UNIVERSAL
ENGINEERING SCIENCES

GEOTECHNICAL EXPLORATION

Proposed Buford Spring Boardwalk
Chaassahowitzka Wildlife Management Area
Weeki Wachee, Florida

UES Project No. 0830.1700203

PREPARED FOR:

Bowman Consulting Group, Ltd.
301 SE Ocean Blvd Suite 301
Stuart, FL 34994

PREPARED BY:

Universal Engineering Sciences
9802 Palm River Road
Tampa, Florida 33619
(813) 740-8506

October 26, 2017

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October 26, 2017

Bowman Consulting Group, Ltd.
301 SE Ocean Blvd Suite 301
Stuart, FL 34994

Attention: Steve Brickley

Reference: Geotechnical Exploration
Proposed Buford Spring Boardwalk
Chaassahowitzka Wildlife Management Area
Weeki Wachee, Florida
UES Project No. 0830.1700203
UES Report No. 1501611

Dear Mr. Brickley:

Universal Engineering Sciences, Inc. (UES) has completed a geotechnical exploration on the above-referenced site in Weeki Wachee, Florida. Our scope of services was in general accordance with UES Proposal # 0830.0817.16, dated August 31, 2017, and authorized by you on September 21, 2017.

This report contains the results of our study, an engineering interpretation of the subsurface data obtained with respect to the project characteristics described to us, geotechnical design recommendations, and general construction and site preparation considerations.

We appreciate the opportunity to have worked with you on this project and look forward to a continued association with Bowman Consulting Group, Ltd. Please do not hesitate to contact us if you should have any questions, or if we may further assist you as your plans proceed.

Respectfully submitted,

UNIVERSAL ENGINEERING SCIENCES, INC.
Certificate of Authorization No. 549

Dušan Jovanović
Senior Project Manager

MARK K. HARDY
LICENSE
NO. 57233
STATE OF FLORIDA
PROFESSIONAL ENGINEER

Mark K. Hardy, P.E.
Regional Manager
Professional Engineer No. 57233
Date: 10/26/2017

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LIST OF APPENDICES

1.0 INTRODUCTION

1.1 GENERAL

In this report we present the results of our geotechnical exploration on the site of the proposed Buford Spring Boardwalk, located within Chaassahowitzka Wildlife Management Area, in Weeki Wachee, Hernando County, Florida. This report contains the results of our study, an engineering interpretation of the subsurface data obtained with respect to the project characteristics described to us, and our recommendations for geotechnical design and general site preparation. Our scope of services was in general accordance with UES Proposal #0830.0817.16, authorized by you on September 21, 2017.

1.2 PROJECT DESCRIPTION

We understand that the project consists of an above ground board walk. We were provided with a copy of the preliminary site layout and used this in planning our exploration.

No preliminary design plans, grading plans, or anticipated structural loads were available for our analyses. We have assumed that construction will proceed on existing grade. Further, we have assumed that loads on individual pilings will be 4 kips or less and will be subject to pedestrian traffic only.

Our geotechnical recommendations are based upon the above assumptions and considerations. If any of this information is incorrect or if you anticipate any changes, please inform Universal Engineering Sciences so that we may review our recommendations, and make revisions as needed.

A general location map of the project area appears in Appendix A: Site Location Map. Also included in Appendix A for your reference are a Site Aerial Photograph, USGS Site Topographic Map and SCS Soil Survey Map.

2.0 PURPOSE AND METHODOLOGIES

2.1 PURPOSE

The purpose of our services was:

- to explore the general subsurface conditions at the site using auger borings supplemented by hand cone penetrometer probing;
- to interpret and review the subsurface conditions with respect to the proposed construction as it was described to us; and
- to provide geotechnical engineering design information and recommendations, and general recommendations for site preparation.

This report presents an evaluation of site conditions on the basis of traditional geotechnical procedures for site characterization. The recovered samples were not examined, either visually or analytically, for chemical composition or environmental hazards.

Our study was confined to the zone of soil likely to be influenced by the proposed structural foundation systems. Our scope of services did not address the potential for surface expression of deep geological conditions, such as sinkhole development related to karst activity.

2.2 FIELD EXPLORATION

The subsurface conditions across the site were explored with seven (7) bucket auger borings supplemented by hand cone penetrometer sounding. Each penetrometer probe was extended to a depth of 5 feet below the ground surface. Soil samples were collected from the auger cuttings wherever a visible change in stratigraphy was apparent.

Consider the indicated locations and depths to be approximate. Our drilling crew located the borings based upon GPS coordinates using a hand held GPS device. If more precise location and elevation data are desired, a registered professional land surveyor should be retained to locate the borings and determine their ground surface elevations. The Boring Location Plan is presented in Appendix B.

Unless other arrangements are agreed upon in writing, UES will store recovered soil samples for no more than 60 calendar days from the date of the report. After that date, UES will dispose of all samples.

2.3 LABORATORY TESTING

The soil samples recovered from the test borings were returned to our laboratory and visually classified by our technical staff. No additional laboratory testing was included in our scope of services or deemed necessary at this time.

3.0 FINDINGS

3.1 SURFACE CONDITIONS

At the start of our geotechnical exploration, we reviewed aerial photographs available from the Hernando County Property Appraiser's office and TerraServer USA, USGS topographic quadrangle maps, and the USDA Soil Conservation Service (SCS) Soil Survey of Hernando County for relevant information about the site. According to USGS topographic information, the elevation across the property is on the order of +5 feet NGVD. The site is heavily wooded with standing water.

3.2 SUBSURFACE CONDITIONS

3.2.1 SOIL SURVEY

According to SCS, there is one native, surficial soil group (with two subgroups) underlying this site. A summary of selected properties for the identified soil group on the site is included below

in Table 1. The location of this group can be observed on the SCS Soil Survey Map provided in the Appendix A.

TABLE 1
SUMMARY OF SOIL INFORMATION

Soil Map Unit & Name	Hydrologic Soil Group	Water Table Type	SHWT Depth	Shrink-Swell Potential	Corrosion Risk	
					Steel	Concrete
37-Okeelanta, Okelanta Part	A/D	Apparent	+2 to 0'	Low	High	Moderate
37- Okeelanta, Terra Ceia Part	A/D	Apparent	+2 to 1.0'	Low	Moderate	Moderate

3.2.2 SOIL BORINGS

The boring locations and detailed subsurface conditions are illustrated in Appendix B: Boring Location Plan and Boring Logs. The classifications and descriptions shown on the logs are based upon visual characterizations of the recovered soil samples. Refer to Appendix B: Soils Classification Chart, for further explanation of the symbols and placement of data on the Boring Logs. The general subsurface soil profile on the site, based on the soil boring information, is described below. For more detailed information, please refer to the boring logs.

The subsurface stratigraphy encountered at the boring locations began with dark brown peat. Based on the SCS information and our penetrometer probe resistance we suspect that surficial peat (muck) is followed by loamy sand (sand with silt and clay or silty sand). Our penetrometer probes encountered refusal at 5 feet of depth which could be upper limestone surface. Based on our experience in the area the limestone is expected at rather shallow depths close to the coast.

The shallow water table was encountered at approximately +1 to +2 feet above existing grade at the boring locations. These readings are subject to fluctuation.

The boring logs and related information included in this report are indicators of subsurface conditions only at the specific locations and times noted. Subsurface conditions, including groundwater levels and the presence of deleterious materials, at other locations on the site may differ significantly from conditions which, in the opinion of UES, exist at the sampling locations. Note, too, that the passage of time may affect conditions at the sampling locations.

4.0 RECOMMENDATIONS

4.1 GENERAL

In this section of the report we present our geotechnical design recommendations and information pertaining to the construction related services UES can provide. Our recommendations are made based upon a review of the attached soil test data, our

understanding of the proposed construction as it was described to us, and our stated assumptions. If the structural loads or site layout differ from those assumed or described to us, we should be retained to review the new or updated information and amend our recommendations with respect to those changes. Additionally, if subsurface conditions are encountered during construction that were not encountered in the test borings, report those conditions immediately to us for observation and recommendations.

4.2 GROUNDWATER

Based upon our visual inspection of the recovered soil samples, review of information obtained from SWFWMD and the USDA Soil Survey of Hernando County, and our knowledge of local and regional hydrogeology, our best estimate is that the seasonal high groundwater level could be at grade or on the order of 1 to 2 feet above the existing grades.

It should be noted that the estimated SHWT does not provide any assurance that groundwater levels will not exceed this level in the future. Should impediments to surface water drainage exist on the site, or should rainfall intensity and duration exceed the normally anticipated amounts, groundwater levels may exceed our seasonal high estimate. Also, future development around the site could alter surface runoff and drainage characteristics, and cause our seasonal high estimate to be exceeded. We therefore recommend positive drainage be established and maintained on the site during construction. Further, we recommend permanent measures be constructed to maintain positive drainage from the site throughout the life of the project. Finally, we recommend all foundation and pavement grades account for the seasonal high groundwater conditions.

4.3 ANTICIPATED PILE CAPACITIES

4.3.1 GENERAL

Please note that a zone of peat or very soft organic soil was encountered at the boring locations starting at the surface and extending to an approximate depth of 5 feet below existing grades. Due to the presence of this very soft zone the minimum required pile embedment depth is recommended at 7 feet below existing grade or to driving refusal, whichever comes first.

Based on the results of our explorations, we estimate that 8-inch pressure treated timber piles, installed to a depth of at least 6 feet below existing grade, would provide an allowable compressional pile capacity of roughly 6 Kips per pile. The allowable uplift capacity was estimated practically at 0. The pile capacities were estimated using the commercially available AllPile v7 software and have a safety factor of 2. The lateral pile capacity was also estimated at 0. Therefore, the lateral stability of the boardwalk structure need to be provided using structural bracing.

4.3.2 PILE INSTALLATION AND QUALITY CONTROL

We strongly recommend that all piles be driven under the full-time observation of a representative of Universal Engineering Sciences. Further, we recommend the use of dynamic pile testing, commonly referred to as PDA (Pile Driving Analyzer) testing on at least 10 percent of piles. In some cases, re-striking can also be performed, after a setup period of at least 2 days, to verify the required capacity has been achieved. In the event that the PDA monitoring

does not verify the design pile capacity, at least one (1) pile should be selected for a full scale load test (taken to at least twice the pile design capacity) in accordance with ASTM D-1143.

An engineering technician familiar with the installation of driven piles into subsurface soil conditions similar to those at this site and acting under the direction and supervision of the geotechnical engineer should witness the installation of the piles. His duties should include, but not be limited to, the following:

- Keep an accurate record of pile installation and driving procedures.
- Verify that all piles are installed to the proper driving resistance and to a depth indicative of the piles bearing in the desired bearing formation.
- Confirm the pile driving equipment is operating properly.
- Inspect the piles prior to installation for defects and confirm that the piles are not damaged during installation.

Specific requirements for driven piles are detailed in the Florida Building Code under Sections 1808 and 1809. These requirements cover group strength, installation methods, and reinforcement cover. We recommend that the piles be designed and constructed in accordance with the requirements outlined therein.

4.3.3 ESTIMATED STRUCTURAL SETTLEMENT

For foundations designed as recommended we estimate total foundation settlement of less than one inch, and differential settlement of less than one half inch. However, if the piles are not installed according to the guidelines provided in this report, our estimates of total and differential settlement may be exceeded during the design life of the structure.

4.4 CONSTRUCTION RELATED SERVICES

Universal Engineering Sciences (UES) operates and maintains an in-house, Florida Department of Transportation certified Construction Materials Testing laboratory. Our technicians are highly trained and experienced, and our engineering staff is already familiar with the details of your project. Therefore, we recommend the owner retain UES to perform construction materials testing and field observations on this project. This includes monitoring all stripping and grading, observation of foundation excavation and construction, verification of pavement subgrade and all other construction testing and inspection services that may be needed on this project.

The geotechnical engineering design does not end with the advertisement of the construction documents. It is an on-going process throughout construction. Because of our familiarity with the site conditions and the intent of the engineering design, our engineers are the most qualified to address problems that might arise during construction in a timely and cost-effective manner.

5.0 LIMITATIONS

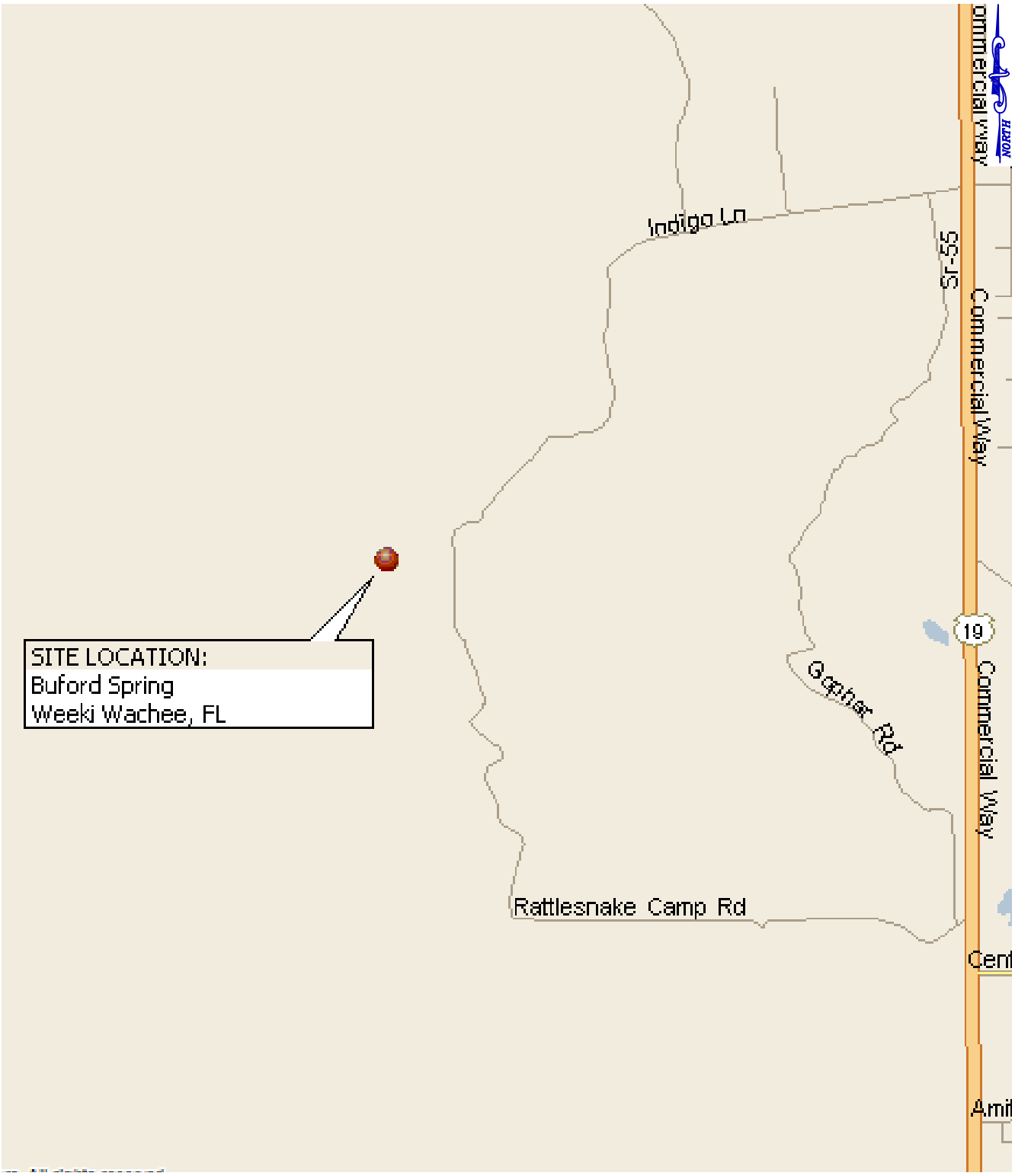
During the early stages of most construction projects, geotechnical issues not addressed in this report may arise. Because of the natural limitations inherent in working with the subsurface, it is not possible for a geotechnical engineer to predict and address all possible subsurface

variations. An Association of Engineering Firms Practicing in the Geosciences (ASFE) publication, "Important Information About This Geotechnical Engineering Report" appears in Appendix C, and will help explain the nature of geotechnical issues. Further, we present documents in Appendix C: Constraints and Restrictions, to bring to your attention the potential concerns and the basic limitations of a typical geotechnical report.

Do not apply any of this report's conclusions or recommendations if the nature, design, or location of the facilities is changed. If changes are contemplated, UES must review them to assess their impact on this report's applicability. Also, note that UES is not responsible for any claims, damages, or liability associated with any other party's interpretation of this report's subsurface data or reuse of this report's subsurface data or engineering analyses without the express written authorization of UES.

* * * * * * * * *

APPENDIX A



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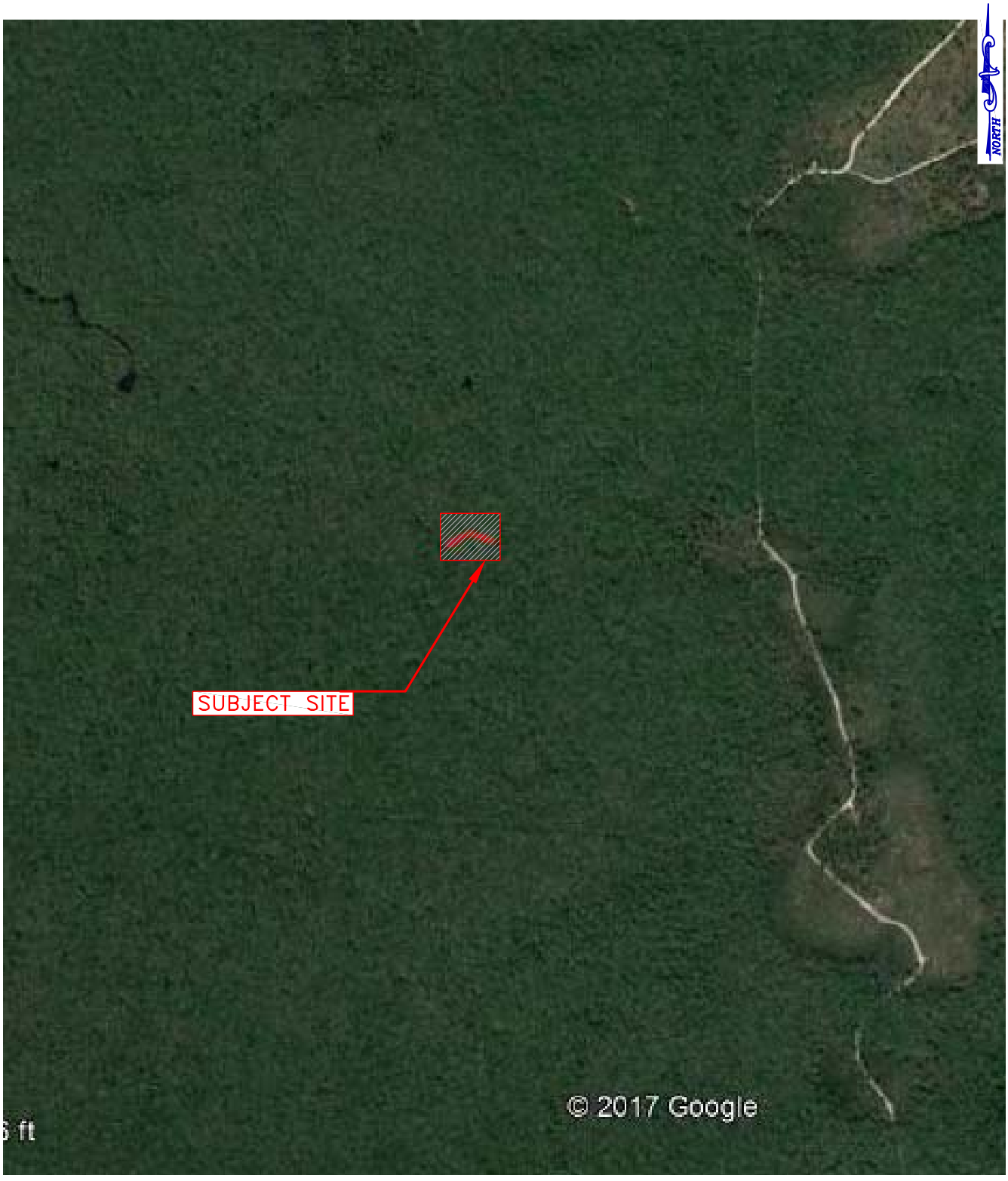
PROPOSED BUFORD SPRING BOARDWALK
CHAASSAHOWITZKA WILDLIFE-MANAGEMENT AREA
WEEKI WACHEE, PASCO COUNTY, FLORIDA

SITE LOCATION MAP

CLIENT: BOWMAN CONSULTING GROUP, LTD		DRAWN BY: SC	DATE: OCT. 15, 2017
SCALE: NOT TO SCALE	PROJECT NO: 0830.1700203	REVIEWED BY: D.J	APPENDIX: A



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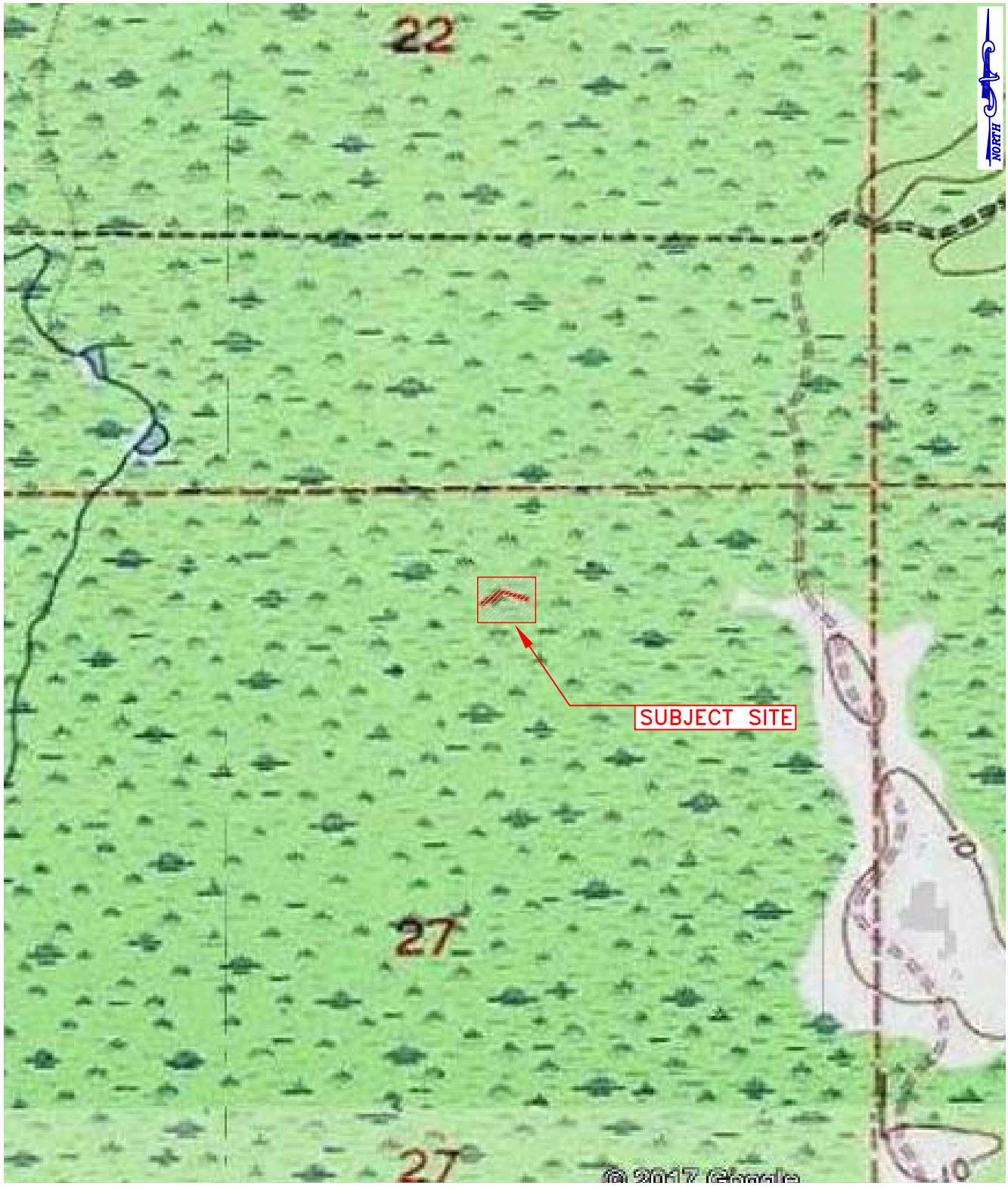
PROPOSED BUFORD SPRING BOARDWALK
CHAASSAHOWITZKA WILDLIFE-MANAGEMENT AREA
WEEKI WACHEE, PASCO COUNTY, FLORIDA

SITE AERIAL PHOTOGRAPH

CLIENT: BOWMAN CONSULTING GROUP, LTD		DRAWN BY: SC	DATE: OCT. 15, 2017
SCALE: NOT TO SCALE	PROJECT NO: 0830.1700203	REVIEWED BY: D.J	APPENDIX: A



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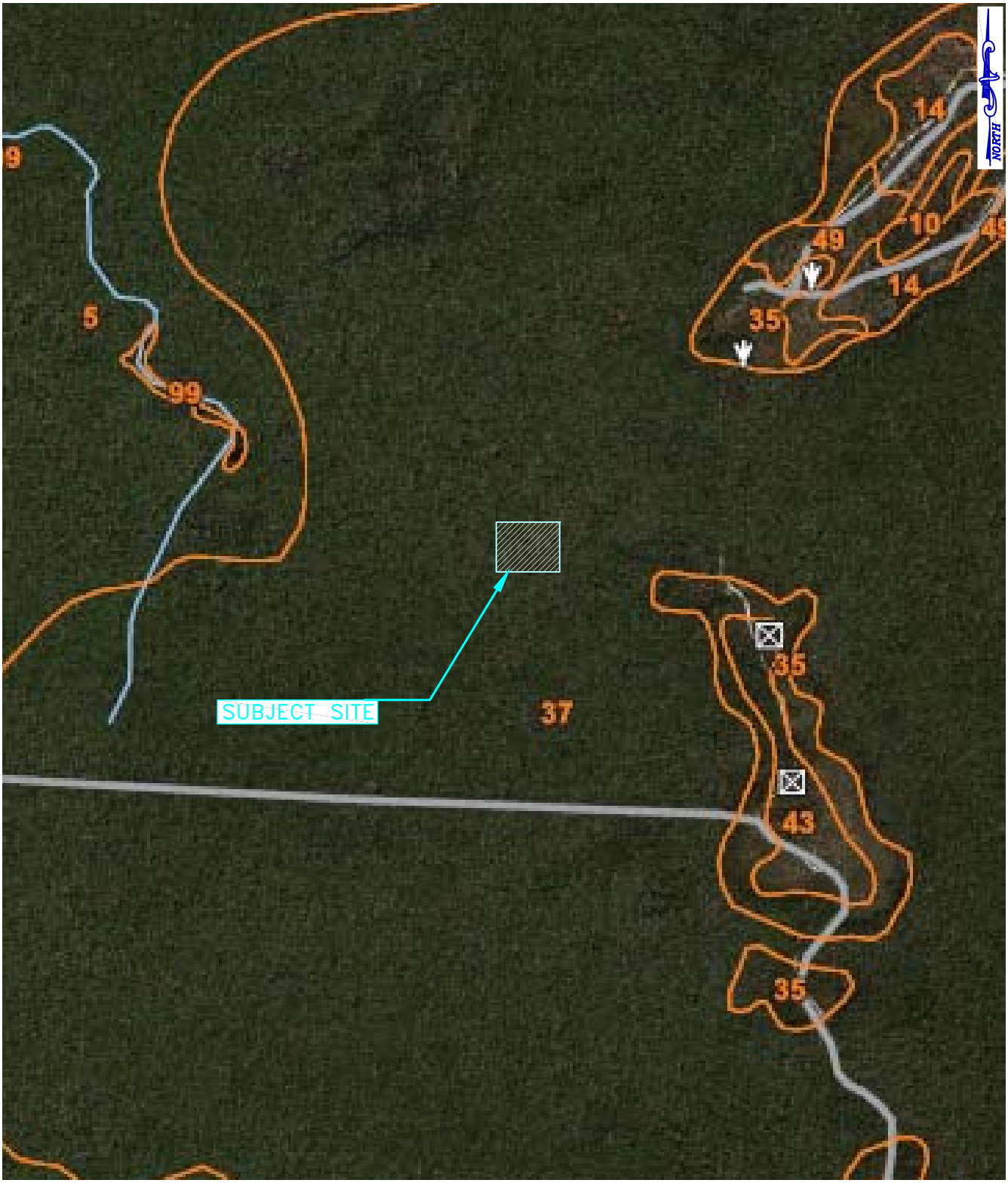
PROPOSED BUFORD SPRING BOARDWALK
CHAASSAHOWITZKA WILDLIFE–MANAGEMENT AREA
WEEKI WACHEE, PASCO COUNTY, FLORIDA

SITE TOPOGRAPHIC MAP

CLIENT: BOWMAN CONSULTING GROUP, LTD		DRAWN BY: SC	DATE: OCT. 15, 2017
SCALE: NOT TO SCALE	PROJECT NO: 0830.1700203	REVIEWED BY: D.J	APPENDIX: A



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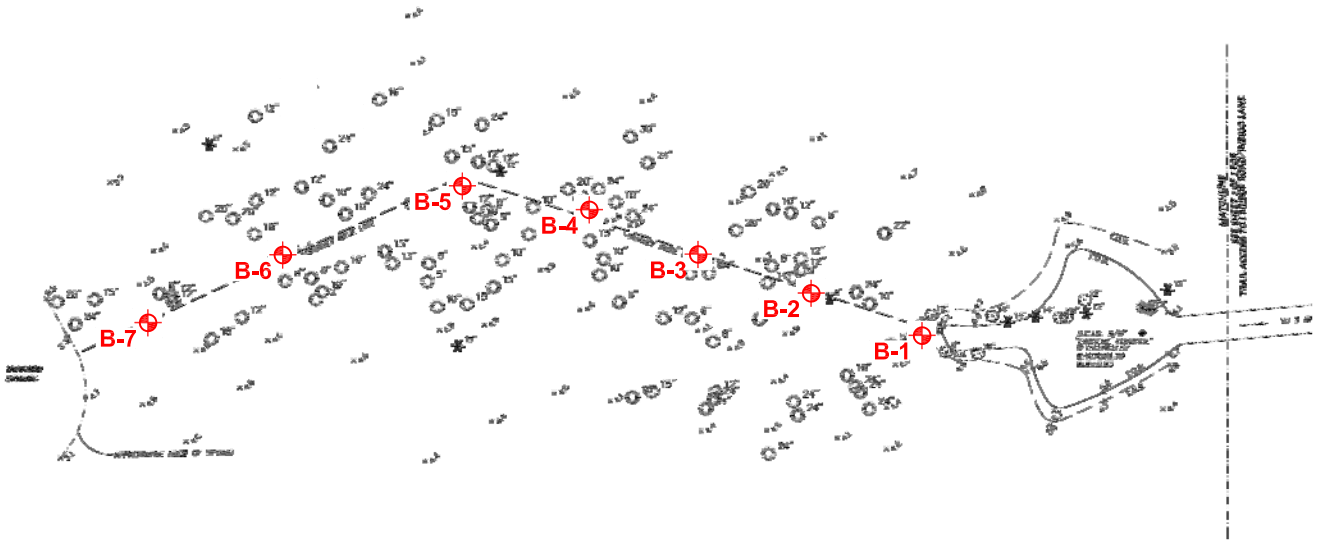
PROPOSED BUFORD SPRING BOARDWALK
CHAASSAHOWITZKA WILDLIFE-MANAGEMENT AREA
WEEKI WACHEE, PASCO COUNTY, FLORIDA

SCS SOIL SURVEY MAP

CLIENT: BOWMAN CONSULTING GROUP, LTD		DRAWN BY: SC	DATE: OCT. 15, 2017
SCALE: NOT TO SCALE	PROJECT NO: 0830.1700203	REVIEWED BY: D.J	APPENDIX: A

APPENDIX B



BORING #	LATITUDE	LONGITUDE
B-1	28°38'0.29"N	82°35'22.77"W
B-2	28°38'0.42"N	82°35'22.77"W
B-3	28°38'0.56"N	82°35'23.69"W
B-4	28°38'0.67"N	82°35'24.11"W
B-5	28°38'0.78"N	82°35'24.48"W
B-6	28°38'0.44"N	82°35'25.28"W
B-7	28°38'0.21"N	82°35'25.85"W

LEGEND:

B–1 Approximate SPT boring location

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PROPOSED BUFORD SPRING BOARDWALK
CHAASSAHOWITZKA WILDLIFE–MANAGEMENT AREA
WEEKI WACHEE, PASCO COUNTY, FLORIDA

BORING LOCATION PLAN

CLIENT: BOWMAN CONSULTING GROUP, LTD		DRAWN BY: SC	DATE: OCT. 15, 2017
SCALE:	PROJECT NO: 0830.1700203	REVIEWED BY: DJ	APPENDIX: B

UNIVERSAL ENGINEERING SCIENCES
9802 Palm River Road
Tampa, Florida 33619
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BORING LOG

PROJECT NO.:	0830.1700203
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PROJECT: Proposed Buford Springs Boardwalk
Chaassahowitzka Wildlife - Management Area
Weeki Wachee, Florida

ENGINEER: Mark K. Hardy, P.E.

CLIENT: Bowman Consulting Group, Ltd.

LOCATION: SEE BORING LOCATION PLAN

REMARKS: R = Penetrometer Refusal

BORING DESIGNATION: **B-01** SHEET: **1 of 1**
SECTION: TOWNSHIP: RANGE:

ELEVATION: DATE STARTED: 10/23/16
WATER TABLE (ft): Standing Water DATE FINISHED: 10/23/16
DATE OF READING: 10/23/2016 DRILLED BY: PH/LR
EST. W.S.W.T. (ft): TYPE OF SAMPLING: AUGER

DEPTH (ft)	SAMPLE	Hand Cone Penetrometer (kg/cm²)	N (bpf)	SPT-N vs DEPTH (bpf) 0 25 50	GWT	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	PL	PI	ORG (%)
0							Dark brown peat (PT)						
1		1					No soil samples obtained due to high water table. Peat assumed to 2 feet of depth (based on SCS information)	6.7	650.6				75.6
2		2					No soil samples obtained due to high water table. Loamy sand assumed from 2 feet of depth to 5 feet of depth (based on SCS information)						
3		7											
4		2											
5		R					Boring terminated at 5 ft.						

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BORING LOG

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PROJECT: Proposed Buford Springs Boardwalk
Chaassahowitzka Wildlife - Management Area
Weeki Wachee, Florida

BORING DESIGNATION: **B-02** SHEET: **1 of 1**
SECTION: TOWNSHIP: RANGE:

ENGINEER: Mark K. Hardy, P.E.

CLIENT: Bowman Consulting Group, Ltd.

LOCATION: SEE BORING LOCATION PLAN

REMARKS: R = Penetrometer Refusal

ELEVATION: DATE STARTED: 10/23/16
WATER TABLE (ft): Standing Water DATE FINISHED: 10/23/16
DATE OF READING: 10/23/2016 DRILLED BY: PH/LR
EST. W.S.W.T. (ft): TYPE OF SAMPLING: AUGER

DEPTH (ft)	SAMPLE	Hand Cone Penetrometer (kg/cm²)	N (bpf)	SPT-N vs DEPTH (bpf) 0 25 50	GWT	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	PL	PI	ORG (%)
0							Dark brown peat (PT)						
1		2					No soil samples obtained due to high water table. Peat assumed to 2 feet of depth (based on SCS information)						
2		2					No soil samples obtained due to high water table. Loamy sand assumed from 2 feet of depth to 5 feet of depth (based on SCS information)						
3		1											
4		5											
5		R					Boring terminated at 5 ft.						

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PROJECT: Proposed Buford Springs Boardwalk
Chaassahowitzka Wildlife - Management Area
Weeki Wachee, Florida

ENGINEER: Mark K. Hardy, P.E.

CLIENT: Bowman Consulting Group, Ltd.

LOCATION: SEE BORING LOCATION PLAN

REMARKS: R = Penetrometer Refusal

BORING DESIGNATION: **B-03** SHEET: **1 of 1**
SECTION: TOWNSHIP: RANGE:

ELEVATION: DATE STARTED: 10/23/16
WATER TABLE (ft): Standing Water DATE FINISHED: 10/23/16
DATE OF READING: 10/23/2016 DRILLED BY: PH/LR
EST. W.S.W.T. (ft): TYPE OF SAMPLING: AUGER

DEPTH (ft)	SAMPLE	Hand Cone Penetrometer (kg/cm²)	N (bpf)	SPT-N vs DEPTH (bpf) 0 25 50	GWT	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	PL	PI	ORG (%)
0							Dark brown peat (PT)						
1		2					No soil samples obtained due to high water table. Peat assumed to 2 feet of depth (based on SCS information)	13.6	554.4				64.9
2		1					No soil samples obtained due to high water table. Loamy sand assumed from 2 feet of depth to 5 feet of depth (based on SCS information)						
3		1											
4		1											
5		R					Boring terminated at 5 ft.						

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PROJECT: Proposed Buford Springs Boardwalk
Chaassahowitzka Wildlife - Management Area
Weeki Wachee, Florida

BORING DESIGNATION: **B-04** SHEET: **1 of 1**
SECTION: TOWNSHIP: RANGE:

ENGINEER: Mark K. Hardy, P.E.

CLIENT: Bowman Consulting Group, Ltd.

LOCATION: SEE BORING LOCATION PLAN

REMARKS: R = Penetrometer Refusal

ELEVATION: DATE STARTED: 10/23/16
WATER TABLE (ft): Standing Water DATE FINISHED: 10/23/16
DATE OF READING: 10/23/2016 DRILLED BY: PH/LR
EST. W.S.W.T. (ft): TYPE OF SAMPLING: AUGER

DEPTH (ft)	SAMPLE	Hand Cone Penetrometer (kg/cm²)	N (bpf)	SPT-N vs DEPTH (bpf) 0 25 50	GWT	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	PL	PI	ORG (%)
0							Dark brown peat (PT)						
1		1					No soil samples obtained due to high water table. Peat assumed to 2 feet of depth (based on SCS information)						
2		2					No soil samples obtained due to high water table. Loamy sand assumed from 2 feet of depth to 5 feet of depth (based on SCS information)						
3		1											
4		1											
5		R					Boring terminated at 5 ft.						

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PROJECT: Proposed Buford Springs Boardwalk
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LOCATION: SEE BORING LOCATION PLAN

REMARKS: R = Penetrometer Refusal

BORING DESIGNATION: **B-05** SHEET: **1 of 1**
SECTION: TOWNSHIP: RANGE:

ELEVATION: DATE STARTED: 10/23/16
WATER TABLE (ft): Standing Water DATE FINISHED: 10/23/16
DATE OF READING: 10/23/2016 DRILLED BY: PH/LR
EST. W.S.W.T. (ft): TYPE OF SAMPLING: AUGER

DEPTH (ft)	SAMPLE	Hand Cone Penetrometer (kg/cm²)	N (bpf)	SPT-N vs DEPTH (bpf) 0 25 50	GWT	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	PL	PI	ORG (%)
0							Dark brown peat (PT)						
1		2					No soil samples obtained due to high water table. Peat assumed to 2 feet of depth (based on SCS information)						
2		1					No soil samples obtained due to high water table. Loamy sand assumed from 2 feet of depth to 5 feet of depth (based on SCS information)						
3		4											
4		2											
5		R					Boring terminated at 5 ft.						

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PROJECT: Proposed Buford Springs Boardwalk
Chaassahowitzka Wildlife - Management Area
Weeki Wachee, Florida

ENGINEER: Mark K. Hardy, P.E.

CLIENT: Bowman Consulting Group, Ltd.

LOCATION: SEE BORING LOCATION PLAN

REMARKS: R = Penetrometer Refusal

BORING DESIGNATION: **B-06** SHEET: **1 of 1**
SECTION: TOWNSHIP: RANGE:

ELEVATION: DATE STARTED: 10/23/16
WATER TABLE (ft): Standing Water DATE FINISHED: 10/23/16
DATE OF READING: 10/23/2016 DRILLED BY: PH/LR
EST. W.S.W.T. (ft): TYPE OF SAMPLING: AUGER

DEPTH (ft)	SAMPLE	Hand Cone Penetrometer (kg/cm²)	N (bpf)	SPT-N vs DEPTH (bpf) 0 25 50	GWT	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	PL	PI	ORG (%)
0							Dark brown peat (PT)						
1		2					No soil samples obtained due to high water table. Peat assumed to 2 feet of depth (based on SCS information)	8.4	572.3				87.3
2		9					No soil samples obtained due to high water table. Loamy sand assumed from 2 feet of depth to 5 feet of depth (based on SCS information)						
3		5											
4		5											
5		R					Boring terminated at 5 ft.						

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PROJECT: Proposed Buford Springs Boardwalk
Chaassahowitzka Wildlife - Management Area
Weeki Wachee, Florida

BORING DESIGNATION: **B-07** SHEET: **1 of 1**
SECTION: TOWNSHIP: RANGE:

ENGINEER: Mark K. Hardy, P.E.

CLIENT: Bowman Consulting Group, Ltd.

LOCATION: SEE BORING LOCATION PLAN

REMARKS: R = Penetrometer Refusal

ELEVATION: DATE STARTED: 10/23/16
WATER TABLE (ft): Standing Water DATE FINISHED: 10/23/16
DATE OF READING: 10/23/2016 DRILLED BY: PH/LR
EST. W.S.W.T. (ft): TYPE OF SAMPLING: AUGER

DEPTH (ft)	SAMPLE	Hand Cone Penetrometer (kg/cm²)	N (bpf)	SPT-N vs DEPTH (bpf) 0 25 50	GWT	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	PL	PI	ORG (%)
0							Dark brown peat (PT)						
1		2					No soil samples obtained due to high water table. Peat assumed to 2 feet of depth (based on SCS information)						
2		3					No soil samples obtained due to high water table. Loamy sand assumed from 2 feet of depth to 5 feet of depth (based on SCS information)						
3		2											
4		2											
5		R					Boring terminated at 5 ft.						

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SOIL CLASSIFICATION CHART

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE-GRAINED SOILS (major portions retained on No. 200 sieve): includes (1) clean gravel and sands and (2) silty or clayey gravels and sands. Condition is rated according to relative density as determined by laboratory tests or standard penetration resistance tests.

Descriptive Terms	Relative Density	SPT Blow Count
Very loose	0 to 15 %	< 4
Loose	15 to 35 %	4 to 10
Medium dense	35 to 65 %	10 to 30
Dense	65 to 85 %	30 to 50
Very dense	85 to 100 %	> 50

FINE-GRAINED SOILS (major portions passing on No. 200 sieve): includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings, SPT blow count, or unconfined compression tests.

Descriptive Terms	Unconfined Compressive Strength kPa	SPT Blow Count
Very soft	< 25	< 2
Soft	25 to 50	2 to 4
Medium stiff	50 to 100	4 to 8
Stiff	100 to 200	8 to 15
Very stiff	200 to 400	15 to 30
Hard	> 400	> 30

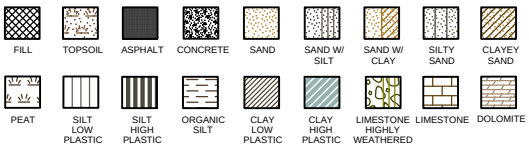
GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.

2. Surface elevations are based on topographic maps and estimated locations.

3. Descriptions on these boring logs apply only at the specific boring locations and at the time the borings were made. They are not guaranteed to be representative of subsurface conditions at other locations or times.

SOIL SYMBOLS



OTHER SYMBOLS

▼ Measured Water Table Level

▽ Estimated Seasonal High Water Table

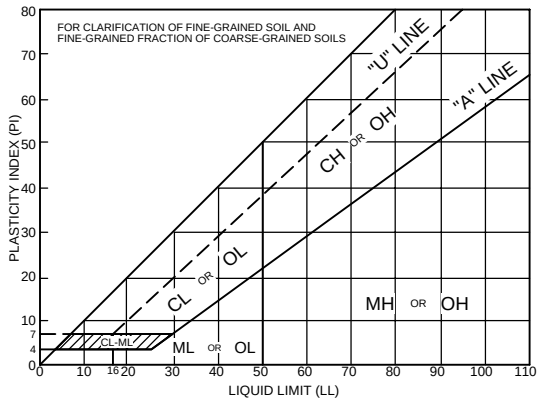
Major Divisions		Group Symbols	Typical Names
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size) — Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-silt mixtures
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size) — Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
		SP	Poorly-graded sands, gravelly sands, little or no fines
	Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or disto-maceous fine sandy or silty soils, organic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
	Highly Organic Soils	Pt	Peat and other highly organic soils

Laboratory Classification Criteria

Determine percentages of sand and gravel from grain size curve, Depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows:

Less than 5 percent..... GW, GP, SW, SP
More than 12 percent..... GM, GC, SM, SC
5 to 12 percent..... Borderline cases requiring dual symbols*

$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3		
Not meeting all gradation requirements for GW		
Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols	
Atterberg limits above "A" line or P.I. greater than 7		
$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3		
Not meeting all gradation requirements for SW		
Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols	
Atterberg limits above "A" line or P.I. greater than 7		



Plasticity Chart

Material	Particle Size: Sieve	Particle Size: mm
Gravel	#4 to 3/4 in.	4.76 to 19.1
Fine	3/4 in. to 3 in.	19.1 to 76.2
Coarse	3 in. to 12 in.	76.2 to 304.8
Cobble	12 in. to 36 in.	304.8 to 914.4
Boulders		

Material	Particle Size: Sieve sizes	Particle Size: mm
Silt or clay	< #200	< 0.074
Sand	#200 to #40	0.074 to 0.42
Fine	#40 to #10	0.42 to 2.00
Medium	#10 to #4	2.00 to 4.76
Coarse		

* When the percent passing a No. 200 sieve is between 5% and 12%, a dual symbol is used to denote the soil. For example; SP-SC, poorly-graded sand with clay content between 5% and 12%.

APPENDIX C

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
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CONSTRAINTS AND RESTRICTIONS

WARRANTY

Universal Engineering Sciences has prepared this report for our client for his exclusive use, in accordance with generally accepted soil and foundation engineering practices, and makes no other warranty either expressed or implied as to the professional advice provided in the report.

UNANTICIPATED SOIL CONDITIONS

The analysis and recommendations submitted in this report are based upon the data obtained from soil borings performed at the locations indicated on the Boring Location Plan. This report does not reflect any variations which may occur between these borings.

The nature and extent of variations between borings may not become known until construction begins. If variations appear, we may have to re-evaluate our recommendations after performing on-site observations and noting the characteristics of any variations.

CHANGED CONDITIONS

We recommend that the specifications for the project require that the contractor immediately notify Universal Engineering Sciences, as well as the owner, when subsurface conditions are encountered that are different from those present in this report.

No claim by the contractor for any conditions differing from those anticipated in the plans, specifications, and those found in this report, should be allowed unless the contractor notifies the owner and Universal Engineering Sciences of such changed conditions. Further, we recommend that all foundation work and site improvements be observed by a representative of Universal Engineering Sciences to monitor field conditions and changes, to verify design assumptions and to evaluate and recommend any appropriate modifications to this report.

MISINTERPRETATION OF SOIL ENGINEERING REPORT

Universal Engineering Sciences is responsible for the conclusions and opinions contained within this report based upon the data relating only to the specific project and location discussed herein. If the conclusions or recommendations based upon the data presented are made by others, those conclusions or recommendations are not the responsibility of Universal Engineering Sciences.

CHANGED STRUCTURE OR LOCATION

This report was prepared in order to aid in the evaluation of this project and to assist the architect or engineer in the design of this project. If any changes in the design or location of the structure as outlined in this report are planned, or if any structures are included or added that are not discussed in the report, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions modified or approved by Universal Engineering Sciences.

USE OF REPORT BY BIDDERS

Bidders who are examining the report prior to submission of a bid are cautioned that this report was prepared as an aid to the designers of the project and it may affect actual construction operations.

Bidders are urged to make their own soil borings, test pits, test caissons or other explorations to determine those conditions that may affect construction operations. Universal Engineering Sciences cannot be responsible for any interpretations made from this report or the attached boring logs with regard to their adequacy in reflecting subsurface conditions which will affect construction operations.

STRATA CHANGES

Strata changes are indicated by a definite line on the boring logs which accompany this report. However, the actual change in the ground may be more gradual. Where changes occur between soil samples, the location of the change must necessarily be estimated using all available information and may not be shown at the exact depth.

OBSERVATIONS DURING DRILLING

Attempts are made to detect and/or identify occurrences during drilling and sampling, such as: water level, boulders, zones of lost circulation, relative ease or resistance to drilling progress, unusual sample recovery, variation of driving resistance, obstructions, etc.; however, lack of mention does not preclude their presence.

WATER LEVELS

Water level readings have been made in the drill holes during drilling and they indicate normally occurring conditions. Water levels may not have been stabilized at the last reading. This data has been reviewed and interpretations made in this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, tides, and other factors not evident at the time measurements were made and reported. Since the probability of such variations is anticipated, design drawings and specifications should accommodate such possibilities and construction planning should be based upon such assumptions of variations.

LOCATION OF BURIED OBJECTS

All users of this report are cautioned that there was no requirement for Universal Engineering Sciences to attempt to locate any man-made buried objects during the course of this exploration and that no attempt was made by Universal Engineering Sciences to locate any such buried objects. Universal Engineering Sciences cannot be responsible for any buried man-made objects which are subsequently encountered during construction that are not discussed within the text of this report.

TIME

This report reflects the soil conditions at the time of exploration. If the report is not used in a reasonable amount of time, significant changes to the site may occur and additional reviews may be required.