Project Number: 0254-1062
February 22, 2019

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Terrebonne Economic Development Authority
8026 W. Main Street #701
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Attn: Ms. Katherine Gilbert-Theriot
Phone: 985.873.6890
Email: ktheriot@tpeda.org

Re: Proposal for Preliminary Geotechnical Site Characterization Services
Proposed LED Rebecca Plantation – South Site
Terrebonne Parish, Louisiana

Dear Ms. Gilbert – Theriot,

Professional Service Industries, Inc. (PSI) is pleased to submit this report that presents the results of the requested preliminary geotechnical engineering parameters and guidance relative to the LED Rebecca Plantation – South Site located in Terrebonne Parish, Louisiana. This exploration was performed in general accordance with PSI Proposal No. 0254-244892 - Revision #1; dated August 7, 2018, which was authorized by Mr. Matt Rookard, CEO of the Terrebonne Economic Development Authority dated August 18, 2018.

We appreciate the opportunity to perform these geotechnical services and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact us.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.

William B. Barker
Geotechnical Project Manager

Name: Reda M. Bakeer, Ph.D., P.E.

Date: February 22, 2019

License No.: 27123

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GEOTECHNICAL SITE CHARACTERIZATION

PSI Project No. 0254-1062
Proposed LED Rebecca Plantation – South Site
Terrebonne Parish, Louisiana

William Barker
Project Manager

Prepared for

Terrebonne Economic Development Authority
8026 W. Main Street #701
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1 PROJECT INFORMATION

Professional Service Industries, Inc. (PSI), an Intertek company, has completed a geotechnical exploration for the Rebecca Plantation, South Site, located in Houma, Louisiana. Our scope of services were outlined in PSI Proposal 0254-244892-Revision #1, dated August 7, 2018. Our geotechnical services were authorized by Mr. Matt Rookard with the Terrebonne Economic Development Authority (TEDA) on August 15, 2018.

1.1 PROJECT DESCRIPTION

Initial project information was provided by Mr. Elliott Boudreaux of CSRS, Inc. on May 8, 2018. That information (which included an approximately 238 acre parcel) was updated on August 6, 2018 to include about 47 acres of additional property for the proposed site. The provided information indicates that the proposed project consists of conducting a Preliminary Geotechnical Characterization Investigation of the subject site located in Terrebonne Parish, Louisiana. These services are required to support the Louisiana Economic Development (LED) Site Certification process. The LED Certified Site Application requires a preliminary geotechnical investigation that would generally characterize the site's soil, rock, and groundwater conditions to substantiate that unfavorable geotechnical conditions do not exist on the site.

The revised tract of land is the approximately 285 acre Rebecca Plantation – South site located off LA Highway 90 in Terrebonne Parish near Houma, Louisiana. PSI was provided with multiple maps depicting the site general location and boundaries. It is understood that the site may be utilized for industrial facilities that may accommodate structures such as tanks, pipe racks, manufacturing buildings, etc. The property is presently used as agricultural fields. In view of this, drilling of the soil borings had to be postponed at the request of the property Owner to allow for the planted crops to mature for harvesting. Consequently, the field investigation was performed in January 2019 with the approval of the Owner and in coordination with TEDA.

The report containing the results of the requested geotechnical characterization investigation should be considered to be "preliminary" and could be used for general evaluation of the suitability of the site for development. However, it should not be used for the preliminary or final design and construction of any structures or foundations. It is understood that a subsequent detailed geotechnical exploration and analysis will be performed at a later stage once design and function of the proposed development have been finalized. Information needed would be the depth to groundwater, depth to a stiff clay material or a dense sand stratum, and the suitability of the soils for development. The explored depth is limited to 100 feet, so it should be noted that the report may state that the stiff clay strata or dense sand strata is "deeper than 100 feet below the existing grade," if it is not encountered within this investigation depth. This is particularly important if the anticipated construction on the subject site could include relatively high loads, requires adding significant amounts of fill to reach design grades, or structures that cannot tolerate settlement. Please note that our scope of services does not include environmental drilling or sampling of soil or groundwater.

The geotechnical recommendations presented in this report are based on the available project information, site location, laboratory testing, and the subsurface materials, as well as the assumptions stated in this report. If any of the noted information is incorrect, PSI should be informed in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

1.2 PURPOSE AND SCOPE OF SERVICES

The purposes of PSI's geotechnical services were to:

- Perform five (5) soil borings at the site;
- Evaluate general subsurface soil conditions and groundwater depth at the boring locations at the time of drilling;
- Perform limited laboratory testing on selected soil samples recovered from the borings; and,
- Provide a general discussion regarding the compatibility of this site with industrial/commercial development and the suitability of soils encountered.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. Prior to development of this site, an environmental assessment is advisable. Additionally, PSI did not provide any service to investigate or detect the presence of moisture, mold or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence or the amplification of the same. Client acknowledges that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. Client further acknowledges that site conditions are outside of PSI's control, and that mold amplification will likely occur, or continue to occur, in the presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or recurrence of mold amplification.

2 GEOTECHNICAL EXPLORATION PROGRAM

2.1 FIELD EXPLORATION

PSI performed five (5) soil borings, to the depths described in Table 1, to explore the subsurface conditions at these randomly selected and accessible locations within the 285 acre site considering its present use.

Table 1: Soil Borings

Boring(s)	Depth (feet)*
B-1	50
B-2	50
B-3	100
B-4	50
B-5	50

**Approximate depth below the existing ground surface at the boring locations*

The approximate locations of the borings are indicated on the Boring Location Plan included in the Appendix.

The soil borings were performed with an ATV track-mounted drilling rig using solid stem auger and wet rotary drilling techniques. Samples were generally obtained at two (2) foot intervals from the ground surface to a depth of ten (10) feet and at maximum five (5) foot intervals thereafter to the boring termination depths. Drilling and sampling were accomplished in general accordance with ASTM Standard Procedures.

Undisturbed samples of cohesive soils were generally obtained using thin-walled tubes in general accordance with the procedures for "Thin-Walled Tube Geotechnical Sampling of Soils" (ASTM D1587). These samples were extruded in the field with a hydraulic ram.

For cohesionless soils and semi-cohesive soils, Standard Penetration Test (SPT) was performed to obtain standard penetration values of the soil. The standard penetration value (N) is defined as the number of blows of a 140 pound hammer falling 30 inches that is required to advance the split-barrel sampler one (1) foot into the soil. To perform the test and obtain a sample, the sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer. The number of blows is recorded for each of three (3) successive increments of six (6) inches penetration. The "N" value is obtained by adding the second and third incremental numbers. The results of the standard penetration test indicate the relative density of cohesionless soils and thereby provide a basis for estimating the relative strength of the soil profile components. Samples of granular soils were obtained utilizing a two (2) inch O.D. split-barrel sampler in general accordance with procedures for "Penetration Test and Split-Barrel Sampling of Soils" (ASTM D-1586).

The samples were identified according to the project number, boring number and depth, and placed in polyethylene plastic wrapping to protect against moisture loss. In addition, undisturbed samples were wrapped in aluminum foil

prior to placing in the plastic wrapping and were transported to the laboratory in containers to minimize further disturbance.

In addition to the field exploration, a laboratory testing program was conducted on the samples obtained from the soil borings to evaluate additional pertinent engineering characteristics of the subsurface materials. The laboratory testing program included supplementary visual classification and water content tests on the soil samples. In addition, selected samples were tested for unconsolidated undrained triaxial strength, Atterberg limits, and percent passing No. 200 sieve. Additional estimates of undrained shear-strength and unconfined compressive strength were also determined through the use of a torvane and a hand penetrometer, respectively.

The results of the laboratory tests are presented on the accompanying boring logs given in the Appendix. The samples which were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

2.2 GEOTECHNICAL LABORATORY TESTING

Geotechnical Laboratory testing of selected soil samples was performed in general accordance with ASTM procedures and included the following:

- Visual Classification (ASTM D2487 / D2488)
- Moisture Content (ASTM D2216)
- Atterberg Limits (ASTM D4318)
- Percent Soil Particles Finer than No. 200 Sieve (ASTM D1140)
- Unconfined Compression Tests (ASTM D2166)
- Unconsolidated Undrained Triaxial Tests (ASTM D2850)

The samples that were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded without further notice.

3 SUBSURFACE CONDITIONS

3.1 SOIL PROFILE

Based on the field observations and the results of the geotechnical laboratory testing, the soils were classified, and the boring logs were developed. The boring logs are presented in the Appendix along with a key to the terms and symbols used on the boring logs. In view of the site size and the limited number of borings made at this time, a generalized subsurface profile at each specific boring location is presented in Tables 2 thru 6.

Table 2: Generalized Soil Profile – B-1

Approximate Depth Range (feet)[(1)]	Consistency/Relative Density	Material Description
0 – 4	Stiff to Very Stiff	Fat Clay (CH)
4 – 13	Firm	Fat Clay (CH)
13 – 25	Medium dense	Silty Sand (SM)
25 – 50	Very Soft to Firm	Fat Clay (CH)

[(1)]Referenced from the existing grade at the boring location.

Table 3: Generalized Soil Profile – B-2

Approximate Depth Range (feet)[(1)]	Consistency/Relative Density	Material Description
0 – 4	Stiff	Fat Clay (CH)
4 – 15	Soft to Firm	Fat Clay (CH)
15 – 50	Very Soft to Firm	Fat Clay (CH)

[(1)]Referenced from the existing grade at the boring location.

Table 4: Generalized Soil Profile – B-3

Approximate Depth Range (feet)[(1)]	Consistency/Relative Density	Material Description
0 – 4	Stiff	Lean Clay (CL)
4 – 28	Soft to Firm	Fat Clay (CH)
28 – 35	Medium dense	Silty Sand (SM)
35 – 100	Very Soft to Firm	Fat Clay (CH)

[(1)]Referenced from the existing grade at the boring location.

Table 5: Generalized Soil Profile – B-4

Approximate Depth Range (feet)[(1)]	Consistency/Relative Density	Material Description
0 – 2	Soft to Firm	Fat Clay (CH)
2 – 6	Firm to Stiff	Fat Clay (CH)
6 – 32	Soft to Firm	Fat Clay (CH)
32 – 37	Very Soft	Fat Clay (CH)
37 – 42	Firm to Stiff	Organic Clay (OH)
42 – 50	Firm to Stiff	Fat Clay (CH)

[(1)]Referenced from the existing grade at the boring location.

Table 6: Generalized Soil Profile – B-5

Approximate Depth Range (feet)[(1)]	Consistency/Relative Density	Material Description
0 – 8	Firm to Stiff	Fat Clay (CH)
8 – 50	Soft to Firm	Fat Clay (CH)

[(1)]Referenced from the existing grade at the boring location.

The above subsurface descriptions are of a generalized nature to highlight the major subsurface stratification features and material characteristics in each exploration area of the site. The boring logs included in the Appendix should be reviewed for specific information at the boring locations. These boring logs also include soil descriptions, stratification, penetration resistances, and locations of the samples and laboratory test data. The stratification shown on the logs represents the conditions only at the actual exploration locations and within that particular area at the time of our field exploration. Therefore, variation may occur, and should be expected across the site considering its size. The stratification represents the approximate boundary between subsurface materials, but the actual transition may be gradual. This is particularly important considering the limited number of borings made at readily accessible areas within the relatively large property where subsurface conditions could vary significantly than those outlined in Table 2 through 6. Groundwater level information obtained during field operations is also shown on the boring logs. As previously discussed, this report is intended for general site characterization and not for use in any formal designs.

3.2 GROUNDWATER INFORMATION

Table 7 presents groundwater levels observed during the time of drilling.

Table 7: Groundwater Levels during the Field Exploration

Boring	Groundwater Depth (feet)[(1)]
B-1	Not Encountered
B-2	8-1/2
B-3	8
B-4	10
B-5	10

[(1)]Referenced from the existing grade at the boring location.

It is possible that seasonal variations (temperature, rainfall, adjacent waterways and drainage canals, etc.) as well as the water level or stage in the nearby water bodies will cause fluctuations in the groundwater level. Additionally, perched water may be encountered in discontinuous zones within the overburden. This condition develops as rainwater in entrapped in the more pervious surface lean clays underlain by less pervious cohesive fat clay soils. The groundwater levels presented in this report are the levels that were measured at the time of our field activities. It is recommended that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to determine the impact, if any, on the construction procedures. This is particularly important considering the size of the site and the limited number of borings drilled at readily accessible locations.

4 PRELIMINARY GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

4.1 GEOTECHNICAL DISCUSSION

The type and depth of foundation suitable for a given structure primarily depends on several factors including the subsurface conditions, the function of the structure, the loads it may carry, the cost of the foundation and the criteria set by the Design Engineer with respect to vertical and differential movements which the structure can withstand without damage. Detailed column loads for specific structures and grading plans were not provided at the time of this study.

Grade supported foundations or surface coverings will likely be governed by the anticipated load and settlement tolerances, particularly where a significant amount of new fill is placed. Driven piles should be viable foundation types considering the subsurface and groundwater conditions encountered. Prior to new fill placement, site preparation should include removal of surficial vegetation, topsoil, organic matter, and soft soil or demucking of wet areas or drainage conveyances and proof rolling in the presence of the Geotechnical Engineer to assess general stability and firmness prior to fill placement.

Based on the limited number of soil borings made at readily accessible locations, field data and laboratory test results, the proposed site is generally suitable for industrial development. The results of the exploration indicate that aside from the the near surface desiccated crust, the underlying soils encountered at the boring locations particularly B-2, B-3 and B-4 are moderately to highly compressible in nature, and poor to fair in bearing quality. In consideration of the existing soil conditions and the impact of any additional fill being planned to raise the site grades, a shallow foundation is expected to undergo excessive settlements and, therefore, will not be suitable for support of “typical” industrial heavy construction. However, spread footing type foundations (square, continuous, mats, etc.) could be used for support of lightly loaded auxiliary structures that can tolerate long-term settlements including some differential with time.

As stated previously, PSI’s opinions and information presented in this site evaluation report are provided for planning purposes and preliminary considerations only; they are based on a very limited geotechnical exploration, and shall not to be used for final design and construction.

4.2 PRELIMINARY SHALLOW FOUNDATION DESIGN

Provided the preliminary findings gleaned from the limited number of borings made at readily accessible locations are confirmed with a comprehensive subsurface investigation, lightly loaded structures can be supported on conventional spread footings bearing on properly compacted structural fill. In this case, additional geotechnical recommendations will have to be provided with regard to site preparation, design parameters and anticipated long-term settlement based on the specific structural loads and configuration.

Foundations should be placed on firm to stiff clay or controlled-compacted fill and at least 2 feet below the finished grade and can be designed for a net allowable bearing pressure of 1,000 psf for dead load plus transient live loads (i.e. wind loads) or 700 psf for dead plus sustained live loads (i.e. equipment inside a structure), whichever results in a larger bearing area. Minimum footing dimension for continuous wall footings should be at least 18 inches. It should be noted that poor quality materials may exist at parts of the site considering the

limited number of explorations locations. Therefore, the footing excavation should be thoroughly inspected to assure that all poor-quality fill materials are removed and replaced with structural fill. The location, depth and lateral extent of unsuitable or poor quality materials shall be delineated through the comprehensive subsurface investigation to be conducted as part of the design phase for the proposed development.

No detailed settlement analyses were made since the anticipated loads, footing configuration, etc. are not known at this time. However, spread footings with a width no larger than five (5) feet, designed as described above, should experience a total settlement on the order of less than one inch. If a cluster of closely spaced footings (i.e., if the center to center spacing of the footings is less than two times the width of the footing) are planned, PSI should be contacted to calculate the amount of settlement. However, the near surface firm to stiff clays are underlain by soft and more compressible clays which could experience larger and differential settlement partially under large footings and if significant fill thickness is needed to raise the site grade.

The base adhesion/frictional resistance and the passive soil resistance will resist the horizontal loads on shallow foundations. For transient loading conditions, an ultimate base adhesion resistance of 550 psf and an ultimate passive resistance of 2,000 psf can be used. For sustained loading conditions, a frictional co-efficient of 0.36 and an ultimate passive resistance of 240 psf per foot depth is recommended. A minimum factor of safety of 2.0 is recommended to arrive at the allowable values. Passive resistance from the upper two (2) feet of soil should be neglected. Also, the passive resistance of any un-compacted fill material should be neglected.

The uplift resistance of a shallow foundation formed in an open excavation will be limited to the weight of the foundation concrete and the soil above it. For design purposes, the ultimate uplift resistance can be based on effective unit weights of 120 and 150 pcf for soil and concrete, respectively above the water table. We recommend that buoyant unit weights of 60 pcf and 90 pcf be utilized in the case of submergence. These values should be reduced by an appropriate factor of safety.

The foundation excavations shall be observed by a representative of the Geotechnical Engineer of Record or a designated representative prior to steel or concrete placement to assess that the foundation materials can support the design loads and are consistent with the materials discussed in the report. Soft or loose soil zones, if encountered at the bottom of the shallow footing excavations, shall be removed and replaced with properly compacted structural fill as directed by the Geotechnical Engineer of Record.

After opening, isolated spread footing excavations should be observed, and concrete placed as quickly as possible to avoid exposure of the footing bottoms to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. If possible, the foundation concrete should be placed during the same day the excavation is made. If it is required that footing excavations be left open for more than one day, they should be protected to reduce evaporation or entry of moisture. While no detailed analyses were made, structures placed on existing soils will be subject up to two (2) to three (3) inches of movement.

4.3 PRELIMINARY DEEP FOUNDATION DESIGN

Using the static method of analyses and results of the soil borings allowable axial capacities have been computed for the following pile types: 7" tip -12" butt diameter large Class "B" treated timber piles and a 14-inch square precast, pre-stressed concrete (PPC) piles. It is recommended that only one pile type and length be used to support a given structure. The estimated pile capacities provided include a design factors of safety of 2.0 in compression and 3.0 in tension. The piles at this site will generally derive their support in compression and tension, or uplift, through "skin friction" along their embedded lengths since no consistent sand stratum was encountered that would offer "good" additional "point support," except for borings B-1 and B-3. The location, thickness, depth and lateral extent of the competent sand stratum shall be delineated through the comprehensive subsurface investigation to be conducted as part of the design phase for the proposed development.

The recommended driven lengths and the estimated corresponding allowable compression and tension capacities for the piles are presented in Tables 8 and 9. Due to the central location and depth of soil boring B-3 and the dissimilarities encountered in all three (3) deep soil borings with regard to soil type, strength and stratification, the soil profile of soil boring B-3 was employed in the pile capacity analysis provided below. The recommended pile lengths are referenced from the existing ground surface and any length of pile needed above, or below, this reference should be added to, or subtracted from, the pile lengths given in Tables 8 and 9. Predrilling through the sand stratum may be necessary to minimize the potential for damaging the piles during driving.

TABLE 8. Timber Pile Allowable Capacities

ESTIMATED ALLOWABLE SINGLE PILE CAPACITY (tons)[1]		
Pile Length (feet)[2]	**Class "B" Timber (7" tip – 12" butt)**	
	Comp.	**Tens.**
35	8	5
40	9	6
45	10	7
50	12	8
55	13	9
60	15	10

[1] Capacities are soil-pile related capacities and consideration should be given to the structural integrity of the pile member.
[2] Pile lengths are referenced from existing ground surface at the time of drilling.

TABLE 9. 14-inch square PPC Allowable Capacities

ESTIMATED ALLOWABLE SINGLE PILE CAPACITY (tons)[1]		
Pile Length (feet)[2]	**Sq. Precast Concrete (14-inch)**	
	Comp.	**Tens.**
60	28	19
65	31	21
70	34	23
75	38	25
80	41	27
85	45	30
90	49	33
95	53	36

[1] Capacities are soil-pile related capacities and consideration should be given to the structural integrity of the pile member.
[2] Pile lengths are referenced from existing ground surface at the time of drilling.

The estimated pile capacities include a factor of safety of two (2) in compression and three (3) in tension. In both cases, pile lengths are measured from the existing ground surface at the boring locations. Any pile lengths needed above, or below, this reference grade should be added to or subtracted from, the tabulated lengths, respectively. Also, a pile cutoff of 2 and 4 feet for timber and PPC piles, respectively, should be of no consequence. It should be noted that if more than three (3) feet of fill is planned, the above pile capacities should be re-evaluated to account for drag loads on the piles. Additional analyses will need to be performed with regard to lateral loads, group effect and settlement based on the specific project loads and layout.

As previously discussed, a relatively shallow sand layer was encountered in soil borings B-1 and B-3 and this stratum will likely cause early refusal during pile driving. It is recommended that the location, depth and lateral extent of this sand layer be defined through the comprehensive subsurface investigation to be conducted as part of the design phase for the proposed development.

5 REPORT LIMITATIONS

The preliminary information submitted in this report is based on the available subsurface data obtained by PSI at the time of our field exploration. PSI warrants that the preliminary findings contained herein have been made in accordance with generally accepted drilling procedures and visual soil classification methods in the local area. No other warranties are implied or expressed. This report has been prepared for the exclusive use of the Terrebonne Economic Development Authority for the specific purpose of determining general subsurface information at the subject site to develop a general geotechnical site characterization.

APPENDIX