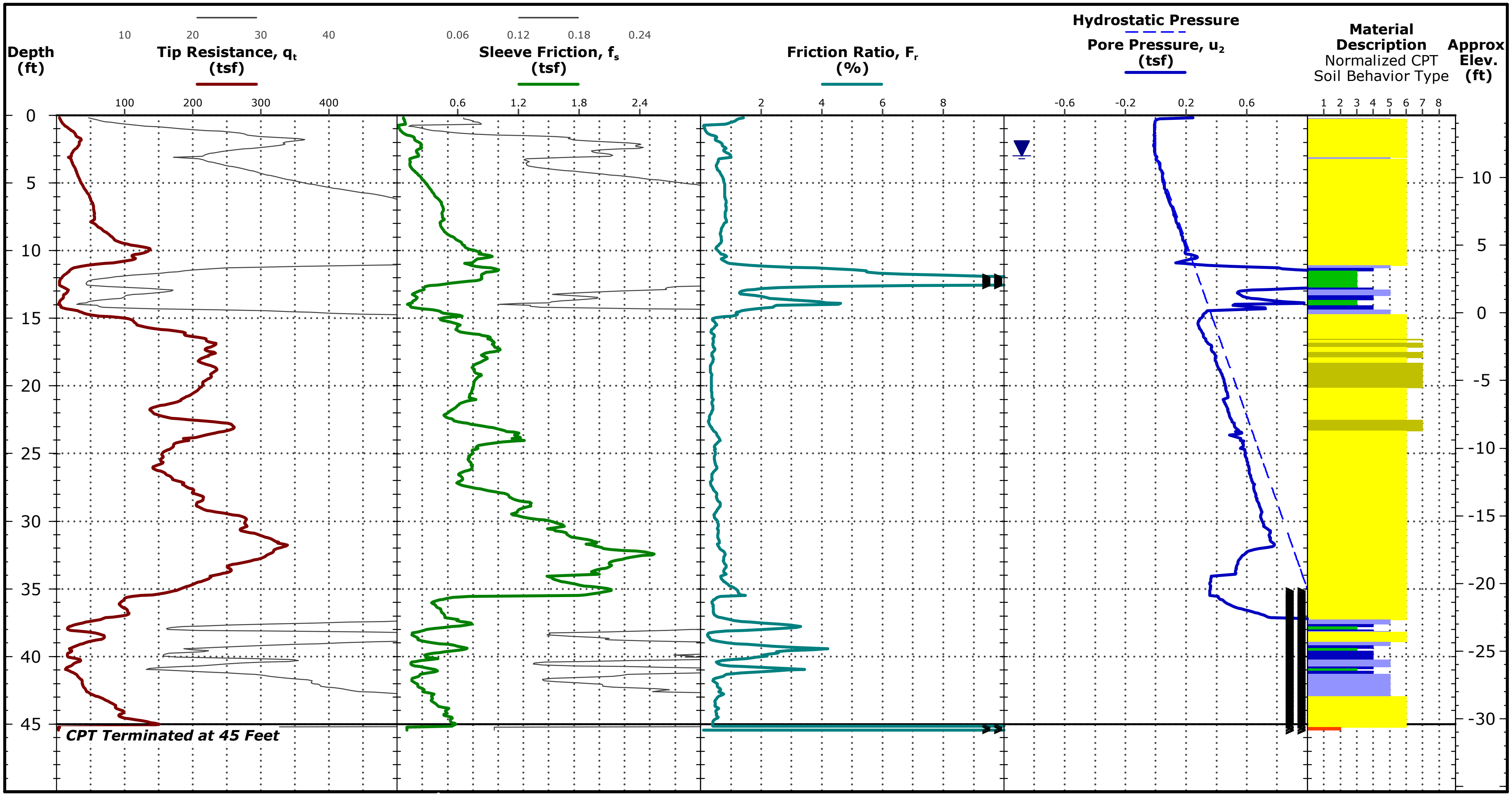
CPT Sounding ID DL-04

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Latitude: 30.1573° Longitude: -85.7519°
North: 30.157275 East: -85.751865

Elevation: 14.6 (ft) +/-
Elevation Reference: Elevations estimated from Google Earth Pro.

CPT Started: 6/28/2024
CPT Completed: 6/28/2024



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.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe 3126 GT

Operator: M. Castillo

CPT sensor calibration reports available upon request

Probe No. 51022 with net area ratio of .845

Manufactured by Geoprobe- Calibrated 2/9/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

3 ft measured water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Express Oil Change
2611 Thomas Drive | Panama City Beach, Florida
Terracon Project No. HF245054

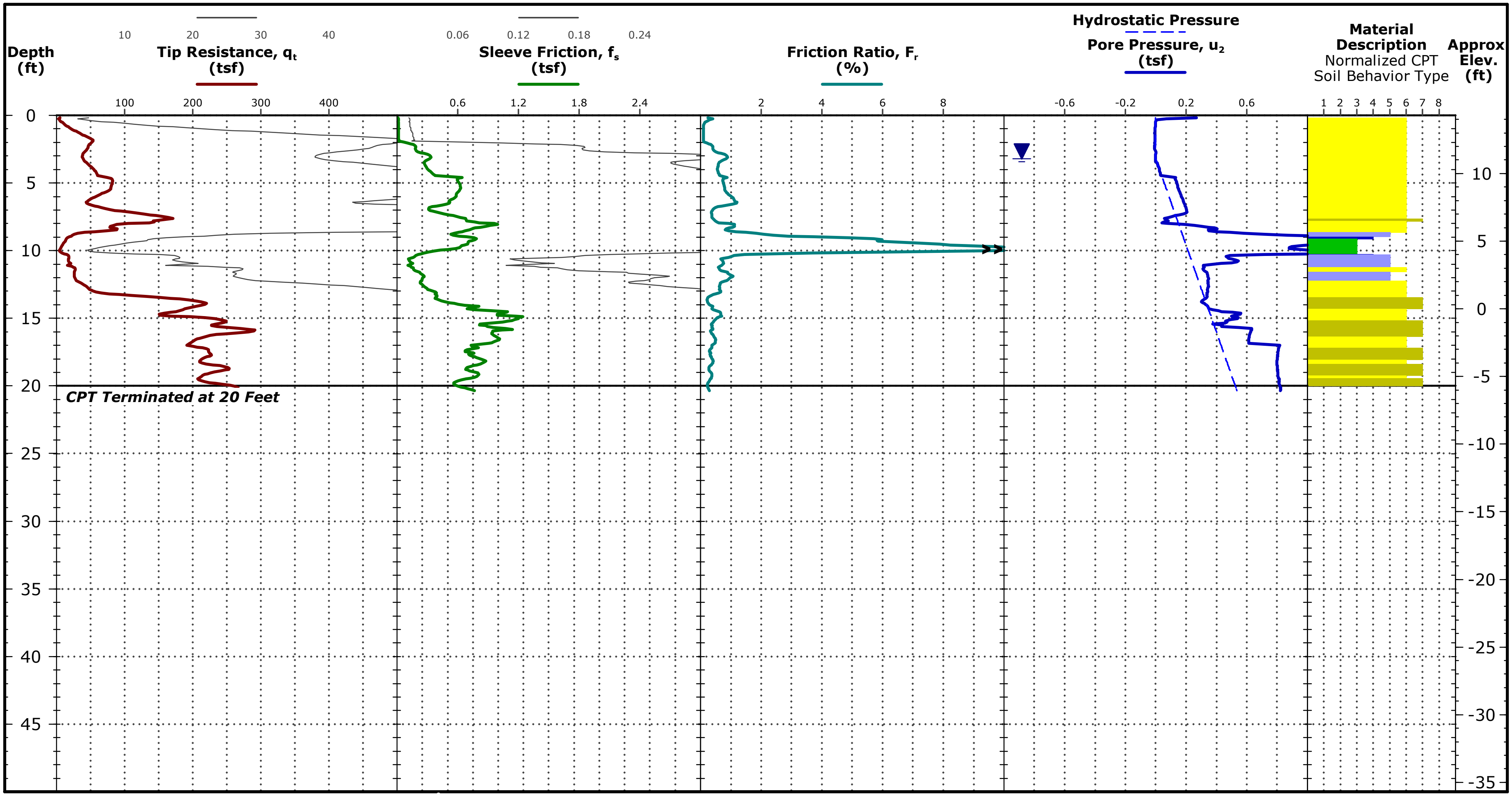
CPT Sounding ID DL-05

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Latitude: 30.1571° Longitude: -85.7520°
North: 30.157139 East: -85.751979

Elevation: 14.3 (ft) +/-
Elevation Reference: Elevations estimated from Google Earth Pro.

CPT Started: 6/28/2024
CPT Completed: 6/28/2024



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.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe 3126 GT

Operator: M. Castillo

CPT sensor calibration reports available upon request

Probe No. 51022 with net area ratio of .845

Manufactured by Geoprobe- Calibrated 2/9/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

3.2 ft measured water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Express Oil Change
2611 Thomas Drive | Panama City Beach, Florida
Terracon Project No. HF245054

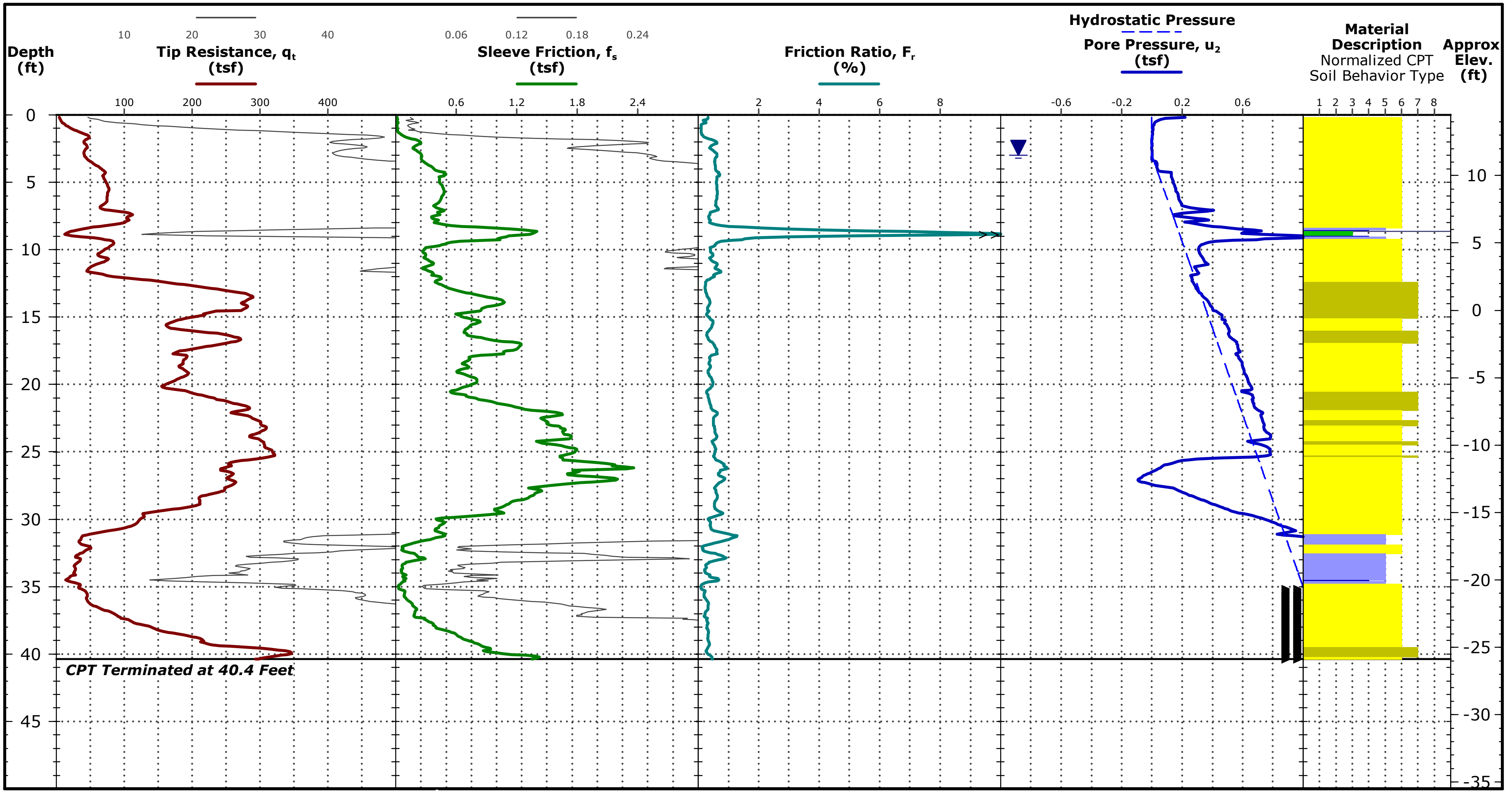
CPT Sounding ID DL-06

Terracon
3559 Timberlane School Rd
Tallahassee, FL

Latitude: 30.1572° Longitude: -85.7518°
North: 30.157192 East: -85.751823

Elevation: 14.5 (ft) +/-
Elevation Reference: Elevations estimated from Google Earth Pro.

CPT Started: 6/28/2024
CPT Completed: 6/28/2024



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.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe 3126 GT

Operator: M. Castillo

CPT sensor calibration reports available upon request

Probe No. 51022 with net area ratio of .845

Manufactured by Geoprobe- Calibrated 2/9/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

3 ft measured water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Laboratory Testing Summary Table

Boring No.	Depth Range (feet)	Moisture Content (%)	Fines Content (%)	Organic Content (%)	USCS Classification
E-1	0-2	6.4	1	-	SP
E-2	2-4	21.0	3	-	SP
E-2	13.5-15	41.8	-	250.8	PT
E-5	0-2	4.2	2	-	SP
E-6	6-8	81.4	6	-	SP-SM
E-6	8-10	52.9	-	8.3	SP-SM
E-7	2-4	25.9	1	-	SP
E-8	0-2	29.1	3	-	SP
E-9	2-4	18.8	4	-	SP
E-9	4-6	26.8	1	-	SP

Infiltration Report

MPD INFILTROMETER
www.upstreamtechnologies.us

Terracon
Explore with us

Terracon Tallahassee

E-9 - Bay County, FL

E-9

Date	5/16/2024
Time	10:59 AM
Latitude	30.157017
Longitude	-85.751646
Initial Volumetric Moisture	1.00 %
Final Volumetric Moisture	12.00 %
Cylinder Size	3 Liter

E-9 Results

Map Pin #	1
Test Number	1
Ksat - mm/hr	1256
Ksat - in/hr	49.4
Capillary Pressure C mm	-155.5
RMS Error of Regression	0.1
Normalized RMS	0.09%

Readings

#	Time	Head	#	Time	Head
1	0 s	34.43 cm	26	125 s	11.34 cm
2	5 s	33.16 cm	27	130 s	10.69 cm
3	10 s	31.9 cm	28	135 s	10.04 cm
4	15 s	30.7 cm	29	140 s	9.42 cm
5	20 s	29.54 cm	30	145 s	8.8 cm
6	25 s	28.4 cm	31	150 s	8.2 cm
7	30 s	27.3 cm	32	155 s	7.61 cm
8	35 s	26.24 cm	33	160 s	7.03 cm
9	40 s	25.2 cm	34	165 s	6.46 cm
10	45 s	24.2 cm	35	170 s	5.9 cm
11	50 s	23.25 cm			
12	55 s	22.3 cm			
13	60 s	21.37 cm			
14	65 s	20.49 cm			
15	70 s	19.61 cm			
16	75 s	18.77 cm			
17	80 s	17.94 cm			
18	85 s	17.14 cm			
19	90 s	16.35 cm			
20	95 s	15.59 cm			
21	100 s	14.84 cm			
22	105 s	14.12 cm			
23	110 s	13.39 cm			
24	115 s	12.69 cm			
25	120 s	12.01 cm			

Supporting Information

Contents:

Note: All attachments are one page unless noted above.

Terracon
3559 Timberlane School Rd
Tallahassee, FL

SPT General Notes

Sampling	Water Level	Field Tests
Standard Penetration Test	Water Initially Encountered Water Level After a Specified Period of Time Water Level After a Specified Period of Time Cave In Encountered 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.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. 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.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		Consistency of Fine-Grained Soils (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	< 3	Very Soft	less than 0.25	0 - 1
Loose	3 - 8	Soft	0.25 to 0.50	1 - 3
Medium Dense	8 - 24	Medium Stiff	0.50 to 1.00	3 - 5
Dense	24 - 40	Stiff	1.00 to 2.00	6 - 12
Very Dense	> 40	Very Stiff	2.00 to 4.00	12 - 24
		Hard	> 4.00	> 24

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

CPT GENERAL NOTES

Terracon

DESCRIPTION OF MEASUREMENTS AND CALIBRATIONS

To be reported per ASTM D5778:

Uncorrected Tip Resistance, q_c
Measured force acting on the cone divided by the cone's projected area

Corrected Tip Resistance, q_t
Cone resistance corrected for porewater and net area ratio effects
$q_t = q_c + u_2(1 - a)$

Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, u
Pore pressure measured during penetration
u_1 - sensor on the face of the cone
u_2 - sensor on the shoulder (more common)

Sleeve Friction, f_s
Frictional force acting on the sleeve divided by its surface area

Normalized Friction Ratio, F_r
The ratio as a percentage of f_s to q_t, accounting for overburden pressure

To be reported per ASTM D7400, if collected:

Shear Wave Velocity, V_s
Measured in a Seismic CPT and provides direct measure of soil stiffness

DESCRIPTION OF GEOTECHNICAL CORRELATIONS

Normalized Tip Resistance, Q_{tn}
$Q_{tn} = ((q_t - \sigma_{v0})/P_a)(P_a/\sigma'_{v0})^n$
$n = 0.381(I_c) + 0.05(\sigma'_{v0}/P_a) - 0.15$

Over Consolidation Ratio, OCR
OCR (1) $= 0.25(Q_{tn})^{1.25}$
OCR (2) $= 0.33(Q_{tn})$

Undrained Shear Strength, S_u
$S_u = Q_{tn} \times \sigma'_{v0}/N_{kt}$
N_{kt} is a soil-specific factor (shown on S_u plot)

Sensitivity, S_t
$S_t = (q_t - \sigma_{v0}/N_{kt}) \times (1/f_s)$

Effective Friction Angle, ϕ'
ϕ' (1) $= \tan^{-1}(0.373[\log(q_c/\sigma'_{v0}) + 0.29])$
ϕ' (2) $= 17.6 + 11[\log(Q_{tn})]$

Unit Weight, γ
$\gamma = (0.27[\log(F_r)]+0.36[\log(q_t/atm)]+1.236) \times \gamma_{water}$
σ_{v0} is taken as the incremental sum of the unit weights

Small Strain Shear Modulus, G_0
G_0 (1) $= \rho V_s^2$
G_0 (2) $= 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$

Soil Behavior Type Index, I_c
$I_c = [(3.47 - \log(Q_{tn}))^2 + (\log(F_r) + 1.22)^2]^{0.5}$

SPT N_{60}
$N_{60} = (q_t/atm) / 10^{(1.1268 - 0.2817Ic)}$

Elastic Modulus, E_s (assumes $q/q_{ultimate} \sim 0.3$, i.e. FS = 3)
E_s (1) $= 2.6\psi G_0$ where $\psi = 0.56 - 0.33\log Q_{tn,clean\ sand}$
E_s (2) $= G_0$
E_s (3) $= 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$
E_s (4) $= 2.5q_t$

Constrained Modulus, M
$M = \alpha_M(q_t - \sigma_{v0})$
For $I_c > 2.2$ (fine-grained soils)
$\alpha_M = Q_{tn}$ with maximum of 14
For $I_c < 2.2$ (coarse-grained soils)
$\alpha_M = 0.0188 \times 10^{(0.55Ic + 1.68)}$

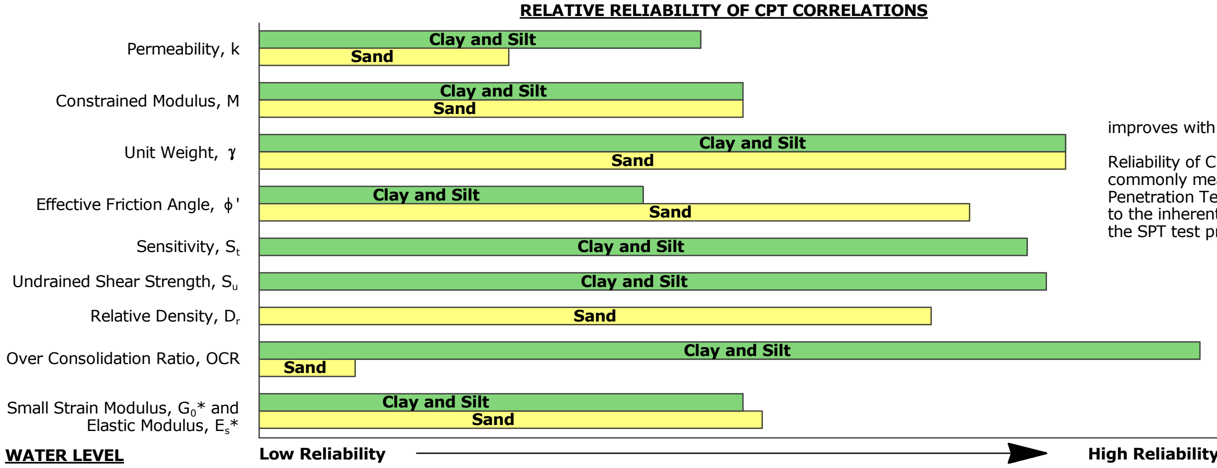
Hydraulic Conductivity, k
For $1.0 < I_c < 3.27$ $k = 10^{(0.952 - 3.04Ic)}$
For $3.27 < I_c < 4.0$ $k = 10^{(-4.52 - 1.37Ic)}$

Relative Density, D_r
$D_r = (Q_{tn} / 350)^{0.5} \times 100$

REPORTED PARAMETERS

CPT logs as provided, at a minimum, report the data as required by ASTM D5778 and ASTM D7400 (if applicable). This minimum data include q_t, f_s, and u. Other correlated parameters may also be provided. These other correlated parameters are interpretations of the measured data based upon published and reliable references, but they do not necessarily represent the actual values that would be derived from direct testing to determine the various parameters. To this end, more than one correlation to a given parameter may be provided. The following chart illustrates estimates of reliability associated with correlated parameters based upon the literature referenced below.

RELATIVE RELIABILITY OF CPT CORRELATIONS



*improves with seismic V_s measurements

Reliability of CPT-predicted N_{60} values as commonly measured by the Standard Penetration Test (SPT) is not provided due to the inherent inaccuracy associated with the SPT test procedure.

WATER LEVEL

The groundwater level at the CPT location is used to normalize the measurements for vertical overburden pressures and as a result influences the normalized soil behavior type classification and correlated soil parameters. The water level may either be "measured" or "estimated:"

Measured - Depth to water directly measured in the field

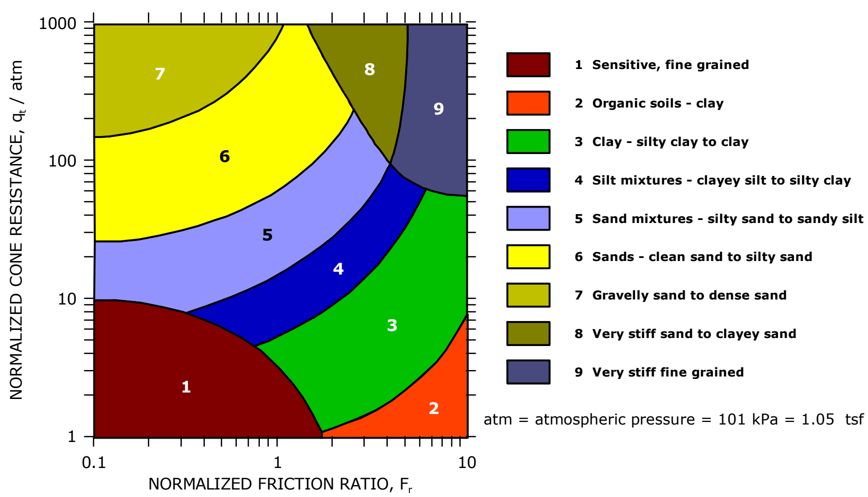
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions

While groundwater levels displayed as "measured" more accurately represent site conditions at the time of testing than those "estimated," in either case the groundwater should be further defined prior to construction as groundwater level variations will occur over time.

CONE PENETRATION SOIL BEHAVIOR TYPE

The estimated stratigraphic profiles included in the CPT logs are based on relationships between corrected tip resistance (q_t), friction resistance (f_s), and porewater pressure (u_2). The normalized friction ratio (F_r) is used to classify the soil behavior type.

Typically, silts and clays have high F_r values and generate large excess penetration porewater pressures; sands have lower F_r's and do not generate excess penetration porewater pressures. The adjacent graph (Robertson *et al.*) presents the soil behavior type correlation used for the logs. This normalized SBT chart, generally considered the most reliable, does not use pore pressure to determine SBT due to its lack of repeatability in onshore CPTs.



atm = atmospheric pressure = 101 kPa = 1.05 tsf

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Kulhawy, F.H., Mayne, P.W., (1997). "Manual on Estimating Soil Properties for Foundation Design," Electric Power Research Institute, Palo Alto, CA.
Mayne, P.W., (2013). "Geotechnical Site Exploration in the Year 2013," Georgia Institue of Technology, Atlanta, GA.
Robertson, P.K., Cabal, K.L. (2012). "Guide to Cone Penetration Testing for Geotechnical Engineering," Signal Hill, CA.
Schmertmann, J.H., (1970). "Static Cone to Compute Static Settlement over Sand,"*Journal of the Soil Mechanics and Foundations Division*,96(SM3), 1011-1043.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	**Group Name** [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.