April 13, 2017

Mr. Tim Hayes, P.E.
WSP / Parsons Brinckerhoff
434 Fayetteville Street, Suite 1500
Raleigh, North Carolina 27601

Reference: **REPORT OF SUBSURFACE EXPLORATION**
NCDOT Passenger Terminals and Parking Lots
Hatteras and Ocracoke Islands, North Carolina
ESP Project No. E4A-FN65.300

Dear Mr. Hayes:

ESP Associates, P.A. (ESP) has completed the subsurface exploration for the proposed passenger terminals on Hatteras and Ocracoke Islands, North Carolina. This exploration was performed in general accordance with our Proposal No. E4A-17028, dated February 14, 2017. Authorization to proceed with this study was provided by written execution of our proposal by Mr. Brock Laforty with WSP/Parsons Brinckerhoff.

The purpose of the exploration was to evaluate the general subsurface conditions within the proposed building and pavement areas with regard to the design and construction of the pile foundation and pavement systems. This report presents our findings, conclusions and recommendations for foundation design, as well as construction considerations for the proposed pile foundations and paved areas.

ESP appreciates the opportunity to assist you during this phase of the project. If you should have any questions concerning this report, or if we may be of further assistance, please contact us.

Sincerely,

ESP Associates, P.A.

Benjamin R. Long, EI
Project Manager

Richard W. Engates Jr., PE
N.C. Registration No. 44287

NORTH CAROLINA PROFESSIONAL SEAL 044287 4-13-17 ENGINEER RICHARD W ENGATES, JR.

BRL/RWE/db

Copies Submitted: (3)

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INTRODUCTION

1.1 SITE AND PROJECT DESCRIPTION

The sites are located on Hatteras Island and Ocracoke Island in North Carolina. The initial site plans are for the construction of covered passenger shelters adjacent to their respective existing Visitor's Centers. Each Passenger Ferry Terminal Shelter will be an open-aired, approximately 1,500 square feet structure with a 500 square foot veranda. The shelters will have a concrete slab-on-grade floor with timber framing. The structure foundations are assumed to be timber piles. The Hatteras terminal will have two parking lot areas along Coast Guard Road within walking distance of the shelter.

The location of the proposed Hatteras shelter is paved and located between the ferry loading area and Visitor's Center. The parking areas will be located behind the Visitor's Center and Maintenance building. The proposed Ocracoke shelter will be located between the Visitor's Center and Irvin Garrish Highway.

1.2 PURPOSE OF SERVICES

The purpose of the exploration was to evaluate the general subsurface conditions within the proposed building and pavement areas with regard to the design and construction of the pile foundation and pavement systems. This report presents our findings, conclusions and recommendations for foundation design, as well as construction considerations for the proposed pile foundations and paved areas. This report also contains a brief description of the field and laboratory testing procedures performed for this study and a discussion of the soil conditions encountered at the site.

2.0 EXPLORATION PROCEDURES

2.1 FIELD

Five (5) soil test borings (Borings B-1 through B-3, B-5 and B-6) and one (1) hand auger boring (Boring B-4) supplemented with Dynamic Cone Penetrometer (DCP) Testing were performed at the approximate locations shown on the attached "Boring Location Plan," Figure 1. The borings were located in the field by a representative from our office using the Boring Location Map provided by Mr. Tim Hayes with WSP/Parsons Brinckerhoff sent via email on January 18 (Hatteras) and February 6, 2017 (Ocracoke). Existing buildings were used as references for measuring distances and approximating right angles. The soil test borings were extended to depths ranging between 5 and 40 feet below the existing ground surface using a 4-wheel drive, truck mounted CME 45 drill rig. Mud rotary drilling was used to advance the solid stem auger borings into the ground. The hand auger boring (Boring B-4) was manually advanced to a depth of approximately 5 feet below the existing ground surface.

Standard Penetration Tests were performed at designated intervals in the soil test borings (Borings B-1 through B-3, B-5 and B-6) in general accordance with ASTM D 1586 in order to obtain data for estimating soil strength and consistency. In conjunction with the penetration testing, split-spoon soil samples were recovered for soil classification and potential laboratory testing. Water level measurements were attempted at the termination of drilling.

The DCP test procedure used during our evaluation of Boring B-4 is as follows. The cone point of the penetrometer is first seated into the bearing material to embed the point. The cone point is driven three 1-3/4 inch intervals using a 15 pound weight falling 20 inches. The penetrometer test result is the number of blows required to drive the cone point 1-3/4-inches. The penetrometer test result is similar to the Standard Penetration Resistance (N-value), as defined by ASTM D 1586. When properly evaluated, the penetrometer test results provide an index for estimating soil strength and relative density.

While in the field, a representative of the geotechnical engineer visually examined each sample to evaluate the type of soil encountered, soil plasticity, moisture condition, organic content, presence of lenses and seams, colors and apparent geological origin. The results of the visual soil classifications for the borings, as well as field test results, are presented on the individual "Geotechnical Boring Report Bore Log," included in the Appendix. Similar soils were grouped into strata on the logs. The strata lines represent approximate boundaries between the soil types; however, the actual transition between soil types in the field may be gradual in both the horizontal and vertical directions.

While coordinating with the Parks and Recreation Department for access to the Ocracoke Ferry Terminal site, it was discovered that it was a historic location. Because of this, an archaeologist retained by WSP/Parsons Brinckerhoff was present during these borings to assess any cultural material discovered.

Shear Wave Velocity Testing

ESP collected surface wave seismic data at the sites and analyzed the data to provide an approximate shear wave velocity distribution of the subsurface. The purpose of the study was to develop a shear wave velocity model to determine the Seismic Site Class for each specific site, as per the 2015 North Carolina State Building Code (the 2012 International Building Code as modified by North Carolina), which references the seismic site class requirements of ASCE 7-10.

The surface wave seismic data was collected at the sites along an approximate 115-foot long alignment oriented approximately northwest-southeast near the center of the site on Hatteras Island and north to south along the center of the site at Ocracoke Island. The distance between the source location and the first geophone was 25 feet for the record selected for processing. The selected record had 15 stacked blows with a 20-pound sledgehammer.

2.2 LABORATORY

Select samples of the on-site soils obtained during the field testing program were tested in the laboratory. Tests performed included grain size distribution, Standard Proctor compaction, and an organic content test. The limited testing program was designed to determine selected engineering properties of the on-site soils relative to their use for the project. The results of the soil tests performed for this study, along with a brief description of the laboratory procedures used, are presented in the Appendix.

3.0 SUBSURFACE CONDITIONS

3.1 PHYSIOGRAPHY AND AREA GEOLOGY

The referenced properties are located on Hatteras and Ocracoke Islands in North Carolina which is in the Coastal Plain Physiographic Province. The Coastal Plain Physiographic Province is comprised of interbedded silts, sands and clays deposited by marine or fluvial action. The virgin soils encountered in this area are the product of surficial and quaternary deposits. In areas not altered by erosion or disturbed by the activities of man, the typical soil profile consists of coarse to fine sands to silty sands.

3.2 SUBSURFACE

The subsurface conditions as indicated by the borings generally consist of topsoil/grassmat underlain by coastal plain deposits. The generalized subsurface conditions at the site are described below. For more detailed soil descriptions and stratifications at a particular boring location, the attached "Geotechnical Boring Report Bore Log" should be reviewed.

Surface (Hatteras): An approximately 2 inch thick layer of asphalt underlain by approximately 4 inches of aggregate base course (ABC) stone was encountered at the surface of Borings B-1 and

B-2. A topsoil/grassmat layer approximately 2 to 3 inches thick was encountered at the surface in Borings B-3 through B-4.

Surface (Ocracoke): A topsoil/grassmat layer approximately 2 to 3 inches thick was encountered at the surface in Borings B-5 through B-6.

Fill (Hatteras): Underlying the surface material in Boring B-3, fill materials were encountered. The fill material consisted of loose, tan to brown, silty sand. Standard Penetration Resistances (N-values) ranged from 5 to 9 blows per foot (bpf). Fill depths were approximately 4 feet below grade.

Fill (Ocracoke): Underlying the surface material in Borings B-5 and B-6, fill materials were encountered. The fill material consisted of loose to medium dense, tan to brown, silty sand. Standard Penetration Resistances (N-values) ranged from 3 to 17 blows per foot (bpf). Fill depths were approximately 4 feet below grade.

Coastal Plain Deposits: Underlying the surface material in Borings B-1 through B-6, coastal plain deposits were encountered. The soils encountered generally consist of loose to medium dense sand and silty sand. Portions of the sand materials contained interbedded clayey silt. Organic material was encountered within the Coastal Plain Deposits in Boring B-4 at a depth of approximately 4 feet below the existing grade in the proposed parking area. The organic material consisted of black clayey material with an anaerobic odor. Standard Penetration Resistances (N-values) in the coastal plain deposits ranged from 3 to 57 blows per foot (bpf). The soil test borings were terminated within the coastal plain deposits at depths ranging from approximately 25 feet to 40 feet below the existing ground surface. The hand auger boring (Boring B-4) was terminated in the coastal plain deposits at a depth of approximately 5 feet below the existing ground surface.

3.3 SUBSURFACE WATER

Water was encountered during drilling at depths ranging between approximately 1.8 and 2.6 feet below the existing ground surface in Borings B-1 through B-6. All borings were terminated below the water table. For safety reasons, the boreholes were backfilled upon completion. Hole cave-in depths ranged between approximately 2 and 4 feet below the existing ground surface.

Subsurface water levels tend to fluctuate with seasonal and climatic variations, as well as with some types of construction operations. Therefore, water may be encountered during construction at depths not indicated during this study.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL

Our conclusions and recommendations are based on the project information previously discussed and on the data obtained from the field and laboratory testing program. If the structural loading, geometry or proposed building locations are changed or significantly differ from those discussed, or if conditions are encountered during construction that differ from those encountered by the borings, ESP requests the opportunity to review our recommendations based on the new information and make any necessary changes.

4.2 SITE DEVELOPMENT

The results of the field testing program and analyses indicate the sites majority of the property appears to be suitable for constructing lightly to moderately loaded structures, provided the following measures are considered.

A) The results from Borings B-4 through B-6 indicates that lower consistency coastal plains deposits (soils exhibiting N-values less than 6 bpf) are present at the sites. The near surface N-values obtained in the borings generally ranged from 3 to 21 bpf and generally extended to approximately 5 feet below the existing ground surface. If these soils are present near the surface in structural and pavement areas, some undercutting and/or reworking of these materials will be required.

B) The results from Borings B-3, B-5, and B-6 indicate existing fill soils from prior construction. Please refer to Section 4.3 for additional information.

4.3 EXISTING FILL

Hatteras Site

Results from the soil test borings performed at the site indicate that fill soils are present in Boring B-3. The fill extends to a depth of approximately 4.5 feet below the existing ground surface. Based on our visual observations of the split-spoon samples recovered and the our field observations, the fill encountered in the soil test borings appeared to contain concentrated organics, debris and other detritus materials. Boring B-4, located behind the Maintenance Building, contains a layer of highly concentrated organics with an anaerobic odor was noted from depths ranging from approximately 3.9 to 5.4 feet below the existing ground surface. Based on our understanding of anticipated pavement ESAL loads, design grades and the composition of the organic layer encountered, it is not anticipated to adversely affect the proposed construction. The soil subgrade may require the installation of geotextiles to stabilize the parking area.

Based on visual observations of the ground surface and Boring B-3, it appears that the fill has been placed in the proposed Hatteras parking lot behind the visitors center. The layer encountered at this location contains sand, gravel, and a piping system for a leach field. The results of the Loss on Ignition test of a sample obtained from this location indicated an approximately 0.65% organic content. It is recommended that the piping system and unsuitable fill be removed prior to construction.

Ocracoke Site

Results from the soil test borings performed at the site indicate that fill soils are present in Borings B-5 and B-6. The fill extends to depths varying between approximately 0.5 and 3 feet below the existing ground surface. Based on our visual observations of the split-spoon samples recovered and the our field observations, the fill encountered in the soil test borings consisted of sand and various construction debris such as bricks, nails and wood pieces. Encountered construction debris was retained by the archeologist for analysis.

Concentrated organics, debris and other deleterious materials were observed in the soil test borings performed by ESP Associates. However, due to the limited testing performed and the wide spacing of the borings, the possibility of additional deleterious inclusions and variable density material in or under the existing fill cannot be completely ruled out. Fill which contains wood fragments, trash, organics, voids or soft lenses, could result in excessive causing building distress. Also, the presence of the existing fill beneath pavement areas presents the risk of increased settlement and subsequently possible increased long term maintenance of the pavement areas. If the owner is not willing to accept the risk then the existing fill should be removed and replaced with compacted suitable structural fill.

4.4 FOUNDATION SUPPORT

For satisfactory performance, the foundation for any structure must satisfy three independent design criteria. First, it must have an acceptable factor of safety against bearing failure of the foundation soils under the maximum design loads. Second, the settlement of the foundations due to consolidation of the underlying soils should be within tolerable limits for the structures. Third, acceptable uplift capacity must be met.

Proposed plans called for the use of 10 x 10 inch square timber piles to be used for the foundation and columns of the shelters. Based on the design criteria provided by Ms. Lisa McGurty, the structural engineer with NRW Engineering in an email to Mr. Benjamin Long with ESP on March 21, 2017, we understand that the piles should be designed utilizing a factor of safety of 2.5 for the following allowable loads:

- 12 kips of compression;
- 4.5 kips of uplift; and
- 3.5 kips of lateral load.

The results of our analyses indicated that uplift would be the controlling design factor. Uplift was calculated based on the FHWA recommendation of assuming the uplift load is 1/3 of the shaft resistance. To achieve the allowable compression and uplift loads provided, we recommend the tip elevation of the timber piles be at least 14 feet below the design ground surface elevation at the Hatteras site and 16 feet at the Ocracoke site. We also recommend that each piling be treated with creosote in accordance with AWPA C-3 specifications.

We recommend that the timber piles be driven to a dynamic driving resistance required for a 30 kip design capacity as determined by the provided ultimate bearing capacity of 12 kips and a factor of safety of 2.5, or to practical refusal, whichever comes first. It is essential that driving be terminated immediately if refusal (i.e., four blows per inch or 48 blows per foot) is reached to prevent damage to the piles.

A wave equation analysis should be performed for the piles, once the driving equipment has been selected. This would help to determine when adequate penetration and pile capacity is achieved in the field. A wave equation analysis would also assess the pile drivability with the selected equipment and would help to prevent pile damage due to overdriving.

The hammer size, operating efficiency and cushion properties should be provided by the contractor. The pile driving hammer should have a rated energy of at least 15,000 foot-pounds per blow. The size and type of the pile hammer should be able to deliver consistently effective dynamic energy, suitable to the piles to be driven and to the subgrade material into which they are to be driven. The pile hammer shall be in sound mechanical condition and be operated at the manufacturer's rated speed and pressure. Pile spacing measured center-to-center should not be less than three times the pile diameter.

We recommend that driving be monitored by a geotechnical engineer or his qualified representative. This should be done to keep driving records and determine that the piles have been driven to adequate resistance in the appropriate strata. We also recommend that the piles be monitored for heave due to driving of adjacent piles. Should heave occur, the pile should be re-driven to its original depth.

Lateral pile analyses were beyond our scope of services for this project. If requested, ESP can provide these services under separate contract.

4.5 FLOOR SLABS

The slab-on-grade floor system can be adequately supported on the coastal plains deposits or newly compacted fill, provided the site preparation and fill placement procedures outlined in this report are implemented. However, as noted in Section 4.1, lower consistency soils were encountered at portions of the sites and as noted in Section 4.2, existing fill soils were encountered at portions of the sites. Depending on final grades, and the Owner's risk tolerance, some undercutting or reworking of these soils may be required to obtain suitable support for slab placement. A thorough evaluation by the geotechnical engineer's representative should be performed during construction to aid in determining the extent of these materials and the appropriate repair method.

Immediately prior to constructing the floor slabs, we recommend the areas be evaluated to detect unstable and/or unsuitable areas that may have been exposed to wet weather or construction traffic. The evaluation may consist of performing field density testing, DCP testing, proofrolling and/or hand probing with a steel probe rod. The evaluation should be performed by a representative of the geotechnical engineer. Areas that are found to be unstable and/or unsuitable should be undercut and replaced with adequately compacted structural fill.

4.6 SEISMIC CLASS

Ocracoke Island

The results of our MASW testing at the site indicate the "average" shear wave velocity for the upper 100 feet is approximately 923 feet per second (ft/s) for the location tested. Based on our review of the 2012 International Building Code, with reference to Table 20.3-1 of ASCE 7-10, the site falls within the range of $Vs_{(100)}$ between 600 and 1200 ft/s and is therefore identified as a **Site Class "D"**

Please reference the "Surface Wave Seismic Processing," Figure 4 and "Shear Wave Velocity Model," Figure 5 in the Appendix for more detailed information regarding our MASW testing.

Hatteras Island

The results of our MASW testing at the site indicate the "average" shear wave velocity for the upper 100 feet is approximately 1,089 feet per second (ft/s) for the location tested. Based on our review of the 2012 International Building Code, with reference to Table 20.3-1 of ASCE 7-10, the site falls within the range of $Vs_{(100)}$ between 600 and 1200 ft/s and is therefore identified as a **Site Class "D"**

Please reference the "Surface Wave Seismic Processing," Figure 8 and "Shear Wave Velocity Model," Figure 9 in the Appendix for more detailed information regarding our MASW testing.

4.7 PAVEMENT AREAS

We recommend that special care be given to providing adequate drainage away from pavement areas to reduce infiltration of surface water to the base course and subgrade materials in these areas. If these materials are allowed to become saturated during the life of the pavement section, then there will be a strength reduction of the materials that could result in a reduced life of the pavement section. It is recommended that areas with unsuitable existing fill and soils with concentrated organics in the near surface area be removed and backfilled with acceptable material. All water should be routed away from the pavement areas and adequate slopes provided to maintain drainage off site. Pavement areas should be proofrolled prior to placing structural fill and/or base course. Proofrolling procedures are outlined in subsequent sections of this report.

4.8 TEMPORARY DEWATERING

Based on existing ground surface elevations, groundwater levels encountered at the time of drilling and proposed subgrade elevations, we anticipate that dewatering will be required at the site. We expect that dewatering could be adequately handled with pumping from sumps excavated at least 3 feet below the bottom of the excavations. Pumping from the sumps should be maintained until fill placement in the excavation is a minimum of 3 feet above the water level. At no time should pumping be performed directly beneath the exposed subgrade elevation since this could result in disturbance of the bearing materials and a loss of soil strength and increased settlement.

4.9 DRAINAGE

Soil strength and settlement potential is highly dependent upon the moisture condition of the supportive soil. Soil characteristics can change dramatically when moisture conditions change. As such, building pads, roadways, structures and surrounding grades should be properly designed and constructed to properly control water (surface and subsurface). Building pads should be designed to shed surface water prior to building construction. Grades surrounding structures should be adequately sloped away from the structure to promote positive drainage and prevent water from ponding near or against the structure. Swales and/or storm drainage structures should be constructed to collect and remove all surface water run-off. All roof drain downspouts should be connected to drain leaders that are properly daylighted or connected to storm drainage structures such that water is removed from structural areas. Roof drain lines and foundation drain lines should always remain independent of each other. Any subsurface water that may rise near structural grades should be controlled by adequately constructed subsurface drainage mechanisms.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 EXISTING UTILITIES

Based on a review of the site plans provided to us and our visual observations during the subsurface exploration, we understand that several underground utility lines are present within the proposed Shelter and parking lots at The Hatteras Terminal location. An existing power line is located near B-2 running from the Ferry Control Building to the loading docks and near B-4 in the southern portion of the property. An existing leach field was encountered at Boring B-3. At the time of our field services, the USCG informed us that the leach field was located approximately 3 to 4 feet below the existing ground surface with the center pipe running parallel to the docks. It was further indicated that the center pipe could also be surrounded by approximately 1.5 to 3 feet of gravel on each side. It is recommended that the entire leach system be removed along with any areas containing concentrated organic material.

5.2 SITE PREPARATION

The entire buildings and pavement areas should be stripped of all topsoil, trash, debris and other organic materials to a minimum of 10 feet beyond the structural and 5 feet beyond the pavement limits. Upon completion of the stripping operations, the exposed subgrade in areas to receive fill should be proofrolled with a loaded dump truck or similar pneumatic tired vehicle (minimum loaded weight of 20 tons) under the observation of a representative of the geotechnical engineer. The proofrolling procedures should consist of complete passes of the exposed areas, with half of the passes being in a direction perpendicular to the preceding ones. After excavation of the site has been completed, the exposed subgrade in cut areas should also be proofrolled as previously described. Any areas which deflect, rut or pump excessively during proofrolling or fail to improve sufficiently after successive passes should be undercut to suitable soils and replaced with structural fill.

Fill was encountered in Borings B-3, B-5 and B-6. The depth of the fill varied between approximately 1 to 4.5 feet below the existing ground surface. Portions of the soil fill observed contained concentrated organics and/or deleterious materials. In addition, some of the near surface Standard Penetration Tests performed in the fill indicate that these soils may not be suitable for slab-on-grade and/or pavement support without remediation. Unsuitable soils may be encountered between the borings during site grading or excavation for foundations, that were not encountered in the borings. Some undercutting of the soft near surface soils and/or fill materials within the upper 3 feet of subgrade should be anticipated. The extent of the undercut required should be evaluated in the field by an experienced representative of the geotechnical engineer while monitoring construction activity. The evaluation should consist of a comprehensive proofrolling program and thorough field evaluation during construction. After the proofrolling operation has been completed and approved, final site grading should proceed immediately. If construction progresses during wet weather, the proofrolling operation should be repeated with at least one pass in each direction immediately prior to placing base course in the parking areas. If unstable conditions are exposed during this operation, then undercutting should be performed.

5.3 EFFECTS OF CONSTRUCTION METHODS

Several aspects of construction at this site could adversely affect the adjacent streets, utilities and nearby facilities. Therefore, proper design and special care during construction will be needed to protect the adjoining properties. These items are discussed below.

Pile driving and other construction activities can generate vibrations that travel off-site. These vibrations can cause damage to adjacent structures if not properly controlled. Care must be taken to prevent damage of newly placed structures, especially fresh concrete. We recommend that vibration monitoring be performed for structures located nearby during the construction activities that generate a large amount of vibration. This will reduce the potential for large magnitude vibrations and subsequent damage claims.

General site dewatering can sometimes cause settlement of adjacent structures due to an increase in effective stresses which can consolidate soils. Based on the available data, we anticipate that this will generally not be a problem at this site. However, pumping of fine soil particles due to improper dewatering techniques can result in unwanted subsidence. Therefore, proper dewatering systems, if required, should be implemented to reduce these effects.

6.0 LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice with regard to the specific conditions and requirements of this site. The conclusions and recommendations contained in this report were based on the applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, expressed or implied, is made.

The analysis and recommendations submitted herein are based, in part, upon the data obtained from the subsurface exploration. The nature and extent of variations between the borings will not be known until construction is underway. If variations appear evident, then we request the opportunity to re-evaluate the recommendations of this report. In the event that any changes in the nature, design, or location of the structures are planned, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and conclusions modified or verified in writing by ESP.

In order to verify that earthwork and foundation recommendations are properly interpreted and implemented, we recommend that ESP be provided the opportunity to review the final plans and specifications. Any concerns observed will be brought to our client's attention in writing.

FIELD EXPLORATION PROCEDURES

Soil Test Boring: Five (5) soil test borings (B-1 through B-3, B-5 and B-6) were drilled at the approximate locations shown on the attached Boring Location Plan. Soil sampling and penetration testing were performed in accordance with ASTM D 1586.

The borings were advanced with hollow-stem augers and, at standard intervals, soil samples were obtained with a standard 1.4-inch I.D., 2-inch O.D., split-tube sampler. The sampler was first seated six (6) inches to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows is designated the "Standard Penetration Resistance." When properly evaluated, the Standard Penetration Resistances provide an index to soil strength, relative density, and ability to support foundations.

Select portions of each soil sample were placed in sealed containers and taken to our office. The samples were examined by a representative of the geotechnical engineer for classification. Test Boring Records are attached showing the soil descriptions and Standard Penetration Resistances.

Auger Boring: One (1) hand auger boring (B-4) was performed at the approximate location shown on the attached Boring Location Plan, Figure 2. The boring was advanced by manually twisting an auger into the ground. The soils encountered were identified, in the field, from cuttings brought to the surface by the drilling process. Auger boring records are attached showing the soil descriptions.

Penetrometer Test: A portable Dynamic Cone Penetrometer was used to estimate the relative density of the existing soils as encountered in Boring B-4 and as outlined in the Sowers and Hedges paper "Dynamic Cone for Shallow In-Situ Penetration Testing." The cone point is first seated two (2) inches to insure that the cone is completely embedded, then the cone point is driven 1-3/4 inches using a 15-pound ring weight hammer falling 20 inches. The number of blows required to drive the cone point 1-3/4 inches is recorded. The cone point is then driven two additional 1-3/4 inch intervals and the number of blows is recorded. The penetrometer reading is defined as the number of blows required to drive the cone point 1-3/4 inches. The penetrometer reading is similar to the Standard Penetration Resistance, or "N" value, as defined in ASTM D 1586.

Shear Wave Testing: The surface wave seismic data was collected at each site across the approximate center of the site. The distance between the source location and the first geophone was 25 feet for the record selected for processing.

The shear wave testing was performed using the active Multi-channel Analysis of Surface Waves (MASW) method. Surface wave seismic data were collected using a one line (spread) consisting of 24 8-Hz vertical geophones spaced 5 feet apart for a total spread length of 115 feet. The geophones were connected by a seismic cable to a laptop-controlled seismograph (Geometrics Geode). The energy source was a 20-pound sledgehammer impacting an aluminum plate offset from one end of the spread. Multiple blows of the sledgehammer were added together (stacked) to increase the signal-to-noise ratio. Several seismic records were collected using various number of stacks and/or different offsets. The field geophysicist reviewed the data in the field for quality control. During data analysis, a seismic record with comparatively higher amplitude and wider frequency range of the surface wave energy was selected for processing.

The seismic data was analyzed using the program Surfseis, version 3.0, produced by the Kansas Geological Survey. The processing steps included assigning geometry, converting the seismic time-series data to the frequency domain, selecting the observed frequency/velocity distribution (observed dispersion curve), and performing an inversion to produce a shear wave velocity model that matched the observed dispersion curve.

The layered velocity model was utilized to calculate the "average" shear wave velocity for the upper 100 feet of the subsurface at this site, using the equation $Vs_{(100)} = 100 \text{ feet} / \sum (d_i/v_i)$, where d_i and v_i are the individual layer thicknesses and velocities for the upper 100 feet of the model.

LABORATORY PROCEDURES

Grain Size Test: Grain size tests were performed to determine the particle size and distribution of the samples tested. The grain size distribution of soils coarser than a No. 200 sieve was determined by passing the samples through a set of nested sieves. The soil particles passing the No. 200 sieve were suspended in solution and the grain size distribution determined from the rate of settlement. The results are presented on the attached Grain Size Distribution Sheets.

Soil Plasticity Tests (Atterberg Limits Test): Select samples were identified for Atterberg Limits testing to determine the soil's plasticity characteristics. The Plasticity Index (PI) is representative of this characteristic and is determined utilizing the Liquid Limit (LL) and the Plastic Limit (PL). The Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid and is determined in accordance with ASTM D 4318. The Plastic Limit is the moisture content at which the soil transitions between the plastic and semi-solid states and is determined in accordance with ASTM D 4318. The data obtained is presented on the attached Summary of Laboratory Test Data sheet.

Standard Proctor Compaction Test: Select samples of the on-site were obtained from auger cuttings to determine their suitability as fill material. Standard Proctor Compaction Tests (ASTM D 698) were performed on these soils to determine their compaction characteristics including maximum dry density and optimum moisture content. The test results are presented on the attached Moisture-Density Relationship Sheets included in the Appendix.

Organic Content of Soils: A select sample was identified for Organic Content of Soils testing to determine the percent of organic matter in the soil. The testing was performed in general accordance with ASTM D 2974.

REPORT OF
SUBSURFACE EXPLORATION
OCRACOKE AND HATTERAS
NCDOT PASSENGERTERMINALS
AND PARKING LOTS
ESP PROJECT NO. E4A-FN65.300

Prepared For:

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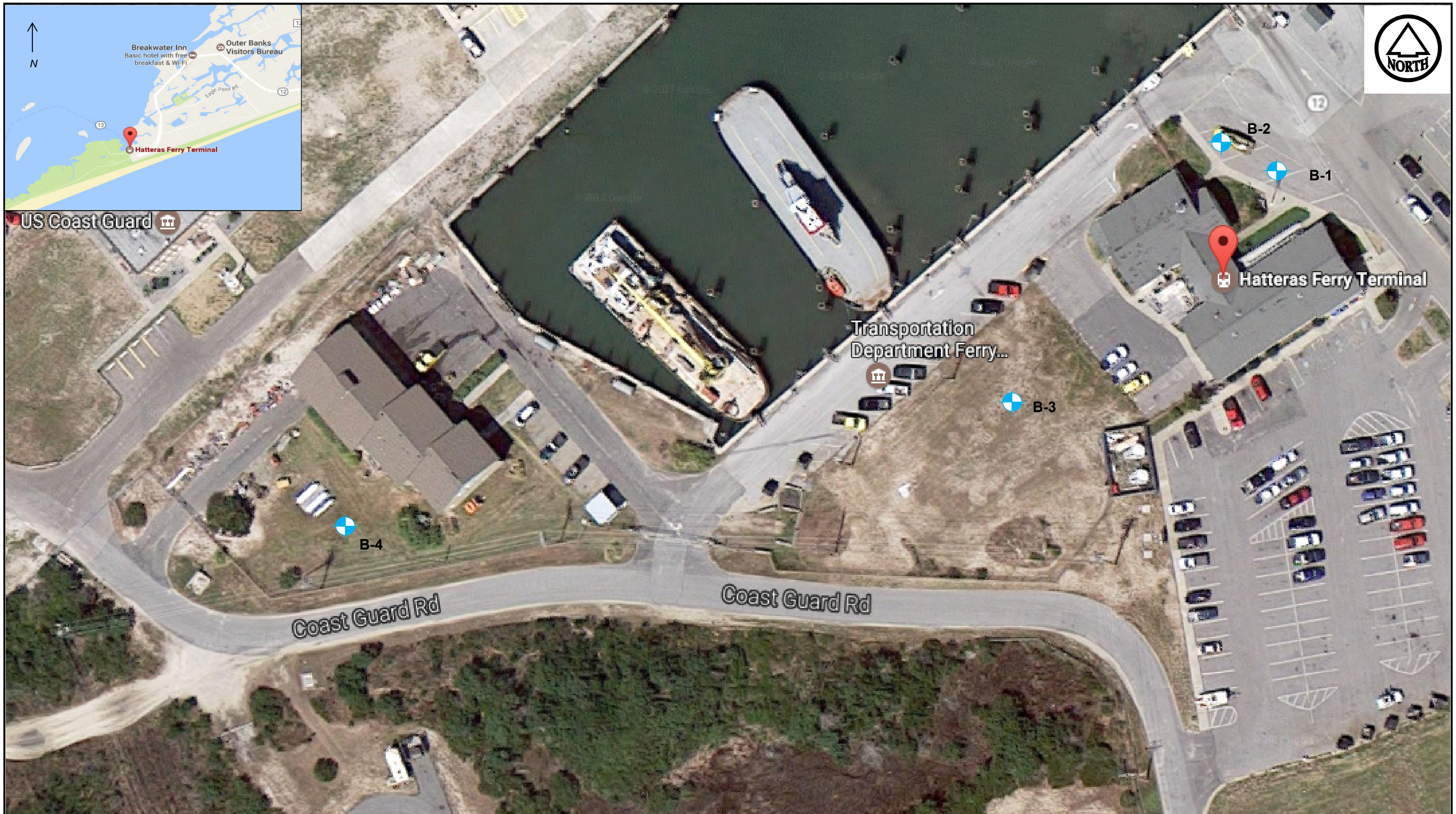
April 13, 2017



LEGEND

APPROXIMATE PREVIOUS BORING LOCATION

APPROXIMATE ADDITIONAL BORING LOCATION

THIS DRAWING IS INTENDED TO SHOW APPROXIMATE TEST LOCATIONS ONLY. NO OTHER INFORMATION IS EXPRESSED OR IMPLIED

PROJECT NO:	FN65.300
SCALE:	NTS
DRAWN BY:	BRL
CHECKED BY:	RWE
DATE:	4/12/2017
FIGURE 1	

SHEET TITLE:

HATTERAS BORING LOCATION PLAN

PROJECT:

NCDOT PASSENGER FERRY TERMINALS AND PARKING LOTS

HATTERAS, NORTH CAROLINA

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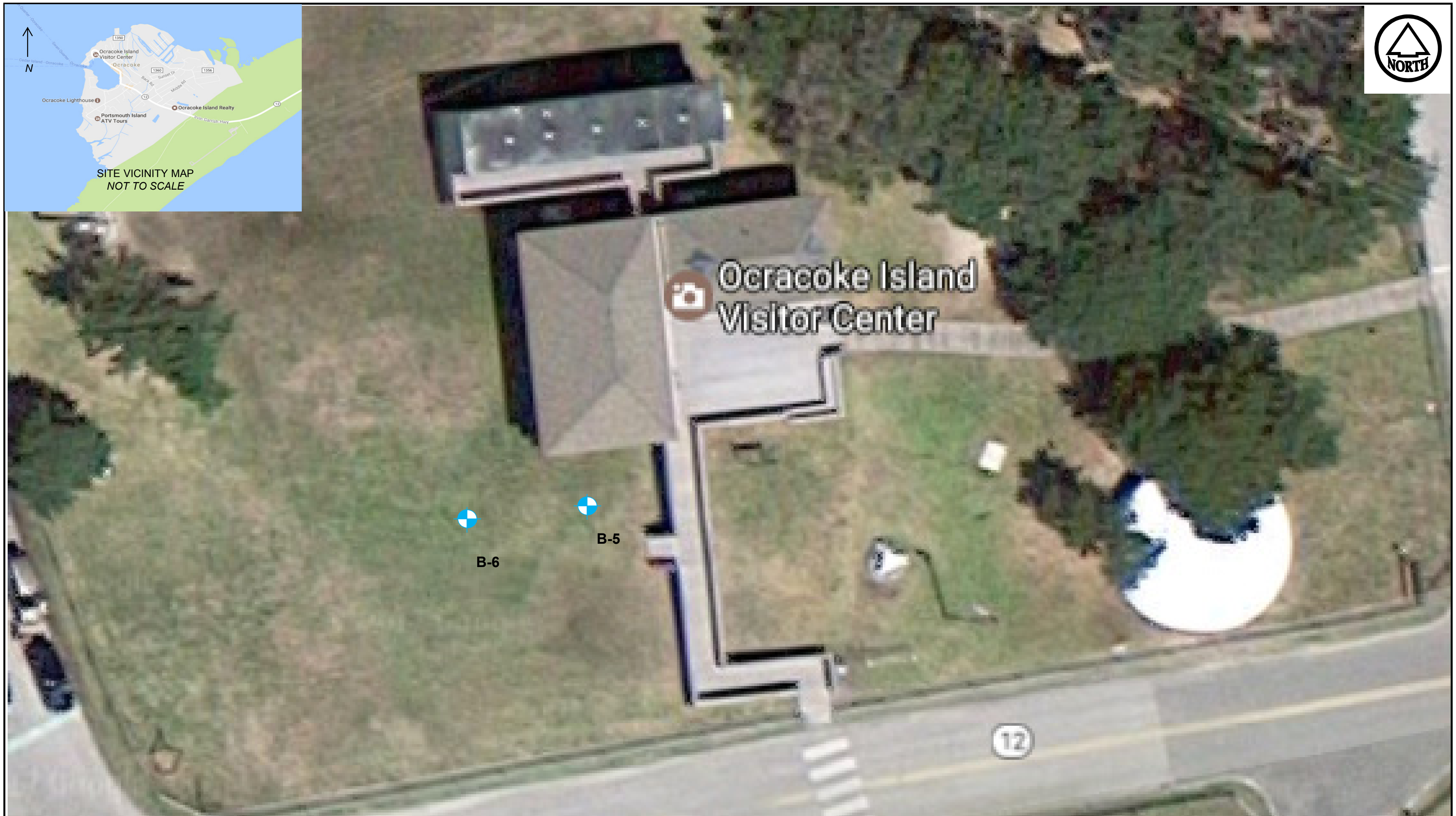
919-678-1070
www.espassociates.com



LEGEND

APPROXIMATE PREVIOUS BORING LOCATION

APPROXIMATE ADDITIONAL BORING LOCATION

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PROJECT NO:	FN65.300
SCALE:	NTS
DRAWN BY:	BRL
CHECKED BY:	RWE
DATE:	4/12/2017

FIGURE 2

SHEET TITLE:

OCRACOKE BORING LOCATION PLAN

PROJECT:

NCDOT PASSENGER FERRY TERMINALS AND PARKING LOTS

OCRACOKE, NORTH CAROLINA

ESP Associates, P.A.

ESP Associates. P.A.
P.O. Box 7030
Charlotte, NC 28241
5121 Kingdom Way Suite 208
Raleigh, NC 27607
919-678-1070
www.espassociates.com

PROJECT REFERENCE NO.	SHEET NO.
SF-830213	2

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

SUBSURFACE INVESTIGATION

SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS
(PAGE 1 OF 2)

SOIL DESCRIPTION

SOIL IS CONSIDERED UNCONSOLIDATED, SEMI-CONSOLIDATED, OR WEATHERED EARTH MATERIALS THAT CAN BE PENETRATED WITH A CONTINUOUS FLIGHT POWER AUGER AND YIELD LESS THAN 100 BLOWS PER FOOT ACCORDING TO THE STANDARD PENETRATION TEST (AASHTO T 206, ASTM D1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY INCLUDE THE FOLLOWING: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. FOR EXAMPLE,

VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6

SOIL LEGEND AND AASHTO CLASSIFICATION

GENERAL CLASS.	GRANULAR MATERIALS (≤ 35% PASSING #200)							SILT-CLAY MATERIALS (> 35% PASSING #200)				ORGANIC MATERIALS		
GROUP CLASS.	A-1		A-3	A-2				A-4	A-5	A-6	A-7	A-1, A-2 A-3	A-4, A-5 A-6, A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5, A-7-6			
SYMBOL														
% PASSING #10	50 MX											GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
#40	30 MX	50 MX	51 MN											
#200	15 MX	25 MX	10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN			
MATERIAL PASSING #40 LL	—		—	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
PI	6 MX		NP	10 MX	10 MX	11 MN	11 MN	10 MX	10 MX	11 MN	11 MN			
GROUP INDEX	0		0	0		4 MX		8 MX	12 MX	16 MX	NO MX			
USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL, AND SAND		FINE SAND	SILTY OR CLAYEY GRAVEL AND SAND				SILTY SOILS		CLAYEY SOILS				
GEN. RATING AS SUBGRADE	EXCELLENT TO GOOD							FAIR TO POOR				FAIR TO POOR	POOR	UNSUITABLE

PI OF A-7-5 SUBGROUP IS ≤ LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30

CONSISTENCY OR DENSENESS

PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTENCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TONS/FT^2)
GENERALLY GRANULAR MATERIAL (NON-COHESIVE)	VERY LOOSE	< 4	N/A
	LOOSE	4 TO 10	
	MEDIUM DENSE	10 TO 30	
	DENSE	30 TO 50	
	VERY DENSE	> 50	
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT	< 2	< 0.25
	SOFT	2 TO 4	0.25 TO 0.5
	MEDIUM STIFF	4 TO 8	0.5 TO 1.0
	STIFF	8 TO 15	1 TO 2
	VERY STIFF	15 TO 30	2 TO 4
	HARD	> 30	> 4

TEXTURE OR GRAIN SIZE

U.S. STD. SIEVE SIZE	4	10	40	60	200	270
OPENING (MM)	4.76	2.00	0.42	0.25	0.075	0.053

BOULDER (BLDR.)	COBBLE (COB.)	GRAVEL (GR.)	COARSE SAND (CSE. SD.)	FINE SAND (F SD.)	SILT (SL.)	CLAY (CL.)

GRAIN SIZE							
MM	305	75	2.0	0.25	0.05	0.005
IN.	12	3				

SOIL MOISTURE - CORRELATION OF TERMS

SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION
	- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE
LL — LIQUID LIMIT; PLASTIC RANGE (PI); PL — PLASTIC LIMIT	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE
OM — OPTIMUM MOISTURE; SL — SHRINKAGE LIMIT	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

PLASTICITY

	PLASTICITY INDEX (PI)	DRY STRENGTH
NON PLASTIC	0-5	VERY LOW
SLIGHTLY PLASTIC	6-15	SLIGHT
MODERATELY PLASTIC	16-25	MEDIUM
HIGHLY PLASTIC	26 OR MORE	HIGH

COLOR

DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YELLOW-BROWN, BLUE-GRAY). MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.

GRADATION

WELL GRADED - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE.
UNIFORMLY GRADED - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE.
GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLE SIZES OF TWO OR MORE SIZES.

ANGULARITY OF GRAINS

THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS: ANGULAR, SUBANGULAR, SUBROUNDED, OR ROUNDED.

MINERALOGICAL COMPOSITION

MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHEN THEY ARE CONSIDERED OF SIGNIFICANCE.

COMPRESSIBILITY

SLIGHTLY COMPRESSIBLE	LL < 31
MODERATELY COMPRESSIBLE	LL = 31 - 50
HIGHLY COMPRESSIBLE	LL > 50

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS	OTHER MATERIAL	
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE	1 - 10%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%	LITTLE	10 - 20%
MODERATELY ORGANIC	5 - 10%	12 - 20%	SOME	20 - 35%
HIGHLY ORGANIC	> 10%	> 20%	HIGHLY	35% AND ABOVE

GROUND WATER

- WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING
- STATIC WATER LEVEL AFTER 24 HOURS
- PW — PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA
- SPRING OR SEEP

MISCELLANEOUS SYMBOLS

- ROADWAY EMBANKMENT (RE) WITH SOIL DESCRIPTION
- SOIL SYMBOL
- ARTIFICIAL FILL (AF) OTHER THAN ROADWAY EMBANKMENT
- INFERRED SOIL BOUNDARY
- INFERRED ROCK LINE
- ALLUVIAL SOIL BOUNDARY
- 25/025 DIP & DIP DIRECTION OF ROCK STRUCTURES
- SPT DPT DMT VST PMT TEST BORING
- AUGER BORING
- CORE BORING
- MW MONITORING WELL
- PIEZOMETER INSTALLATION
- SLOPE INDICATOR INSTALLATION
- CONE PENETROMETER TEST
- SOUNDING ROD
- TEST BORING WITH CORE
- SPT N-VALUE

RECOMMENDATION SYMBOLS

- UNDERCUT
- SHALLOW UNDERCUT
- UNCLASSIFIED EXCAVATION - UNSUITABLE WASTE
- UNCLASSIFIED EXCAVATION - ACCEPTABLE DEGRADABLE ROCK
- UNCLASSIFIED EXCAVATION - ACCEPTABLE, BUT NOT TO BE USED IN THE TOP 3 FEET OF EMBANKMENT OR BACKFILL

ABBREVIATIONS

AR - AUGER REFUSAL
BT - BORING TERMINATED
CL. - CLAY
CPT - CONE PENETRATION TEST
CSE. - COARSE
DMT - DILATOMETER TEST
DPT - DYNAMIC PENETRATION TEST
e - VOID RATIO
F - FINE
FOSS. - FOSSILIFEROUS
FRAC. - FRACTURED, FRACTURES
FRAGS. - FRAGMENTS
HI. - HIGHLY
MED. - MEDIUM
MICA. - MICACEOUS
MOD. - MODERATELY
NP - NON PLASTIC
ORG. - ORGANIC
PMT - PRESSUREMETER TEST
SAP. - SAPROLITIC
SD. - SAND, SANDY
SL. - SILT, SILTY
SLI. - SLIGHTLY
TCR - TRICONE REFUSAL
w - MOISTURE CONTENT
V - VERY
VST - VANE SHEAR TEST
WEA. - WEATHERED
γ - UNIT WEIGHT
γ_d - DRY UNIT WEIGHT

SAMPLE ABBREVIATIONS

S - BULK
SS - SPLIT SPOON
ST - SHELBY TUBE
RS - ROCK
RT - RECOMPACTED TRIAXIAL
CBR - CALIFORNIA BEARING RATIO

EQUIPMENT USED ON SUBJECT PROJECT

DRILL UNITS:
- [ ] CME-45C
- [ ] CME-55
- [X] CME-550
- [ ] VANE SHEAR TEST
- [ ] PORTABLE HOIST
- [ ] ______
- [ ] ______

ADVANCING TOOLS:
- [ ] CLAY BITS
- [ ] 6" CONTINUOUS FLIGHT AUGER
- [X] 8" HOLLOW AUGERS
- [ ] HARD FACED FINGER BITS
- [ ] TUNG.-CARBIDE INSERTS
- [X] CASING [X] W/ ADVANCER
- [ ] TRICONE ______" STEEL TEETH
- [ ] TRICONE ______" TUNG.-CARB.
- [ ] CORE BIT
- [ ] ______

HAMMER TYPE:
- [X] AUTOMATIC
- [ ] MANUAL

CORE SIZE:
- [ ] -B ______
- [ ] -H ______
- [ ] -N ______

HAND TOOLS:
- [ ] POST HOLE DIGGER
- [ ] HAND AUGER
- [ ] SOUNDING ROD
- [ ] VANE SHEAR TEST
- [ ] ______

PROJECT REFERENCE NO.	SHEET NO.
SF-830213	2A

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

SUBSURFACE INVESTIGATION

SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS
(PAGE 2 OF 2)

ROCK DESCRIPTION

HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT REFUSAL IF TESTED. AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS IN NON-COASTAL PLAIN MATERIAL. THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK.
ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:

WEATHERED ROCK (WR)	NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.
CRYSTALLINE ROCK (CR)	FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.
NON-CRYSTALLINE ROCK (NCR)	FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YEILD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.
COASTAL PLAIN SEDIMENTARY ROCK (CP)	COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.

WEATHERING

FRESH	ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.
VERY SLIGHT (V SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN, CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY. ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.
SLIGHT (SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH. OPEN JOINTS MAY CONTAIN CLAY. IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED. CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.
MODERATE (MOD.)	SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS. IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.
MODERATELY SEVERE (MOD. SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION. ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK. ROCK GIVES "CLUNK" SOUND WHEN STRUCK. *IF TESTED, WOULD YIELD SPT REFUSAL*
SEVERE (SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL. IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT. SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. *IF TESTED, WOULD YIELD SPT N VALUES > 100 BPF*
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE THAT ONLY MINOR VESTIGES OF ORIGINAL ROCK FABRIC REMAIN. *IF TESTED, WOULD YIELD SPT N VALUES < 100 BPF*
COMPLETE	ROCK REDUCED TO SOIL. ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS. QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS. SAPROLITE IS ALSO AN EXAMPLE.

ROCK HARDNESS

VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.
HARD	CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.
MODERATELY HARD	CAN BE SCRATCHED BY KNIFE OR PICK. GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGIST'S PICK. HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.
MEDIUM HARD	CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT. CAN BE EXCAVATED IN SMALL CHIPS TO PEICES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.
SOFT	CAN BE GROVED OR GOUGED READILY BY KNIFE OR PICK. CAN BE EXCAVATED IN FRAGMENTS FROM CHIPS TO SEVERAL INCHES IN SIZE BY MODERATE BLOWS OF A PICK POINT. SMALL, THIN PIECES CAN BE BROKEN BY FINGER PRESSURE.
VERY SOFT	CAN BE CARVED WITH KNIFE. CAN BE EXCAVATED READILY WITH POINT OF PICK. PIECES 1 INCH OR MORE IN THICKNESS CAN BE BROKEN BY FINGER PRESSURE. CAN BE SCRATCHED READILY BY FINGERNAIL.

FRACTURE SPACING

TERM	SPACING
VERY WIDE	MORE THAN 10 FEET
WIDE	3 TO 10 FEET
MODERATELY CLOSE	1 TO 3 FEET
CLOSE	0.16 TO 1 FOOT
VERY CLOSE	LESS THAN 0.16 FEET

BEDDING

TERM	THICKNESS
VERY THICKLY BEDDED	4 FEET
THICKLY BEDDED	1.5 - 4 FEET
THINLY BEDDED	0.16 - 1.5 FEET
VERY THINLY BEDDED	0.03 - 0.16 FEET
THICKLY LAMINATED	0.008 - 0.03 FEET
THINLY LAMINATED	< 0.008 FEET

INDURATION

FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.

FRIABLE	RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.
MODERATELY INDURATED	GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.
INDURATED	GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.
EXTREMELY INDURATED	SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.

TERMS AND DEFINITIONS

ALLUVIUM (ALLUV.) - SOILS THAT HAVE BEEN TRANSPORTED BY WATER.

AQUIFER - A WATER BEARING FORMATION OR STRATA.

ARENACEOUS - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND.

ARGILLACEOUS - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, SUCH AS SHALE, SLATE, ETC.

ARTESIAN - GROUND WATER THAT IS UNDER SUFFICIENT PRESSURE TO RISE ABOVE THE LEVEL AT WHICH IT IS ENCOUNTERED, BUT WHICH DOES NOT NECESSARILY RISE TO OR ABOVE THE GROUND SURFACE.

CALCAREOUS (CALC.) - SOILS THAT CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE.

COLLUVIUM - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE.

CORE RECOVERY (REC.) - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

DIKE - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK.

DIP - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL.

DIP DIRECTION (DIP AZIMUTH) - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH.

FAULT - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE.

FISSILE - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES.

FLOAT - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL.

FLOOD PLAIN (FP) - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM.

FORMATION (FM.) - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD.

JOINT - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED.

LEDGE - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT.

LENS - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS.

MOTTLED (MOT.) - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS. MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE.

PERCHED WATER - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM.

RESIDUAL (RES.) SOIL - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK.

ROCK QUALITY DESIGNATION (RQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

SAPROLITE (SAP.) - RESIDUAL SOIL THAT RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK.

SILL - AN INTRUSIVE BODY OF IGNEOUS ROCK OF APPROXIMATELY UNIFORM THICKNESS AND RELATIVELY THIN COMPARED WITH ITS LATERAL EXTENT, THAT HAS BEEN EMPLACED PARALLEL TO THE BEDDING OR SCHISTOSITY OF THE INTRUDED ROCKS.

SLICKENSIDE - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE.

STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT) - NUMBER OF BLOWS (N OR BPF) OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO PRODUCE A PENETRATION OF 1 FOOT INTO SOIL WITH A 2 INCH OUTSIDE DIAMETER SPLIT SPOON SAMPLER. SPT REFUSAL IS PENETRATION EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS.

STRATA CORE RECOVERY (SREC.) - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE.

STRATA ROCK QUALITY DESIGNATION (SRQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS WITHIN A STRATUM EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF STRATA AND EXPRESSED AS A PERCENTAGE.

TOPSOIL (TS.) - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.

BENCH MARK: BM #2: RR SPIKE IN BASE OF 30" OAK; N 573243, E 1655489; -BL- STATION 12+06.00 111' LEFT

ELEVATION: 423.99 FEET

NOTES:

F.I.A.D= FILLED IMMEDIATELY AFTER DRILLING

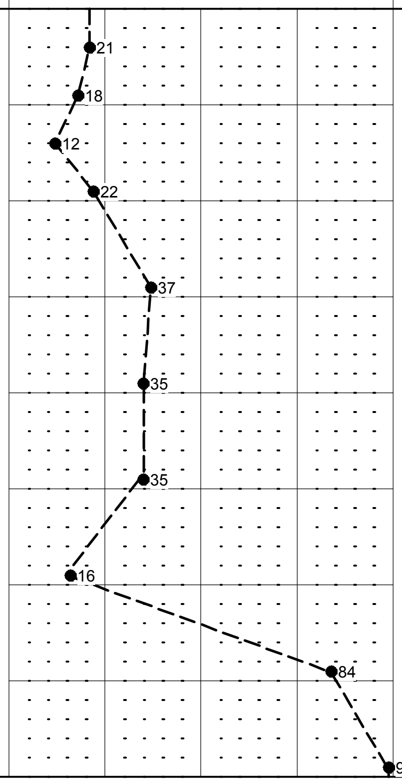
DATE: 8-15-14

SHEET 1

GEOTECHNICAL BORING REPORT
BORE LOG

WBS N/A	**TIP** N/A	**COUNTY** DARE	**GEOLOGIST** Pastrana, C.R.
SITE DESCRIPTION Design Development for NCDOT Hatteras Island Passenger Terminal			**GROUND WTR (ft)**
BORING NO. B-1	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A — **0 HR.** 3.1
COLLAR ELEV. 0.0 ft	**TOTAL DEPTH** 40.0 ft	**NORTHING** 546,883	**EASTING** 2,984,777 — **24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE BRI0674 CME-45C 89% 05/04/2016		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic
DRILLER Eister, G.	**START DATE** 03/14/17	**COMP. DATE** 03/14/17	**SURFACE WATER DEPTH** N/A

DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT	SAMP. NO.	MOI
-1.0	1.0	4	10	11	21		
-3.5	3.5	5	9	9	18		Sat.
-6.0	6.0	6	6	6	12		Sat.
-8.5	8.5	6	11	11	22		Sat.
-13.5	13.5	11	17	20	37		Sat.
-18.5	18.5	16	17	18	35	SS-1	Sat.
-23.5	23.5	10	16	19	35		Sat.
-28.5	28.5	8	8	8	16	SS-2	Sat.
-33.5	33.5	13	27	57	84		Sat.
-38.5	38.5	30	48	51	99		Sat.



SOIL AND ROCK DESCRIPTION

ELEV. (ft)	Description	DEPTH (ft)
0.0	GROUND SURFACE	0.0
-0.5	0.2' of Asphalt over 0.3' of ABC Stone	0.5
	UNDIVIDED COASTAL PLAIN Moist to Saturated, Tan Brown to Gray, Medium Dense, Coarse to Fine Sand (A-3 , SP), Trace Silt	
-21.5	Gray to Dark Gray, Medium Dense to Very Dense, Silty Fine to Coarse SAND (A-2-4, SM) with Shell Fragments	21.5
-40.0		40.0

Boring Terminated at Elevation -40.0 ft In Undivided Coastal Plain: Silty SAND (A-2-4, SM)

Note: Boring elevations and locations were not surveyed. A value of 0' for elevations was used for all borings. The Northings and Eastings are approximate.

GEOTECHNICAL BORING REPORT
BORE LOG

WBS N/A	**TIP** N/A	**COUNTY** DARE	**GEOLOGIST** Pastrana, C.R.
SITE DESCRIPTION Design Development for NCDOT Hatteras Island Passenger Terminal			**GROUND WTR (ft)**
BORING NO. B-2	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A — **0 HR.** N/A
COLLAR ELEV. 0.0 ft	**TOTAL DEPTH** 25.0 ft	**NORTHING** 546,905	**EASTING** 2,984,762 — **24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE BRI0674 CME-45C 89% 05/04/2016	**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic	
DRILLER Eister, G.	**START DATE** 03/14/17	**COMP. DATE** 03/14/17	**SURFACE WATER DEPTH** N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
0										0.0 GROUND SURFACE 0.0
										-0.5 0.2' of Asphalt over 0.3' of ABC Stone 0.5
	-1.0	1.0	5	9	11	20		M		**UNDIVIDED COASTAL PLAIN** Tan Brown to Gray, Medium Dense to Loose, Coarse to Fine Sand (A-3 , SP), Trace Silt
-5	-3.5	3.5	5	8	9	17		Sat.		Note: Moderate Petroleum Odor Encountered at Sample Depth 3.5'-5.0'
	-6.0	6.0	3	3	4	7		Sat.		
-10	-8.5	8.5	3	7	6	13		Sat.		
-15	-13.5	13.5	11	13	16	29		Sat.		
-20	-18.5	18.5	13	24	26	50		Sat.		
										-22.0 Gray to Dark Gray, Medium Dense to Dense, Silty Coarse to Fine SAND (A-2-4, SM) 22.0
-25	-23.5	23.5	8	9	17	26		Sat.		-25.0 25.0

Boring Terminated at Elevation -25.0 ft In Undivided Coastal Plain: Silty SAND (A-2-4, SM)

Note: Boring elevations and locations were not surveyed. A value of 0' for elevations was used for all borings. The Northings and Eastings are approximate.

GEOTECHNICAL BORING REPORT
BORE LOG

WBS N/A	**TIP** N/A	**COUNTY** DARE	**GEOLOGIST** Pastrana, C.R.

SITE DESCRIPTION Design Development for NCDOT Hatteras Island Passenger Terminal — **GROUND WTR (ft)**

BORING NO. B-3	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A	**0 HR.** N/A
COLLAR ELEV. 0.0 ft	**TOTAL DEPTH** 7.5 ft	**NORTHING** 546,754	**EASTING** 2,984,606	**24 HR.** FIAD

DRILL RIG/HAMMER EFF./DATE BRI0674 CME-45C 89% 05/04/2016 — **DRILL METHOD** Mud Rotary — **HAMMER TYPE** Automatic

DRILLER Eister, G. — **START DATE** 03/14/17 — **COMP. DATE** 03/14/17 — **SURFACE WATER DEPTH** N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT (0 25 50 75 100)	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
0										0.0 GROUND SURFACE 0.0
	-1.0	1.0	3	5	4	9		M		**ARTIFICIAL FILL** Brown, Loose, Fine SAND (A-3, SP) Trace Organics
-5	-3.5	3.5	2	2	3	5		M		-4.0 4.0 **UNDIVIDED COASTAL PLAIN** Tan Brown to Gray to Brown, Loose to Medium Dense, Coarse to Fine SAND (A-3, SP)
	-6.0	6.0	5	5	5	10	SS-3	23%		-7.5 7.5

Boring Terminated at Elevation -7.5 ft In Undivided Coastal Plain: SAND (A-3, SP)

Note: Boring offset 5' from proposed location in proposed parking area, a preexsisting leech field is approx. 3.0' to 4.0' below grade. According to USCG, the center pipe in the field, running parallel to the docks, has gravel packed around it that could extend 1.5' to 3.0 ' on each side.

Note: Boring elevations and locations were not surveyed. A value of 0' for elevations was used for all borings. The Northings and Eastings are approximate.

GEOTECHNICAL BORING REPORT
BORE LOG

WBS N/A	**TIP** N/A	**COUNTY** DARE	**GEOLOGIST** Pastrana, C.R.
SITE DESCRIPTION Design Development for NCDOT Hatteras Island Passenger Terminal			**GROUND WTR (ft)**
BORING NO. B-4	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A
COLLAR ELEV. 0.0 ft	**TOTAL DEPTH** 5.4 ft	**NORTHING** 546,654	**EASTING** 2,984,196
DRILL RIG/HAMMER EFF./DATE BRI0674 CME-45C 89% 05/04/2016	**DRILL METHOD** Hand Auger	**HAMMER TYPE** N/A	
DRILLER N/A	**START DATE** 03/14/17	**COMP. DATE** 03/14/17	**SURFACE WATER DEPTH** N/A

0 HR. 2.6
24 HR. FIAD

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT (0 25 50 75 100)	SAMP. NO.	MOI	LOG
0									
	-0.5	0.5	N/A	2	3	5	S-1	▽	
	-1.0	1.0	N/A	3	4	7			
	-2.0	2.0	N/A	3	3	6			
	-3.0	3.0	N/A	2	3	5			
	-4.0	4.0	N/A	2	2	4		Sat.	
-5	-5.0	5.0	N/A	4	4	8			

SOIL AND ROCK DESCRIPTION

ELEV. (ft)	Description	DEPTH (ft)
0.0	GROUND SURFACE	0.0
	UNDIVIDED COASTAL PLAIN 0.3' of Sandy Topsoil over Moist to Saturated, Tan Brown, Loose to Medium Dense, Coarse to Fine SAND (A-3, SP), Trace Organics (Roots)	
-2.8	Gray, Medium Dense, Silty Coarse to Fine SAND (A-2-4, SM)	2.8
-3.9	Black, Loose to Medium Dense, Clayey Silty Fine Sand (A-2-5, SC - SM), Highly Organic	3.9
-5.4	Boring Terminated at Elevation -5.4 ft In Undivided Coastal Plain: Silty SAND (A-2-5, SC-SM)	5.4

Note: SPT N values represent the equivalent SPT value per foot for DCP tests done over 1.75 inch increments.

Note: After hand augering past the 4.0' DCP test, continuous cave-in occured to approx. 3.5'. The DCP values for the 5.0' sample may not reflect the actual soil strength.

Note: Boring elevations and locations were not surveyed. A value of 0' for elevations was used for all borings. The Northings and Eastings are approximate.

GEOTECHNICAL BORING REPORT
BORE LOG

WBS N/A	**TIP** N/A	**COUNTY** HYDE	**GEOLOGIST** Pastrana, C.R.
SITE DESCRIPTION Design Development for NCDOT Ocracoke Island Passenger Terminal			**GROUND WTR (ft)**
BORING NO. B-5	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A — **0 HR.** 1.8
COLLAR ELEV. 0.0 ft	**TOTAL DEPTH** 40.0 ft	**NORTHING** 510,898	**EASTING** 2,901,077 — **24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE BRI0674 CME-45C 89% 05/04/2016		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic
DRILLER Eister, G.	**START DATE** 03/16/17	**COMP. DATE** 03/16/17	**SURFACE WATER DEPTH** N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
0										0.0 GROUND SURFACE 0.0
	-1.0	1.0	4	8	9	17		▽		**UNDIVIDED COASTAL PLAIN** Moist to Saturated, Brown to Brownish Gray, Medium Dense to Loose, Fine to Coarse SAND (A-3, SP), Little Crushed Shell Fragments, Trace Silt, and Trace Organics
-5	-3.5	3.5	2	2	3	5				-5.4 ... 5.4
	-6.0	6.0	2	6	6	12		Sat.		Brownish Gray to Gray, Loose to Very Dense, Silty Coarse to Fine SAND (A-2-4, A-2-5, SP-SM) with Shell Fragments and Trace Clay
-10	-8.5	8.5	2	7	10	17		Sat.		
-15	-13.5	13.5	8	11	11	22		Sat.		
-20	-18.5	18.5	9	11	13	24		Sat.		
-25	-23.5	23.5	4	5	4	9		Sat.		
-30	-28.5	28.5	9	9	9	18		Sat.		
-35	-33.5	33.5	8	12	16	28		Sat.		
-40	-38.5	38.5	19	26	35	61		Sat.		-40.0 40.0

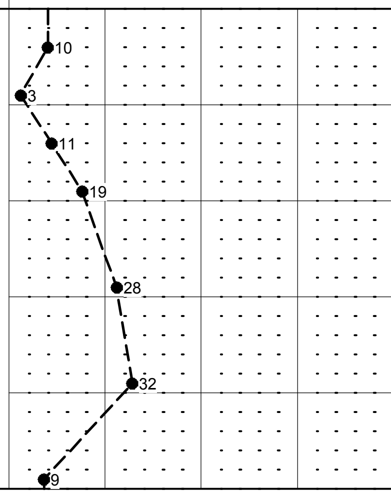
Boring Terminated at Elevation -40.0 ft In Undivided Coastal Plain: Silty SAND (A-2-4, SP-SM)

Note: Boring elevations and locations were not surveyed. A value of 0' for elevations was used for all borings. The Northings and Eastings are approximate.

GEOTECHNICAL BORING REPORT
BORE LOG

WBS N/A	**TIP** N/A	**COUNTY** HYDE	**GEOLOGIST** Pastrana, C.R.
SITE DESCRIPTION Design Development for NCDOT Ocracoke Island Passenger Terminal			**GROUND WTR (ft)**
BORING NO. B-6	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A — **0 HR.** 2.1
COLLAR ELEV. 0.0 ft	**TOTAL DEPTH** 25.0 ft	**NORTHING** 510,894	**EASTING** 2,901,053 — **24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE BRI0674 CME-45C 89% 05/04/2016	**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic	
DRILLER Eister, G.	**START DATE** 03/16/17	**COMP. DATE** 03/16/17	**SURFACE WATER DEPTH** N/A

DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT	SAMP. NO.	MOI
-1.0	1.0	2	6	4	10	S-2	∇
-3.5	3.5	1	2	1	3	SS-4	Sat.
-6.0	6.0	3	5	6	11		Sat.
-8.5	8.5	6	10	9	19		Sat.
-13.5	13.5	10	11	17	28		Sat.
-18.5	18.5	12	15	17	32		Sat.
-23.5	23.5	5	5	4	9		Sat.



SOIL AND ROCK DESCRIPTION

ELEV. (ft)	Description	DEPTH (ft)
0.0	GROUND SURFACE	0.0
	UNDIVIDED COASTAL PLAIN Moist to Saturated, Brownish Gray, Medium Dense to Very Loose, Fine to Coarse SAND (A-3, SP), Trace Clay, Trace Silt, and Trace Organics	
-5.5		5.5
	Brownish Gray to Gray, Loose to Medium Dense, Silty Coarse to Fine SAND (A-2-4, SP-SM) with Shell Fragments	
-25.0		25.0

Boring Terminated at Elevation -25.0 ft In Undivided Coastal Plain: Silty SAND (A-2-4, SP-SM)

Note: Boring elevations and locations were not surveyed. A value of 0' for elevations was used for all borings. The Northings and Eastings are approximate.

NCDOT GEOTECHNICAL ENGINEERING UNIT
FIELD BORELOG (ENGLISH)

PROJECT NUMBER —	ID —	CO Dare	GEO Pastrana, C.R.	GROUND WATER: 0 HOUR / 24 HOUR
PROJ DESC Design Development for NCDOT Hatteras Island Passenger Terminal				Depth to WATER: 3.1 / T-IAD
BORING NUMBER B-1	STA N/A	OFFSET N/A FT N/A	ALIGNMENT N/A	Depth to BTTM: 3.7 / IAD
ELEVATION — FT	TOTAL DEPTH 40.0' FT	NORTH 546883	EAST 2984777	DATE mm/dd: 3-14-17 / 3-14-2017
DRILL MACHINE CME 45 TRAILER	DRILL EQMT NUMBER 190674	DRILL METHOD ~~HSA~~ MUD ROTARY		HAMMER TYPE Automatic
START DATE 3-14-2017	COMP DATE 3-14-2017	SURFACE WTR DEPTH N/A FT	DEPTH TO ROCK N/A FT	DRILLER G. LEISTER

STRATUM FROM	STRATUM TO	SAMPLE NUMBER	SAMPLE FROM	SAMPLE TO	DRIVE/SPT FROM	DRIVE/SPT TO	0.5 ft	0.5 ft	0.5 ft	MOI	ORIGIN	SOIL & ROCK DESCRIPTION SOIL or ROCK NAME (w/ color, density/consistency, texture, plasticity, organics, other)
0.0		SS-1			1.0	2.5	4	10	11	M	CP ~~[illegible]~~	TAN BROWN, MED. DENSE, CSE TO FINE SAND. (A-3, SP)
		SS-2			3.5	5.0	5	9	9	SAT	CP ~~[illegible]~~	SAME, TAN TO GRAY
		SS-3			6.0	7.5	6	6	6	SAT	CP	GRAY, MED DENSE, CSE TO F. SAND (A-3, SP)
		SS-4			8.5	10.0	6	11	11	SAT	CP	GRAY, MED DENSE, FINE SAND (A-3, SP~~SM~~) TRACE SILT ~~Change at 12.5'~~
	12.5											
12.5		SS-5			13.5	15.0	11	17	20	SAT	CP	GRAY, DENSE ~~SILTY, FINE SAND (A-2-4, SM)~~ CSE - F SAND (A-3)
		SS-6			18.5	20.0	16	17	18	SAT	CP	GRAY SAME
												CHANGE @ 21.5'
		SS-7			23.5	25.0	10	16	19	SAT	CP	GRAY, DENSE, SILTY, F. TO CSE SAND (A-2-4, SM)
		SS-8			28.5	30.0	8	8	8	SAT	CP	DARK GRAY, MED DENSE, SILTY F. SAND (A-2-4, SM) SIGNIFICANTLY MORE SILT THAN PREVIOUS SAMPLES
		SS-9			33.5	35.0	13	27	37	SAT	CP	DARK GRAY, V DENSE, SILTY, F. TO CSE SAND (A-2-4, SM) (WITH SHELL FRAGMENTS)
		SS-10			38.5	40.0	30	48	51	SAT	CP	SAME, NO SHELL FRAGMENTS
												*@ 2" ASPHALT OVER 3' ABC STONE
											*	BORING LOCATIONS + ELEVATIONS WERE NOT SURVEYED N+E ARE APPROXIMATE

REDLINED BY (sign): DATE

Boring terminated at 40.0 ft (IN)/ON SILTY SAND

Form GEU-003e Revised 2/6/2007

2 15/16 BIT / 0.2' ASPHALT
0.3' GRAVEL BASE

NCDOT GEOTECHNICAL ENGINEERING UNIT
FIELD BORELOG (ENGLISH)

PROJECT NUMBER —	ID —	CO Dare	GEO Pastrana, C.R.
PROJ DESC Design Development for NCDOT Hatteras Island Passenger Terminal			
BORING NUMBER B-2	STA N/A	OFFSET N/A FT N/A	ALIGNMENT N/A
ELEVATION — FT	TOTAL DEPTH 25.0 FT	NORTH 546905	EAST 2984762
DRILL MACHINE CME 45	DRILL EQMT NUMBER 190674	DRILL METHOD ~~HSA~~ MUD ROTARY	
START DATE 3-14-17	COMP DATE 3-14-17	SURFACE WTR DEPTH N/A FT	DEPTH TO ROCK N/A FT

GROUND WATER	0 HOUR	24 HOUR
Depth to WATER	N/A	FIAD
Depth to BTTM	N/A	FIAD
DATE mm/dd	3-14-17	3-14-17
HAMMER TYPE	Automatic	
DRILLER	G. EISTER	

STRATUM FROM	STRATUM TO	SAMPLE NUMBER	SAMPLE FROM	SAMPLE TO	DRIVE/SPT FROM	DRIVE/SPT TO	0.5 ft	0.5 ft	0.5 ft	MOI	ORIGIN	SOIL & ROCK DESCRIPTION (SOIL or ROCK NAME (w/ color, density/consistency, texture, plasticity, organics, other))
0.0		SS-11			1.0	2.5	5	9	11	M	CP	TAN BROWN, MED. DENSE, CSE TO F SAND (A-3, SP)
		SS-12			3.5	5.0	5	8	9	SAT	CP	GRAY, MED. DENSE, CSE TO F SAND (A-3, SP) TRACE SILT * Moderate PETROLEUM ODOR
		SS-13			6.0	7.5	3	3	4	SAT	CP	SAME, LOOSE * NO PETROLEUM ODOR
		SS-14			8.5	10.0	3	7	6	SAT	CP	GRAY, MED. DENSE, F. SAND (A-3, SP)
	12.5											~~Change at 13.5~~
12.5		SS-15			13.5	15.0	11	13	16	SAT	CP	GRAY, MED. DENSE ~~SILTY~~ CSE-F. SAND ~~(A-2-4, SM)~~ (A-3, SP)
		SS-16			18.5	20.0	13	24	26	SAT	CP	SAME, DENSE CHANGE @ 22.0'
		SS-17			23.5	25.0	8	9	17	SAT	CP	GRAY, MED. DENSE, SILTY COARSE TO F. SAND (A-2-4, SM)
											*	0.2' ASPHALT OVER 0.3' ABC STONE
											*	BORING ELEVATION + LOCATION WERE NOT SURVEYED N+E ARE APPROXIMATE

REDLINED BY (sign): DATE

Boring terminated at 25.0 ft (IN) / ON CP: SILTY SAND

NCDOT GEOTECHNICAL ENGINEERING UNIT
FIELD BORELOG (ENGLISH)

PROJECT NUMBER	—	ID	—	CO	Dare	GEO	Pastrana, C.R.
PROJ DESC	Design Development for NCDOT Hatteras Island Passenger Terminal						
BORING NUMBER	B-3	STA	N/A	OFFSET	N/A FT N/A	ALIGN-MENT	N/A
ELEVATION	— FT	TOTAL DEPTH	FT	NORTH	546754	EAST	2984606
DRILL MACHINE	CME 45	DRILL EQMT NUMBER	190674	DRILL METHOD	~~HSA~~ MUD ROTARY		
START DATE	3/14/2017	COMP DATE	3/14/2017	SURFACE WTR DEPTH	N/A FT	DEPTH TO ROCK	N/A FT

GROUND WATER	0 HOUR	24 HOUR
Depth to WATER	N/A	FOUND
Depth to BTTM	N/A	FOUND
DATE mm/dd	3-14-2017	3-14-2017
HAMMER TYPE	Automatic	
DRILLER	G. EISTER	

STRATUM FROM	STRATUM TO	SAMPLE NUMBER	SAMPLE FROM	SAMPLE TO	DRIVE/SPT FROM	DRIVE/SPT TO	0.5 ft	0.5 ft	0.5 ft	MOI	ORIGIN	SOIL & ROCK DESCRIPTION (SOIL or ROCK NAME (w/ color, density/consistency, texture, plasticity, organics, other))
0.0		SS-18	1.0	3.0	1.0	2.5	3	5	4	M	AF	BROWN, LOOSE, F. SAND (A-3, SP) TRACE ORGANICS
	4.0											Gravel at 4.0'
4.0		SS-19			3.5	5.0	2	2	3	M	CP	TAN BROWN, LOOSE, CSE TO F. SAND (A-3, SP)
	5.5											~~Gravel at 5.5'~~
5.5		SS-20			6.0	7.5	5	5	5	SAT	CP	GRAY TO BROWN, LOOSE TO MED. DENSE, ~~CSE TO F.T. SILTY CSE TO~~ ~~F CSE~~ ~~F~~ SAND ~~(A-2-4, SM)~~ ~~(A3, SP-SM)~~ ~~TRACE SILT~~ CSE TO F SAND (A-3, SP)
											*	BORING ELEVATION AND LOCATION WERE NOT SURVEYED N+E ARE APPROXIMATE
											*	BORING OFFSET 5' DUE HITTING OLD LEACH FIELD @ 3.0' USCG INFORMED US THAT IT IS AN OLD LEACH FIELD ≈ 3-4' BELOW GRADE ALSO, MENTIONED ONE SIDE OF LEACH FIELD IN MIDDLE HAD GRAVEL PACKED AROUND IT

REDLINED BY (sign): DATE

Boring terminated at 7.5 ft (IN) ON CP: SILTY SAND

Form GEU-003e Revised 2/6/2007

NCDOT GEOTECHNICAL ENGINEERING UNIT
FIELD BORELOG (ENGLISH)

PROJECT NUMBER	—	ID	—	CO	Dare	GEO	Pastrana, C.R.
PROJ DESC	Design Development for NCDOT Hatteras Island Passenger Terminal						
BORING NUMBER	B-4	STA	N/A	OFFSET	N/A FT N/A	ALIGNMENT	N/A
ELEVATION	— FT	TOTAL DEPTH	5.0 FT	NORTH	546654	EAST	2984196
DRILL MACHINE	N/A	DRILL EQMT NUMBER	N/A	DRILL METHOD	~~HSA~~ DCP + HAND AUGER	HAMMER TYPE	Automatic
START DATE	3-14-17	COMP DATE	3-14-17	SURFACE WTR DEPTH	N/A FT	DEPTH TO ROCK	N/A FT
DRILLER	G. EISTER						

GROUND WATER	0 HOUR	24 HOUR
Depth to WATER	2.6	FIAD
Depth to BTTM	N/A	FIAD
DATE mm/dd	3-14-17	3-14-17

STRATUM FROM	STRATUM TO	SAMPLE NUMBER	SAMPLE FROM	SAMPLE TO	FROM	TO	~~DRIVE / SPT~~ DCP ~~0.5 ft~~ 1.75"	~~0.5 ft~~ 1.75"	~~0.5 ft~~ 1.75"	MOI	ORIGIN	SOIL & ROCK DESCRIPTION (SOIL or ROCK NAME (w/ color, density/consistency, texture, plasticity, organics, other))
0.0		S-1	0.0	4.0	0.0		5	7	7	M	CP	0.3' SANDY TOPSOIL OVER
		* BULK 5 gal BUCKET										TAN BROWN, LOOSE TO MED.
					1.0		9	10	12			DENSE CSE TO F SAND (A-3, SP)
	2.8									SAT	CP	TRACE ORGANICS (ROOTS)
					2.0		7	7	8			
2.8												GRAY, MED. DENSE, SILTY CSE,
	3.9 ~~4.0~~				3.0		6	7	7			TO F SAND (A-2-4, SM)
		S-2	4.0	5.0						SAT	CP	BLACK, LOOSE TO MED DENSE,
4.0		* SAMPLE BAG			4.0		4	4	4			CLAYEY SILTY F. SAND (A-2-5, SM)
												~~HIGHLY ORGANIC~~ OL HIGHLY ORGANIC (SC-SM)
					5.0		11	12	12			* POSSIBLE (A-2-7)

DCP TEST INTERVAL IS OVER 1 3/4" INTERVALS

* AFTER 4.0' DCP'S HOLE CAVIN TO 3.5' CONTINUOUSLY

* BORING ELEVATION + LOCATION WERE NOT SURVEYED N+E ARE APPROXIMATE

REDLINED BY (sign): DATE

Boring terminated at 5.0 ft (IN) ON CP' ~~SILT~~ CLAYEY SILTY SAND

Form GEU-003e Revised 2/6/2007

NCDOT GEOTECHNICAL ENGINEERING UNIT
FIELD BORELOG (ENGLISH)

PROJECT NUMBER —	ID —	CO Hyde	GEO Pastrana, C.R.	GROUND WATER	0 HOUR	24 HOUR
PROJ DESC Design Development for NCDOT Ocracoke Island Passenger Terminal				Depth to WATER	1.8	FIAD
BORING NUMBER B-5	STA N/A	OFFSET N/A FT N/A	ALIGNMENT N/A	Depth to BTTM	2.2	FIAD
ELEVATION — FT	TOTAL DEPTH 40.0' FT	NORTH	EAST	DATE mm/dd	3-16-17	3-16-17
DRILL MACHINE CME 45 TRAILER	DRILL EQMT NUMBER 190674	DRILL METHOD ~~HSA~~ MUD ROTARY		HAMMER TYPE	Automatic	
START DATE 3-16-17	COMP DATE 3-16-17	SURFACE WTR DEPTH N/A FT	DEPTH TO ROCK N/A FT	DRILLER	G. EISTER	

STRATUM FROM	STRATUM TO	SAMPLE NUMBER	SAMPLE FROM	SAMPLE TO	DRIVE/SPT FROM	DRIVE/SPT TO	0.5 ft	0.5 ft	0.5 ft	MOI	ORIGIN	SOIL & ROCK DESCRIPTION (SOIL or ROCK NAME (w/ color, density/consistency, texture, plasticity, organics, other))
0.0	3.2	SS-21			1.0	2.5	4	8	9	M	CP/FILL	BROWN, MED. DENSE, CSE TO F SAND (A-3, SP) LITTLE ~~GRAVEL~~/SHELL FRAGS AND TRACE SILT AND TRACE ORGANICS. NOTE POSSIBLE FILL? Change at 3.2'
3.2	5.4	SS-22			3.5	5.0	2	2	3	W	CP	BROWNISH GRAY, LOOSE, ~~CLAYEY~~ F. SAND (A-3, SP) ~~(A-2-4, SC)~~ TRACE ORGANIC ODOR, TRACE SILT + TRACE CLAY. Change at 5.4'
5.4	12.5	SS-23			6.0	7.5	2	6	6	SAT	CP	BROWNISH GRAY, MED. DENSE, SILTY FINE SAND (A-2-4, SM) TRACE SHELL FRAGMENTS
		SS-24			8.5	10.0	2	7	10	SAT	CP	SAME,
12.5	22.5	SS-25			13.5	15.0	8	11	11	SAT	CP	GRAY, MEDIUM DENSE, SILTY F. SAND (A-2-5, SM) * SIGNIFICANTLY MORE SILT THAN PREVIOUS SAMPLES
		SS-26			18.5	20.0	9	11	13	SAT	CP	SAME
22.5	27.5	SS-27			23.5	25.0	4	5	4	SAT	CP	GRAY, LOOSE, SILTY F. SAND (A-2-5, SM) TRACE CLAY?
27.5		SS-28			28.5	30.0	9	9	9	SAT	CP	GRAY, MED. DENSE SILTY CSE TO FINE SAND (A-2-4, SM) WITH SHELL FRAGMENTS (SIZE OF CSE SAND)
		SS-29			33.5	35.0	8	12	16	SAT	CP	SAME,
		SS-30			38.5	40.0	19	26	35	SAT	CP	GRAY, V. DENSE, SILTY, F TO CSE SAND (A-2-4, SM)
											*	FROM SE CORNER OF BUILDING 11.8' TOWARDS DOCK, 9.0' RIGHT FACING BUILDING
											*	BORING ELEVATIONS + LOCATION WERE NOT SURVEYED N + E ARE APPROXIMATE

REDLINED BY (sign): DATE

Boring terminated at 40.0 ft (IN) ON SILTY SAND (A-2-4)

Form GEU-003e Revised 2/6/2007

NCDOT GEOTECHNICAL ENGINEERING UNIT
FIELD BORELOG (ENGLISH)

PROJECT NUMBER: —	ID: —	CO: Hyde	GEO: Pastrana, C.R.	GROUND WATER	0 HOUR	24 HOUR	
PROJ DESC: Design Development for NCDOT Ocracoke Island Passenger Terminal				Depth to WATER	2.0	FIAD	
BORING NUMBER: B-6	STA: N/A	OFFSET: N/A FT N/A	ALIGNMENT: N/A	Depth to BTTM	8.3	FIAD	
ELEVATION: — FT	TOTAL DEPTH: 25.0' FT	NORTH	EAST	DATE mm/dd	3-16-17	3-16-17	
DRILL MACHINE: CME 45 TRAILER	DRILL EQMT NUMBER: 190674	DRILL METHOD: ~~HSA~~ MUD ROTARY		HAMMER TYPE: Automatic			
START DATE: 3-16-17	COMP DATE: 3-16-17	SURFACE WTR DEPTH: N/A FT	DEPTH TO ROCK: N/A FT	DRILLER: G. EISTER			

STRATUM FROM	STRATUM TO	SAMPLE NUMBER	SAMPLE FROM	SAMPLE TO	DRIVE/SPT FROM	DRIVE/SPT TO	0.5 ft	0.5 ft	0.5 ft	MOI	ORIGIN	SOIL & ROCK DESCRIPTION (SOIL or ROCK NAME (w/ color, density/consistency, texture, plasticity, organics, other))
0.0		SS-31			1.0	2.5	2	6	4	M	CP?	BROWNISH GRAY, LOOSE TO MED. DENSE, ~~SILTY~~ FINE SAND A-3 (~~A-24~~, SP-~~SM~~) TRACE CLAY, + SILT POSSIBLE FILL?
		S-2	0	3								
	~~2~~	* BULK SAMPLE										
	2.6											Change at 2.6'
2.6		SS-32			3.5	5.0	1	2	1	SAT	CP	BROWNISH GRAY, V. LOOSE (A-3, SP) ~~CLAYEY~~ FINE SAND (~~A-2-7, SC~~) TRACE SILT, TRACE CLAY
	5.5											Change at 5.5
5.5		SS-33			6.0	7.5	3	5	6	SAT	CP	BROWNISH GRAY, MED. DENSE, SILTY FINE TO CSE SAND (A-2-4, SM) W/ SHELL FRAGMENTS
		SS-34			8.5	10.0	6	10	9	SAT	CP	SAME
		SS-35			13.5	15.0	10	11	17	SAT	CP	GRAY, MED DENSE, SILTY FINE SAND (A-2-4, SM)
		SS-36			18.5	20.0	12	15	17	SAT	CP	SAME, DENSE
		SS-37			23.5	25.0	5	5	4	SAT	CP	GRAY, LOOSE, SILTY F. SAND (A-2-4, SM)
											*	S-2 - BULK SAMPLE TAKEN FROM POINTS BETWEEN B-5 + B-6
											*	BORING ELEVATIONS + LOCATION WERE NOT SURVEYED N+E ARE APPROXIMATE

REDLINED BY (sign): DATE

Boring terminated at 25.0 ft (IN) / ON SILTY SAND (A-2-4)

Form GEU-003e Revised 2/6/2007

PROJECT NO.	FN65.300
SCALE	AS SHOWN
DATE	3/7/17
BY	DMN

FIGURE 3
LOCATION OF SEISMIC ARRAY

HATTERAS FERRY LANDING SITE
HATTERAS, NORTH CAROLINA

ESP Associates, P.A.
PO Box 7030
Charlotte, NC 28241
1.800.960.7317
www.espassociates.com

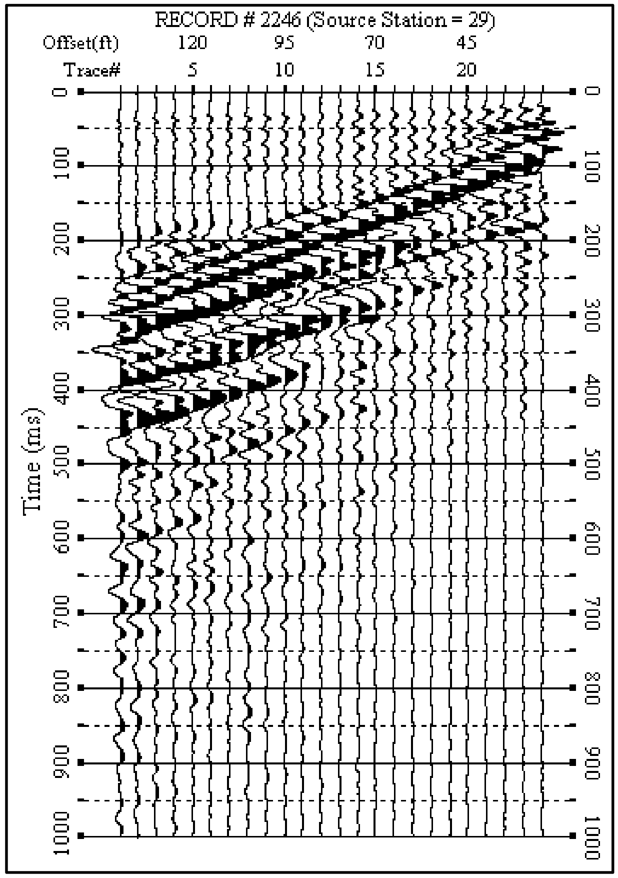
2.a. Photo looking southeast showing seismograph (yellow box) and geophone array laid out across site .

2.b. Photo showing 20-pound sledgehammer used as energy source.

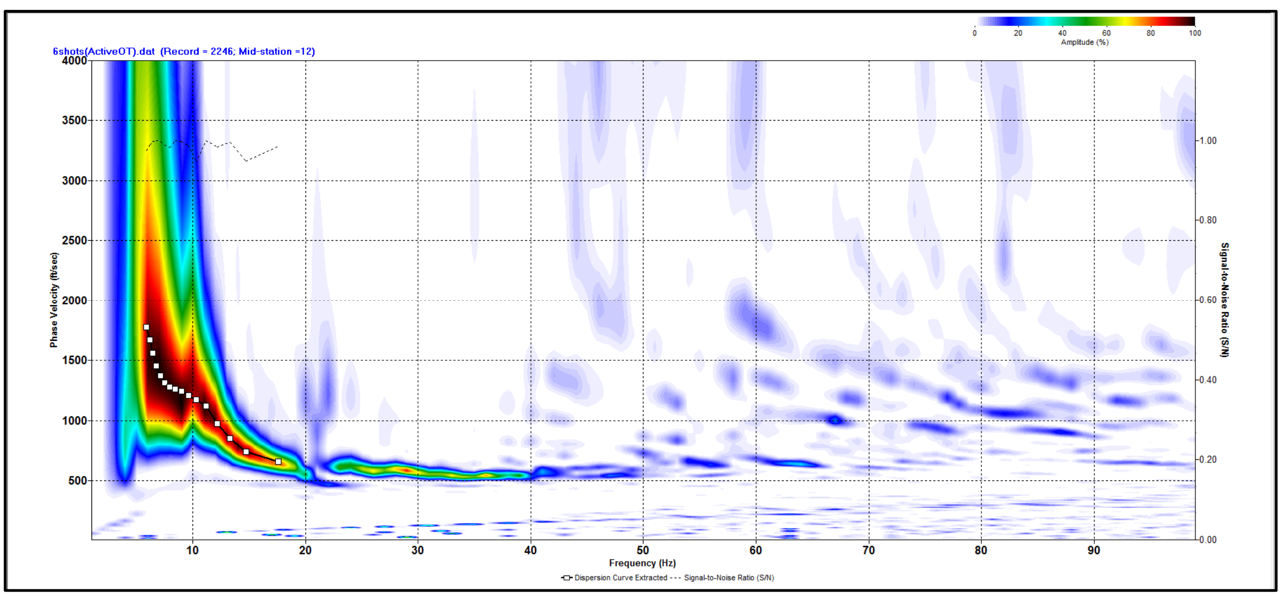
PROJECT NO.		
FN65.300	***FIGURE 4***	ESP Associates, P.A.
SCALE NTS	***PHOTOGRAPHS OF DATA ACQUISITION***	
DATE 3/7/17	***HATTERAS FERRY LANDING SITE***	
BY DMN	***HATTERAS, NORTH CAROLINA***	

PO Box 7030
Charlotte, NC 28241
1.800.960.7317

www.espassociates.com



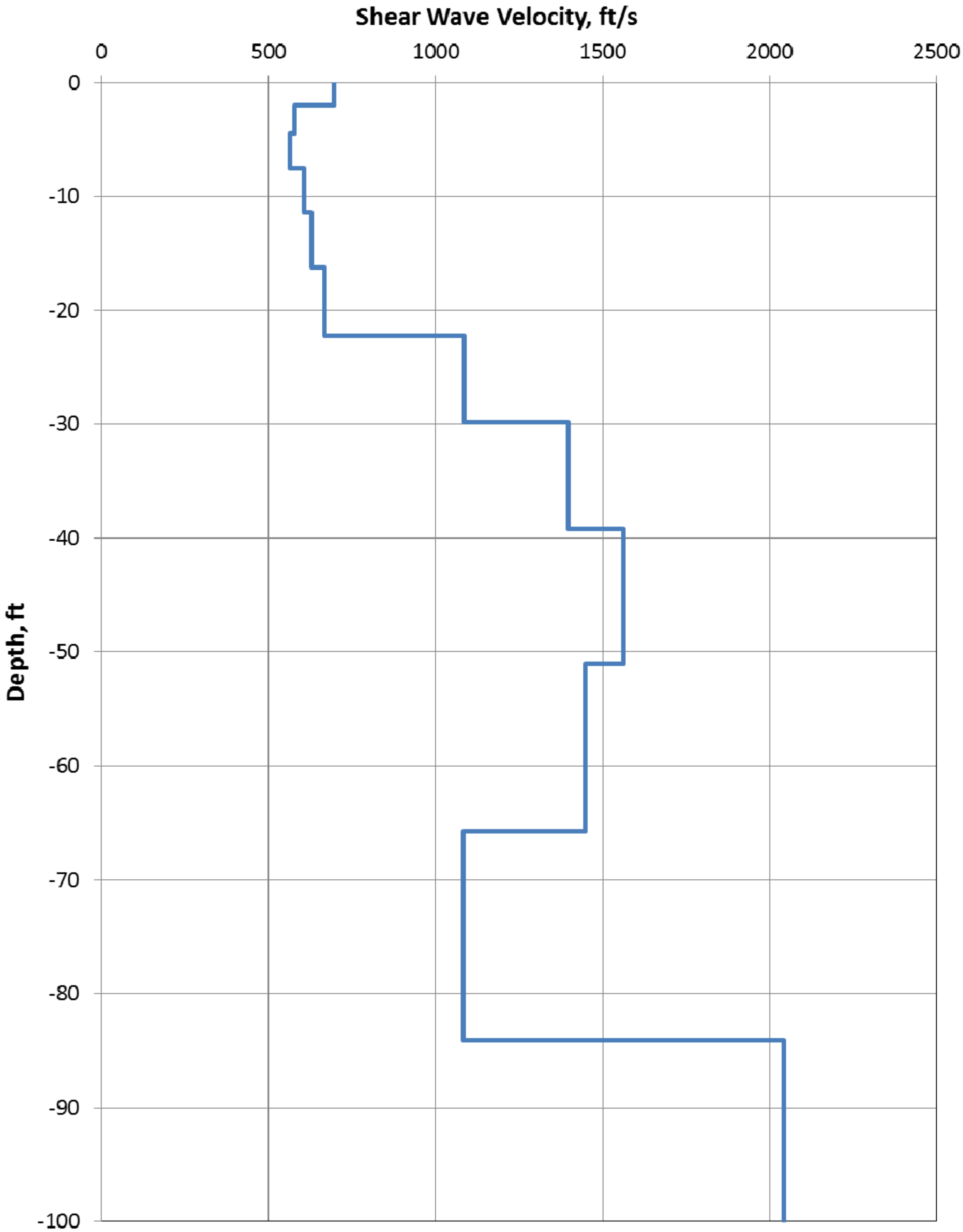
3.a. Time-series seismic data (selected record)



3.b. Data converted to frequency-phase velocity domain showing selected dispersion curve used for inversion

PROJECT NO.	
FN65.300	***FIGURE 5***
SCALE: AS SHOWN	***SURFACE WAVE SEISMIC PROCESSING***
DATE: 3/7/17	***HATTERAS FERRY LANDING SITE***
BY: DMN	***HATTERAS, NORTH CAROLINA***

ESP Associates, P.A.
PO Box 7030
Charlotte, NC 28241
1.800.960.7317
www.espassociates.com



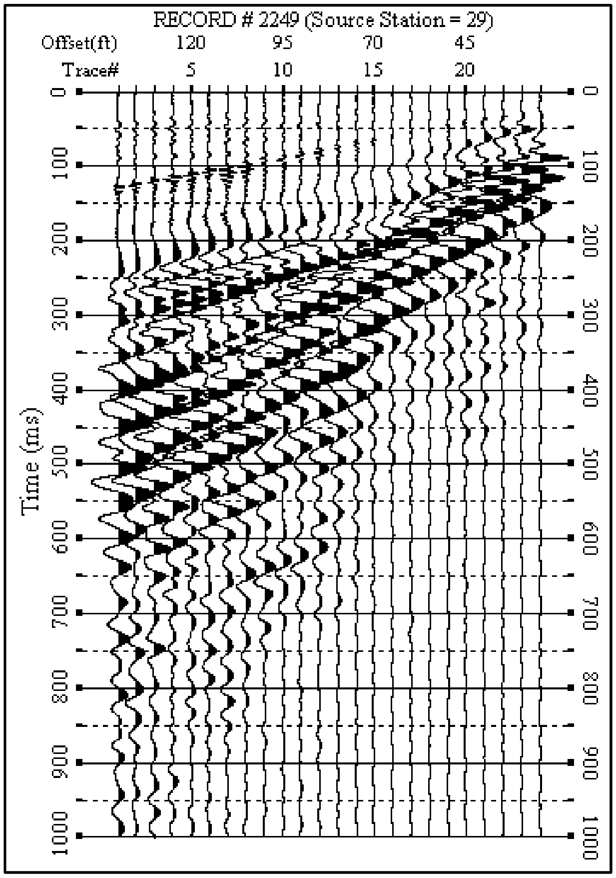
PROJECT NO. FN65.300	***FIGURE 6*** ***SHEAR WAVE VELOCITY MODEL***	ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241 1.800.960.7317 www.espassociates.com
SCALE AS SHOWN		
DATE 3/7/17	***HATTERAS FERRY LANDING SITE*** ***HATTERAS, NORTH CAROLINA***	
BY DMN		

PROJECT NO. FN65.300	FIGURE 7 LOCATION OF SEISMIC ARRAY	ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241 1.800.960.7317 www.espassociates.com
SCALE AS SHOWN		
DATE 3/8/17	OCRACOKE FERRY LANDING SITE OCRACOKE, NORTH CAROLINA	
BY DMN		

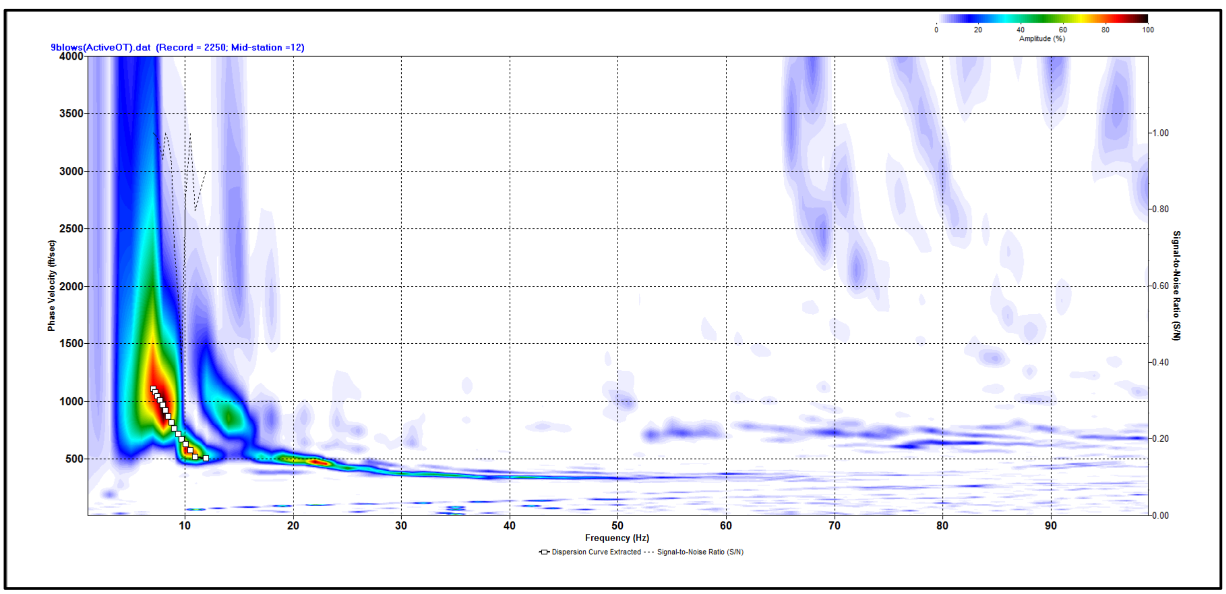
2.a. Photo looking south showing seismograph (yellow box) and geophone array laid out across site .

2.b. Photo showing 20-pound sledgehammer and metal plate used as energy source.

PROJECT NO. FN65.300	*FIGURE 8* *PHOTOGRAPHS OF DATA ACQUISITION*	ESP Associates, P.A.
SCALE NTS		PO Box 7030 Charlotte, NC 28241 1.800.960.7317
DATE 3/8/17	*OCRACOKE FERRY LANDING SITE* *OCRACOKE, NORTH CAROLINA*	www.espassociates.com
BY DMN		

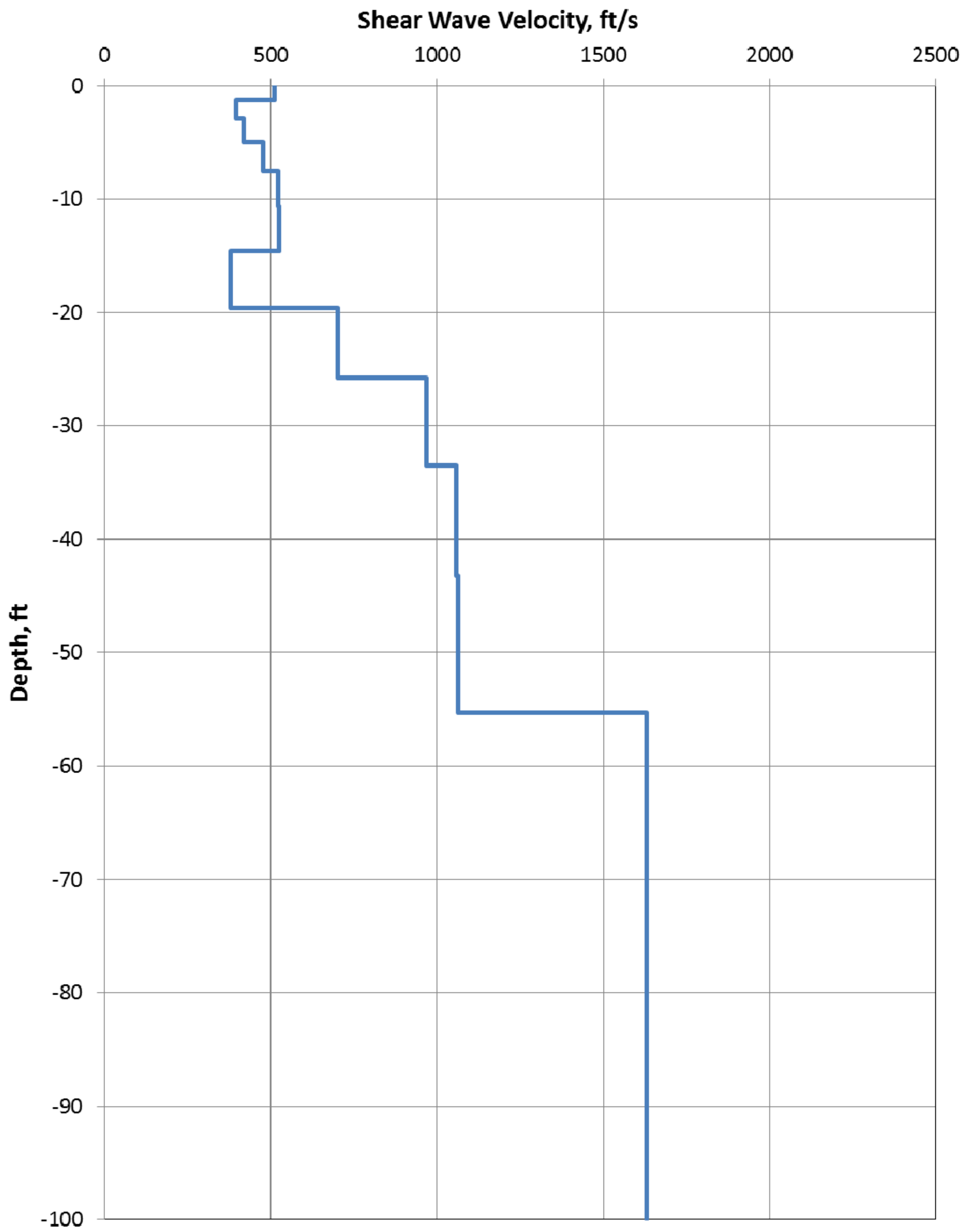


3.a. Time-series seismic data (selected record)

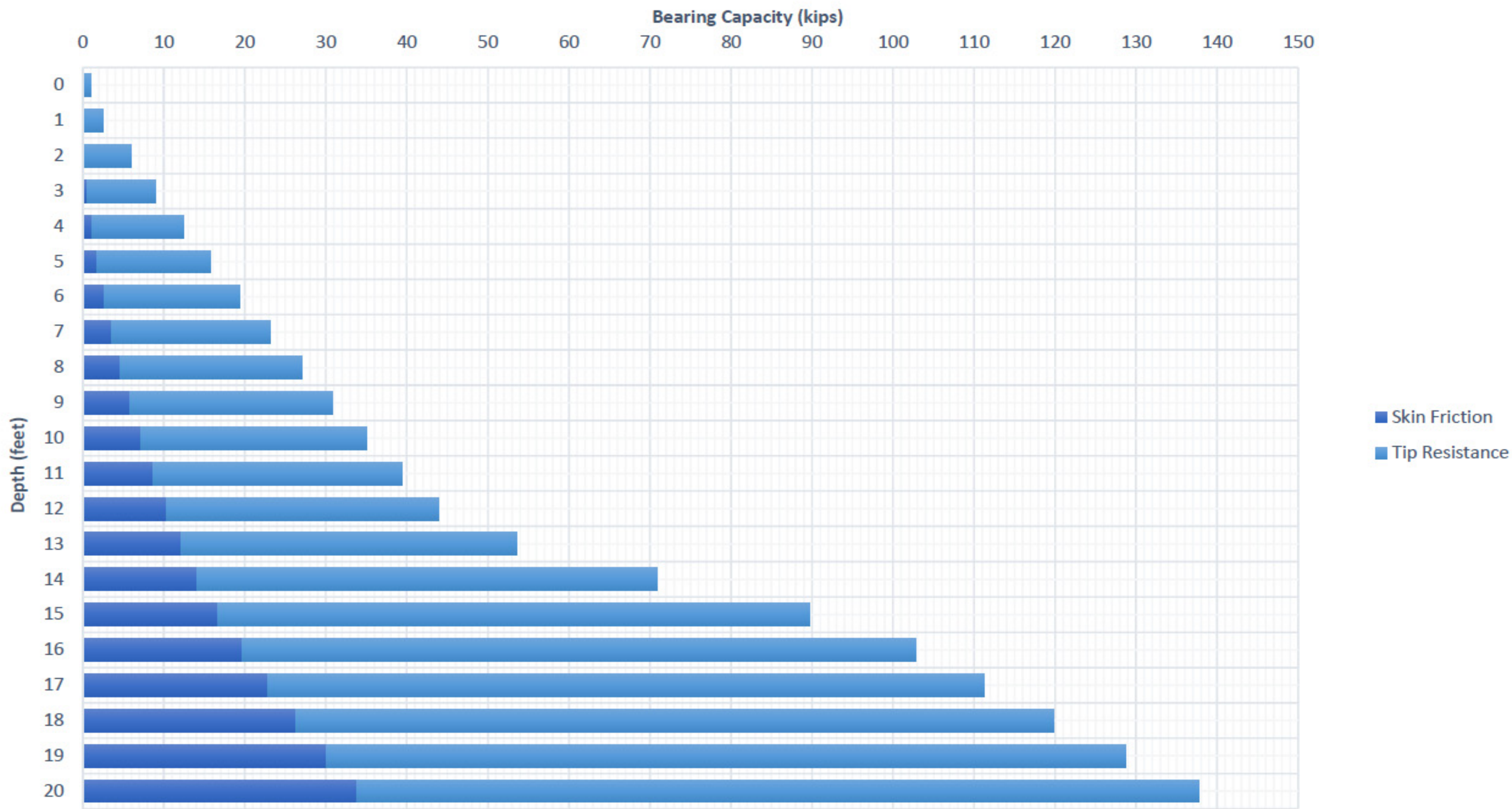


3.b. Data converted to frequency-phase velocity domain showing selected dispersion curve used for inversion

PROJECT NO. FN65.300	***FIGURE 9*** ***SURFACE WAVE SEISMIC PROCESSING***	ESP Associates, P.A.
SCALE AS SHOWN		PO Box 7030 Charlotte, NC 28241 1.800.960.7317
DATE 3/8/17	***OCRACOKE FERRY LANDING SITE*** ***OCRACOKE, NORTH CAROLINA***	www.espassociates.com
BY DMN		



PROJECT NO. FN65.300	***FIGURE 10***	ESP Associates, P.A.
SCALE AS SHOWN	***SHEAR WAVE VELOCITY MODEL***	PO Box 7030 Charlotte, NC 28241 1.800.960.7317
DATE 3/8/17	***OCRACOKE FERRY LANDING SITE***	www.espassociates.com
BY DMN	***OCRACOKE, NORTH CAROLINA***	

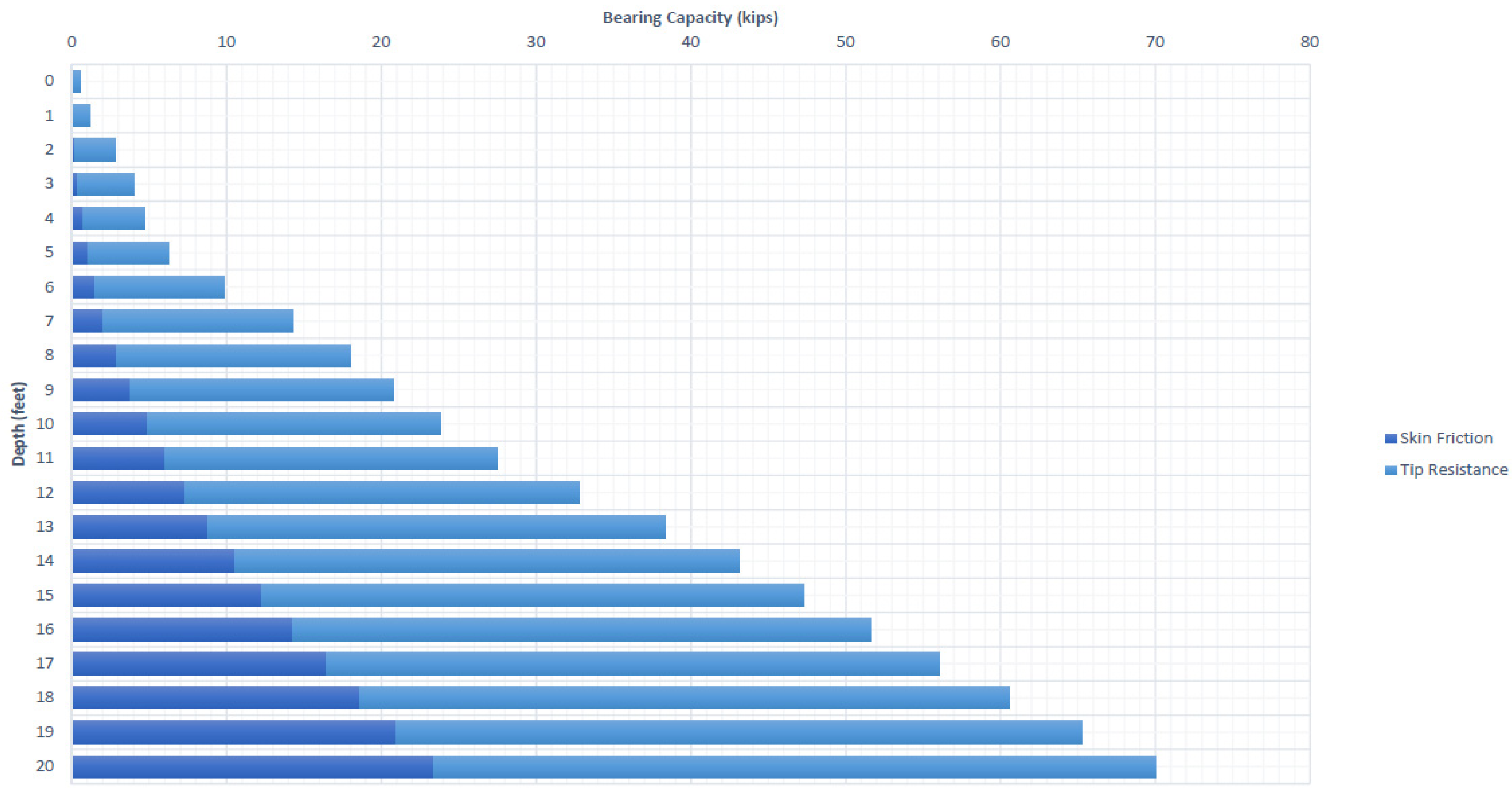


Hatteras Ultimate Soil Bearing Capacities

PROJECT NO: FN65.300	SHEET TITLE: SOIL BEARING CAPACITY HATTERAS SITE	
DRAWN BY: BRL		
CHECKED BY: RWE	PROJECT: NCDOT PASSENGER FERRY TERMINALS AND PARKING LOTS	
DATE: 4/14/2017		
FIGURE 11	FORT MILL, SOUTH CAROLINA	

ESP Associates, P.A.

ESP Associates. P.A.
P.O. Box 7030
Charlotte, NC 28241
3475 Lakemont Blvd.
Fort Mill, SC 29708
704-583-4949 (NC)
803-802-2440 (SC)
www.espassociates.com



Ocracoke Ultimate Soil Bearing Capacities

PROJECT NO: FN65.300	SHEET TITLE: SOIL BEARING CAPACITY OCRACOKE SITE	ESP Associates, P.A.	ESP Associates, P.A. P.O. Box 7030 Charlotte, NC 28241 3475 Lakemont Blvd. Fort Mill, SC 29708 704-583-4949 (NC) 803-802-2440 (SC) www.espassociates.com
DRAWN BY: BRL			
CHECKED BY: RWE	PROJECT: NCDOT PASSENGER FERRY TERMINALS AND PARKING LOTS FORT MILL, SOUTH CAROLINA		
DATE: 4/14/2017			
FIGURE 12			

NCDOT Hatteras Island Passenger Terminal
Soil Strength Parameters based on Boring No. B-1

Layer	Drive Depth	z	γ_t	z_w	σ_o	u	σ'_o	N	N_{60}	C_N	$N1_{60}$	$N1_{60av}$	s_u	ϕ'
#	ft	ft	pcf	ft	ksf	ksf	ksf	bpf	bpf	dim	bpf	bpf	ksf	deg
1	0.0	0.0	125	0.0	0.00	0.00	0.00	-	-	-	-	-	-	-
	-1.0	1.0	125	1.0	0.13	0.06	0.06	21	31.2	2.00	62	46	-	37
	-3.5	3.5	125	3.5	0.44	0.22	0.22	18	26.7	1.74	47		-	
	-6.0	6.0	125	6.0	0.75	0.38	0.38	12	17.8	1.56	28		-	
	-8.5	8.5	125	8.5	1.06	0.53	0.53	22	32.6	1.45	47		-	
2	-13.5	13.5	130	13.5	1.69	0.84	0.84	37	54.9	1.29	71	63	-	40
	-18.5	18.5	130	18.5	2.34	1.16	1.18	35	51.9	1.18	61		-	
	-23.5	23.5	130	23.5	2.99	1.47	1.52	35	51.9	1.09	57		-	
3	-28.5	28.5	125	28.5	3.64	1.78	1.86	16	23.7	1.03	24	24	-	32
4	-33.5	33.5	135	33.5	4.26	2.09	2.17	84	124.6	0.97	121	129	-	40
	-38.5	38.5	135	38.5	4.94	2.41	2.53	99	146.9	0.92	136		-	

Notes:

z, z_w = depth of the SPT test location below ground surface and groundwater level, respectively

γ_t = total unit weight of soil

u = pore water pressure at SPT test, $u = z_w$ (62.5/1000); and u = 0 when z_w is negative

σ_o, σ'_o = total and effective stress at SPT test loaction, respectively; $\sigma'_o = \sigma_o - u$

N = uncorrected SPT blow count as measured in the field

N_{60} = SPT blow count corrected for hammer efficiency, $N_{60} = (ER/60\%) N$ and ER = hammer efficiency = 89%

$N1_{60}$ = $C_N N_{60}$, where $C_N = [0.77 \log_{10} (40/\sigma'_o)]$ and $C_N \leq 2.0$

$N1_{60av}$ = average of $N1_{60}$ values for a layer

s_u = undrained shear strength of soil, based on GDM, Equation 7-30

ϕ' = average drained friction angle of soil

NCDOT Ocracoke Island Passenger Terminal
Soil Strength Parameters based on Boring No. B-5

Layer	Drive Depth	z	γ_t	z_w	σ_o	u	σ'_o	N	N_{60}	C_N	$N1_{60}$	$N1_{60av}$	s_u	ϕ'
#	ft	ft	pcf	ft	ksf	ksf	ksf	bpf	bpf	dim	bpf	bpf	ksf	deg
1	0.0	0.0	125	0.0	0.00	0.00	0.00	-	-	-	-	-	-	-
	-1.0	1.0	110	1.0	0.13	0.06	0.06	17	25.2	2.00	50	50	-	33
2	-3.5	3.5	120	3.5	0.40	0.22	0.18	5	7.4	1.80	13	13	-	30
3	-6.0	6.0	125	6.0	0.70	0.38	0.33	12	17.8	1.61	29	33	-	35
	-8.5	8.5	125	8.5	1.01	0.53	0.48	17	25.2	1.48	37		-	
4	-13.5	13.5	125	13.5	1.64	0.84	0.79	22	32.6	1.31	43	43	-	36
	-18.5	18.5	125	18.5	2.26	1.16	1.11	24	35.6	1.20	43		-	
5	-23.5	23.5	115	23.5	2.89	1.47	1.42	9	13.4	1.12	15	15	-	31
6	-28.5	28.5	125	28.5	3.46	1.78	1.68	18	26.7	1.06	28	28	-	33
7	-33.5	33.5	125	33.5	4.09	2.09	1.99	28	41.5	1.00	42	42	-	36
8	-38.5	38.5	130	38.5	4.71	2.41	2.31	61	90.5	0.95	86	86	-	40

Notes:

z, z_w = depth of the SPT test location below ground surface and groundwater level, respectively

γ_t = total unit weight of soil

u = pore water pressure at SPT test, $u = z_w$ (62.5/1000); and u = 0 when z_w is negative

σ_o, σ'_o = total and effective stress at SPT test loaction, respectively; $\sigma'_o = \sigma_o - u$

N = uncorrected SPT blow count as measured in the field

N_{60} = SPT blow count corrected for hammer efficiency, N_{60} = (ER/60%) N and ER = hammer efficiency = 89%

$N1_{60}$ = $C_N N_{60}$, where $C_N = [0.77 \log_{10} (40/\sigma'_o)]$ and $C_N \leq 2.0$

$N1_{60av}$ = average of $N1_{60}$ values for a layer

s_u = undrained shear strength of soil, based on GDM, Equation 7-30

ϕ' = average drained friction angle of soil

SOILS LABORATORY TESTS RESULTS

WBS NO.: -

TIP NO.: -

COUNTY: Dare / Hyde

SITE DESCRIPTION: Design Development for NCDOT Ocracoke Island and Hatteras Island Passenger Terminal

SAMPLE NO.	Boring	DEPTH INTERVAL (ft.)	AASHTO CLASS	N	L.L	P.I.	% BY WEIGHT				% PASSING SIEVES			% MOISTURE	% ORGANIC
							CSE. SAND	F. SAND	SILT	CLAY	10	40	200		
SS-1	B-1	18.5-20.0	A-3 (1)	35	NP	NP	50	46	3	1	100	93	4	-	-
SS-2	B-1	28.5-30.0	A-2-4 (1)	16	NP	NP	18	60	19	3	98	89	22	-	-
SS-3	B-3	6.0-7.5	A-3 (1)	10	NP	NP	55	43	1	1	100	79	2	23	0.65
SS-4	B-6	3.5-5.0	A-3 (1)	3	-	-	27	64	5	4	100	91	9	-	-
S-1	B-4	0.0-3.9	A-3 (1)	N/A	-	-	53	45	1	1	98	86	2	-	-
S-2	B-5 & B-6	0.0-3.0	A-3 (1)	N/A	-	-	55	40	2	3	92	74	5	-	-

Tony Dunmore

Certification No. 121-01-1108

Job No. FN65.300
Project Hatteras and Ocracoke Terminals
Buxton, North Carolina

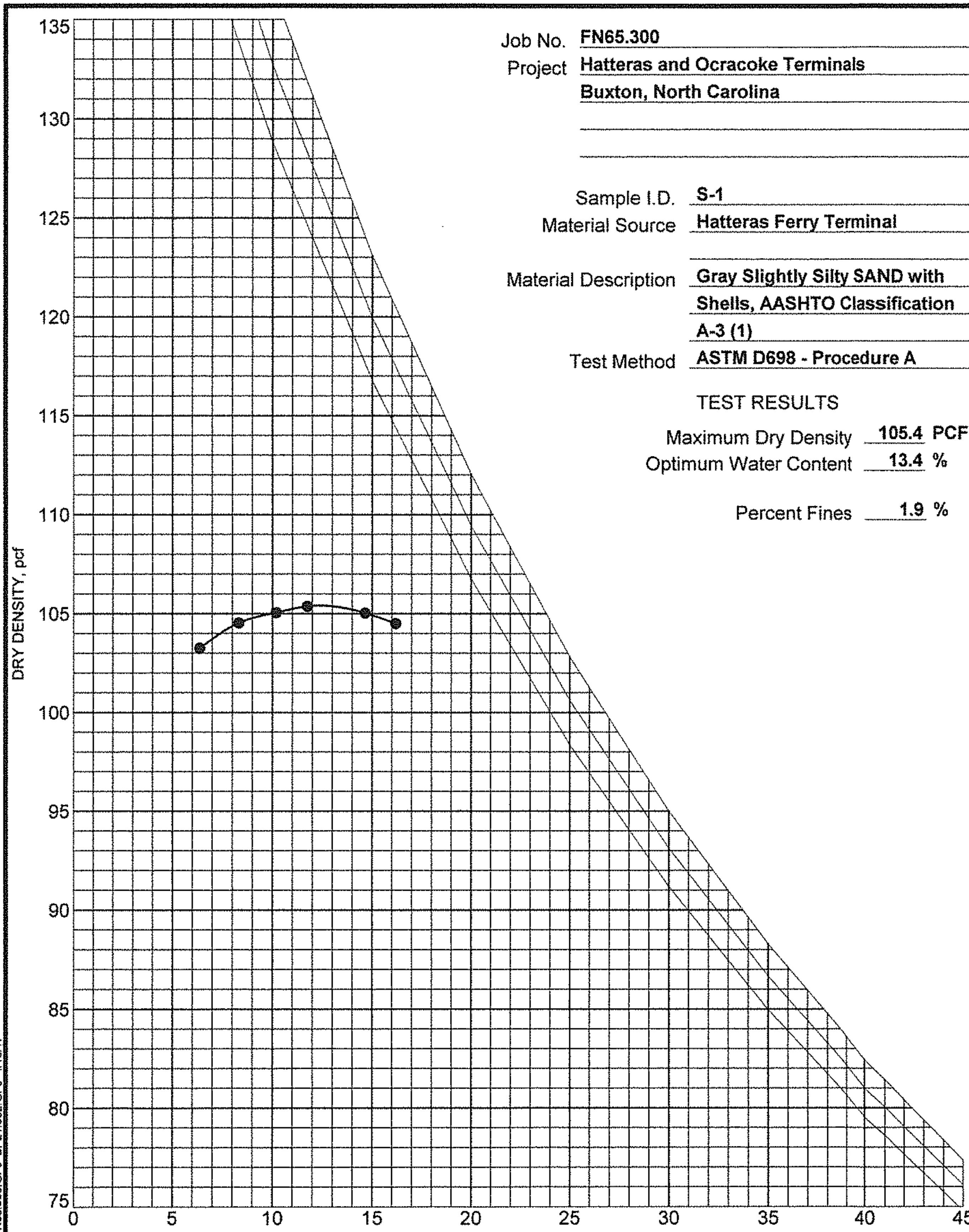
Sample I.D. S-1
Material Source Hatteras Ferry Terminal

Material Description Gray Slightly Silty SAND with Shells, AASHTO Classification A-3 (1)
Test Method ASTM D698 - Procedure A

TEST RESULTS

Maximum Dry Density 105.4 PCF
Optimum Water Content 13.4 %

Percent Fines 1.9 %



Zero Air Voids Curves For G_s = 2.6 - 2.8

MOISTURE-DENSITY RELATIONSHIP

ESP
ESP Associates, P.A.
3475 Lakemont Blvd
Fort Mill, SC
Telephone: 803-802-2440
Fax: 803-802-2515

Project: Hatteras and Ocracoke Terminals
Location: Buxton, North Carolina
Number: FN65.300

ESP COMPACTION - SINGLE FN65.300.GPJ BP21.302.GPJ 4/13/17

Job No. FN65.300

Project Hatteras and Ocracoke Terminals
Buxton, North Carolina

Sample I.D. S-2

Material Source Ocracoke Ferry Terminal

Material Description Gray Slightly Silty SAND with Shells, AASHTO Classification A-3 (1)

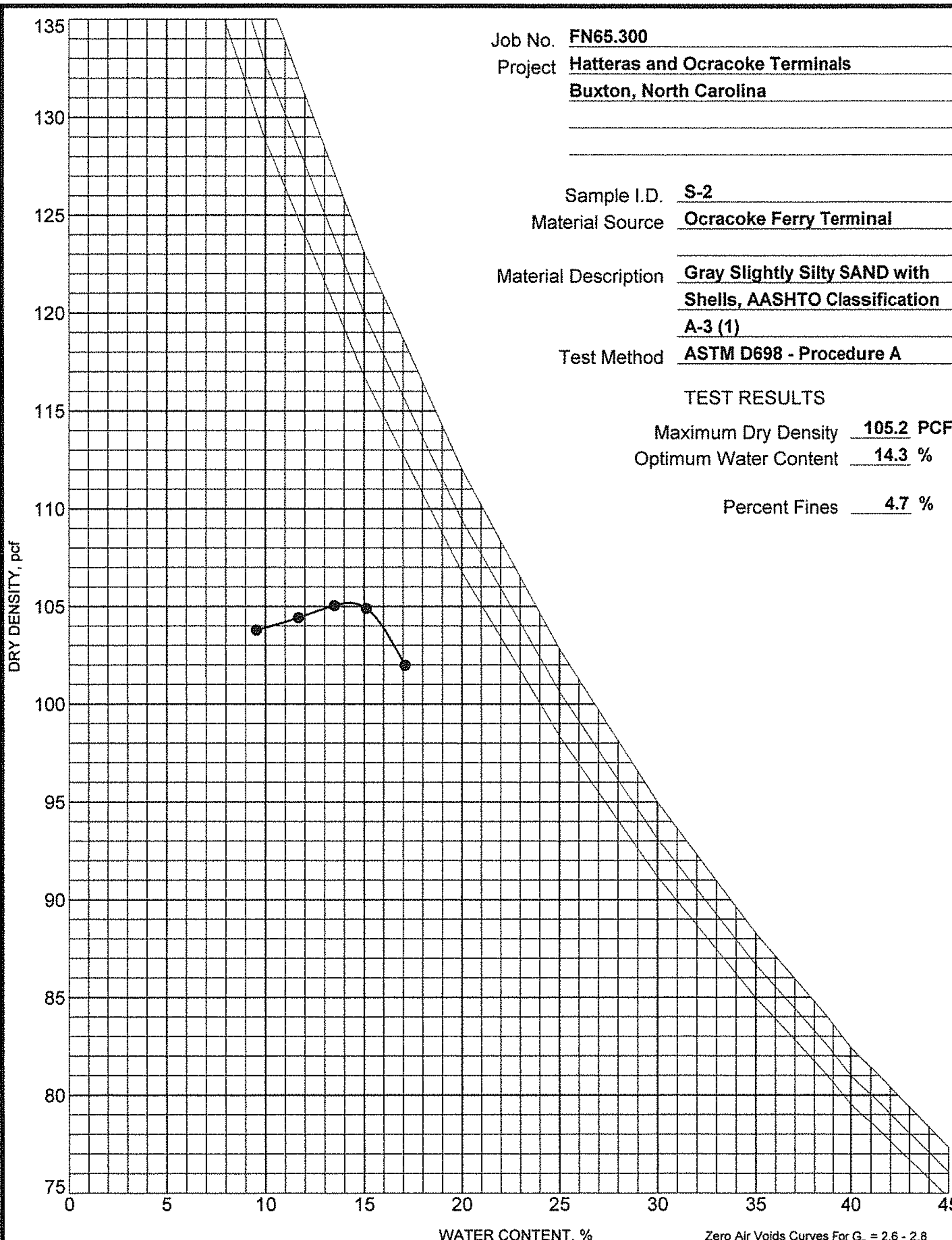
Test Method ASTM D698 - Procedure A

TEST RESULTS

Maximum Dry Density 105.2 PCF

Optimum Water Content 14.3 %

Percent Fines 4.7 %



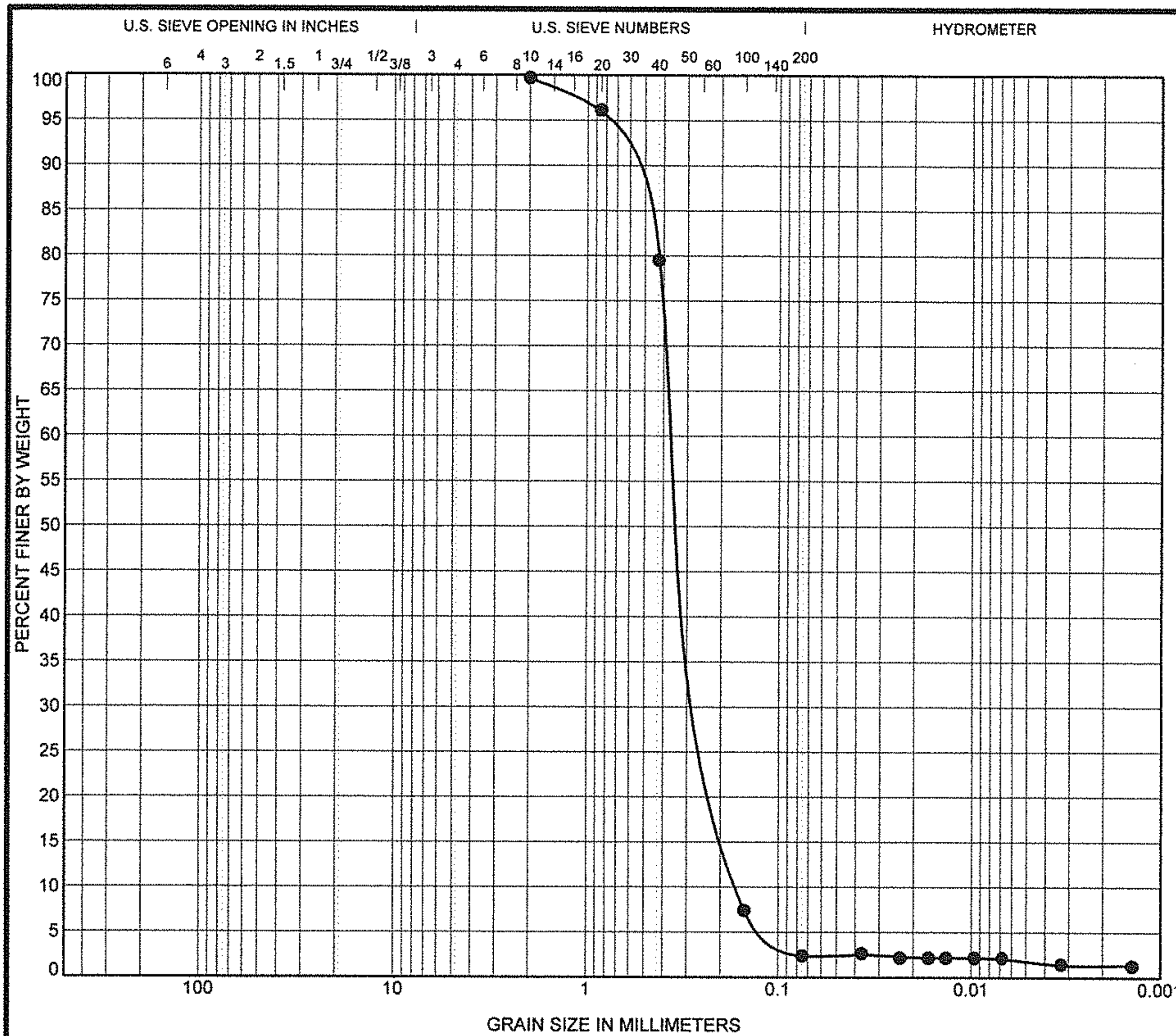
MOISTURE-DENSITY RELATIONSHIP

ESP Associates, P.A.
3475 Lakemont Blvd
Fort Mill, SC
Telephone: 803-802-2440
Fax: 803-802-2515

Project: Hatteras and Ocracoke Terminals

Location: Buxton, North Carolina

Number: FN65.300



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● B-3 SS-20 (6.5'-7')	**POORLY GRADED SAND SP**	**NP**	**NP**	**NP**	**0.87**	**2.06**
	AASHTO Classification					
	A-3 (1)					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-3	2	0.321	0.208	0.156	0.0	97.3	1.0	1.4

ESP GRAIN SIZE FN65.300.GPJ LOG-LAB.GDT 4/12/17

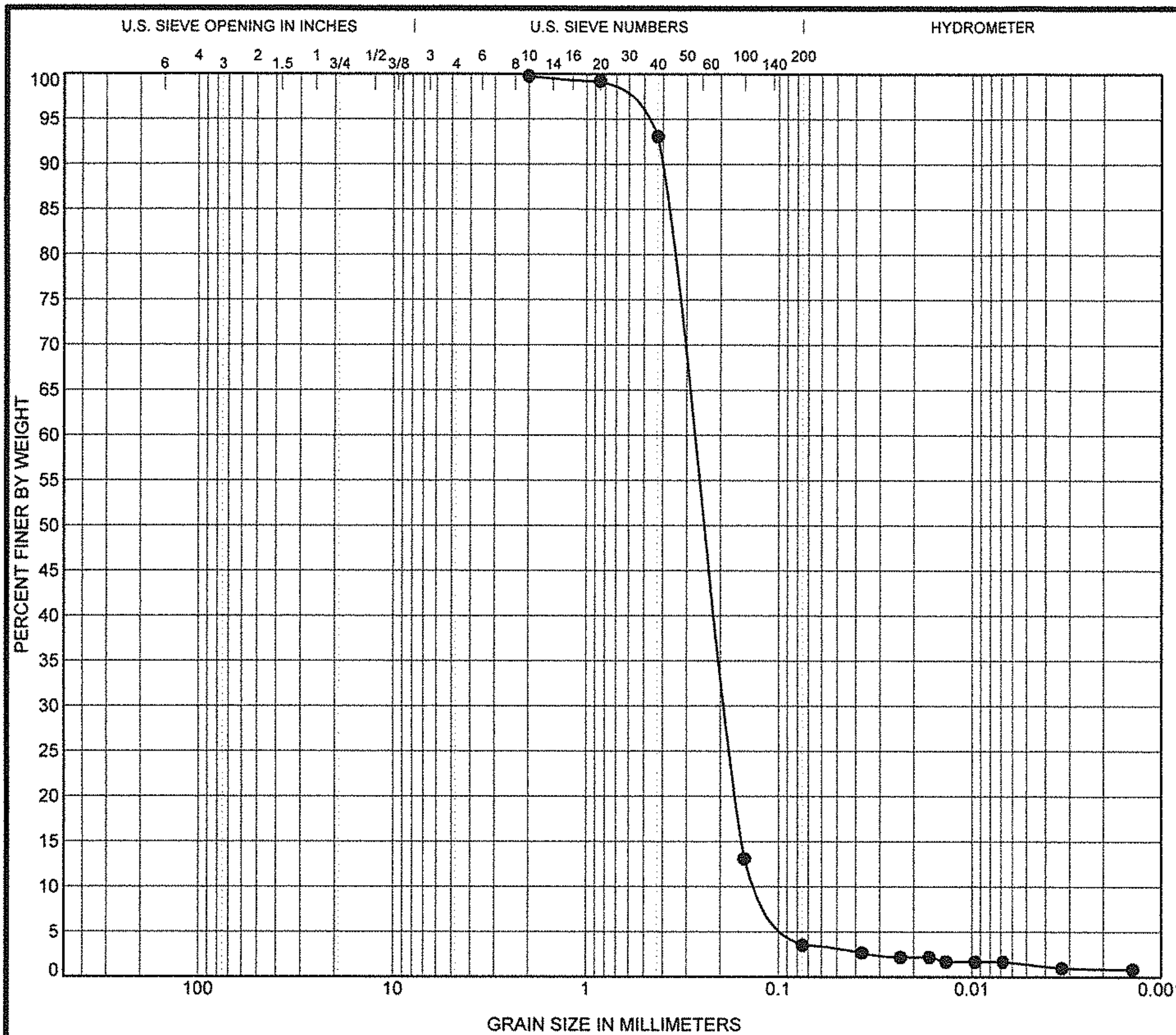
ESP
ESP Associates, P.A.
3475 Lakemont Blvd
Fort Mill, SC
Telephone: 803-802-2440
Fax: 803-802-2515

GRAIN SIZE DISTRIBUTION

Project: Hatteras and Ocracoke Terminals

Location: Buxton, North Carolina

Number: FN65.300



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	B-1 SS-6 (18.5'-20')	**POORLY GRADED SAND SP**				1.06	2.31
		AASHTO Classification					
		A-3 (1)					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	2	0.276	0.187	0.12	0.0	96.3	2.6	0.9

ESP GRAIN SIZE FN65.300.GPJ LOG-LAB.GDT 4/12/17

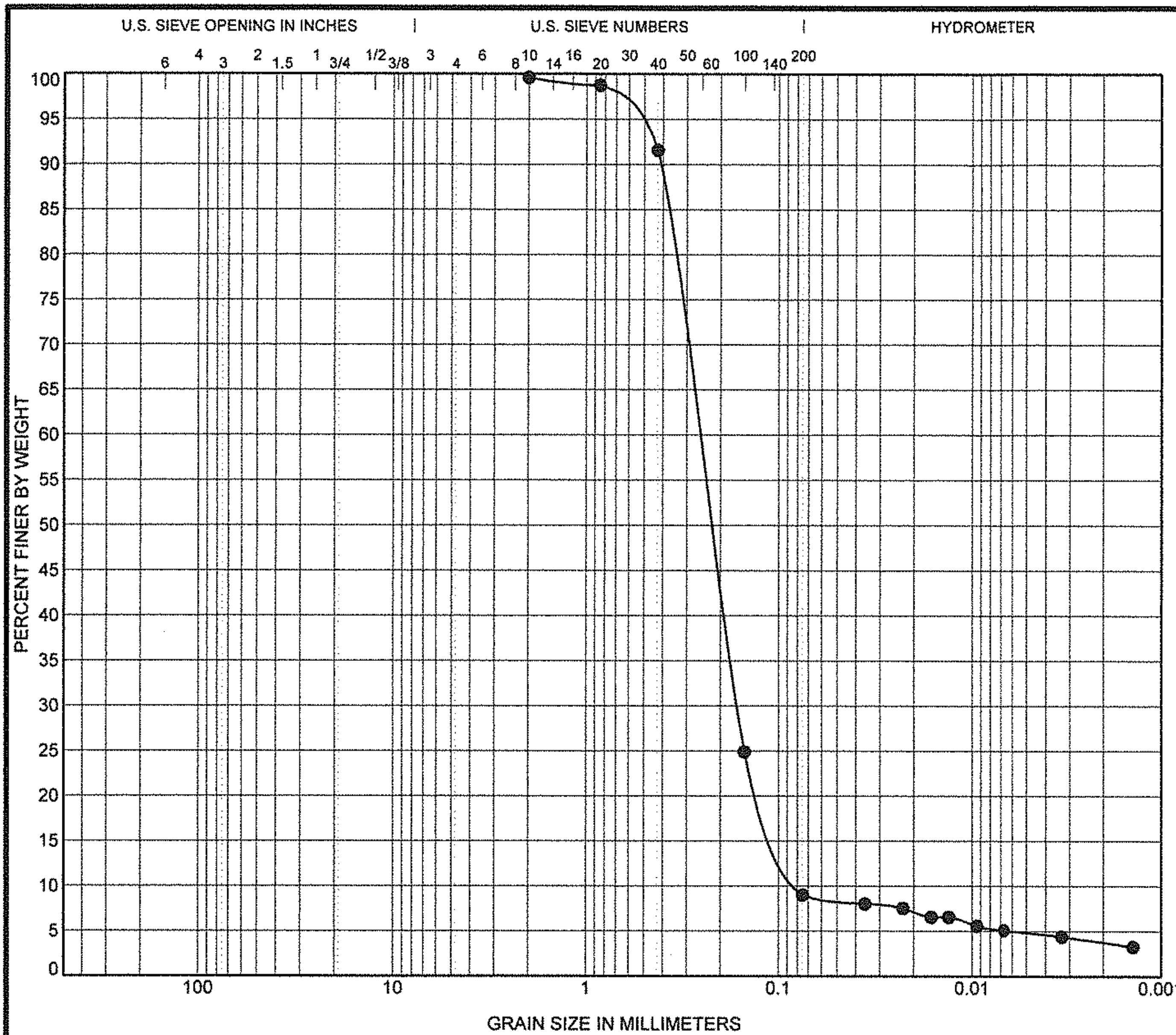
ESP
ESP Associates, P.A.
3475 Lakemont Blvd
Fort Mill, SC
Telephone: 803-802-2440
Fax: 803-802-2515

GRAIN SIZE DISTRIBUTION

Project: Hatteras and Ocracoke Terminals

Location: Buxton, North Carolina

Number: FN65.300



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● **B-6 SS32 (3.5'-5')**	**POORLY GRADED SAND with SILT SP-SM**	**NP**	**NP**	**NP**	**1.30**	**3.32**
	AASHTO Classification					
	A-3 (1)					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-6**	**2**	**0.259**	**0.162**	**0.078**	**0.0**	**90.6**	**5.3**	**3.7**

ESP GRAIN SIZE FN65.300.GPJ LOG-LAB.GDT 4/12/17

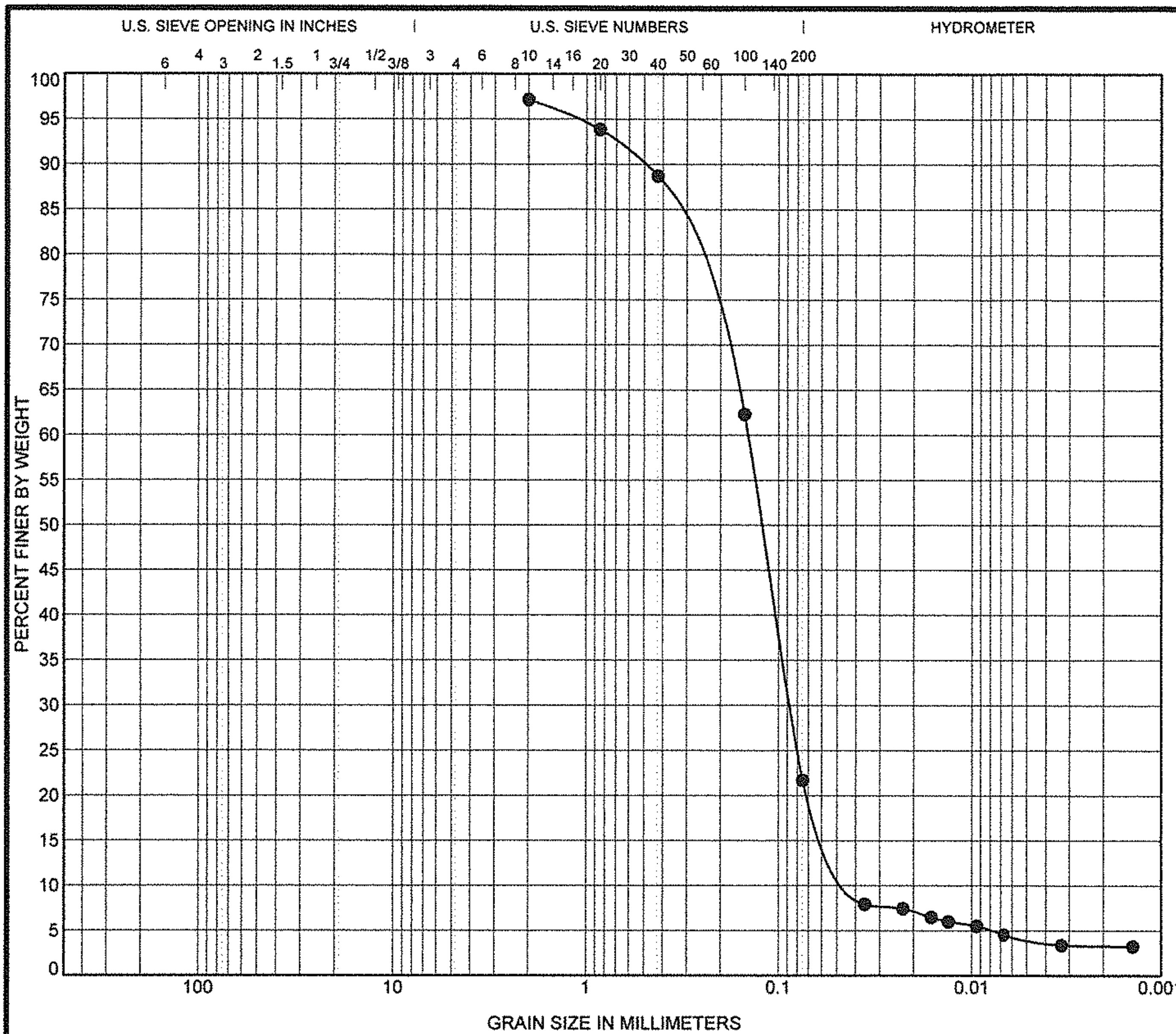
ESP
ESP Associates, P.A.
3475 Lakemont Blvd
Fort Mill, SC
Telephone: 803-802-2440
Fax: 803-802-2515

GRAIN SIZE DISTRIBUTION

Project: Hatteras and Ocracoke Terminals

Location: Buxton, North Carolina

Number: FN65.300



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	B-1 SS-8 (28.5'-30')	SILTY SAND SM	NP	NP	NP	1.29	3.61
		AASHTO Classification					
		A-2-4 (1)					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1 SS-8	2	0.144	0.086	0.04	0.0	75.4	18.4	3.3

ESP Associates, P.A.
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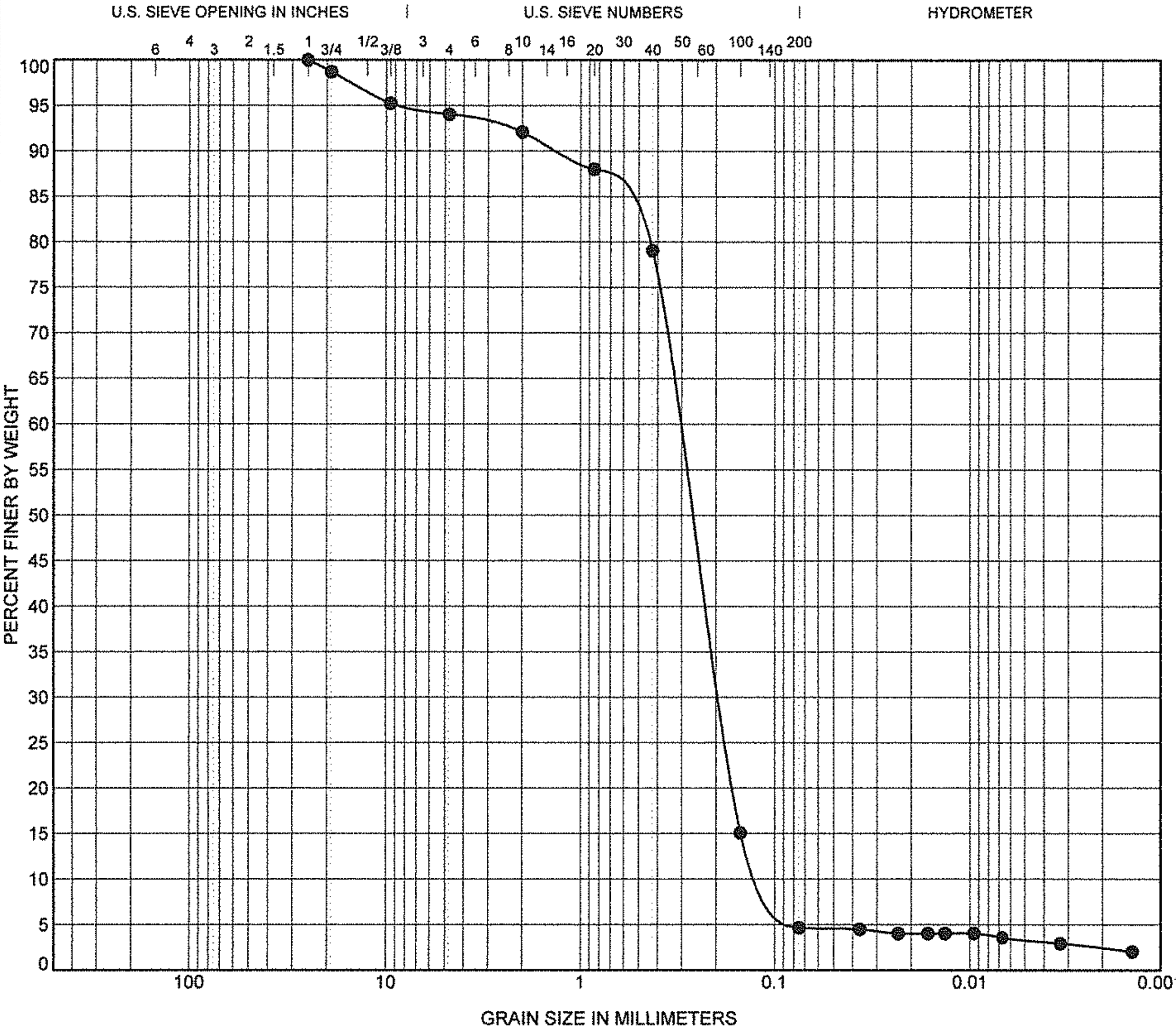
Fort Mill, SC
Telephone: 803-802-2440
Fax: 803-802-2515

GRAIN SIZE DISTRIBUTION

Project: Hatteras and Ocracoke Terminals

Location: Buxton, North Carolina

Number: FN65.300



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	S-2	**POORLY GRADED SAND SP**				**1.10**	**2.91**
		AASHTO Classification					
		A-3 (1)					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	S-2	**25**	**0.312**	**0.191**	**0.107**	**5.9**	**89.4**	**2.2**	**2.4**

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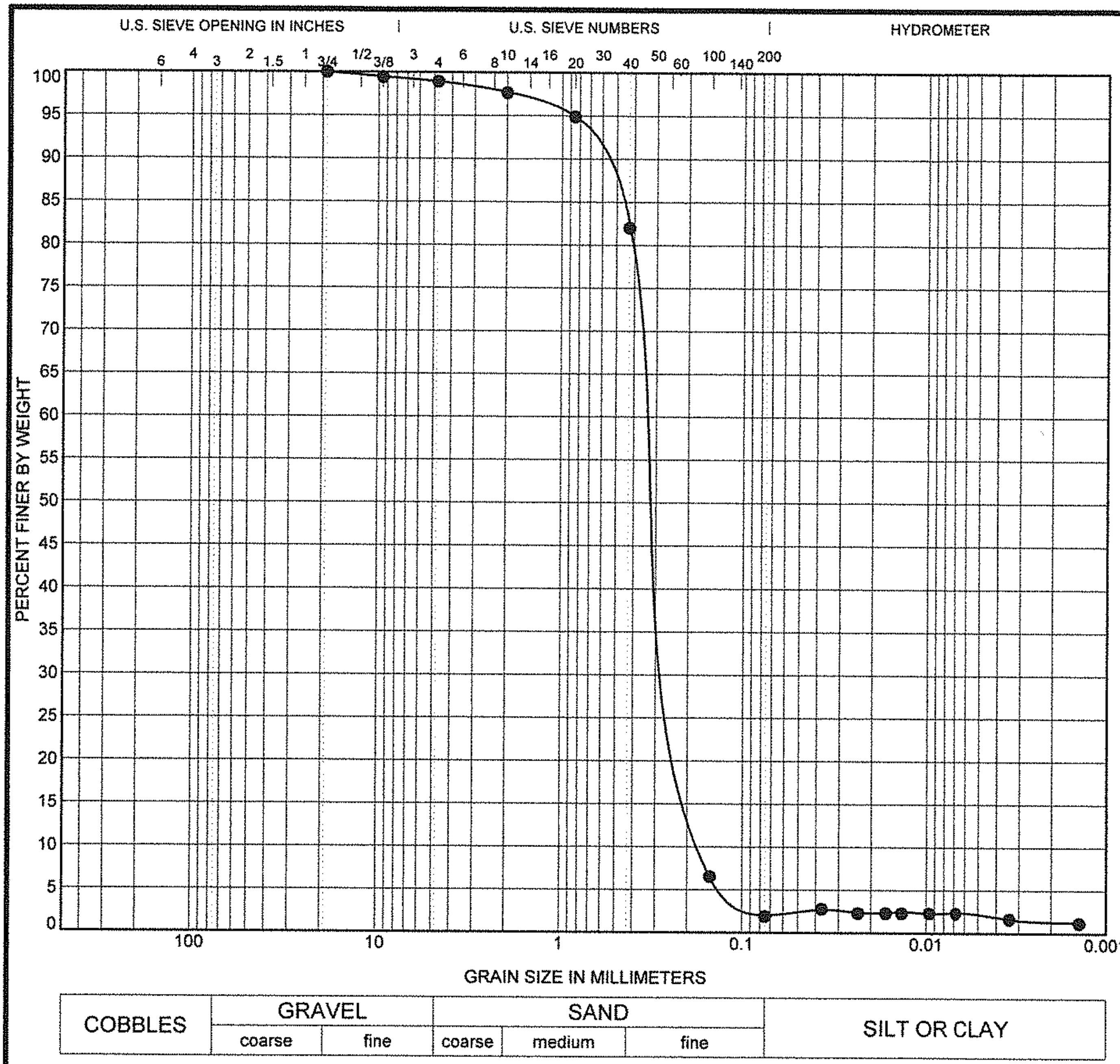
Location: Buxton, North Carolina

Number: FN65.300



Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● S-1	**POORLY GRADED SAND SP**				**0.87**	**1.99**
	AASHTO Classification					
	A-3 (1)					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● S-1	**19**	**0.314**	**0.207**	**0.157**	**1.1**	**97.0**	**0.5**	**1.4**

ESP GRAIN SIZE FN65.300.GPJ LOG-LAB.GDT 4/12/17

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GRAIN SIZE DISTRIBUTION

Project: Hatteras and Ocracoke Terminals

Location: Buxton, North Carolina

Number: FN65.300

REPORT OF
SUBSURFACE EXPLORATION
OCRACOKE AND HATTERAS
NCDOT PASSENGERTERMINALS
AND PARKING LOTS
ESP PROJECT NO. E4A-FN65.300

Prepared For:

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April 13, 2017