Geotechnical Engineering Report

Highway 929 & 930 Roundabout
Gonzales, Louisiana

October 19, 2018

Terracon Project No. EH185168

Prepared for:

Volkert, Inc.
Baton Rouge, Louisiana

Prepared by:

Terracon Consultants, Inc.
Baton Rouge, Louisiana

October 19, 2018

Volkert, Inc.
7967 Office Park Blvd.
Baton Rouge, Louisiana 70809

Attn: Ms. Ashley Beckendorf
P: 225-218-9440
E: ashley.beckendorf@volkert.com

Re: Geotechnical Engineering Report
Highway 929 & 930 Roundabout
Highway 929 & Highway 930
Gonzales, Louisiana
Terracon Project No. EH185168

Dear Ms. Beckendorf:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PEH185168 dated May 22, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction pavements 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,
Terracon Consultants, Inc.

STATE OF LOUISIANA
LYNNE E. ROUSSEL
License No. 35152
10/19/18
PROFESSIONAL ENGINEER

Lynne E. Roussel, PE
Principal

Stephen E. Greaber, PE
Principal

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Geotechnical Engineering Report

Highway 929 & 930 Roundabout
Highway 929 & Highway 930
Gonzales, Louisiana
Terracon Project No. EH185168
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INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed roundabout to be located at Highway 929 & Highway 930 in Gonzales, Louisiana. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Demolition considerations
- Excavation considerations
- Pavement design and construction

The geotechnical engineering scope of services for this project included the advancement of eight test borings to depths of approximately 8 feet below existing site grades.

Maps showing the site and exploration locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section of this report.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at Highway 929 & Highway 930 in Gonzales, Louisiana. Latitude: 30.29857, Longitude: -90.95556 (approximate). See **Site Location**
Existing Improvements	Existing roadways and adjacent public utility right-of-ways with open ditches.
Current Ground Cover	Asphalt pavement in roads and grass fields in right-of-ways.

Item	Description
Existing Topography	Relatively flat.
Geology	The property is located within an area of the Hammond alloformation (Pph). These Pleistocene Age deposits of middle to late Wisconsin Coastal Plain streams include flood-plain deposits of the late Pleistocene Mississippi River, exposed in the eastern valley wall of the modern Mississippi River alluvial valley. The unit is blanketed by Peoria Loess, which in places is underlain by Sicily Island Loess. The deposits typically consist of upper very silty clay or silt overlying medium stiff to very stiff tan and light gray silty clays and clays with silt and sand layering. The soils within the Prairie Terrace are overconsolidated, and normally only marginally compressible. In some areas that are very dry and desiccated, the potential for expansive properties exists, but these conditions are not typical of the Prairie Terrace deposits. Alluvial soils associated with a drainage ditch is located in close proximity to the eastern approach to the traffic circle.  **Ponchatoula 30x60 Minute Geologic Quadrangle, Louisiana Geological Survey 2003**

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

PHOTOGRAPHY LOG

Looking southeast from Hwy 930

Looking east from Hwy 929

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. Volkert recently completed a project specific traffic count/distribution. Our final understanding of the project conditions is as follows:

Item	Description
Project Description	We understand a roundabout will be constructed at the intersection of LA 929 and LA 930. Traffic information was provided by Volkert and consisted of a breakdown of the vehicle types for each direction of LA929 and LA930 approaching the intersection.
Traffic	The traffic counts indicate a majority of the traffic is along Parish Road 929 with nearly equal ADT in both directions. Most of the traffic is passenger vehicles and light trucks (approximately 90%) with tractor trailer type vehicles representing less than 1% of the ADT. School bus traffic was also less than about 0.5 % of the traffic. It is noted that approximately 4.4% of the traffic was listed as not classified; based on discussions with Volkert, it was assumed that this traffic should be included in light truck classification. For the pavement design, the traffic data for the direction with the largest ADT (e.g., West Bound PR 929 east of LA930) was used as the design traffic for the roundabout. An annual traffic increase of 1.6% was used to establish the 20 Year design traffic volume. The designer should verify the applicability of the above assumptions.
Grading/Slopes	It is assumed that a few feet of embankment will be needed to bring the planned roundabout section to the site grade.
Pavements	A single lane paved roundabout road is planned. We assume that a flexible (asphalt) pavement section will be considered. It is understood that the pavement section will consist of the following components, in sequential order: 1) Subgrade layer as specified in Section 305 of the 2016 LSSRB 2) Class II Soil Cement Base as specified in Section 302 of the 2016 LSSRB. 3) Class II Aggregate Base as specified in Section 302 of the 2016 LSSRB 4) Asphalt Binder and Surface course as specified in Section 502 of of the 2016 LSSRB.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The following table provides our geotechnical characterization.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are possible.

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Classification
Surface	2 to 9 inches	Asphalt Pavement	N/A
Base	6 to 11 inches	Sandy Gravel, Treated soil	N/A
1	8 feet (Boring Termination)	Lean Clay and Fat Clay	USCS: CL to CH AASHTO: A-6 to A-7-6 Lean Clay PI: 15 to 25 Fat Clay PI: 30 to 38 Average Moisture: 23%
Notes	1. In non-pavement borings, 6 to 8 inches of topsoil was observed.		

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Groundwater Conditions

The boreholes were observed while auger drilling for the presence and level of groundwater. For borings that encountered groundwater the drilling operations were suspended for about 15 minutes to observe the change in water level over that time period. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized below.

Boring Number	Approximate Depth to Groundwater while Drilling (feet) [1]	Approximate Depth to Groundwater after about 15 Minutes (feet) [1]
B-01	3.5	3.0

1. Below ground surface

Groundwater was not observed in the remaining borings while auger drilling, or for the short duration the borings could remain open. However, this does not necessarily mean the borings terminated above groundwater, or the water levels summarized above are stable groundwater levels. Due to the low permeability of the subgrade soils encountered in the borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, ditch water levels, site modification, and other factors not evident at the time the borings were performed. It is also not unusual to encounter a perched water table, where surface water that infiltrates through an upper desiccated soil and rests upon a low permeability layer. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The planned road alignment is currently mainly asphalt paved with adjacent grass fields and roadside open ditches inside the public right-of-way. It is expected that these existing developments will be cleared for new pavement construction. It is further understood that the roundabout may likely be shifted off the alignment to account for right-of-way acquisition and maintenance of traffic during construction.

The near surface, medium plasticity lean clay to high plasticity fat clay could become unstable with typical clearing, earthwork and construction traffic, especially after precipitation events. Effective drainage should be completed early in the construction sequence and maintained during and after construction to reduce potential degradation of the subgrade If possible, the initial clearing and grading should be performed during the warmer and drier time of the year. If clearing is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations including proof-rolling and embankment placement are provided in the **Earthwork** section.

Water runoff on both highways and the bordering properties collects in ditches along both sides of the road. The ditches are directly adjacent to the road shoulders with varying slopes and typically begin at the shoulder edge. Ideally, these slopes should not be steeper than 2H:1V (Horizontal: Vertical) for support of the shoulder. We recommend that fill slopes be built from the lowest elevation to highest elevation, and that they be overbuilt and then cut back to the planned slope inclination to develop an adequately compacted slope face. Soil slopes should be covered for protection from erosion from surface runoff. For erosion protection, a protective cover of grass or other vegetation including temporary erosion control aids, should be established on permanent soil slopes as soon as possible.

The pavement base and subgrade should be sloped to drain or have a subdrainage system for positive drainage away from the road to limit the time that saturated conditions below the base can be present. Frequent wetting of the subgrade soils can lead to softening, pumping, and eventual rutting/base failure of pavements over time. To improve pavement drainage and the performance of the road, the bottom of dry ditches should be at least one foot below the bottom of the asphalt pavement or the permeable base layer; for ditches that routinely hold water, the bottom of the pavement subgrade should be at least one foot above the mean high water line. Current LADOTD practices along similar road sections suggest that placing an edge drain to drain a permeable base above a soil cement base improves the relative performance of roadways.

The **Pavements** section addresses the design of pavement systems. As indicated, traffic counts/vehicle distributions were obtained by Volkert and used to develop the design traffic loading. A summary of the ESAL determination and the SN calculations are included in the Attachments.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is expected to include demolition of existing pavements, clearing and grubbing, proof-rolling, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria as necessary to render the site in the state considered in our geotechnical engineering evaluation for the base and pavements.

Site Preparation

We anticipate construction will be initiated by stripping existing pavement sections, vegetation, and loose, soft or otherwise unsuitable material. Complete stripping of the topsoil or root mat should be performed in the undeveloped proposed pavement areas. Stripped materials consisting of vegetation and organic materials should be wasted off site or used to vegetate landscaped areas. Topsoil or pavement section thickness measurements were made at the boring locations; however, stripping depths at or between our boring locations and across the site could vary considerably and may not represent average values. As such we recommend actual stripping depths be evaluated by a representative of Terracon during construction to aid in preventing removal of excess material. It is also not unusual to find soft and wet soils immediately beneath existing pavements. The demolition phase may also encounter buried debris, old fills, or other past site improvements. Former utility lines and utility backfill, where present, should be removed from beneath the building, and the resulting excavations should be properly backfilled as outlined herein. If roots are encountered, the entire root ball should be excavated such that the remaining roots measure 1 inch in diameter or less.

After stripping and before embankment placement, the subgrade should be proof-rolled with heavy rubber tire construction equipment such as a loaded scraper or partially loaded tandem axle dump truck. The vehicle should weigh approximately 15 Tons (total vehicle weight). The proof-rolling should be performed under the direction of the Geotechnical Engineer or a qualified inspector. Proof-rolling should be performed after a suitable period of dry weather to avoid degrading an otherwise acceptable subgrade and to reduce the amount of undercutting/remedial work required. Excessively wet or dry material should typically be moisture conditioned (e.g., dried) and recompacted. Areas excessively deflecting under the proof-roll should be delineated and subsequently addressed by the Geotechnical/Project Engineer. Such areas can typically be mitigated by 1) discing/drying and compaction, 2) undercut to stable subgrade and replacement with compacted embankment, or 3) lime treatment in general accordance with LADOTD Section 304, Type D as directed by Project Engineer.

Fill Material Types

Engineered fill should meet the following material property requirements:

Soil Type [1]	Specifications	USCS Classification	Acceptable Location for Placement
On-site soils [2]	Usable Soil (2016 LSSRB 203.06.1) CL, SC (PI<25) Silt Content <50% for PI<10 Organics <5%	Primarily CL	The on-site lean clay soils appear suitable for use as fill; however, if they do not meet the specified criteria below, they should not be utilized within 24 inches of finished grade beneath pavement areas.
On-site soils [2]	LL<60	CH	Some on-site soils consist of fat clay. This material is not recommended for use as embankment. If present at planned subgrade layer elevation, it can be treated with lime and cement as specified in Section 305 of the 2016 LSSRB.

Soil Type [1]	Specifications	USCS Classification	Acceptable Location for Placement
Imported Usable Soils	Usable Soil (2016 LSSRB 203.06.1) CL, SC (PI<25) Silt Content <50% for PI<10 Organics <5%	CL, SC	Embankment, Subgrade Layer
Soils for Class II Soil Cement	2016 LSSRB 302.02.1 LL<35, PI<15 Organics<2 % Silt <60% Sand<79%	CL, SC	Class II Soil Cement Base
Class II Aggregate Base	(2016 LSSRB 1003.03) #610 Stone	GP-GM	Class II Aggregate Base

1. Controlled, compacted fill should consist of approved materials free of organic matter and debris. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
2. Delineation of fat clays and lean clays should be performed in the field by a qualified geotechnical engineer or their representative, and could require additional laboratory testing.

Fill Compaction Requirements

Engineered fill should meet the following compaction requirements:

Item	Description
Fill Lift Thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Compaction Requirements [1]	Minimum 95% of the Proctor maximum dry density as determined by TR415/TR418.
Moisture Content of Cohesive Soil	Within the range of 2% below to 2% above the optimum moisture content value as determined by the standard Proctor test at the time of placement and compaction with stability present.
Moisture Content of Granular Material [2]	Workable moisture levels

Item	Description
1.	The moisture content and compaction should be measured for each lift of engineered fill during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2.	Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proof-rolled.

Cross Drain Bedding

It is our assumption that some cross drains may be placed or constructed. The bedding material should consist of minimum 6 inches of sand-aggregate mix, meeting the requirements in Section 1003.10 of LSSRB 2016 Edition. Cross drain bedding should be constructed in accordance with section 701 of LSSRB 2016 Edition. We anticipate that some weak subgrade soils may be found at existing cross drain locations. Excavations should continue until soils capable of supporting compaction with stability are present but no deeper than 3 feet. If excavation to remove weak soils becomes excessive, an open graded #57 stone bedding with placement of QPL-listed geotextile fabric might be recommended by the geotechnical engineer to assist in bridging over relatively isolated areas of soft subgrade.

Grading and Drainage

All grades must provide effective drainage away from the pavement during and after construction and should be maintained throughout the life of the road. Water retained next to the road can result in decreased performance than those discussed in this report.

After construction, final grades should be verified to document effective drainage has been achieved. Grades around the road should also be periodically inspected and adjusted as necessary as part of the maintenance program. A maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Fill Construction Observation and Testing

The exposed subgrade and each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the geotechnical engineer's representative prior to placement of additional lifts. We recommend that each lift of fill be tested for density and moisture content at a frequency of one test for every 250 linear feet of compacted fill per lane in round about pavement areas. We recommend one density and moisture content test for every 50 linear feet of compacted utility/drainage structure trench backfill.

Earthwork Construction Considerations

It is anticipated that shallow excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to pavement construction and observed by Terracon.

Surface water should not be allowed to pond on the site and soak into the soil during construction. Construction staging should provide drainage of surface water and precipitation away from the subgrade areas. Any water that collects over or adjacent to construction areas should be promptly removed, along with any softened or disturbed soils. Surface water control in the form of sloping surfaces, diversion berms, drainage ditches and trenches, and sump pits and pumps will be important to avoid ponding and associated delays due to precipitation and seepage.

As stated previously, the groundwater table was at a depth of about 3 feet below existing grade at the time the borings were drilled. However, it should be anticipated that the groundwater table could rise and affect some excavation efforts. As indicated, areas of surface water were noted in the ditches along the alignment.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors.

Construction site safety is the sole responsibility of the contractor who controls the means, methods and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean that Terracon is assuming any responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proofrolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade, and just prior to construction of the pavements.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs, noted in this section, must be applied to the site, which has been prepared as recommended in the **Earthwork** section.

Designs for minimum thicknesses for new pavement sections for this project have been based on the procedures outlined in the 1993 Guideline for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO-1993) and related LADOTD design guidelines. Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of a clay subgrade. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%;
- The subgrade and pavement surface should have a minimum 2% slope/crown to promote proper surface drainage;

Traffic Conditions

The following table presents a summary of the traffic conditions for pavements on this project developed by the design team. From the Volkert traffic study data, the maximum one-way vehicles per day per a segment was established at 8,200. The autos, light trucks, and heavy trucks were set at 7 days/week and the buses set at 5 days/week. The planners and designers should review and validate this assumption. Using this information, the ADT and truck and bus percentage values which generated the Equivalent Single Axle Load (ESAL) values for the roadway section are shown in the table below. Details of the ESAL determination are included in the attachments.

Parameter	Roadway
Performance Period (years)	20 years
One-Way Average Daily Traffic (ADT)	8,200 vehicles
Number of Lanes in Design Direction	1 lane
Growth Factor	1.6%
Percent Bus Traffic	0.5%
Percent Heavy Truck Traffic	0.7%
Percent of Vehicles in Design Lane	100%
Percent of Trucks in Design Direction	100%

Pavement Design Parameters

The following table presents a summary of the design parameters for rigid and flexible pavements on this project.

Design Parameter	Flexible Pavement
Initial Serviceability [1]	4.0
Terminal Serviceability [1]	2.0
Reliability Level [2]	90%
Overall Standard Deviation [3]	0.47
Roadbed Soil Resilient Modulus [4]	10,000 psi (Section 305 Subgrade Layer)
Calculated Design Lane ESALs [5]	2,600,000 (SN_{req}= 3.57)

1. Values obtained from Table 1 of the Implementation of the New AASHTO Pavement Design Procedure in Louisiana, June 1990.
2. Values obtained from Table 2 of the Implementation of the New AASHTO Pavement Design Procedure in Louisiana, June 1990.
3. Per the Implementation of the New AASHTO Pavement Design Procedure in Louisiana, June 1990. Page 18
4. This value is based on treatment of the subgrade layer in accordance with Section 305 of the 2016 LSSRB.
5. Based on traffic count/distribution data provided by Volkert. Autos, light trucks, and heavy trucks set at 7 days/week whereas busses set at 5 days/week for the 20 year design life.

The traffic types, volumes and design parameters presented in the tables above were used as input in the design calculations. The engineer responsible for the final pavement design should review the traffic information and design parameters for accuracy/applicability.

Asphaltic Cement Concrete Pavement Section Thicknesses

Minimum ACC Pavement Section (Inches) SNreq=3.57					
ROADWAY	**Alternative**	**Asphalt Surface** [1]	**Asphalt Binder** [1]	**Aggregate Base** [2]	**Soil Cement Base** [3]
929/930 Roundabout	AC-AGG/SC SN=3.83	2	2-1/2	4	8

1. Design and construction of asphaltic or bituminous concrete should be in accordance with Louisiana Department of Transportation Specifications for Roads and Bridges 2016 (LSSRB).
2. Aggregate base course should be a No. 610 limestone or similarly graded recycled concrete compacted to 95% of its max dry density as determined by TR418 with stability present.
3. A soil cement base should be constructed as a Class II Base in general accordance with Section 302 of the 2016 LSSRB.

The estimated pavement sections provided in this report are minimums for the assumed design criteria, and as such, periodic maintenance should be expected. Areas for concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. A maintenance program including surface sealing, joint cleaning and sealing, and timely repair of cracks and deteriorated areas will increase the pavement's service life. As an option, thicker sections could be constructed to decrease future maintenance.

Pavement Drainage

Pavements should be sloped/crowned to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the first priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

GENERAL COMMENTS

As the project progresses, we address assumptions by incorporating information provided by the design team, if any. Revised project information that reflects actual conditions important to our services is reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations 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. Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, 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.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Locations	Type of Exploration	Planned Depth (feet) [1]	Planned Location
4	Borings	8	Planned turn lanes
4	Cores and Borings	8	Existing Roadway

1. Below ground surface.

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provide the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from the most recent Google Earth™ imagery and the accuracy of the ground surface at each point is probably about 2 feet. If elevations and a more precise boring layout are desired, we recommend borings be surveyed following completion of fieldwork.

Subsurface Exploration Procedures: We advanced soil borings with a hand auger for soil sampling and the soil borings in pavement were cored with a trailer-mounted, coring rig. The existing pavement and base was cored with a diamond tip core barrel to measure the thickness of the existing roadway surface and base. Disturbed soil samples were collected using a 4-inch diameter hand auger that is manually twisted into the soil and then retrieved in increments of approximately 4 to 6 inches. A soil sample from each soil strata is collected. The soil content from the auger is visually classified, labeled and placed in a sealed container to minimize moisture loss during transportation to the laboratory. We observe and record groundwater levels during drilling and sampling. For safety purposes, all borings are backfilled with auger cuttings consistent with state regulations after their completion and pavements are patched with cold-mix asphalt, as appropriate.

Our exploration team prepares field boring logs as part of the drilling operations. These field logs include visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs are prepared from the field logs. The final boring logs represent the geotechnical engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviews the field data and assigns various laboratory tests to better understand the engineering properties of the various soil strata as necessary for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216-10 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318-10e1 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D6913-17/D6913M-17 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- ASTM D7928-17/TR-407 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

The laboratory testing program often includes examination of soil samples by an engineer. Based on the material's texture and plasticity, we describe and classify the soil samples in accordance with the Unified Soil Classification and AASHTO Systems.

SITE LOCATION AND EXPLORATION PLANS

SITE LOCATION

Highway 929 & 930 Roundabout ■ Gonzales, LA
June 14, 2018 ■ Terracon Project No. EH185168

Terracon GeoReport

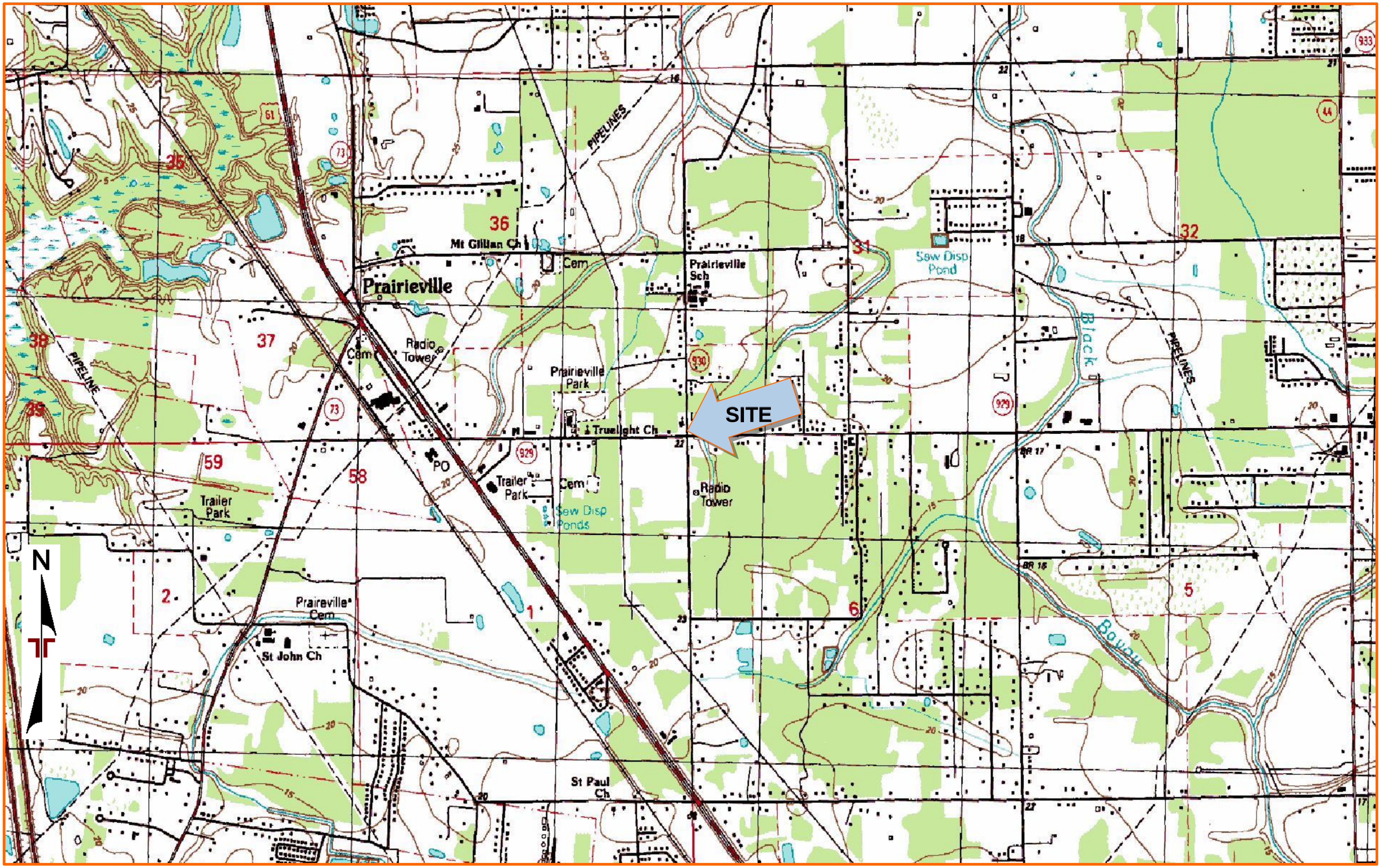

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: PRAIRIEVILLE, LA (1/1/2006).

EXPLORATION PLAN

Highway 929 & 930 Roundabout ■ Gonzales, LA

July 9, 2018 ■ Terracon Project No. EH185168

Terracon GeoReport

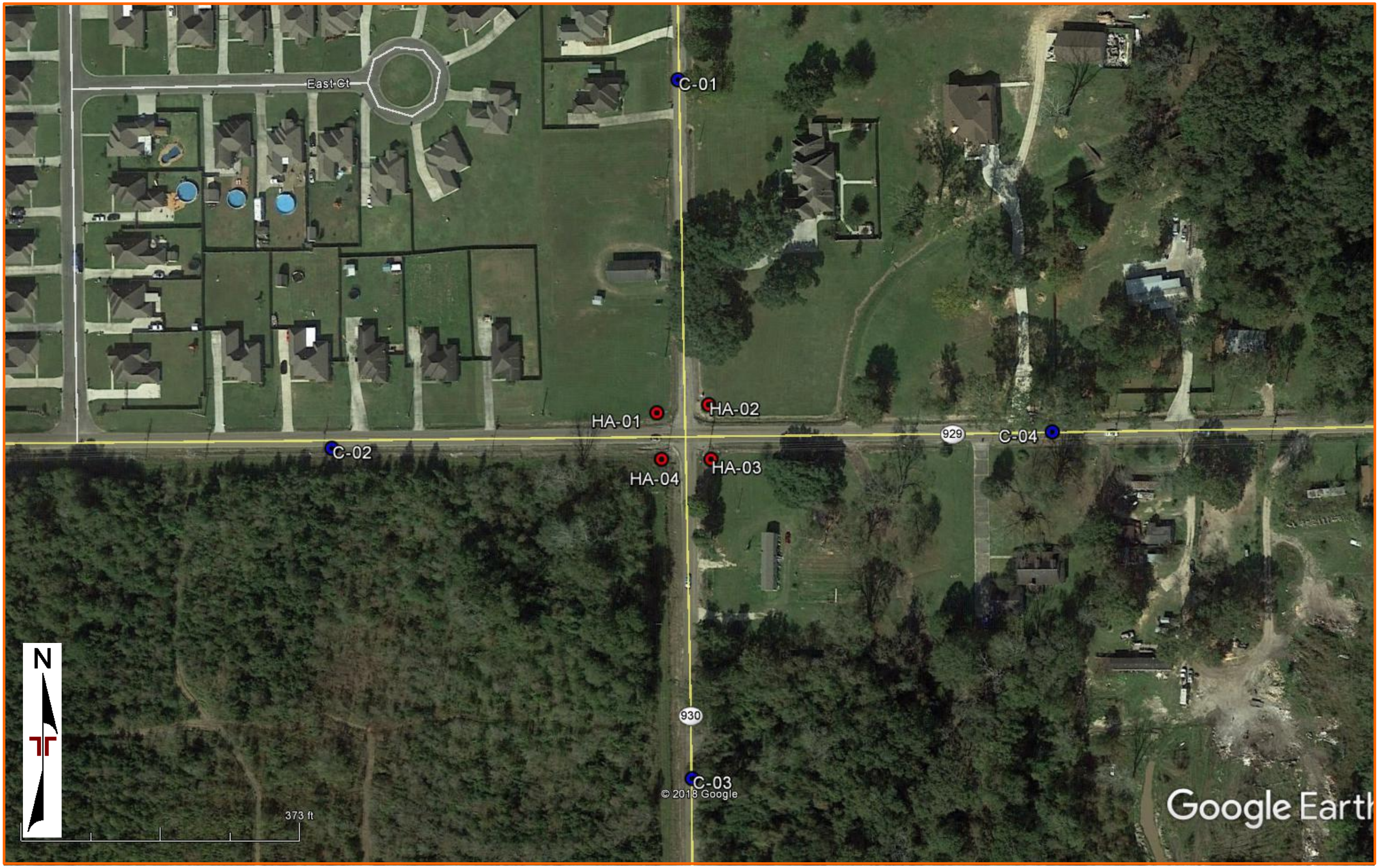

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY GOOGLE EARTH

EXPLORATION RESULTS

BORING LOG NO. HA-01

PROJECT: Highway 929 & 930 Roundabout

**CLIENT: Volkert, Inc.
Baton Rouge, LA**

**SITE: Highway 929 & Highway 930
Gonzales, LA**

LOCATION See Exploration Plan

Latitude: 30.2987° Longitude: -90.9557°

Approximate Surface Elev: 21 (Ft.) +/-

GRAPHIC LOG	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.6	**7" TOPSOIL**	20.5+/-						
		FAT CLAY (CH), grayish brown, with roots, trace sand					24	50-20-30	97
	4.0	-tan and brown below 2'	17+/-				24	56-19-37	97
		LEAN CLAY (CL), gray, tan, and brown, trace sand		5			22	45-17-28	96
	8.0		13+/-				23	38-17-21	96
		Boring Terminated at 8 Feet							

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

Advancement Method:
0'-8' Hand Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation based on Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
2822 Oneal Ln Bldg B
Baton Rouge, LA

Boring Started: 06-19-2018	Boring Completed: 06-19-2018
Drill Rig: Hand Auger	Driller: D. Gannfors
Project No.: EH185168	

BORING LOG NO. HA-02

PROJECT: Highway 929 & 930 Roundabout

**CLIENT: Volkert, Inc.
Baton Rouge, LA**

**SITE: Highway 929 & Highway 930
Gonzales, LA**

LOCATION See Exploration Plan

Latitude: 30.2987° Longitude: -90.9555°

Approximate Surface Elev: 21 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**6" TOPSOIL**	20.5+/-						
2.0	**LEAN CLAY (CL)**, brown and tan, trace sand	19+/-				22	35-19-16	95
	FAT CLAY (CH), brownish tan, trace sand					24	54-19-35	97
6.0	-tannish gray below 4'	15+/-	5			23	57-19-38	97
8.0	**LEAN CLAY (CL)**, tannish brown, trace sand	13+/-				22	42-18-24	97

Boring Terminated at 8 Feet

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

Advancement Method:
0'-8' Hand Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation based on Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
2822 Oneal Ln Bldg B
Baton Rouge, LA

Boring Started: 06-19-2018	Boring Completed: 06-19-2018
Drill Rig: Hand Auger	Driller: D. Gannfors
Project No.: EH185168	

BORING LOG NO. HA-03

PROJECT: Highway 929 & 930 Roundabout

CLIENT: Volkert, Inc.
Baton Rouge, LA

SITE: Highway 929 & Highway 930
Gonzales, LA

LOCATION See Exploration Plan

Latitude: 30.2985° Longitude: -90.9555°

Approximate Surface Elev: 21 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.6	**7" TOPSOIL**	20.5+/-						
2.0	**FAT CLAY (CH)**, brownish tan, trace sand	19+/-				24	52-20-32	98
	LEAN CLAY (CL), brownish tan, trace sand					23	45-19-26	98
			5			22	46-19-27	98
8.0	-brownish gray below 6'	13+/-				22	43-19-24	98
	Boring Terminated at 8 Feet							

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

Advancement Method:
0'-8' Hand Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation based on Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
2822 Oneal Ln Bldg B
Baton Rouge, LA

Boring Started: 06-19-2018	Boring Completed: 06-19-2018
Drill Rig: Hand Auger	Driller: D. Gannfors
Project No.: EH185168	

BORING LOG NO. HA-04

PROJECT: Highway 929 & 930 Roundabout

CLIENT: Volkert, Inc. Baton Rouge, LA

SITE: Highway 929 & Highway 930 Gonzales, LA

LOCATION See Exploration Plan

Latitude: 30.2985° Longitude: -90.9557°

Approximate Surface Elev: 21 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.7	**8" TOPSOIL**	20.5+/-						
	LEAN CLAY (CL), brown, trace sand					27	40-22-18	96
	-brown and tan below 2'					23	48-19-29	97
			5			22	46-19-27	98
8.0		13+/-				22	44-19-25	97

Boring Terminated at 8 Feet

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

Advancement Method:
0'-8' Hand Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation based on Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
2822 Oneal Ln Bldg B
Baton Rouge, LA

Boring Started: 06-19-2018	Boring Completed: 06-19-2018
Drill Rig: Hand Auger	Driller: D. Gannfors
Project No.: EH185168	

BORING LOG NO. C-01

PROJECT: Highway 929 & 930 Roundabout

CLIENT: Volkert, Inc.
Baton Rouge, LA

SITE: Highway 929 & Highway 930
Gonzales, LA

LOCATION See Exploration Plan

Latitude: 30.2999° Longitude: -90.9556°

Approximate Surface Elev: 22 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.8	**9" ASPHALT**	21+/-						
1.4	**7" GRAVELY CLAY**	20.5+/-						
	LEAN CLAY (CL), brown, trace sand					21	42-18-24	98
	-trace ferrous nodules from 2' to 4'					24	49-20-29	99
			5			24	37-20-17	99
8.0	-light gray and tan, with ferrous nodules below 6'	14+/-				22	30-15-15	95

Boring Terminated at 8 Feet

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

Advancement Method:
0'-1.3' Coring Machine 1.3'-8' Hand Auger

Abandonment Method:
Boring backfilled with auger cuttings and capped with an asphalt patch upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation based on Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
2822 Oneal Ln Bldg B
Baton Rouge, LA

Boring Started: 07-06-2018	Boring Completed: 07-06-2018
Drill Rig: Coring Trailer	Driller: D. Gannfors
Project No.: EH185168	

BORING LOG NO. C-02

PROJECT: Highway 929 & 930 Roundabout

CLIENT: Volkert, Inc.
Baton Rouge, LA

SITE: Highway 929 & Highway 930
Gonzales, LA

LOCATION See Exploration Plan

Latitude: 30.2985° Longitude: -90.9571°

Approximate Surface Elev: 22 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**6" ASPHALT**	21.5+/-						
1.4	**11" SAND AND GRAVEL MIXTURE**	20.5+/-						
2.0	**LEAN CLAY (CL)**, brown, with sand	20+/-				16	27-16-11	94
	LEAN CLAY (CL), brown and tan, with calcareous nodules to 2', trace sand			▽ ▽		21	45-19-26	96
	-brown below 4'		5			25	36-19-17	98
8.0		14+/-				23	30-19-11	96

Boring Terminated at 8 Feet

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

Advancement Method:
0'-1.4' Coring Machine 1.4'-8' Hand Auger

Abandonment Method:
Boring backfilled with auger cuttings and capped with an asphalt patch upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation based on Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Groundwater first encountered*

▽ *After 15 minutes*

Terracon
2822 Oneal Ln Bldg B
Baton Rouge, LA

Boring Started: 07-06-2018	Boring Completed: 07-06-2018
Drill Rig: Coring Trailer	Driller: D. Gannfors
Project No.: EH185168	

BORING LOG NO. C-03

PROJECT: Highway 929 & 930 Roundabout

CLIENT: Volkert, Inc.
Baton Rouge, LA

SITE: Highway 929 & Highway 930
Gonzales, LA

LOCATION See Exploration Plan

Latitude: 30.2973° Longitude: -90.9555°

Approximate Surface Elev: 22 (Ft.) +/-

GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3	**3" ASPHALT**	21.5+/-						
	1.1	**9" LIME-TREATED SOIL**	21+/-						
	2.0	**LEAN CLAY (CL)**, black, with sand, with gravel	20+/-				19	42-18-24	92
		LEAN CLAY (CL), brown, trace sand					23	46-19-27	95
				5			24	33-22-11	98
	8.0		14+/-				22	32-19-13	96
		Boring Terminated at 8 Feet							

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

Advancement Method:
0'-1' Coring Machine 1'-8' Hand Auger

Abandonment Method:
Boring backfilled with auger cuttings and capped with an asphalt patch upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation based on Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
2822 Oneal Ln Bldg B
Baton Rouge, LA

Boring Started: 07-06-2018	Boring Completed: 07-06-2018
Drill Rig: Coring Trailer	Driller: D. Gannfors
Project No.: EH185168	

BORING LOG NO. C-04

PROJECT: Highway 929 & 930 Roundabout

CLIENT: Volkert, Inc.
Baton Rouge, LA

SITE: Highway 929 & Highway 930
Gonzales, LA

LOCATION See Exploration Plan

Latitude: 30.2986° Longitude: -90.954°

Approximate Surface Elev: 21 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**2" ASPHALT**	20.5+/-						
1.0	**6" SAND AND GRAVEL MIXTURE**	20+/-						
2.0	**FAT CLAY (CH)**, brown	19+/-				25	56-19-37	100
	LEAN CLAY (CL), brown					22	42-21-21	100
	-trace sand below 4'		5			24	35-18-17	98
8.0		13+/-				21	30-14-16	95
	Boring Terminated at 8 Feet							

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

Advancement Method:
0'-1' Coring Machine 1'-8' Hand Auger

Abandonment Method:
Boring backfilled with auger cuttings and capped with an asphalt patch upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation based on Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
2822 Oneal Ln Bldg B
Baton Rouge, LA

Boring Started: 07-06-2018	Boring Completed: 07-06-2018
Drill Rig: Coring Trailer	Driller: D. Gannfors
Project No.: EH185168	

SUPPORTING INFORMATION

AASHTO 1993 ESAL Calculator for Flexible Pavements

Vehicle Description	Traffic Volume: Quantity in the Design Lane	Traffic Volume: Days per Week	Traffic Volume: Weeks per Year	Analysis Period (years)	Axle 1 (kips)		Axle 2 (kips)		Axle 3 (kips)		Gross Weight (pounds)	Equivalency Factors: Axle 1	Equivalency Factors: Axle 2	Equivalency Factors: Axle 3	ESAL's
Passenger car	**5,000**	**7**	**52**	**20**	2	S	2	S			4,000	0.0002	0.0002	0	17,001
Pick-up truck or van	**2,700**	**7**	**52**	**20**	2	S	4	S			6,000	0.0002	0.002	0	50,489
Recreational vehicle					4	S	4	S			8,000	0.002	0.002	0	0
School bus	**40**	**5**	**52**	**20**	6	S	14	S			20,000	0.01	0.35	0	87,433
TARC bus					8	S	14	S			22,000	0.033	0.35	0	0
Greyhound MC-12 bus					13.4	S	18.4	S	6	S	37,800	0.2999	1.11	0.01	0
Package delivery truck	**450**	**7**	**52**	**20**	4	S	14	S			18,000	0.002	0.35	0	1,346,472
Beverage delivery truck	**15**	**7**	**52**	**20**	6	S	12	S	12	S	30,000	0.01	0.183	0.183	47,943
Garbage/dumpster truck					20	S	35	T			55,000	1.55	1.23	0	0
Concrete truck (full)					20	S	48	R			68,000	1.55	1.014	0	0
Dump truck (full)					20	S	48	R			68,000	1.55	1.014	0	0
Semi-tractor (no trailer)					8	S	2	T			10,000	0.033	0	0	0
Semi-tractor trailer (empty)					8	S	8	T	6	T	22,000	0.033	0.003	0.001	0
Semi-tractor trailer	**55**	**7**	**52**	**20**	12	S	34	T	34	T	80,000	0.183	1.08	1.08	1,095,407
User Defined					6	S	29	s	20	T	55,000	0.01	7.51	0.117	0
User Defined					8	S	32	T		T	40,000	0.033	0.842	0	0
Vehicle type H10					4	S	16	S			20,000	0.002	0.612	0	0
Vehicle type H15					6	S	24	S			30,000	0.01	3.33	0	0
Vehicle type H20					8	S	32	S			40,000	0.033	11.5	0	0
Vehicle type 3					16	S	34	T			50,000	0.612	1.08	0	0
Vehicle type HS15					6	S	24	S	24	S	54,000	0.01	3.33	3.33	0
Vehicle type HS20					8	S	32	S	32	S	72,000	0.033	11.5	11.5	0
Vehicle type 3S2					10	S	31	T	31	T	72,000	0.085	0.7425	0.7425	0

Terminal Serviceability, r_t	**2.0**
Assumed Structural Number, SN	**4**
Traffic Growth Rate, %/yr	**1.6**

Summary:		
Total AASHTO ESAL's		**2,644,745**
	Superpave	**ESAL Class 2**
Traffic Category	**Heavy Duty Pavement**	

Project: ighway 929 & 930 Roundabo Location: Gonzales, Louisiana

Job No.: EH185168 Date: 9/27/2018

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Highway 929 & 930 Roundabout ■ Gonzales, LA

October 19, 2018 ■ Terracon Project No. EH185168

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Auger Cuttings; Rock Core	▽ **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.	**N** – **Standard Penetration Test Resistance (Blows/Ft.)** **(HP)** – **Hand Penetrometer** **(T)** – **Torvane** **(DCP)** – **Dynamic Cone Penetrometer** **UC** – **Unconfined Compressive Strength** **(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, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL		RELATIVE PROPORTIONS OF FINES	
Descriptive Term(s) of other constituents	Percent of Dry Weight	**Descriptive Term(s) of other constituents**	**Percent of Dry Weight**
Trace	<15	Trace	<5
With	15-29	With	5-12
Modifier	>30	Modifier	>12

GRAIN SIZE TERMINOLOGY		PLASTICITY DESCRIPTION	
Major Component of Sample	**Particle Size**	**Term**	**Plasticity Index**
Boulders	Over 12 in. (300 mm)	Non-plastic	0
Cobbles	12 in. to 3 in. (300mm to 75mm)	Low	1 - 10
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)	Medium	11 - 30
Sand	#4 to #200 sieve (4.75mm to 0.075mm	High	> 30
Silt or Clay	Passing #200 sieve (0.075mm)		

UNIFIED SOIL CLASSIFICATION SYSTEM

Highway 929 & 930 Roundabout ■ Gonzales, Louisiana

October 19, 2018 ■ Terracon Project No. EH185168

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: 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 ³ 4 and 1 £ Cc £ 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 ³ 6 and 1 £ Cc £ 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"		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 ³ 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 ³ 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 ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ³ 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.