Geotechnical Engineering Investigation

Waste Management Trucking Facility
Hardeeville, South Carolina

September 7, 2017
Terracon Project No. ES175222

Prepared for:
Waste Management, Inc.
Marietta, Georgia

Prepared by:
Terracon Consultants, Inc.
Savannah, Georgia

September 7, 2017

Waste Management, Inc.
1850 Parkway Place
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Attn: John Workman
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Re: Geotechnical Engineering Investigation
Waste Management Trucking Facility
Hardeeville, South Carolina
Terracon Project No.: ES175222

Dear Mr. Workman:

Terracon Consultants, Inc. (Terracon) has completed the Geotechnical Engineering Investigation for the above-referenced project. The services were performed in general accordance with our proposal No. PES175222 dated July 19, 2017. This report presents the findings of the subsurface exploration and provides geotechnical recommendations for the design and construction of the project.

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

Sincerely,
Terracon Consultants, Inc.

SOUTH CAROLINA
TERRACON CONSULTANTS, INC.
No. 2220
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
REGISTERED PROFESSIONAL ENGINEER
No. 16696
GUOMING LIN

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cc: 1 – Client (PDF)
1 – File

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APPENDICES

EXECUTIVE SUMMARY

This report presents the findings of our Geotechnical Engineering Investigation for the proposed Waste Management Trucking Facility located off U.S.17 in Hardeeville, South Carolina. The investigation included a field exploration program and engineering evaluation of the subsurface conditions and foundation recommendations. Based on the results of the subsurface exploration and analyses, the following geotechnical considerations were identified:

- The subsurface conditions are relatively variable across the site. In general, the soils in the upper 2 to 6 feet are very loose to medium dense silty sands, underlain by a layer of 6 to 10 feet thick soft to stiff silty/sandy clays interbedded with clayey/silty sands.

- The groundwater was encountered at approximate depths of 0 to 3.5 feet below the existing ground surface (BGS) based on CPT soundings and hand auger borings. In addition, we installed two piezometers at C1 and C5, and the groundwater was measured at 1 to 3 feet BGS in one week.

- In the pond area (i.e., HA11 to HA13), the soils in the upper 2 to 2.5 feet are silty sands to sands with silt/clay, underlain by clayey sands to sandy clays to the boring termination at a depth of 8 feet BGS. Therefore, the soils in the upper 2 to 2.5 feet are considered suitable for structural fills after the removal of topsoil. The clayey sands to sandy clays are considered unsuitable for structural fills.

- The information on structural loads is not available, and we assume a maximum column load of 100 kips and slab load of 500 pounds per square foot (psf) for our settlement analyses. We performed settlement analyses for shallow foundations using the assumed foundation loads and the soil profiles obtained from the CPT soundings. Based on the settlement analyses, the total settlement was estimated to be less than 1.0 under the assumed loads. Therefore, we recommend the proposed building and other structures be supported on a shallow foundation system provided the maximum column load is less than 100 kips and slab load less than 500 psf.

- A net allowable bearing capacity of 2,000 pounds per square foot (psf) is recommended for shallow foundation design. The allowable bearing capacity is allowed to increase by 1/3 for transient wind load and seismic load conditions. Terracon should be retained to confirm and test the subgrade during construction to provide more specific recommendations on subgrade repair based on the conditions of the subgrade at the time of construction.

- For seismic design purposes, the subject site shall be classified as **Site Class D** in accordance with the International Building Code (IBC) 2015 and ASCE 7-10 Section 11.4.2.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details are not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the findings and recommendations contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report's limitations.

GEOTECHNICAL ENGINEERING INVESTIGATION

Waste Management Trucking Facility
Hardeeville, South Carolina

Terracon Project No. ES175222
September 7, 2017

1.0 INTRODUCTION

Terracon has completed the Geotechnical Engineering Investigation for the proposed Waste Management Trucking Facility located off U.S. 17 in Hardeeville, South Carolina. The investigation included a field exploration program and engineering evaluation of the subsurface conditions and foundation recommendations.

The field exploration program consisted of five (5) cone penetration test (CPT) soundings to a maximum depth of about 35.4 feet below the existing ground surface (BGS) and thirteen (13) hand auger borings to a maximum depth of about 8 feet BGS. The CPT sounding logs and hand auger boring logs along with a site location map and exploration location plan are included in **Appendix A** of this report.

The purpose of this study is to provide subsurface information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- site preparation
- groundwater conditions
- foundation design and construction
- pavement recommendation
- seismic considerations

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Proposed improvements	The construction of a new Waste Management Trucking Facility, which consists of: • Maintenance bays, truck wash, and container repair. • Office/support area. • CNG fueling network and compressor. • Concrete and asphalt paving • Utilities; public water and sewer, natural gas. • SCDOT entrance. • Container storage. Storm water pond/borrow source.
Finished floor elevation	Not provided but assumed to be close to the existing ground surface.
Maximum loads	Not provided but following values are assumed for our settlement analysis **Column load** = 100 kips (assumed) **Slab load** = 500 psf (assumed) **Wall load** = 4 kips per linear foot (assumed)
Maximum allowable settlement	Total settlement: 1 inch (assumed). Differential settlement: ½ inches over 40 feet or between columns (assumed).
Grading	It is anticipated the site will be graded with a minimal amount of cut and fill, and we assume the maximum fill height will be less than two feet.

2.2 Site Location and Description

Item	Description
Location	The site is located off U.S. 17 in Hardeeville, South Carolina. Latitude: 32.2023°, Longitude: -81.0779°
Existing improvements	None.
Current ground cover and access conditions	It is a wooded area with dirt access road.
Existing topography	The existing elevations are in the range of 8 to 15 feet. In general, the site slopes from the west to the east.

Should any of the above information or assumptions be inconsistent with the planned construction, Terracon should be informed so that modifications to this report can be made as necessary.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of the field exploration, the subsurface conditions at the project site are relatively variable, and can be generalized as follows:

Description	Elevation of Bottom of Stratum (feet)	Material Encountered	Equivalent SPT - N_{60}
Topsoil	13.5 to 7*	Silty sands with grass/tree roots or pine needles.	--
Stratum 1	10.5 to 8	Very loose to medium dense silty sands.	1 to 20
Stratum 2	2.5 to -4	Soft to stiff silty/sandy clays interbedded with clayey/silty sands	2 to 15
Stratum 3	-10 to -12.5	Medium dense silty sands	10 to 25
Stratum 4	-13 to -17	Soft to stiff silty/sandy clays	3 to 9
Stratum 5	-23	Medium dense silty sands	15 to 30
Stratum 6	-25, termination of soundings	Very stiff sandy clays interbedded with silty sands.	20

*The thickness of topsoil may be variable during earthwork as described in **Section 4.2**.

The elevations are interpolated from the plan provided by Waste Management, Inc. on 9/5/2017. Details of the subsurface conditions encountered at each sounding/boring location are presented on the individual CPT sounding and hand auger boring logs in **Appendix A** of this report. Stratification boundaries shown on the logs represent the approximate depth of changes in soil types; the transition between materials may be gradual.

3.2 Groundwater

The groundwater table was measured using a water level meter in hand auger borings and CPT soundings at depths of 0 to 3.5 feet BGS (elevation of 13 to 6.5 feet) during the field exploration. Mottling of the soils was noted at depths of 0.5 to 4 feet BGS (elevation of 13 to 6.5 feet) during our hand auger borings, which is interpreted as an indication of seasonal high groundwater level.

We installed two piezometers at soundings C1 and C5. The groundwater was measured at 1 to 3 feet BGS (elevations of 10.5 to 8.5 feet) for one week.

It should be noted that groundwater levels tend to fluctuate with seasonal and climatic variations, as well as with construction activities. As such, the possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. The groundwater table should be checked prior to construction to assess its effect on site work and other construction activities.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The subsurface conditions of this site are considered relatively variable. The generalized soil profile is presented in **Section 3.1**.

The information on structural loads is not available, and the assumed loads are included in **Section 2.1** of this report. Shallow foundation settlement analyses were performed at each sounding location using the soil parameters derived from the CPT soundings and the maximum column load of 100 kips and slab load of 500 psf. Based on the settlement analyses, total settlements were estimated to be less than one inch at all sounding locations.

We recommend the proposed building and structures be supported on a shallow foundation provided the maximum column loads are less than 100 kips and slab load less than 500 psf.

During the site preparation, in some localized areas such as those represented by C1, C4 and C5, the soft clayey soils found at 2 to 3 feet below the existing ground surface will be exposed and will likely cause an unstable subgrade for footing/slab support. To achieve a stable subgrade, the contractor should expect undercutting and backfilling of these soft areas. It is anticipated that subgrade undercutting and backfilling will be required in those soft areas for footing/slab support.

At hand auger borings HA4, HA5, HA6, HA9 and HA13, organics such as roots were found to depths of up to 3.5 feet BGS. During site preparation, all organics if encountered should be removed.

We recommend hand auger borings and dynamic cone penetration (DCP) testing be performed during construction to evaluate and confirm the subgrade conditions under the footings. It is anticipated that subgrade soil undercutting may be required during subgrade preparation for the foundation.

During site preparation, topsoil, organic matter, stumps, existing fill, or other unsuitable materials should not be left in subgrade under buildings or pavements. All footings/slab should bear on suitable natural soil, or on properly compacted structural fills. Compacted fill should be placed directly on suitable natural soil. We recommend Terracon be retained to test the footing subgrade during construction so that Terracon can provide additional recommendations to prepare the subgrade based on the conditions uncovered during the footing preparation.

The following sections present our recommendations for the site work and subgrade preparations for the shallow foundations.

4.2 Earthwork

The site work conditions will be largely dependent on the weather and the contractor's means and methods in controlling surface drainage and protecting the subgrade. Site preparation should include installation of a site drainage system, topsoil stripping and grubbing, subgrade preparation, densification and proofrolling. **Please bear in mind**, due to the uneven ground surface of the site, the volume of topsoil and organics may be significantly greater than the area times the topsoil/organics thickness indicated in the boring logs. Rutting of the subgrade can also cause mixing of topsoil/organics with underlying soils, which will result in additional required topsoil/organics stripping. Deeper undercut may be needed in some localized areas to remove tree stumps or other unsuitable materials.

4.2.1 Site Drainage

An effective drainage system should be installed prior to the initiation of site preparation and grading activities to intercept surface water and to improve overall shallow drainage. The drainage system may consist of perimeter ditches supplemented with parallel ditches and swales. Pumping equipment should be used if the above ditch system cannot effectively drain water away from the site, especially during the rainy season. The site should be graded to shed water and avoid ponding over the subgrade.

4.2.2 Densification and Proofrolling

Prior to fill placement, the entire building and pavement areas should be densified with a heavy-duty vibratory roller to achieve a uniform subgrade. The subgrade should be thoroughly proofrolled after the completion of densification. Proofrolling will help detect any isolated soft or loose areas that "pump", deflect or rut excessively, and also densify the near-surface soils for floor slab support.

A loaded tandem axle dump truck, capable of transferring a load in excess of 20 tons, should be utilized for this operation. Proofrolling should be performed under Terracon's observation. Areas where pumping, excessive deflection or rutting is observed after successive passes of the proofrolling equipment should be undercut, backfilled and then properly compacted.

4.2.3 Fill Material Consideration

Structural fill should be placed over a stable or stabilized subgrade. The soils to be used as structural fill should be free of organics, roots, or other deleterious materials. It should be a non-plastic granular material containing less than 25 percent fines passing the No. 200 sieve. In general, after the removal of topsoil, the onsite soils in the upper 2 to 3.5 feet which consist of silty sands (SM) to sands with silt/clay (SP-SM or SP-SC) are considered suitable for structural fill.

For the pond area (i.e., HA11 to HA13), the soils in upper 2 to 2.5 feet are silty sands to sands with silt/clay, underlain by clayey sands to sandy clays to the boring termination at a depth of 8 feet BGS. Therefore, in the wet pond area, after the removal of topsoil, the soils in the upper 2 to 2.5 feet are considered suitable for fill materials. However, the clayey sands to sandy clays are considered unsuitable for structural fills.

All structural fills should be placed in thin (8 to 10 inches loose) lifts and compacted to a minimum of 95% of the soil's Modified Proctor maximum dry density (ASTM D-1557). Fill brought to the site should be within 3 percent (wet or dry) of the optimum moisture content.

Some manipulation of the moisture content (such as wetting, drying) will be required during the filling operation to achieve the specified degree of compaction. The manipulation of the moisture content is highly dependent on both the weather and site drainage conditions. Therefore, the contractor should prepare both dry and wet fill materials to obtain the specified compaction during grading. A sufficient number of density tests should be performed to confirm the required compaction of the fill material.

4.3 Spread Footing Foundations

The proposed buildings can be supported on a shallow foundation system provided subgrade improvement is performed as described in **Section 4.1**. The following sections present design recommendations and construction considerations for the shallow foundations for the proposed building and related structural elements.

4.3.1 Spread Footing Design Recommendations

Description	Column	Wall
Net allowable bearing pressure [1]	2,000 psf	2,000 psf
Minimum dimensions	12 inches	12 inches
Minimum embedment below finished grade	18 inches	12 inches
Approximate total settlement [2]	<1 inch	<1 inch

Estimated differential settlement	<1 inch between columns	<1/2 inch over 40 feet
Ultimate Coefficient of sliding friction [3]	0.32	

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. It assumes any unsuitable fill or soft soils, if encountered, will be replaced with compacted structural fill.
2. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations. Footings should be proportioned to reduce differential settlements. Proportioning on the basis of equal total settlement is recommended; however, proportioning to relative constant dead-load pressure will also reduce differential settlement between adjacent footings.
3. Sliding friction along the base of the footing will not develop where net uplift conditions exist.

The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

Foundation excavations should be observed by Terracon. If the soil conditions encountered differ significantly from those presented in this report, Terracon should be contacted to provide additional evaluation and supplemental recommendations.

4.3.2 Spread Footing Construction Considerations

The bottom of all foundation excavations should be free of water and loose soil prior to placing concrete. Concrete should be placed soon after excavation to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Extremely wet or dry material, or any loose or disturbed material in the bottom of the footing excavations should be removed before concrete is placed. If the soils at bearing level become excessively dry, disturbed or saturated, the affected soils should be removed prior to placing concrete. A lean concrete mud-mat should be placed over the bearing soils if the excavations must remain open overnight or for an extended period of time.

Regarding construction of footings, we generally anticipate suitable material will be present at the bottom of the footings. However, there is a possibility that isolated zones of soft or loose native soils could be encountered below footing bearing level, even though field density tests are expected to be performed during fill placement. Therefore, it is important that Terracon be retained to observe, test, and evaluate the bearing soil prior to placing reinforcing steel and concrete to determine if additional footing excavation or other subgrade repair is needed for the design loads.

If unsuitable bearing soils are encountered in footing excavations, the excavations should be extended deeper to suitable soils and the footings could bear directly on those soils at the lower level or on lean concrete backfill placed in the excavations. As an alternative, the footings could also bear on properly compacted structural backfill extending down to the suitable soils. Over-excavation for compacted backfill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing base elevation.

The over-excavation should then be backfilled up to the footing base elevation with well-graded granular material placed in lifts of 6 inches or less in loose thickness and compacted to at least 95 percent of the material's maximum dry density as determined by the Modified Proctor test (ASTM D-1557). No. 57 stone is recommended in lieu of structural fill when the volume of excavation is relatively small, recompaction of the fill is difficult, or the weather or construction schedule becomes a controlling factor.

4.4 Floor Slabs

4.4.1 Floor Slab Design Recommendations

Item	Description
Floor slab support	Compacted structural fill/inspected and tested natural ground.[1]
Modulus of subgrade reaction	120 pounds per square inch per in (psi/in) for point loading conditions.
Base course/capillary break [2]	4 inches of free draining granular material.
Vapor barrier	Project Specific.[3]
Structural considerations	Floor slabs should be structurally separated from columns and walls to allow relative movements.[4]

1. Because the existing ground may have been filled or disturbed previously, we recommend the subgrade be inspected and tested with proofrolling after the topsoil is stripped as outlined in **Section 4.2** of this report.
2. The floor slab design should include a base course comprised of free-draining, compacted, granular material, at least 4 inches thick. The granular subbase may be graded aggregate base (GAB) or sands containing less than 5 percent fines (material passing the #200 sieve). GAB subbase can also help improve the workability of the subgrade, especially during rain periods.
3. The use of a vapor retarder should be considered beneath concrete slabs on the grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.
4. Floor slabs should be structurally independent of any building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation. Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates that any differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks that occur beyond the length of the structural dowels. The structural engineer should account for this potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

4.4.2 Floor Slab Construction Considerations

Prior to construction of grade supported slabs, varying levels of remediation may be required to reestablish stable subgrades within slab areas due to construction traffic, rainfall, disturbance, desiccation, etc. As a minimum, the following measures are recommended.

- Interior trench backfills placed beneath slabs should be compacted in accordance with recommendations outlined in **Section 4.2** of this report.
- All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the stone base and concrete.

4.5 Pavement Considerations

We understand that the proposed development will include paved roads and parking lots. This section presents thickness recommendations for asphalt and concrete pavements and general considerations for pavement design and construction. The required pavement thickness will depend on:

- The traffic loads including traffic pattern and the service life of the pavement;
- Subgrade conditions including soil strength and drainage characteristics;
- Paving material characteristics;
- Climatic conditions of the region.

Traffic patterns and anticipated loading conditions were not available at this time. However, based on our experience with the similar projects in this area, we have provided three different types of asphalt concrete pavement: heavy duty, intermediate duty and light duty pavements: Heavy duty pavements should be used for access road, intermediate duty pavement should be used for truck parking while light duty pavements may be used for employee and guest parking. The recommended pavement design sections are provided in **Table 4.5.1**. A design life of 20 years was assumed to develop the total traffic in the thickness design. However, as typical for pavements, some maintenance repairs are required after a period of 7 to 10 years**. If heavier traffic loads are anticipated, please inform us so we can revise our recommendations.**

The subgrade conditions will depend on the in-situ soils at the subgrade level, characteristics of the fill material for the subgrade as well as site preparation procedures. Assuming the finished subgrade will be near the existing ground surface, after the removal of topsoil, the near surface soils are mostly silty sands to sands with silt/clay which have good drainage characteristics and are deemed suitable for subgrade support.

However, in some areas, after the removal of topsoil, the near surface soils will be clayey sands to sandy clays which have poor drainage characteristics and are deemed unsuitable for subgrade support. We recommend the upper two feet of the subgrade be relatively clean sands with percent fines less than 15 percent. A California Bearing Ratio (CBR) value of 8 has been estimated based on the in-situ soils at the site and typical imported fills available in this area.

Climatic conditions are considered in the design subgrade support value listed above and in the paving material characteristics. Recommended paving material characteristics, taken from the South Carolina Department of Transportation's (SCDOT) *Standard Specifications for Highway Construction, 2007 edition* are included for the asphalt concrete sections.

4.5.1 Pavement Design Recommendations

Material[1]	Asphalt Section Thickness (inches)		
	Light Duty Section[2]	Intermediate Duty Section (Truck Parking)[3]	Heavy Duty Section Truck Access Road[4]
Asphalt Surface Course	2	1.5	2
Asphalt Intermediate Course	0	2.5	2.5
Aggregate Base Course	7	7	8
Total Pavement Section	**9**	**11**	**12.5**

1. Subgrade, base and pavement construction operations and materials should meet the minimum requirements of the South Carolina Department of Transportation (SCDOT) Standard Specifications for Highway Construction, 2007 edition. The Aggregate Base Course should be compacted to 100% of its Modified Proctor as determined by AASHTOM T-180. The Asphalt Concrete should be compacted to at least 95% of the maximum unit weight, as determined by the Marshall Mix Design Procedures.
2. Light-duty section assumes only car traffic like employee and guest parking.
3. Intermediate duty section assumes truck parking
4. Heavy-duty section assumes truck access road.

For the areas subject to concentrated and repetitive loading conditions such as container parks, truck delivery docks and ingress/egress aprons, we recommend using a Portland cement concrete pavement be used.

Rigid (Concrete) Pavement Design Recommendations

Material	Minimum Section Thickness (inch)		
	Light Duty Section (Auto Parking)	Intermediate Duty Section (Truck Parking)	Heavy Duty Section (Truck Turning / Truck Access Road)
Concrete[1]	5	7	8

Graded aggregate base[2]	4	4	4
Select fill / improved subgrade[3]	24	24	24

1. The concrete should be air entrained and have a minimum compressive strength of 4,000 psi after 28 days of lab curing per ASTM C-31.
2. Base construction operations and materials should meet the minimum requirements of the South Carolina Department of Transportation (SCDOT) Standard Specifications for Highway Construction, 2007 edition. The Aggregate Base Course should be compacted to 100% of its Modified Proctor as determined by AASHTOM T-180.
3. If SP or SP-SM or SM soils exist at the proposed subgrade elevation extending to a depth at least 24 inches below the proposed subgrade level, the in-situ soils can replace the select fill and the subgrade should be improved using densification as discussed in **Section 4.2**.

Notes:

- Concrete joints should be sealed properly to avoid ingress of surface water into the subgrade soils. Proper surface and subgrade drainage system should be installed to avoid saturation of subgrade soils underneath the concrete pavements. The site drainage should be designed to maintain the groundwater at least 2 feet below the top of the subgrade.
- Some subgrade soil undercutting and backfilling with suitable structural fill will be required if unstable subgrade soils are encountered during subgrade preparation. The use of geogrid (Tensar BX1200 or equivalent) may be necessary to help reduce the depth of undercut to achieve stability if the unstable subgrade soils extend to greater depths. The need for geogrid and/or the need for undercutting and backfilling should be determined in the field during subgrade preparation.

The concrete pavement can be poured over compacted granular subgrade (sand) or on at least 4-inches of graded aggregate base (GAB stone). The GAB stone base is not part of the pavement structural design so is not considered absolutely necessary. Based on our experience, the stone base can be significantly help improve the constructability during construction especially in rainy seasons. Furthermore, the stone base will help maintain subgrade stability and support when the subgrade is wet due to the rise of groundwater or infiltration of surface water through the pavement joints or cracks. As such, even though it is not part of the structural design, the stone base enhances pavement constructability condition during construction and long-term performance. We recommend the use of stone base be considered based on the cost benefit analysis.

The above rigid and flexible pavement sections represent the minimum design thicknesses and, as such, periodic maintenance should be anticipated. Prior to the placement of the crushed stones, the pavement subgrade should be thoroughly proofrolled.

4.5.2 Pavement and Subgrade Drainage

Poor subgrade drainage is the most common cause of pavement failure. Pavement should be sloped to provide rapid drainage of surface water. Water should not be allowed to pond on or adjacent to the pavement which would saturate the subgrade soils and weaken the subgrade support. We recommend the site drainage be designed to maintain the groundwater at least two feet below the top of the subgrade.

Pavement subgrade drainage should surround the areas anticipated to have frequent wetting or having poor natural drainage, such as landscaped islands, along curbs, and gutters and around drainage structures. All landscaped areas in or adjacent to pavements should be sealed to reduce moisture migration to subgrade soils. Subgrade drains should be installed at the bottom of the Graded Aggregate Base (GAB) level. The civil engineer should decide the placement of the subgrade drains to avoid the saturation of pavement subgrade.

4.5.3 Pavement Maintenance

The performance of pavements will require regular maintenance. One key component of the maintenance is to minimize infiltration of water into the pavement base and subgrade. Preventive maintenance should include crack and joint sealing and patching as well as overall surface sealing and overlay. Additional engineering observation and evaluation is recommended prior to any major maintenance.

4.5.4 Pavement Construction Considerations

Pavement subgrades prepared early in the project should be carefully evaluated as the time for pavement construction approaches. We recommend the pavement areas be rough graded and then thoroughly proofrolled with a loaded tandem-axle dump truck. Particular attention should be paid to high traffic areas that are rutted and disturbed, and to areas where backfilled trenches are located. Areas where unsuitable conditions are noted should be repaired by removing and replacing the materials with properly compacted fill. After proofrolling and repairing subgrade deficiencies, the entire subgrade should be scarified to a depth of 12 inches, and uniformly compacted to at least 95 percent of the materials' modified Proctor maximum dry density.

4.6 Seismic Considerations

4.6.1 Site Class Determination

Based on the findings in the field exploration and our knowledge of the local geological formation in the project area, the site can be classified as Site Class D in accordance with IBC 2015 and ASCE 7-10. The seismic design parameters obtained based on IBC 2015 and ASCE 7-10 are summarized in the table below. The design response spectrum curve, as presented in the appendix, was developed based on the S_{DS} and S_{D1} values.

Summary of Seismic Design Parameters

Site Location (Lat. – Long.)	Site Classification	S_s	S_1	F_a	F_v	S_{DS}	S_{D1}
32.2022° -81.0776°	D	0.336g	0.126g	1.531	2.294	0.343g	0.193g

- In general accordance with the 2015 International Building Code and ASCE 7-10.
- The 2015 IBC and ASCE 7-10 require a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope does not include 100-foot soil profile determination. Explorations for this project extended to a maximum depth of 35.4 feet and this seismic site class definition was provided in consideration of the overall soil conditions as well as the general geology of the area.

4.6.2 Liquefaction Analyses

Liquefaction is a phenomenon in which the strength and stiffness of soil are reduced by earthquake shaking or other rapid cyclic loading. The effects of soil liquefaction on the built environment can be extremely damaging. A liquefaction analysis was performed in accordance with IBC 2015 by using shear stress ratio method with an earthquake magnitude of 7.3 and the peak ground acceleration (PGA_M) of 0.256g. The earthquake magnitude of 7.3 and the peak ground acceleration (PGA_M) of 0.256g was obtained from the United States Geological Survey (USGS) database.

The total settlement induced by liquefaction was estimated to be about 1.5 to 3.5 inches as shown in **Exhibit B-2** in **Appendix B**. In the event of an earthquake, the structure may sustain some damage that should be repairable. Assuming the facility is not required to be operational after a major earthquake event, we recommend the structural engineer to design the structures to accommodate the expected settlements and avoid a total collapse. Since seismic design is required to safeguard human life, not to prevent property damage, it would not be necessary to apply liquefaction mitigation measures to limit the liquefaction induced settlement at this site.

5.0 GENERAL COMMENTS

Terracon should be consulted to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the project design and specifications. Terracon should also be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analyses and recommendations presented in this report are based upon the data obtained from the explorations performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between exploration locations, across the site, or may be caused due to the modifying effects of construction or weather. Bear in mind that the nature and extent of such variations may not become evident until construction has started or until construction activities have ceased.

If variations do appear, Terracon should be notified immediately so that further evaluation and supplemental recommendations can be provided. The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or hazardous conditions. If the owner is concerned about the potential for such contamination or pollution, please advise so that additional studies may be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project and site discussed, and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes, and then either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

Exhibit A-1	Site Location Map
Exhibit A-2	Exploration Location Plan
Exhibit A-3	Field Exploration Description
Exhibit A-4	CPT Cross Section
Exhibit A-5	CPT Logs
Exhibit A-6	Hand Auger Boring Logs

Image Courtesy of
Google Earth™

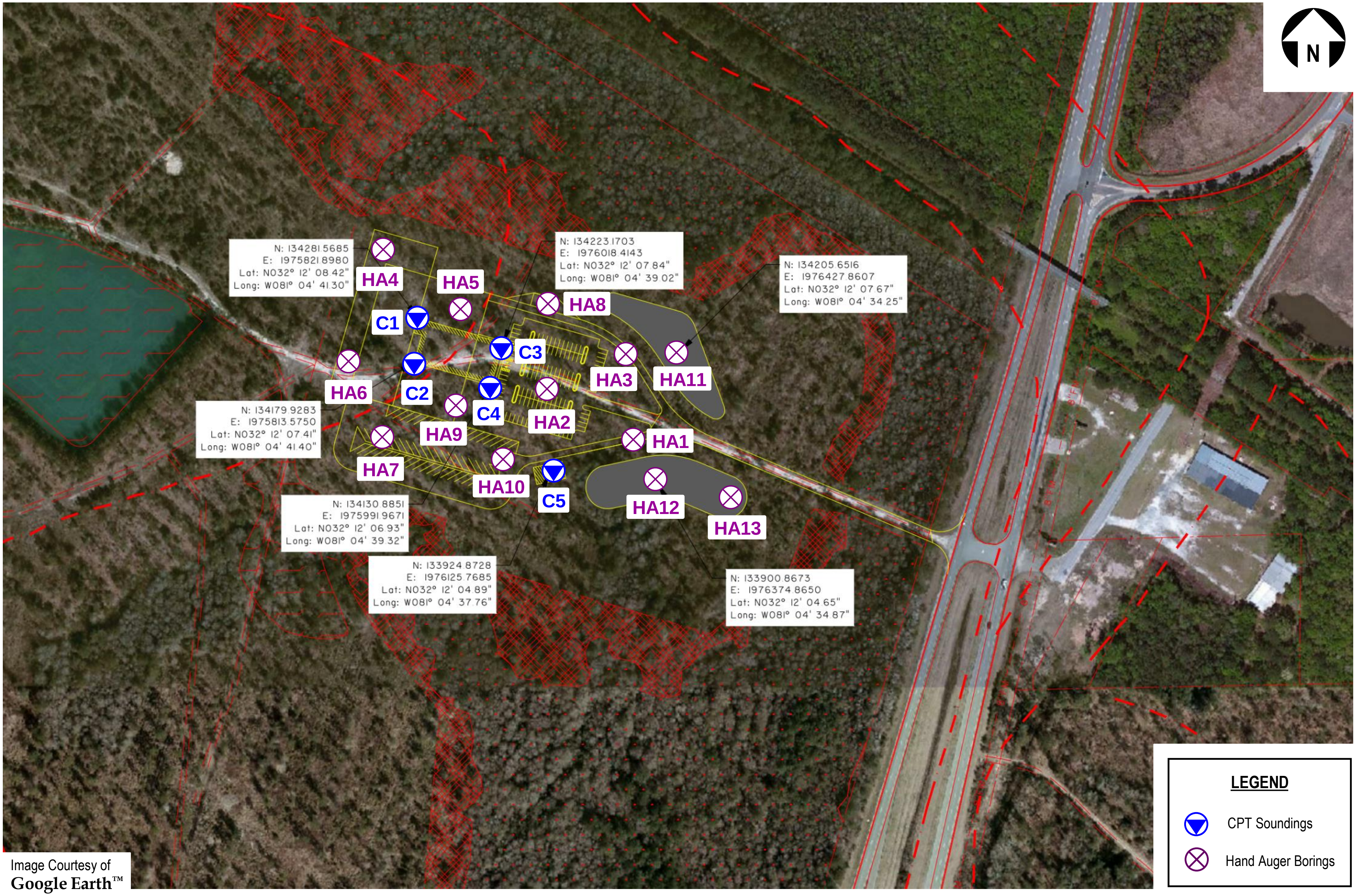
Project Manager: YH	Project No. ES175222
Drawn by: YH	Scale: N.T.S.
Checked by: GL	File Name:
Approved by: GL	Date: 8-17-17

Terracon
Consulting Engineers & Scientists
2201 Rowland Avenue Savannah, Georgia 31404
Phone (912) 629 4000 Fax (912) 629 4001

SITE LOCATION MAP

Trucking Facility
Hardeeville
Jasper County, South Carolina

Exhibit: **A-1**



NOTES:

CONCEPTUAL PLAN PROVIDED TO TERRACON BY WASTE MANAGEMENT VIA EMAIL ON 7-18-17.

ALL EXPLORATION LOCATIONS WERE LOCATED IN THE FIELD USING A GPS UNIT AND / OR SITE LANDMARKS. EXPLORATION LOCATIONS SHOULD BE CONSIDERED APPROXIMATE. DIAGRAM IS FOR GENERAL LOCATION ONLY; NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Manager:	YH
Drawn by:	YH
Checked by:	GL
Approved by:	GL

Project No.	ES175222
Scale:	N.T.S.
File Name:	
Date:	8-17-17

Terracon
Consulting Engineers & Scientists

2201 Rowland Avenue Savannah, Georgia 31404
Phone (912) 629 4000 Fax (912) 629 4001

EXPLORATION LOCATION PLAN

Trucking Facility
Hardeeville
Jasper County, South Carolina

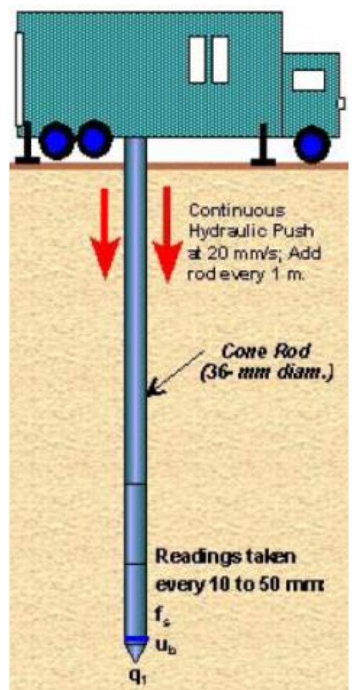
Exhibit:
A-2

Field Exploration Description

The locations of Cone Penetration Test (CPT) soundings and Hand Auger borings are determined by Terracon based on the proposed development and were located in the field using hand-held GPS units and in reference to existing features. These locations are shown in the Exploration Location Plan and should be considered approximate.

Cone Penetration Testing

The CPT hydraulically pushes an instrumented cone through the soil while nearly continuous readings are recorded to a portable computer. The cone is equipped with electronic load cells to measure tip resistance and sleeve resistance and a pressure transducer to measure the generated ambient pore pressure. The face of the cone has an apex angle of 60° and an area of 10 cm^2. Digital data representing the tip resistance, friction resistance, pore water pressure, and probe inclination angle are recorded about every 2 centimeters while advancing through the ground at a rate between 1½ and 2½ centimeters per second. These measurements are correlated to various soil properties used for geotechnical design. No soil samples are gathered through this subsurface investigation technique.



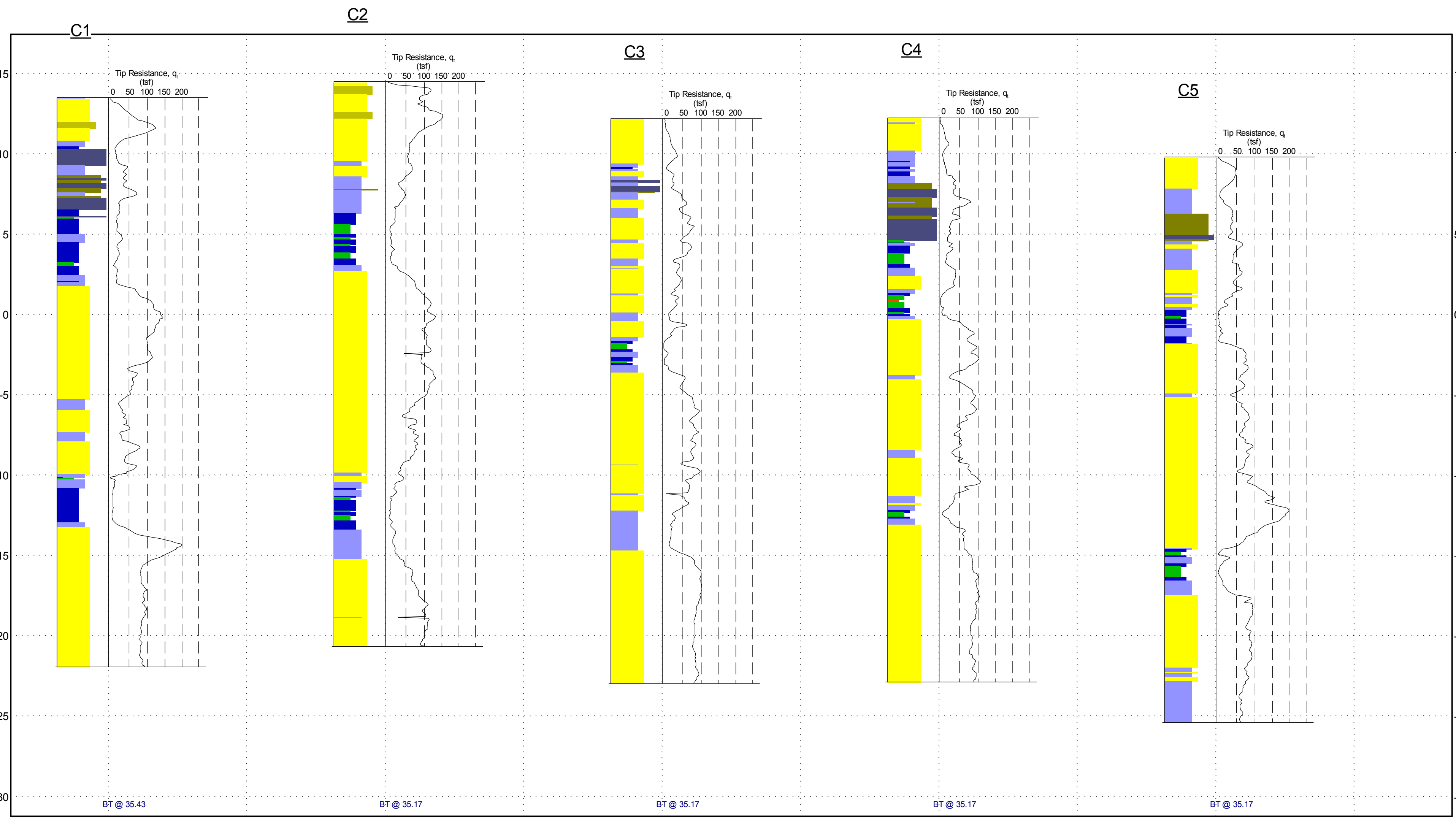
Source: FHWA NHI-06-088

CPT testing is conducted in general accordance with ASTM D5778 "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils."

Upon completion, the data collected were analyzed and processed by the project engineer.

Hand Auger Borings

Hand auger borings were conducted in general accordance with ASTM D 1452-80, Standard Practice for Soil Investigation and Sampling by Auger Borings. In this test, hand auger borings are drilled by rotating and advancing a bucket auger to the desired depths while periodically removing the auger from the hole to clear and examine the auger cuttings. The soils were classified in accordance with ASTM D2488.



Explanation

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

NOTES:
See Exhibit for orientation of soil profile.
See General Notes in Appendix C for symbols and soil classifications.
Soils profile provide dfor illustration purposes only.
Soils between borings may differ
AR - Auger Refusal
BT - Boring Termination

Project Manager:	Project No.: ES175222		**SUBSURFACE PROFILE**	EXHIBIT
Drawn by: YH	Scale: N.T.S.		HARDEEVILLE TRUCKING FACILITY	A-4
Approved by: GL	File Name:	**2201 Rowland Avenue Savannah, Georgia**		
Date: 9/6/2017		**PH. 912-629-4000** **FAX. 912-629-4001**	HARDEEVILLE, SOUTH CAROLINA	

SHEET 0 OF 1

CPT LOG NO. C1

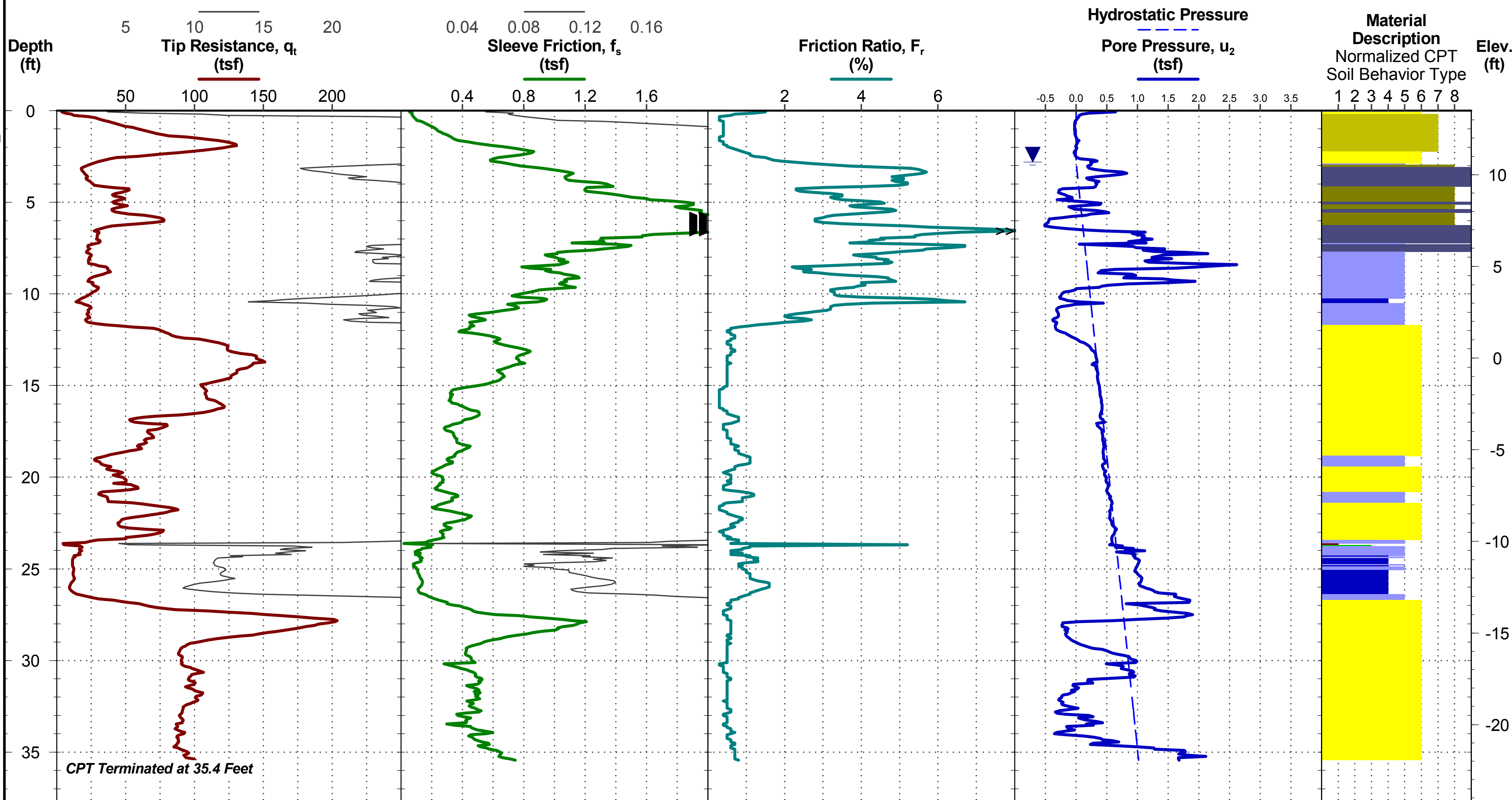
PROJECT: Hardeeville Trucking Facility

CLIENT: Waste Management, Inc.
Marietta, GA

SITE: Hardeeville, South Carolina

TEST LOCATION: See Exhibit A-2

Surface Elev.: 13.5 ft
Latitude: 32.20234°
Longitude: -81.07814°



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan provided by Waste Management on 9/5/2017 .

CPT sensor calibration reports available upon request.

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

WATER LEVEL OBSERVATION				
2.8 ft measured water depth (used in normalizations and correlations; see Appendix B)	Probe no. 4815 with net area ratio of 0.88 U2 pore pressure transducer location Manufactured by Geotech A.B.; calibrated 2/20/2017 Tip and sleeve areas of 10 cm^2 and 150 cm^2 Ring friction reducer with O.D. of 1.875 in	Terracon 2201 Rowland Ave Savannah, GA	CPT Started: 8/31/2017 Rig: Pagani TG73-200 Project No.: ES175222	CPT Completed: 8/31/2017 Operator: JB Exhibit: A-5-1

CPT LOG NO. C2

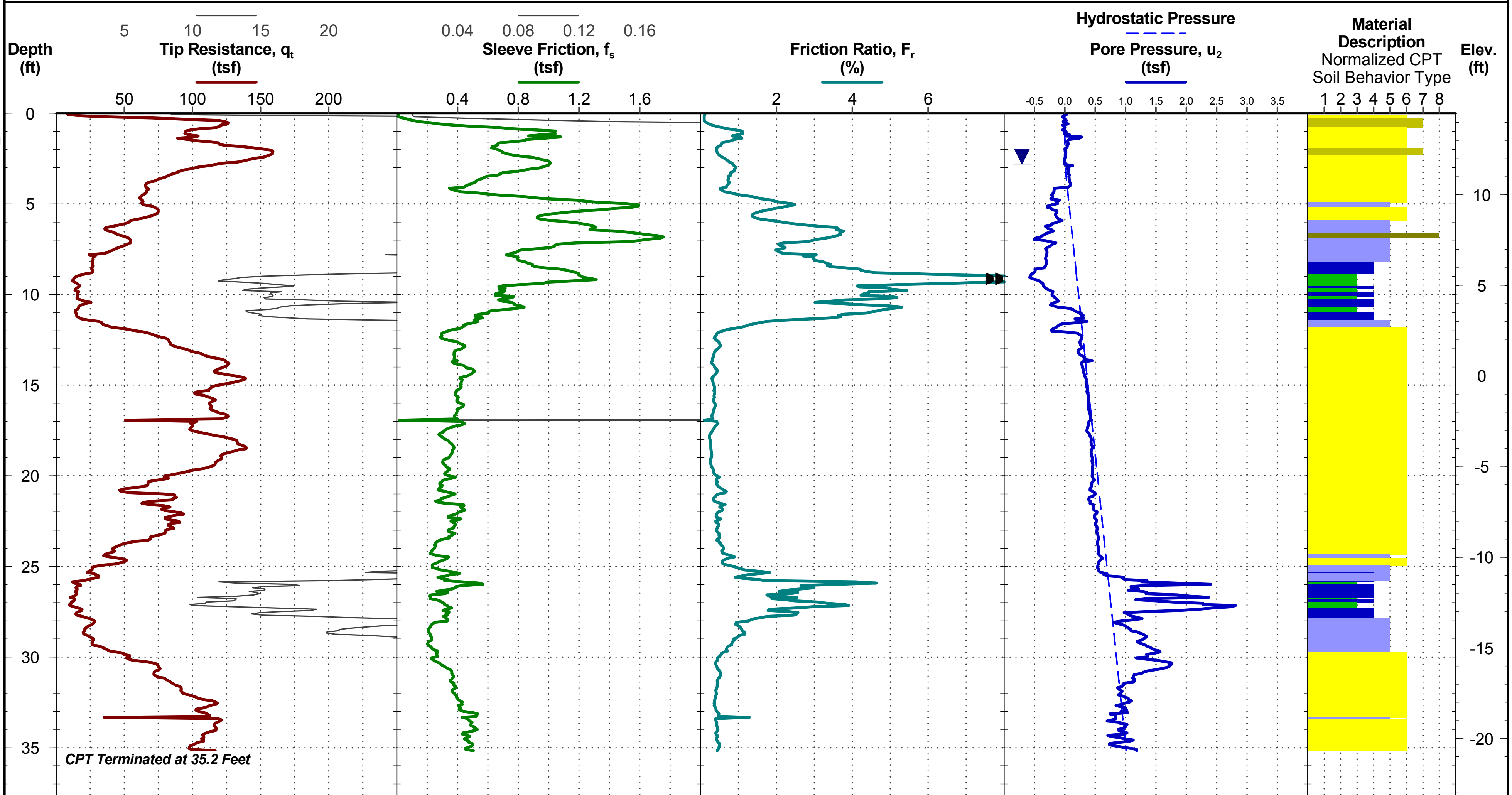
PROJECT: Hardeeville Trucking Facility

CLIENT: Waste Management, Inc.
Marietta, GA

TEST LOCATION: See Exhibit A-2

Surface Elev.: 14.5 ft
Latitude: 32.20206°
Longitude: -81.07817°

SITE: Hardeeville, South Carolina



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan provided by Waste Management on 9/5/2017 .

CPT sensor calibration reports available upon request.

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

WATER LEVEL OBSERVATION

▼ 2.8 ft estimated water depth
(used in normalizations and correlations; see Appendix B)

Probe no. 4815 with net area ratio of 0.88
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 2/20/2017
Tip and sleeve areas of 10 cm^2 and 150 cm^2
Ring friction reducer with O.D. of 1.875 in

Terracon
2201 Rowland Ave
Savannah, GA

CPT Started: 8/31/2017	CPT Completed: 8/31/2017
Rig: Pagani TG73-200	Operator: JB
Project No.: ES175222	Exhibit: A-5-2

CPT LOG NO. C3

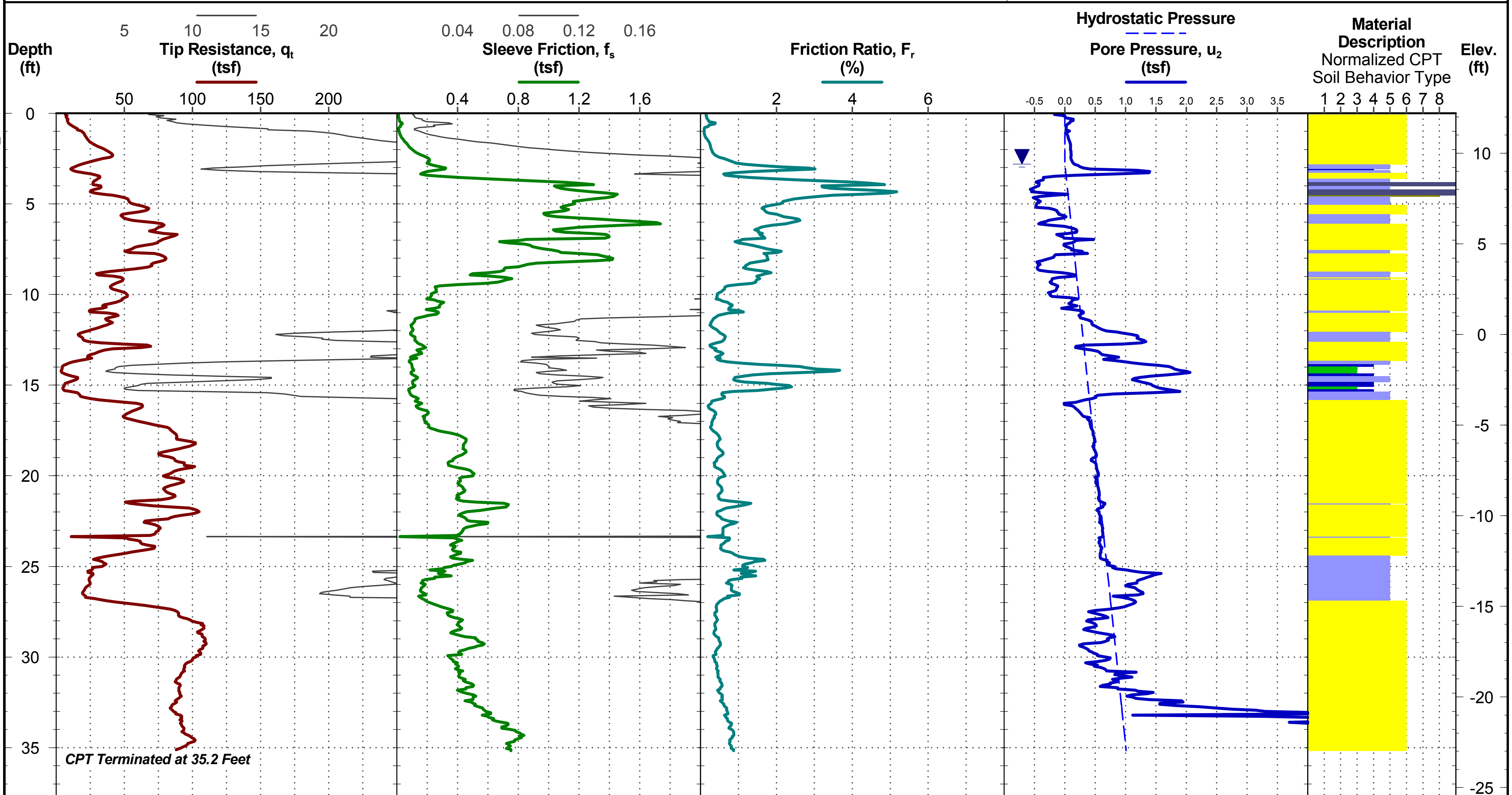
PROJECT: Hardeeville Trucking Facility

CLIENT: Waste Management, Inc.
Marietta, GA

SITE: Hardeeville, South Carolina

TEST LOCATION: See Exhibit A-2

Surface Elev.: 12.2 ft
Latitude: 32.20218°
Longitude: -81.07751°



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan provided by Waste Management on 9/5/2017 .

CPT sensor calibration reports available upon request.

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

WATER LEVEL OBSERVATION

2.8 ft estimated water depth
(used in normalizations and correlations; see Appendix B)

Probe no. 4815 with net area ratio of 0.88
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 2/20/2017
Tip and sleeve areas of 10 cm^2 and 150 cm^2
Ring friction reducer with O.D. of 1.875 in

Terracon
2201 Rowland Ave
Savannah, GA

CPT Started: 8/31/2017
Rig: Pagani TG73-200
Project No.: ES175222

CPT Completed: 8/31/2017
Operator: JB
Exhibit: A-5-3

CPT LOG NO. C4

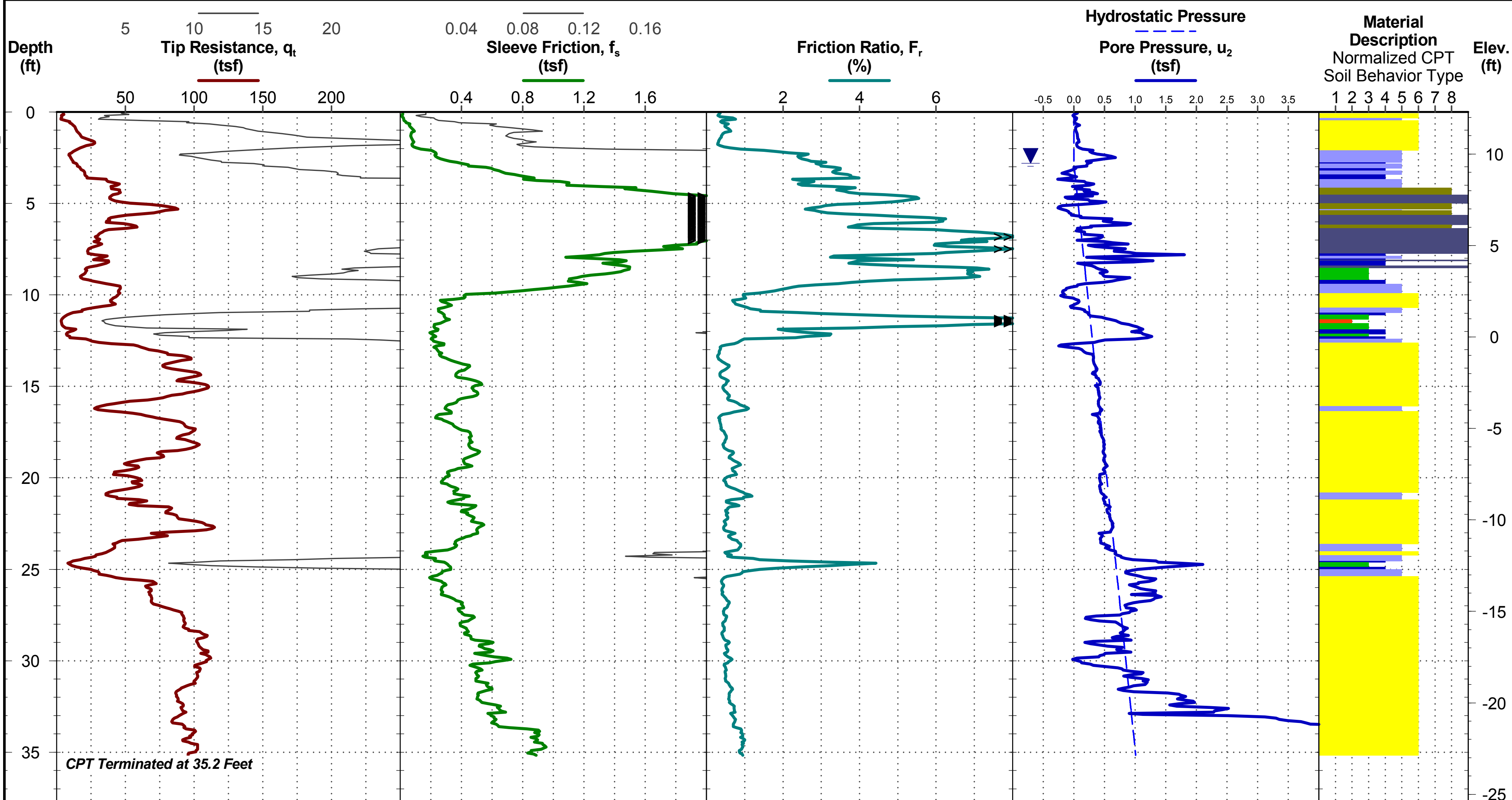
PROJECT: Hardeeville Trucking Facility

CLIENT: Waste Management, Inc.
Marietta, GA

TEST LOCATION: See Exhibit A-2

Surface Elev.: 12.3 ft
Latitude: 32.20193°
Longitude: -81.07759°

SITE: Hardeeville, South Carolina



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan provided by Waste Management on 9/5/2017 .

CPT sensor calibration reports available upon request.

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

WATER LEVEL OBSERVATION

2.8 ft estimated water depth
(used in normalizations and correlations; see Appendix B)

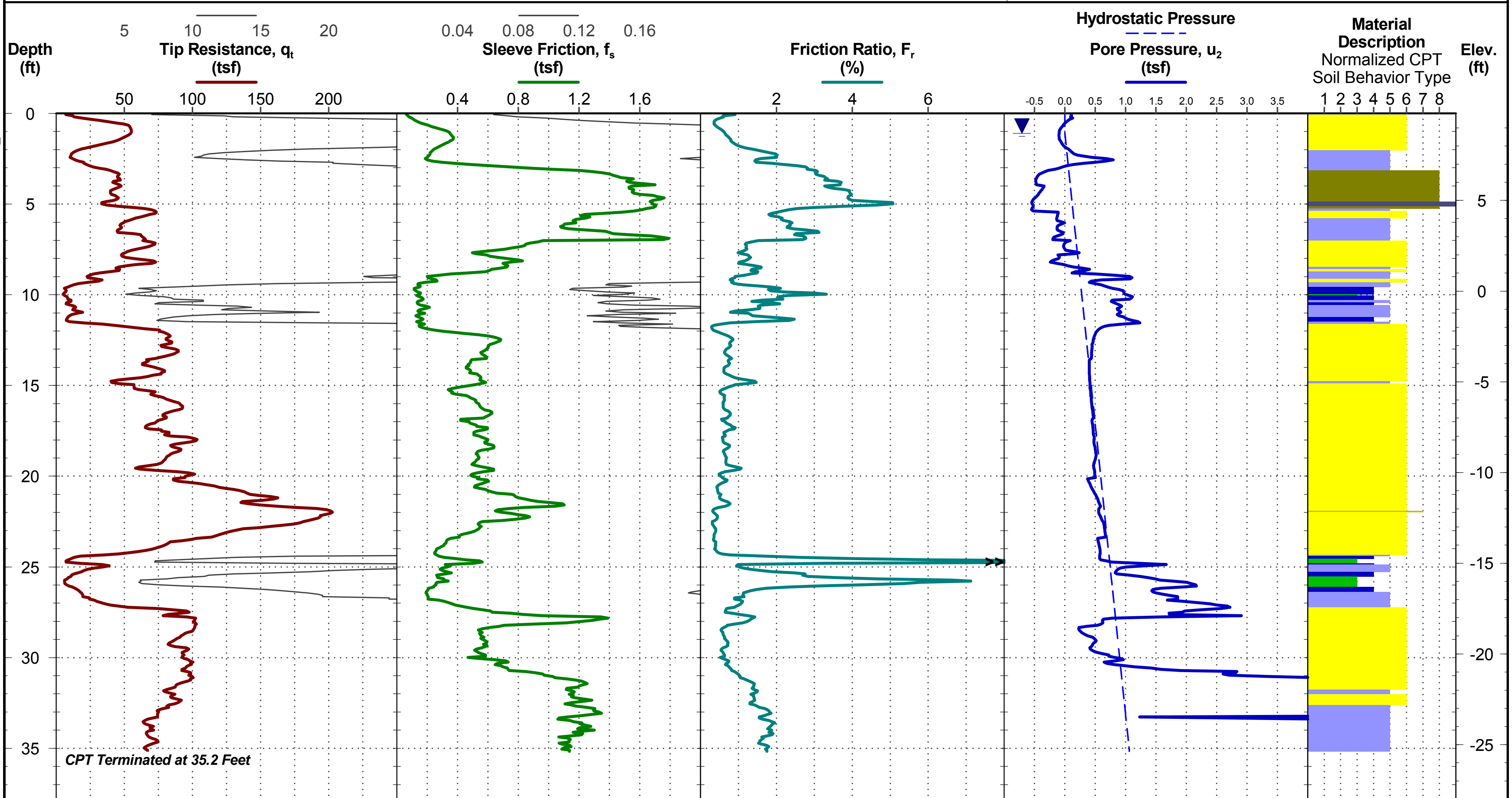
Probe no. 4815 with net area ratio of 0.88
U2 pore pressure transducer location
Manufactured by Geotech A.B.; calibrated 2/20/2017
Tip and sleeve areas of 10 cm^2 and 150 cm^2
Ring friction reducer with O.D. of 1.875 in

Terracon
2201 Rowland Ave
Savannah, GA

CPT Started: 8/31/2017	CPT Completed: 8/31/2017
Rig: Pagani TG73-200	Operator: JB
Project No.: ES175222	Exhibit: A-5-4

CPT LOG NO. C5

PROJECT: Hardeeville Trucking Facility	**CLIENT:** Waste Management, Inc. Marietta, GA	**TEST LOCATION:** See Exhibit A-2
SITE: Hardeeville, South Carolina		Surface Elev.: 9.8 ft Latitude: 32.20136° Longitude: -81.07716°



See Exhibit A-3 for description of field procedures.
See Appendix B for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan provided by Waste Management on 9/5/2017 .

CPT sensor calibration reports available upon request.

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

WATER LEVEL OBSERVATION	Probe no. 4815 with net area ratio of 0.88 U2 pore pressure transducer location Manufactured by Geotech A.B.; calibrated 2/20/2017 Tip and sleeve areas of 10 cm^2 and 150 cm^2 Ring friction reducer with O.D. of 1.875 in	Terracon 2201 Rowland Ave Savannah, GA	CPT Started: 8/31/2017	CPT Completed: 8/31/2017
1.1 ft measured water depth (used in normalizations and correlations; see Appendix B)			Rig: Pagani TG73-200	Operator: JB
			Project No.: ES175222	Exhibit: A-5-5

Hand Auger Boring Logs

Project Name: Hardeeville Truck Facility
Project No. ES175222
Project Location: Hardeeville, South Carolina

Tested date: 9/6/17 Performed by: AD

HA1		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 10	Dark brown fine silty sands with leaves and roots (topsoil)	--
10 to 16	Light gray fine sands with silt	SP-SM
16 to 24	Brown fine silty sands	SM
24 to 30	Gray/orange fine clayey sands	SC
30 to 60	Gray/orange sandy clays	CL
Groundwater @ 30" BGS	**Mottling @ 24" BGS**	

HA2		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 10	Light brown fine silty sands with roots and leaves (topsoil)	--
10 to 24	Light gray fine sands with silt	SP-SM
24 to 60	Orange/light brown/red fine clayey sands	SC
Groundwater @ 30" BGS	**Mottling @ 18" BGS**	

HA3		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 10	Dark brown fine silty sands with tree roots and pine needles	--
10 to 18	Light brown/orange fine silty sands	SM
18 to 60	Gray/orange/red sandy clays	CL
Groundwater @ 42" BGS	**Mottling @ 10" BGS**	

HA4		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 6	Dark brown fine silty sands with roots (topsoil)	--
6 to 30	Light brown fine sands with silt with roots to 12" BGS	SP-SM
30 to 42	Orange fine clayey sands	SC
42 to 60	Gray/orange/red sandy clays	CL
Groundwater @ 30" BGS	**Mottling @ 18" BGS**	

BGS = Below existing Ground Surface

Hand Auger Boring Logs

Project Name: Hardeeville Truck Facility
Project No. ES175222
Project Location: Hardeeville, South Carolina

Tested date: 9/6/17 Performed by: AD

HA5		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 6	Dark brown fine silty sands with tree roots (topsoil)	--
6 to 36	Light brown fine sands with silt with trace of roots at 24" BGS	SP-SM
36 to 60	Gray/orange/red sandy clays	CL
Groundwater @ 24" BGS	**Mottling @ 24" BGS**	

HA6		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 6	Dark brown fine silty sands with tree roots and pine needles	--
6 to 36	Light brown/orange fine silty sands with trace of roots and organics at 22" BGS	SM
36 to 40	Gray/orange/red sandy clays	CL
Terminated @ 40" BGS due to flowing sands		
Groundwater @ 24" BGS	**Mottling @ 24" BGS**	

HA7		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 6	Dark brown fine silty sands with roots (topsoil)	--
6 to 30	Light brown fine sands with silt	SP-SM
30 to 60	Orange/gray/red find clayey sands	SC
No groundwater noted	**Mottling @ 30" BGS**	

HA8		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 6	Light brown fine silty sands with roots and leaves (topsoil)	--
6 to 24	Light brown/light gray fine silty sands	SM
24 to 42	Light gray/orange fine sands with silt	SP-SM
42 to 46	Gray/orange fine clayey sands	SC
Terminated @ 46" due to no material in the auger		
Groundwater @ 42" BGS	**Mottling @ 24" BGS**	

BGS = Below existing Ground Surface

Hand Auger Boring Logs

Project Name: Hardeeville Truck Facility
Project No. ES175222
Project Location: Hardeeville, South Carolina

Tested date: 9/6/17 Performed by: AD

HA9		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 8	Light brown fine silty sands with roots and leaves (topsoil)	--
8 to 24	Light gray fine sands with silt	SP-SM
24 to 36	Orange/red/gray fine clayey sands	SC
36 to 60	Orange/red/gray sandy clays with roots at 42" BGS	CL
Saturated soils with perched water from 20" to 36" BGS		
Groundwater @ 42" BGS	**Mottling @ 24" BGS**	

HA10		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 8	Brown/gray fine silty sands with tree roots and leaves (topsoil)	--
8 to 30	Light brown fine silty sands	SM
30 to 60	Gray/orange sandy clays	CL
Groundwater @ 24" BGS	**Mottling @ 18" BGS**	

HA11		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 10	Dark brown fine silty sands with pine needles and tree roots	--
10 to 18	Brown fine silty sands	SM
18 to 24	Light brown/orange fine sands with clay	SP-SC
24 to 66	Light gray/orange sandy clays	CL
66 to 78	Light gray/orange fine clayey sands	SC
78 to 96	Light gray/orange sandy clays	CL
Groundwater @ surface	**Mottling @ 18" BGS**	

HA12		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 8	Dark brown fine silty sands with pine needles and tree roots	--
8 to 18	Light gray fine sands with silt	SP-SM
18 to 30	Light brown/orange fine silty sands	SM
30 to 48	Gray/orange/red fine clayey sands	SC
48 to 96	Gray/orange/red sandy clays	CL
Groundwater @ 18" BGS	**Mottling @ 18" BGS**	

BGS = Below existing Ground Surface

Hand Auger Boring Logs

Project Name: Hardeeville Truck Facility
Project No. ES175222
Project Location: Hardeeville, South Carolina

Tested date: 9/6/17   Performed by: AD

HA13		
Depth (inch, BGS)	**Material Description**	**USCS Classification**
0 to 8	Brown/gray fine silty sands with pine needles and roots (topsoil)	--
8 to 30	Light brown fine silty sands	SM
30 to 96	Gray/orange fine clayey sands with roots at 30" BGS	SC
Groundwater @ 30" BGS	**Mottling @ 24" BGS**	

BGS = Below existing Ground Surface

APPENDIX B
SUPPORTING INFORMATION

Seismic Design Parameters Based on IBC2012 Code and ASCE 7-10 Standard
Terracon Project Name: Hardeeville Truck Facility
Terracon Project Number: ES175222

Site Location: Hardeeville, South Carolina
Latitude : 32.2022
Longitude : -81.0776

Site Class: D
Design Response Spectrum for the Site Class

S_s	0.336	S_1	0.126
F_a	1.531	F_v	2.294
S_{MS}	0.515	S_{M1}	0.290
S_{DS}	0.343	S_{D1}	0.193

	Period (sec)	Sa (g)
	0.000	0.137
T_0	0.113	0.343
	0.200	0.343
T_S	0.563	0.343
T	0.700	0.276
	0.800	0.241
	0.900	0.214
	1.000	0.193
	1.100	0.175
	1.200	0.161
	1.300	0.148
	1.400	0.138
	1.500	0.129
	1.600	0.121
	1.700	0.114
	1.800	0.107
	1.900	0.102
	2.000	0.097

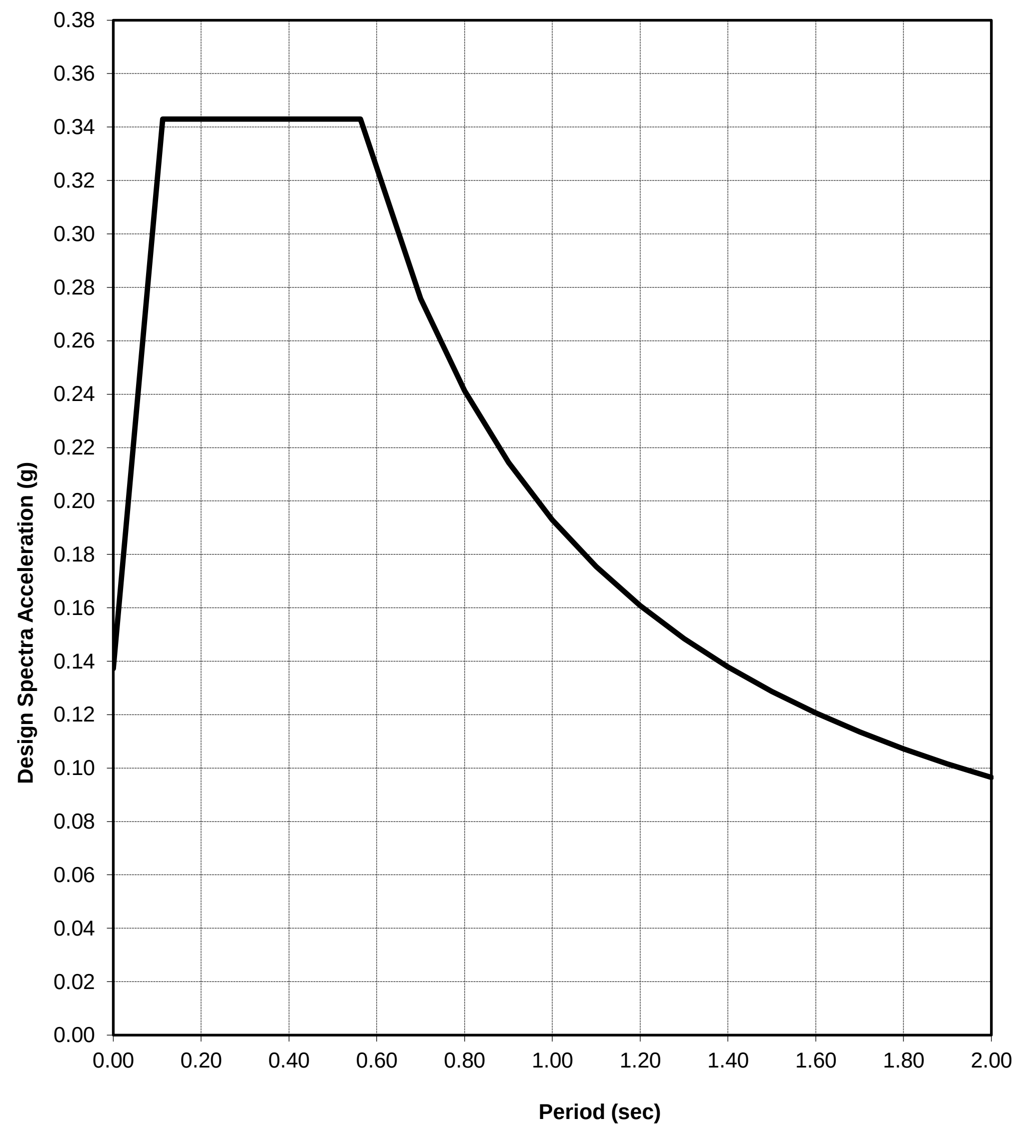


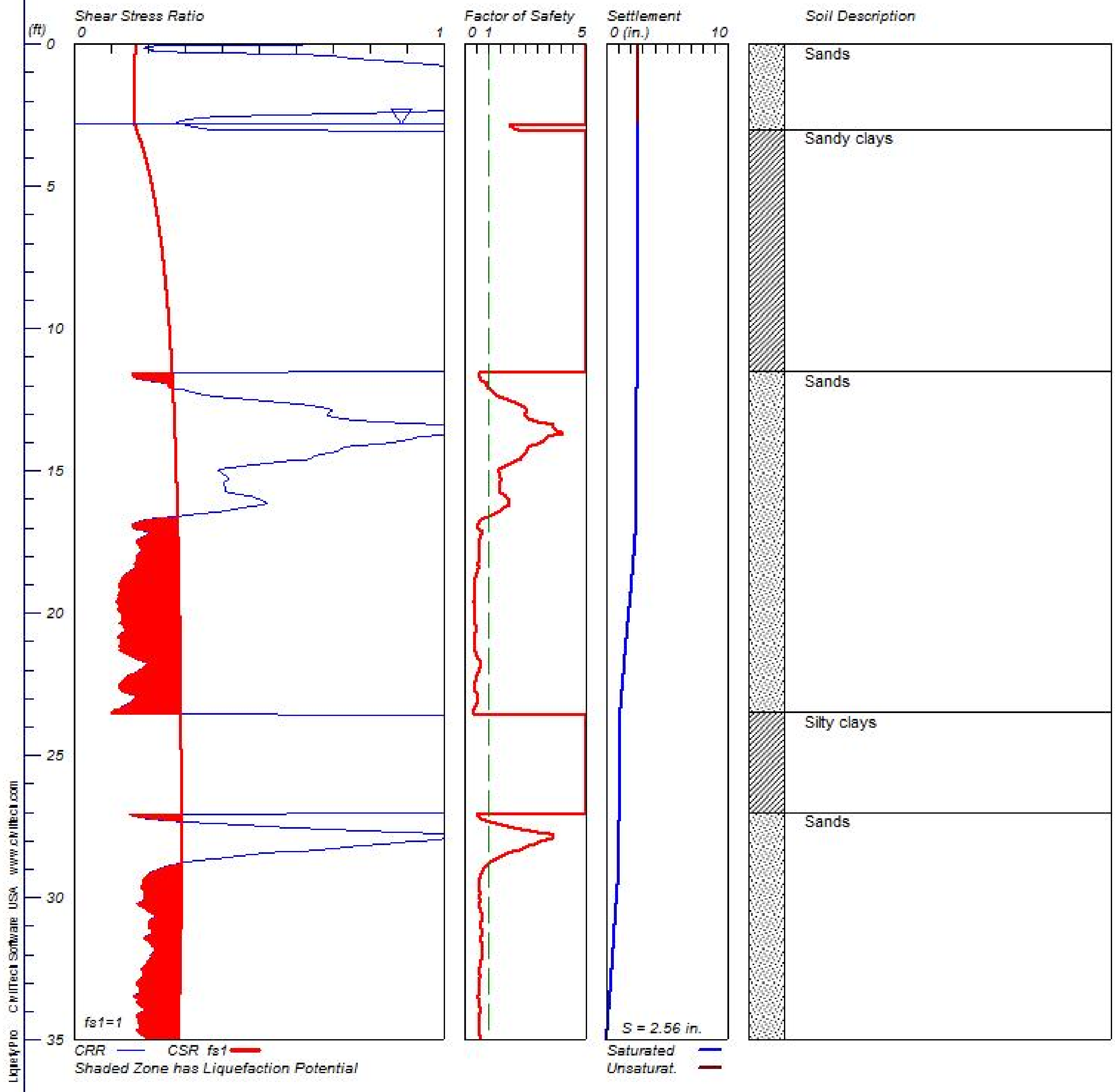
Exhibit B-1

LIQUEFACTION ANALYSIS

Hardeeville Truck Facility

Hole No.=C1   Water Depth=2.8 ft

Magnitude=7.3
Acceleration=0.256g

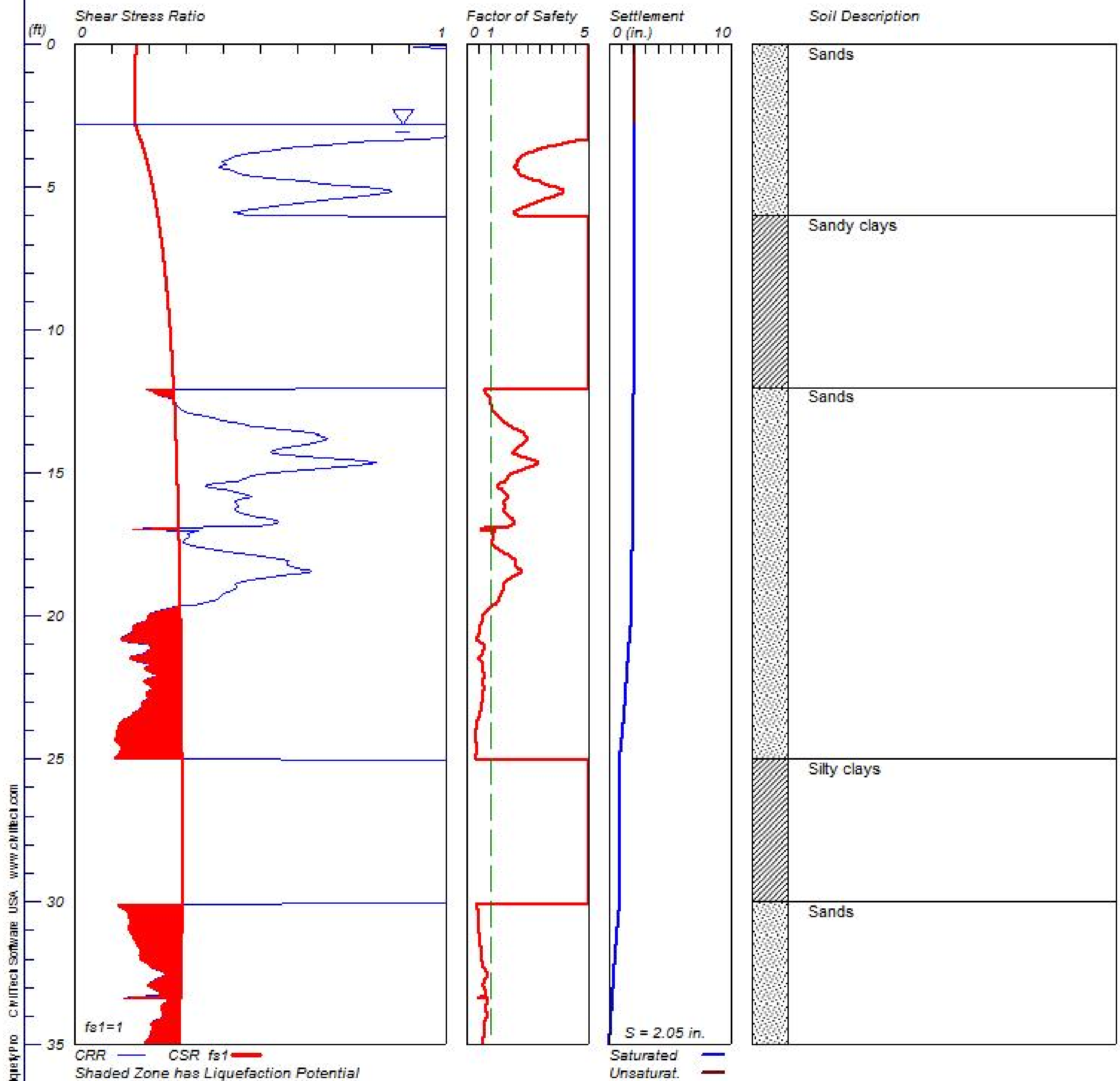


LIQUEFACTION ANALYSIS

Hardeeville Truck Facility

Hole No.=C2 Water Depth=2.8 ft

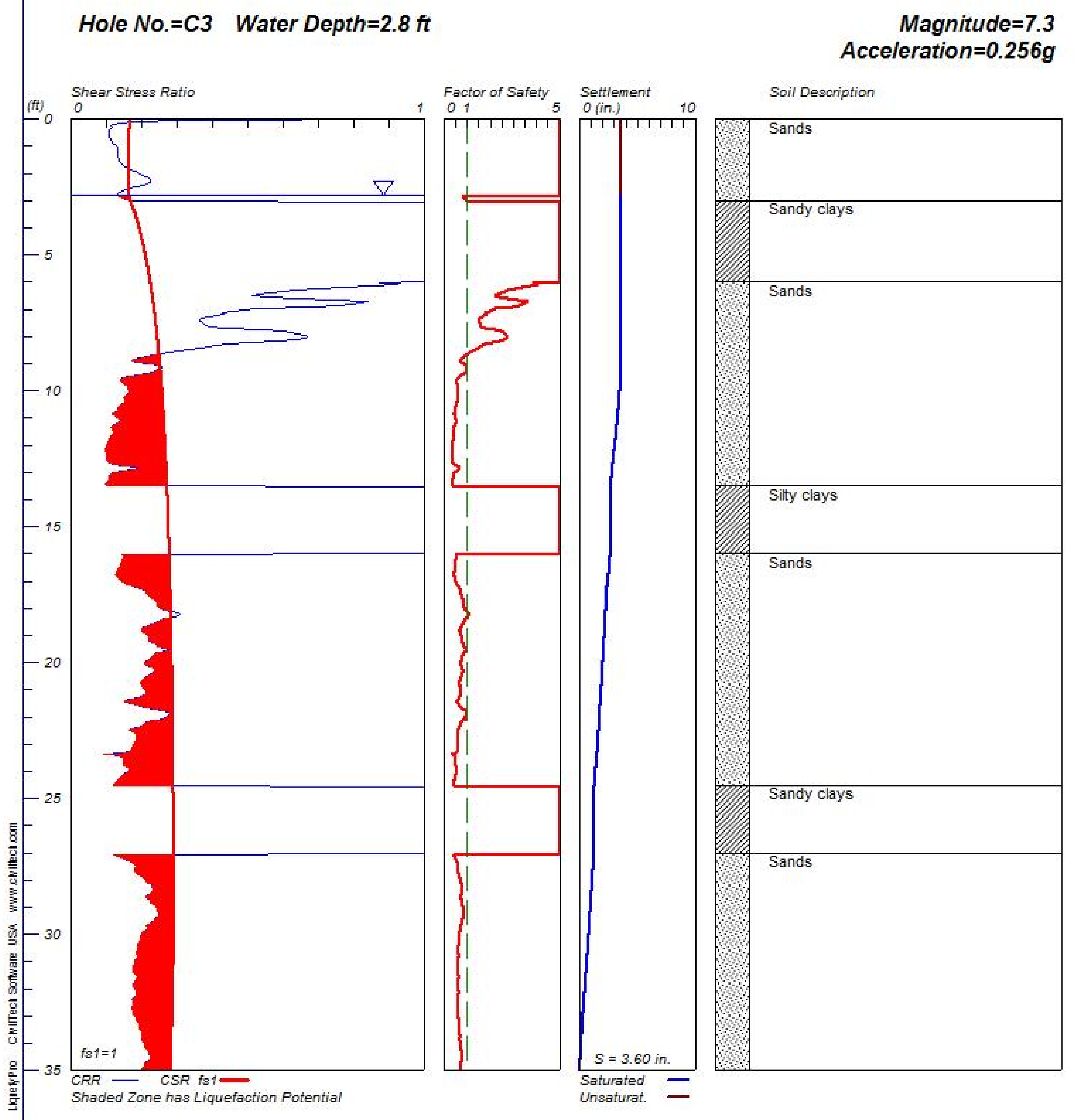
Magnitude=7.3
Acceleration=0.256g



Terracon ES175222

LIQUEFACTION ANALYSIS

Hardeeville Truck Facility

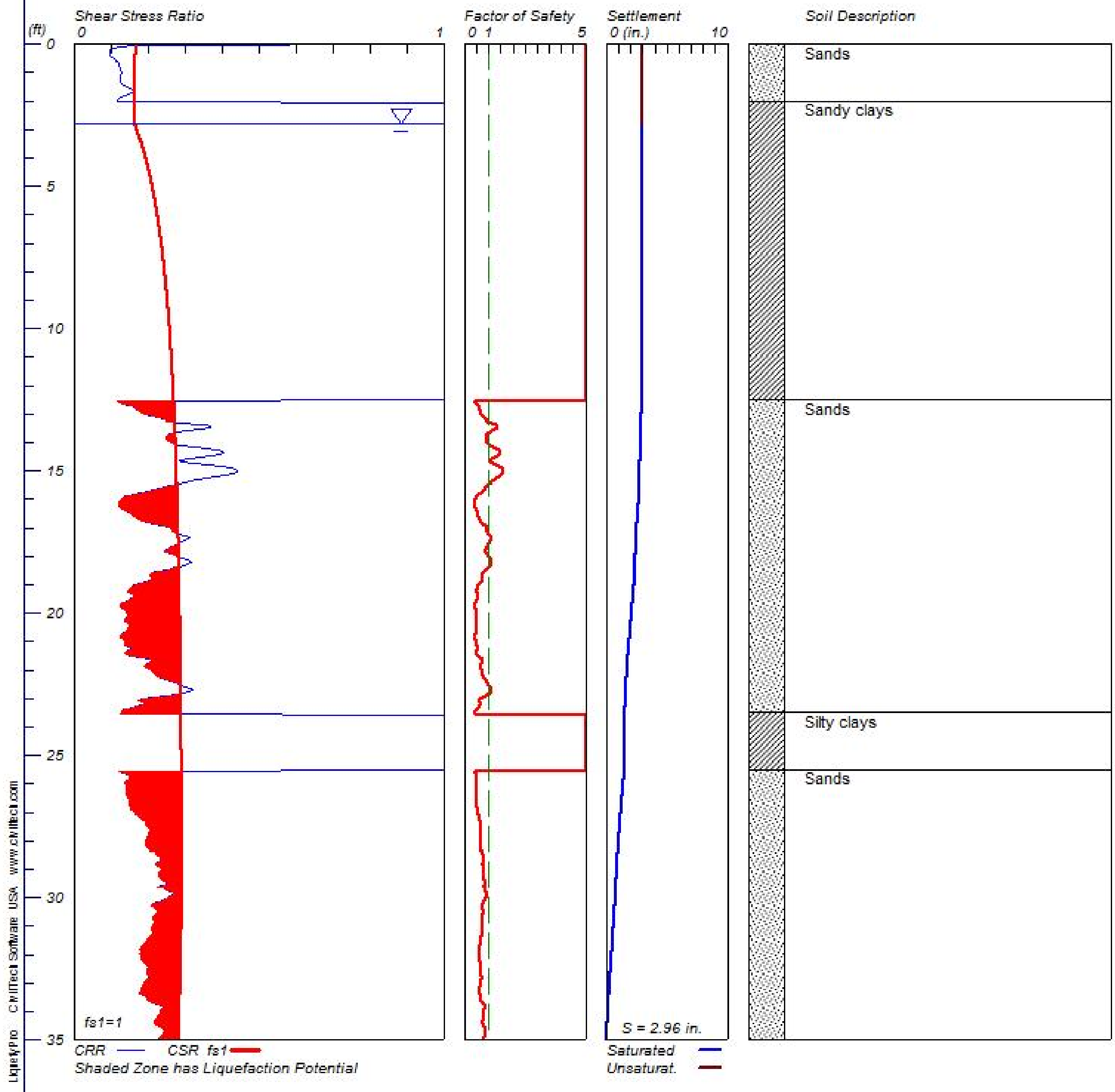


LIQUEFACTION ANALYSIS

Hardeeville Truck Facility

Hole No.=C4 Water Depth=2.8 ft

Magnitude=7.3
Acceleration=0.256g

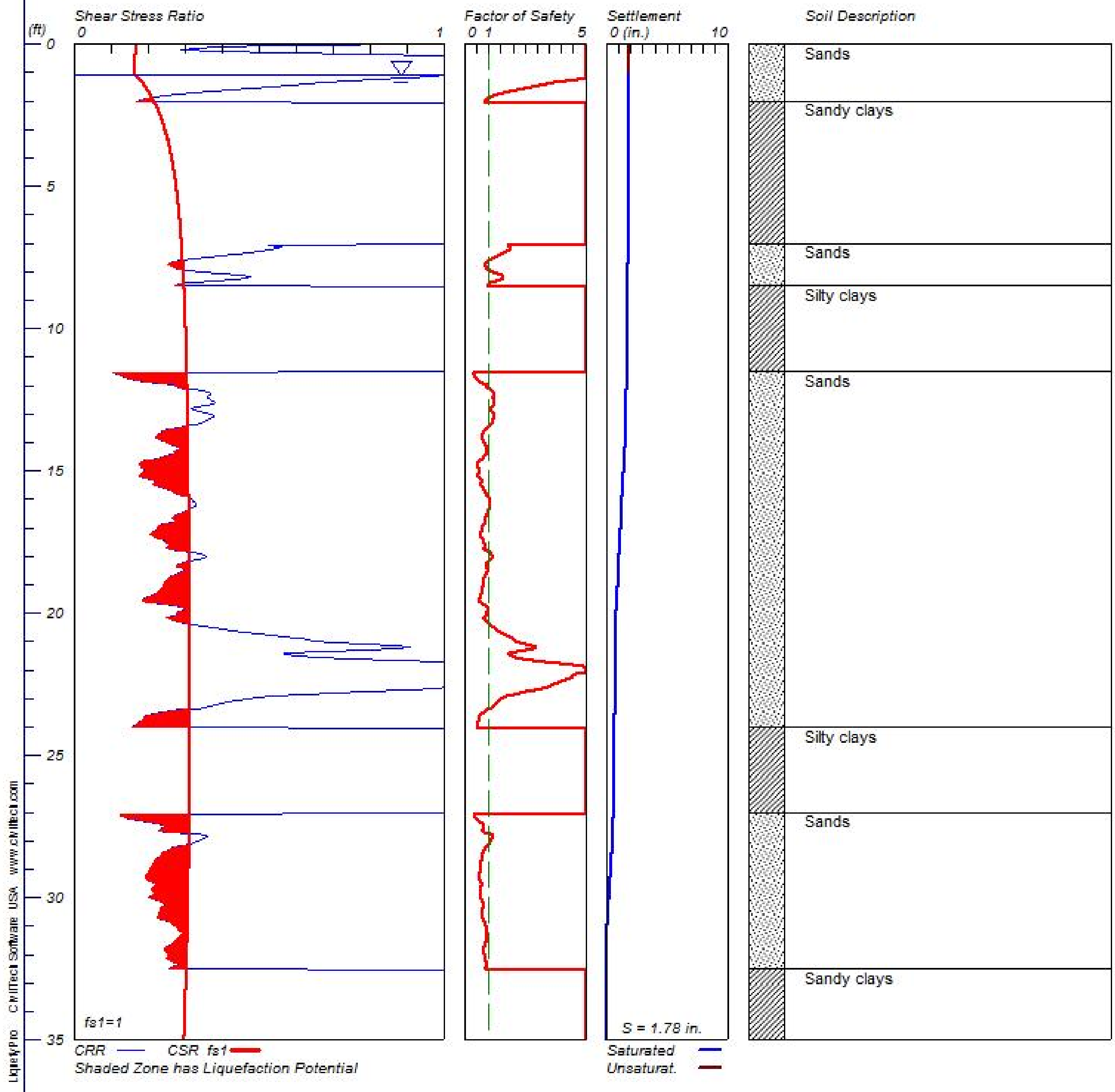


LIQUEFACTION ANALYSIS

Hardeeville Truck Facility

Hole No.=C5   Water Depth=1.1 ft

Magnitude=7.3
Acceleration=0.256g



Terracon   **ES175222**

Exhibit B-2-5

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING	GROUNDWATER	FIELD TESTS
Auger Split Spoon Shelby Tube Macro Core No Recovery Rock Core Ring Sampler	Groundwater Initially Encountered Groundwater Level After a Specified Period of Time Static Groundwater Level After a Specified Period of Time No Groundwater Observed 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.	(HP) Hand Penetrometer (T) Torvane (b/f) Standard Penetration Test (blows per foot) (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

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

LOCATION AND ELEVATION NOTES

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

STENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.		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		
Descriptive Term (Density)	**Std. Penetration Resistance (blows per foot)**	**Descriptive Term (Consistency)**	**Undrained Shear Strength (kips per square foot)**	**Std. Penetration Resistance (blows per foot)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium-Stiff	0.50 to 1.00	5 - 7
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 14
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	above 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Descriptive Term(s) of other constituents	Percent of Dry Weight
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

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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]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[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 on or above "A" line[J]	CL	Lean clay[K,L,M]
			$PI < 4$ or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	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	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	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-in. (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] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 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 $\geq$ 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 $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ 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.

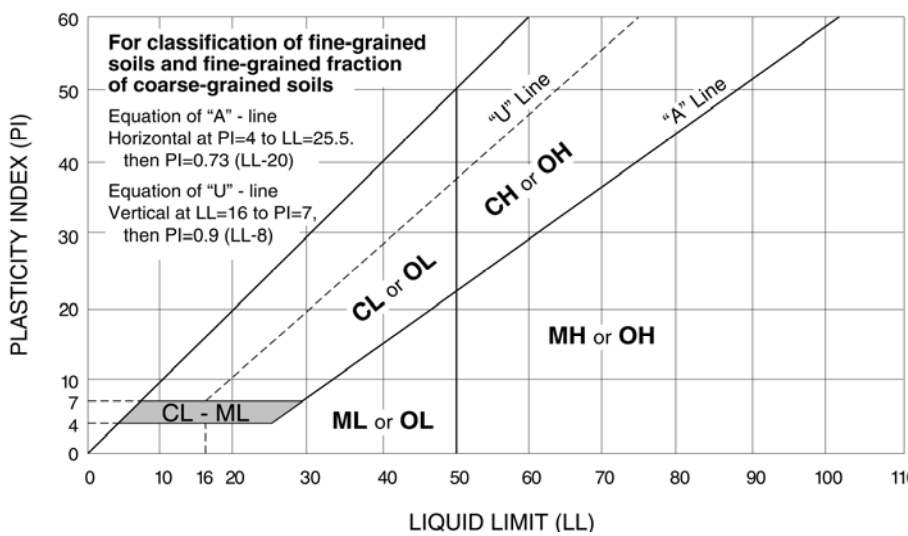

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Exhibit B-4

CPT GENERAL NOTES

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
$q_t = q_c + U2(1 - a)$
Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, U1/U2
Pore pressure generated during penetration
U1 - sensor on the face of the cone
U2 - sensor on the shoulder (more common)

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

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

To be reported per ASTM D7400, if collected:

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

DESCRIPTION OF GEOTECHNICAL CORRELATIONS

Normalized Tip Resistance, Q_t
$Q_t = (q_t - \sigma_{Vo})/\sigma'_{Vo}$

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

Undrained Shear Strength, Su
Su = $Q_t \times \sigma'_{Vo}/N_{kt}$
N_{kt} is a geographical factor (shown on Su plot)

Sensitivy, St
St = $(q_t - \sigma_{Vo}/N_{kt}) \times (1/fs)$

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

Unit Weight
UW = $(0.27[\log(FR)]+0.36[\log(q_t/atm)]+1.236) \times UW_{water}$
σ_{Vo} is taken as the incremental sum of the unit weights

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

Soil Behavior Type Index, Ic
$Ic = [(3.47 - \log(Q_t))^2 + (\log(FR) + 1.22)^2]^{0.5}$

Small Strain Modulus, G_0
$G_0 = \rho Vs^2$

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

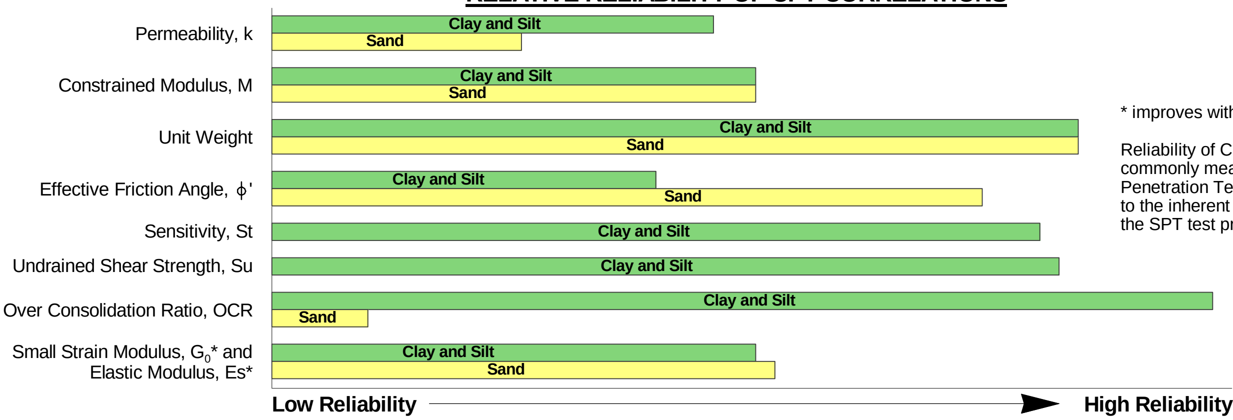
Constrained Modulus, M
$M = \alpha_M(q_t - \sigma_{Vo})$
For Ic > 2.2 (fine-grained soils)
$\alpha_M = Q_t$ with maximum of 14
For Ic < 2.2 (coarse-grained soils)
$\alpha_M = 0.0188 \times 10^{(0.55Ic + 1.68)}$

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

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 tip resistance, sleeve resistance, and porewater pressure. 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. 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 Vs 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

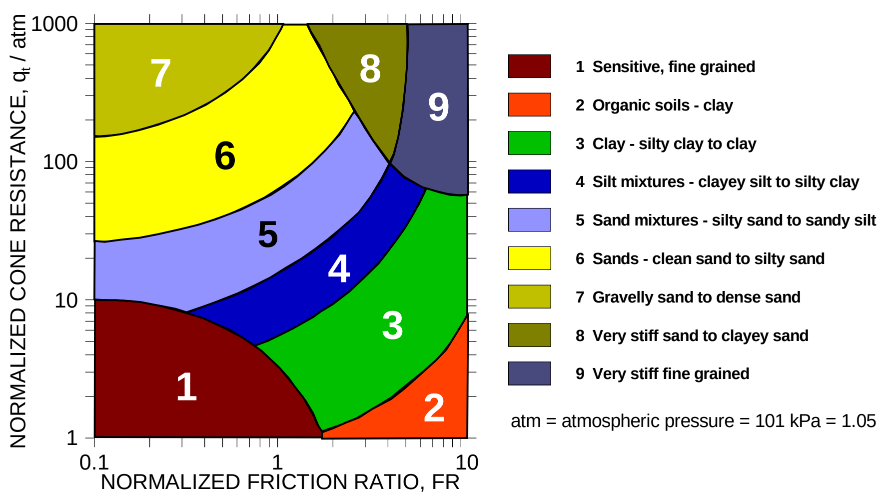
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions

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 (fs), and porewater pressure (U2). The normalized friction ratio (FR) is used to classify the soil behavior type.

Typically, silts and clays have high FR values and generate large excess penetration porewater pressures; sands have lower FRs and do not generate excess penetration porewater pressures. Negative pore pressure measurements are indicative of fissured fine-grained material. 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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