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Procurement Department

ADDENDUM # 3

To: File 1611-909-23-4577
RFP for: New Affordable Home Construction Services

The following additional information is hereby incorporated into the RFP Attachments:

See the attached soils reports dated January 30, 2017.

By: Charles R Bode
Charles Bode Asst. Director of Procurement

Date: January 30, 2017

RABA KISTNER

GEOTECHNICAL ENGINEERING STUDY

FOR

BLUERIDGE SUBDIVISION
SAN ANTONIO HOUSING AUTHORITY
SAN ANTONIO, TEXAS

RABA KISTNER
CONSULTANTS

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Project No. ASA17-001-00
January 30, 2017

Ms. Lori Hall
San Antonio Housing Authority
818 South Flores Street
San Antonio, Texas 78204

RE: Geotechnical Engineering Study
Blueridge Subdivision
San Antonio, Texas

Dear Ms. Hall:

RABA KISTNER Consultants Inc. (RKCI) is pleased to submit the report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with RKCI Proposal No. PSA16-211-00 Revised, dated December 9, 2016. The purpose of this study was to drill borings within select pad sites, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting foundation design and construction recommendations for the proposed single family homes.

The following report contains our design recommendations and considerations based on our current understanding of the information provided to us at the time of study. There may be alternatives for value engineering of the foundation system, and RKCI recommends that a meeting be held with the Owner and design team to evaluate these alternatives.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

Samrawit Haile.

FOR Weston C. Tietze, E.I.T.
Graduate Engineer

ERIC J. NEUNER
116311
1/30/2017

Eric Neuner, P.E.
Associate | Manager, San Antonio Engineering

WCT/EJN/kv

Attachments

Copies Submitted: Above (1) Electronic

GEOTECHNICAL ENGINEERING STUDY

For

BLUERIDGE SUBDIVISION
SAN ANTONIO HOUSING AUTHORITY
SAN ANTONIO, TEXAS

Prepared for

SAN ANTONIO HOUSING AUTHORITY
San Antonio, Texas

Prepared by

RABA KISTNER CONSULTANTS, INC.
San Antonio, Texas

PROJECT NO. ASA17-001-00

January 30, 2017

RABAKISTNER

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ATTACHMENTS

The following figures are attached and complete this report:

Attachment

INTRODUCTION

RABA KISTNER Consultants Inc. (RKCI) has completed the authorized subsurface exploration for the Blueridge Subdivision located south of Cima Street in San Antonio, Texas. This report briefly describes the procedures utilized during this study and presents our findings along with our recommendations for foundation design and construction considerations.

PROJECT DESCRIPTION

The structures to be considered in this study are 40 new, single-family homes to be located in the Blueridge Subdivision in San Antonio, Texas. Site grading plans and proposed structural loads were not available at the time of our exploration. However, relatively light loads are anticipated to be carried by the foundation systems. The recommendations presented in this report were prepared with the assumption that final grades for the residential structure will be within plus or minus 1 ft of existing grades.

PREVIOUS STUDIES

RKCI performed a previous geotechnical engineering study at this site in 1971 and 1992 (RKCI Project No. ASA70-148-00, dated March 11, 1971 and ASA92-168-00, dated March 25, 1993), the results of which are on file in our office. Our previous data was used as supplementary information in the preparation of this report.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of south/central Texas and for the use of San Antonio Housing Authority (CLIENT) and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods. The attachments and report text should not be used separately.

The recommendations submitted in this report are based on the data obtained from 9 borings drilled at this site, our understanding of the project information provided to us, our previous studies at the site, and the assumption that site grading will result in only minor changes in the existing topography. If the project information described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. The construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, it may be necessary to reevaluate our recommendations after performing on-site observations and tests to establish the engineering impact of the variations.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

If additional mass site grading is performed at the site which results in elevations that vary significantly from existing grades (more than plus or minus 1 ft), our office should be informed about these changes. If needed and/or if desired, we will reexamine our analyses and make supplemental recommendations. A review of the report is not required if the only additional fill materials placed at the site are select fill materials placed in building pad areas.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by 9 borings drilled at the locations shown on the Boring Location Map, Attachment 1 - Figure 1 and previously drilled borings. The current locations are approximate and distances were measured using a hand-held, recreational-grade GPS locator. The borings were drilled to depths ranging from approximately 15 to 25 ft below the existing ground surface using a truck-mounted drilling rig. During drilling operations, Split-Spoon samples (with Standard Penetration Test) and relatively undisturbed Shelby tube samples were collected. Each sample was visually classified in the laboratory by a member of our geotechnical engineering staff. The geotechnical engineering properties of the strata were evaluated by moisture content tests, Atterberg Limits (plasticity tests) and hydrometer analyses.

The results of the laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures 2 through 10. A key to classification terms and symbols used on the logs is presented on Figure 11. The results of the laboratory and field testing are also tabulated on Figure 12 for ease of reference. The result of the grain size analysis is presented on the Grain Size Distribution, Figure 13.

Standard Penetration Test results are noted as “blows per ft” on the boring logs and Figure 12, where “blows per ft” refers to the number of blows by a falling hammer required for 1 ft of penetration into the soil/weak rock (N-value). Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal “ref” for 6 in. or less will be noted on the boring logs and on Figure 11. The previously drilled boring logs are illustrated in Attachment 2.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

GENERAL SITE CONDITIONS

SITE DESCRIPTION

The project site is a recently demolished area of the single family homes in the Blueridge Subdivision located south of Cima Street in San Antonio, Texas. Since the site is previously developed, it is likely that abandoned foundations, structures, and utilities are present. The presence of buried structures (old foundations, pavements, brick, debris, trash, abandoned utilities, etc.) should be anticipated during construction.

GEOLOGY

A review of the *Geologic Atlas of Texas, San Antonio Sheet*, indicates that this site is naturally underlain with the soils of the Navarro Group and Marlbrook Marls. This formation typically consists of clays and marly clays and can contain hard layers of marl, sandstone, and siltstone. The clays of this formation are typically highly expansive, montmorillonitic clays. **A key geotechnical engineering concern for development supported on this formation is expansive, soil-related movements.**

SEISMIC CONSIDERATIONS

Based upon a review of Section 1613 *Earthquake Loads – Site Ground Motion* of the 2012/2015 International Building Code, the following information has been summarized for seismic considerations associated with this site.

- Site Class Definition (Chapter 20 of ASCE 7): **Class C**. Based on the soil borings conducted for this investigation, the upper 100 feet of soil may be characterized as very dense soil and soft rock.
- Risk-Targeted Maximum Considered Earthquake Ground Motion Response Accelerations for the Conterminous United States of 0.2-Second Spectral Response Acceleration (5% Of Critical Damping) (Figure 1613.3.1(1)): **S_s = 0.079g**. Note that the value taken from Figure 1613.3.1(1) is based on Site Class B and is adjusted per 1613.3.3.
- Risk-Targeted Maximum Considered Earthquake Ground Motion Response Accelerations for the Conterminous United States of 1-Second Spectral Response Acceleration (5% Of Critical Damping) (Figure 1613.3.1(2)): **S_1 = 0.029g**. Note that the value taken from Figure 1613.3.1(2) is based on Site Class B and is adjusted per 1613.3.3.
- Values of Site Coefficient (Table 1613.3.3(1)): **F_a = 1.2**
- Values of Site Coefficient (Table 1613.3.3(2)): **F_v = 1.7**
- Where g is the acceleration due to gravity.

The Maximum Considered Earthquake Spectral Response Accelerations are as follows:

- 0.2 sec, adjusted based on equation 16-37: **S_{ms} = 0.094g**
- 1 sec, adjusted based on equation 16-38: **S_{m1} = 0.049g**

The Design Spectral Response Acceleration Parameters are as follows:

- 0.2 sec, based on equation 16-39: **S_{DS} = 0.063g**
- 1 sec, based on equation 16-40: **S_{D1} = 0.033g**

Based on the parameters listed above, Tables 1613.3.5(1) and 1613.3.5(2), and calculations performed using the United States Geological Survey (USGS) website, the Seismic Design Category for both short period and 1 second response accelerations is **A**. As part of the assumptions required to complete the calculations, a Risk Category of “I or II or III” was selected.

STRATIGRAPHY

Fill was encountered in the borings and varied in depth from approximately 1/2 to 4-1/2 ft below the existing ground surface. In general, the fill contained concrete rubble in a clay matrix. The natural subsurface stratigraphy below the fill can be described as dark brown clay that is underlain by tan clay with calcareous deposits. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The boring logs should be consulted for more specific stratigraphic information. Unless noted on the boring logs, the lines designating the changes between various strata represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. The stratification given on the boring logs, or described herein, is for use by RKCI in its analyses and should not be used as the basis of design or construction cost estimates without realizing that there can be variation from that shown or described.

The boring logs and related information depict subsurface conditions only at the specific locations and times where sampling was conducted. The passage of time may result in changes in conditions, interpreted to exist, at or between the locations where sampling was conducted.

GROUNDWATER

Groundwater was not observed in the borings either during or immediately upon completion of the drilling operations. All borings remained dry during the field exploration phase. However, it is possible for groundwater to exist beneath this site at shallow depths on a transient basis, particularly following periods of precipitation. Fluctuations in groundwater levels occur due to variation in rainfall and surface water run-off. The construction process itself may also cause variations in the groundwater level.

Based on our experience in this region, shallow groundwater seepage may be encountered at this project site. We believe that groundwater seepage encountered during site earthwork activities and foundation construction may be controlled using temporary earthen berm and conventional sump-and-pump dewatering methods. For deep foundation excavations, this could include the use of temporary casing to reduce groundwater seepage.

FOUNDATION RECOMMENDATIONS AND CONSIDERATIONS

Site features that will influence the geotechnical approach to the proposed project include:

- Presence of localized existing fills, and
- Presence of highly expansive soil and potential for soil-related movements

SITE GRADING

Site grading plans can result in changes in almost all aspects of foundation recommendations. We have prepared all foundation recommendations based on the existing ground surface and the stratigraphic conditions encountered at the time of our study. If additional mass site grading is performed at the site which results in elevations that vary significantly from the grades existing at the time of our study (more than plus or minus 1 ft), our office should be informed about these changes. If needed and/or if desired, we will reexamine our analyses and make supplemental recommendations. A review of the report is not required if the only additional fill materials placed at the site are select fill materials placed within the interior of grade beams for slab support.

EXISTING FILL

As previously discussed, existing fill was encountered in all our borings to depths ranging from approximately 1/2 ft to 4-1/2 ft below the existing ground surface at the time of our exploration. On the basis of the boring results, laboratory tests, and in the absence of fill placement/compaction records, the existing fill should be considered uncontrolled and potentially compressible. It is not possible to assign reliable soil parameters to the existing fill to calculate settlement. The more positive approach to site development for grade supported structures is to completely remove the existing fill and replace with compacted engineered fill to reduce the settlement risk. As discussed in the following section, the fill remediation may be incorporated with reducing the effects of soil-related movements associated with the presence of the highly expansive fills and soils. Alternatively, the structure may be supported on shallow foundations that extend through the existing fill. **The existing fill may be reused as general fill provided that the material does not contain deleterious materials.** Limited or partial fill improvement could be considered in the pavement areas provided the client understands that partial fill improvement will require acceptance of a greater risk (in exchange for cost savings) for pavement distress and settlement compared to full-depth improvement.

EXPANSIVE SOIL-RELATED MOVEMENTS

The anticipated ground movements due to swelling of the underlying soils at the site were estimated for slab-on-grade construction using the empirical procedure, Texas Department of Transportation (TxDOT) Tex-124-E, Method for Determining the Potential Vertical Rise (PVR). PVR values ranging from 3-1/2 to 5-1/2 in. were estimated for the stratigraphic conditions encountered in our borings. A surcharge load of 1 psi (concrete slab and sand layer), an active zone of 15 ft, and dry moisture conditions were assumed in estimating the above PVR values.

The TxDOT method of estimating expansive soil-related movements is based on empirical correlations utilizing the measured plasticity indices and assuming typical seasonal fluctuations in moisture content. If desired, other methods of estimating expansive soil-related movements are available, such as estimations based on swell tests and/or soil-suction analyses. However, the performance of these tests and the detailed analysis of expansive soil-related movements were beyond the scope of the current study. It should also be noted that actual movements can exceed the calculated PVR values due to isolated changes in moisture content (such as due to leaks, landscape watering....) or if water seeps into the soils to greater depths than the assumed active zone depth due to deep trenching or excavations.

Overexcavation and Select Fill Replacement

To reduce expansive soil-related movements in at-grade construction, a portion of the upper highly expansive subgrade clays in the building areas can be removed by overexcavating and backfilling with a suitable select fill material. PVR values have been estimated for overexcavation and select fill replacement to various depths below the existing ground surface and are summarized in the table below. Recommendations for the selection and placement of select backfill materials are addressed in a subsequent section of this report.

Depth of Overexcavation and Select Fill Replacement (ft)*	Estimated PVR (in.)
0	5-1/2
2	4-1/2
4	3-1/2
6	2-3/4
8	2
10	1-1/4
11	1

*below the ground surface elevation existing at the time of our study.

With this approach, we recommend that the overexcavation extend a minimum of 3 ft beyond the proposed building areas. To maintain the estimated PVR values, subsequent fill placed in the building areas should consist of select fill material in accordance with the *Select Fill* section of this report.

The overexcavated onsite soils may be reused on site as general fill but must be placed beyond the building pad, provided that the potential vertical movements in excess of those discussed previously will not adversely impact either the structural or operational tolerances for the proposed improvements for which this material is being considered.

Another option is to reuse the overexcavated soils as fill material provided they are treated with approximately 5 percent lime or 6 percent cement by weight. If the lime/cement treatment of on-site clay option is chosen, this percentage should be verified at the earliest stages of construction by conducting lime/cement series curves to determine the percentage of product required to adequately treat the on-site clays. If lime treatment is utilized, we recommend additional testing to evaluate the sulfate content and whether traditional lime stabilization can be used according to the Texas Department of Transportation – Guidelines for treatment of sulfate-rich soils and bases in pavement Structures, 09/2005. When the soil soluble sulfate content of the on-site clays exceeds 3,000 ppm, the use of lime to treat the soils is much more difficult to treat and this option should be reconsidered.

Drainage Considerations

When overexcavation and select fill replacement is selected as a method to reduce the potential for expansive soil-related movements at any site, considerations of surface and subsurface drainage may be crucial to construction and adequate foundation performance of the soil-supported structures. Filling an excavation in relatively impervious plastic clays with relatively pervious select fill material creates a "bathtub" beneath the structure, which can result in ponding or trapped water within the fill unless good surface and subsurface drainage is provided.

Water entering the fill surface during construction or entering the fill exposed beyond the building lines after construction may create problems with fill moisture control during compaction and increased access for moisture to the underlying expansive clays both during and after construction.

Several surface and subsurface drainage design features and construction precautions can be used to limit problems associated with fill moisture. These features and precautions may include but are not limited to the following:

- Installing berms or swales on the uphill side of the construction area to divert surface runoff away from the excavation/fill area during construction;
- Sloping of the top of the subgrade with a minimum downward slope of 1.5 percent out to the base of a dewatering trench located beyond the building perimeter;
- Sloping the surface of the fill during construction to promote runoff of rain water to drainage features until the final lift is placed;
- Sloping of a final, well maintained, impervious clay or pavement surface (downward away from the building) over the select fill material and any perimeter drain extending beyond the building lines, with a minimum gradient of 6 in. in 5 ft;
- Constructing final surface drainage patterns to prevent ponding and limit surface water infiltration at and around the building perimeter;
- Locating the water-bearing utilities, roof drainage outlets and irrigation spray heads outside of the select fill and perimeter drain boundaries; and
- Raising the elevation of the ground level floor slab.

Details relative to the extent and implementation of these considerations must be evaluated on a project-specific basis by all members of the project design team. Many variables that influence fill drainage considerations may depend on factors that are not fully developed in the early stages of design. For this reason, drainage of the fill should be given consideration at the earliest possible stages of the project.

SHALLOW FOUNDATION

On the basis of our borings, the existing fill should be considered potentially compressible. It is not possible to assign reliable soil parameters to the existing fill to calculate settlement. The more positive approach to site development is complete removal and replacement of the fill with controlled, compacted engineered fill. Based on the amount of overexcavation and replacement to reduce soil related movements, it appears that the fill will be removed with this approach. Alternatively, consideration may be given to leaving the fill in place and extending the building foundations through the fill to bear on the underlying natural soil. Where the fill is deeper than the planned foundation subgrade, the foundation excavation may extend through the fill into the natural soils and the excavation may be backfilled with flowable fill or lean concrete to the proposed foundation subgrade. Where fill depth is variable across the footprint of the structure, we recommend that the foundation overexcavations be extended to a uniform elevation. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

The proposed residential buildings may be founded on shallow foundations or rigid-engineered beam and slab foundations, provided the selected foundation type can be designed to withstand the geotechnical considerations previously discussed (see *Expansive Soil-Related Movements*) without impairing either the structural or the operational performance of the structure.

Allowable Bearing Capacity

Shallow foundations founded on natural soil or compacted, select fill should be proportioned using the design parameters tabulated below.

Allowable Bearing Capacity Parameters	
Minimum depth below final grade	18 in.
Minimum beam or strip footing width	12 in.
Minimum widened beam / spread footing width	18 in.
Maximum allowable bearing pressure for grade beams or strip footings	1,000 psf*
Maximum allowable bearing pressure for widened beams or spread footings	1,500 psf*

* Provided the foundations bear on compacted fill or on natural soil.

The above presented maximum allowable bearing pressures will provide a factor of safety of about 3, provided that fill is placed as discussed herein and the subgrade is prepared in accordance with the recommendations outlined in the *Site Preparation* section of this report.

Uplift Resistance

Resistance to vertical force (uplift) is provided by the weight of the concrete footing plus the weight of the soil directly above the footing. For this site, it is recommended that the ultimate uplift resistance be based on total unit weights for soil and concrete of 120 pcf and 150 pcf, respectively. The calculated ultimate uplift resistance should be reduced by a factor of safety of 1.2 to calculate the allowable uplift resistance.

Lateral Resistance

Horizontal loads acting on spread footings will be resisted by passive earth pressure acting on one side of the footing and by base adhesion for footings bearing on engineered fills or natural materials. Resistance to sliding for foundations bearing on natural/compacted soil or select fill should be calculated utilizing an ultimate coefficient of friction of 0.30. The ultimate resistance for these foundations should be limited to 750 psf. An ultimate equivalent fluid pressure of 250 pcf should be utilized to determine the ultimate passive resistance, if required.

SHALLOW FOUNDATION CONSIDERATIONS

The structural engineer may consider the use of alternate design methods for foundation design. Recommendations for B.R.A.B., WRI, and PTI are provided in the following. If some removal and replacement is desired, RKCI should be contacted for supplemental recommendations. **For soils as highly expansive as those encountered at this site it has been our experience that the deflections predicted by the PTI method can be underestimated and therefore we recommend that the deflections be calculated by more than one method if the PTI is selected as a basis for the slab design for the proposed structure**s.

W.R.I. and B.R.A.B. Criteria

Beam and slab foundations may be designed using either the criteria developed by the Building Research Advisory Board (B.R.A.B.) or Wire Reinforcement Institute (W.R.I.). The design plasticity index, Climatic Rating (C_w), soil support index (C), and minimum unconfined compressive strength (q_u) presented in the following tables may be considered for the proposed buildings. These design parameters apply for conditions encountered in our borings and for the grades existing at the time of our field exploration.

W.R.I. and B.R.A.B. Criteria for Existing Site Conditions	
Parameters	**Proposed Selected Lots**
Unconfined Compressive Strength (q_u)	600 psf
Climatic Rating (Cw)	16

It should be noted that if the highest plasticity index (PI) value encountered in the subsurface profile occurs in the uppermost subsurface layer, both B.R.A.B. and W.R.I. criterion requires that this PI value be selected as the design PI. The design criteria will change if a select fill building pad is constructed for the proposed structures. Different design criteria have been estimated for various amounts of overexcavation and select replacement and are presented in the following table.

Depth of Overexcavation and Select Fill Replacement (ft)	W.R.I. and B.R.A.B. Design Plasticity Index	Soil Support Index (C)
0	52	0.60
2	46	0.65
4	37	0.76
6	29	0.85
8	23	0.92
10	16	0.94

PTI Design Parameters

Post Tensioning Institute (PTI) design parameters were estimated for existing stratigraphic conditions using the procedures and criteria discussed in the Post-Tensioning Institute Manual entitled *"Design of Post-Tensioned Slabs-on-Ground, Third Edition"* dated 2004 with the 2008 supplement.

Differential vertical swell has been estimated for center lift and edge lift conditions for use in designing foundation slabs for the stratigraphy encountered in our borings. These values were determined using a computer program entitled VOLFLO Win 1.5, as recommended by the Post Tensioning Institute. As recommended by PTI, we have evaluated differential swell for both 1) conditions varying from equilibrium and 2) conditions varying between extremes (wet/dry). The values for both of these conditions are presented in the table below. Because soil moisture conditions are likely to vary from wet to dry and vice versa over many cycles during the lifetime of the structure, we recommend that the latter conditions be assumed in design.

	Differential Swell (in.)			
Design Condition	**From Equilibrium to Wet**	**From Equilibrium to Dry**	**From Dry to Wet**	**From Wet to Dry**
A	1 (EL)	1 (CL)	3-1/2 (EL)	2-1/4 (CL)
B	1/4 (EL)	3/4 (CL)	1 (EL)	1-1/2 (CL)

(EL) Edge Lift Condition (CL) Center Lift Condition

Additional design parameters are summarized in the following table:

PTI Design Parameters	
Percent Clay of Fill	49(1)
Depth to Constant Suction, ft	15
Thornthwaite Index, IM	-13
Constant Soil Suction	3.6 pF
Edge Moisture Variation Distance (center lift)	9.0 ft
Edge Moisture Variation Distance (edge lift)	4.3 ft

(1)Based on results of our hydrometer testing and our experience with the soils in the region.

AREA FLATWORK

It should be noted that ground-supported flatwork such as walkways, driveways, etc. will be subject to the same magnitude of potential soil-related movements as discussed previously (see *Expansive Soil-Related Movement* section). In addition, if uncontrolled fill underlie these features, settlement related distress may occur. Complete removal and replacement of the existing fill would provide the lowest risk for unacceptable settlement of the flatwork. In lieu of full-depth fill remediation, limited fill remediation could be considered provided the client understands that partial fill remediation will require acceptance of a greater risk for flatwork distress compared to full-depth remediation. The risk potential cannot be quantified. Partial fill remediation in flatwork areas could be removed and replaced to depths up to 2 ft below subgrade. Greater depths of removal and replacement may be required based on observation during proofrolling. The existing fill may be re-used for engineered fill provided the material is placed as discussed herein.

Where these types of elements abut rigid building foundations or isolated structures, differential movements should be anticipated. As a minimum, we recommend that flexible joints be provided where such elements abut the main structure to allow for differential movement at these locations. Where the potential for differential movement is objectionable, it may be beneficial to consider methods of reducing anticipated movements to match the adjacent building performance (i.e. constructing a hinged structural slab.

FOUNDATION CONSTRUCTION CONSIDERATIONS

SITE DRAINAGE

Drainage is an important key to the successful performance of any foundation. Good surface drainage should be established prior to and maintained after construction to help prevent water from ponding within or adjacent to the building foundation and to facilitate rapid drainage away from the building foundation. Failure to provide positive drainage away from the structure can result in localized differential vertical movements in soil supported foundations and floor slabs (which can in turn result in cracking in the sheetrock partition walls, shifting of ceiling tiles, as well as improper operation of windows and doors).

Also to help control drainage in the vicinity of the structure, we recommend that roof/gutter downspouts and landscaping irrigation systems not be located adjacent to the building foundation. Where a select fill overbuild is provided outside of the floor slab/foundation footprint, if any, the surface should be sealed with an impermeable layer (pavement or clay cap) to reduce infiltration of both irrigation and surface waters. Careful consideration should also be given to the location of water bearing utilities, as well as to provisions for drainage in the event of leaks in water bearing utilities. All leaks should be immediately repaired.

Other drainage and subsurface drainage issues are discussed in the *Expansive Soil-Related Movements* section of this report.

SITE PREPARATION

Each residential lot should be properly prepared for slab-on-grade foundation construction. The building area for each residence should be stripped of all vegetation, loose topsoil, utilities, structures, and associated backfill. The existing fill should be remediated as discussed herein. Tree roots greater than 1 inch in diameter should be grubbed and removed. Any voids resulting from removal of limestone boulders or tree roots should be backfilled with a suitable, compacted fill material, free of organics, degradable material, and particles exceeding 4 inches in size. In a highly expansive clay environment, on-site clays should be utilized.

Exposed subgrades should be thoroughly proofrolled in order to locate weak, compressible zones. A fully-loaded dump truck or a similar heavily-loaded piece of construction equipment should be used for planning purposes. Proofrolling operations should be observed by the Geotechnical Engineer or their representative to document subgrade condition and preparation. Weak or soft areas identified during proofrolling should be removed and replaced with suitable, compacted on-site clays, free of organics, oversized materials, and degradable or deleterious materials.

Upon completion of the proofrolling operations and just prior to fill placement or slab construction, the exposed subgrade should be moisture conditioned by scarifying to a minimum depth of 6 in. and recompacting to a minimum of 95 percent of the maximum density determined from TxDOT, Tex-114-E, Compaction Test. The moisture content of the subgrade should be maintained within the range of optimum moisture content to 3 percentage points above optimum moisture content until permanently covered.

SELECT FILL

Options for select fill materials that may be utilized at this site are provided below.

Imported Crushed Limestone Base – Imported crushed limestone base materials should be crushed stone or gravel aggregate. We recommend that materials specified for use as select fill meet the TxDOT 2014 Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, Item 247, Flexible Base, Type A or B, Grades 1-2 or 3.

Treated Onsite Materials – Lime/cement/super slurry treatment of the onsite soils may be considered in reducing the soil plasticity index (TxDOT Item 260 for Lime and Item 275 for cement). A sufficient quantity of product should be mixed with the subgrade soils to reduce the soil-product mixture plasticity index to approximately 15 or less. We estimate that approximately 5 percent lime and 6 percent cement by dry unit weight be assumed for treatment. If cement treatment is selected, the mellowing period may be reduced to 24 hours prior to placing subsequent lifts. The final lift shall be cured for a minimum of 48 hours prior to placement of building foundation.

Alternatively super slurry treatment can be used to reduce the PI and increase the soil stiffness. However, this is a proprietary product and the supplier should be contacted to evaluate the appropriate dosage rate. For this process, the contractor should allow a minimum of 12 hours, preferably 24 hours, before placing subsequent lifts.

We recommend that during site grading operations that additional laboratory testing be performed to determine the appropriate treatment dosage rate and concentration of soluble sulfates in the subgrade and imported soils.

Granular Pit Run Materials – Granular pit run materials should consist of GC, SC & combination soils (clayey gravels), as classified according to the Unified Soil Classification System (USCS). Alternative select fill materials shall have a maximum liquid limit not exceeding 40, a plasticity index between 7 and 15, and a maximum particle size not exceeding 4 inch. In addition, if these materials are utilized, grain size analyses and Atterberg Limits must be performed during placement at a rate of one test each per 5,000 cubic yards of material due to the high degree of variability associated with pit-run materials.

Low PI Materials – Low PI materials should consist of CL clays, as classified according to the Unified Soil Classification System (USCS). Alternative select fill materials shall have a maximum liquid limit not exceeding 40, a plasticity index between 7 and 15, and a maximum particle size not exceeding 4 inch. In addition, if these materials are utilized, grain size analyses and Atterberg Limits must be performed during placement at a rate of one test each per 5,000 cubic yards of material due to the high degree of variability associated with these materials.

Select fill should be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 95 percent of maximum density as determined by TxDOT, Tex-113-E, Compaction Test. The moisture content of the fill should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction for imported crushed limestone base or granular pit run materials. For low PI materials, the moisture content of the fill should be maintained within the range of optimum to plus 3 percentage points above the optimum moisture content until permanently covered.

Potentially expansive clays (PI greater than 15) should **not** be used as select fill unless the clay is treated as discussed previously. Alternatively, untreated material may be used in areas where potential vertical movements will not adversely impact either the structural or operational tolerances for the individual foundations, slabs or walls for which this material is being considered.

Conventional “bagging” techniques may also be used to construct the underslab fill material with the structural fill being placed in 8 in. maximum loose lifts. The material should be wetted as necessary and each lift of the material compacted to at least 90 percent of the maximum dry density as determined by the TxDOT, Tex-113-E, Compaction Test. We recommend that density tests be performed to verify that adequate compaction has been achieved.

SHALLOW FOUNDATION EXCAVATIONS

Shallow foundation excavations should be observed by the Geotechnical Engineer or their representative prior to placement of reinforcing steel and concrete. This is necessary to observe that the bearing soils at the bottom of the excavations are similar to those encountered in our borings and that excessive loose materials and water are not present in the excavations. If soft soils are encountered in the foundation excavations, they should be removed and replaced with a compacted non-expansive fill material or lean concrete up to the design foundation bearing elevations.

EXCAVATION SLOPING AND BENCHING

If utility trenches or other excavations extend to or below a depth of 5 ft below construction grade, the contractor or others shall be required to develop a trench safety plan to protect personnel entering the trench or trench vicinity. The collection of specific geotechnical data and the development of such a plan, which could include designs for sloping and benching or various types of temporary shoring, are beyond the scope of the current study. Any such designs and safety plans shall be developed in accordance with current OSHA guidelines and other applicable industry standards.

EXCAVATION EQUIPMENT

Our boring logs are not intended for use in determining construction means and methods and may therefore be misleading if used for that purpose. We recommend that earth-work and utility contractors interested in bidding on the work perform their own tests in the form of test pits to determine the quantities of the different materials to be excavated, as well as the preferred excavation methods and equipment for this site.

UTILITIES

Utilities which project through slab-on-grade, slab-on-fill, “floating” floor slabs, or any other rigid unit should be designed with either some degree of flexibility or with sleeves. Such design features will help reduce the risk of damage to the utility lines as vertical movements occur.

Our experience indicates that significant settlement of backfill can occur in utility trenches, particularly when trenches are deep, when backfill materials are placed in thick lifts with insufficient compaction, and when water can access and infiltrate the trench backfill materials. The potential for water to access the backfill is increased where water can infiltrate flexible base materials due to insufficient penetration of curbs, and at sites where geological features can influence water migration into utility trenches (such as fractures within a rock mass or at contacts between rock and clay formations). It is our belief that another factor which can significantly impact settlement is the migration of fines within the backfill into the open voids in the underlying free-draining bedding material.

To reduce the potential for settlement in utility trenches, we recommend that consideration be given to the following:

- All backfill materials should be placed and compacted in controlled lifts appropriate for the type of backfill and the type of compaction equipment being utilized and all backfilling procedures should be tested and documented.
- Curbs should completely penetrate base materials and be installed to a sufficient depth to reduce water infiltration beneath the curbs into the pavement base materials.
- Consideration should be given to wrapping free-draining bedding gravels with a geotextile fabric (similar to Mirafi 140N) to reduce the infiltration and loss of fines from backfill material into the interstitial voids in bedding materials.

CONSTRUCTION RELATED SERVICES

CONSTRUCTION MATERIALS TESTING AND OBSERVATION SERVICES

As presented in the attachment to this report, *Important Information About Your Geotechnical Engineering Report*, subsurface conditions can vary across a project site. The conditions described in this report are based on interpolations derived from a limited number of data points. Variations will be encountered during construction, and only the geotechnical design engineer will be able to determine if these conditions are different than those assumed for design.

Construction problems resulting from variations or anomalies in subsurface conditions are among the most prevalent on construction projects and often lead to delays, changes, cost overruns, and disputes. These variations and anomalies can best be addressed if the geotechnical engineer of record, RKCI is retained to perform construction observation and testing services during the construction of the project. This is because:

- RKCI has an intimate understanding of the geotechnical engineering report’s findings and recommendations. RKCI understands how the report should be interpreted and can provide such interpretations on site, on the client’s behalf.

- RKCI knows what subsurface conditions are anticipated at the site.
- RKCI is familiar with the goals of the owner and project design professionals, having worked with them in the development of the geotechnical workscope. This enables RKCI to suggest remedial measures (when needed) which help meet the owner's and the design teams' requirements.
- RKCI has a vested interest in client satisfaction, and thus assigns qualified personnel whose principal concern is client satisfaction. This concern is exhibited by the manner in which contractors' work is tested, evaluated and reported, and in selection of alternative approaches when such may become necessary.
- RKCI cannot be held accountable for problems which result due to misinterpretation of our findings or recommendations when we are not on hand to provide the interpretation which is required.

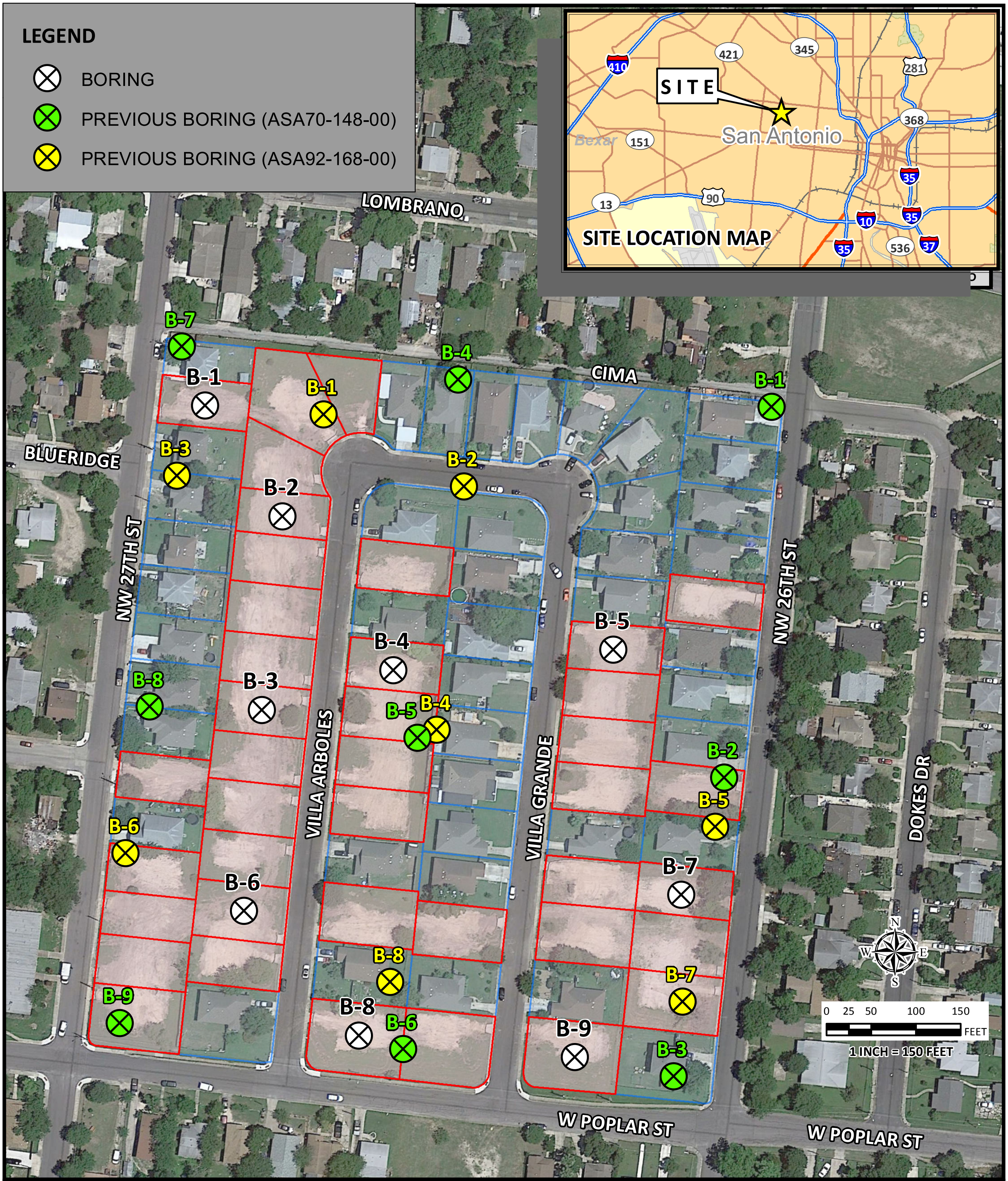
BUDGETING FOR CONSTRUCTION TESTING

Appropriate budgets need to be developed for the required construction testing and observation activities. At the appropriate time before construction, we advise that RKCI and the project designers meet and jointly develop the testing budgets, as well as review the testing specifications as it pertains to this project.

Once the construction testing budget and scope of work are finalized, we encourage a preconstruction meeting with the selected contractor to review the scope of work to make sure it is consistent with the construction means and methods proposed by the contractor. RKCI looks forward to the opportunity to provide continued support on this project, and would welcome the opportunity to meet with the Project Team to develop both a scope and budget for these services.

* * * * * * * * * * * * * * * * * *

ATTACHMENTS



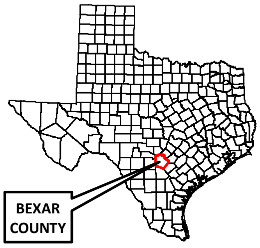
RABA KISTNER ENVIRONMENTAL

Raba Kistner Environmental, Inc.
12821 West Golden Lane
San Antonio, Texas 78249
P 210 :: 699 :: 9090
F 210 :: 699 :: 6426
www.rkci.com
TBPE Firm F-3257 / TBPG Firm #50220

SOURCE: Google Earth Imagery, 1995 Aerial Photograph

BORING LOCATION MAP

PROPOSED BLUERIDGE SUBDIVISION
SAN ANTONIO, BEXAR COUNTY, TEXAS



PROPOSAL No.:
ASA17-001-00

ISSUE DATE:	01/23/2017
DRAWN BY:	KRB/CCL
CHECKED BY:	SH
REVIEWED BY:	EJN

FIGURE
1

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LOG OF BORING NO. B-1

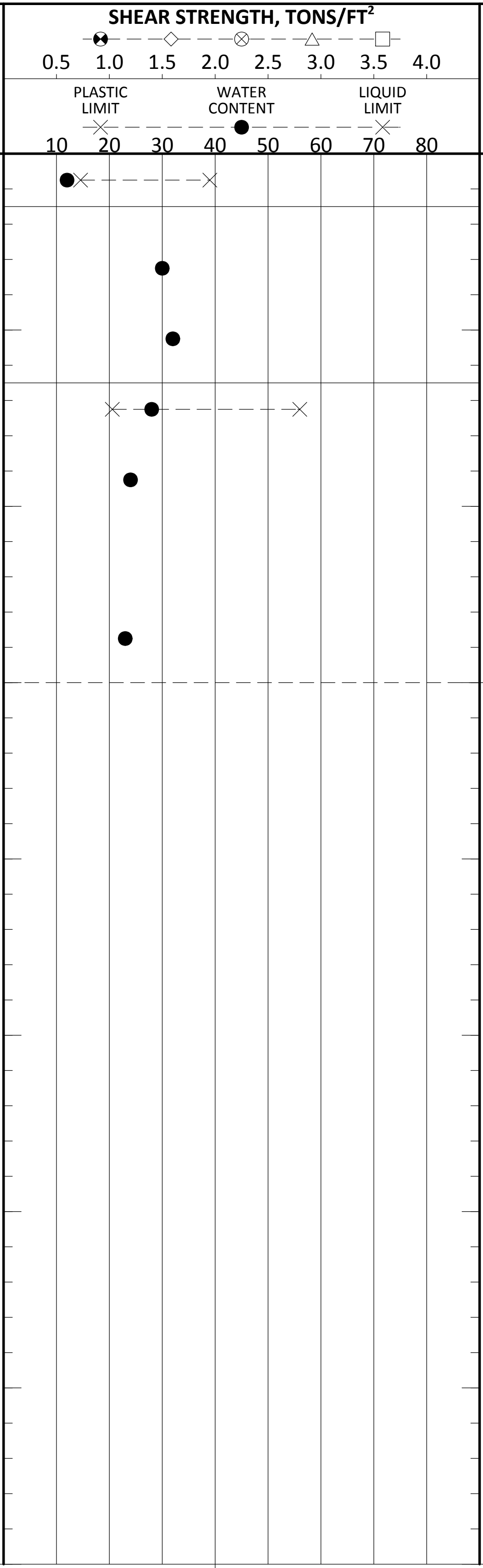
Blueridge Subdivision
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44456; W 98.54536

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
			FILL: CLAY, Silty, Stiff, Dark Brown, with gravel and concrete rubble	10		24	30
			CLAY, Firm, Dark Brown				
				5			
5				6			
			CLAY, Stiff, Tan, with gray mottling	11		35	
			- with gypsum crystals from 7-1/2 to 13 ft	14			
10							
15			Boring Terminated				
20							
25							
30							
35							



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 15.0 ft
DATE DRILLED: 1/10/2017

DEPTH TO WATER: DRY
DATE MEASURED: 1/10/2017

PROJ. No.: ASA17-001-00
FIGURE: 2

LOG OF BORING NO. B-2

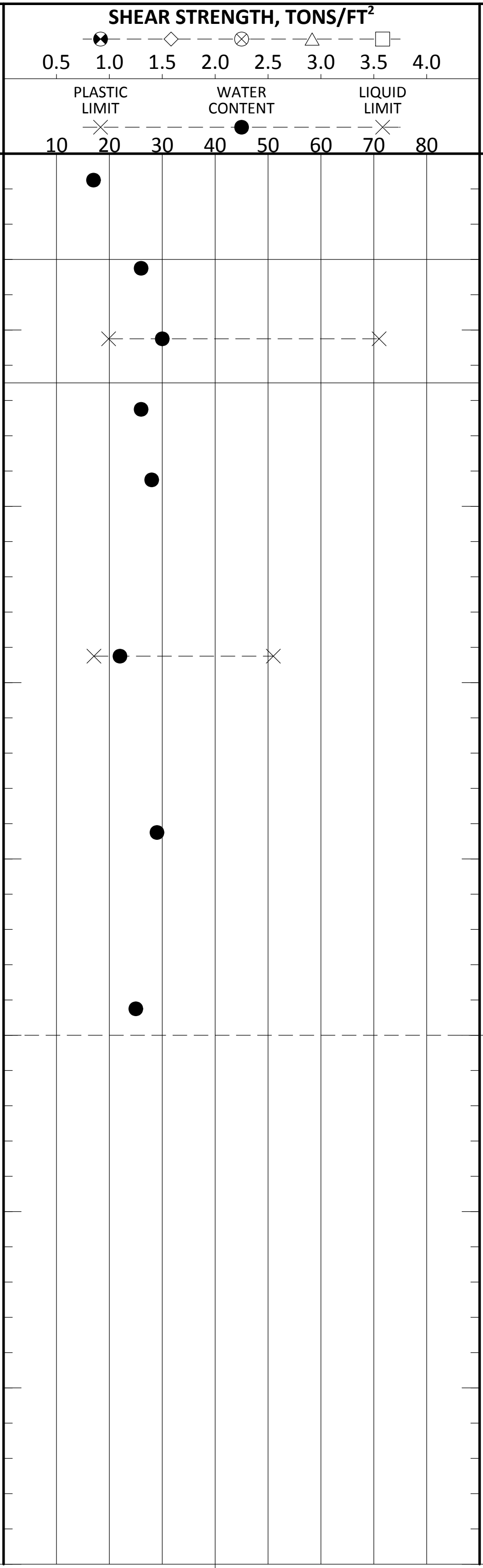
Blueridge Subdivision
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44427; W 98.54507

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	FILL: CLAY, Gravelly, Firm, Dark Brown	5			
	CLAY, Firm, Dark Brown	7			
5		7		51	
	CLAY, Stiff to Very Stiff, Tan, with gray mottling and gypsum crystals	10			
		14			
10					
		18		34	
15					
		15			
20					
		22			
25	Boring Terminated				
30					
35					



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 25.0 ft
DATE DRILLED: 1/10/2017
DEPTH TO WATER: DRY
DATE MEASURED: 1/10/2017
PROJ. No.: ASA17-001-00
FIGURE: 3

LOG OF BORING NO. B-3

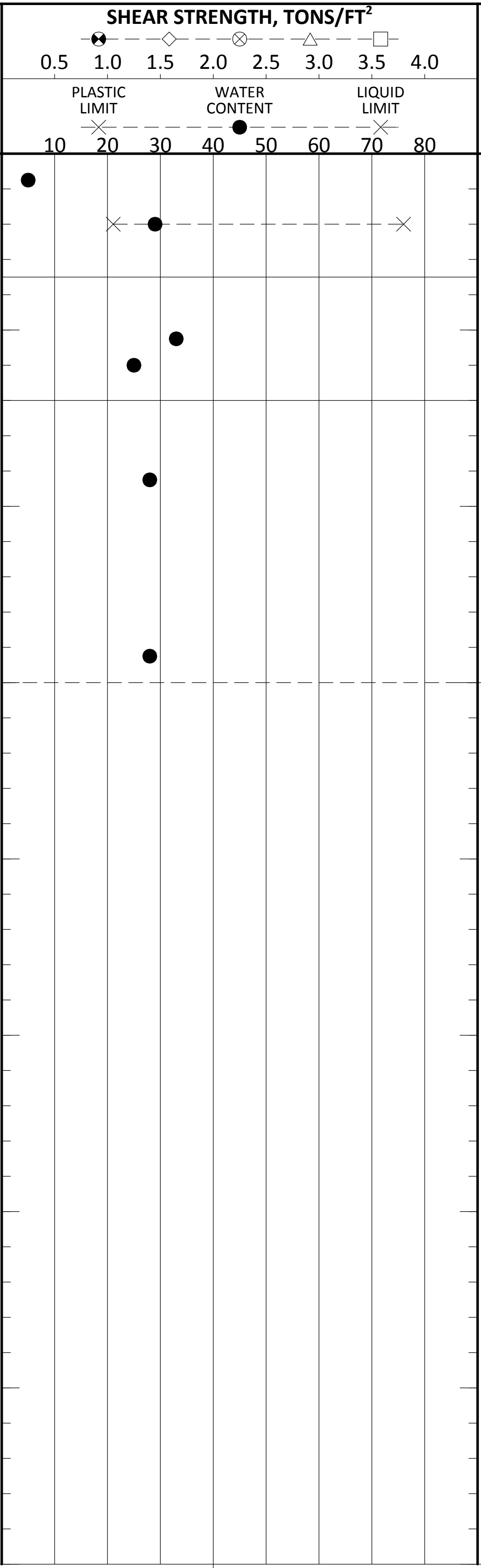
Blueridge Subdivision
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44364; W 98.54512

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
FILL: CLAY, Stiff to Firm, Dark Brown, with gravel and concrete rubble	10			
			55	
	7			
CLAY, Firm, Dark Brown	6			
CLAY, Stiff, Tan, with gray mottling	8			
	9			
- with gypsum crystals at 14 ft	14			
Boring Terminated				



DEPTH, FT: 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 15.0 ft
DATE DRILLED: 1/10/2017

DEPTH TO WATER: DRY
DATE MEASURED: 1/10/2017

PROJ. No.: ASA17-001-00
FIGURE: 4

LOG OF BORING NO. B-4

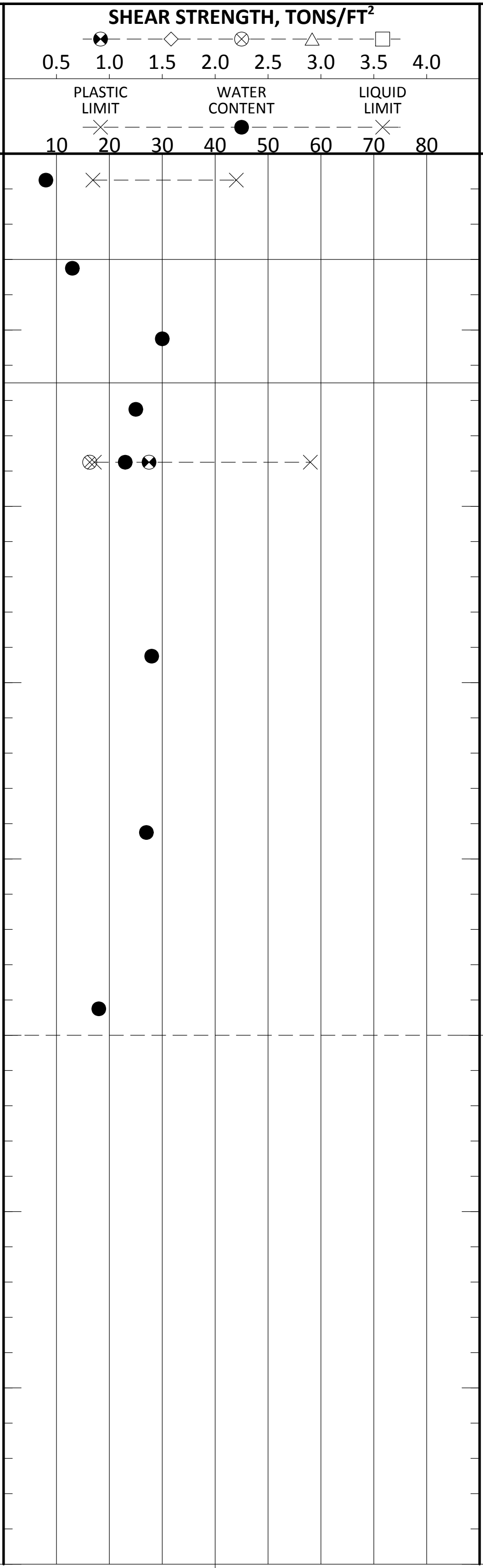
Blueridge Subdivision
San Antonio, Texas

TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44378; W 98.54464

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
FILL: CLAY, Silty, Firm, Dark Brown, with gravel and concrete rubble	7		27	81
CLAY, Firm, Dark Brown	7			
	7			
CLAY, Stiff to Very Stiff, Tan, with gray mottling	8			
		100	41	
	12			
	18			
	24			
Boring Terminated				



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 25.0 ft
DATE DRILLED: 1/10/2017

DEPTH TO WATER: DRY
DATE MEASURED: 1/10/2017

PROJ. No.: ASA17-001-00
FIGURE: 5

LOG OF BORING NO. B-5

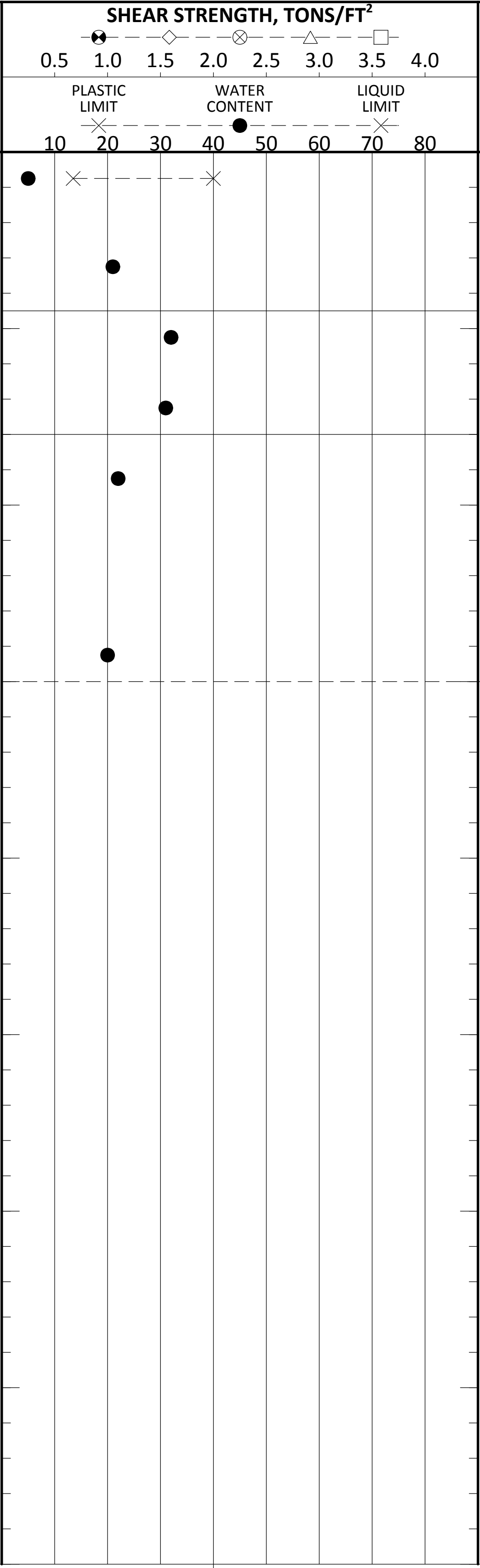
Blueridge Subdivision
San Antonio, Texas

TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44379; W 98.54377

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	FILL: CLAY, Silty, Stiff, Dark Brown, with gravel and concrete rubble	10		27	
		9			
5	CLAY, Firm, Dark Brown	4			
		4			
	CLAY, Very Stiff, Tan, with gray mottling	24			
10					
	- with gravel from 11 ft to12 ft.				
		17			
15	Boring Terminated				
20					
25					
30					
35					



DEPTH DRILLED: 15.0 ft
DATE DRILLED: 1/10/2017

DEPTH TO WATER: DRY
DATE MEASURED: 1/10/2017

PROJ. No.: ASA17-001-00
FIGURE: 6

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-6

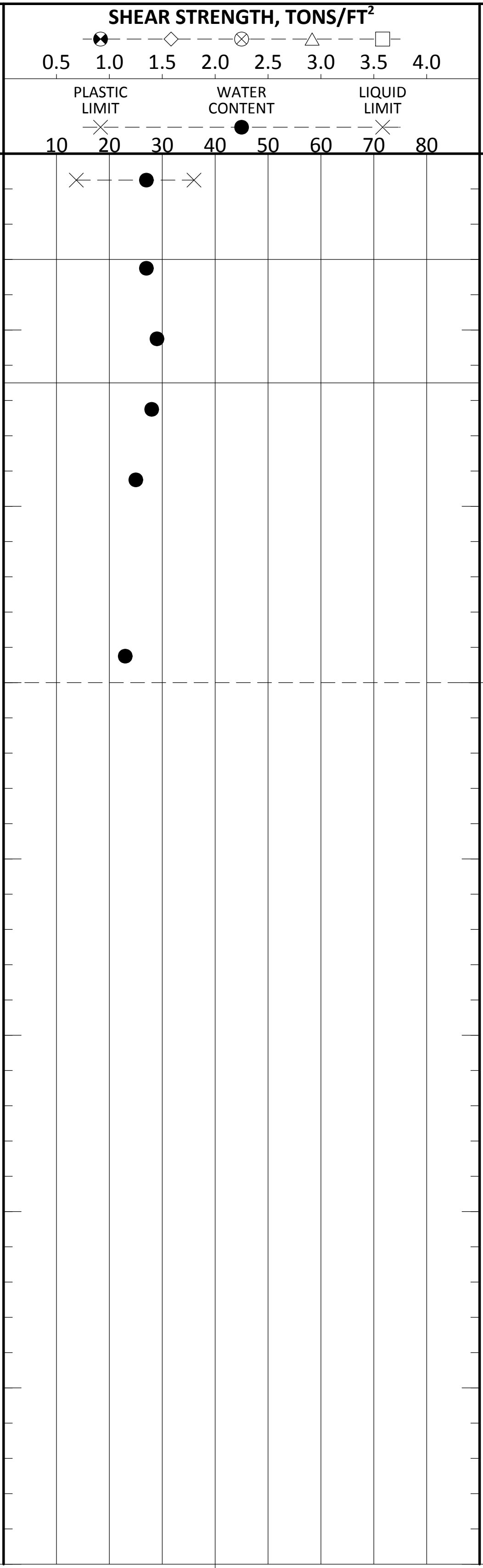
Blueridge Subdivision
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44302; W 98.54523

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
			FILL: CLAY, Silty, Firm, Dark Brown, with gravel and concrete rubble	5		22	22
			CLAY, Stiff, Dark Brown	8			
5				8			
			CLAY, Stiff, Tan, with gray mottling	8			
10				10			
				9			
15			Boring Terminated				
20							
25							
30							
35							



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	15.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA17-001-00
DATE DRILLED:	1/10/2017	**DATE MEASURED:**	1/10/2017	**FIGURE:**	7

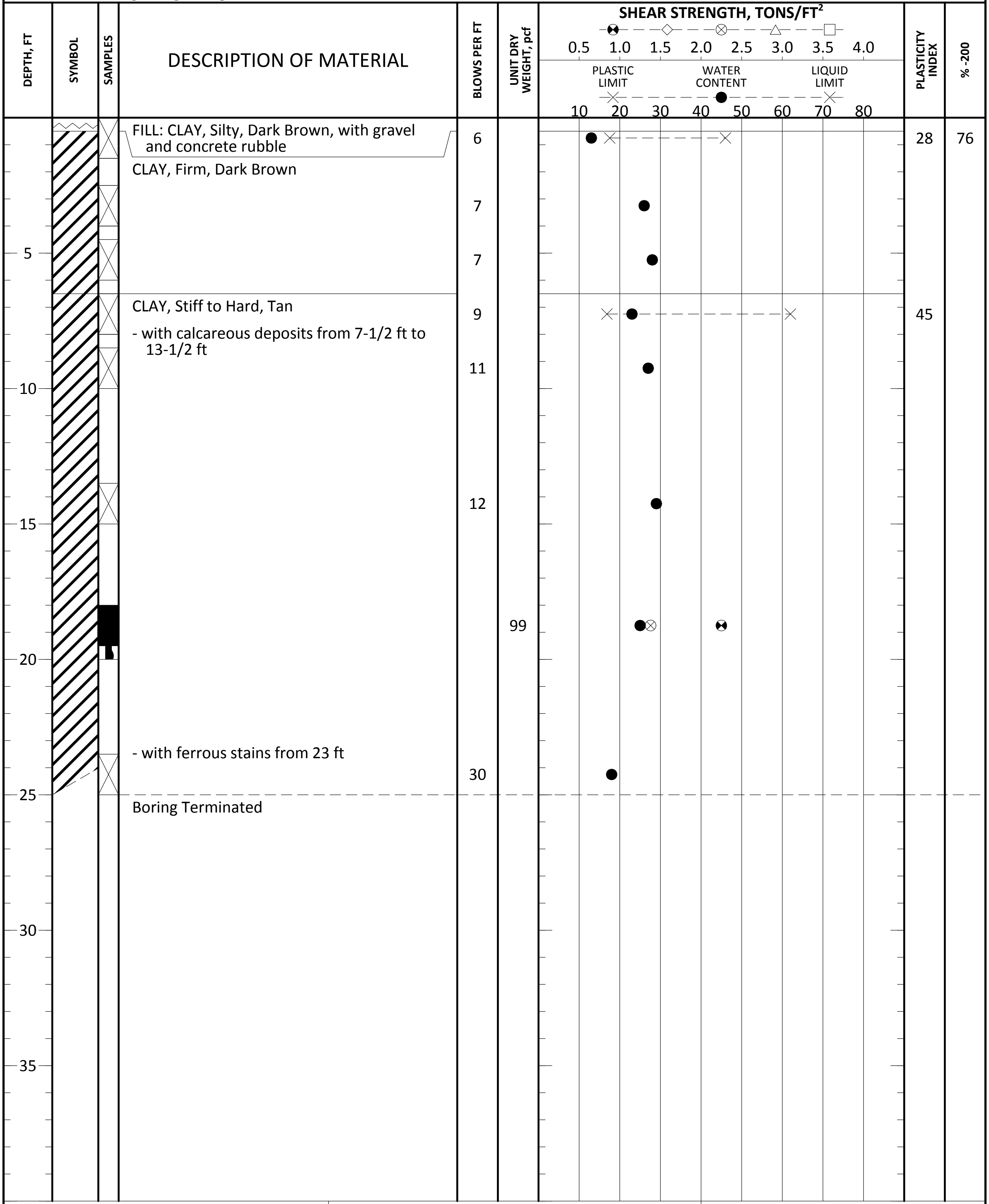
LOG OF BORING NO. B-7

Blueridge Subdivision
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44313; W 98.54361



DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
FILL: CLAY, Silty, Dark Brown, with gravel and concrete rubble	6		28	76
CLAY, Firm, Dark Brown				
	7			
	7			
CLAY, Stiff to Hard, Tan	9		45	
- with calcareous deposits from 7-1/2 ft to 13-1/2 ft				
	11			
	12			
		99		
- with ferrous stains from 23 ft				
	30			
Boring Terminated				

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 25.0 ft
DATE DRILLED: 1/10/2017

DEPTH TO WATER: DRY
DATE MEASURED: 1/10/2017

PROJ. No.: ASA17-001-00
FIGURE: 8

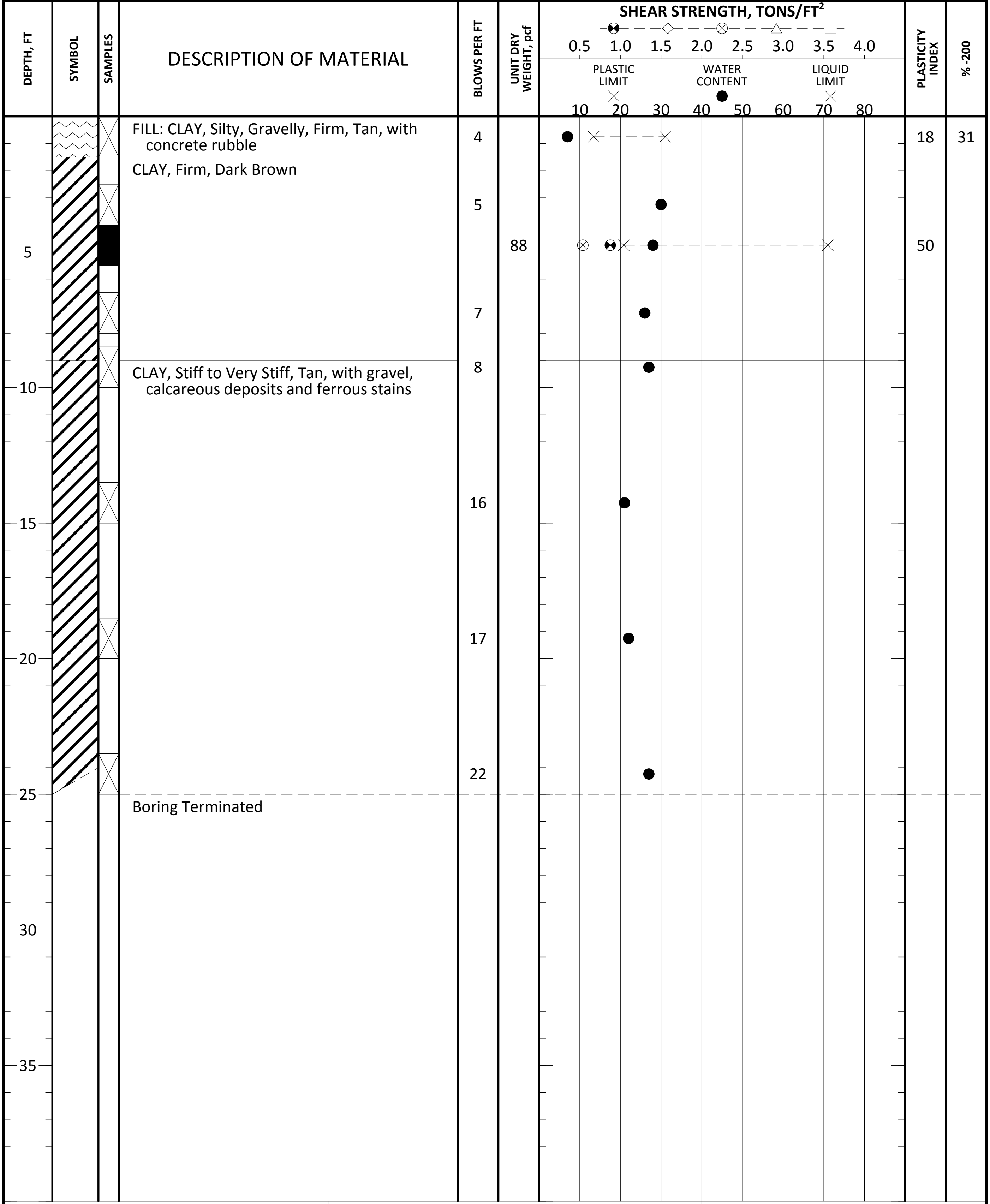
LOG OF BORING NO. B-8

Blueridge Subdivision
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44262; W 98.54476



DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
FILL: CLAY, Silty, Gravelly, Firm, Tan, with concrete rubble	4		18	31
CLAY, Firm, Dark Brown	5			
		88	50	
	7			
CLAY, Stiff to Very Stiff, Tan, with gravel, calcareous deposits and ferrous stains	8			
	16			
	17			
	22			
Boring Terminated				

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 25.0 ft
DATE DRILLED: 1/10/2017

DEPTH TO WATER: DRY
DATE MEASURED: 1/10/2017

PROJ. No.: ASA17-001-00
FIGURE: 9

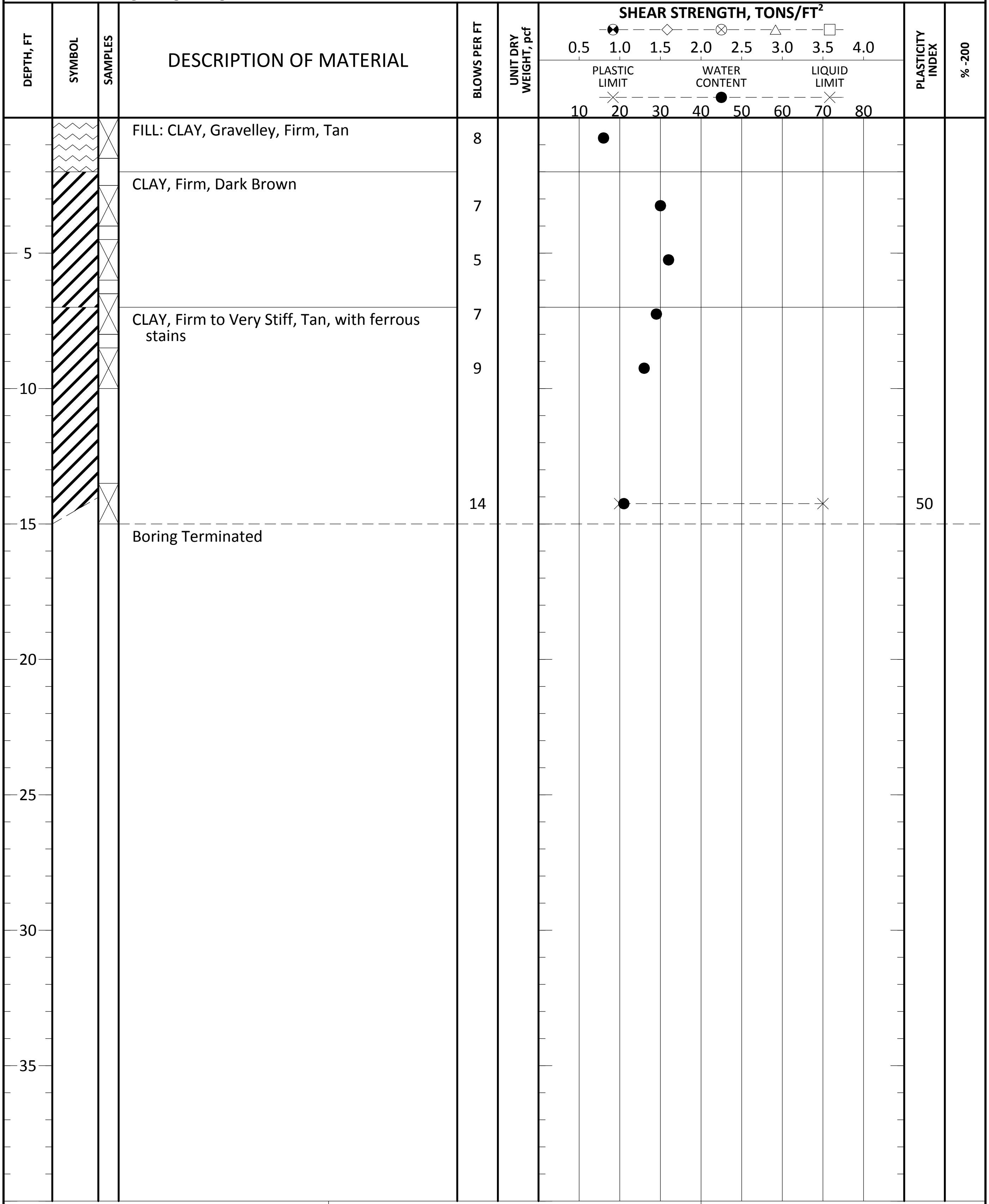
LOG OF BORING NO. B-9

Blueridge Subdivision
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.44262; W 98.54403



DESCRIPTION OF MATERIAL	BLOWS PER FT	PLASTICITY INDEX
FILL: CLAY, Gravelley, Firm, Tan	8	
CLAY, Firm, Dark Brown	7	
	5	
CLAY, Firm to Very Stiff, Tan, with ferrous stains	7	
	9	
	14	50
Boring Terminated		

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 15.0 ft
DATE DRILLED: 1/10/2017

DEPTH TO WATER: DRY
DATE MEASURED: 1/10/2017

PROJ. No.: ASA17-001-00
FIGURE: 10

KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

SOIL TERMS

- CALCAREOUS
- CALICHE
- CLAY
- CLAYEY
- GRAVEL
- GRAVELLY
- PEAT
- SAND
- SANDY
- SILT
- SILTY
- FILL

ROCK TERMS

- CHALK
- CLAYSTONE
- CLAY-SHALE
- CONGLOMERATE
- DOLOMITE
- IGNEOUS
- LIMESTONE
- MARL
- METAMORPHIC
- SANDSTONE
- SHALE
- SILTSTONE

OTHER

- ASPHALT
- BASE
- CONCRETE/CEMENT
- BRICKS / PAVERS
- WASTE
- NO INFORMATION

WELL CONSTRUCTION AND PLUGGING MATERIALS

- BLANK PIPE
- SCREEN
- BENTONITE
- CEMENT GROUT
- BENTONITE & CUTTINGS
- CONCRETE/CEMENT
- CUTTINGS
- GRAVEL
- SAND
- VOLCLAY

SAMPLE TYPES

- AIR ROTARY
- GRAB SAMPLE
- CORE
- GEOPROBE SAMPLER
- ROTOSONIC -DAMAGED
- MUD ROTARY
- NO RECOVERY
- NX CORE
- PITCHER
- ROTOSONIC -INTACT
- SHELBY TUBE
- SPLIT BARREL
- SPLIT SPOON
- TEXAS CONE PENETROMETER
- DISTURBED

STRENGTH TEST TYPES

●	POCKET PENETROMETER
◇	TORVANE
⊗	UNCONFINED COMPRESSION
△	TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED
□	TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. ASA17-001-00

FIGURE 11a

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
El = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

PROJECT NO. ASA17-001-00

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Blueridge Subdivision
San Antonio, Texas

FILE NAME: GINT.GPJ 1/20/2017

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-1	0.0 to 1.5	10	12	39	15	24	GC		30		
	2.5 to 4.0	5	30								
	4.5 to 6.0	6	32								
	6.5 to 8.0	11	28	56	21	35					
	8.5 to 10.0	14	24								
	13.5 to 14.0		23								
B-2	0.0 to 1.5	5	17								
	2.5 to 4.0	7	26								
	4.5 to 6.0	7	30	71	20	51					
	6.5 to 8.0	10	26								
	8.5 to 10.0	14	28								
	13.5 to 15.0	18	22	51	17	34					
	18.5 to 20.0	15	29								
	23.5 to 25.0	22	25								
B-3	0.0 to 1.5	10	5								
	2.0		29	76	21	55					
	2.5 to 4.0	7									
	4.5 to 6.0	6	33								
	6.0		25								
	6.5 to 8.0	8									
	8.5 to 10.0	9	28								
	13.5 to 15.0	14	28								
B-4	0.0 to 1.5	7	8	44	17	27	CL		81		
	2.5 to 4.0	7	13								
	4.5 to 6.0	7	30								
	6.5 to 8.0	8	25								
	8.0 to 9.5		23	58	17	41		100		0.81	UC
	9.5 to 10.0										
	13.5 to 15.0	12	28								
	18.5 to 20.0	18	27								
	23.5 to 25.0	24	18								
B-5	0.0 to 1.5	10	5	40	13	27					
	2.5 to 4.0	9	21								
	4.5 to 6.0	4	32								
	6.5 to 8.0	4	31								
	8.5 to 10.0	24	22								
	13.5 to 15.0	17	20								
B-6	0.0 to 1.5	5	27	36	14	22	GC		22		
	2.5 to 4.0	8	27								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA17-001-00

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FIGURE 12a

RESULTS OF SOIL SAMPLE ANALYSES

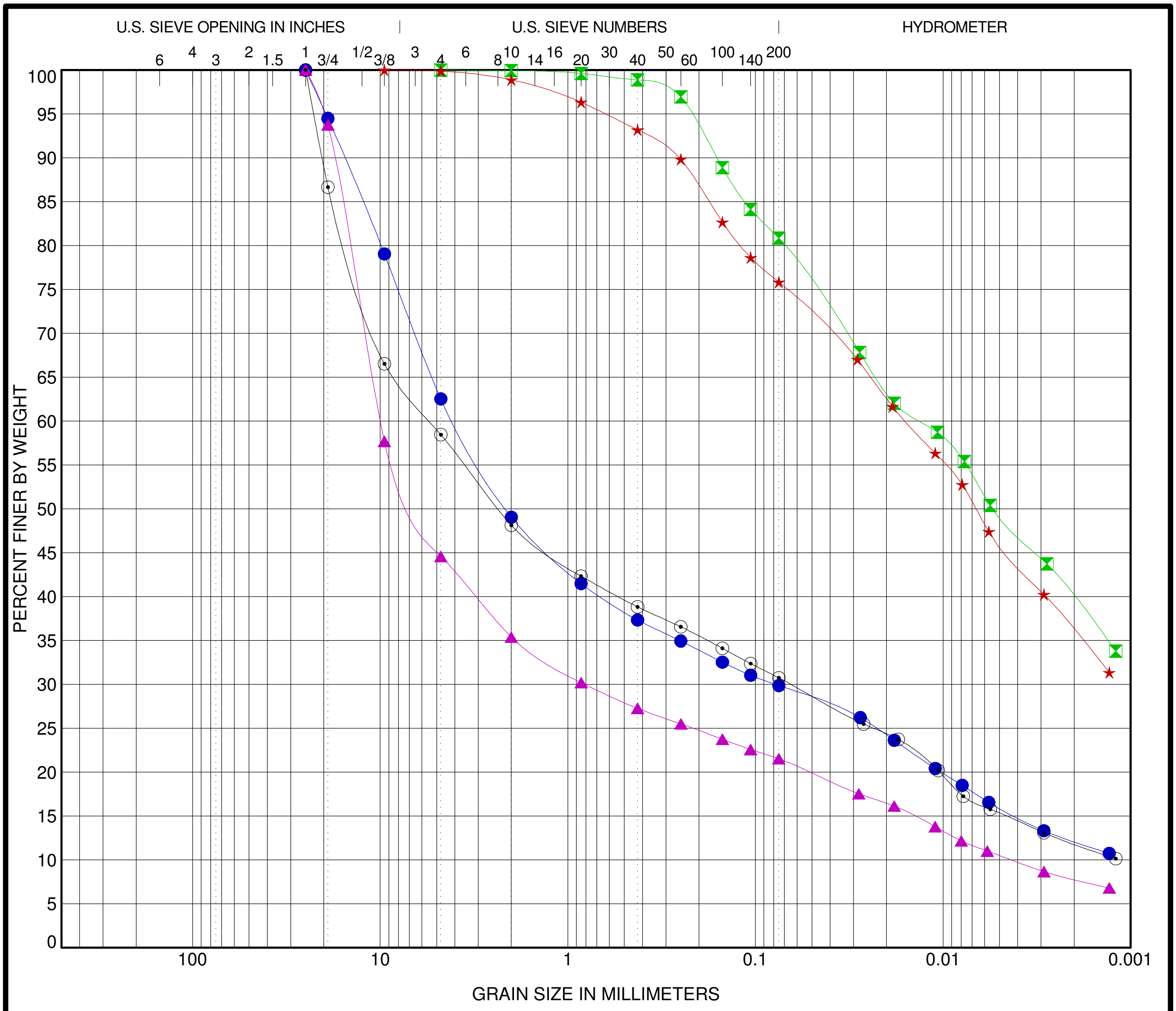
PROJECT NAME: Blueridge Subdivision
San Antonio, Texas

FILE NAME: GINT.GPJ 1/20/2017

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-6	4.5 to 6.0	8	29								
	6.5 to 8.0	8	28								
	8.5 to 10.0	10	25								
	13.5 to 15.0	9	23								
B-7	0.0 to 1.5	6	13	46	18	28	CL		76		
	2.5 to 4.0	7	26								
	4.5 to 6.0	7	28								
	6.5 to 8.0	9	23	62	17	45					
	8.5 to 10.0	11	27								
	13.5 to 15.0	12	29								
	18.0 to 19.5		25					99		1.38	UC
	19.5 to 20.0										
	23.5 to 25.0	30	18								
B-8	0.0 to 1.5	4	7	31	13	18	GC		31		
	2.5 to 4.0	5	30								
	4.0 to 5.5		28	71	21	50		88		0.54	UC
	5.0 to 5.5										
	6.5 to 8.0	7	26								
	8.5 to 10.0	8	27								
	13.5 to 15.0	16	21								
	18.5 to 20.0	17	22								
	23.5 to 25.0	22	27								
B-9	0.0 to 1.5	8	16								
	2.5 to 4.0	7	30								
	4.5 to 6.0	5	32								
	6.5 to 8.0	7	29								
	8.5 to 10.0	9	26								
	13.5 to 15.0	14	21	70	20	50					

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-1	0.0	CLAYEY GRAVEL with SAND(GC)	39	15	24		
☒	B-4	0.0	LEAN CLAY with SAND(CL)	44	17	27		
▲	B-6	0.0	CLAYEY GRAVEL with SAND(GC)	36	14	22	15.40	2307.5
★	B-7	0.0	LEAN CLAY with SAND(CL)	46	18	28		
⊙	B-8	0.0	CLAYEY GRAVEL with SAND(GC)	31	13	18		

Specimen Identification			G_s	2 mm	0.425 mm	0.075 mm	0.02 mm	0.002 mm	0.001 mm
●	B-1	0.0	2.672	49.0	37.3	29.9	24.2	12.1	
☒	B-4	0.0	2.654	99.9	98.9	80.9	63.3	39.8	
▲	B-6	0.0	2.719	35.4	27.3	21.5	16.4	7.8	
★	B-7	0.0	2.655	98.9	93.2	75.8	62.6	36.1	
⊙	B-8	0.0	2.716	48.1	38.8	30.7	24.3	11.9	

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GRAIN SIZE DISTRIBUTION

Blueridge Subdivision
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Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GBC GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

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