BURGE • MARTINEZ
CONSULTING, INC.

REPORT OF

GEOTECHNICAL ENGINEERING STUDY

BANDERA RETAIL CENTER
7800 BANDERA ROAD
SAN ANTONIO, TEXAS
BMC PROJECT NO. 12-18-0058

FOR

BANDERA RETAIL CENTER, LLC
12300 WEST IH-10
SAN ANTONIO, TEXAS 78230

MARCH 29, 2018

BURGE • MARTINEZ CONSULTING, INC.
Geotechnical Engineering • Environmental • Testing

March 29, 2018

Mr. Bijan Bonakchi
Bandera Retail Center, LLC
12300 West IH-10
San Antonio, Texas 78230

RE: Geotechnical Engineering Study
Bandera Retail Center
7800 Bandera Road
San Antonio, Texas
BMC Project No. 12-18-0058

Dear Mr. Bonakchi:

Burge-Martinez Consulting, Inc. (BMC) has completed the subsurface exploration and geotechnical engineering analysis for the above-referenced project, in general accordance with BMC Proposal No. P12-18-060, dated March 8, 2018. Our report, which includes the results of our subsurface exploration program, laboratory testing program, and geotechnical engineering analysis, is enclosed with this letter.

Based on the results of the field exploration program, the site is considered suitable for the proposed development, provided that the recommendations enclosed in this report are followed.

We appreciate the opportunity to be of service to you during the design phase of this project. We look forward to continuing our involvement with this project during the construction phase by providing the special inspection and testing services required by City of San Antonio. If you have any questions regarding the information contained in this report or if we can be of further assistance to you, please feel free to contact us.

Respectfully submitted,
BURGE•MARTINEZ CONSULTING, INC.
Texas Registered Engineering Firm F-7740
Geotechnical Engineering Services

3/29/18

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APPENDIX I

PROJECT OVERVIEW

Project Location

This report presents the results of our subsurface exploration and engineering analysis for the proposed retail building located at 7800 Bandera Road in San Antonio, Texas. The approximate site location is shown on the *Site Vicinity Map* provided in the Appendix.

Scope of Work

The conclusions and recommendations contained in this report are based on four (4) soil/FILL borings (B-1 through B-4) performed by Tero Drilling, LLC on March 15, 2018. Borings B-1 and B-2 were drilled within the proposed building area and extended to a termination depth of approximately 20 feet below the existing ground surface elevations. Borings B-3 and B-4 were drilled in the proposed pavement areas and extended to a termination depth of six (6) feet below existing grade.

Proposed Construction

Based on information provided to us, the project will include the design and construction of a new retail building. The building will be approximately 9,900 square-feet in plan area. Development also includes associated paved parking areas and drive areas, concrete flatwork, and underground utilities. It is anticipated that the building will be lightly-loaded and supported by a monolithic slab-on-grade foundation system. The proposed construction is shown in relation to the borings on the *Boring Location Plan*, provided in the Appendix.

It should be noted that BMC was not provided with any structural information, existing elevations, proposed grades, or a finished floor elevation. However, based on our site reconnaissance and our understanding of the proposed construction, we anticipate that cut/fill requirements for grading purposes will be on the order of about ±2 feet.

The *Boring Location Plan* was developed from the *Dimensional Site Plan (Sheet SK2)* prepared by Professional StruCivil Engineers, Inc., dated January 9, 2018. Since existing elevations were not provided to us, the elevations are not noted on the boring logs. The borings were located in the field using pacing/taping procedures from existing structures/landmarks identified on the available site plan.

Purposes of Exploration

The purposes of this study were to explore the subsurface soil/rock and groundwater conditions at the site and to develop engineering recommendations to guide design and construction of the soil/FILL/rock-supported elements of the project. We accomplished these purposes by:

1. reviewing available geologic and soil survey maps of the project area,
2. drilling borings to explore the subsurface soil/FILL/rock and groundwater conditions,
3. performing laboratory tests on selected representative samples from the borings to evaluate pertinent engineering properties, and
4. analyzing the field and laboratory data to develop appropriate engineering recommendations.

EXPLORATION PROCEDURES

Subsurface Exploration Procedures

The borings were performed with a standard, truck-mounted drill rig, which utilized continuous, straight-flight auger drilling techniques to advance the boreholes. Upon completion of the borings, the boreholes were backfilled with spoils generated during the drilling process and capped with on-site material.

Representative samples of the subsurface soil/rock were obtained employing split-spoon sampling procedures in general accordance with ASTM D-1586. The split-spoon sampler collects relatively disturbed samples at selected depths in the borings by driving a standard two (2) inch outer diameter split-spoon sampler 18 inches into the subsurface material using a 140 pound hammer falling 30 inches. The number of blows required to drive the split-spoon sampler the final 12 inches of penetration (N-value) is recorded in the “SPT N-value” column of the boring logs. Where limited sample was recovered, subsurface samples were collected directly of the cuttings.

An engineering technician maintained field logs of the soil/rock encountered in the borings. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample were then sealed and delivered to our laboratory for further visual examination and laboratory testing.

Laboratory Testing Program

Representative soil/rock samples were selected and tested in our laboratory to check field classifications and to determine pertinent engineering properties. The laboratory testing program included visual classifications, moisture contents, and Atterberg Limits tests. Visual classifications conducted in the laboratory were performed by a licensed professional engineer. All data obtained from the laboratory tests are included on the representative boring logs in the Appendix.

Each soil sample was classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS). A brief explanation of the USCS is included with this report. The various soil/rock types were grouped into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs and profiles are approximate; in situ, the transitions may be gradual. The soil/rock samples will be retained in our laboratory for a period of 30 days, after which, they will be discarded unless other instructions are received by the client.

EXPLORATION RESULTS

Site Conditions

At the time of our field exploration, the property was undeveloped and mostly vegetated with grasses. The property surface was covered with undocumented fill material (FILL). The FILL is believed to be associated with the nearby developments. The property has good drainage that slopes downward to the southwest towards a drainage swale that runs along Bandera Road. The property is surrounded by commercial developments.

Regional Geology and Soil Survey

According to the Bureau of Economic Geology at The University of Texas at Austin, San Antonio Sheet, the proposed site is located in the Austin Chalk, Kau. This Upper Cretaceous Age formation consists of alternating layers of chalk and marl. The chalk is grayish white to white and averages about 85 percent calcium carbonate. The marl is medium gray with bentonitic seams locally. Thickness is about 350 to 580 feet.

The Soil Survey of Bexar County, Texas published by the United States Department of Agriculture, National Cooperative Soil Survey, indicates that the shallow soils in the general vicinity of the site are classified as Lewisville Silty Clay, 1 to 3 percent slopes, (LvB). Lewisville Silty Clay consists of moderately deep, dark colored alluvial soils that occupy long, narrow sloping areas along major drainage ways. The surface layer is dark grayish brown silty clay or light clay and is about 24 inches thick. The subsurface layer, about 17 inches thick, is brown silty clay that is very firm but crumbly when moist. The underlying material is reddish yellow silty clay that contains large amounts of lime. Permeability is slow to moderate, and the capacity to hold water is good. Erosion can be a hazard if the surface is unprotected.

Soil Conditions

The near surface conditions, which were observed during our field exploration program consists of FILL overlying clay and bedrock. Based on our observations at the time of our field study, the stratigraphy of the subsurface materials at this site can generally be described as presented in the following table:

Stratum	Range in Depth (ft)	Soil Description and Classification
FILL	0 – 8	Brown, tan, or dark brown clay with varying amounts of gravel, organics, and interbeds of chalk and limestone fragments
I	4 – 16	Very stiff to hard, brown FAT CLAY (CH)
II	3 – 20	Very dense, tan MARL or hard, tan LEAN CLAY (CL)

FILL – Undocumented fill material (FILL) was encountered at all four (4) boring locations, and consisted of a mixture of brown, tan, or dark brown clay with varying amounts of gravel, organics, and interbeds of chalk and limestone fragments. Atterberg Limits tests conducted on representative samples of this FILL indicated this FILL has Liquid Limits (LL's) ranging from 41 to 64 with corresponding Plasticity Indices (PI's) ranging from 26 to 44. Based on these measured indices, this FILL has a high potential for large changes in volume if fluctuations in the FILL's moisture content occur. Based on the Standard Blow Counts from our sampler, the general consistency of the FILL appeared to be stiff to hard, but is difficult to measure accurately due to the presence of oversized cobbles and/or boulders.

Based on the dry consistency and variability of the FILL, we do not feel that the material is suitable for direct support of the proposed lightly-loaded structure. As such, a portion of the FILL shall be removed and replaced with select structural fill in compacted controlled lifts. The FILL on the property should be evaluated during grading operations as recommended herein to determine it's suitability for re-use on non-structural areas of the property. Any trash, brush, and asphalt/concrete debris encountered during grading should be removed and properly disposed of off-site. Any large boulders and cobbles or highly organic material should be hauled off-site.

Stratum I – This stratum was comprised of very stiff to hard, brown FAT CLAY (CH). An Atterberg Limits test conducted on a representative sample of this stratum indicated this clay has a LL of 62 and corresponding PI of 45. Based on these measured indices, this clay has a very high potential for large changes in volume if fluctuations in the soil's moisture content occur.

Stratum II – This stratum was comprised of very dense, tan MARL or hard, tan LEAN CLAY (CL). An Atterberg Limits test conducted on a weathered portion of this stratum indicated this material has a LL of 39 and corresponding PI of 25. Based on this stratum's depth and cemented consistency, this stratum has a low to moderate potential for changes in volume if fluctuations in the material's moisture content occur. **This stratum became very dense, massive bedrock with depth.** Typically, blow counts of 50 blows for 2 inches or less is not deemed ripable and usually requires removal through milling/sawing or other removal methods. The site and utility contractors should review the boring logs, as well as the entire geotechnical report, during preparation of their bids.

Groundwater Observations

Groundwater was not encountered during drilling operations. Observations for groundwater were made during sampling and upon completion of the drilling operations. In dry auger drilling operations, water is not introduced into the boreholes, and the groundwater position can often be determined by observing water flowing into or out of the borehole. Furthermore, visual observation of the soil samples retrieved during the auger drilling operations can often be used in evaluating the groundwater conditions. It should be noted that groundwater conditions can fluctuate due to seasonal and climatic variations, and should be measured (checked) prior to construction activities.

ANALYSIS AND RECOMMENDATIONS

The following recommendations are based on the four (4) borings performed at the site and the limited design information provided to us. We recommend that if there are any changes to the project characteristics as discussed in this report, BMC should be retained to review them so it can be determined if changes to the recommendations are necessary. The subject site is suitable for supporting the proposed structure on a monolithic slab-on-grade foundation system over an improved building pad, which is discussed in the following sections.

Expansive Soil Conditions

Based on the existing subsurface soil conditions, the project site is considered to be expansive, as defined by 2015 International Building Code (IBC), Section 1803.5.3. Although we have provided measures to reduce the magnitude of movements, these measurements are not as stringent as outlined by the IBC to classify the site as non-expansive.

The proposed structure may be founded on a grade-supported foundation system provided it is designed for the subsurface conditions encountered at this site. The potential vertical rise (PVR) for the subsurface soil stratigraphy encountered in the borings drilled at this site was calculated using the Texas Department of Transportation (TxDOT) Method TEX-124-E. These calculations indicate potential vertical movements ranging from one (1) inch to two and one-quarter (2-¼) inches with effective design plasticity indices ranging from 21 to 33. These calculations are based on the existing site conditions and account for an over-burden pressure of one (1) psi.

Given the presence of FILL at the surface of the site and to reduce the existing PVR to about one (1) inch, we highly recommend over-excavating a minimum of five (5) feet of the FILL or until Stratum II is encountered, **whichever is less**, and replace it with moisture conditioned and compacted select structural fill material below the floor slab. We anticipate that additional fill will be required on a portion of the building footprint area due to grading requirements. Any additional fill required for grading purposes must also consist of properly moisture conditioned and compacted select structural fill. This minimum thickness is required so that there is a similar bearing material below the entire floor slab. The on-site FILL material is NOT suitable for use as select fill material.

A PVR value of one (1) inch or less is generally considered to be tolerable for this type of at-grade construction. Obviously, this does not mean that foundation movements are eliminated. It only means that the monolithic foundation system can be structurally designed for the magnitude of movement without failure of the foundation system. However, this movement does not take into account the movement criteria that is required or perceived by the building owner/occupants. This "operational" performance criteria may be, and often is, more restrictive than the structural criteria or tolerances.

Slab-on-Grade Foundation System

The subsurface conditions encountered at the site are determined to be suitable for supporting the proposed structure on a monolithic slab-on-grade foundation system over an improved building pad. Based on the anticipated structural loading and SPT values, as monitored during drilling of our borings, we recommend that the monolithic slab-on-grade foundation system be designed for a maximum net allowable end bearing capacity of 2,000 psf into compacted select fill material. At beam intersections, or as required at column locations, the grade beams may be widened to support additional loads. At these areas, the bearing capacity may be increased to 2,300 psf; however, the beams must be at least 30 inches in the smallest dimension and poured monolithically with the slab.

We recommend that the beams have a minimum width of 12 inches and extend a minimum of 18 inches below finished grade and into compacted select structural fill material or approved in-situ soil. Exterior grade beams should extend a minimum of 24 inches below the finished exterior grade. These recommendations are for proper development of bearing capacity for the continuous beam sections of the foundation system and are NOT based on structural considerations. Grade beam widths and depths for structural considerations may need to be greater than recommended herein and should be properly evaluated and designed by the structural engineer.

The following table presents the design criteria published by the Building Research Advisory Board (BRAB), Wire Reinforcement Institute (WRI), and the Post-Tensioning Institute (PTI), 3rd Edition. These values were based on our understanding of the proposed project, our interpretation of the information and data collected as part of this study, the criteria publications, and on our past experience with similar projects.

Based on the soil/rock conditions, the proposed structure may be supported using a Type III reinforced slab-on-grade foundation system in accordance with BRAB (or suitable alternative).

Recommended BRAB, WRI, & PTI Criteria for Slab-on-Grade Foundation	Modified Condition
Minimum Over-excavation[1]	5 feet[1]
Minimum Select Fill Pad Thickness	5 feet[1]
Potential Vertical Rise (PVR)	1 inch
Effective Design Plasticity Index (PI)	28
Unconfined Compressive Strength, (tsf)	2.0
Slope Correction Coefficient	1.0
Constant Soil Suction, pF	3.8
Climatic Rating (C_w)	17
Soil Support Index, c	0.86
Edge Moisture Variation Distance, e_m, Center	8.5 feet
Edge Moisture Variation Distance, e_m, Edge	4.3 feet
Thornthwaite Index (I_m)	-14
Differential Soil Movement, y_m, Center Lift	0.4 inch
Differential Soil Movement, y_m, Edge Lift	0.8 inch

Note 1) Over-excavate at least 5 feet of FILL, or until Stratum II is encountered, whichever is less, and replace with select fill below the floor slab. That is, if Stratum II is encountered prior to over-excavating at least 5 feet, then the over-excavation may cease. Due to the presence of FILL, the BMC Geotechnical Engineer, or his representative, shall approve of the subgrade following over-excavation operations.

Following any over-excavation and site preparation processes and if required by final grade elevations, the proposed building pad shall be built-up and leveled using additional select structural fill material, as detailed in the *Subgrade Preparation and Earthwork Operations* Section.

For a monolithic slab-on-grade foundation system, designed and constructed as recommended in this report, post construction settlements should be one (1) inch or less. Settlement response of a fill supported slabs is influenced more by the quality of construction than by soil-structure interaction. Therefore, it is essential that the recommendations for both the foundation and the building pad construction be strictly followed throughout the construction phase of the proposed building's foundation.

Seismic Considerations

According to the IBC (Section 1613.3.2), the site shall be classified in accordance with Chapter 20 of ASCE 7-10: Minimum Design Loads for Buildings and Structures. According to the ASCE 7-10 and 2009 IBC documents, the site classification is based on the subsurface soil/rock profile to a depth of 100 feet. Since the maximum depth explored for this study was approximately 20 feet, we have assumed that the geologic formation condition extends to a depth of at least 100 feet. Based on the soil profile encountered and these assumptions, the Site Class is "C" as defined by ASCE 7-10, Table 20.3-1 (or 2009 IBC, Table 1613.5.2).

Subgrade Preparation and Earthwork Operations

After excavating to the specified depth within the building area and pavement areas, and prior to fill placement, the exposed subgrade surfaces shall be observed by the Geotechnical Engineer or authorized representative. Any areas of soft or wet clay or loose/dry FILL may require removal and replacement with suitable fill material; however, BMC must be on site to approve any additional cut/fill operations.

The following site preparation would be necessary for a monolithic slab-on-grade foundation system:

1) Existing vegetation, topsoil and any existing loose materials should be stripped and removed from the proposed building footprint.

2) Following stripping operations, the floor slab area should be over-excavated as recommended in the *Expansive Soil Conditions* and Slab-on-Grade Foundation System sections. The over-excavation areas should extend a minimum of four (4) feet beyond the horizontal limits of the proposed building footprint. The Geotechnical Engineer of Record or his qualified representative shall be on-site during earthwork operations to observe and approve any cut areas prior to fill placement.

3) Following excavation and due to the presence of FILL, the exposed subgrade area should be proof-rolled to expose any weak, soft, wet, or otherwise unsuitable soils that should be removed. At the discretion of the Geotechnical Engineer, any weak, soft, wet, or unsuitable soils observed during proof-rolling shall be removed down to expose suitable on-site soil or bedrock.

4) Following proof-rolling, the subgrade shall be scarified to a depth of six (6) inches, moisture conditioned between 0 and +4 percentage points above optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined in accordance with ASTM D698. Areas of exposed bedrock are not required to be compacted and shall be approved upon the proof-roll.

5) Following approval of the subgrade, the select fill should be placed up to the desired final building pad elevation. The select fill should be placed in eight (8) inch maximum thick loose lifts. The select fill should be moisture conditioned between -3 and +3 percentage points of optimum moisture content and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698, Standard Proctor Method. A minimum of three (3) nuclear density tests shall be performed per lift.

When placing the select fill, care should be taken to avoid water ponding in the select fill layer. This could cause post-construction movements, which exceed the estimated values. Care must be taken to prevent landscape watering, surface drainage, leaking utility lines or other sources of water from entering the select fill.

Any import or select fill should be an approved inorganic material, free of debris. The select fill material should be approved by the Geotechnical Engineer prior to importing on site. Although not anticipated, the on-site soils may be utilized provided the following recommendations for select fill are met. This material should be placed in lifts not exceeding eight (8) inches in loose thickness, moisture conditioned to within $\pm$3 percentage points of the optimum moisture content, and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698, Standard Proctor Method. Select fill material should have a Plasticity Index (PI) ranging between 5 and 17 and have a maximum particle size of three (3) inches.

Pavement Design

General parking areas and drive areas will be provided primarily for general automobile traffic, and some heavy truck traffic for deliveries and trash pick up. No detailed information regarding the expected traffic loads were known at the time of our report preparation. Therefore, assumptions were made regarding the anticipated traffic conditions.

Our pavement analysis was generally based on the design procedure developed by AASHTO's *Guide for Design of Pavement Structures*, 1993, as well as the American Concrete Institute's (ACI's) *Guide for the Design and Construction of Concrete Parking Lots*, ACI 330R-08.

Based on the site location and facility type, we utilized an effective pavement life of 20 years. Also for this analysis, we estimated a CBR (California Bearing Ratio) value of three (3) percent for in-situ FILL, which will likely be the predominant subgrade material following rough grading operations. We estimated this CBR value since evaluation of CBR values by either field or laboratory testing was not included in the scope of our services. We selected this value based on our knowledge and experience with similar soil conditions in this region. We suggest that additional testing, including CBR testing and Atterberg Limits, be conducted on the actual subgrade materials at the time of construction in order to verify the assumptions in this report.

The following design parameters and criteria were considered in our analyses:

- Resilient Modulus: 4,500 psi
- Reliability: 70 percent
- Overall Standard Deviation: 0.45 for flexible pavement
- Initial Serviceability: 4.2
- Terminal Serviceability: 2.0

The minimum recommended thicknesses for flexible pavement sections (asphaltic concrete) are presented in the following table. Entrances to the new development as well as areas expected to require excessive maneuvering, such as dumpster areas or areas expected to accommodate heavy truck traffic, should consists of a rigid (concrete) pavement system. Minimum thicknesses for a rigid pavement section are also provided.

	Light Duty Pavement Section	**Medium Duty Pavement Section**	**Heavy Duty Pavement Section**
Pavement Material	**Thickness, (in)**	**Thickness, (in)**	**Thickness, (in)**
Reinforced Concrete	---	---	6
Type D, Hot Mix Asphaltic Concrete	1.5	2.0	---
Crushed Limestone Base	9	11	Note 1
Compacted Subgrade	6	6	6

Notes 1.) Although not required as a structural layer, crushed limestone base may be used as a level-up course.

For the above pavement sections, we have calculated traffic loading conditions equal to or greater than 25,000 18-kip equivalent single-axle loads (ESALs) for the light-duty section and 110,000 for the medium-duty section. Typically, the light-duty section will meet the requirements for the parking spaces, while the medium-duty section will meet the requirements for the drive lanes and emergency vehicle access lanes, due to infrequency of loading. If our assumptions or the traffic loading conditions do not meet the intended use or if further information comes available, we would be happy to provide further design recommendations.

The following paragraphs specify the pavement materials to be used to construct the proposed pavement areas:

<u>Hot Mix Asphaltic Concrete Surface Course</u> - The asphaltic concrete surface course should be plant mixed, hot laid Type D (Fine Graded Surface Course) meeting the 2004 Texas Department of Transportation (TxDOT) specification, Item 340 and specific criteria for the job mix formula. The mix should be designed for a stability of at least 40 and should be compacted to between 91 and 95 percent of the maximum theoretical density as determined in accordance with Tex-207-F. The asphalt cement content by percent of total mixture weight should fall within a tolerance of $\pm$ 0.3 percent asphalt cement from the specific mix design. In addition, the mix should be designed so that 75 to 85 percent of the voids in the mineral aggregate (VMA) are filled with asphalt cement.

<u>Reinforced Concrete</u> - Concrete should be designed to exhibit a flexural strength (third point loading) of at least 630 psi at 28 days (this is a compressive strength of about 4,000 psi). The flexural strength (M_r) may be approximated by the following formula from ACI 330R-08: $M_r=10\ (f_c')^{1/2}$, where f_c' is the average 28 day compressive strength of the concrete test cylinders. The actual relationship between flexural and compressive strength for the proposed mix should be evaluated in the laboratory.

<u>Crushed Limestone Base</u> - Base material should be composed of crushed limestone meeting the requirements of TxDOT Item 247, Grade 1 or 2, Type A. The base should be compacted to a minimum of 95 percent of the maximum dry density as determined by the modified moisture-density relationship (ASTM D 1557) at -2 to +2 percentage points of optimum moisture content. The base material should be placed in loose lifts measuring no greater than eight (8) inch in thickness.

Compacted Subgrade - Subgrade should be moisture conditioned between optimum and plus four (+4) percentage points above optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined in accordance with ASTM D-698. Due to the presence of FILL across the site, we highly recommend a proof-roll of the entire pavement area in addition to moisture conditioning and compacting. The proof-roll will aid in identifying any areas of unsuitable or yielding FILL.

In the event that the rigid pavements are utilized throughout, the following recommendations are provided for reinforcement and jointing.

Type of Joint	Joint Spacing	Joint Depth	Joint Width[2]
Contraction (Control)	15 feet each way	One-fourth (¼) of slab thickness	One-eighth (⅛) to one-fourth (¼) inch
Construction	At location of contraction joints	Full depth of pavement thickness	One-eighth (⅛) to one-fourth (¼) inch
Isolation	As required to isolate from structures	Full depth of pavement thickness	Three-fourths (¾) to one (1) inch
Expansion[1]	60 feet each way	Full depth of pavement thickness	Three-fourths (¾) to one (1) inch

Notes: 1.) Serious consideration should be given to the total elimination of expansion joints. In this region, drying shrinkage of concrete typically significantly exceeds anticipated expansion due to thermal affects. As a result, the need for expansion joints is eliminated. Construction of an unnecessary joint may be also become a maintenance problem.

2.) All joint widths should be as noted above or as required by the joint sealant manufacturer.

Distributed Steel: Steel reinforcement may consist of either steel bars or welded wire fabric (WWF) described below:

No. 3 reinforcing steel bars at 18 inches on center each way, Grade 60; or

WWF: W2.9 X W2.9, six (6) inches by six (6) inches, flat sheets only; or W1.4 X W1.4, four (4) inches by four (4) inches, flat sheets only.

Note: It is imperative that the distributed steel be positioned accurately in the pavement cross section. Properly supported, this is typically easier to accomplish with steel bars than with WWF.

All construction joints shall have dowels, and dowel information varies with pavement thickness. The applicable dowel information for this project is provided below:

Pavement Thickness:	6 inches
Dowels	¾-inch diameter
Dowel Spacing	12 inches on center
Dowel Length	14 inches long
Dowel Embedment	6 inches minimum

Any general fill material placed in the pavement areas should be an approved inorganic material, free of debris, and have a maximum particle size of three (3) inches. Any import fill material should be approved by the Geotechnical Engineer prior to importing on site. The on-site soils may be utilized provided the recommendations provided herein are met. This material should be placed in lifts not exceeding eight (8) inches in loose thickness. Coarse-grained soils (SC, GC, or more granular) should be moisture conditioned to within ±3 percentage points of the optimum moisture content and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698. If fine grained soils (CL or CH) are used for grading purposes on the site, then they shall be placed in compacted controlled lifts by moisture conditioning to within 0 to +4 percentage points of optimum moisture content and compacting to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D698.

Proper perimeter drainage in and around pavement sections is very important, and should be provided so that infiltration of surface water from unpaved areas surrounding the pavement areas is minimized. We do not recommend installation of landscape beds or islands in the pavement. Such features provide an avenue for water to enter into the pavement section and the underlying subgrade soil. Water penetration usually results in degradation of the pavement section with time, and as vehicular traffic traverses the area of moisture infiltration. Above grade planter boxes, with drainage discharging onto the top of the pavement, or directed into storm sewers, should be considered if landscape features are desired.

If landscaping is used adjacent to the paved areas, we recommend the curbs extend through the base and at least six (6) inches into the subgrade. This will help reduce migration of groundwater into the pavement base course from adjacent areas. A crack sealant compatible to both asphalt and concrete should be provided at all concrete-asphalt interfaces, and at all interfaces of existing/new pavement areas.

Cracking, particularly longitudinal cracking within one (1) to five (5) feet of the pavement edges, should be expected of any asphalt pavements constructed where expansive soil is the subgrade material. Although not common, this longitudinal cracking may even occur further than this distance from the curb line. The cracking occurs as the expansive soils adjacent to and below the pavements shrink and swell with seasonal moisture fluctuations. Therefore, proper maintenance, including sealing all cracks on a timely manner, should be conducted throughout the life of any asphalt pavements.

Utility Trench Recommendations

Rock excavation equipment/techniques will likely be required for installation of any deep site utilities. The contractor should review the boring logs and visit the site property during bid preparation. We suggest that the site and utility contractors perform any other necessary testing, as deemed necessary, to provide a suitable bid to the owner, which could include test pits or additional borings in areas not explored as part of this study.

It is vital that all backfill being placed into utility trenches be moisture conditioned and compacted to a degree that meets or exceeds the compaction of the adjacent areas, so that no settlement will occur. Additionally, it is important that proper backfill material be used. Generally, the material that is excavated from the trenches is stockpiled on site and subsequently used as backfill material in the trenches.

Additionally, it is our recommendation that all backfill material used in the utility trenches be moisture conditioned to within three (3) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined in accordance with ASTM D-698. Furthermore, it is our recommendation that the backfill material be placed in six (6) inch lifts. The backfill material should be tested for moisture content and compaction for each six (6) inch lift at a minimum frequency of one (1) test per 100 linear feet. For narrow trenches that would be too confined to sufficiently compact the backfill materials, it is our recommendation that a flowable fill material be used to backfill the trench.

Construction Considerations

The site should be graded such that surface water runoff is directed away from any excavations during construction. In addition, site grading should allow for surface and roof drainage away from the structure during its design life. We suggest verifying final grades around the structure to document that effective drainage has been achieved.

Exposure to the environment may weaken the soils at the foundation bearing level if the excavations remain open for extended periods of time. Therefore, foundation concrete and select fill material should be placed as soon as possible after the excavations are completed. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete or select fill material. If rainfall becomes imminent while the foundation bearing soils are exposed, we recommend that a 1-to 3-inch thick "mud-mat" of "lean" concrete be placed on the bearing soils to prevent softening.

In a dry and undisturbed state, the surficial soil at the site will provide sufficient subgrade support for fill placement and construction operations. However, when wet, these soils will degrade quickly with disturbance from contractor operations. Therefore, good site drainage should be maintained during earthwork operations which will help maintain the integrity of the soil.

Limitations

This report has been prepared to aid in the evaluation of subsurface conditions at this site and to assist design professionals in the geotechnical related design of this project. It is intended for use with regard to the specific project as described in this report. Any substantial changes or differences in assumed building loads or building layout should be brought to our attention so that we may determine any effect on the recommendations provided in this report.

The scope of our study did not include an environmental assessment of the soil, rock, or water conditions either on or adjacent to the site. As such, no environmental opinions are presented in this report.

The opinions and conclusions expressed in this report are those of BMC and represent interpretation of the subsurface conditions based on tests and the results of our analyses. BMC is not responsible for the interpretation or implementation by others of recommendations provided in this report. This report has been prepared in accordance with generally accepted principles of geotechnical engineering practice and no warranties are included, expressed, or implied, as to the professional services provided under the terms of our agreement.

The analysis and recommendations submitted in this report are based upon the data obtained from the test borings performed at the locations indicated in the *Boring Location Plan*, and from other information described in this report. This report does not reflect any variations that may occur between the test borings. In the performance of the subsurface exploration, specific information is obtained at specific locations and times. However, it should be noted that variations in soil/rock conditions, such as presence or depth of FILL, exist on most sites between the test boring locations, and conditions such as groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction.

If variations appear evident, BMC should be allowed to perform on-site observations during the construction period and note characteristics and variations to determine if a re-evaluation of the recommendations in this report will be necessary.

Closing

We recommend that the construction activities be monitored on a call-out basis by a qualified Geotechnical Engineer, or representative. We also recommend that once the plans are prepared, BMC be retained to review them so it can be determined if changes to the recommendations are necessary or if additional recommendations are required.

APPENDIX

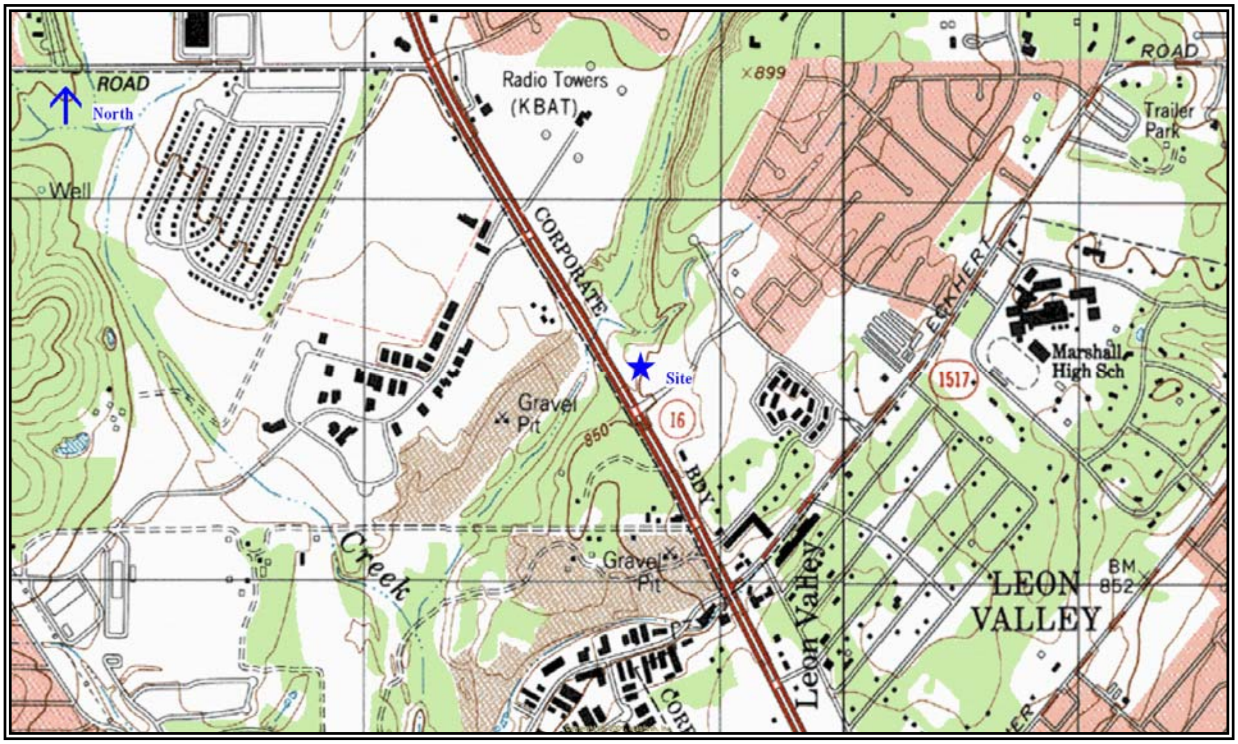
Site Vicinity Map

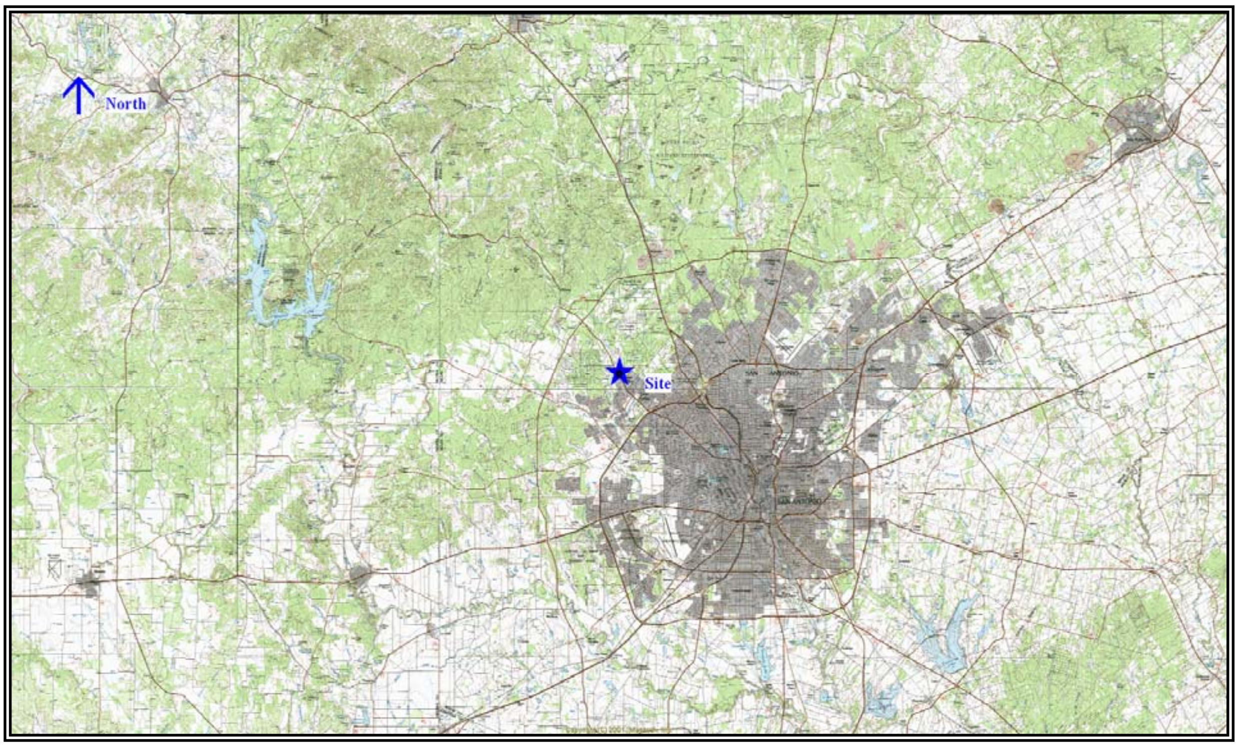
Boring Location Plan

Boring Logs (B-1 through B-4)

Soil Classification Chart

Laboratory and Field Test Procedures





Geotechnical Engineering Study
Bandera Retail Center
7800 Bandera Road
San Antonio, Texas
BMC Project No. 12-18-0058

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FIGURE 1

SITE VICINITY MAP

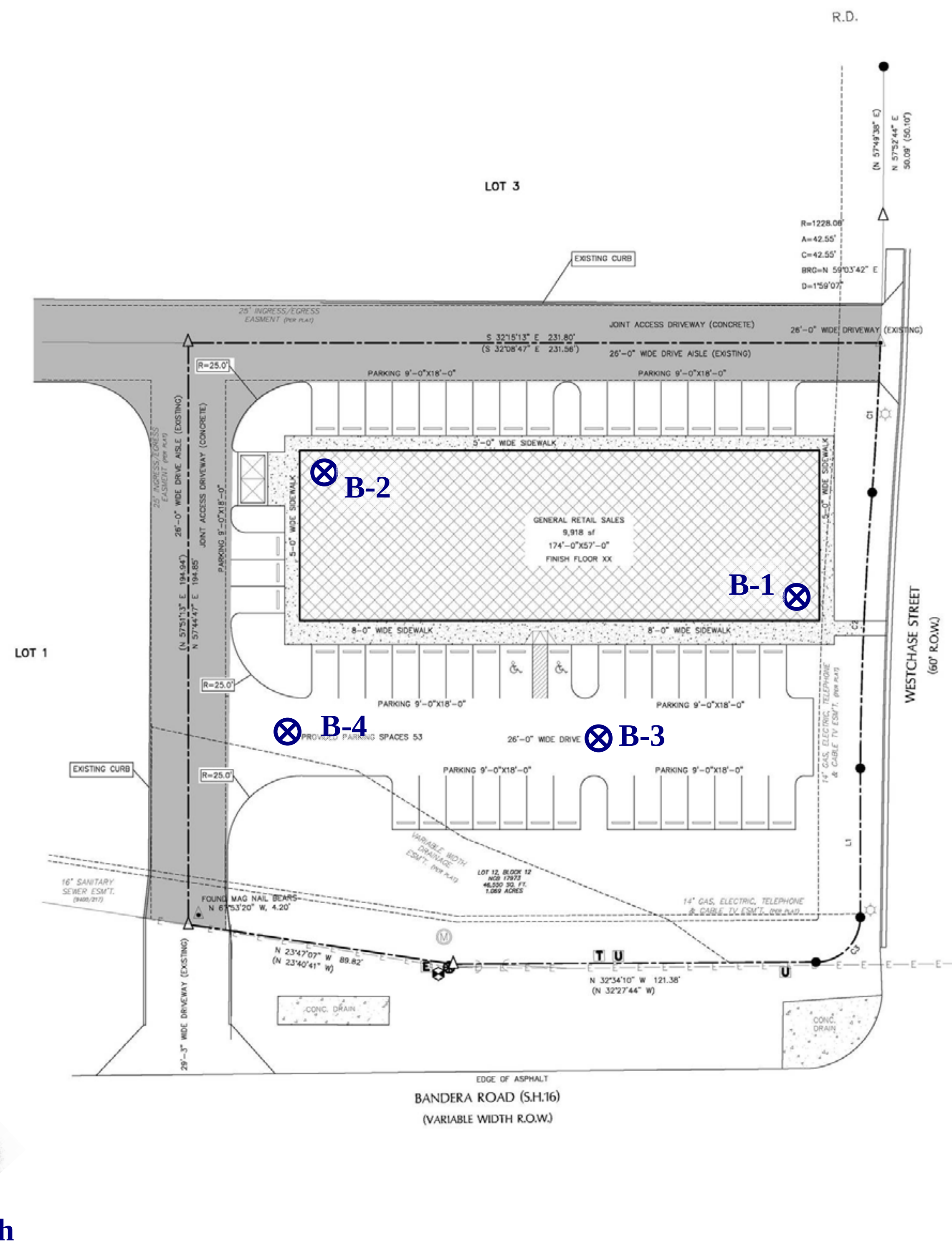

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FIGURE 2

BORING LOCATION PLAN

Burge-Martinez Consulting, Inc.
3453 North Pan Am Expressway, Suite 201
San Antonio, Texas 78219
Telephone: 210-646-8566
Fax: 210-590-7476

BORING NUMBER B-1

CLIENT Bandera Retail Center
PROJECT NAME Bandera Retail Center
PROJECT NUMBER 12-18-0058
PROJECT LOCATION 7800 Bandera Rd, San Antonio, Texas
DATE STARTED 3/15/18 **COMPLETED** 3/15/18
GROUND ELEVATION **HOLE SIZE** 6"
DRILLING CONTRACTOR Tero Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY J. Burge **CHECKED BY** R. Burge
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling operations.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		FILL - Brown clay with gravel	SS 1		25-38-19 (57)			12				
		- increase in gravel below 2 feet	SS 2		28-50/4"			9	43	17	26	
		Stratum II - Very dense, tan MARL										
5			SS 3		50/3"			8				
			SS 4		50/2"			6				
		- weathered seam from 8 to 10 feet	SS 5		50/4"			9	39	14	25	
10												
15			SS 6		50/1"			15				
20			SS 7		50/1"			10				
		Bottom of hole at 20.0 feet.										

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Fax: 210-590-7476

BORING NUMBER B-2

CLIENT Bandera Retail Center

PROJECT NAME Bandera Retail Center

PROJECT NUMBER 12-18-0058

PROJECT LOCATION 7800 Bandera Rd, San Antonio, Texas

DATE STARTED 3/15/18 **COMPLETED** 3/15/18

GROUND ELEVATION **HOLE SIZE** 6"

DRILLING CONTRACTOR Tero Drilling

GROUND WATER LEVELS:

DRILLING METHOD Dry Auger

AT TIME OF DRILLING ---

LOGGED BY J. Burge **CHECKED BY** R. Burge

AT END OF DRILLING ---

NOTES Groundwater not encountered during drilling operations.

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		FILL - Brown clay with gravel and organics from 0 to 2 feet	SS 1		25-24-21 (45)			8				
		- tan to pale brown clayey gravel to gravelly clay from 2 to 4 feet	SS 2		24-39-40 (79)			8	41	15	26	
5		- pale brown gravelly clay with interbedded chalk from 4 to 6 feet	SS 3		21-31-27 (58)			8				
		- brown and tan clay with interbedded chalk and some gravel from 6 to 8 feet	SS 4		22-25-24 (49)			12	55	19	36	
10		Stratum I - Hard, brown FAT CLAY (CH)	SS 5		17-36-41 (77)			11				
15			SS 6		15-18-30 (48)			18	62	17	45	
		Stratum II - Hard, tan LEAN CLAY (CL)										
20			SS 7		20-20-17 (37)			17				
		Bottom of hole at 20.0 feet.										

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San Antonio, Texas 78219
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Fax: 210-590-7476

BORING NUMBER B-3

CLIENT Bandera Retail Center
PROJECT NAME Bandera Retail Center
PROJECT NUMBER 12-18-0058
PROJECT LOCATION 7800 Bandera Rd, San Antonio, Texas
DATE STARTED 3/15/18 **COMPLETED** 3/15/18
GROUND ELEVATION **HOLE SIZE** 6"
DRILLING CONTRACTOR Tero Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY J. Burge **CHECKED BY** R. Burge
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling operations.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	FINES CONTENT (%)
0		FILL - Brown clay with trace gravel	SS 1		4-4-6 (10)			15	64	21	43	
			SS 2		4-6-8 (14)			14				
		Stratum I - Very stiff, brown FAT CLAY (CH)										
5			SS 3		5-7-12 (19)			15				
		Bottom of hole at 6.0 feet.										

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San Antonio, Texas 78219
Telephone: 210-646-8566
Fax: 210-590-7476

BORING NUMBER B-4

CLIENT Bandera Retail Center
PROJECT NAME Bandera Retail Center
PROJECT NUMBER 12-18-0058
PROJECT LOCATION 7800 Bandera Rd, San Antonio, Texas
DATE STARTED 3/15/18 **COMPLETED** 3/15/18
GROUND ELEVATION **HOLE SIZE** 6"
DRILLING CONTRACTOR Tero Drilling
GROUND WATER LEVELS:
DRILLING METHOD Dry Auger
AT TIME OF DRILLING ---
LOGGED BY J. Burge **CHECKED BY** R. Burge
AT END OF DRILLING ---
NOTES Groundwater not encountered during drilling operations.
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	FINES CONTENT (%)
0		FILL - Brown gravelly clay with interbedded chalk from 0 to 2 feet	SS 1		6-9-13 (22)			13				
		- mixture of dark brown and pale bown clay with limestone fragments from 2 to 6 feet	SS 2		23-50/4"			14	63	19	44	
5			SS 3		36-50/4"			8				
		Bottom of hole at 6.0 feet.										

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Laboratory and Field Test Procedures

Soil Classification per ASTM D2487
This soil testing standard was used for classifying soils according to the Unified Soil Classification System. The soil classifications of the earth materials encountered are as noted in the attached boring logs.

Soil Water Content per ASTM D2216
This test determines the water content of soil or rock expressed as a percentage of the solid mass of the soil. The test results are listed under Moisture Content in the attached boring logs.

Soil Liquid Limit per ASTM D4318
The soil Liquid Limit identifies the upper limit soil water content at which the soil changes from a moldable (plastic) physical state to a liquid state. The Liquid Limit water content is expressed as a percentage of the solid mass of the soil.

Soil Plastic Limit per ASTM D4318
The soil Plastic Limit identifies a lower limit soil water content at which the soil changes from a moldable (plastic) physical state to a non-moldable (semi-solid) physical state. The Plastic Limit water content is expressed as a percentage of the solid mass of the soil.

Plasticity Index per ASTM D4318
This is the numeric difference between the Liquid Limit and Plastic Limit. This index also defines the range of water content over which the soil-water system acts as a moldable (plastic) material. Higher Plasticity Index (PI) values indicate that the soil has a greater ability to change in soil volume or shrink and swell with lower or higher water contents, respectively.

Standard Penetration Test (SPT) and Split Spoon Sampler (SS) per ASTM D1586
This is the standard test method for both the penetration test and split-barrel (spoon) sampling of soils. This sampling method is used for soils or rock too hard for sampling using Shelby Tubes. The method involves penetration of a split spoon sampler into the soil or rock through successive blows of a 140 pound hammer in a prescribed manner.

Blow Counts (N) per ASTM D1586
This is the number of blows required to drive a Split Spoon Sampler by means of a 140 pound hammer for a distance of 12 inches in accordance with the variables stated in the test procedures.

Boring Logs: This is a summary of the above described information at each boring location.