Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

May 31, 2019
File Number 19-55-9492

Genesis Halff
2507 Callaway Road, Suite 100
Tallahassee, Florida 32303

Attention: Mr. David Goree

Subject: **Geotechnical Engineering Services Report**
Andrews Wildlife Area Improvements
Chiefland, Florida

Dear Mr. Goree:

Ardaman & Associates, Inc. (Ardaman) is pleased to submit this report of our subsurface soil exploration for the above referenced project. Our services were provided in general accordance with those outlined in our Proposal No. 19-p110, dated April 26, 2019. The purpose of this exploration was to evaluate the general stratification and engineering properties of the subsurface soils at the subject site, and to provide foundation recommendations. In addition, general site preparation recommendations have been provided. The assessment of site environmental conditions for the presence of pollutants in the soil, rock, or groundwater at this site was beyond the scope of this exploration.

This Report of Subsurface Soil Exploration was prepared for the exclusive use of Genesis Halff and their consultants. The conclusions and recommendations made herein are applicable only to those structures and facilities described herein. This geotechnical study was performed in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

PROJECT INFORMATION

Project information was provided by email correspondence. Project plans include a pre-fab free-standing restroom, two pavilions, and an office trailer. A geotechnical study was performed for the project by Universal Engineering Sciences (UES). Results were presented in a March 28, 2019 geotechnical study. Five soil borings were performed. Sandy soils were present in the upper 5 to 7 feet. Clayey soils were then typically found from 8 to at least 21 feet below the existing ground surface. Limestone was encountered within the upper 15 feet in 3 of the 5 borings. Some of the borings were extraordinarily soft and loose, indicating an elevated potential for sinkhole development. Groundwater was reported at a depth of 19 feet.

The maximum loads associated with the proposed structure were not available at the time of this proposal. However, based on our experience with similar projects, the maximum loads associated with the proposed structures are expected to be as follows:

Wall Load:	1 to 2 kips/linear ft
Column Load:	50 kips
Floor Load:	100 lbs/sq ft

We have also assumed that less than 3.0 feet of fill will be required to achieve finished floor elevations. We understand no more than about 20 parking spaces is planned. Current plans call for proposed parking and driveway areas to receive about 3 inches of No. 57 Stone. Less than 100 linear feet of concrete sidewalk is planned.

FIELD EXPLORATION

Cone Penetrometer Test

Three Cone Penetrometer Test (CPT) soundings (CPT-01 through CPT-03) were performed at the site in order to verify the findings of the previous geotechnical study and to further evaluate subsurface conditions at this site. The CPT soundings extended to depths ranging from 7.8 to 38.2 feet below the existing ground surface (bgs) where practical advancement of the cone was terminated due to apparent rock being encountered.

Cone technology is widely used and is recognized as a highly effective method for site soils characterizations, especially when thin layers of soft soil or very loose or very soft soil strata might be encountered. The CPTs was performed in general accordance with the procedures outlined in ASTM Standard D-5778. The general procedures for performing the CPT soundings are summarized in Appendix of this report.

SUBSURFACE CONDITIONS

The delineation of the vertical extent of individual soil strata, the identification of pertinent soil engineering properties, where applicable, and a description of each geologic layer discovered in the course of this geotechnical study is given on the Sounding Logs attached to this report. While the penetrations are representative of subsurface conditions at their respective locations and vertical reaches, local variations which are characteristic of the subsurface materials of the region, or which may be due to man-made alteration of the native geologic conditions, may be encountered.

Piezo-Cone Penetrometer Test Soundings

A general guide regarding CPT Tip Resistance (qt) values as they relate to soil density/stiffness is summarized below:

Tip Resistance, tons per square foot (tsf)	**Soil Density/Stiffness**
<10	Very loose/very soft
10 to 50	Loose/soft
50 to 100	Medium Dense/Firm
100 to 150	Dense/Stiff
>150	Very Dense/Hard

CPT Sounding

Very loose to loose sandy soils (10 to 40 tsf) were encountered in the upper 5 to 15 feet at the three CPT locations. Variably weathered sandy limestone was encountered below these upper sandy soils. At CPT-01, the initial layer of weathered limestone extended from about 15 to 20 feet and was able to be penetrated. Under this initial layer of weathered limestone, from about 20 to 30 feet, very soft clayey/sandy soils were encountered. This zone is possibly an infilled solution cavity. At 30 feet, loose to medium sand was found until a harder layer of sandy limestone material resulted in CPT termination at 38.2 feet deep. CPT-01 was terminated due to a combination of harder soils/rock and increasing inclination/bending of the CPT tip, probably as a result of the cone following a seam of weathered rock. AT CPT-02, weathered rock material was encountered at about 10 feet. At 20.1 feet, a very hard layer (about 480 tsf) was encountered, resulting in CPT refusal. AT CPT-03, weathered rock was encountered at about 5 feet. Very hard rock (about 450 tsf) encountered at a depth of about 7.8 feet resulted in CPT termination.

EVALUATION AND RECOMMENDATIONS

The following evaluations and recommendations are based on the project information provided, anticipated loading for the proposed structure based on our experience on similar projects, and the subsurface soil conditions encountered during this geotechnical study.

It is the professional opinion of Ardaman & Associates, Inc. that the test area indicates the presence of sinkhole activity. The standard practice for remedial treatment of sinkholes is deep grout injection. However, as previously mentioned in the project information, the cost of grouting remediation can be relatively high. Due to the unknown volume and extent of buried solution features/voids within the limestone, the cost of grouting is also relatively difficult to estimate.

A less expensive alternate to reduce the potential impact from sinkhole development on structures is to place high strength geotextiles under them. This option is not considered to be as effective as grouting, but it is significantly less expensive with a more certain cost. We don’t recommend it for facilities that could not be readily evacuated such as medical facilities or some classes of commercial structures. For other structures that could readily be evacuated and repaired in the unlikely event of sinkhole development, this approach may be appropriate. It is essential that the owner understand the limit of this alternate sinkhole remediation approach.

The placement of a high strength geotextile under the proposed structures will reduce the localized impact of possible sinkhole formation and allow for observation of and appropriate reaction to sinkhole development in the unlikely event that it occurs within the footprint of proposed structures at this site. We recommend Mirafi HP 370 or engineer approved equal geotextile be placed three feet below the foundations of the proposed structures, then backfilled with compacted fill. The sandy soils anticipated to be excavated are suitable for backfilling and compaction.

Site Preparation Recommendations

The existing surficial soils should be prepared, prior to placement of structural fill and foundation construction on the soils, in accordance with the following site preparation recommendations. The recommended procedures should be covered in the project specifications and completed prior to construction of the foundation system.

1) Prior to construction, the location of any existing underground utility lines within the construction area should be established. Provision should then be made to relocate any interfering utility lines within the construction area to appropriate locations. In this regard, it should be noted that if underground pipes are not properly removed or plugged, they may serve as conduits for subsurface erosion which subsequently may result in excessive settlement. The construction area should be cleared and grubbed of any vegetation, stumps, tree root systems and sod. Organic topsoil should be excavated and removed. As a minimum, it is recommended that the clearing operations extend at least 5 feet beyond the perimeter of the foundation system. Strippings, debris and organic soils should be disposed in accordance with the owner's instructions. Any holes larger than 3 feet in diameter, resulting from the removal of any object, should be ramped to allow compaction of the bottom and sides with mechanical equipment prior to filling.

2) As stated above, this site has a relatively high potential for sinkhole development. Typically, grouting is performed to remediate the impact of sinkhole development and/or subsurface solution features at a site. Grouting is relatively expensive, with highly variable costs associated with filling and/or stabilizing unknown subsurface solution features and/or voids. Since the nature of the proposed structures is that they can be readily evacuated, less expensive measures to reduce the impact of sinkhole development may be considered. One measure includes the steps presented below:

   a) Excavate soil to a minimum depth of 3 feet below the bottom of proposed foundations. This excavation should extend a minimum of 10 feet outside the perimeter of the proposed structures;
   b) Compact the exposed soils to provide a relatively firm and unyielding surface;
   c) Place Mirafi HP 370 or engineer approved equal geotextile. We recommend a minimum overlap of three feet of this material in order to help provide adequate support in the event of sinkhole development;
   d) Backfill excavated sandy soil to a minimum of 95% of their modified Proctor value, in accordance with the recommended fill procedures provided below.

3) It is recommended that within the building area, the natural ground be compacted to a dry density of at least 95 percent of the Modified Proctor maximum dry density (ASTM D-1557) to a minimum depth of 12 inches below the stripped grade. Within parking areas the natural ground should be compacted to a dry density of at least 98 percent of the Modified Proctor maximum dry density (ASTM D-1557) to a minimum depth of 12 inches below the stripped grade. It is recommended that at least one in-place density test be taken for each 2,500 square feet of building area and 5,000 square feet of parking area.

4) During the compaction process, soil moisture contents may need to be controlled in order to facilitate proper compaction. If additional moisture is necessary to achieve compaction objectives of imported structural fill, then water should be applied in such a way that it will not cause erosion or removal of the subgrade soils. In the event that applied water does not penetrate sufficiently deep into natural soils to act as a lubricant in the compaction process, it will be necessary to disk or otherwise break up the soils before and during application of water. A moisture content within two percentage points of the optimum indicated by the modified Proctor test (ASTM D-1557) is recommended prior to compaction of the natural ground and structural fill.

5) After satisfactory completion of the compaction of the exposed subgrade in accordance with the above,

the proposed construction area may be brought up to finished subgrade levels, if required. Acceptable structural fill should consist of fine sand (SP) to slightly silty fine sand (SP-SM) or slightly clayey fine sand (SP-SC) with less than 12 percent passing the No. 200 sieve, free of rubble, organics, clay balls, debris and other unsuitable material. Any off-site structural fill should be tested and approved prior to acquisition. The structural fill material should be placed in loose lifts not exceeding 12 inches in thickness. Each lift should be compacted by repeated passes with appropriate equipment to achieve a minimum of 95 percent of the Modified Proctor maximum dry density (ASTM D-1557) in the structure areas, while a maximum dry density of 98 percent should be achieved in the pavement areas. Density tests to confirm compaction should be performed in each fill lift before the next lift is placed. The placement of structural fill and compaction operations should continue until the desired elevation is achieved. It is recommended that at least one in-place density test be taken for each 2,500 square feet of structural fill placed within the building area per lift, while at least one test for 5,000 square feet of parking area per lift.

6) Continuous wall footing trenches and individual footing pits should be excavated to footing line and bottom grade. Bearing soils should be compacted with suitable mechanical equipment to achieve the specified level of density to the required depth. Foundation bottom grade should be tested to confirm that a minimum density of 95 percent of the Modified Proctor maximum dry density (ASTM D-1557) exists to a depth of 12 inches below footing bottom. If necessary, the bottom of the footing excavation shall be over-excavated, refilled, and recompacted with mechanical equipment to achieve the necessary minimum field density to the required depth. It is recommended that at least one in-place density test be taken per 50 linear foot of continuous wall footing, and at-least one in-place density test be taken in each individual footing pit.

7) In the unlikely event that groundwater is encountered during construction, dewatering measures should be implemented to adequately lower the groundwater levels to a depth of at least one-foot below footing excavations.

8) Immediately prior to placement of the reinforcing steel, it is suggested that the bearing surfaces of all footing and floor slab areas be compacted using hand operated mechanical tampers. In this manner, any localized areas that have been loosened by excavation operations should be adequately recompacted.

<u>Foundation Recommendations</u>

Following the preparation of the subgrade soils as described above, the shallow foundations may be proportioned for a maximum net allowable soil bearing pressure of 2,500 pounds per square foot for individual and continuous footings.

Continuous footings should be a minimum of 18 inches wide, while pad or column footings should be a minimum of 24 inches wide. The minimum footing sizes should be used regardless of whether or not the foundation loads, and allowable bearing pressures dictate a smaller size. These minimum footing sizes tend to provide adequate bearing area to develop bearing capacity and account for minor variations in the bearing materials. It is important that the structural elements be centered on the footings such that the load is transferred evenly, in accordance with Florida Building Code requirements, unless the footings are proportioned for eccentric loads.

All footings should be embedded so that the bottom of foundation is a minimum of 12 inches below adjacent compacted grades on all sides. For exterior foundations, consideration should be given to increasing this depth of embedment to 18 inches. This additional embedment reduces the potential that these exterior foundations will be undermined by adjacent excavations or erosion. Assuming that the site is prepared in accordance with the above recommendations, we estimate that a total settlement of less than one inch will occur, with an estimated differential settlement of one-half inch. Most of the settlement should occur concurrent with structural loading due to the sandy nature of the underlying soils. In addition, all footings should be constructed in a "dry" fashion; it is recommended that the building grades be selected so that normal seasonal high groundwater levels remain at least one foot below footing bases.

Driveway and Parking Areas

As stated previously, we understand a limited amount of driveway and parking area is planned. These areas are currently planned to have three (3) inches of FDOT No. 57 Coarse Aggregate placed. If desired, the Mirafi HP 370 could be placed upon the ground surface to provide separation between the underlying sandy soils and the No. 57 Aggregate.

QUALITY ASSURANCE

Site preparation operations, including preparation of foundation bearing surfaces and compaction of any structural fill, should be observed by an Ardaman & Associates geotechnical engineer or his representative. Observations by our representative are necessary to verify that subsurface conditions, which are revealed during the site preparation operations, are consistent with those found during this geotechnical study, to confirm that the foundation design is being constructed as indicated in the approved construction documents, and to confirm that the earthwork procedures are completed in accordance with the recommendations contained in this report.

CLOSURE

This Report of Geotechnical Engineering Services was prepared for the exclusive use of Genesis Halff. The conclusions made herein are applicable only to those structures and facilities described herein. This geotechnical study was performed in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. Ardaman is not responsible for conclusions and/or recommendations of others based upon the data included in our report.

We appreciate the opportunity to be of service to Genesis Halff on this important project. Should you have any questions in regards to this report, or if we can be of any further assistance, please contact this office. We also have great interest in providing materials testing and inspection services during the construction of this project, and will be pleased to meet with you at your convenience to discuss these engineering services.

Very truly yours,

ARDAMAN & ASSOCIATES, INC.
Florida Certificate of Authorization No. 00005950

Maria M. Chess
Asst. Project Engineer

Martin E. Millburg, P.E.
Senior Geotechnical Engineer
Florida License No. 36584

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Distribution: 1 – Addressee via email (David Goree) dgoree@Halff.com
1 - File

Appendix: Figure 1 – Test Location Plan
CPT Sounding Log
Field Testing Procedures

MARTIN E. MILLBURG LICENSE No. 36584 STATE OF FLORIDA PROFESSIONAL ENGINEER

Digitally signed by: Martin E. Millburg, P.E. DN: CN = Martin E. Millburg, P.E. email = mmillburg@ardaman.com C = US O = Ardaman & Associates, Inc. OU = Geotechnical Engineering Dept. Date: 2019.05.31 09:01:43 -05'00'

APPENDIX

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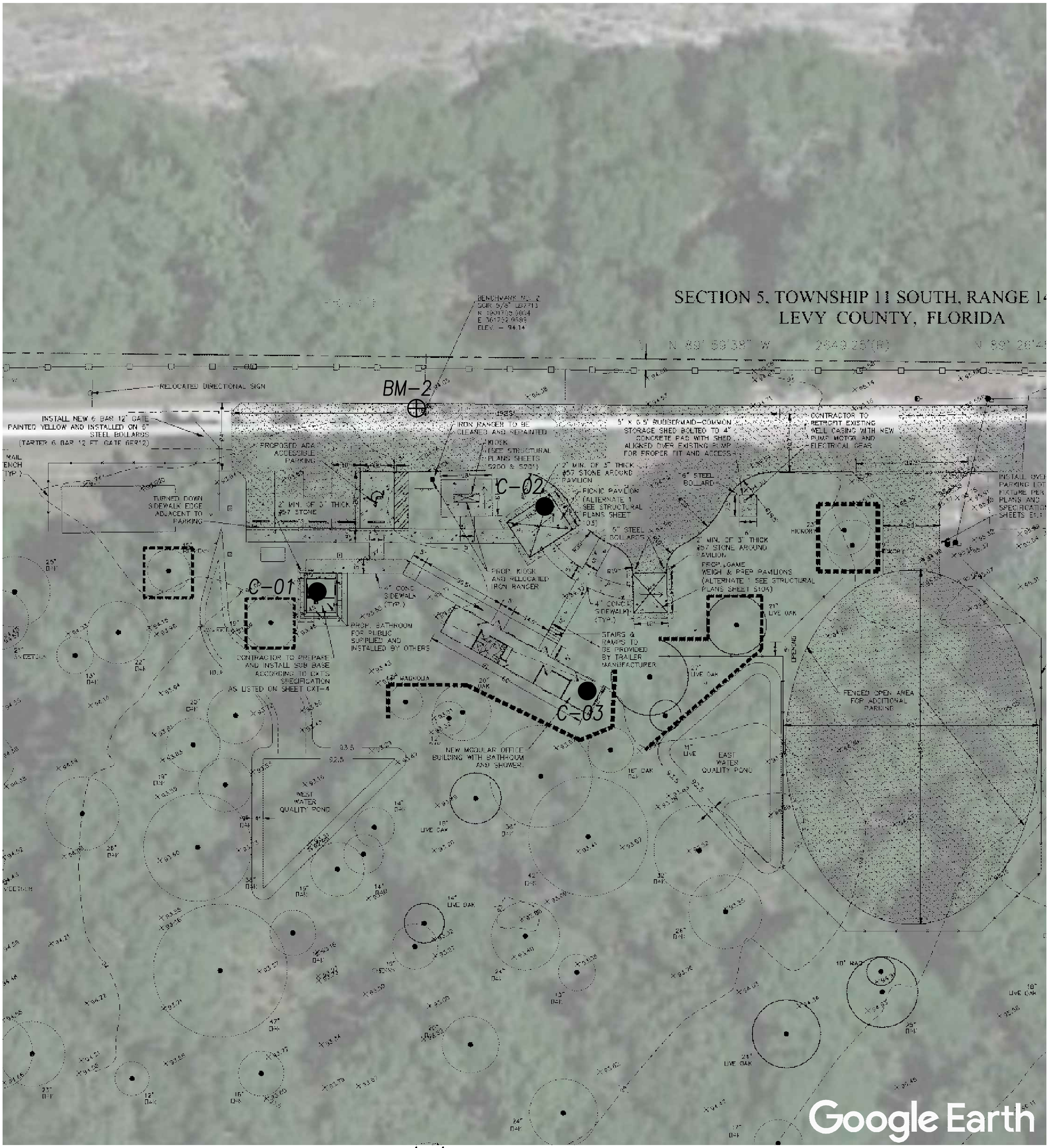

REFERENCE: GOOGLE EARTH PRO 2019 IMAGERY DATED 5/26/2017

LEGEND

● APPROXIMATE LOCATION OF CPT SOUNDING

N

0 25 50

APPROXIMATE SCALE: 1"=50'

TEST LOCATION PLAN

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

ANDREWS WILDLIFE AREA MANAGEMENT
ENTRANCE & FACILITY IMPROVEMENTS
NW 160TH STREET, 900' W OF NW 90TH AVENUE
FANNING SPRINGS, FLORIDA

DRAWN BY:	CHECKED BY:	DATE:
ajd	MC	5/30/19

FILE NO.	APPROVED BY:	FIGURE:
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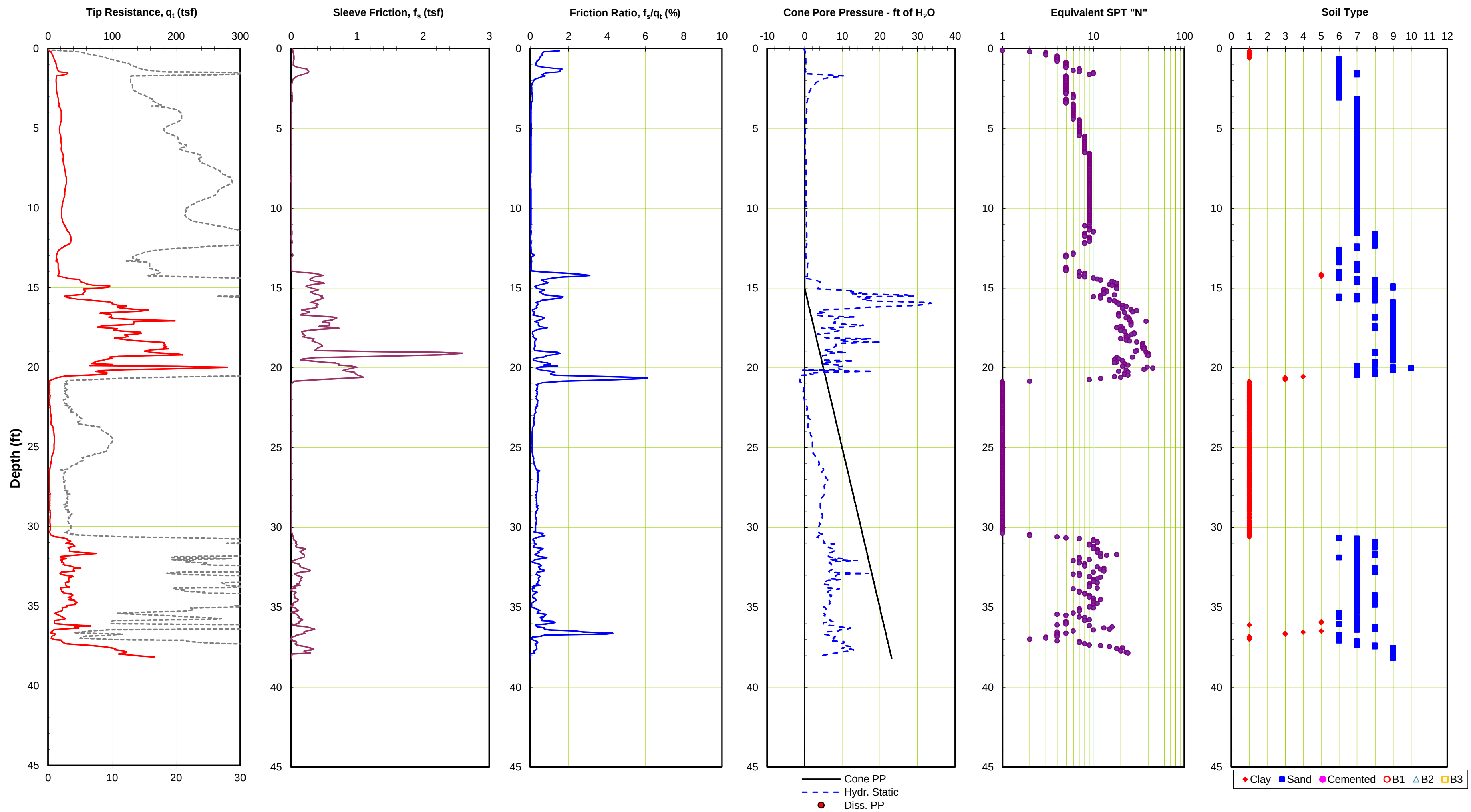


Soil I.D. #	Soil Description
1	Sensitive Fine Grained
2	Organic Material
3	Clay
4	Silty Clay to Clay
5	Clayey Silt to Silty Clay
6	Sandy Silt to Clayey Silt

Soil I.D. #	Soil Description
7	Silty Sand to Sandy Silt
8	Sand to Silty Sand
9	Sand
10	Gravelly Sand to Sand
11	Very Stiff Fine Grained (OC Clay)
12	Sand to Clayey Sand (Cemented)

Notes: Vertek Cone, Pore Pressure at u2

S/N 4644.101XX

CPT-01

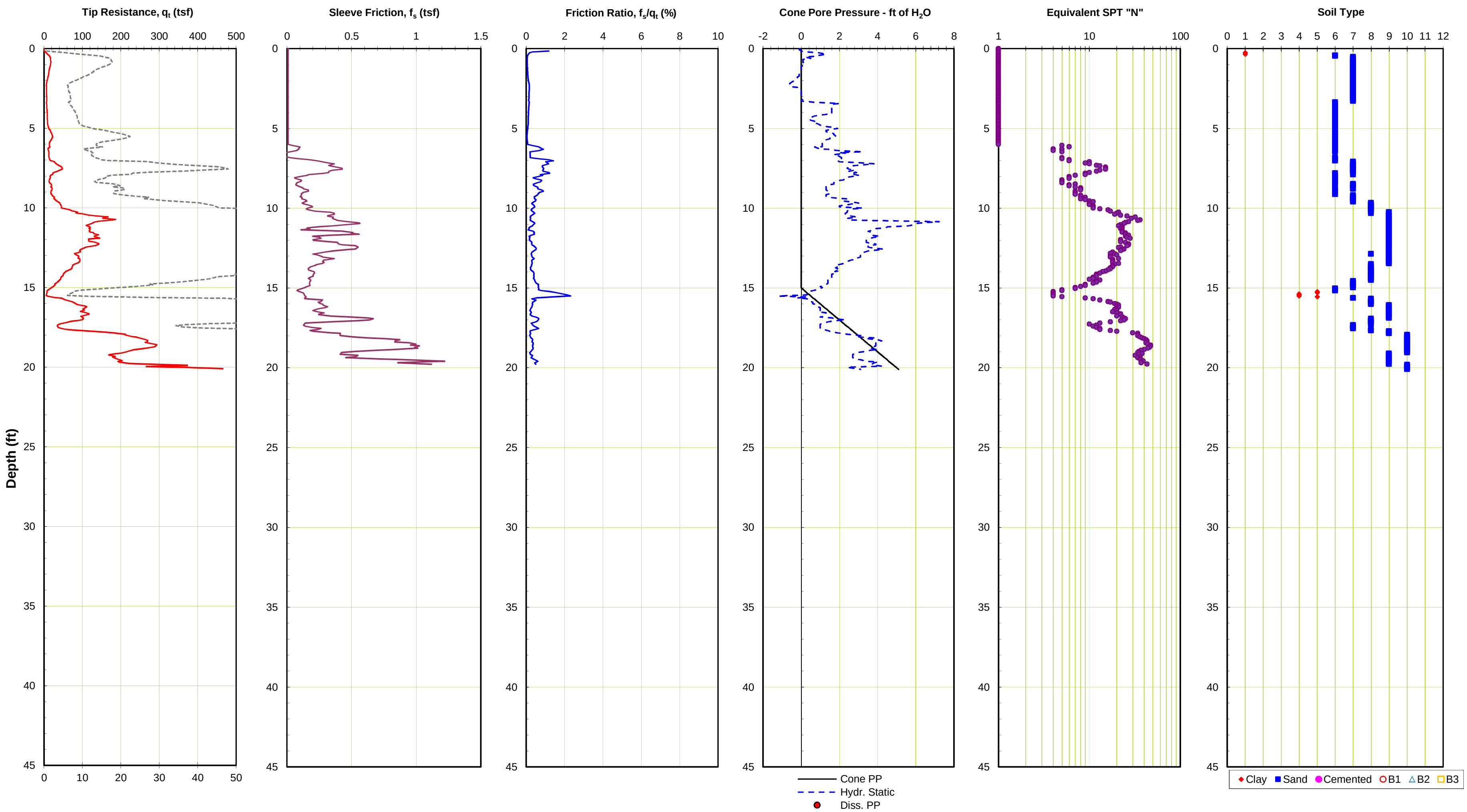
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

Andrews Wildlife Improvement
Fanning Springs, Florida

Job No. 17-55-9492 | Test Date: 5/24/2019

Soil Classification by Robertson et al, 1986

I.D. #'s 11 and 12 are Over Consolidated or Cemented



Soil I.D. #	Soil Description
1	Sensitive Fine Grained
2	Organic Material
3	Clay
4	Silty Clay to Clay
5	Clayey Silt to Silty Clay
6	Sandy Silt to Clayey Silt

Soil I.D. #	Soil Description
7	Silty Sand to Sandy Silt
8	Sand to Silty Sand
9	Sand
10	Gravelly Sand to Sand
11	Very Stiff Fine Grained (OC Clay)
12	Sand to Clayey Sand (Cemented)

Notes: Vertek Cone, Pore Pressure at u2
S/N 4644.101XX

CPT-02

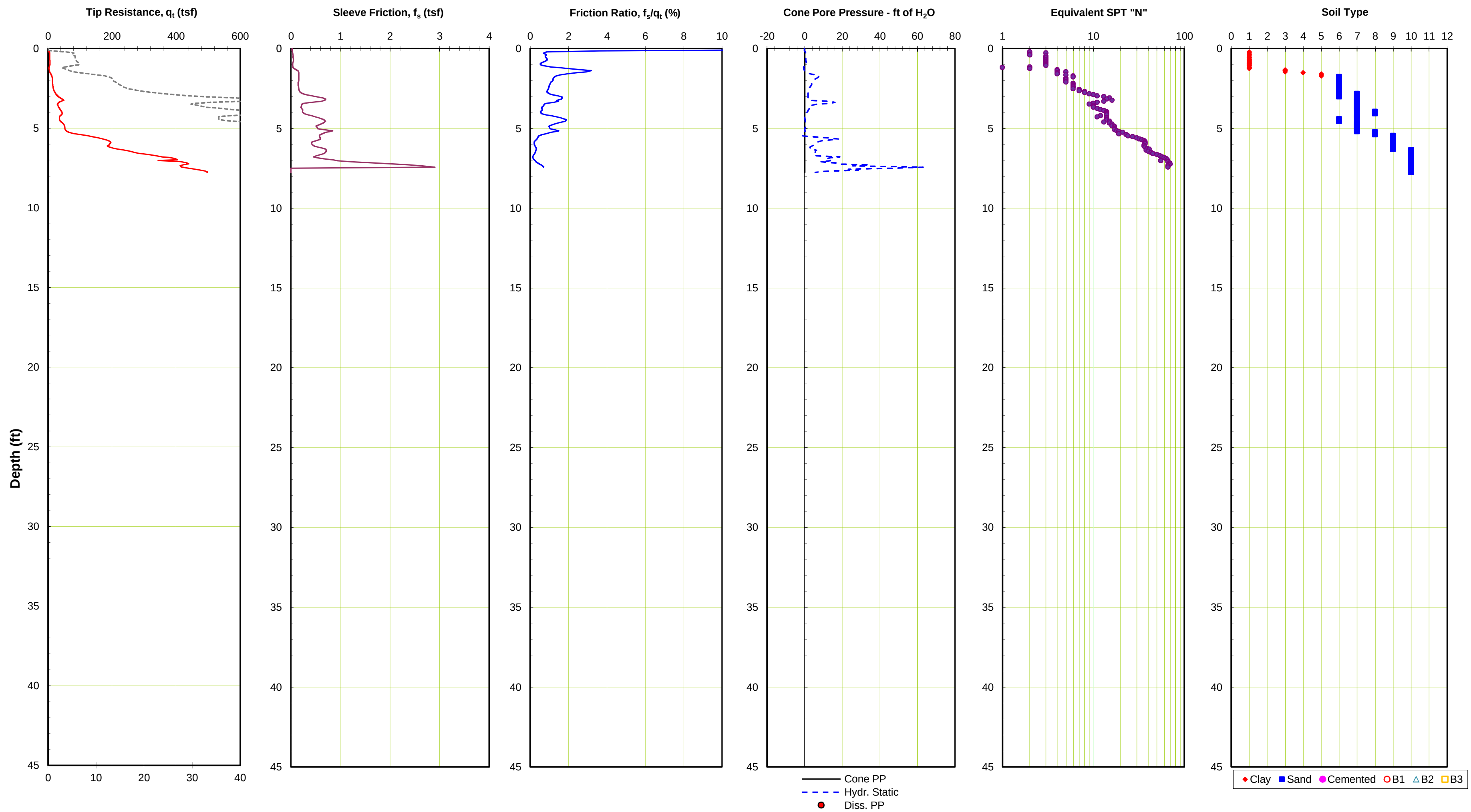
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

Andrews Wildlife Improvement
Fanning Springs, Florida

Job No. 17-55-9492 | Test Date: 5/24/2019

Soil Classification by Robertson et al, 1986

I.D. #'s 11 and 12 are Over Consolidated or Cemented



Soil I.D. #	Soil Description	Soil I.D. #	Soil Description
1	Sensitive Fine Grained	7	Silty Sand to Sandy Silt
2	Organic Material	8	Sand to Silty Sand
3	Clay	9	Sand
4	Silty Clay to Clay	10	Gravelly Sand to Sand
5	Clayey Silt to Silty Clay	11	Very Stiff Fine Grained (OC Clay)
6	Sandy Silt to Clayey Silt	12	Sand to Clayey Sand (Cemented)

Notes: Vertek Cone, Pore Pressure at u2
S/N 4644.101XX

CPT-03

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

Andrews Wildlife Improvement
Fanning Springs, Florida

Job No. 17-55-9492 | Test Date: 5/24/2019

Soil Classification by Robertson et al, 1986

I.D. #'s 11 and 12 are Over Consolidated or Cemented

FIELD TESTING PROCEDURES

Prior to initiating the field activities, the Sunshine State One-Call of Florida, Inc. Call Center (Call Sunshine) was notified of our intent to perform soil test boring, utilizing a drill rig. The location, date, and other operation particulars were provided to allow participating utility companies the opportunity to mark the location of their buried lines, prior to our field activities. No conflicts with underground utilities were encountered at the boring locations.

PIEZOCONE PENETROMETER TEST SOUNDINGS

The site exploration program for this project included the performance of Piezocone Penetration Test ($CPTu_2$) soundings in general accordance with ASTM Standard D-5778. Piezocone exploration techniques were selected in order to improve the quality and continuity of data for evaluation of subsurface conditions. CPT technology is in wide use nationally and internationally, and is recognized as a superior method for site soils characterization, especially when thin layers of soft soil might affect foundation performance or excavation safety. Additionally, $CPTu_2$ soundings allow the collection of pore pressure data that is very useful when evaluating the presence of a vertical seepage gradient which may be indicative of sinkhole activity. The system utilized by Ardaman & Associates, Inc. for this project includes a pore pressure element mounted between the cone tip and the friction sleeve (u_2) to measure water pressures induced by pushing the cone through the soil.

Procedures for use of the friction sleeve cone penetrometer in Florida were developed at the University of Florida in the early 1970's. [1] In 1974, Ardaman & Associates, Inc. developed a Piezocone system for site explorations in difficult soils, [2] and has been a leader in the application of Piezocone technology for site characterization and foundation design. Many others have recognized that the cone penetrometer is the best system for exploration of soil conditions for foundation design [3 4 5].

The characteristics of the Piezocone Penetrometer used by Ardaman for this project are as follows:

Tip Area:	10.0 cm^2
Friction Sleeve:	150 cm^2
Piezometric Element:	U_2, a filter element mounted above the cone tip and below the friction sleeve

The cone is typically inserted and extracted by a high capacity hydraulic jack mounted in a heavy truck, but in certain applications, the cone may be inserted using a drill rig. The cone data acquisition system consists of electronic load cells to measure tip resistance, sleeve friction and pore water pressure. A portable computer is used to collect the load cell data. A complete suite of load cell readings is recorded at least every one second. The correlation with soil properties is detailed in Reference 4, and in a subsequent paper presented to the Transportation Research Board 77th Annual Meeting, Committee A2K01, Soil and Rock Instrumentation by Kurup and Tumay. Calibration testing by Ardaman & Associates, Inc. and many university researchers has shown that cone techniques provided finer resolution of soil profile variations than SPT borings due to the continuity of the measurements. In addition, cone techniques were proven to provide reliable measurement of soil strength.

Extensive testing using cone techniques by Ardaman & Associates in Florida with correlations between SPT borings and CPT data has proven that CPT exploration techniques can provide more vertically detailed

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site characterization data and better data for definition of soil engineering properties than Standard Penetration Test borings.

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[1] The Piezometer Probe", In-Situ Measurement of Soil Properties, Vol. I (ASCE), NC State, Raleigh, Wissa, A.E.Z, Martin, R.T., and Garlanger, J.E., 1975

[2] Guidelines for Cone Penetration Test Performance and Design" Report FHWA-TS-78-209, Federal Highway Administration, Washington, D.C., Schmertmann, J.H., 1978

[3] Penetrometers for Soil Permeability and Chemical detection, P. W. Mayne, PhD, PE and S. E. Burns, PhD, PE; Report to National Science Foundation and U.S. Army Research Office, Georgia Institute of Technology School of Civil and Environmental Engineering, July 1998.

[4] A Continuous Intrusion Electronic Miniature Cone Penetration Test System, M. T. Tumay, PhD, P. U. Kurup, PhD and R. L. Boggess; Geotechnical Site Characterization, Robertson & Mayne (eds) © 1998 Balkema, Rotterdam, ISBN 90 54 10 939 4

[5] National Report on CPT, Mayne, P.W., Mitchell, J. K., Auxt, J.A. and Yilmaz, R. "Proceedings, Cone Penetration Testing (CPT'95), Vol. 1, Linkoping, Sweden, USNS/ISSMFE, Oct 1995, 263-276.