Geotechnical Engineering Report

Coquina Beach Drainage Improvements
Bradenton Beach, Florida

July 16, 2018
Dunkelberger Project No. HC155032

Prepared for:
Manatee County Construction Services Division
Bradenton, Florida

Prepared by:
Dunkelberger Engineering & Testing, a Terracon Company
Sarasota, Florida

DUNKELBERGER
engineering & testing, inc.
A Terracon COMPANY

DUNKELBERGER
engineering & testing, inc.
A Terracon COMPANY

July 16, 2018

Manatee County Construction Services Division
1112 Manatee Avenue, Suite 868C
Bradenton, FL 34205

Attn: Mr. Michael Sturm, P.E.
Project Manager

Re: Geotechnical Engineering Report
Coquina Beach Drainage Improvements
Bradenton Beach, Manatee County, Florida
DUNKELBERGER Project Number: HC155032

Dear Mr. Sturm:

Dunkelberger Engineering & Testing, a Terracon Company (DUNKELBERGER) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with Manatee County, Florida Work Assignment No. W1600014, dated October 20, 2015.

This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of pervious pavements and groundwater control for the proposed project.

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

Sincerely,
Dunkelberger Engineering & Testing, a Terracon Company

JAMES M. JACKSON LICENSE No. 77733 STATE OF FLORIDA PROFESSIONAL ENGINEER

James M. Jackson, P.E. 7/16/18
Project Engineer
FL License No.: 77733

7/16/18
Douglas S. Dunkelberger, P.E.
Principal
FL License No.: 33317

Enclosures

cc: 1 – Client (PDF)
1 – File

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

EXECUTIVE SUMMARY

A geotechnical study has been completed for the proposed Coquina Beach Drainage Improvements project which will be located on the west side of Gulf Drive South at Coquina Beach in Bradenton Beach, Manatee County, Florida. Thirty (30) Standard Penetration Test (SPT) borings, designated B-1 through B-30, were spaced at approximately 200-foot centers across the site. The borings were drilled to a maximum depth of 25 feet below the existing ground surface (bgs). Additionally, four (4) borehole permeability (BHP) tests and four (4) double ring infiltration (DRI) tests were run at locations spaced evenly across the site.

Based on the information obtained from our geotechnical exploration, it appears that the site can be developed for the proposed project. The following geotechnical considerations were identified:

- Organic fine sand was found in Borings B-16, B-17, and B-20 at depths ranging from about 4 to 8 feet bgs. The organic material represents risk of more than normal settlement, particularly differential settlement, beneath the planned rigid pavement section. For that reason, we recommend that the buried organic layer be removed from the pavement areas and replaced with engineered fill.

- Other than the organic layer, the borings generally found fine sands with varying amounts of silt and shell fragments from the existing ground surface to the maximum borehole termination depth of 25 feet.

- Based upon the test boring results, the shallow soils appear to have the required strength, stiffness, and permeability for support of typical pervious pavement sections.

- Field-measured horizontal permeability values ranged from 0.8 to 11.3 feet per day within the depth interval of 2 to 25 feet bgs. The measured permeability rates are considered relatively slow to moderate.

- Field-measured vertical infiltration values ranged from 6.5 to 15.1 inches per hour at a depth ranging from about 1 to 2 feet bgs. The measured infiltration rates at this depth are considered moderate to relatively high.

- The position of the Seasonal High Groundwater Level (SHGWL) was estimated at about +1 ½ feet-NAVD88 on the southern half of the site and +2 feet-NAVD88 on the northern half of the site.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design objectives for earthwork, pavements and sub-structure aspects of the project. We therefore recommend that DUNKELBERGER be retained to monitor this portion of the work.

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

GEOTECHNICAL ENGINEERING REPORT
COQUINA BEACH DRAINAGE IMPROVEMENTS
BRADENTON BEACH, MANATEE COUNTY, FLORIDA

DUNKELBERGER Project No. HC155032

July 16, 2018

1.0 INTRODUCTION

A geotechnical study has been completed for the proposed Coquina Beach Drainage Improvements project which will be located on the west side of Gulf Drive South at Coquina Beach in Bradenton Beach, Manatee County, Florida. Thirty (30) Standard Penetration Test (SPT) borings, designated B-1 through B-30, were spaced at approximately 200-foot centers across the site. The borings were drilled to a maximum depth of 25 feet below the existing ground surface (bgs). Additionally, four (4) borehole permeability (BHP) tests and four (4) double ring infiltration (DRI) tests were run at locations spaced evenly across the site. Logs of the borings along with a boring location plan are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- pervious pavement design and construction
- drainage and groundwater control design

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-4: Boring Location Plan
Grading	Assumed to be minimal (i.e. less than 1 foot)
Pavements	Approximately 173,728 square feet (sf) of 8-inch thick pervious concrete pavement and 97,705 sf of 10-inch thick pervious concrete pavement; the pervious concrete is to be directly underlain by either 4inches of “Bold & Gold Media” or Select Fill
Groundwater Control	An underdrain system (FDOT Type II Underdrain) is planned for groundwater control

If project conditions are different than the assumptions given above, then we should be advised to allow for re-evaluation of the recommendations and conclusions presented in this report.

2.2 Site Location and Description

Item	Description
Location	The project is to be located on the west side of Gulf Drive South at Coquina Beach in Bradenton Beach, Florida
Existing improvements	Shell-stabilized parking and drive areas cover the majority of the site; an asphalt paved bus loop exists near the midpoint of the site
Current ground cover	Sand-shell soil mixture
Existing topography	Based information obtained from ZNS Engineering, the site appears to slope upward from the south to the north from an elevation of about +3 to +6 feet-NAVD88

3.0 SUBSURFACE CONDITIONS

3.1 Site Geologic Conditions

The Florida Geological Survey Bulletin No. 68, issued in 2008, was reviewed to describe the general geological and hydrogeological conditions for the area. The Florida Geological Survey shows that the area is comprised of the Tampa Member of the Arcadia Formation. In general, the uppermost 20 feet of the land surface is mapped with Holocene sediments, which include quartz, sands, carbonate sands and muds, and organics. Holocene sediments occur near the present coastline at elevations generally less than 5 feet. The surficial aquifer system consists primarily of undifferentiated sands, shell material, silts, and clayey sands.

3.2 Soil Survey

The Soil Survey of Manatee County, Florida (i.e. Soil Survey), issued December 1984 and published by the Soil Conservation Service (U.S. Department of Agriculture), was reviewed to determine the surficial soil map units at this site. The soil survey map, which is shown on Exhibit A-2 in *Appendix A* indicates that the southern third of the site is mapped with Soil Unit 8, *Canaveral fine sand*, and the northern two-thirds of the site is mapped with Soil Unit 10, *Canaveral fine sand, organic substratum* and Soil Unit 9, *Canaveral fine sand, filled*.

Unit 8, Canaveral fine sand, consists of fine sands with shell fragments to a depth of 65 inches. The Seasonal High Groundwater Table (SHGWT) is at a depth of 10 to 40 inches for 2 to 6 months out of the year. Unit 9, *Canaveral fine sand, fill*, and Unit 10, *Canaveral fine sand, organic* substratum consist of fill material made up of fine sand and shell fragments. However, a layer of **muck** is present in Unit 10 from a depth of about 45 to 70 inches and in a few small areas of Unit 9 at a depth of 80

inches or more. The SHGWT is dependent on the thickness of the fill material for these two soil units, but, is reported to lie at a depth of 30 to 60 inches bgs. Permeability in these sand and fill materials is very rapid and is moderately rapid in the organic (i.e. muck) layer. Detailed descriptions of the soils mapping units can be found on Exhibit A-3 in *Appendix A*.

It should be noted that the Soil Survey is not intended as a substitute for site-specific geotechnical exploration; rather it is a useful tool in planning a project scope in that it provides information on soil types likely to be encountered.

3.3 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1, 2	1 - 25	Fine SAND (SP, SP-SM) with trace to slight amounts of silt, occasionally with trace to some shell fragments	Very Loose to Very Dense
3[1]	6 - 8	Organic fine SAND (PT, SM), sometimes with tree debris	Very Loose to Loose
4	17 ½	Silty fine SAND (SM)	Very Loose to Loose

1. Only found in Borings B-16, B-17, and B-20.

Conditions encountered at each boring location and results of laboratory testing are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report. Descriptions of our field exploration are included as Exhibit A-5 in Appendix A. Descriptions of our laboratory testing procedures are included as Exhibit B-1.

3.4 Groundwater

Groundwater levels were measured on November 12 to 17, 2015 at 24 hours after the completion of drilling and are shown in the table below.

Boring No.	GSE[1] (feet-NAVD)	Measured Groundwater Depth (feet-bgs)	Measured Groundwater Elevation (feet-NAVD)	Estimated SHGWL based on SCS (feet-bgs)	Estimated SHGWL (feet-NAVD)
B-2	+3.5	3.0	+0.5	0.8 – 3.3	+1 ½
B-4	+3.4	2.7	+0.7	0.8 – 3.3	+1 ½
B-6	+2.8	2.3	+0.5	0.8 – 3.3	+1 ½
B-8	+3.2	2.6	+0.6	0.8 – 3.3	+1 ½
B-10	+3.7	3.2	+0.5	0.8 – 3.3	+1 ½
B-12	+3.6	2.9	+0.7	0.8 – 3.3	+1 ½
B-14	+4.1	3.5	+0.6	0.8 – 3.3	+1 ½
B-16	+3.7	3.1	+0.6	0.8 – 3.3	+1 ½
B-18	+5.2	4.3	+0.9	2.5 – 5	+2
B-20	+5.4	4.4	+1.0	2.5 – 5	+2
B-22	+5.5	4.5	+1.0	2.5 – 5	+2
B-24	+5.6	4.7	+0.9	2.5 – 5	+2
B-26	+4.3	3.3	+1.0	2.5 – 5	+2
B-28	+4.7	3.9	+0.8	2.5 – 5	+2
B-30	+4.7	3.7	+1.1	2.5 – 5	+2

1. GSE = Ground Surface Elevation provided by ZNS Engineering.

The groundwater level was not measured in the 10-foot deep SPT borings due to the boreholes being collapsed at 24hours after the completion of drilling. Therefore, only the groundwater data from the 25-foot deep SPT borings were considered for our SHGWL estimates.

As seen in the table above, the groundwater measurements ranged from about +½ feet-NAVD88 (2 ½ to 3 ½ feet bgs) on the southern half of the site to about +1 foot-NAVD88 (3 to 4 ½ feet bgs) on the northern half of the site. The groundwater levels are likely to closely mimic average water levels in the nearby Gulf of Mexico and Sarasota Bay. Groundwater levels are probably also influenced, to a lesser degree, by ground surface elevation change across the site and seasonal variations in rainfall.

As presented herein, the SHGWL is considered to be the highest sustained groundwater elevation during a typical (normal or average rainfall amount) wet season, coupled with high tide conditions, and not the peak groundwater elevation immediately following a major storm event. Therefore, the SHGWL referred to in this report is an average, high value and not necessarily a peak (upper bound) value.

Based on review of tide tables for the site area, the average tide level in the Gulf of Mexico was about +0.1 feet-NAVD for 2015. Additionally, the SCS soil survey indicates that our measured

groundwater levels are near the lower end of the estimated SHGWL which can be attributed to the seasonally dry conditions. Accordingly, we made a 1 foot upward (seasonal) adjustment to our measured groundwater levels. On that basis, we estimate the SHGWL will at about +1 ½ feet-NAVD88 in the southern half of the site and about +2 feet-NAVD in the northern half of the site which is consistent with the mid-range of the predicted SCS values. A groundwater contour map is provided on Exhibit A-40 in Appendix A.

3.5 Double Ring Infiltration Test and Borehole Permeability Test

The results of the field double ring infiltration (DRI) tests are summarized in the table below.

Location	Depth (feet)	USCS Classification	Infiltration (in/hr)
DRI-1	1	SP-SM	9.3
DRI-2	1.5	SP-SM	15.1
DRI-3	2	SP-SM	15.1
DRI-4	1	SP-SM	6.5

The results of the field borehole permeability (BHP) tests are summarized in the table below.

Location	Screened Interval (ft)	Horizontal Permeability, K_h (ft/day)	Vertical Permeability, K_v (ft/day)
BHP-1	2 - 25	11.3	5.7
BHP-2	2 - 25	5.8	2.9
BHP-3	2 - 25	0.8	0.4
BHP-4	2 - 25	2.1	1.1

The horizontal permeability values were calculated using an equation for a “single packer” test set-up. The field data was input into an equation developed by the U. S. Bureau of Reclamation, and presented by Harry Cedergren in his text “Seepage, Drainage and Flow Nets”, published in 1977, which is as follows:

$$k_h = \frac{q}{2p\ Lh} \log_e \frac{L}{R} \qquad \text{For L greater than or = 10r}$$

k_h = Permeability, feet/sec; q = flow, cfs

L = Screen length, feet; h = head, feet

r = Borehole radius, feet

The vertical permeability values were assumed to be half of the calculated horizontal permeability values.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Organic sand, with organic contents ranging from about 7 to 16 percent, was encountered in Borings B-16, B-17, and B-20 at depths ranging from about 4 to 8 feet bgs. Based on the 2015 version of Florida Department of Transportation (FDOT) Standard Index No. 500, organic soils should be removed from the planned pavement areas when the average organic content exceeds 5 percent or an individual organic content test exceeds 7 percent. Therefore, on this basis, the organic material encountered in the borings is considered unsuitable for construction of the proposed pavement and should be removed from the pavement areas and replaced with engineered fill. Recommendations for demucking can be found in **Section 4.2** of this report.

We recommend additional field exploration, via hand augured borings, at and around the three test borings that contained organic material (i.e. muck). The additional data will allow for more specific parameters (lateral and vertical extent) related to removal of unsuitable deposits. The soil survey shows that much of the site is mapped with Soil Units 9 and 10 which contain an organic substratum. Therefore, it is likely the additional borings may find a more widespread organic soil condition.

Other than the organic material, the borings found fine sands with varying amounts of silt and shell fragments to the maximum borehole termination depth of 25 feet bgs. According to information provided on the National Ready Mixed Concrete Associations (NRMCAs) internet website, these materials, following improvement of relative density at shallow depths, should meet the required stiffness, strength, and drainage characteristics to provide adequate subgrade support for the pervious pavement sections. We recommend that 4 inches of Select Fill meeting the material requirements specified in **Section 4.3.2** be placed beneath the bottom of the pervious pavement.

Design and construction recommendations for pervious pavement sections and the underdrain system are outlined below.

4.2 Demucking/ Removal and Replacement

1. The organic materials (i.e. organic fine sand and tree debris) should be removed in their entirety from the planned pavement areas in accordance with the guidelines of FDOT

Standard Index No. 500. The excavated organic material should be disposed of off-site. The sand soils, overlying the organic layer, could be stockpiled on site and re-used as excavation backfill provided that they meet the material requirements presented below in **Section 4.3.2**.

2. Removal of the organic fill soils will require dewatering to facilitate the excavation work and permit the visual inspection of the excavation bottom.

3. The bottom of the de-mucked excavation should be visually inspected by a DUNKELBERGER engineer to verify satisfactory removal of the organic fill soils.

4. The resulting excavation should be backfilled, in the dry, with well-compacted granular soil as further described in the following recommendations.

4.3 Earthwork

4.3.1 Site Preparation

Following the recommended demucking, earthwork operations should continue with the removal of the existing shell-stabilized parking and drive areas, and stripping of any remaining surficial organic soil (topsoil) from the planned pavement areas. Topsoil should be removed from the construction areas. The shell-stabilized sand material can be stockpiled for re-use as backfill in the demucking excavations and as general fill. Wet or dry material should either be removed or moisture conditioned and re-compacted. After demolition, stripping, and grubbing, the exposed surface should be proof-rolled to aid in locating loose or soft areas. Proof-rolling should be performed with a fully-loaded, tandem-axle dump truck or front-end loader. The roller should make a minimum of eight overlapping passes over all areas of the site, the latter four passes at right angles to previous passes. The soils should be compacted sufficiently to obtain a minimum compaction as defined in **Section 4.3.3**. Unstable soil (pumping) should be removed or moisture conditioned and compacted in place prior to placing fill.

4.3.2 Material Requirements

Engineered fill should meet the following material property requirements:

Fill Type	USCS Classification	Acceptable Location for Placement
Select	SW, SP, GW, GP (fines content < 5 percent, maximum particle size < 1 inch, organic content < 2 percent)	Between the bottom of pavement and top of subgrade/general fill; at least 4 inches thick
General [1]	SP, SP-SM (fines content < 12 percent, maximum particle size < 2 inches, organic content < 3 percent)	At all locations and elevations beneath the Select Fill

1. Strata 1 and 2 soils at this site appear to meet this criterion. Soils with fines content > 12 percent may retain moisture and be difficult to compact and achieve specified density and stability. These soils may need to be maintained dry of optimum to properly compact.

4.3.3 Compaction Requirements-Mass Fill Areas

Item	Description
Fill Lift Thickness	12 inches or less in loose thickness when heavy vibratory compaction equipment is used. Maximum particle size should not exceed 2 inches in a 12-inch lift. 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used. Maximum particle size should not exceed 1 inch in a 4- to 6-inch lift.
Minimum Compaction Requirements	Greater than one foot below pavement subgrade elevation should be compacted to at least 95 percent of the maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). The upper one foot of pavement subgrades should be compacted to between 92 and 95 percent of the maximum dry density as determined by the Modified Proctor Test (ASTM D-1557).
Moisture Content [1]	Within ±2 percent of optimum moisture content as determined by the Modified Proctor test, at the time of placement and compaction
Minimum Testing Frequency	One field density test per 5,000 square feet.

1 We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate compaction limits have not been met, the area represented by the test should be reworked and retested as required until achieving the compaction requirements..

4.3.4 Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction.

4.4 Pervious Pavements

4.4.1 Subgrade Preparation

Site grading is typically accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to temporarily improve ride comfort. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

We recommend the moisture content and density of the top 12 inches of the subgrade be evaluated and the pavement subgrades be proof rolled and tested within two days prior to commencement of actual paving operations. Compaction tests should be performed at a frequency of 1 test per 10,000 square feet or fraction thereof. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and re-compacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled

trenches are located. Areas where unsuitable conditions are found should be repaired by removing and replacing the materials with properly compacted fills.

After proof-rolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and prepared as recommended in **Section 4.3** of the **Earthwork** section this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

4.4.2 Underdrain Design

Based on the results of the groundwater modeling completed by Andreyev Engineering, Inc., we recommend a FDOT Type II underdrain be installed at approximate intervals of 60 feet throughout the pervious pavement area or beneath the centerline of the drive lane along the east end of the project. Underdrains should be designed to have positive outfall. Cleanout points should be designed and installed to allow periodic maintenance of the underdrain system. The underdrain should be consistent with the *Underdrain Detail* provided on Sheet 12 of the Conceptual Plan by the Manatee County Public Works department, dated August 2015. We recommend that the coarse aggregate consist of FDOT No. 57 stone or equivalent wrapped in a FDOT Type D-3 filter fabric. A report summarizing the groundwater modeling analysis is included in Appendix D of this report.

4.5 Temporary Dewatering

Dewatering will be needed to facilitate earthwork, specifically demucking, and underground utility installation operations for this project. Actual dewatering means and methods should be left up to a contractor experienced in installation and operation of dewatering systems. The contractor should provide a dewatering plan for review and approval by the engineer prior to the installation of the dewatering systems.

4.6 30-Year Erosion Protection Line

Taylor Engineering, Inc. completed a historical beach recession analysis and estimate of the position of the Mean High Water (MHW) line 30 years from the present for the site. The entire Taylor Engineering report is included in Appendix E of this report.

5.0 ADDITIONAL CONSIDERATIONS

We recommend that additional exploratory borings be drilled within the proposed pavement areas, during the design process, to better characterize the depth, thickness, and lateral extent of the organic sands. To do that, we recommend 10 to 12-foot deep auger borings be drilled in a grid-like pattern around the Borings B-16, B-17, and B-20.

6.0 GENERAL COMMENTS

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

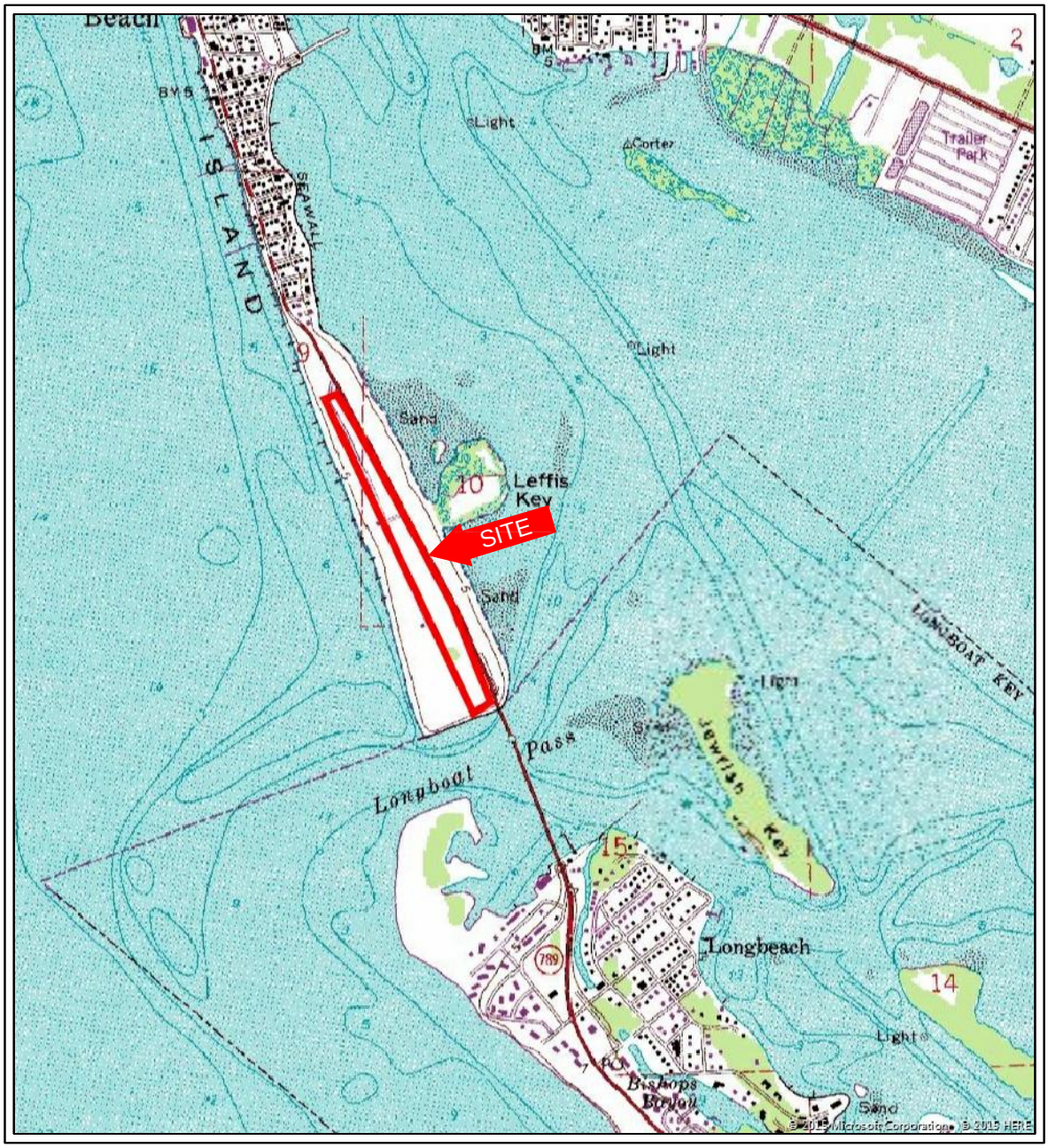
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

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

APPENDIX A
FIELD EXPLORATION

UNITED STATES – DEPARTMENT OF THE INTERIOR – GEOLOGICAL SURVEY



SCALE 1:24 000

1 .5 0 KILOMETERS 1 2

1000 0 METERS 1000 2000

1 .5 0 1

MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

CONTOUR INTERVAL: 5 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

N

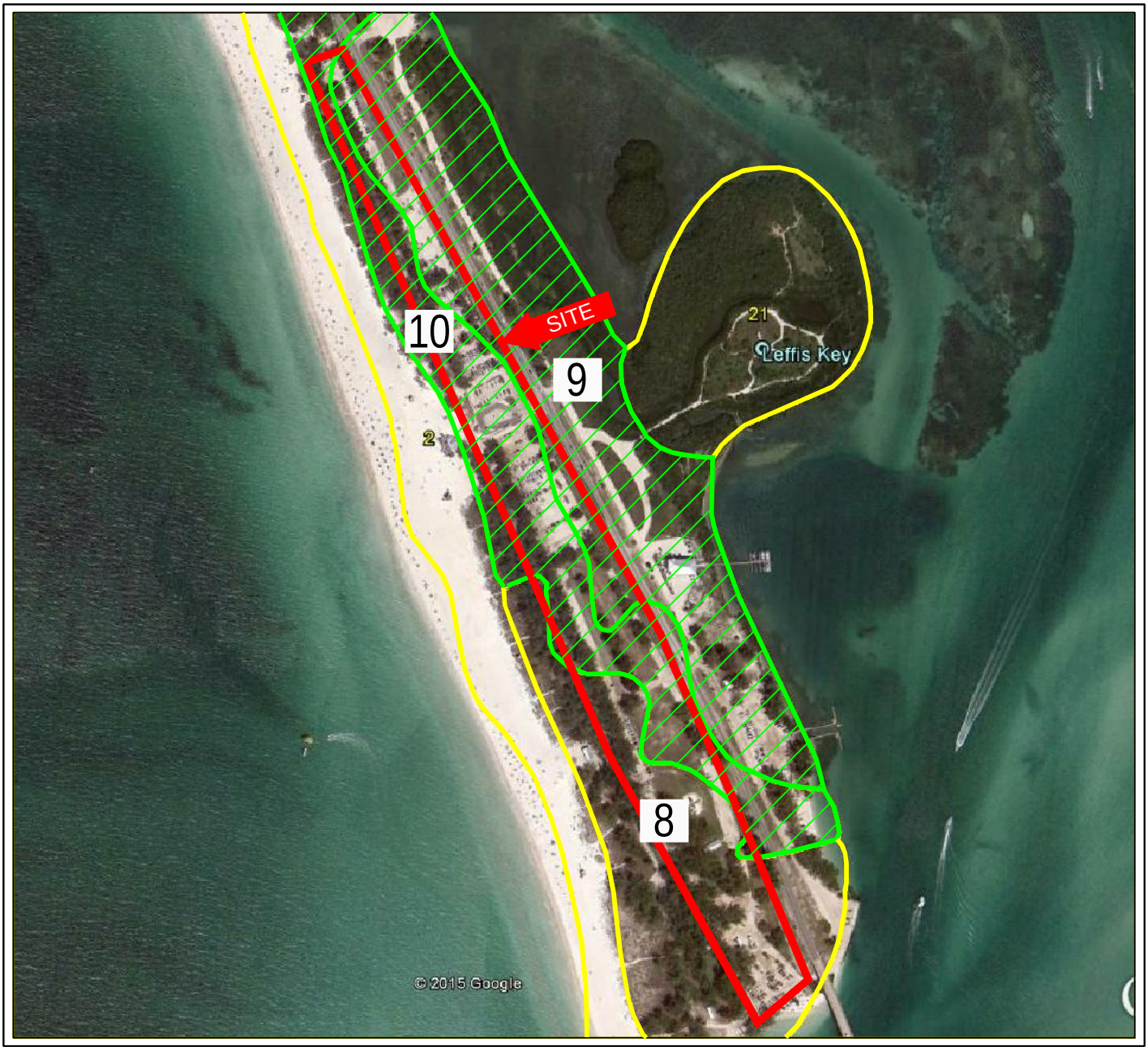
BRADENTON BEACH, FL
1987
7.5 MINUTE SERIES (TOPOGRAPHIC)

Project Mngr:	JMJ
Drawn By:	DCV
Checked By:	JMJ
Approved By:	DSD
Project No.	HC155032
Scale:	AS-SHOWN
File No.	HC155032-1
Date:	1-21-16

Terracon
Consulting Engineers and Scientists
8260 VICO COURT, UNIT B SARASOTA, FL 34240
PH. (941) 379-0621 FAX. (941) 379-5061

TOPOGRAPHIC VICINITY MAP
GEOTECHNICAL ENGINEERING REPORT
COQUINA BEACH DRAINAGE IMPROVEMENTS
2651 GULF DRIVE
BRADENTON BEACH, MANATEE COUNTY, FLORIDA

EXHIBIT
A-1



SCALE 1" = 600'

300 0 300 600 900 1200 1500 1800 2100 2400 2700 3000

U.S.D.A. SOIL SURVEY FOR MANATEE COUNTY, FLORIDA
ISSUED: APRIL 1983

N

SOIL LEGEND

8	CANAVERAL FINE SAND
9	CANAVERAL SAND, FILLED
10	CANAVERAL SAND, ORGANIC SUBSTRATUM

POSSIBLE PRESENCE OF ORGANIC MATERIAL

Project Mngr:	JMJ
Drawn By:	DCV
Checked By:	JMJ
Approved By:	DSD
Project No.	HC155032
Scale:	AS-SHOWN
File No.	HC155032-1
Date:	1-21-16

Terracon
Consulting Engineers and Scientists
8260 VICO COURT, UNIT B SARASOTA, FL 34240
PH. (941) 379-0621 FAX. (941) 379-0621

SOILS MAP

GEOTECHNICAL ENGINEERING REPORT
COQUINA BEACH DRAINAGE IMPROVEMENTS
2651 GULF DRIVE
BRADENTON BEACH, MANATEE COUNTY, FLORIDA

EXHIBIT
A-2

Soil Survey Descriptions

Unit 8, *Canaveral fine sand,* is comprised of nearly level to gently sloping, moderately well drained to somewhat poorly drained soil on narrow to broad dunelike ridges on the larger islands and keys and in some places on the mainland. Permeability is very rapid and the available water capacity is low. The typical soil profile consists of fine sand and fine sand with shell fragments to a depth of 65 inches. Under natural (pre-development) conditions, the Seasonal High Groundwater Table (SHGWT) is reported to lie at a depth of 10 to 40 inches for 2 to 6 months of the year.

Unit 9, *Canaveral sand, filled*, is comprised of nearly level, moderately well drained to somewhat poorly drained soil that consists of sand and shells that have been dredged or excavated from water areas and then leveled and smoothed, mainly for urban use. Permeability is very rapid and the available water capacity is low. The fill material varies within short distances and ranges from about 20 to 80 inches in thickness. The typical soil profile consists of fine to coarse sand with shell and may contain balls of clayey or loamy material in some places. The Seasonal High Groundwater Table (SHGWT) is reported to lie at a depth of 40 to 60 inches and is dependent on the thickness of the fill material.

Unit 10, *Canaveral sand, organic substratum*, is comprised of nearly level, moderately well drained to somewhat poorly drained soil consisting of sand and shells overlying organic material. Permeability is very rapid and the available water capacity is low in the fill material and the permeability is moderately rapid and the available water capacity is very high in the organic layer. The sand and shells have been dredged or excavated from water areas and deposited on tidal swamps or marshes. The fill material ranges from about 40 to 70 inches in thickness and is about 10 to 80 percent shells. The sand is fine to coarse with some lenses of clayey or loamy material. A layer of **muck** is generally found beneath the fill material from a depth of about 45 to 70 inches. In most areas, this soil group is artificially drained with a Seasonal High Groundwater Table (SHGWT) at a depth of about 30 to 60 inches. The SHGWT is dependent on the thickness of the fill material.

SOURCE: MANATEE COUNTY PUBLIC WORKS DEPARTMENT

LEGEND

B-1/ BHP-1 — APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING AND BOREHOLE PERMEABILITY TEST

DRI-1 — APPROXIMATE LOCATION OF DOUBLE RING INFILTRATION TEST

300 0 150 300

SCALE IN FEET

Project Mngr:	JMJ
Drawn By:	DCV
Checked By:	JMJ
Approved By:	DSD
Project No.	HC155032
Scale:	AS-SHOWN
File No.	HC155032-4
Date:	1-21-16

Terracon
Consulting Engineers and Scientists
8260 VICO COURT, UNIT B SARASOTA, FL 34240
PH. (941) 379-0621 FAX. (941) 379-5061

BORING LOCATION PLAN

GEOTECHNICAL ENGINEERING REPORT

COQUINA BEACH DRAINAGE IMPROVEMENTS

2651 GULF DRIVE

BRADENTON BEACH, MANATEE COUNTY, FLORIDA

EXHIBIT A-4

Field Exploration Description

The boring locations were determined prior to visiting the site by a DUNKELBERGER engineer using the provided site plan. The boring locations were then staked at the project site by a DUNKELBERGER engineer using a hand-held GPS unit and existing site features as reference points.

The SPT soil borings were drilled with a rubber track mounted, rotary drilling rig equipped with a safety hammer. The boreholes were advanced with a cutting head and stabilized with the use of bentonite (drillers' mud). Soil samples were obtained by the split spoon sampling procedure in general accordance with the Standard Penetration Test (SPT) procedure. In the split spoon sampling procedure, the number of blows required to advance the sampling spoon the last 12 inches of an 18-inch penetration or the middle 12 inches of a 24-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (N). This value is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. The sampling depths and penetration distance, plus the standard penetration resistance values, are shown on the boring logs.

Portions of the samples from the borings were sealed in jars to reduce moisture loss, and then the jars were taken to our laboratory for further observation and classification. Upon completion, the boreholes were sealed from bottom to top with cement grout. Borings drilled in the asphalt pavement were capped with cold-mix asphalt patch.

Field logs of each boring were prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. The boring logs included with this report represent an interpretation of the field logs and include modifications based on laboratory observation of the samples.

The double ring infiltration (DRI) test was run to aid in the design of the stormwater management area. The DRI test procedure consisted of installing a 12-inch diameter aluminum ring and a 24-inch diameter aluminum ring concentrically into the ground. Water was then added to the desired head level of approximately 14 inches in both casings and held constant. The amount of infiltration observed in the inner ring versus time was then recorded. This procedure was repeated for a total of 4 hours or until a stabilized infiltration rate was achieved.

The borehole permeability (BHP) test was completed by installing 23 feet of 2-inch diameter machine slotted PVC pipe (0.10-inch slot width) that was flush joint coupled to 2 feet of solid riser pipe of similar composition. A filter sand pack of 20/30 silica sand was placed around the well screen interval followed by about 1 foot of 60/30 fine sand and capped with about 1 foot of bentonite chips (to provide a low permeability seal) that extended to the ground surface. The completed pipe installations were pumped until the development water was free of sediment.

Field permeability tests were completed by filling the pipe with water at the measured volumetric rate required to maintain a constant head in the pipe.

BORING LOG NO. B-1

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44501° Longitude: -82.68918°

Surface Elev.: +3.7 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						7-9-9-9 N=18			
						7-11-15-15 N=26			
			5	▽		3-8-16-23 N=24			
						10-20-25-28 N=45			
						9-22-31-40 N=53			
	10.0	-6.5	10						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to light gray, medium dense to very dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 | Boring Completed: 11/13/2015

Drill Rig: BR2500 | Driller: JM

Project No.: HC155032 | Exhibit: A-6

BORING LOG NO. B-2

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44534° Longitude: -82.68874°

Surface Elev.: +3.5 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray to gray, medium dense to dense					5-7-8-8 N=15			
						8-8-13-14 N=21			
			5	▽		3-12-16-14 N=28			
						4-11-13-20 N=24			
						13-23-26-28 N=49			
			10						
						13-15-16 N=31			
			15						
						8-15-19 N=34			
			20						
						12-22-24 N=46			
	25.0	-21.5	25						
	Boring Terminated at 25 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-7

BORING LOG NO. B-3

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44556° Longitude: -82.68918°

Surface Elev.: +2.8 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to gray, medium dense to very dense					5-5-6-9 N=11			
						13-19-17-23 N=36			
			5	▽		6-12-20-26 N=32			
						13-27-25-26 N=52			
						5-16-19 N=35			
	10.0	-7	10						
	Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-8

BORING LOG NO. B-4

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44548° Longitude: -82.68954°

Surface Elev.: +3.4 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						5-7-6-8 N=13			
						6-13-17-20 N=30			
			5	▽		3-11-13-20 N=24			
						4-11-18-27 N=29			
						5-21-28-34 N=49		22	9
			10						
						8-9-5 N=14			
			15						
						7-15-26 N=41			
			20						
						8-15-25 N=40			
	25.0	-21.5	25						

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light brown to gray, medium dense to dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-9

BORING LOG NO. B-5

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44605° Longitude: -82.68955°

Surface Elev.: +3.1 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	0	+3							
						6-6-9-11 N=15			
						10-18-22-19 N=40			
			5	▽		5-11-15-20 N=26			
						9-19-30-26 N=49			
						10-20-23-28 N=43			
	10.0	-7	10						

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray to gray, medium dense to dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-10

BORING LOG NO. B-6

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44651° Longitude: -82.68934°

Surface Elev.: +2.5 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						4-5-5-9 N=10			
						8-10-15-20 N=25			
			5	▽		3-7-16-19 N=23			
						8-18-22-22 N=40			
						6-14-16-20 N=30			
			10						
						8-12-14 N=26			
			15						
						13-15-15 N=30			
			20						
						10-18-23 N=41			
	25.0	-22	25						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown and light gray to gray, loose to dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-11

BORING LOG NO. B-7

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44705° Longitude: -82.68951°

Surface Elev.: +3.1 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	0.0	+3.1							
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to light brown, medium dense to dense					4-6-8-11 N=14			
						6-12-15-17 N=27			
			5	▽		2-3-9-5 N=12			
						8-16-17-16 N=33			
	10.0	-7				18-7-6-9 N=13			
	Boring Terminated at 10 Feet		10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-12

BORING LOG NO. B-8

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44645° Longitude: -82.69001°

Surface Elev.: +3.2 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	0.0	+3.2							
						3-7-7-14 N=14			
						10-15-20-22 N=35			
			5	▽		4-14-19-21 N=33			
						9-11-14-18 N=25			
						7-17-19-22 N=36			
			10						
						5-4-6 N=10			
			15						
						7-11-19 N=30			
			20						
						9-20-21 N=41			
	25.0	-22	25						

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray to gray, loose to dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-13

BORING LOG NO. B-9

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.4471° Longitude: -82.69044°

Surface Elev.: +3.4 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), with shell fragements, fine grained, dark gray, medium dense				6-12-12-17 N=24			
	2.0	1.5							
		SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray, medium dense to very dense				12-25-27-33 N=52			
			5	▽		6-11-17-19 N=28			
						6-14-19-20 N=33			
						9-16-20-20 N=36			
	10.0	-6.5	10						
		Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-14

BORING LOG NO. B-10

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44759° Longitude: -82.68973°

Surface Elev.: +3.7 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						5-6-6-8 N=12			
						6-4-3-4 N=7			
			5	▽		6-6-11-16 N=17			
						6-3-2-8 N=5			
						4-15-15-17 N=30			
			10						
						2-3-6 N=9			
			15						
						5-7-9 N=16			
			20						
						2-7-8 N=15			
	25.0	-21.5	25						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to dark gray and gray, loose to medium dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-15

BORING LOG NO. B-11

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44807° Longitude: -82.69001°

Surface Elev.: +4.6 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						7-8-9-8 N=17			
						8-7-6-5 N=13			
			5	▽		2-1-4-12 N=5			
						9-14-15-15 N=29			
						6-7-9-12 N=16			
	10.0	-5.5	10						

SLIGHTLY SILTY SAND (SP-SM), some shell fragments, fine grained, light brown to light gray and gray, loose to medium dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-16

BORING LOG NO. B-12

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44764° Longitude: -82.69065°

Surface Elev.: +3.6 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						13-14-10-12 N=24		22	8
						9-20-26-21 N=46			
			5			7-9-11-12 N=20			
				▽		4-4-13-18 N=17			
						15-12-19-20 N=31			
			10						
						11-8-2 N=10			
			15						
						12-5-8 N=13			
			20						
						5-6-8 N=14			
	25.0	-21.5	25						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to light gray, medium dense to dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 8 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/11/2015 Boring Completed: 11/11/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-17

BORING LOG NO. B-13

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44815° Longitude: -82.69089°

Surface Elev.: +3.7 feet-NAVD

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	SLIGHTLY SILTY SAND (SP-SM), some shell fragments, fine grained, brown, medium dense				11-14-14-10 N=28			
2.0	1.5							
	SLIGHTLY SILTY SAND (SP-SM), some tree debris, fine grained, gray, medium dense				8-8-12-13 N=20			
4.0	-0.5							
	SLIGHTLY SILTY SAND (SP-SM), fine grained, light gray to gray, loose to medium dense	5	▽		7-10-12-12 N=22			
					6-6-7-9 N=13			
					5-3-4-10 N=7			
10.0	-6.5	10						
	Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-18

BORING LOG NO. B-14

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44837° Longitude: -82.69053°

Surface Elev.: +4.1 feet-NAVD

DEPTH		ELEVATION (Ft.)
1.0	**SLIGHTLY SILTY SAND (SP-SM)**, with shell fragments, fine grained, brown, medium dense	3
2.0	**SLIGHTLY SILTY SAND (SP-SM)**, organic stained, fine grained, black, medium dense	2
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray, medium dense	
25.0		-21
	Boring Terminated at 25 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
			6-5-8-11 N=13	1.2	13	
			8-8-9-7 N=17			
5	▽		6-8-9-10 N=17			
			7-6-8-10 N=14			
			3-7-6-4 N=13			
10						
			5-8-14 N=22		23	6
15						
			7-9-12 N=21			
20						
			11-10-15 N=25			
25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-19

BORING LOG NO. B-15

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44906° Longitude: -82.69061°

Surface Elev.: +4.9 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	0.0	+4.9							
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, brown to light gray and gray, loose to medium dense					7-11-14-16 N=25			
						9-11-10-9 N=21			
			5	▽		4-5-7-3 N=12			
						2-2-6-9 N=8			
						3-9-12-15 N=21			
	10.0	-5	10						
	Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-20

BORING LOG NO. B-16

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44868° Longitude: -82.69117°

Surface Elev.: +3.7 feet-NAVD

DEPTH	ELEVATION (Ft.)		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, brown to light gray and light brown, medium dense				5-7-15-20 N=22			
						11-9-10-5 N=19			
4.0	-0.5	**ORGANIC SAND (SM, PT)**, fine grained, gray and black, loose	5	▽		1-3-4-14 N=7	7.2	47	
6.0	-2.5	**SLIGHTLY SILTY SAND (SP-SM)**, trace shell fragments, fine grained, light gray to gray, medium dense to dense				10-15-18-17 N=33			
						8-13-21-21 N=34			
			10						
						9-9-17 N=26			
			15						
						5-7-10 N=17			
			20						
25.0	-21.5					13-12-16 N=28			
		Boring Terminated at 25 Feet	25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-21

BORING LOG NO. B-17

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44915° Longitude: -82.69139°

Surface Elev.: +6.2 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						6-8-16-20 N=24			
						16-17-14-7 N=31			
	4.0	2							
	ORGANIC SAND (SM, PT), tree debris, fine grained, dark brown to dark gray, very loose		5	▽		3-1-2-1 N=3	7.5	58	
	6.0	0							
	SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray, medium dense					7-8-12-15 N=20			
						14-9-7-6 N=16			
	10.0	-4	10						
	Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-22

BORING LOG NO. B-18

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44955° Longitude: -82.69091°

Surface Elev.: +5.2 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray and light brown to dark brown and dark gray, medium dense to dense				11-12-14-17 N=26			
						15-14-17-18 N=31			
4.0	1	**SAND (SP)**, fine grained, light gray, medium dense	5	▽		6-10-9-6 N=19		23	2
6.0	-1	**SLIGHTLY SILTY SAND (SP-SM)**, trace to some shell fragments, fine grained, light gray and light brown to dark brown and dark gray, loose to dense				2-1-7-12 N=8			
						5-14-17-13 N=31			
			10						
						7-17-17 N=34			
			15						
						8-9-11 N=20			
			20						
						9-9-7 N=16			
25.0	-20		25						
		Boring Terminated at 25 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-23

BORING LOG NO. B-19

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45003° Longitude: -82.69121°

Surface Elev.: +5.1 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						19-18-15-21 N=33			
						15-12-15-15 N=27			
			5	▽		6-7-8-6 N=15			
						4-3-8-14 N=11			
						9-12-11-15 N=23			
	10.0	-5	10						

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light brown and light gray to gray and brown, medium dense to dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-24

BORING LOG NO. B-20

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45051° Longitude: -82.6915°

Surface Elev.: +5.4 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, orange and brown							
2.0	3.5								
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, light gray to gray, medium dense		▽					
			5		X	6-6-8-6 N=14			
6.0	-0.5								
		ORGANIC SAND (SM, PT), fine grained, black to gray, very loose			X	3-1-1-4 N=2	15.9	106	
8.0	-2.5								
		SLIGHTLY SILTY SAND (SP-SM), fine grained, light gray to dark gray, loose to medium dense			X	10-13-11-10 N=24			
			10						
					X	5-5-4 N=9			
			15						
					X	3-4-8 N=12			
			20						
					X	4-5-5 N=10			
25.0	-19.5		25						
		Boring Terminated at 25 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 4 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/11/2015 Boring Completed: 11/11/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-25

BORING LOG NO. B-21

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.451° Longitude: -82.6918°

Surface Elev.: +5.4 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, orange and brown, dense				13-17-18-20 N=35			
	2.0	3.5							
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray, medium dense to dense				21-19-22-21 N=41			
			5	▽		5-5-11-11 N=16			
						12-13-13-20 N=26			
						5-5-8-3 N=13			
	10.0	-4.5	10						
		Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-26

BORING LOG NO. B-22

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45148° Longitude: -82.6921°

Surface Elev.: +5.5 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to brown, medium dense to dense				8-12-15-13 N=27		7	9
						13-14-18-20 N=32			
			5	▽		8-16-11-20 N=27			
						7-9-6-6 N=15			
						8-12-14-18 N=26			
12.5	-7		10						
		SILTY SAND (SM), fine grained, dark gray, very loose				1-2-1 N=3			
17.5	-12		15						
		SLIGHTLY SILTY SAND (SP-SM), fine grained, gray to dark gray, loose to medium dense				1-2-5 N=7			
			20						
						4-10-9 N=19			
25.0	-19.5		25						
		Boring Terminated at 25 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-27

BORING LOG NO. B-23

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45198° Longitude: -82.69239°

Surface Elev.: +5.9 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray and brown, loose to dense					12-18-19-22 N=37			
						12-13-18-32 N=31			
			5	▽		16-19-13-18 N=32			
						5-13-5-12 N=18			
						4-2-6-3 N=8			
	10.0	-4	10						
	Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-28

BORING LOG NO. B-24

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45247° Longitude: -82.6927°

Surface Elev.: +5.6 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						6-15-15-16 N=30			
						12-9-50/4"			
			5	▽		20-18-13-18 N=31			
						11-10-5-4 N=15			
						4-11-12-12 N=23			
			10						
						11-11-16 N=27			
			15						
						4-3-3 N=6			
			20						
						4-9-8 N=17			
	25.0	-19.5	25						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray and brown, medium dense to very dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-29

BORING LOG NO. B-25

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45295° Longitude: -82.69299°

Surface Elev.: +5.2 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						15-13-14-20 N=27			
						16-18-18-17 N=36			
			5	▽		4-4-9-12 N=13			
						5-4-3-1 N=7			
						4-7-15-15 N=22			
	10.0	-5	10						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to dark graay, loose to dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-30

BORING LOG NO. B-26

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45285° Longitude: -82.69326°

Surface Elev.: +4.3 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), fine grained, light gray to brown, medium dense				9-10-12-13 N=22			
						18-13-12-7 N=25			
4.0	0.5	**SLIGHTLY SILTY SAND (SP-SM)**, large tree debris, fine grained, gray and brown, medium dense	5	▽		3-3-10-19 N=13			
6.0	-1.5	**SLIGHTLY SILTY SAND (SP-SM)**, trace shell fragments, fine grained, light gray to dark brown, very loose to dense				3-11-17-25 N=28			
						7-14-19-17 N=33			
			10						
						1-1-1 N=2			
			15						
						3-9-11 N=20			
			20						
25.0	-20.5					3-4-4 N=8			
		Boring Terminated at 25 Feet	25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-31

BORING LOG NO. B-27

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45332° Longitude: -82.69341°

Surface Elev.: +4.5 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						7-5-12-16 N=17			
						11-14-13-18 N=27			
			5	▽		17-14-16-20 N=30			
						7-5-5-10 N=10			
						8-17-20-25 N=37			
	10.0	-5.5	10						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray and light brown to gray, medium dense to dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-32

BORING LOG NO. B-28

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.4538° Longitude: -82.69366°

Surface Elev.: +4.7 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown and light gray to gray, loose to medium dense				3-4-5-10 N=9			
						11-14-11-11 N=25			
			5	▽		2-8-6-8 N=14			
						3-6-8-10 N=14			
						3-4-7-6 N=11			
12.5	-8		10						
		SILTY SAND (SM), fine grained, dark gray, very loose				1-1-2 N=3			
17.5	-13		15						
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, brown to gray, medium dense to dense				9-11-9 N=20			
			20						
						11-16-21 N=37			
25.0	-20.5		25						
		Boring Terminated at 25 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-33

BORING LOG NO. B-29

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45434° Longitude: -82.69393°

Surface Elev.: +4.7 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						5-5-8-23 N=13			
						15-22-16-20 N=38			
			5	▽		7-7-6-13 N=13			
						6-5-3-7 N=8			
						6-3-1-1 N=4			
	10.0	-5.5	10						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray, very loose to very dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-34

BORING LOG NO. B-30

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45485° Longitude: -82.6943°

Surface Elev.: +4.7 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to gray, dense							
4.0	0.5					12-15-21-26 N=36			
		SLIGHTLY SILTY SAND (SP-SM), organic staqined, fine grained, gray and black, loose	5	▽		7-2-3-2 N=5			
6.0	-1.5					7-1-4-9 N=5			
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray, loose to medium dense				8-12-13-20 N=25			
12.5	-8		10						
		SILTY SAND (SM), trace shell fragments, fine grained, gray, loose				2-3-2 N=5		24	13
17.5	-13		15						
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, gray to dark gray, medium dense				8-10-10 N=20			
			20						
25.0	-20.5					8-12-13 N=25			
		Boring Terminated at 25 Feet	25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

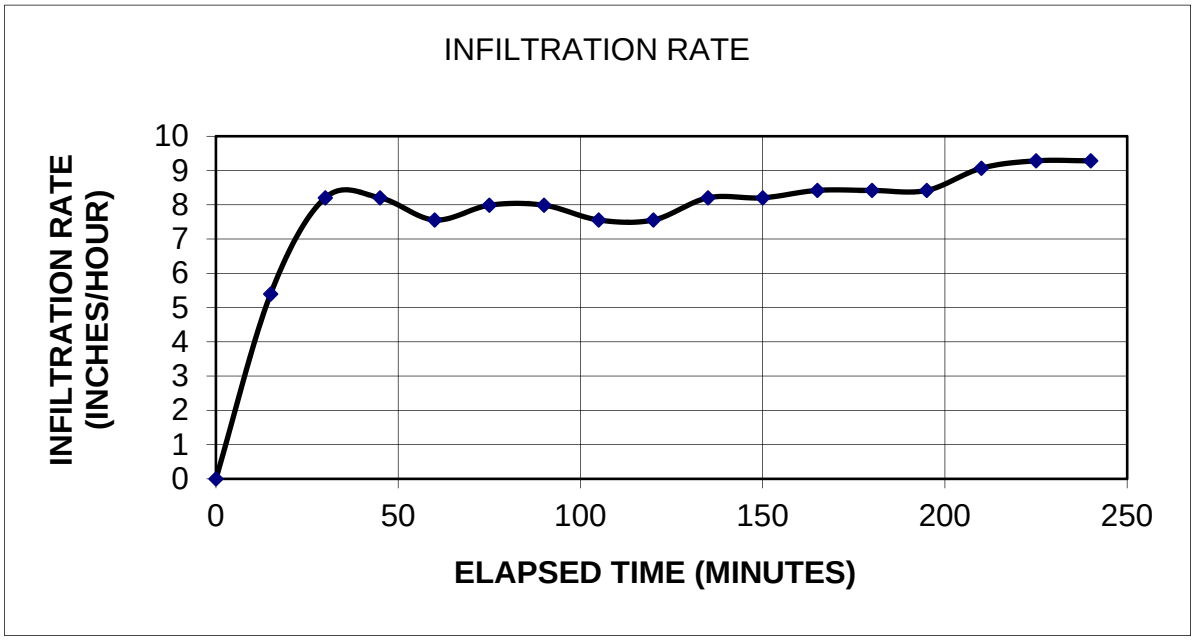
Project No.: HC155032 Exhibit: A-35

DRI-1

DOUBLE RING INFILTRATION TEST RESULTS
PROJECT NAME: Coquina Beach Drainage Improvements
PROJECT No.: HC155032
TEST LOCATION: DRI-1

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
8:30	15	0	0	0
8:45	15	15	2500	5.40
9:00	15	30	3800	8.20
9:15	15	45	3800	8.20
9:30	15	60	3500	7.56
9:45	15	75	3700	7.99
10:00	15	90	3700	7.99
10:15	15	105	3500	7.56
10:30	15	120	3500	7.56
10:45	15	135	3800	8.20
11:00	15	150	3800	8.20
11:15	15	165	3900	8.42
11:30	15	180	3900	8.42
11:45	15	195	3900	8.42
12:00	15	210	4200	9.07
12:15	15	225	4300	9.28
12:30	15	240	4300	9.28

DIAMETER OF INNER RING = 12 INCHES
DIAMETER OF OUTER RING = 24 INCHES



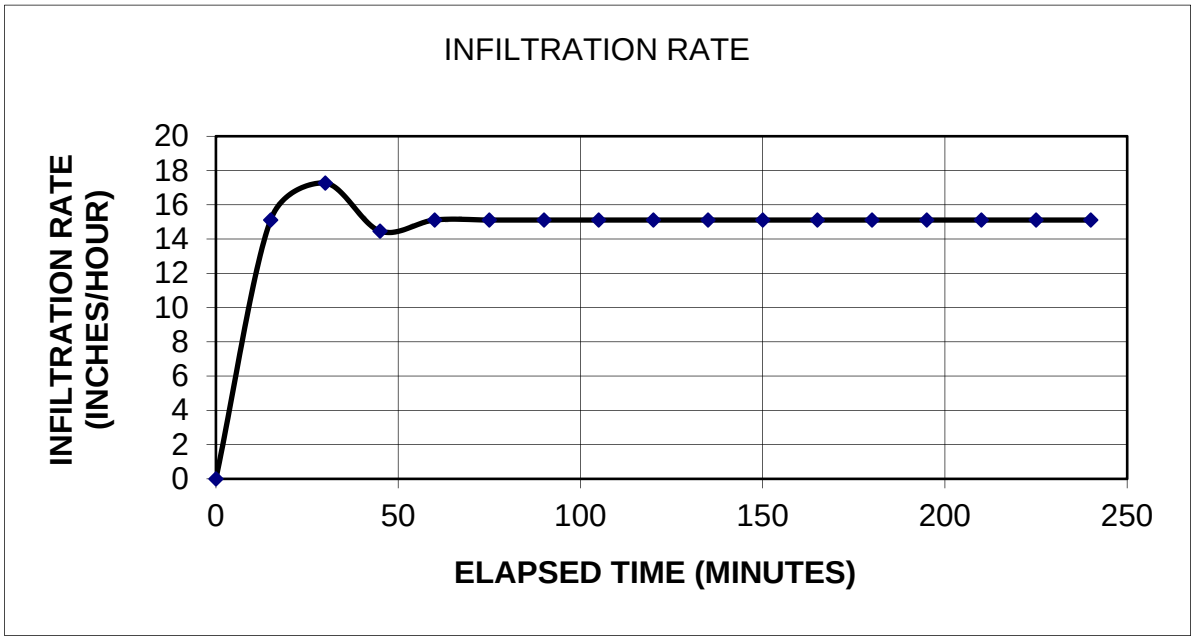
DEPTH OF TEST = 12 inches
MATERIAL DESCRIPTION = White fine SAND (SP)

DRI-2

DOUBLE RING INFILTRATION TEST RESULTS
PROJECT NAME: Coquina Beach Drainage Improvements
PROJECT No.: HC155032
TEST LOCATION: DRI-2

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
7:30	15	0	0	0
7:45	15	15	7000	15.11
8:00	15	30	8000	17.27
8:15	15	45	6700	14.46
8:30	15	60	7000	15.11
8:45	15	75	7000	15.11
9:00	15	90	7000	15.11
9:15	15	105	7000	15.11
9:30	15	120	7000	15.11
9:45	15	135	7000	15.11
10:00	15	150	7000	15.11
10:15	15	165	7000	15.11
10:30	15	180	7000	15.11
10:45	15	195	7000	15.11
11:00	15	210	7000	15.11
11:15	15	225	7000	15.11
11:30	15	240	7000	15.11

DIAMETER OF INNER RING = 12 INCHES
DIAMETER OF OUTER RING = 24 INCHES



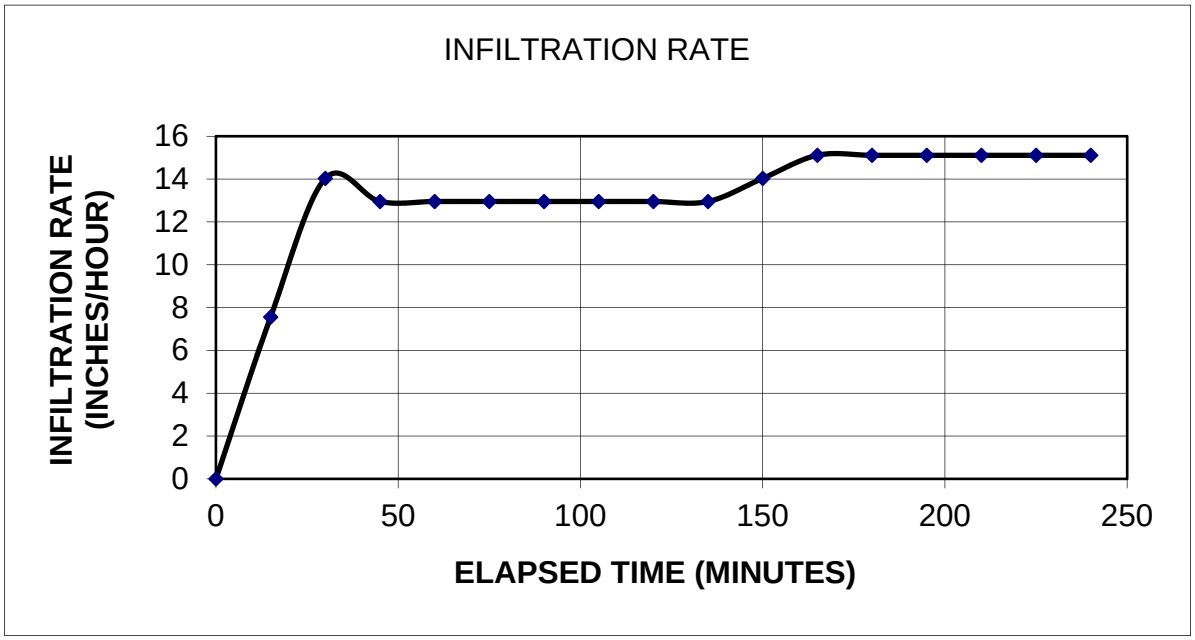
DEPTH OF TEST = 20 inches
MATERIAL DESCRIPTION = White fine SAND (SP)

DRI-3

DOUBLE RING INFILTRATION TEST RESULTS
PROJECT NAME: Coquina Beach Drainage Improvements
PROJECT No.: HC155032
TEST LOCATION: DRI-3

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
11:30	15	0	0	0
11:45	15	15	3500	7.56
12:00	15	30	6500	14.03
12:15	15	45	6000	12.95
12:30	15	60	6000	12.95
12:45	15	75	6000	12.95
13:00	15	90	6000	12.95
13:15	15	105	6000	12.95
13:30	15	120	6000	12.95
13:45	15	135	6000	12.95
14:00	15	150	6500	14.03
14:15	15	165	7000	15.11
14:30	15	180	7000	15.11
14:45	15	195	7000	15.11
15:00	15	210	7000	15.11
15:15	15	225	7000	15.11
15:30	15	240	7000	15.11

DIAMETER OF INNER RING = 12 INCHES
DIAMETER OF OUTER RING = 24 INCHES



DEPTH OF TEST = 25 inches
MATERIAL DESCRIPTION = White fine SAND (SP)

DUNKELBERGER
engineering & testing, inc.
A Terracon COMPANY

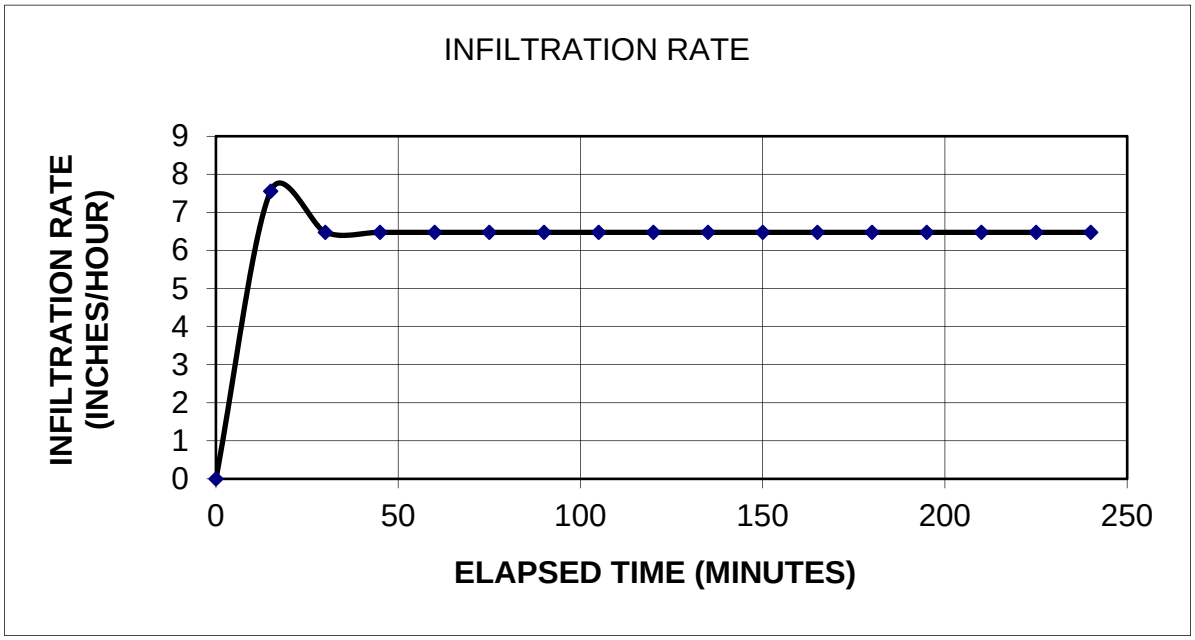
Exhibit A-38

DRI-4

DOUBLE RING INFILTRATION TEST RESULTS
PROJECT NAME: Coquina Beach Drainage Improvements
PROJECT No.: HC155032
TEST LOCATION: DRI-4

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
7:30	15	0	0	0
7:45	15	15	3500	7.56
8:00	15	30	3000	6.48
8:15	15	45	3000	6.48
8:30	15	60	3000	6.48
8:45	15	75	3000	6.48
9:00	15	90	3000	6.48
9:15	15	105	3000	6.48
9:30	15	120	3000	6.48
9:45	15	135	3000	6.48
10:00	15	150	3000	6.48
10:15	15	165	3000	6.48
10:30	15	180	3000	6.48
10:45	15	195	3000	6.48
11:00	15	210	3000	6.48
11:15	15	225	3000	6.48
11:30	15	240	3000	6.48

DIAMETER OF INNER RING = 12 INCHES
DIAMETER OF OUTER RING = 24 INCHES



DEPTH OF TEST = 12 inches
MATERIAL DESCRIPTION = White fine SAND (SP)

SOURCE: GOOGLE EARTH PRO

N

NOTES:

1) GROUNDWATER ELEVATIONS SHOWN IN FEET-NAVD 88.

2) GROUNDWATER ELEVATIONS SHOWN ARE BASED ON FIELD MEASURED GROUNDWATER LEVELS RECORDED DURING A RELATIVELY DRY TIME OF YEAR. WE ANTICIPATE SHGWLS TO BE ABOUT 1 FOOT HIGHER THAN THE LEVELS SHOWN ON THIS MAP.

300 0 150 300

SCALE IN FEET

Project Mngr:	JMJ
Drawn By:	DCV
Checked By:	JMJ
Approved By:	DSD

Project No.	HC155032
Scale:	AS-SHOWN
File No.	HC155032-40
Date:	1-21-16

Terracon
Consulting Engineers and Scientists
8260 VICO COURT, UNIT B SARASOTA, FL 34240
PH. (941) 379-0621 FAX. (941) 379-5061

GROUNDWATER CONTOUR MAP
GEOTECHNICAL ENGINEERING REPORT
COQUINA BEACH DRAINAGE IMPROVEMENTS
2651 GULF DRIVE
BRADENTON BEACH, MANATEE COUNTY, FLORIDA

EXHIBIT
A-40

APPENDIX B
LABORATORY TESTING

Laboratory Testing Procedures

During the field exploration, a portion of each recovered sample was sealed in a jar and transported to our laboratory for further visual observation and laboratory testing. The soil samples were classified in general accordance with the appended General Notes and the Unified Soil Classification System based on the material's texture and plasticity. The estimated group symbol for the Unified Soil Classification System is shown on the boring logs and a brief description of the Unified Soil Classification System is included in Appendix C.

Laboratory tests conducted for this project included moisture content, organic content, and determination of the amount passing a U.S. No. 200 sieve. The results of the laboratory testing are summarized in the table below and shown on the boring logs in Appendix A.

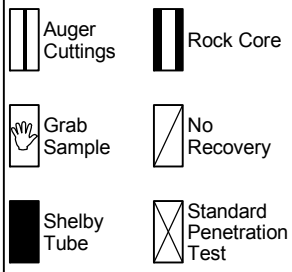
Boring No.	USCS Classification	Depth (ft)	Moisture Content (%)	Fines Content (%)	Organic Content
B-4	SP-SM	8	21.6	8.6	-
B-12	SP-SM	0	21.5	8.1	-
B-14	SP-SM	0	13.0	-	1.2
B-14	SP-SM	13.5	22.6	5.5	-
B-16	SP-SM, PT	4	46.6	-	7.2
B-17	SP-SM, PT	4	58.1	-	7.5
B-18	SP	4	23.0	2.1	-
B-20	SP-SM, PT	6	106.2	-	15.9
B-22	SP-SM	0	7.4	9.2	-
B-30	SM	0	24.3	12.8	-

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING



WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

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

LOCATION AND ELEVATION NOTES

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

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

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

PLASTICITY DESCRIPTION

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

Terracon

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

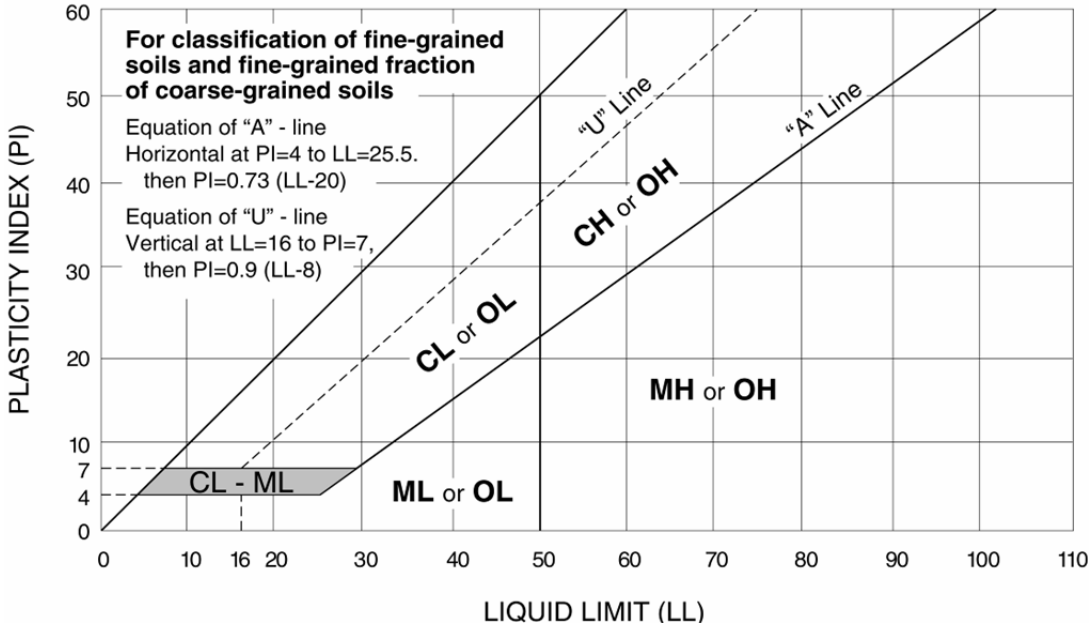
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Exhibit C-2

APPENDIX D
ANDREYEV ENGINEERING GROUNDWATER MODELING REPORTS

Andreyev Engineering, Inc.

ST. PETERSBURG OFFICE
3740 54th Avenue North
St. Petersburg, Florida 33714
727-527-5735
Fax: 727-527-6084

Groundwater ▼ Environmental ▼ Geotechnical ▼ Construction Materials Testing

Revised: January 18, 2016
AEI Project No.: APGT-15-0122

TO: **Mr. James Jackson**
Dunkelberger Engineering and Testing
8260 Vico Court, Suite B
Sarasota, Florida 34240

SUBJECT: Groundwater Modeling of Proposed Underdrain System, Coquina Beach Improvements, Manatee County, Florida

---

Dear Mr. Jackson:

Andreyev Engineering, Inc. (AEI) has completed groundwater modeling for the proposed underdrain system. The results of our groundwater modeling efforts with recommendations for underdrain construction are included herein.

AEI appreciates the opportunity to participate in this project, and we trust that the information herein is sufficient for your design. If you have any questions or comments concerning the contents of this report, please do not hesitate to contact our office.

Sincerely,

ANDREYEV ENGINEERING, INC.

JEFFERY E. ELLER LICENSE No 0057434 STATE OF FLORIDA PROFESSIONAL ENGINEER

1-18-16
Jeffery E. Eller, P.E.
Vice President
Florida Registration No. 57434

Project Description and Approach

Based on the plans provided for our review, we understand that the proposed project consists of the design and construction of an underdrain system to control the shallow groundwater below proposed pervious concrete pavement. The purpose of the groundwater modeling was to evaluate the groundwater conditions prior to and following the installation of the system. The scope of our study consisted of the following:

1. Reviewed project plans, published information on local geology and hydrogeology and results of geotechnical studies and permeability testing.

2. Performed groundwater modeling using MODFLOW. The model was calibrated to existing conditions.

3. Prepared a hydrogeologic report summarizing our modeling results.

Subsurface Soil and Groundwater Conditions

The soil and aquifer conditions over the project area were investigated by Dunkelberger Engineering and Testing (Dunkelberger) in November of 2015. A total of thirty (30) SPT borings were conducted to depths of 10 to 25 feet below land surface (bls). The SPT borings generally encountered fine sands and slightly silty fine sands with traces of shell to the termination depths of 10 and 25 feet bls. Several of the borings encountered shallow layers of organic sands. The shallow groundwater table was encountered at elevations of +0.5 to +1.0 feet in the SPT borings conducted by Dunkelberger.

In order to determine the hydraulic conductivity of the shallow soils Dunkelberger conducted four open borehole permeability tests and four double rings infiltrometer (DRI) tests over the project area. Based on the results of the field testing the saturated horizontal hydraulic conductivity ranged from 0.8 to 11.3 feet per day. The vertical infiltration rate, measured at the DRI locations, ranged from 13 to 30 feet per day. The results of the soil borings and permeability testing completed by Dunkelberger are included in **Appendix A**.

Groundwater Modeling

For this modeling effort, the MODFLOW Vistas groundwater flow model was utilized. The conceptual model was characterized by utilizing the site specific soil borings and groundwater level data as well as the available regional hydrogeologic data. A two layer model was set up for this project, with Layer 1 representing the sandy, unsaturated surficial aquifer system and Layer 2 representing the sandy, saturated portion of the surficial aquifer system.

The permeability of Layers 1 and 2 were initially estimated from the field investigation and testing and then adjusted through the model calibration process to reproduce the field measured groundwater levels within an acceptable level of accuracy.

The model domain was established to encompass the project area plus a perimeter of at least 400 feet. Model dimensions were 3,000 by 5,000, divided into 150,000 cells per layer and each cell having a dimension of 10 feet by 10 feet. The grid size was selected based on the configuration of the project area. The project area was placed in the approximate center of the model grid.

For model calibration, the average aquifer parameters were utilized, as estimated from the geotechnical studies. The lower-bound hydraulic conductivity for Layer 1 (effective aquifer thickness of 5 feet) was estimated at 12 feet per day from the field test data and the hydraulic conductivity for Layer 2 (effective aquifer thickness of 40 feet) was estimated at 8 feet per day based on the field testing. The vertical permeability between Layer 1 and Layer 2 was estimated at 0.5 feet per day. The aquifer parameters were then adjusted by trial and error until the modeled levels closely matched the levels measured during the geotechnical investigation completed by Dunkelberger.

The calibration utilized three stress periods with recharge corresponding to average conditions over a ten year period, wet season and dry season. The net recharge for stress period 1 (average conditions) was 10 inches. In stress periods 2 (wet season) and 3 (dry season) the corresponding recharge was 8 and 2 inches, respectively. Table 1 contains the calibrated model parameters.

Table 1: Model Aquifer Parameters

Aquifer Parameter	Layer 1	Layer 2
Storage Coefficient	0.25	0.001
Porosity	0.30	0.30
Hydraulic Conductivity (ft/day)	12	8
Vertical Permeability between L1 to L2 (ft/day)	0.5	--
Elevation of Bottom of Aquifer (ft)	0	-40
Elevation of Top of Aquifer (ft)	10	0

Modeled groundwater contours for the three calibration stress periods are included in **Figures 1, 2 and 3**.

Following calibration the proposed underdrain system was added to the model in order to simulate the expected drawdown in the surficial aquifer created by the underdrain system. The sizes and locations of the system components were taken from the project plans supplied by Dunkelberger. The project plans did not include a control elevation for the underdrain system so models were created for assumed control elevations of 0.5 feet and 1.0 feet.

Modeled drawdown contours using a 0.5 foot control elevation, for wet and dry season conditions, are shown in **Figures 4 and 5**. Modeled drawdown contours using a 1.0 foot control elevation, for wet and dry season conditions, are shown in **Figures 6 and 7**. For a control elevation of 0.5 feet the modeling indicates that during an average wet season the groundwater drawdown created by the underdrain system is about 0.8 to 1.2 feet at the location of the underdrains. For a control elevation of 1.0 feet the modeling indicates that during an average wet season the groundwater drawdown created by the underdrain system is about 0.2 to 0.8 feet at the location of the underdrains.

FIGURES

LEGEND:

2.0 GROUNDWATER CONTOUR (FEET)

0 300 600 1200

GRAPHIC SCALE: 1"=600'

Andreyev Engineering, Inc.

APPROXIMATE SCALE: 1"=600'	DATE: 12/22/15	ENGINEER: JE
	PN: APGW-15-0122	DRAWN BY: DLS

GROUNDWATER MODELING
FOR PAVEMENT UNDERDRAIN SYSTEM

COQUINA BEACH

MANATEE COUNTY, FL

MODEL CALIBRATION
10 YEAR AVERAGE CONDITIONS

FIGURE 1

LEGEND:

2.0 GROUNDWATER CONTOUR (FEET)

0 300 600 1200

GRAPHIC SCALE: 1"=600'

Andreyev Engineering, Inc.

APPROXIMATE SCALE: 1"=600'	DATE: 12/22/15	ENGINEER: JE
	PN: APGW-15-0122	DRAWN BY: DLS

GROUNDWATER MODELING
FOR PAVEMENT UNDERDRAIN SYSTEM

COQUINA BEACH

MANATEE COUNTY, FL

MODEL CALIBRATION
WET SEASON CONDITIONS

FIGURE 2

LEGEND:

2.0 GROUNDWATER CONTOUR (FEET)

0 300 600 1200

GRAPHIC SCALE: 1"=600'

Andreyev Engineering, Inc.

APPROXIMATE SCALE: 1"=600'	DATE: 12/22/15	ENGINEER: JE
	PN: APGW-15-0122	DRAWN BY: DLS

GROUNDWATER MODELING
FOR PAVEMENT UNDERDRAIN SYSTEM

COQUINA BEACH

MANATEE COUNTY, FL

MODEL CALIBRATION
DRY SEASON CONDITIONS

FIGURE 3

CONTROL ELEVATION SET TO 0.5 FEET

LEGEND:

2.0 GROUNDWATER CONTOUR (FEET)

0 300 600 1200

GRAPHIC SCALE: 1"=600'

Andreyev Engineering, Inc.

APPROXIMATE SCALE: 1"=600'	DATE: 12/23/15	ENGINEER: JE
	PN: APGW-15-0122	DRAWN BY: DLS

GROUNDWATER MODELING FOR PAVEMENT UNDERDRAIN SYSTEM

COQUINA BEACH

MANATEE COUNTY, FL

DRAWDOWN CONTOURS FOR WET SEASON CONDITIONS

FIGURE 4

CONTROL ELEVATION SET TO 0.5 FEET

LEGEND:

2.0 GROUNDWATER CONTOUR (FEET)

0 300 600 1200

GRAPHIC SCALE: 1"=600'

Andreyev Engineering, Inc.

APPROXIMATE SCALE: 1"=600'	DATE: 12/23/15	ENGINEER: JE
	PN: APGW-15-0122	DRAWN BY: DLS

GROUNDWATER MODELING FOR PAVEMENT UNDERDRAIN SYSTEM

COQUINA BEACH

MANATEE COUNTY, FL

DRAWDOWN CONTOURS FOR DRY SEASON CONDITIONS

FIGURE 5

CONTROL ELEVATION SET TO 1.0 FEET

LEGEND:

2.0 GROUNDWATER CONTOUR (FEET)

0 300 600 1200

GRAPHIC SCALE: 1"=600'

Andreyev Engineering, Inc.

APPROXIMATE SCALE: 1"=600'	DATE: 12/23/15	ENGINEER: JE
	PN: APGW-15-0122	DRAWN BY: DLS

GROUNDWATER MODELING FOR PAVEMENT UNDERDRAIN SYSTEM

COQUINA BEACH

MANATEE COUNTY, FL

DRAWDOWN CONTOURS FOR WET SEASON CONDITIONS

FIGURE 6

CONTROL ELEVATION SET TO 1.0 FEET

LEGEND:

2.0 GROUNDWATER CONTOUR (FEET)

0 300 600 1200

GRAPHIC SCALE: 1"=600'

Andreyev Engineering, Inc.

APPROXIMATE SCALE: 1"=600'	DATE: 12/23/15	ENGINEER: JE
	PN: APGW-15-0122	DRAWN BY: DLS

GROUNDWATER MODELING FOR PAVEMENT UNDERDRAIN SYSTEM

COQUINA BEACH

MANATEE COUNTY, FL

DRAWDOWN CONTOURS FOR DRY SEASON CONDITIONS

FIGURE 7

APPENDIX A

DUNKELBERGER SOIL BORINGS & PERMEABILITY TESTING RESULTS


EL 0'
EL +0.5'
EL +1'
+0.7'
+0.6'
+0.7'
+0.6'
+0.6'
+0.9'
+1.0'
+1.0'
+1.0'
+1.0'
+0.8'
+1.1
+0.5'
+0.5'
+0.5'
B-1
B-2
B-3
B-4/BHP-1
B-5
B-6
B-7
B-8
B-9
B-10
B-11
B-13
B-14
B-15
B-16
B-17
B-18
B-19
B-21
B-22
B-23
B-24
B-25
B-26
B-27
B-29
B-30
DRI-1
DRI-2
DRI-3
DRI-4
789
Google earth
© 2015 Google
N
1000 ft

BORING LOG NO. B-1

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44501° Longitude: -82.68918°

Surface Elev.: +3.7 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						7-9-9-9 N=18			
						7-11-15-15 N=26			
			5	▽		3-8-16-23 N=24			
						10-20-25-28 N=45			
						9-22-31-40 N=53			
	10.0	-6.5	10						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to light gray, medium dense to very dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 | Boring Completed: 11/13/2015

Drill Rig: BR2500 | Driller: JM

Project No.: HC155032 | Exhibit: A-6

BORING LOG NO. B-2

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44534° Longitude: -82.68874°

Surface Elev.: +3.5 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray to gray, medium dense to dense					5-7-8-8 N=15			
						8-8-13-14 N=21			
			5	▽		3-12-16-14 N=28			
						4-11-13-20 N=24			
						13-23-26-28 N=49			
			10						
						13-15-16 N=31			
			15						
						8-15-19 N=34			
			20						
						12-22-24 N=46			
	25.0	-21.5	25						
	Boring Terminated at 25 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-7

BORING LOG NO. B-3

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44556° Longitude: -82.68918°

Surface Elev.: +2.8 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to gray, medium dense to very dense					5-5-6-9 N=11			
						13-19-17-23 N=36			
			5	▽		6-12-20-26 N=32			
						13-27-25-26 N=52			
						5-16-19 N=35			
	10.0	-7	10						
	Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-8

BORING LOG NO. B-4

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44548° Longitude: -82.68954°

Surface Elev.: +3.4 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						5-7-6-8 N=13			
						6-13-17-20 N=30			
			5	▽		3-11-13-20 N=24			
						4-11-18-27 N=29			
						5-21-28-34 N=49		22	9
			10						
						8-9-5 N=14			
			15						
						7-15-26 N=41			
			20						
						8-15-25 N=40			
	25.0	-21.5	25						

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light brown to gray, medium dense to dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-9

BORING LOG NO. B-5

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44605° Longitude: -82.68955°

Surface Elev.: +3.1 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	0	+3							
						6-6-9-11 N=15			
						10-18-22-19 N=40			
			5	▽		5-11-15-20 N=26			
						9-19-30-26 N=49			
						10-20-23-28 N=43			
	10.0	-7	10						

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray to gray, medium dense to dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-10

BORING LOG NO. B-6

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44651° Longitude: -82.68934°

Surface Elev.: +2.5 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						4-5-5-9 N=10			
						8-10-15-20 N=25			
			5	▽		3-7-16-19 N=23			
						8-18-22-22 N=40			
						6-14-16-20 N=30			
			10						
						8-12-14 N=26			
			15						
						13-15-15 N=30			
			20						
						10-18-23 N=41			
	25.0	-22	25						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown and light gray to gray, loose to dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-11

BORING LOG NO. B-7

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44705° Longitude: -82.68951°

Surface Elev.: +3.1 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	0.0	+3.1							
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to light brown, medium dense to dense					4-6-8-11 N=14			
						6-12-15-17 N=27			
			5	▽		2-3-9-5 N=12			
						8-16-17-16 N=33			
	10.0	-7				18-7-6-9 N=13			
	Boring Terminated at 10 Feet		10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-12

BORING LOG NO. B-8

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44645° Longitude: -82.69001°

Surface Elev.: +3.2 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	0.0	+3.2							
						3-7-7-14 N=14			
						10-15-20-22 N=35			
			5	▽		4-14-19-21 N=33			
						9-11-14-18 N=25			
						7-17-19-22 N=36			
			10						
						5-4-6 N=10			
			15						
						7-11-19 N=30			
			20						
						9-20-21 N=41			
	25.0	-22	25						

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray to gray, loose to dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-13

BORING LOG NO. B-9

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.4471° Longitude: -82.69044°

Surface Elev.: +3.4 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), with shell fragements, fine grained, dark gray, medium dense				6-12-12-17 N=24			
	2.0	1.5							
		SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray, medium dense to very dense				12-25-27-33 N=52			
			5	▽		6-11-17-19 N=28			
						6-14-19-20 N=33			
						9-16-20-20 N=36			
	10.0	-6.5	10						
		Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-14

BORING LOG NO. B-10

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44759° Longitude: -82.68973°

Surface Elev.: +3.7 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						5-6-6-8 N=12			
						6-4-3-4 N=7			
			5	▽		6-6-11-16 N=17			
						6-3-2-8 N=5			
						4-15-15-17 N=30			
			10						
						2-3-6 N=9			
			15						
						5-7-9 N=16			
			20						
						2-7-8 N=15			
	25.0	-21.5	25						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to dark gray and gray, loose to medium dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-15

BORING LOG NO. B-11

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44807° Longitude: -82.69001°

Surface Elev.: +4.6 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						7-8-9-8 N=17			
						8-7-6-5 N=13			
			5	▽		2-1-4-12 N=5			
						9-14-15-15 N=29			
						6-7-9-12 N=16			
	10.0	-5.5	10						

SLIGHTLY SILTY SAND (SP-SM), some shell fragments, fine grained, light brown to light gray and gray, loose to medium dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-16

BORING LOG NO. B-12

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44764° Longitude: -82.69065°

Surface Elev.: +3.6 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to light gray, medium dense to dense				13-14-10-12 N=24		22	24
						9-20-26-21 N=46			
			5			7-9-11-12 N=20			
				▽		4-4-13-18 N=17			
						15-12-19-20 N=31			
			10						
						11-8-2 N=10			
			15						
						12-5-8 N=13			
			20						
	25.0	-21.5				5-6-8 N=14			
		Boring Terminated at 25 Feet	25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 8 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/11/2015 Boring Completed: 11/11/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-17

BORING LOG NO. B-13

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44815° Longitude: -82.69089°

Surface Elev.: +3.7 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	SLIGHTLY SILTY SAND (SP-SM), some shell fragments, fine grained, brown, medium dense					11-14-14-10 N=28			
	2.0	1.5							
	SLIGHTLY SILTY SAND (SP-SM), large tree debris, fine grained, gray, medium dense					8-8-12-13 N=20			
	4.0	-0.5							
	SLIGHTLY SILTY SAND (SP-SM), fine grained, light gray to gray, loose to medium dense		5	▽		7-10-12-12 N=22			
						6-6-7-9 N=13			
						5-3-4-10 N=7			
	10.0	-6.5	10						
	Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-18

BORING LOG NO. B-14

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44837° Longitude: -82.69053°

Surface Elev.: +4.1 feet-NAVD

DEPTH		ELEVATION (Ft.)
1.0	**SLIGHTLY SILTY SAND (SP-SM)**, with shell fragments, fine grained, brown, medium dense	3
2.0	**SLIGHTLY SILTY SAND (SP-SM)**, organic stained, fine grained, black, medium dense	2
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray, medium dense	
25.0		-21
	Boring Terminated at 25 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
			6-5-8-11 N=13	1.2	13	
			8-8-9-7 N=17			
5	▽		6-8-9-10 N=17			
			7-6-8-10 N=14			
			3-7-6-4 N=13			
10						
			5-8-14 N=22		23	6
15						
			7-9-12 N=21			
20						
			11-10-15 N=25			
25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-19

BORING LOG NO. B-15

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44906° Longitude: -82.69061°

Surface Elev.: +4.9 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	0.0	+4.9							
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, brown to light gray and gray, loose to medium dense					7-11-14-16 N=25			
						9-11-10-9 N=21			
			5	▽		4-5-7-3 N=12			
						2-2-6-9 N=8			
						3-9-12-15 N=21			
	10.0	-5	10						
	Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-20

BORING LOG NO. B-16

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44868° Longitude: -82.69117°

Surface Elev.: +3.7 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, brown to light gray and light brown, medium dense				5-7-15-20 N=22			
						11-9-10-5 N=19			
4.0	-0.5	**ORGANIC SAND (SP-SM, PT)**, fine grained, gray and black, loose	5	▽		1-3-4-14 N=7	7.2	47	
6.0	-2.5	**SLIGHTLY SILTY SAND (SP-SM)**, trace shell fragments, fine grained, light gray to gray, medium dense to dense				10-15-18-17 N=33			
						8-13-21-21 N=34			
			10						
						9-9-17 N=26			
			15						
						5-7-10 N=17			
			20						
						13-12-16 N=28			
25.0	-21.5		25						
		Boring Terminated at 25 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-21

BORING LOG NO. B-17

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44915° Longitude: -82.69139°

Surface Elev.: +6.2 feet-NAVD

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
1.0	5				6-8-16-20 N=24			
					16-17-14-7 N=31			
4.0	2							
		5	▽		3-1-2-1 N=3	7.5	58	
6.0	0							
					7-8-12-15 N=20			
					14-9-7-6 N=16			
10.0	-4	10						

ORGANIC SAND (SP-SM, PT), fine grained, dark gray, medium dense to dense

SLIGHTLY SILTY SAND (SP-SM), fine grained, light gray, medium dense

ORGANIC SAND (SP-SM, PT), tree debris, fine grained, dark brown to dark gray, very loose

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light gray, medium dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: JM

Project No.: HC155032 Exhibit: A-22

BORING LOG NO. B-18

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.44955° Longitude: -82.69091°

Surface Elev.: +5.2 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						11-12-14-17 N=26			
						15-14-17-18 N=31			
			5	▽		6-10-9-6 N=19		23	2
						2-1-7-12 N=8			
						5-14-17-13 N=31			
			10						
						7-17-17 N=34			
			15						
						8-9-11 N=20			
			20						
						9-9-7 N=16			
	25.0	-20	25						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray and light brown to dark brown and dark gray, medium dense to dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-23

BORING LOG NO. B-19

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45003° Longitude: -82.69121°

Surface Elev.: +5.1 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						19-18-15-21 N=33			
						15-12-15-15 N=27			
			5	▽		6-7-8-6 N=15			
						4-3-8-14 N=11			
						9-12-11-15 N=23			
	10.0	-5	10						

SLIGHTLY SILTY SAND (SP-SM), trace shell fragments, fine grained, light brown and light gray to gray and brown, medium dense to dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/16/2015 Boring Completed: 11/16/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-24

BORING LOG NO. B-20

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45051° Longitude: -82.6915°

Surface Elev.: +5.4 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, orange and brown							
2.0	3.5								
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, light gray to gray, medium dense		▽					
			5			6-6-8-6 N=14			
6.0	-0.5								
		ORGANIC SAND (SP-SM, PT), fine grained, black to gray, very loose				3-1-1-4 N=2	15.9	106	
8.0	-2.5								
		SLIGHTLY SILTY SAND (SP-SM), fine grained, light gray to dark gray, loose to medium dense				10-13-11-10 N=24			
			10						
			15			5-5-4 N=9			
			20			3-4-8 N=12			
			25			4-5-5 N=10			
25.0	-19.5								
		Boring Terminated at 25 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 4 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/11/2015 Boring Completed: 11/11/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-25

BORING LOG NO. B-21

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.451° Longitude: -82.6918°

Surface Elev.: +5.4 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, orange and brown, dense				13-17-18-20 N=35			
	2.0	3.5							
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray, medium dense to dense				21-19-22-21 N=41			
			5	▽		5-5-11-11 N=16			
						12-13-13-20 N=26			
						5-5-8-3 N=13			
	10.0	-4.5	10						
		Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-26

BORING LOG NO. B-22

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45148° Longitude: -82.6921°

Surface Elev.: +5.5 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to brown, medium dense to dense				8-12-15-13 N=27		7	9
						13-14-18-20 N=32			
			5	▽		8-16-11-20 N=27			
						7-9-6-6 N=15			
						8-12-14-18 N=26			
12.5	-7		10						
		SILTY SAND (SM), fine grained, dark gray, very loose				1-2-1 N=3			
17.5	-12		15						
		SLIGHTLY SILTY SAND (SP-SM), fine grained, gray to dark gray, loose to medium dense				1-2-5 N=7			
			20						
						4-10-9 N=19			
25.0	-19.5		25						
		Boring Terminated at 25 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-27

BORING LOG NO. B-23

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45198° Longitude: -82.69239°

Surface Elev.: +5.9 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
	SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray and brown, loose to dense					12-18-19-22 N=37			
						12-13-18-32 N=31			
			5	▽		16-19-13-18 N=32			
						5-13-5-12 N=18			
						4-2-6-3 N=8			
	10.0	-4	10						
	Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-28

BORING LOG NO. B-24

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45247° Longitude: -82.6927°

Surface Elev.: +5.6 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						6-15-15-16 N=30			
						12-9-50/4"			
			5	▽		20-18-13-18 N=31			
						11-10-5-4 N=15			
						4-11-12-12 N=23			
			10						
						11-11-16 N=27			
			15						
						4-3-3 N=6			
			20						
						4-9-8 N=17			
	25.0	-19.5	25						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray and brown, medium dense to very dense

Boring Terminated at 25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-29

BORING LOG NO. B-25

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45295° Longitude: -82.69299°

Surface Elev.: +5.2 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						15-13-14-20 N=27			
						16-18-18-17 N=36			
			5	▽		4-4-9-12 N=13			
						5-4-3-1 N=7			
						4-7-15-15 N=22			
	10.0	-5	10						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to dark graay, loose to dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-30

BORING LOG NO. B-26

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45285° Longitude: -82.69326°

Surface Elev.: +4.3 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), fine grained, light gray to brown, medium dense				9-10-12-13 N=22			
						18-13-12-7 N=25			
4.0	0.5	**SLIGHTLY SILTY SAND (SP-SM)**, large tree debris, fine grained, gray and brown, medium dense	5	▽		3-3-10-19 N=13			
6.0	-1.5	**SLIGHTLY SILTY SAND (SP-SM)**, trace shell fragments, fine grained, light gray to dark brown, very loose to dense				3-11-17-25 N=28			
						7-14-19-17 N=33			
			10						
						1-1-1 N=2			
			15						
						3-9-11 N=20			
			20						
25.0	-20.5					3-4-4 N=8			
		Boring Terminated at 25 Feet	25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-31

BORING LOG NO. B-27

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45332° Longitude: -82.69341°

Surface Elev.: +4.5 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						7-5-12-16 N=17			
						11-14-13-18 N=27			
			5	▽		17-14-16-20 N=30			
						7-5-5-10 N=10			
						8-17-20-25 N=37			
	10.0	-5.5	10						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray and light brown to gray, medium dense to dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-32

BORING LOG NO. B-28

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.4538° Longitude: -82.69366°

Surface Elev.: +4.7 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown and light gray to gray, loose to medium dense				3-4-5-10 N=9			
						11-14-11-11 N=25			
			5	▽		2-8-6-8 N=14			
						3-6-8-10 N=14			
						3-4-7-6 N=11			
12.5	-8		10						
		SILTY SAND (SM), fine grained, dark gray, very loose				1-1-2 N=3			
17.5	-13		15						
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, brown to gray, medium dense to dense				9-11-9 N=20			
			20						
						11-16-21 N=37			
25.0	-20.5		25						
		Boring Terminated at 25 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-33

BORING LOG NO. B-29

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45434° Longitude: -82.69393°

Surface Elev.: +4.7 feet-NAVD

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
						5-5-8-23 N=13			
						15-22-16-20 N=38			
			5	▽		7-7-6-13 N=13			
						6-5-3-7 N=8			
						6-3-1-1 N=4			
	10.0	-5.5	10						

SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray, very loose to very dense

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-34

BORING LOG NO. B-30

PROJECT: Coquina Beach Drainage Improvements

CLIENT: Manatee County Construction Services Division
Bradenton, Florida

SITE: 2651 Gulf Drive
Bradenton Beach, Florida

LOCATION See Exhibit A-4

Latitude: 27.45485° Longitude: -82.6943°

Surface Elev.: +4.7 feet-NAVD

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	ORGANIC CONTENT (%)	WATER CONTENT (%)	PERCENT FINES
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light brown to gray, dense							
4.0	0.5					12-15-21-26 N=36			
		SLIGHTLY SILTY SAND (SP-SM), organic staqined, fine grained, gray and black, loose	5	▽		7-2-3-2 N=5			
6.0	-1.5					7-1-4-9 N=5			
		SLIGHTLY SILTY SAND (SP-SM), trace to some shell fragments, fine grained, light gray to gray, loose to medium dense				8-12-13-20 N=25			
12.5	-8		10						
		SILTY SAND (SM), trace shell fragments, fine grained, gray, loose				2-3-2 N=5		24	13
17.5	-13		15						
		SLIGHTLY SILTY SAND (SP-SM), with shell fragments, fine grained, gray to dark gray, medium dense				8-10-10 N=20			
			20						
25.0	-20.5					8-12-13 N=25			
		Boring Terminated at 25 Feet	25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-5 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater initally observed at a depth of 5 feet bgs*

Terracon
8260 Vico Court, Unit B
Sarasota, Florida

Boring Started: 11/13/2015 Boring Completed: 11/13/2015

Drill Rig: BR2500 Driller: MF

Project No.: HC155032 Exhibit: A-35

Table 2 - Hydraulic Conductivity and Infiltration Rate Test Results			
Location	Horizontal Hydraulic Conductivity (ft/day)	Vertical Hydraulic Conductivity (ft/day)	Vertical Infiltration Rate (in/hr)
BHP-1	11.3	5.7	-
BHP-2	5.8	2.9	-
BHP-3	0.8	0.4	-
BHP-4	2.1	1.1	-
DRI-1	-	-	9.3
DRI-2	-	-	15.1
DRI-3	-	-	15.1
DRI-4	-	-	6.5

Andreyev Engineering, Inc.

ST. PETERSBURG OFFICE
3740 54th Avenue North
St. Petersburg, Florida 33714
727-527-5735
Fax: 727-527-6084

Groundwater ▼ Environmental ▼ Geotechnical ▼ Construction Materials Testing

January 13, 2016
AEI Project No.: APGT-15-0122

TO: **Dunkelberger Engineering and Testing**
8260 Vico Court, Suite B
Sarasota, Florida 34240

Attention: Mr. James Jackson

SUBJECT: Spacing Recommendations for Proposed Underdrain System, Coquina Beach Improvements, Manatee County, Florida

---

Dear Mr. Jackson:

Andreyev Engineering, Inc. (AEI) has completed an evaluation in order to determine the adequate spacing for the proposed underdrain system. A spreadsheet was created to calculate the required spacing given the measured soil and aquifer parameters and the design information supplied by the client. The design spreadsheet is attached with this letter. Based on our calculations the underdrains should be spaced on 60 foot centers throughout the proposed pavement areas. These recommendations should be incorporated into the general recommendations provided in our original report.

AEI appreciates the opportunity to participate in this project, and we trust that the information herein is sufficient for your design. If you have any questions or comments concerning the contents of this report, please do not hesitate to contact our office.

Sincerely,

ANDREYEV ENGINEERING, INC.

JEFFERY E. ELLER LICENSE No 0057434 STATE OF FLORIDA PROFESSIONAL ENGINEER

1-13-16
Jeffery E. Eller, P.E.
Vice President
Florida Registration No. 57434

Attachment: Underdrain Calculations

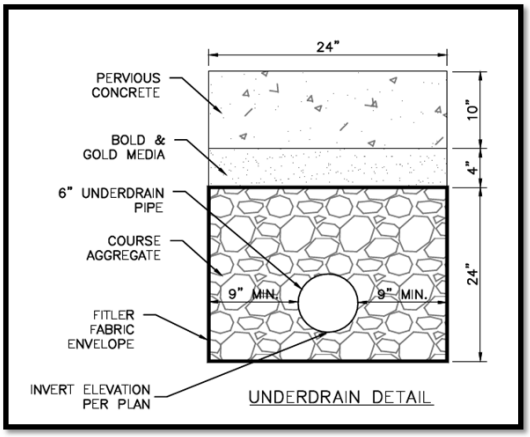
UNDERDRAIN CALCULATIONS

UNDERDRAIN CALCULATIONS
Coquina Beach Pervious Concrete - 1" Rain, 72 hr Recovery, factor of safety of 2

Project: Coquina Beach Pervious Concrete 1" Storm Recovery
Project No:
Location:
ASSUMPTIONS: Largest area of pervious concrete 180 ft x 180 ft. 1" or rain to recover from top of concrete down to 1 foot below bottom of concrete slab in 36 hrs (72 hr/2 FS)

Depth of Treatment Volume in Pond =	0.083	ft					
Pond Freeboard =	0	ft					
Pipe Diameter =	6	inches	=	0.500	ft		
Gravel Envelope on each side of pipes =	9	inches	=	0.750	ft		
Minimum distance between Pond Bottom and top gravel envelope =	1.17	feet (m + r)					
Depth from natural ground to impermeable layer =	20	feet					
Area of Pond (from top of treatment volume) =	32400.00	ft^2					
Max top dimension of pond perpendicular to pipes =	180	feet					
K (soil permbility rate) =	3	in/hr	=	0.250	ft/hr	=	6 ft/day
Slope of Pipes =	0.002	ft/ft	=	0.20	%		
n =	0.2						
Safety Factor =	2						

"T" shaped drainage network.



*DESIGN UNDERDRAIN TO LOWER WATER LEVEL TO A LEVEL 1' BELOW POND BOTTOM WITHIN 72 HOURS

1) Calculate the required drain spacing.

d = Depth of Treatment Volume + Depth of Freeboard + Depth of Soil Between Pond Bottom/Envelope + Depth of Gravel Envelope + Drain Radius

d = 0.08333333 ft + 0 ft + 1.16666667 ft + 0.750 ft + 0.250 ft

d = 2.250 ft

Determine the height of the drain above the impermeable layer:

a = D - d = 20 ft - 2.250 ft = 17.750 ft

Depth of Water Table after drawdown (c) = treatment volume depth + freeboard depth + (r) = (r = 6")

c = 0.08333333 ft + 0 ft + 0.500 ft = 0.58333333 ft

m = d - c = 2.250 ft - 0.58333333 ft = 1.667 ft m^2 = 2.778 ft^2

Determine the drainage coefficient (q) with t = 36hrs to incorporate a safety factor of 2.

q = c / t = 0.58333333 ft / 36 hr = 0.0162037 ft/hr = 0.19444444 in/hr

Determine the Spacing (S)

S = $[(4 * K * (m^2 + 2 * a * m)) / q]^{\wedge 0.5}$ = **62 ft**

Determine the number of laterals (N)

N > D_{PER} / S = **3**

2) Calculate the length of the Laterals.

D_{PAR} = A_{TL} / D_{PER} = 32400.00 ft^2 / 180 ft = 180.0 ft

Find the length of each lateral (L)

L = 180 ft - 62 ft = **118 ft**

3) Size the drainage laterals.

Q_r = [q * S * (L + S/2) / (C * F)] = 0.041 cfs ($Q_{4"pipe}$) = 0.1 cfs

4) Size the main and outlet pipe.

Flow in outlet = 0.072 cfs/lateral * 62 laterals = 4.5 cfs

(Q_{15pipe}) = 3.42 cfs

APPENDIX E
TAYLOR ENGINEERING 30 YEAR EROSION PROJECTION LINE REPORT

December 17, 2015

Mr. James M. Jackson, P.E.
Dunkelberger Engineering and Testing
8260 Vico Ct., Unit B
Sarasota, FL 34240

Re: Coquina Beach, Manatee County, Florida
30-year Erosion Projection

Dear Mr. Jackson:

This letter report details the methods and results of a historical beach recession analysis and estimate of the position of the Mean High Water (MHW) line 30 years from the present for an unprotected portion of Coquina Beach in Manatee County, Florida.

Specifically, this report provides a site overview, tidal characteristics of the study area, procedures of the beach recession analysis, and a 30-year projection of the MHW shoreline. The 30-year shoreline projection follows the methodology defined by Rule 62B-33.024, *Florida Administrative Code (F.A.C.)*. The report attachment contains all referenced figures.

1.0 Site Overview

Coquina Beach lies on the Gulf of Mexico along the southern end of Anna Maria Island. At the southern end of Coquina Beach, Longboat Pass connects the Gulf of Mexico to the northern extent of Sarasota Bay. The Florida Department of Environmental Protection (FDEP) classifies the entire gulf shore of Anna Maria Island, including the study area, as a critically eroded shoreline. Figures 1 and2 illustrate the project location and the study area.

The study area specifically encompasses the 0.9-mile stretch of beach between FDEP Manatee County Reference Monuments R-36 – R-41 (Figure 2). As required by Rule 62B-33.024, *F.A.C.*, 30-year Erosion Projection Procedures, Taylor Engineering analyzed shoreline changes at the monuments within the study area and at three adjacent monuments north of the study area (R-33 – R-35). Table 1.1 lists the 2001 FDEP tabulated monument locations and profile azimuths associated with the historical shoreline surveys and analysis. Figure 2 shows the monument locations.

2.0 Tidal Characteristics

To assess tidal characteristics at the site, Taylor Engineering reviewed National Oceanic and Atmospheric Administration (NOAA) tide station datums along the Gulf of Mexico nearest to the project site. NOAA Station 872643 (Anna Maria Outside) lies 3.6 miles north of the project site and Station 8725916 (Casey Key) lies 21.1 miles south of the project site. Additionally, Taylor Engineering reviewed the datum from NOAA Station 872628 (Anna Maria City Pier), which lies within Tampa Bay approximately 6.5 miles north of the project site. Table 2.1 lists the tide datums of these stations.

Table 1.1 Manatee County Reference Monument Locations

FDEP Monument		Easting[1] (ft)	Northing[1] (ft)	Azimuth[2] (°N)
Adjacent Monuments	R-33	429,715.8	1,138,740.1	260
	R-34	429,987.1	1,137,821.8	260
	R-35	430,302.4	1,136,852.4	250
Project Area	R-36	430,565.5	1,135,966.7	250
	R-37	430,927.0	1,135,004.8	250
	R-38	431,367.4	1,134,225.9	252
	R-39	431,732.6	1,133,368.8	250
	R-40	431,999.3	1,132,501.4	250
	R-41	432,317.7	1,131,701.5	258

[1]State Plane, Florida West Zone, North American Datum of 1983 (NAD83)
[2]Degrees clockwise from north

Table 2.1 Tide Datums near Project Site

Tide Datum	ANNA MARIA CITY PIER NOAA Station 8726282 (ft-NAVD88)	ANNA MARIA OUTSIDE NOAA Station 8726243 (ft-NAVD88)	CASEY KEY NOAA Station 8725916 (ft-NAVD88)
Mean Higher High Water (MHHW)	0.54	0.64	0.5
Mean High Water (MHW)	0.29	0.34	0.2
Mean Tide Level (MTL)	-0.48	-0.45	-0.43
Mean Low Water (MLW)	-1.25	-1.24	-1.07
Mean Lower Low Water (MLLW)	-1.62	-1.62	-1.34
Mean Tide Range	1.54	1.58	1.27

This study adopted a MHW elevation of 0.34 ft-NAVD for the Coquina Beach study area based on NOAA Station 872643 (Anna Maria Outside). This station lies closest the project site and, with a slightly higher MHW, provides a more conservative MHW elevation compared to the other NOAA stations. Notably, MHW varies by less than two inches between all three tide stations.

3.0 FDEP 30-Year Erosion Analysis Procedure

Taylor Engineering analyzed FDEP historical shoreline data, vetted the data for historic changes with morphological impact (e.g., beach nourishments and jetty construction), and derived shoreline change rates for each monument within the study area.

Taylor Engineering analyzed 33 FDEP historical MHW shoreline positions dating from 1883–2011. For quality assurance, Taylor Engineering plotted the positions over an aerial of the study area and processed historic surveys from the FDEP database to evaluate the accuracy of elevation and positions of

the historic MHW shoreline data. The survey data to shoreline data comparison revealed slight discrepancies in MHW position of approximately 1–2 feet. Table 3.1 lists the survey dates and respective ranges for each monument as provided by FDEP historic shoreline data. Figures 3–5 illustrate the August 1974, December 1992, February 2000, and February 2011 MHW shoreline positions with straight lines connecting shoreline positions at each monument.

Throughout the 128-year analysis period, construction of the Longboat Pass jetties and beach nourishment affected the natural morphology of the study area. As illustrated in Figure 2, the northern jetty of Longboat Pass lies approximately 350 feet south of monument R-41. With littoral drift predominantly south to north along the gulf coast, the 1957 construction of the Longboat Pass jetties (Dabees and Moore, 2011) significantly altered the morphological processes in the study area by introducing an up-drift littoral barrier (the jetty). Further, the 1960s construction of the Cortez Beach groins approximately 200 feet north of the study area (R-36), likely also influenced the local morphological processes at the northern end of the study area. Given that these activities significantly altered the local morphology, Taylor Engineering excluded surveys prior to 1964 from this analysis to ensure the present study only considered morphological processes relevant to the present study.

The entire 7.5-mile gulf shoreline of Anna Maria Island, including the study area, lies within the federal Anna Maria Island Shore Protection Project (SPP). The federal government originally authorized the SPP in 1965, and has currently authorized it until 2043 (FDEP, 2015). Through the SPP authorization, the U.S. Army Corps of Engineers (USACE) conducted large-scale beach nourishments along the central portion of Anna Maria Island (R-7 to R-36) in 1992/93 and 2002 which terminated at the northern limit of the study area (R-36). In 2005, USACE conducted a smaller storm repair project within the central portion of the island. The proximity of these nourishments, along with analysis of the shoreline positions, indicates influence to the project area via longshore dispersal of the beach fill. More significantly, the 2011 Coquina Beach nourishment placed approximately 235,000 cubic yards (cy) within the study area, between monuments R-36 and R-41 (Hunsicker, et. al. 2013). Therefore, Taylor Engineering excluded the May 2011 survey from this analysis as it appears to describe the post-construction survey of the 2011 nourishment and does not represent background changes. Further, research indicated that in 2014, an additional non-federal nourishment placed approximately 260,000 cy between R-33and R-40.5 (FDEP, 2015). Analysis of data prior to the initial 1992 nourishment did not suggest clear historic trends in shoreline change and, because the current authorization of the SPP suggests perpetual nourishments within this area until 2043, Taylor Engineering primarily relied on survey data following the initial nourishment (i.e., during the 19-year period of December 1992–February 2011) to develop trends in shoreline change.

To determine the historic shoreline change rate at each monument, Taylor Engineering applied both shoreline rate change averaging between surveys and conducted a linear regression analysis of the shoreline positions at each monument, striving to exclude outlying and inconsistent data points. Comparison of the shoreline change rates produced by the two analysis methods revealed that linear regression of the shoreline ranges provided the more reliable shoreline change rate estimates at each monument.

4.0 FDEP 30-year Erosion Projection Results

Throughout the study area, Taylor Engineering found relatively uniform erosive shoreline change rates ranging between -1.8 and -2.8 feet/year. Within the project area, the resultant shoreline change rates compared conservatively to shoreline changes extrapolated by Absalonsen and Dean (2010) for survey years 1974–2008. Table 4.1 lists the shoreline change rates and the resultant 30-year erosion projections.

Table 3.1 Historic Monument Locations

Survey Date	Range from Monument (ft)								
	Adjacent Monuments			Project Area					
	R-33	R-34	R-35	R-36	R-37	R-38	R-39	R-40	R-41
1883	540	630	681	765	892	945	958	918	971
1925-1926	294	274	294	305	506	509	475	369	382
1942-1944	107	146	139	250	301	348	270	196	45
1952	183	78	110	61	148	182	130	12	33
1962-1964	159	74	143	111	231	285	301	315	456
August 1974	150	148	137	69	173	233	258	204	378
1977-1979	148	298	245	242	298	355	318	220	367
September 1986	177	210	203	196	271	372	392	323	333
December 1992	170	221	155	110	209	274	356	302	344
August 1993	365	344	207	122	217	270	365	262	364
October 1993	366	359	240	135	236	288	373	254	371
February 1994	361	377	246	120	201	262	353	239	313
May 1994	358	369	257	122	212	263	371	288	289
February 1995	343	330	250	164	188	242	321	220	340
June 1995	-	-	-	-	-	264	307	224	323
August 1996	-	-	-	-	-	245	318	233	302
August 1997	289	387	282	191	288	359	328	246	348
February 1998	283	312	260	174	216	268	370	286	328
March 1998	283	299	263	165	210	267	352	278	339
February 1999	294	302	244	166	223	281	335	341	315
February 2000	285	313	240	143	227	279	351	270	356
January 2002	-	-	-	-	223	267	368	288	300
May 2002	336	320	259	140	233	274	375	290	313
April 2003	314	319	227	137	214	257	344	250	298
September 2004	-	-	-	124	204	246	310	214	286
July 2005	300	327	228	161	216	256	309	253	331
May 2006	305	327	221	137	234	232	327	234	308
January 2008	288	317	215	128	214	232	293	231	349
December 2008	307	330	211	124	226	236	278	232	344
October 2009	276	298	221	134	209	245	296	238	337
February 2011	295	320	218	150	208	232	310	230	369
May 2011	298	336	228	209	258	300	465	372	405

Table 4.1 Shoreline Change Rates and Projections

FDEP Monument		Average Shoreline Change Rate (ft/yr)	30-year Erosion Projection (ft from existing)
Adjacent Monuments	R-33	-1.8	-53.1
	R-34	-2.0	-61.2
	R-35	-2.4	-71.6
Project Area	R-36	-2.0	-59.1
	R-37	-2.2	-65.8
	R-38	-1.9	-57.4
	R-39	-2.8	-83.2
	R-40	-2.3	-68.4
	R-41	-2.1	-63.6

Taylor Engineering applied these rates to the February 2011 survey to project the 30-year erosion line. This survey provided the most recent available information prior to the 2011 Coquina Beach nourishment. For a conservative analysis, Taylor Engineering first projected erosion to present day (December 2015), and subsequently developed the 30-year projection from the theoretical December 2015 condition. Table 4.2 lists the 30-year (2045) projected shoreline positions in State Plane Coordinates of the Florida West Zone, North American Datum of 1983 (NAD83). Figures 3–5 illustrate the projected shoreline over a 2013 aerial photograph.

Table 4.2 30-year Erosion Projected Shoreline Positions

FDEP Monument		Easting[1] (ft)	Northing[1] (ft)
Project Area	R-36	430,516.7	1,135,948.7
	R-37	430,892.7	1,134,999.9
	R-38	431,208.6	1,134,173.8
	R-39	431,531.8	1,133,295.2
	R-40	431,857.1	1,132,449.7
	R-41	432,028.5	1,131,639.4

[1]State Plane, Florida West Zone, North American Datum of 1983 (NAD83)
[2]Degrees clockwise from north

5.0 Conclusion

This letter report describes the 30-year erosion projection in accordance with Rule 62B-33.024, *F.A.C.*, for Coquina Beach in Manatee County, Florida. Taylor Engineering performed an investigation of historic FDEP shoreline data and applied a linear regression analysis to determine shoreline change rates during an approximate 20-year duration with similar littoral processes to the existing conditions. Taylor

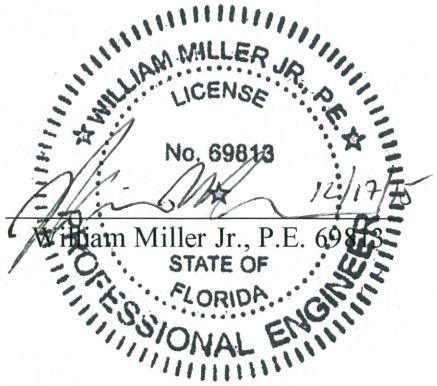
Engineering then projected these yearly shoreline change rates on to the February 2011 shoreline through 2045 to obtain project an erosion line 30 years out from 2015.

Should you have any questions or comments regarding this report, please contact me at (904) 731-7040.

Sincerely,

William Miller Jr., Ph.D., P.E.
Senior Coastal Engineer

/wm
Attachment



William Miller Jr., P.E. 69813

References

Dabees, M.A. and B.D. Moore. 2011. *Inlet Evolution Modeling of Multiple Inlet Systems in Southwest and Central Florida*, Journal of Coastal Research: Special Issue 59: pp. 130 – 137.

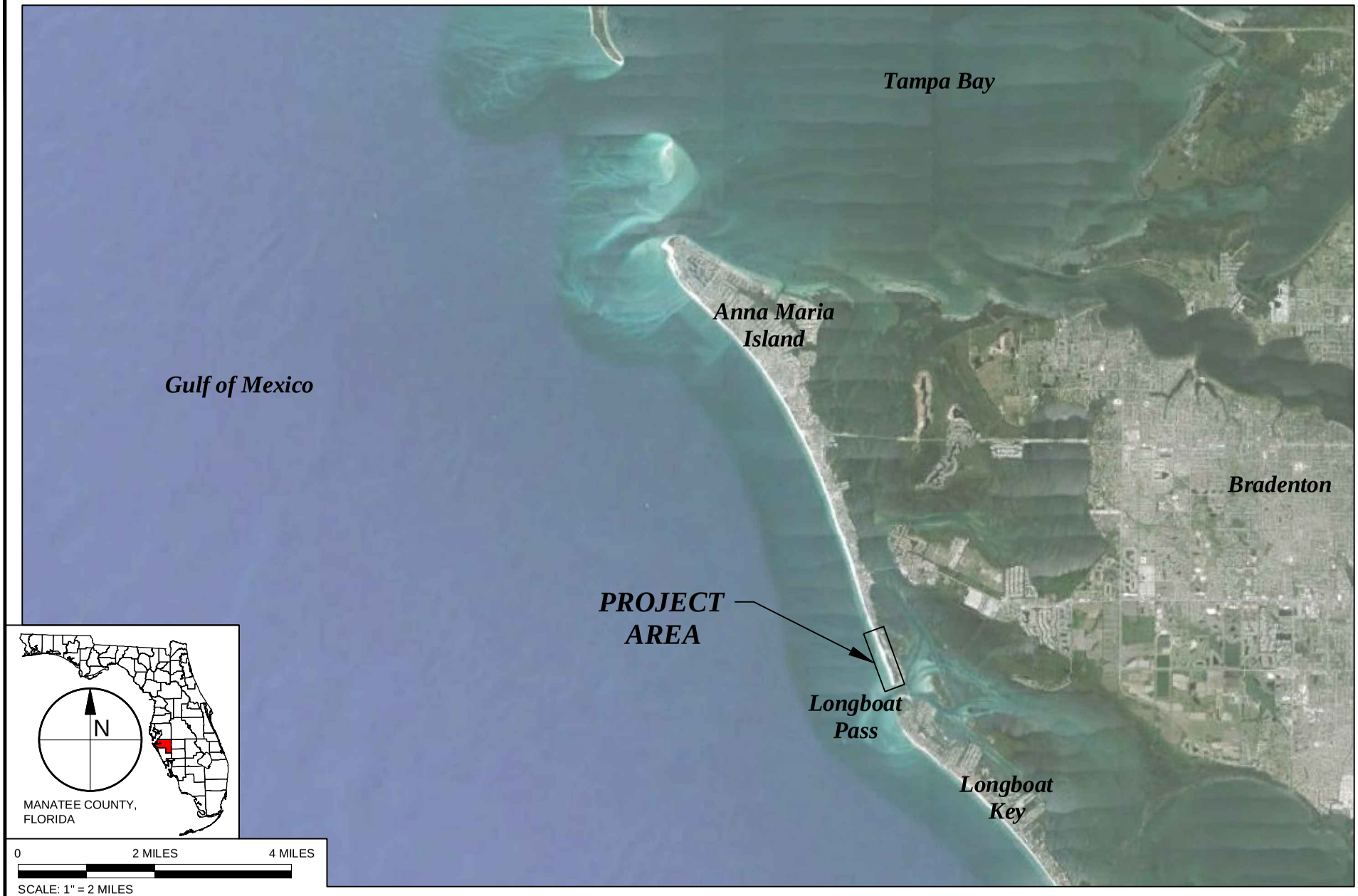
Hunsicker, C.; R. Spadoni; T. Pierro; and L. Floyd. 2013. Manatee County, Florida Board of County Commissioners Beach Renourishment Workshop Presentation.

Florida Department of Environmental Protection (FDEP). 2015. *Strategic Beach Management Plan Southwest Gulf Coast Region*. Tallahassee, FL.

Absalonsen, L. and R.G. Dean. 2010. *Characteristics of Shoreline Change along the Sandy Beaches of the State of Florida: An Atlas*. Department of Civil and Coastal Engineering, University of Florida, Gainesville, FL.

ATTACHMENT

Figures



DUNCAN GREER \\SJAX1\PROJECTS\2015\C2015-062 TERRACONCOQUINABEACHEROSIONLINE\DWG\COQUINALOCATION.DWG 12/17/2015 11:43:27 AM

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 1
LOCATION MAP
COQUINA BEACH 30-YEAR EROSION PROJECTION
MANATEE COUNTY, FL

PROJECT	C2015-062
DRAWN BY	DG
SHEET	1 of 5
DATE	DEC 2015

SCALE: 1" = 1,000'

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 2
SITE OVERVIEW
COQUINA BEACH 30-YEAR EROSION PROJECTION
MANATEE COUNTY, FL

PROJECT	C2015-062
DRAWN BY	DG
SHEET	2 of 5
DATE	DEC 2015

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 3
HISTORIC SHORELINE POSITIONS
COQUINA BEACH 30-YEAR EROSION PROJECTION
MANATEE COUNTY, FL

PROJECT	C2015-062
DRAWN BY	DG
SHEET	3 of 5
DATE	DEC 2015

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 4
HISTORIC SHORELINE POSITIONS
COQUINA BEACH 30-YEAR EROSION PROJECTION
MANATEE COUNTY, FL

PROJECT	C2015-062
DRAWN BY	DG
SHEET	4 of 5
DATE	DEC 2015

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 5
HISTORIC SHORELINE POSITIONS
COQUINA BEACH 30-YEAR EROSION PROJECTION
MANATEE COUNTY, FL

PROJECT	C2015-062
DRAWN BY	DG
SHEET	5 of 5
DATE	DEC 2015