



REPORT OF GEOTECHNICAL EXPLORATION

**Crystal Beach Park
Okaloosa County, Florida**

Tierra Project No. 4511-22-002

Prepared for:

**Baskerville-Donovan, Inc.
449 West Main Street
Pensacola, Florida 32502
Attn: Mr. Michael Langston, PE**

Prepared by:

**Tierra, Inc.
1300 West Main Street
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February 21, 2022



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TIERRA

February 21, 2022

Baskerville-Donovan, Inc.
449 West Main Street
Pensacola, Florida 32502
Attn: Mr. Michael Langston, PE

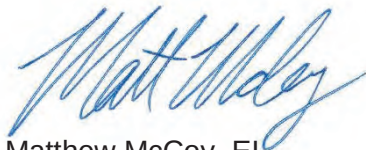
Subject: Crystal Beach Park
Okaloosa County, Florida
Tierra Project No. 4511-22-002

Mr. Langston:

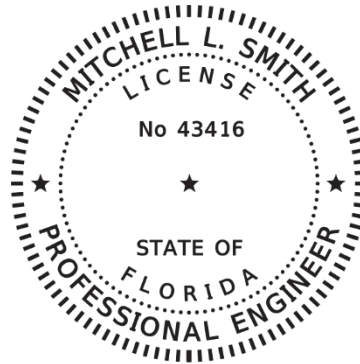
Thank you for choosing Tierra, Inc. (Tierra) as your Geotechnical consultant. Per your authorization, we have completed the Geotechnical exploration for the subject project. The results of the study are discussed in this report.

Should you have any questions regarding the enclosed report or the project in general, please do not hesitate to contact us at (850) 462-8774.

Sincerely,
TIERRA, INC.



Matthew McCoy, EI
Geotechnical Engineer



THIS ITEM HAS BEEN DIGITALLY
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Mitchell L Smith 2022.02.21
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APPENDIX A

Boring Location Plan and Soil Profiles

Falling Head Permeability Test Results

1.0 PROJECT INFORMATION

1.1 Project Authorization

Authorization to proceed on this project was issued by Mr. Michael Langston, PE with Baskerville-Donovan, Inc. (BDI). A formal contract has been executed between Tierra, Inc. (Tierra) and BDI for these services.

1.2 Project Description

Based on the information provided, we understand that a new 600 sf restroom facility will be constructed in the southeast corner of the expanded Crystal Beach Park. The single-story off-grade structure will be founded on timber piles. Based on information provided by the structural engineer, Mr. Steve Leonard, PE (Berube Leonard, LLC), a pile compression capacity on the order of 10 tons is desired.

Two drainage swale areas are proposed to manage stormwater runoff from the proposed improvements. The treatment swales are expected to be relatively shallow (less than 3 feet deep).

If any of the project information noted above is incorrect or has changed, please inform Tierra so that we may amend the recommendations presented in this report, if necessary.

1.3 Purpose and Scope of Services

The purpose of this exploration was to evaluate the subsurface conditions present in the subject area and to render timber pile foundation recommendations as well as parameters for stormwater drawdown analysis for the proposed stormwater treatment facilities.

The exploration consisted of one 35 foot deep Standard Penetration Test (SPT) boring to evaluate the subsurface conditions for the restroom and two 7 foot to 10 foot deep auger borings in the proposed treatment swale areas; laboratory soil testing including water content tests, wash #200 sieve tests, and falling head permeability tests; and a site visit, visual classification of the soil samples, and analysis by our engineering staff.

2.0 SITE AND SUBSURFACE CONDITIONS

2.1 Site Location and Description

The site is located south of Scenic Highway 98 near the intersection of Hutchinson Street in Okaloosa County, Florida. The property fronts the Gulf of Mexico. An aerial photograph depicting the site location is shown on the Boring Location Plan (Appendix A).

At the time of our exploration, a residential property was present immediately east of the existing Crystal Beach park. The eastern-most residential property located near the proposed restroom facility was demolished in preparation for the park expansion.

Based on review of the topographic survey provided as well as the survey data on Google Earth, the site slopes downward from the north (at/near EL +22 feet) to the south (at/near EL +10 feet).

2.2 Subsurface Conditions

The Boring Location Plan and the Soil Profiles of the borings drilled for this study can be found in Appendix A. The borings were field located and staked using a Garmin GPSMap 64ST Global Positioning System (GPS) unit with a reported accuracy of ± 1 meter. Therefore, the boring locations should be considered approximate.

We have estimated ground surface elevations at the boring locations using the topographic survey provided as well as the topographic information provided in Google Earth. The subsurface conditions encountered will be discussed in general terms below.

The restroom boring (B-1) generally encountered very loose sand from the ground surface (approximately EL +19 feet) to a depth of approximately 18 feet below existing grade (or to approximately EL +1 feet) underlain by dense sand to the bottom of the 35 foot deep boring (terminated at approximately EL -16 feet).

The treatment swale auger borings (AB-1 and AB-2) generally encountered sand from the ground surface (approximately EL +19 feet) to the bottom of the 7 foot to 10 foot deep borings.

The above subsurface descriptions are of a generalized nature, provided to highlight the major soil stratum encountered. The Soil Profiles should be reviewed for specific subsurface conditions at each boring location. The stratification shown on the Soil Profiles represents the subsurface

conditions at the actual boring locations only, and variations in the subsurface conditions can and may occur between boring locations and should therefore be expected. The stratification represents the approximate boundary between subsurface materials, and the transitions between strata may be gradual.

2.3 Groundwater Conditions

Groundwater was encountered in SPT boring B-1 at approximately 15 feet below existing grade at the time of drilling, which was during a period of below-normal seasonal rainfall. Based on the ground surface elevation at the boring location estimated from the topographic survey and Google Earth, this corresponds to groundwater elevation of approximately +4 feet NAVD 88.

Groundwater levels will fluctuate with rainfall and tides and could vary several feet during typical seasonal fluctuations. Larger fluctuations are possible under severe weather conditions. We recommend that the Contractor determine the actual groundwater levels at the time of construction to determine potential impacts groundwater can/will have on construction procedures.

2.4 Laboratory Soil Testing

Laboratory soil testing consisted of water content tests, wash #200 sieve tests, and falling head permeability tests. The results of the tests can be found on the Soil Profiles opposite the samples tested.

Falling head permeability tests were performed on remolded bulk samples of the more permeable soil strata encountered in the treatment swale borings. The densities to which the samples were remolded were based on the N_f values obtained from the SPT test boring nearby. The results of the tests are summarized in Table 1 below. The laboratory permeability test data sheets are attached in Appendix A.

TABLE 1 - LABORATORY FALLING HEAD PERMEABILITY TEST RESULTS						
Soil Stratum	Boring	Sample Elevation, ft. NAVD 88	Sample Description	% Fines	Dry Density, pcf	Vertical Permeability, ft/day
1	AB-1	18.5 to 12	Light brown, white SAND	0.2	95.9	57.4
1	AB-2	15.5 to 9	Light brown, white SAND	0.4	97.8	28.4

3.0 EVALUATION AND RECOMMENDATIONS

3.1 General Comments

Based on our understanding of the proposed facility, the exploration encountered subsurface conditions that will provide adequate support for the proposed structure provided the recommendations presented in this report are followed.

The subsurface conditions encountered in the treatment swale borings are suitable for conventional dry treatment. Stormwater design parameters are presented in Section 3.5 below.

3.2 Timber Pile Foundation Recommendations

We have evaluated compression and tension pile capacities for 6-inch, 8-inch, and 10-inch tip diameter timber piles to support the proposed restroom facility. Table 2 below shows allowable compression and tension capacities for driven timber piles with a tip elevation of -6 feet NAVD 88 (note – all elevations referenced to NAVD 88). The capacities presented in Table 2 assume a pile butt elevation of +24 feet, a ground surface elevation of +19 feet (no scour), include a Factor of Safety of 2, and assume jetting or predrilling the piles to elevation +6 feet to aide in standing the piles prior to driving.

TABLE 2 ALLOWABLE TIMBER PILE COMPRESSION & TENSION CAPACITIES		
Pile Size	Allowable Compression Capacity	Allowable Tension Capacity
6-inch Diameter Timber Pile	5 tons	2 tons
8-inch Diameter Timber Pile	10 tons	3 tons
10-inch Diameter Timber Pile	15 tons	4 tons

3.3 Pile Group Action

No reductions of the individual pile capacities will be required if piles are spaced center-to-center a minimum of 3 times their width/diameter. If piles are spaced closer, our office should be notified so that pile capacity reductions can be evaluated.

3.4 Settlement

Settlements of driven pile foundations are typically small and should not be a concern on this project provided the piles are embedded as recommended herein. Pile head settlements should be on the order of ½ inch or less. Group settlements are estimated to be on the same order of magnitude for the expected lightly loaded structure.

3.5 Stormwater Management Facility Recommendations

The subsurface conditions encountered in the treatment swale auger borings are suitable for conventional dry treatment of stormwater runoff. Geotechnical parameters for analysis/design are presented below:

- **Effective Aquifer Thickness:** A confining unit, which would hydrogeologically define the thickness of the surficial aquifer, was not encountered to a depth of 35 feet below existing grade (the deepest boring drilled on the site). For the purposes of modeling, we recommend setting the bottom of the aquifer no deeper than the bottom of the boring elevation (elevation -16 feet). Note that a shallower effective aquifer thickness for modeling a shallow swale may be more appropriate, and a sensitivity analysis using this parameter is warranted.
- **Seasonal High Groundwater Level:** Groundwater was encountered at approximately EL +4 feet at the time of drilling. Given that the boring was drilled during a period of below-normal rainfall and when tides are typically at their lowest, we have estimated the “normal” SHWT to be at/near elevation +6 feet.
- **Vertical Permeability:** Vertical flow from the bottom of the treatment swales will be controlled by the vertical permeability of the soil immediately beneath the bottom of the swale. Based on the results of the falling head permeability tests (Table 1), an average vertical permeability of 42.9 ft/day for Stratum 1 would be reasonable for modeling.

- **Horizontal Permeability:** Horizontal flow from the pond will be through the Stratum 1 soils. The horizontal permeability of Stratum 1 has been estimated based on the results of the vertical permeability tests and extensive experience with similar soils from field permeability tests. While horizontal permeabilities have generally been found to range from 3 to 10 times higher than vertical permeabilities of regional deposits, we recommend that a multiplier of 3 with a factor of safety of 2 be used for design (effectively, a 1.5 multiplier). Therefore, a K_h value of 64.4 ft/day would be reasonable for modeling the Stratum 1 materials (42.9 ft/day x 1.5).
- **Effective Porosity:** Based on the fines contents of the soils encountered in the test borings, an effective porosity of 0.30 would be appropriate for modeling the Stratum 1 soils.

4.0 REPORT LIMITATIONS

The recommendations submitted are based on the available soil information obtained by Tierra, Inc. and design details furnished by Baskerville-Donovan for the subject project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, Tierra should be notified immediately to determine if changes in the foundation, or other, recommendations are required. If Tierra is not retained to perform these functions, we cannot be responsible for the impact of such conditions on the performance of the project.

The findings, recommendations, specifications, and professional advice contained herein have been made in accordance with generally accepted professional Geotechnical engineering practices in the local area.

After the plans and specifications are more complete, the Geotechnical engineer should be provided the opportunity to review the final design plans and specifications to assure our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of Baskerville-Donovan for the specific application to the subject project.

APPENDIX A

Boring Location Plan and Soil Profiles

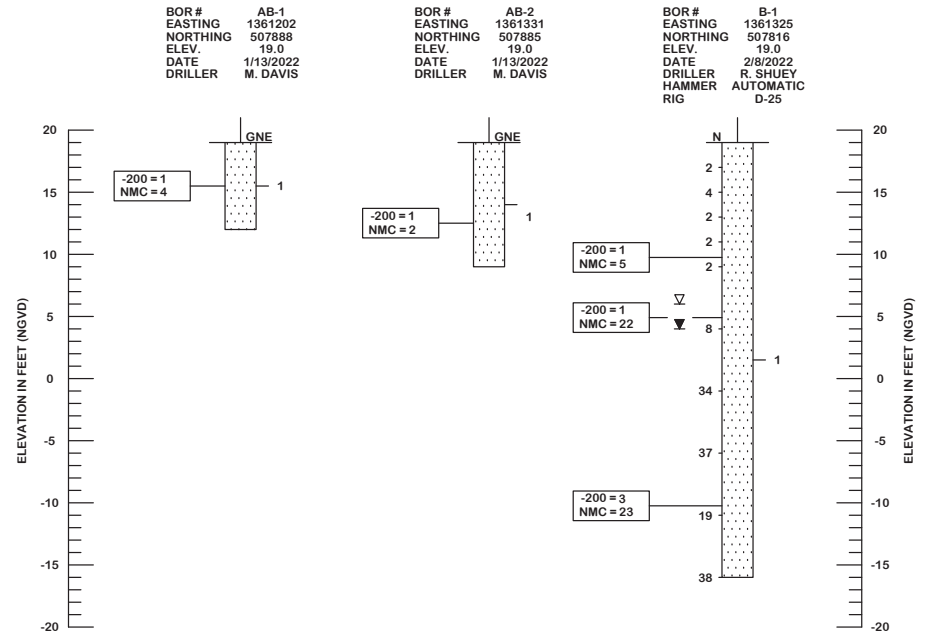
Falling Head Permeability Test Results



LEGEND

- | | | | | |
|---|---|--|------|--|
| 1 |  | LIGHT BROWN, WHITE SAND (SP) | N | SPT N-VALUE IN BLOWS/FOOT FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED) |
| |  | GROUNDWATER LEVEL ENCOUNTERED DURING INVESTIGATION | SP | UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2488) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW. |
| |  | ESTIMATED "NORMAL" SEASONAL HIGH GROUNDWATER TABLE | GNE | GROUNDWATER TABLE NOT ENCOUNTERED |
| |  | APPROXIMATE LOCATION OF AUGER BORING | -200 | PERCENT PASSING #200 SIEVE |
| |  | APPROXIMATE LOCATION OF SPT BORING | NMC | NATURAL MOISTURE CONTENT (%) |

SOIL PROFILES



AUTOMATIC HAMMER	
GRANULAR MATERIALS- RELATIVE DENSITY	SPT (BLOWS/FT.)
VERY LOOSE	LESS THAN 3
LOOSE	3 TO 8
MEDIUM	8 TO 24
DENSE	24 TO 40
VERY DENSE	GREATER THAN 40
SILTS AND CLAYS CONSISTENCY	SPT (BLOWS/FT.)
VERY SOFT	LESS THAN 1
SOFT	1 TO 3
FIRM	3 TO 6
STIFF	6 TO 12
VERY STIFF	12 TO 24
HARD	GREATER THAN 24

ENGINEER OF RECORD:
MITCHELL L. SMITH, P.E.
FLORIDA LICENSE NO.:
43416



PROJECT NUMBER:
4511-22-002

SHEET 1

FALLING HEAD PERMEABILITY TEST



Project Name: Crystal Beach Park
Project Number: 4511-22-002 **Sample Location:** AB-1, EL +18.5 to +12.0 feet
Sample Description: Light brown, white SAND (Stratum 1) **Soil Classification:** SP
Remolded Compactive Effort: Standard Proctor **No. of Layers:** 3 **Blows Per Layer:** 25

- Assumes:**
1. Standard Proctor Mold (L = 4.5 in.)
 2. 1/2 Inch Diameter Tubing

$$v = \frac{(2.3 \cdot a \cdot L) \log (h_1/h_2)}{(A) (\Delta t)}$$

where

- 1.267 cm (area of tube)
- 4.5 in. (height of soil sample)
- 11.43 cm (L = 4.5 in. for full mold)
- 12.57 sq. in. (area of Proctor mold)
- 81.1 sq. cm

Head (ft)	Time (sec)		Avg. Time (sec)
	Run #1	Run #2	
7	0	0	0
6	1	1	1.0
5	3	3	3.0
4	5	5	5.0
3	8	8	8.0
2	11	11	11.0
1	17	17	17.0

h1	h2	Delta t (sec)	K _v (cm/sec)
7	1	17	2.0E-02
6	1	16	2.0E-02
7	2	11	2.0E-02

Average K _v =	2.0E-02 cm/sec
	57.4 ft/day

Remolded Test Sample Density

Can #	1
Wt. Can + Wet Soil, g	388.6
Wt. Can + Dry Soil, g	369.7
Wt. of Water, g	18.9
Wt. of Can, g	260.1
Wt. of Dry Soil, g	109.6
Moisture Content, %	17.2%
Wt. Wet Soil + Mold, lbs.	8.2
Wt. of Mold, lbs.	4.5
Wt. of Wet Soil, lbs.	3.7
Wet Density, pcf	112.4
Dry Density, pcf	95.9

Fines Content of Test Sample

Can #	1
Wt. Can + Wet Soil, g	249.6
Wt. Can + Dry Soil, g	245.4
Wt. of Water, g	4.2
Wt. of Can, g	127.1
Wt. of Dry Soil, g	118.3
Wt. of Dry Sample After Washing + Can, g	245.2
Wt. of Soil Lost During Washing, g	0.2
Moisture Content, %	3.6%
Percent Fines, %	0.2%

FALLING HEAD PERMEABILITY TEST



Project Name: Crystal Beach Park
Project Number: 4511-22-002 **Sample Location:** AB-2, EL +15.5 to +9.0 feet
Sample Description: Light brown, white SAND (Stratum 1) **Soil Classification:** SP
Remolded Compactive Effort: Standard Proctor **No. of Layers:** 3 **Blows Per Layer:** 25

- Assumes:**
1. Standard Proctor Mold (L = 4.5 in.)
 2. 1/2 Inch Diameter Tubing

$$v = \frac{(2.3 \cdot a \cdot L) \log (h_1/h_2)}{(A) (\Delta t)}$$

where

- 1.267 cm (area of tube)
- 4.5 in. (height of soil sample)
- 11.43 cm (L = 4.5 in. for full mold)
- 12.57 sq. in. (area of Proctor mold)
- 81.1 sq. cm

Head (ft)	Time (sec)		Avg. Time (sec)
	Run #1	Run #2	
7	0	0	0
6	3	3	3.0
5	6	6	6.0
4	10	10	10.0
3	15	15	15.0
2	22	22	22.0
1	35	35	35.0

h1	h2	Delta t (sec)	K _v (cm/sec)
7	1	35	9.9E-03
6	1	32	1.0E-02
7	2	22	1.0E-02

Average K _v =	1.0E-02 cm/sec
	28.4 ft/day

Remolded Test Sample Density

Can #	1
Wt. Can + Wet Soil, g	370.8
Wt. Can + Dry Soil, g	354.3
Wt. of Water, g	16.5
Wt. of Can, g	260.1
Wt. of Dry Soil, g	94.2
Moisture Content, %	17.5%
Wt. Wet Soil + Mold, lbs.	8.3
Wt. of Mold, lbs.	4.5
Wt. of Wet Soil, lbs.	3.8
Wet Density, pcf	115.0
Dry Density, pcf	97.8

Fines Content of Test Sample

Can #	2
Wt. Can + Wet Soil, g	276.9
Wt. Can + Dry Soil, g	274.2
Wt. of Water, g	2.7
Wt. of Can, g	126.1
Wt. of Dry Soil, g	148.1
Wt. of Dry Sample After Washing + Can, g	273.6
Wt. of Soil Lost During Washing, g	0.6
Moisture Content, %	1.8%
Percent Fines, %	0.4%