Subsurface Soil Exploration and
Geotechnical Engineering Evaluation
UCNSB Smyrna Substation Improvements
Williamson Boulevard
New Smyrna Beach, Volusia County, Florida

Ardaman & Associates, Inc.

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March 9, 2018
File No. 17-6469

Fred Wilson & Associates, Inc.
2970 Hendrick Avenue
Jacksonville, Florida 32207-5398

Attention: Mr. Ed Wisser, P.E.

Subject: Subsurface Soil Exploration and
Geotechnical Engineering Evaluation
UCNSB Smyrna Substation Improvements
Williamson Boulevard
New Smyrna Beach, Volusia County, Florida

Dear Mr. Wisser:

As requested and authorized, we have completed a shallow subsurface soil exploration for the subject project. The purposes of performing this exploration were to evaluate the general subsurface soil stratigraphy and the depth to the groundwater table at the boring locations and to provide recommendations for site preparation and foundation support. In addition, we have provided ultimate soil strength parameters for deep foundation design and estimated the normal seasonal high groundwater level at the boring locations. This report documents our findings and presents our engineering recommendations.

SITE LOCATION AND SITE DESCRIPTION

The subject substation site is located on Williamson Boulevard in New Smyrna Beach, Volusia County, Florida (Section 21, Township 17 South, Range 33 East). The general site location is shown superimposed on the New Smyrna Beach, Florida U.S.G.S. quadrangle map presented on Figure 1.

The site is currently developed with an existing substation facility and adjacent undeveloped land with vegetation ranging from grass covered to pine trees. We note that standing (i.e.; ponded) water was observed in the undeveloped portions of the subject site during an initial field visit on January 29, 2018 prior to our subsurface soil exploration.

PROPOSED CONSTRUCTION AND GRADING

It is our understanding that the proposed development includes the expansion of the existing substation facility. We understand that typical substation structures including transformers, circuit breakers and bus support structures supported by mat foundations; and pull off towers supported by drilled shaft/pile foundations.
For the purposes of our analysis, we have assumed the maximum loading conditions for the transformers, circuit breakers, and bus supports to be less than 150 kips. Grading plans are not complete at this time, therefore we have assumed that 0 to 2 feet of fill is required to raise the structure areas to final elevations. If actual structure loads, cut depth or fill height exceed our assumptions, then the recommendations in this report may not be valid.

We understand that the stormwater run-off is to be retained on-site.

**REVIEW OF SOIL SURVEY MAPS**

Based on the 1980 Soil Survey for Volusia County, Florida, as prepared by the U.S. Department of Agriculture Soil Conservation Service, the site is located in an area mapped as the “Smyrna fine sand” soil series.

The “Smyrna fine sand” soil series consists of nearly level sandy soil occurring as broad areas in the flatwoods, low-lying areas adjacent to depressions, and low areas within sandhills. The internal drainage of the “Smyrna fine sand” is poor and the soil permeability is moderate or moderately rapid in the subsoil and rapid in the other layers. According to the Soil Survey, the seasonal high water table for the “Smyrna fine sand” soil series is typically within a depth of 10 inches of the natural ground surface.

**FIELD EXPLORATION PROGRAM**

**SPT and Auger Borings**

The field exploration program included performing 5 Standard Penetration Test (SPT) borings, 3 auger borings, and 3 hand auger borings. The SPT borings were advanced to a depth of 40 feet below the ground surface using the methodology outlined in ASTM D-1586. A summary of this field procedure is included in Appendix I. Split-spoon soil samples recovered during performance of the borings were visually classified in the field and representative portions of the samples were transported to our laboratory in sealed sample jars.

The auger borings were drilled using a truck-mounted, 4-inch diameter, continuous flight auger to a depth of 15 feet below the ground surface. A summary of this field procedure is included in Appendix I. Representative soil samples were recovered from the auger borings and transported to our laboratory for further analysis.

The hand auger borings were conducted using a 3-inch diameter manual bucket auger to depths of 2 and 2½ feet below the existing ground surface. Borings could not be advanced deeper than 2 to 2½ feet due to borehole collapse, which is common when manually advancing borings below the water table. A summary of the hand auger boring procedure is included in Appendix I. Representative soil samples were recovered from the auger borings and transported to our laboratory for further analysis.
The groundwater level at each of the boring locations was measured during drilling. The SPT borings were grouted with a cemente bentonite slurry upon completion and the auger borings were backfilled with soil cuttings upon completion.

**Double Ring Infiltrometer Tests**

Three double-ring infiltration (DRI) tests were conducted adjacent to each of the three hand auger borings. The double-ring infiltration tests were conducted in general accordance with ASTM D-3385 procedure, “Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer”.

Prior to running the test, an excavation was made to a depth of 6 inches below ground surface at the test location(s). The double-ring infiltration tests consisted of driving two open cylinders, one inside the other, into the ground at the test locations. The inner ring was seated 4 inches below the bottom of the excavation and the outer ring was seated 8 inches below the bottom of the excavation. The rings were partially filled with water until a constant water level was achieved. A measurement of time versus water volumes added to the rings to maintain a constant water level was then recorded. The test results are presented in the Double Ring Infiltration Tests (DRI) results section of this report.

**Test Locations**

The approximate locations of the borings and DRI tests are schematically illustrated on a boring location plan shown on Figure 2. These locations were staked in the field by the project surveyor.

We note that in order to maintain a safe working distance to existing overhead utilities lines, the auger boring locations were offset to the locations shown on Figure 2. Hand auger borings/DRI tests were conducted at the originally requested locations.

**LABORATORY PROGRAM**

Representative soil samples obtained during our field sampling operation were packaged and transferred to our laboratory for further visual examination and classification. The soil samples were visually classified in general accordance with the Unified Soil Classification System (ASTM D-2488). The resulting soil descriptions are shown on the soil boring profiles presented on Figures 3 through 6.

In addition, we conducted 2 organic content tests (ASTM D2974-87), 2 natural moisture content tests (ASTM D2216), and 2 percent fines analyses (ASTM D1140) on selected soil samples obtained from the borings. The results of these tests are presented adjacent to the sample depth on the boring profiles on Figures 3 through 6.
Corrosion Property Testing

Four soil samples obtained from Borings TH-2 and TH-3 were tested for corrosion properties. Properties tested included pH, resistivity, chloride and sulfate content. Results of the soil corrosivity tests are presented in the following table.

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Sample Depth (feet)</th>
<th>Chloride Content (mg/L)</th>
<th>Sulfate Content (mg/L)</th>
<th>pH</th>
<th>Resistivity (ohm-cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH-2</td>
<td>5</td>
<td>75</td>
<td>BDL</td>
<td>6.43</td>
<td>3,049</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>BDL</td>
<td>137</td>
<td>6.06</td>
<td>3,086</td>
</tr>
<tr>
<td>TH-3</td>
<td>5</td>
<td>BDL</td>
<td>BDL</td>
<td>6.98</td>
<td>16,393</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>45</td>
<td>55</td>
<td>6.48</td>
<td>3,788</td>
</tr>
</tbody>
</table>

*BDL = Below Detectable Limit

GENERAL SUBSURFACE CONDITIONS

General Soil Profile

The results of the field exploration and laboratory programs are graphically summarized on the soil boring profiles presented on Figures 3 through 6. The stratification of the boring profiles represents our interpretation of the field boring logs and the results of laboratory examinations of the recovered samples. The stratification lines represent the approximate boundary between soil types. The actual transitions may be more gradual than implied.

The results of the borings indicate the following general soil profile:

<table>
<thead>
<tr>
<th>Depth Below Ground Surface (feet)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 0</td>
<td>To 5</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>22½</td>
</tr>
<tr>
<td>22½</td>
<td>27½</td>
</tr>
<tr>
<td>27½</td>
<td>40</td>
</tr>
</tbody>
</table>
We note that deleterious organic muck (OH, Pt) was encountered between depths of approximately 1 to 3 feet below the existing ground surface at two boring locations. In addition, we note that substation yard gravel was present at Borings TH-1 and TH-3 to a depth of approximately 1 foot.

The above soil profile is outlined in general terms only. Please refer to Figures 3 through 6 for soil profile details.

**Groundwater Level**

The groundwater level was measured in the boreholes during drilling. As shown on Figures 3 through 6, groundwater was encountered at depths that ranged from 1.8 to 4.4 feet below the existing ground surface on the dates indicated. Fluctuation in groundwater levels should be anticipated throughout the year primarily due to seasonal variations in rainfall and other factors that may vary from the time the borings were conducted.

**NORMAL SEASONAL HIGH GROUNDWATER LEVEL**

The normal seasonal high groundwater level each year is the level in the August-September period at the end of the rainy season during a year of normal (average) rainfall. The water table elevations associated with a higher than normal rainfall and in the extreme case, flood, would be higher to much higher than the normal seasonal high groundwater level. The normal high water levels would more approximate the normal seasonal high groundwater levels.

The seasonal high groundwater level is affected by a number of factors. The drainage characteristics of the soils, the land surface elevation, relief points such as drainage ditches, lakes, rivers, swamp areas, etc., and distance to relief points are some of the more important factors influencing the seasonal high groundwater level.

Based on our interpretation of the site conditions using our boring logs, we estimate the normal seasonal high groundwater level at the boring locations to be approximately at the levels indicated in Figures 3 through 6.

We note that the estimated normal seasonal high groundwater level is at or above the existing ground surface at some boring locations (referenced “AOGS” on Figures 3 through 6). The height to which water may rise above the existing ground surface should be determined by the drainage engineer.

**ENGINEERING EVALUATION AND RECOMMENDATIONS –SOIL PARAMETERS FOR DEEP FOUNDATIONS DESIGN**

We understand that piles or drilled shaft foundations may be designed for this project. For this purpose, classification in accordance with the Unified Soil Classification System, along with estimates of the unit weights, the angle of internal friction, and the moduli of lateral subgrade reaction for the types of soil encountered in the borings are presented in Table 1.
The following should be noted when reviewing Table 1:

- \( \gamma_{\text{Buoyant}} = \gamma_{\text{Sat}} - \gamma_{\text{Water}} \)
- Values given in Table 1 were based on empirical correlations with the average soil conditions encountered in the referenced borings. Appropriate safety factors should be used with these values.

We caution that the soil layers shown in Table 1 are very generalized and should be used for design purposes only. The soil stratigraphy on the boring logs (Figures 3 and 4) are more detailed than presented in Table 1. The information in Table 1 should not be used for assessing the constructability of the structure foundations.

ENGINEERING EVALUATION AND RECOMMENDATIONS – TRANSFORMERS, CURCUI T BREAKERS AND BUS SUPPORTS

General

The results of our exploration indicate that, with proper site preparation as recommended in this report, the existing soils with the exception of the deleterious organic muck are suitable for supporting the proposed transformers, circuit breakers and bus support structures on conventional shallow foundation systems. Mat foundations should provide an adequate support system for the structures.

Deleterious organic muck (Stratum 5 on Figure 3 through 6) was encountered at depths between 1 and 3 feet deep in Borings TH-1 and AB-C. Organic muck, including to deeper depths, may be present at unexplored locations. Because of the potential for large total and differential settlements, deleterious organic muck should not be used as a foundation soil and should be completely removed (i.e. “demucked”) in accordance with the recommendations presented in this report.

The fine sand with silt containing organics as encountered in Borings TH-4 and TH-5 did not contain enough organics to be considered unsuitable, if it is properly compacted. However, it did contain enough organics to make it difficult to moisture condition and compact. It may be more cost effective to remove the fine sand with silt containing organics and replace it with suitable compacted fill soils that are relatively free of organics, than to go to the additional effort to moisture condition and compact these soils. We caution that if the fine sand with silt with organics as encountered in the previously mentioned borings had a relatively small increase in organic content, it would be considered deleterious organic muck. This could be the case at unexplored locations.

The following are our recommendations for overall site preparation and foundation support which we feel are best suited for the proposed facility and existing soil conditions. The recommendations are made as a guide for the design engineer and/or architect, parts of which should be incorporated into the project's specifications.
**Stripping and Grubbing**

The "footprints" of the proposed development area, plus a minimum margin of five feet, should be stripped of all substation yard gravel, surface vegetation, stumps, debris, organic topsoil or other deleterious materials, as encountered. Specifically, the organic topsoil as encountered in the borings to a depth of three inches should be stripped.

After stripping, the site should be grubbed or root-raked such that roots with a diameter greater than \( \frac{1}{2} \) inch, stumps, or small roots in a dense state, are completely removed. The actual depth(s) of stripping and grubbing must be determined by visual observation and judgment during the earthwork operation.

All existing foundations, slabs, asphalt, and any other underground structures should be removed from the proposed construction area. If pipes or any collapsible or leak prone utilities are not removed or completely filled (with grout or concrete), they might serve as conduits for subsurface erosion resulting in excessive settlements. Over-excavated areas resulting from the removal of underground structures and unsuitable materials should be backfilled in accordance with the fill soils section of this report. This excavation must not undermine the existing structure foundation(s).

Provide shoring, bracing, and/or underpinning of existing structures as necessary to protect from failure.

It has been our experience that soils in the vicinity of existing developments sometimes contain pockets of construction debris or other deleterious materials requiring removal and replacement with compacted clean fine sands. Therefore, we recommend that the stripped surface be inspected by Ardaman & Associates, Inc.

**Demucking**

The deleterious organic muck (Stratum 5 as shown on the boring profiles) should be removed (demucked) to its entire vertical limits and to a minimum horizontal margin equivalent to the depth of the deleterious material outside the development area. A minimum horizontal margin of 5 feet should be used if the depth to the bottom of the deleterious material is less than 5 feet.

The excavated organic muck must not be used as fill material and should be disposed of as directed by the owner. Excavation and backfilling operations should be monitored continuously by a representative of Ardaman & Associates to verify that the unsuitable material is removed and that backfill soils are suitable and well compacted.

Excavation slopes and/or bracing are the responsibility of the contractor. However, at a minimum, all excavations should be sloped and/or braced to meet the requirements of the Occupational Health and Safety Administration (OSHA) latest Standards.
If the excavation extends below the groundwater table, the control of the groundwater will be required. Excavation and backfilling should be conducted “in-the-dry”. The use of well points, rim ditches, sheet piles, etc. may be required to help control groundwater during excavation and backfilling. Regardless of the dewatering method used, we recommend that the groundwater table be maintained at least 24 inches below earthwork and compaction surfaces.

Actual limits of muck removal will be determined based on visual observation during construction. The final quantity of muck removal should be determined after excavation has been completed using methods such as truck volume and/or survey conducted during removal of the deleterious material.

**Proof-rolling**

We recommend proof-rolling the cleared and/or demucked surface to locate any unforeseen soft areas or unsuitable surface or near-surface soils, to increase the density of the upper soils, and to prepare the existing surface for the addition of the fill soils (as required). Proof-rolling of the structure areas should consist of at least 10 passes of a compactor capable of achieving the density requirements described in the next paragraph. Each pass should overlap the preceding pass by 30 percent to achieve complete coverage. If deemed necessary, in areas that continue to "yield", remove all deleterious material and replace with clean, compacted sand backfill. The proof-rolling should occur after cutting and before filling.

A density equivalent to or greater than 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value for a depth of 2 feet in the structure areas must be achieved beneath the stripped and grubbed and/or demucked ground surface. Additional passes and/or overexcavation and compaction may be required if these minimum density requirements are not achieved. The soil moisture should be adjusted as necessary during compaction.

Proof-rolling may cause upward movement or "pumping" of the groundwater. However, we recommend that the existing surface be level and firm prior to the addition of fill soils. Proof-rolling with a front-end loader may help achieve the desired surface and compaction condition before adding the fill soils. The site should be dewatered as necessary. Depending on the time of year, a 12- to 18-inch layer of clean fine sand (SP) fill may be required prior to proof-rolling.

Care should be exercised to avoid damaging any neighboring structures while the compaction operation is underway. Prior to commencing compaction, occupants of adjacent structures should be notified and the existing condition (i.e. cracks) of the structures documented with photographs and survey (if deemed necessary). Compaction should cease if deemed detrimental to adjacent structures, and Ardaman & Associates should be notified immediately. Heavy vibratory compaction should not be used within 200 feet of existing structures.

**Suitable Fill Material and Compaction of Fill Soils**

All fill materials should be free of organic materials, such as roots and vegetation. We recommend using fill with less than 12 percent by dry weight of material passing the U.S. Standard No. 200
sieve size. The fine sand and fine sand with silt (Strata No. 1 and 2 without roots, and/or organics as shown on Figures 3 through 6 and any other objectionable material) are suitable for use as fill materials and, with proper moisture control, should densify using conventional compaction methods.

All structural fill should be placed in level lifts not to exceed 12 inches in compacted thickness. Each lift should be compacted to at least 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value. The filling and compaction operations should continue in lifts until the desired elevation(s) is achieved. If hand-held compaction equipment is used, the lift thickness should be reduced to no more than 6 inches.

The use of soils with relatively high fines content (i.e.; silty and clayey soils) as fill should be avoided near the ground surface in green-space areas since these relatively low permeability soils promote ponding of water during and following rainfall. Also, in high groundwater areas, silty and clayey soils may cause a rise in the water table elevation due to capillary action. Additionally, these relatively low permeability soils should not be used directly beneath any pavement section as they may trap water within the pavement section leading to premature pavement failure.

Our fill soil recommendations do not apply to the pond area or to areas of the substation yard or adjacent greenspace that will be used for stormwater treatment as the pond designer should recommend types of fill, if any, in the stormwater areas that are compatible with the design.

**Foundation Support by Mat Foundation and Foundation Compaction Criteria**

Excavate the foundations to the proposed bottom of slab elevation and, thereafter, verify the in-place compaction for a depth of 2 feet below the slab bottom. If necessary, compact the soils at the bottom of the excavations to at least 95 percent of the modified Proctor maximum dry density (ASTM D-1557) for a depth of 2 feet below the slab bottom. Based on the existing soil conditions and, assuming the above outlined site preparation and compaction criteria are implemented, an allowable soil bearing pressure of up to 1,500 psf across the bottom of the foundations should result in total settlement of 1-inch or less, and differential settlement up to 3/4-inch.

Any mat foundation in which the loading exceeds 150 kips or the bearing pressure exceeds 1,500 psf over an area greater than 100 square feet, respectively, should be individually analyzed for settlement once the actual loading information and foundation sizes are known.

**Dewatering**

The control of the groundwater will be required to achieve the necessary stripping, demucking, and subsequent construction, backfilling, and compaction requirements presented in the preceding sections. The requirement for control of groundwater should particularly be anticipated for footing and utility excavations. The actual method(s) of dewatering should be determined by the contractor. However, regardless of the method(s) used, we suggest drawing down the water table sufficiently, say 2 to 3 feet, below the bottom of any excavation or compaction surface to preclude “pumping” and/or compaction-related problems with the foundation soils.
Double Ring Infiltration Test (DRI) Results

The results of the Double Ring Infiltration (DRI) tests are presented in the following table.

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Measured Infiltration Rate (Feet/Day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRI-1</td>
<td>0.0</td>
</tr>
<tr>
<td>DRI-2</td>
<td>0.0</td>
</tr>
<tr>
<td>DRI-3</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Please refer to Appendix I for detailed test measurements.

QUALITY ASSURANCE

We recommend establishing a comprehensive quality assurance program to verify that all site preparation and foundation and pavement construction is conducted in accordance with the appropriate plans and specifications. Materials testing and inspection services should be provided by Ardaman & Associates.

As a minimum, an on-site engineering technician should monitor all test pits, removal of deleterious material, stripping and grubbing, and demucking to verify that deleterious materials have been removed and should observe the proof-rolling operation to verify that the appropriate number of passes are applied to the subgrade. In-situ density tests should be conducted during filling activities and below all footings to verify that the required densities have been achieved. In-situ density values should be compared to laboratory Proctor moisture-density results for each of the different natural and fill soils encountered.

Finally, we recommend inspecting and testing the construction materials for the foundations and other structural components.

IN-PLACE DENSITY TESTING FREQUENCY

In Central Florida, earthwork testing is typically performed on an on-call basis when the contractor has completed a portion of the work. The test result from a specific location is only representative of a larger area if the contractor has used consistent means and methods and the soils are practically uniform throughout. The frequency of testing can be increased and full-time construction inspection can be provided to account for variations. We recommend that the following minimum testing frequencies be utilized.

In proposed structural areas, a minimum frequency of one in-place density test for each 2,500 square feet of area should be used. In-place density testing should be performed at this minimum frequency for a depth of 2 feet below natural ground and for every 1-foot lift of fill placed in the

Fred Wilson & Associates, Inc.
File No. 17-6469
structural area. In addition, density tests should be performed in each mat foundation for a depth of 2 feet below the bearing surface.

Representative samples of the various natural ground and fill soils should be obtained and transported to our laboratory for Proctor compaction tests. These tests will determine the maximum dry density and optimum moisture content for the materials tested and will be used in conjunction with the results of the in-place density tests to determine the degree of compaction achieved.

**CLOSURE**

The analyses and recommendations submitted herein are based on the data obtained from the soil borings presented on Figures 3 through 6 and the assumed loading conditions. This report does not reflect any variations which may occur adjacent to or between the borings. The nature and extent of the variations between the borings may not become evident until during future exploration and/or construction. We recommend performing test pits to further explore for the presence of deleterious organic muck. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report after performing on-site observations during the construction period and noting the characteristics of the variations.

In the event any changes occur in the design, nature, or location of the proposed facility, we should review the applicability of conclusions and recommendations in this report. We recommend a general review of final design and specifications by our office to verify that earthwork and foundation recommendations are properly interpreted and implemented in the design specifications. Ardaman and Associates should attend the pre-bid and preconstruction meetings to verify that the bidders/contractor understand the recommendations contained in this report.

This study is based on a relatively shallow exploration and is not intended to be an evaluation for sinkhole potential. This study does not include an evaluation of the environmental (ecological or hazardous/toxic material related) condition of the site and subsurface.

This report has been prepared for the exclusive use of Fred Wilson & Associates in accordance with generally accepted geotechnical engineering practices for the purpose of the subject project. No other warranty, expressed or implied, is made.
We are pleased to be of assistance to you on this phase of the project. When we may be of further service to you or should you have any questions, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

[Signature]
Virginia A. Goff, E.I.
Assistant Project Engineer

[Stamp]
Charles H. Cunningham, P.E.
Orlando Branch Manager
Florida License No. 98189

3-9-18
**TABLE 1**
RECOMMENDED DESIGN SOIL PARAMETERS
UCNSB Smyrna Substation
Williamson Boulevard
New Smyrna Beach, Volusia County, Florida

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Depth Below Ground Surface (ft)</th>
<th>Soil Type¹</th>
<th>Avg. SPT “N” Value</th>
<th>Unit Weight (pcf)</th>
<th>Unit Weight (pcf)</th>
<th>Φ² (degrees)</th>
<th>C (psf)</th>
<th>Earth Pressure Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>γₘoist</td>
<td>γ₈₅T</td>
<td></td>
<td></td>
<td>Ka³</td>
</tr>
<tr>
<td>TH-1</td>
<td>1-2</td>
<td>SP</td>
<td>--</td>
<td>95</td>
<td>100</td>
<td>28</td>
<td>--</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>2-3</td>
<td>OH, Pt</td>
<td>--</td>
<td>95</td>
<td>100</td>
<td>24</td>
<td>--</td>
<td>0.59</td>
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<tr>
<td></td>
<td>3-6½</td>
<td>SP, SP-SM</td>
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<td>95</td>
<td>100</td>
<td>28</td>
<td>--</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>6½-22½</td>
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<td>--</td>
<td>115</td>
<td>31</td>
<td>--</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>22½-27½</td>
<td>SC</td>
<td>3</td>
<td>--</td>
<td>100</td>
<td>28</td>
<td>--</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>27½-32½</td>
<td>SC</td>
<td>13</td>
<td>--</td>
<td>115</td>
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<td></td>
<td>32½-40</td>
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<td>33</td>
<td>--</td>
<td>0.46</td>
</tr>
<tr>
<td>TH-2</td>
<td>0-5</td>
<td>SP, SP-SM</td>
<td>--</td>
<td>95</td>
<td>100</td>
<td>28</td>
<td>--</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>5-22½</td>
<td>SP, SP-SM</td>
<td>11</td>
<td>105</td>
<td>110</td>
<td>30</td>
<td>--</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>22½-27½</td>
<td>SP-SM</td>
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(1) Unified Soil Classification System (refer to Figures 3 and 4).
(2) Reference: after Teng. 1962
(3) $K_o = 1 - \sin(\Phi)$
(4) $K_a = \tan^2(45 - \Phi/2)$
(5) $K_p = \tan^2(45 + \Phi/2)$
(6) $\gamma_{Buoyant} = \gamma_{Sat} - \gamma_{Water}$
(7) $\Phi$: angle of internal friction; $C$: cohesion; $K_o$: at-rest earth pressure; $K_a$: active earth pressure; $K_p$: passive earth pressure
### TABLE 1 (CONTINUED)
#### RECOMMENDED DESIGN SOIL PARAMETERS

UCNSB Smyrna Substation  
Williamson Boulevard  
New Smyrna Beach, Volusia County, Florida

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<th>Boring No.</th>
<th>Depth Below Ground Surface (ft)</th>
<th>Soil Type$^1$</th>
<th>Avg. SPT “N” Value</th>
<th>Unit Weight (pcf)</th>
<th>$\Phi$ (degrees)</th>
<th>C (psf)</th>
<th>Earth Pressure Coefficients</th>
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<td>117</td>
<td>32</td>
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<td>0.47 0.31 3.25</td>
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(6) $\gamma_{\text{buoyant}} = \gamma_{\text{SAT}} - \gamma_{\text{Water}}$  
(7) $\Phi$: angle of internal friction; C: cohesion; $K_o$: active earth pressure; $K_p$: passive earth pressure; $K_o$: at-rest earth pressure
SECTION 21
TOWNHIP 17 SOUTH
RANGE 33 EAST

OBTAINED FROM U.S.G.S. QUAD MAP; NEW SMYRNA BEACH, FLORIDA 1958
(PHOTOREVISIED 1983)
LEGEND

- **TH**: STANDARD PENETRATION TEST (SPT) BORING LOCATION
- **AB**: AUGER BORING LOCATION
- **HAB**: HAND AUGER BORING LOCATION
- **DRI**: DOUBLE RING INFILTRATION TEST LOCATION

**NOTE**: THE BASE MAP FOR THE BORING LOCATION PLAN IS A SITE PLAN BY FRED WILSON AND ASSOCIATES, INC. DATED 01/24/18.
SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP-SM)
3. FINE SAND WITH CLAY (SP-SC)
4. CLAYEY FINE SAND (SC)
5. ORGANIC MUCK/PEAT (OH-P)
6. SUBSTATION YARD GRAVEL

TH
STANDARD PENETRATION TEST (SPT) BORING
N
STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT

LEGEND

COLORS

A LIGHT BROWN TO BROWN
B LIGHT ORANGE BROWN
C LIGHT GRAY TO GRAY
D DARK GRAY OR DARK BROWN

NOTES:
1) UPON COMPLETION OF EACH SPT BORING, THE BOREHOLE WAS GROUTED WITH CEMENT-BENTONITE SLURRY.
2) ALL SPT BORINGS WERE PERFORMED USING A SAFETY HAMMER IN THE UPPER 10 FEET AND AN AUTOMATIC HAMMER BELOW 10 FEET TO THE BORING TERMINATION DEPTH. AUTOMATIC HAMMER N-VALUES MAY BE CONVERTED TO EQUIVALENT SAFETY HAMMER N-VALUES BY MULTIPLYING BY 1.24.

SHELL CONTENT
TRACE: <5%
FEW: 5 TO 10%
LITTLE: 15 TO 25%
SOME: 30 TO 45%
MOSTLY: 50 TO 100%

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION

BLOW COUNT "N"

VERY LOOSE
<4

LOOSE
4 TO 10

MEDIUM DENSE
10 TO 30

DENSE
30 TO 50

VERY DENSE
>50

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR.

SOIL BORING PROFILES

SUBSURFACE SOIL EXPLORATION
LOMELI CANTIDAD IRRIGATION IMPROVEMENTS
NEW SMYRNA BEACH, FLORIDA

Arteaga & Associates, Inc.
Comprehensive Environmental and Geotechnical Services

Sheet No. 3
Printed by:\n4-23-18
Page 3
SUBSURFACE SOIL DESCRIPTIONS

LEGEND

SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP-SM)
3. FINE SAND WITH CLAY (SP-SC)
4. CLAYEY FINE SAND (SC)
5. ORGANIC MUCK/PEAT (OH, Pt)
6. SUBSTATION YARD GRAVEL

COLORS

1. LIGHT BROWN TO BROWN
2. LIGHT ORANGE BROWN
3. LIGHT GRAY TO GRAY
4. DARK GRAY OR DARK BROWN

TH STANDARD PENETRATION TEST (SPT) BORING
N STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
GROUNDWATER LEVEL MEASURED ON DATE DRILLED
ESTIMATED NORMAL SEASONAL GROUNDWATER LEVEL
AOGS AT OR ABOVE GROUND SURFACE
NM NATURAL MOISTURE CONTENT IN PERCENT (ASTM D-2216)
OC ORGANIC CONTENT IN PERCENT (ASTM D-2974)
SP,SP-SM UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)
SM,SC,CH

NOTES:
1) UPON COMPLETION OF EACH SPT BORING, THE BOREHOLE WAS GROUTED WITH CEMENT-BENTONITE SLURRY.
2) ALL SPT BORINGS WERE PERFORMED USING A SAFETY HAMMER IN THE UPPER 10 FEET AND AN AUTOMATIC HAMMER BELOW 10 FEET TO THE BORING TERMINATION DEPTH. AUTOMATIC HAMMER N-VALUES MAY BE CONVERTED TO EQUIVALENT SAFETY HAMMER N-VALUES BY MULTIPLYING BY 1.24.

ENGINEERING CLASSIFICATION

COHESIONLESS SOILS

DESCRIPTION

BLOW COUNT "N"

VERY LOOSE

<4

LOOSE

4 TO 10

MEDIUM DENSE

10 TO 30

DENSE

30 TO 50

VERY DENSE

>50

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR.
WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED. GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR.
While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and may be encountered. The boring logs and related information are based on the driller’s logs and visual examination of selected samples in the laboratory. The delineation between soil types shown on the logs is approximate and the description represents our interpretation of subsurface conditions at the designated boring locations on the particular date drilled. Groundwater elevations shown on the boring logs represent groundwater surfaces encountered on the dates shown. Fluctuations in water table levels should be anticipated throughout the year.
APPENDIX I

Standard Penetration Test, Auger, and Hand Auger Boring Procedures
**STANDARD PENETRATION TEST**

The standard penetration test is a widely accepted test method of *in situ* testing of foundation soils (ASTM D 1586). A 2-foot long, 2-inch O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 30 inches. The number of blows needed for each 6 inches of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch increments of penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual examination and classification of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load.

The tests are usually performed at 5-foot intervals. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is a bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, NX-size flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid.

Representative split-spoon samples from the soils are brought to our laboratory in air-tight jars for further evaluation and testing, if necessary. Samples not used in testing are stored for 30 days prior to being discarded.
AUGER BORINGS

Auger borings are used when continuous sampling of soil strata close to ground surface is desired. A 4-inch diameter, continuous flite, helical auger with a cutting head at its end is screwed into the ground in 5-foot sections. It is powered by the rotating action of the Kelly bar of a rotary drill rig. The sample is recovered by withdrawing the auger out of the ground without rotating it. The soil sample so obtained, is classified and representative samples put in bags or jars and brought back to the laboratory for classification testing.
HAND AUGER BORINGS

Auger borings are used when continuous sampling of soil strata close to ground surface is desired. A 3-inch diameter, hand-held bucket auger with a cutting head at its end is screwed into the ground in 1-foot sections. The sample is recovered by withdrawing the auger out of the ground without rotating it. The soil sample so obtained, is classified and representative samples put in bags or jars and brought back to the laboratory for classification testing.
APPENDIX II

Double-Ring Infiltration Test Results
## DOUBLE-RING INFILTRATION TEST RESULTS

(ASTM STANDARD D-3385)

**Project:** UCNSB Substation Improvements  
**Location:** DRI-A  
**A & A File No.:** 17-6469  
**Date:** 2/19/17

### AREA (in^2)
- Inner Ring: 113.1
- Outer Ring: 452.4
- Annular Space: 339.3

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<td>CUMMUL INTAKE (ml)</td>
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### Graph
- **Infiltration Rate (ft/day)** vs **Time (minutes)**
- **Inner Ring**
- **Outer Ring**
DOUBLE-RING INFILTRATION TEST RESULTS  

(ASTM STANDARD D-3385)

Project: UCNSB Substation Improvements  
Location: DRI-B  
A & A File No.: 17-6469  
Date: 2/19/17

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### Infiltration Rate (ft/day)

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### Graph

- **Inner Ring**
- **Outer Ring**

**Infiltration Rate (ft/day)** vs **Time (minutes)**
## DOUBLE-RING INFILTRATION TEST RESULTS

*(ASTM STANDARD D-3385)*

**Project:** UCNSB Substation Improvements  
**Location:** DRI-C  
**A & A File No.:** 17-6469  
**Date:** 2/19/17

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**AREA (in^2):**  
- Inner Ring: 113.1  
- Outer Ring: 452.4  
- Annular Space: 339.3

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**Graph:**
- **Infiltration Rate (ft/day)** vs **Time (minutes)**
  - Graph shows infiltration rates for Inner and Outer Ring.
  - Inner Ring: Orange line  
  - Outer Ring: Blue line