Geotechnical Engineering Study

First Methodist Church Parking Lot
205 James Street
San Antonio, Texas

Arias Job No. 2025-655

Prepared For:

First Methodist Church

December 4, 2025

142 Chula Vista, San Antonio, Texas 78232 • Phone: (210) 308-5884 • Fax: (210) 308-5886

December 4, 2025
Arias Job No. 2025-655 VIA Email: jwallace@fumc-boerne.org

Ms. Jeanan Wallace
First Methodist Church
205 James Street
Boerne, TX 78006

RE: Proposal for Geotechnical Engineering Services
First Methodist Church Parking Lot
205 James Street
Boerne, Texas

Dear Ms. Wallace:

This Geotechnical Engineering Report presents the results of our geotechnical study for the proposed reconstruction of parking lot at 205 James Street in Boerne, Texas. This project was authorized through the execution of the professional service agreement between First United Methodist Church, Boerne, and Arias and Associates proposal 2025-655 dated October 16, 2025 and signed on November 4, 2025.

The purpose of this geotechnical engineering study was to establish pavement engineering properties of the subsurface soil and groundwater conditions present at the site. The scope of the study is to provide geotechnical engineering criteria for use by design engineers in preparing the pavement design. Our findings and recommendations should be incorporated into the design and construction documents for the proposed development.

The long-term success of the project will be affected by the quality of materials used for construction and the adherence of the construction to the project plans and specifications. The quality of construction can be evaluated by implementing Quality Assurance (QA) testing through a qualified and certified testing laboratory.

Thank you for the opportunity to be of service to you.

Sincerely,
Arias & Associates, Inc.
TBPE Registration No: F-32

12/4/2025

STATE OF TEXAS
MARK J. O'CONNOR
79252
REGISTERED PROFESSIONAL ENGINEER

Summit Pokhrel, E.I.T.
Graduate Engineer

Mark J. O'Connor, P.E.
Senior Geotechnical Engineer

REPORT FORMAT INFORMATION

To improve clarity with the intent of our geotechnical recommendations for this project, the report is organized into two separate, but equally important sections.

Section I – *Synopsis* is a summary of our geotechnical recommendations specific to this project.

Section II - The *Main Report* contains more detailed information including foundation and pavement design parameters and site work recommendations.

A study of both of the above referenced sections is recommended for the Project Team Members. Arias cautions that Section I is a consolidated quick reference overview of the more detailed geotechnical recommendations contained in Section II and should not be utilized exclusively from the remainder of the report.

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SECTION I: SYNOPSIS

This synopsis includes a brief description of the project, subsurface findings, generalized pavement recommendations, and specific items of concern from a geotechnical standpoint for consideration during the design, construction, and maintenance phases of this project.

Table 1: Project Description

Project:	First Methodist Church
Project Location:	205 James Street Boerne, Texas
Proposed Development:	Reconstruction of Parking Lot

Table 2: Existing Conditions at Time of Geotechnical Study

Ground Cover:	Existing Pavement Area
Predominant Soil Types:	SANDY LEAN CLAY (CL)
Plasticity Index (PI):	Average: 20 Range: 19 to 23
Groundwater Depth Measured:	Groundwater was not encountered in any of the borings at the time of the field exploration on November 13, 2025 *Groundwater conditions may vary with time and be different at the time of construction*
Estimated Potential Vertical Rise (PVR):	1 inch
California Bearing Ratio (CBR):	3.0

Table 3: Project Compaction, Moisture and Testing Requirements

Description	Material	Percent Compaction	Optimum Moisture Content	Testing Requirement
		According to Standard Proctor ASTM D 698		
Pavement Areas	Scarified, Moisture Conditioned On-site Soil (Subgrade)	≥ 95%	0 to +4%	1 per 2,500 SF; min. 3 tests
	General Fill (Onsite Material)	≥ 95%	0 to +4%	1 per 2,500 SF; min. 3 per lift
	Base Material	≥ 95% (ASTM D 1557)	±3%	1 per 2,500 SF; min. 3 per lift
	Hot-mix asphaltic concrete	91% to 95% Theoretical Lab Density (TEX 207 F)	Not applicable	1 per 2,500 SF; min. 3 per lift
Non-Structural Areas (Outside Pavement Areas)	General Fill (On-site Material)	≥ 95%	0 to +4%	1 per 2,500 SF; min. 3 per lift

SECTION II: MAIN REPORT

INTRODUCTION

This report presents the results of a Geotechnical Engineering Study for the proposed reconstruction of the parking lot located at 205 James Street in Boerne, Texas.

This project was authorized through the execution of the Professional Service Agreement between First Methodist Church and Arias proposal 2025-655 dated October 16, 2025, and signed on November 4, 2025.

SCOPE OF SERVICES

The purpose of this geotechnical engineering study was to conduct a subsurface exploration and laboratory testing to establish the engineering properties of the subsurface materials present on the project site. This information was used to develop the geotechnical engineering criteria for use by design engineers to aid in preparing the pavement design(s). *Environmental, slope stability, pavement drainage, utility, retaining wall analysis and foundation engineering studies of any kind were not a part of our authorized scope of services for this project.*

PROJECT AND SITE DESCRIPTION

We understand that the project consists of the reconstruction of a parking lot with an area of approximately 20,880 square feet in Boerne, Texas. As per the general information provided by the client, there are two sections of the parking lot and there is a saw cut line between them.

SOIL BORINGS

Five (5) borings were drilled within the proposed limits of the parking lot, and the locations are shown on the Boring Location Plan included as Figure 2 in Appendix A. The five (5) borings were first cored through the existing pavement section and then drilled to a depth of six (6) feet below the existing grade surface at the time the geotechnical exploration was conducted on November 13, 2025.

Boring details are summarized in Table 4 below.

Table 4: Boring Locations

Boring	Structure	Latitude	Longitude	Depth(ft)
B-1	Pavement	29° 47' 30.63" N	98° 43' 40.93" W	6
B-2		29° 47' 30.99" N	98° 43' 41.92" W	6
B-3		29° 47' 30.22" N	98° 43' 41.74" W	6
B-4		29° 47' 31.95" N	98° 43' 41.70" W	6
B-5		29° 47' 31.64" N	98° 43' 41.72" W	6

Note: Depths are measured from the existing pavement elevation at the time of drilling on November 13, 2025.

Drilling was performed in general accordance with ASTM D 1586 for Split Spoon sampling techniques as described in Appendix C.

A truck-mounted drill rig using continuous flight augers together with the sampling tools noted was used to secure the subsurface soil samples. After completion of drilling, the boreholes were backfilled with soil cuttings and then patched with cold mix asphalt to match existing grade.

The sample depth intervals are included on the soil boring logs presented in Appendix B. Arias' field representative visually logged each recovered sample and placed a portion of it into an air-tight plastic bag with zipper-lock for transport to our laboratory.

Soil classifications and borehole logging were conducted during the field exploration by our senior field engineering technician (logger) who worked under the supervision of the Project Geotechnical Engineer. Final soil classifications, as seen on the attached boring logs, were determined by the Project Geotechnical Engineer based on laboratory and field test results and applicable ASTM procedures.

LABORATORY TESTING

General

As a supplement to the field exploration, laboratory testing to determine soil water content, Atterberg Limits, and percent passing the US Standard No. 200 sieve was conducted. The laboratory results are reported in the boring logs included in Appendix B.

A key to the terms and symbols used on the logs is also included in Appendix B. The soil laboratory testing for this project was done in accordance with applicable ASTM procedures and definitions for these tests listed in Appendix C.

Remaining soil samples recovered from this exploration will be routinely discarded following submittal of this report.

SUBSURFACE CONDITIONS

Geology, existing pavement section, generalized stratigraphy, and groundwater conditions at the project site are discussed in the following sections. The subsurface and groundwater conditions are based on our observations at the boring locations to the depths explored.

Geology

According to the Geologic Atlas of Texas, the project area is mapped as containing Glen Rose Limestone (Kgr). This formation is known to have alternating layers of clay, sand, and sometimes Sandstone. These layers are resistant and recessive beds that form a stairstep topography. The limestone is fine grained and can range from being very hard to being soft and marly. The clay is partly sandy and marly. Sand and clay layers are commonly thin bedded.

Existing Pavement Section

Pavement thickness was determined in each boring where preexisting pavement was encountered. Table 5 below summarizes the existing pavement section at each encounter.

Table 5: Existing Pavement Section

Boring	Asphalt Thickness (inches)	Base Thickness (inches)	Total Section (inches)
P-1	2.0	1.25	3.25
P-2	1.25	8.0	9.25
P-3	2.5	4.0	6.5
P-4	3.0	6.0	9.0
P-5	2.0	3.0	5.0

Groundwater

A dry soil sampling method was used to obtain the soil samples at the project site. Groundwater was not encountered during drilling on November 13, 2025. Following the drilling and sampling operations, the open boreholes were backfilled with drill cuttings and then the surface was patched with asphalt to match existing grade.

It should be noted that water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the soils. Groundwater levels at the time of construction may differ from the observations obtained during the field exploration because perched groundwater is subject to seasonal conditions, recent rainfall, flooding, drought or temperature affects. Leaking underground utilities can also impact subsurface water levels.

Groundwater levels should be verified immediately prior to construction. Gravels and sandy soils, as well as seams of these more permeable type materials, can transmit "perched" groundwater. Granular utility backfills can provide a conduit for water to collect under pavements and can ultimately lead to pavement distress. Provisions to intercept and divert "perched" or subsurface water should be made if subsurface water conditions become problematic. Should dewatering become required, it is considered "means and methods" and is solely the responsibility of the Contractor.

Moisture Fluctuations Beneath Pavements

It is common for moisture content values to remain more constant in the middle of the pavement. That is, the moisture levels in the subgrade soils located near the edge of pavement are more susceptible to changes in moisture that occur due to natural seasonal moisture fluctuations. The edges will dry and shrink during drought conditions, relative to the center of the street pavement. During extremely wet climate periods, the edges will swell relative to the center of the street pavement. The shrinking and swelling of subgrade soils near the edge of pavements will result in longitudinal, surface cracking that occurs parallel to the street pavement. Undulating pavement and curbs could also result from these shrink/swell movements. Based on our experience, edge cracking typically occurs at a distance of 3 to 9 feet from the edge of the street pavement. Edge cracking associated with soil shrinkage movements may occur at greater distances during extreme environmental conditions. The implementation of moisture barriers along the pavement edges can improve the long-term performance of the pavement by reducing the impact of the expansive soils.

Based on the results of this study, the Owner can consider the option of constructing vertical and/or lateral (horizontal) moisture barriers to help maintain more consistent moisture conditions beneath the pavement, thus reducing the severity of expansive soil-related distress. Even with the implementation of a moisture barrier, the Owner should be prepared to provide pavement maintenance and repair; please refer to the "Performance Considerations" section of this Report for additional information. The Owner may decide to forgo the implementation of a moisture barrier and accept an increased risk for expansive soil-related movement. Potential risks would include costs for maintenance such as patching of cracks and occasional overlays over the life of the pavements.

Some options for moisture barriers to aid in reducing moisture change in the pavement subgrade soils include:

- <u>Vertical Moisture Barriers (VMB)</u>. VMBs may consist of polyethylene plastic sheeting placed in an excavated vertical trench that is backfilled with flowable fill. We recommend that a VMB be considered to extend to a depth of at least 6 (six) feet below existing grade at the time of our investigation. VMBs should be considered for installation along the length of the project on both sides of the street, or at least where the existing pavement is experiencing more distress. Careful coordination will be required by the installation contractor during construction to prevent from damaging existing utilities. It is our opinion that VMBs would be effective in reducing the chances and severity of edge cracking.

- Lateral Moisture Barriers (LMB). LMBs can consist of pavement shoulders located adjacent to the planned pavements. The use of shoulders along the length of the project will help provide protection from moisture fluctuations along the pavement edges. As previously noted, based on our experience, edge cracking typically occurs at a distance of 3 to 9 feet from the edge of the street pavement. Thus, the wider the shoulders, the more protection will be provided.

Potential landscaping adjacent to the proposed pavement areas will increase the potential for moisture fluctuations along the pavement edges. Careful consideration should be provided by the designers to provide positive drainage away from these areas at all times. Ponding should not be allowed near the edges of the planned pavements.

PAVEMENT RECOMMENDATIONS FOR PARKING LOTS

Pavement Design Parameters and Assumptions

The pavement recommendations were prepared in accordance with the 1993 AASHTO Guide for the Design of Pavement Structures for asphalt and the ACI 330R (Guide for Design and Construction of Concrete Parking Lots) for concrete. We performed a Dynamic Cone Penetration Test (DCP) at the site to determine the design California Bearing Ratio (CBR). No traffic specific design information was received for this project. Therefore, the following design parameters and assumptions were used in our analysis:

Table 6: Pavement Design Parameters and Assumptions- Parking Lot

Design Parameters	Flexible Pavement	Rigid Pavement
Reliability Factor	70%	
Overall Standard Deviation	0.45	0.35
Initial Serviceability Index	4.2	4.5
Terminal Serviceability Index	2.0	
CBR (%)	3	--
Modulus of Subgrade Reaction (psi/in)	--	75
18-kip Equivalent Axle Loads (ESALs)	15,000	50,000

Table 7: Material Coefficients for Flexible Pavements

Material	Structural Coefficient
Hot Mix Asphaltic Concrete – Type “C” or “D” Surface Course	0.44
Flexible Base Course – TxDOT Item 247, Type A, Grades 1 or 2	0.14

Based on these parameters, the thickness of the pavement sections were calculated and presented in Table 8.

Table 8: Recommended Pavement Sections

Layer	Material	Flexible Asphaltic Concrete		Rigid Concrete	
		Parking Area - Light Duty	Access Drive, Truck Lane - Medium Duty	Parking Area - Light Duty	Access Drives, Truck Lane - Medium Duty
Surface	HMAC (Type C or D)/PCC	2”	3”	5”	6”
Base	Flexible Base (Type A)	8”	8”	--	--
Subgrade	Moisture Conditioned and compacted	6”	6”	6”	6”

Notes:

1. Pavements founded on top of expansive soils will be subjected to PVR soil movements estimated and presented in this report (*i.e.,* approximately less than 1 inch). These potential soil movements are typically activated to some degree during the life of the pavement. Consequently, pavements can be expected to crack and require periodic maintenance. Periodic/preventative maintenance should be planned for to reduce deterioration of the pavement structure while aiding to preserve the investment.
2. Light duty areas include parking and drive lanes that are subjected to passenger vehicle traffic only. Light duty areas exclude entrance aprons and drives to the site and single access route drive lanes to parking areas.
3. Medium duty areas include entrance aprons and drives into the site, single access route drive lanes (Drive Through Lane) to parking areas, and areas where paving will be subjected to lightly loaded trucks. Medium duty areas exclude areas where tractor trailers may travel or park, dock areas, areas where trash collection vehicles may travel and load or unload.
4. Heavy duty areas include areas subjected to 18-wheel tractor trailers, trash collection vehicles, forklifts, dumpster pad including dumpster truck path from street to pad, loading and unloading areas, and areas where truck turning and maneuvering may occur and drive through lanes. Asphalt pavement should not be used for the Dumpster Pad or drive through lanes. **At least eight (8)-inch thick concrete is recommended for heavy duty pavement areas (such as Dumpster Pads and drive through lanes) and is not shown in Table 8.**

5. During the paving life, maintenance to seal surface cracks within concrete or asphalt paving and to reseal joints within concrete pavement should be undertaken to achieve the desired paving life. Perimeter drainage should be controlled to reduce the influx of surface water from areas surrounding the paving. Water penetration into base or subgrade materials, sometimes due to irrigation or surface water infiltration leads to pre-mature paving degradation. Curbs should be used in conjunction with paving to reduce potential for infiltration of moisture into the base course. Curbs should extend the full depth of the base course and should extend at least 3 inches into the underlying clayey subgrade. The base layer should be tied into the area inlets to drain water that may collect in the base.

Alternately, we performed the pavement thickness analysis utilizing the geogrid. The analysis was performed using "Tensar+" online tool. The pavement section is summarized in Table 9.

Table 9: Flexible Pavement Option – Geogrid (Light Duty)

HMA Type C or D	2"
Geogrid Stabilized Type "A" Flex Base Course (Tensar HX5.5)	6"
Calculated ESAL's	**116,000**

Note: Tensar + program used to determine the pavement design.

If more heavy-duty 18-wheeler truck traffic is anticipated (i.e more than 1 truck per day), we recommend the use of an eight (8)-inch-thick concrete pavement.

A heavy truck traffic section (8-inch-thick concrete) is recommended for use at entrances, driveways, dumpster pads and channeled traffic areas such as the path the dumpster truck traverses from street to dumpster pad and the drive through lane. Areas subjected to truck traffic stopping, starting, loading, unloading or turning should not utilize asphalt pavement. For these areas, a concrete section is recommended. The heavy truck traffic section of at least 8 inches of concrete pavement is not shown in Table 8.

Rigid Concrete Pavement Joints

Placement of expansion joints in concrete paving on potentially expansive subgrade or on granular subgrade subject to piping often results in horizontal and vertical movement at the joint. Many times, concrete spalls adjacent to the joint and eventually a failed concrete area is the result. This problem is primarily related to water infiltration through the joint.

One method to mitigate the problem of water infiltration through the joints is to eliminate all Expansion Joints that are not absolutely necessary. It is our opinion that expansion or isolation joints are needed only adjacent where the pavement abuts intersecting drive lanes and other structures. Elimination of all expansion joints within the main body of the pavement area would significantly reduce access of moisture into the subgrade. Regardless of the type of expansion joint sealant used, eventually openings in the sealant occur resulting in water infiltration into the subgrade.

The use of sawed and sealed joints (Contraction Joints) should be designed in accordance with current Portland Cement Association (PCA) or American Concrete Institute (ACI) guidelines. Research has proven that joint design and layout can have a significant effect on the overall performance of concrete pavement.

Recommendations presented herein are based on the use of reinforced concrete pavement. Local experience has shown that the use of distributed steel placed at a distance of 1/3 the slab thickness from the top is of benefit in crack control for concrete pavements. Improved crack control also reduces the potential for water infiltration.

Performance Considerations

Our pavement recommendations have been developed to provide an adequate structural thickness to support the anticipated traffic volumes shown in Table 9. Some shrink/swell movements due to moisture variations in the underlying soils, or potential movement from settling utility backfill material, should be anticipated over the life of the pavements. The owner should recognize that over a period of time, pavements may crack and undergo some deterioration and loss of serviceability. We recommend the project budgets include an allowance for maintenance such as patching of cracks or occasional overlays over the life of the pavement.

Pavement Subgrade and Section Materials

Recommendations for the planned pavement subgrade and section materials are below in Tables 10 through 14:

Table 10: Pavement Subgrade Materials

Subgrade Preparation Prior to Paving Section Construction	
Minimum undercut depth	6 inches or as needed to remove organics, old pavements, and accommodate pavement sections. All soft, wet and loose materials should also be removed down to firmer natural materials

Reuse excavated soils	Provided they are free of roots and debris and meet the material requirements for their intended use
Horizontal extent for undercut	2 feet beyond the paving limits
Exposed subgrade treatment (before moisture conditioning)	Proof roll with rubber-tired vehicle weighing at least 20 tons such as a loaded dump truck with Geotechnical Engineer's representative present during proof rolling. Moisture condition and compact after proof rolling approval as outlined in this report.
Pumping/rutting areas discovered during proof rolling	Pumping and/rutting should be expected and then removed to firmer materials and replaced with compacted general or select fill under direction of Geotechnical Engineer's representative

Table 11: Fill Requirements and Subgrade Treatment Options

Fill Requirements for Grade Increases	
General fill type	Material free of roots, debris and other deleterious material with a maximum rock size of 3 inches; on-site clays having CBR $\geq$ 3.0 may be used
Minimum general fill thickness	As required to achieve grade
Maximum general fill loose lift thickness	8 inches
General fill compaction and moisture criteria	ASTM D 698 ≥ 95% compaction at 0 to +4 from optimum
Subgrade Treatment Option - Moisture Conditioning	
Depth of moisture conditioning	6 inches (disk in place and moisture condition)
Compaction and moisture criteria	ASTM D 698 ≥ 95% compaction at 0 to +4 from optimum
In-Place Density and Moisture Verification Testing	
Testing frequency (Subgrade)	1 test per 2,500 square feet with minimum of 3 tests

Table 12: Flexible Pavement Requirements

Flexible Pavement Section Requirements	
Flexible Base Material Type	2014 TxDOT Item 247, Type A, Grade 1 or 2
Maximum Flexible Base Loose Lift Thickness	9 inches
Flexible Base Placement Criteria	Compact to > 95% maximum dry density at -3 to +3 percentage points of optimum moisture content (ASTM D 1557)
Hot Mix Asphaltic Concrete (HMAC) Type	2024 TxDOT Item 341, Type D
HMAC Placement Criteria	91% to 95% Theoretical Lab Density (TEX 207 F)

Table 13: Rigid Pavement Section Materials

Portland Cement Concrete Section Requirements	
Minimum compressive strength at 28 days	4,000 psi at 28 days
Desired slump during placement	5 ± 1 inch
Reinforced Steel	At Least #4 @ 18” each way placed D/3 from top of slab, where D=Pavement Thickness
Construction Joint Dowels	• Light duty 5, 6-inch section: 5/8” diameter, 12” long @ 12” on center and lubricated both sides, dowel embedment of 5”. • Medium duty 6, 7 -inch section: 3/4” diameter, 14” long @ 12” on center and lubricated both sides, dowel embedment of 6”. • Heavy duty 8-inch section: 1” diameter, 14” long @ 12” on center and lubricated both sides, dowel embedment of 6”.
Expansion Joints	May be eliminated except at tie-ins with existing concrete and structures

Contraction Joints – transverse and longitudinal	Meet spacing and sawing requirements of ACI 330R (Guide for Design and Construction of Concrete Parking Lots)
Placement	In accordance with ACI 304R (guide for measuring, mixing, transporting, and placing), ACI 305R (hot weather concreting, and ACI 306R (cold weather concreting)

To help reduce degradation of the prepared subgrade, paving preferably should be placed within 14 days. If pavement placement is delayed, protection of the subgrade surface with an emulsion-based sealer should be considered. Alternately, the paving section could be slightly overbuilt so blading performed to remove distressed sections does not reduce the treated subgrade thickness.

CONSTRUCTION CRITERIA

Site Preparation

Strip away any existing asphalt, concrete, topsoil, grass, organics, soft or wet materials, and deleterious debris as needed and dispose outside of the pavement and other structural areas. Undercut to the required depth and extent as noted in the main report. Additional excavation may be required to remove existing fill materials, utilities or foundations. Additional excavation may also be necessary due to encountering deleterious materials such as buried debris and/or rubble, or undesirable soft and wet subgrade conditions and/or existing fill materials. The site representative of the Geotechnical Engineer should observe undercutting operations. Unless passing density reports are provided for a specific area, existing fill soils found during the excavation should be considered as uncertified and removed to suitable natural soils.

After the surface materials are removed, the exposed subgrade surface should be proof rolled with a heavily loaded dump truck weighing at least 20 tons. Any areas which excessively yield or pump under the wheel loading should be undercut to the depth specified by the Geotechnical Engineer's representative and replaced with compacted select fill to existing grade as specified. The voids in undercut areas can be backfilled and compacted with on-site general fill materials.

Table 14: Site Work (Non Structural/General Fill) Requirements

Stripping Depth	6-inch minimum or as needed to remove any existing asphalt, concrete, and vegetation
Non-Structural/General Fill Type	On-site material free of roots, debris and other deleterious material with a maximum particle size of 4 inches

Maximum Non-Structural/General Fill Loose Lift Thickness	9 inches

The backfill should be placed and compacted in accordance with the General Fill requirements in Table 3 in Section I.

Drainage

Good positive drainage during and after construction is very important to reduce expansive soil volume changes that can detrimentally affect the performance of the planned development. Proper attention to surface and subsurface drainage details during the design and construction phase of development can aid in preventing many potential soil shrink-swell related problems during and following the completion of the project.

GENERAL COMMENTS

This report was prepared as an instrument of service for this project exclusively for the use of First Methodist Church and the project design team. If the development plans change relative to layout, anticipated traffic loads, or if different subsurface conditions are encountered during construction, we should be informed and retained to ascertain the impact of these changes on our recommendations. We cannot be responsible for the potential impact of these changes if we are not informed.

Design Review

Arias should be given the opportunity to review the design and construction documents. The purpose of this review is to check to see if our recommendations are properly interpreted into the project plans and specifications. Please note that design review was not included in the authorized scope and additional fees may apply.

Geogrid

We recommend the use of Tensar HX5.5 geogrid for the section as referenced in Table 10. Geogrid should be installed between the subgrade and flexible base layer. The grid should be installed as per manufactures guidelines. A representative of the geogrid supplier should be present at the start of placement to instruct the workforce on proper installation techniques.

Flexible Base Course

The base material should comply with TxDOT Standard Specifications for Construction, Item 247, “Flexible Base”, Type A Grade 1 or 2. The flexible base should be compacted in maximum 8-inch loose lifts to at least 95 percent of the maximum dry density as evaluated by ASTM D 698 within plus or minus 3 percent of optimum moisture content. Compaction tests should be performed as outlined in the “Quality Assurance Testing” section of this report.

Subsurface Variations

Soil and groundwater conditions may vary away from the sample boring locations. Transition boundaries or contacts, noted on the boring logs to separate soil types, are approximate. Actual contacts may be gradual and vary at different locations. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions or highly variable subsurface conditions are encountered during construction, we should be contacted to evaluate the significance of the changed conditions relative to our recommendations.

Quality Assurance Testing

The long-term success of the project will be affected by the quality of materials used for construction and the adherence of the construction to the project plans and specifications. Arias should be immediately contacted if differing subsurface conditions are encountered during construction. Differing materials may require modification to the recommendations that we provided herein.

Subgrade preparation and fill placement operations should be observed and tested by Arias & Associates. As a guideline, at least one in-place density test should be performed according to the table below, with a minimum of 3 tests per lift. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

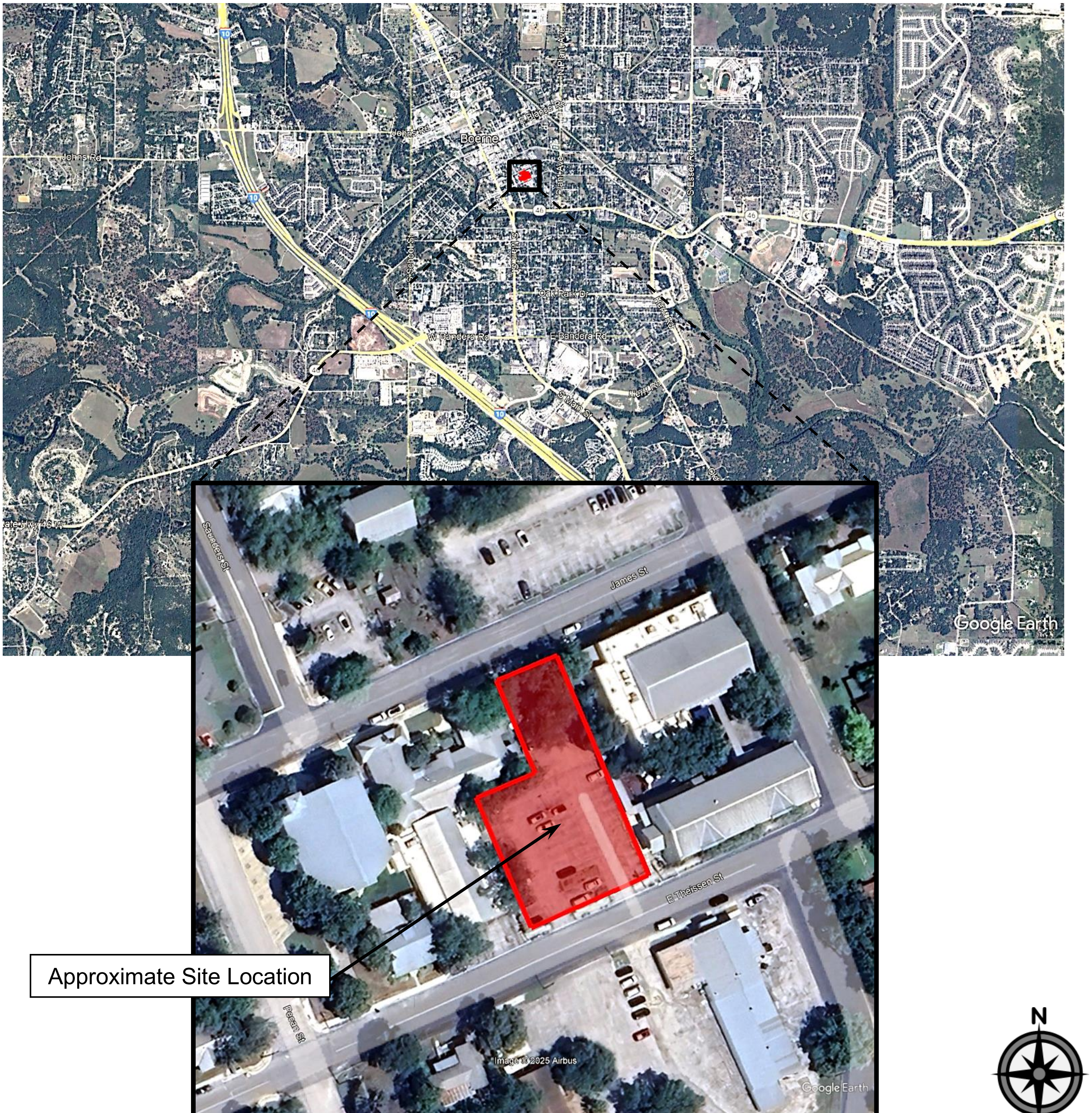
Table 15: Density Test Guidelines for Street Pavement Elements

Element	Frequency of Density Tests
Subgrade, Flexible Base, Asphaltic Base, Asphalt Course(s)	Every 2,500 Square Feet for each Lift with a Minimum of at Least 3 Tests per Lift

Standard of Care

Subject to the limitations inherent in the agreed scope of services as to the degree of care and amount of time and expenses to be incurred, and subject to any other limitations contained in the agreement for this work, Arias has performed its services consistent with that level of care and skill ordinarily exercised by other professional engineers practicing in the same locale and under similar circumstances at the time the services were performed.

APPENDIX A: FIGURES



ARIAS

142 Chula Vista, San Antonio, Texas 78232
Phone: (210) 308-5884 • Fax: (210) 308-5886

VICINITY MAP

First Methodist Church
205 James Street
Boerne, Texas

Date: November 14, 2025	Job No.: 2025-655
Drawn By: MEB	Checked By: SP
Approved By: MJO	Scale: N.T.S.

Figure 1

ARIAS
142 Chula Vista, San Antonio, Texas 78232
Phone: (210) 308-5884 • Fax: (210) 308-5886

BORING LOCATION PLAN

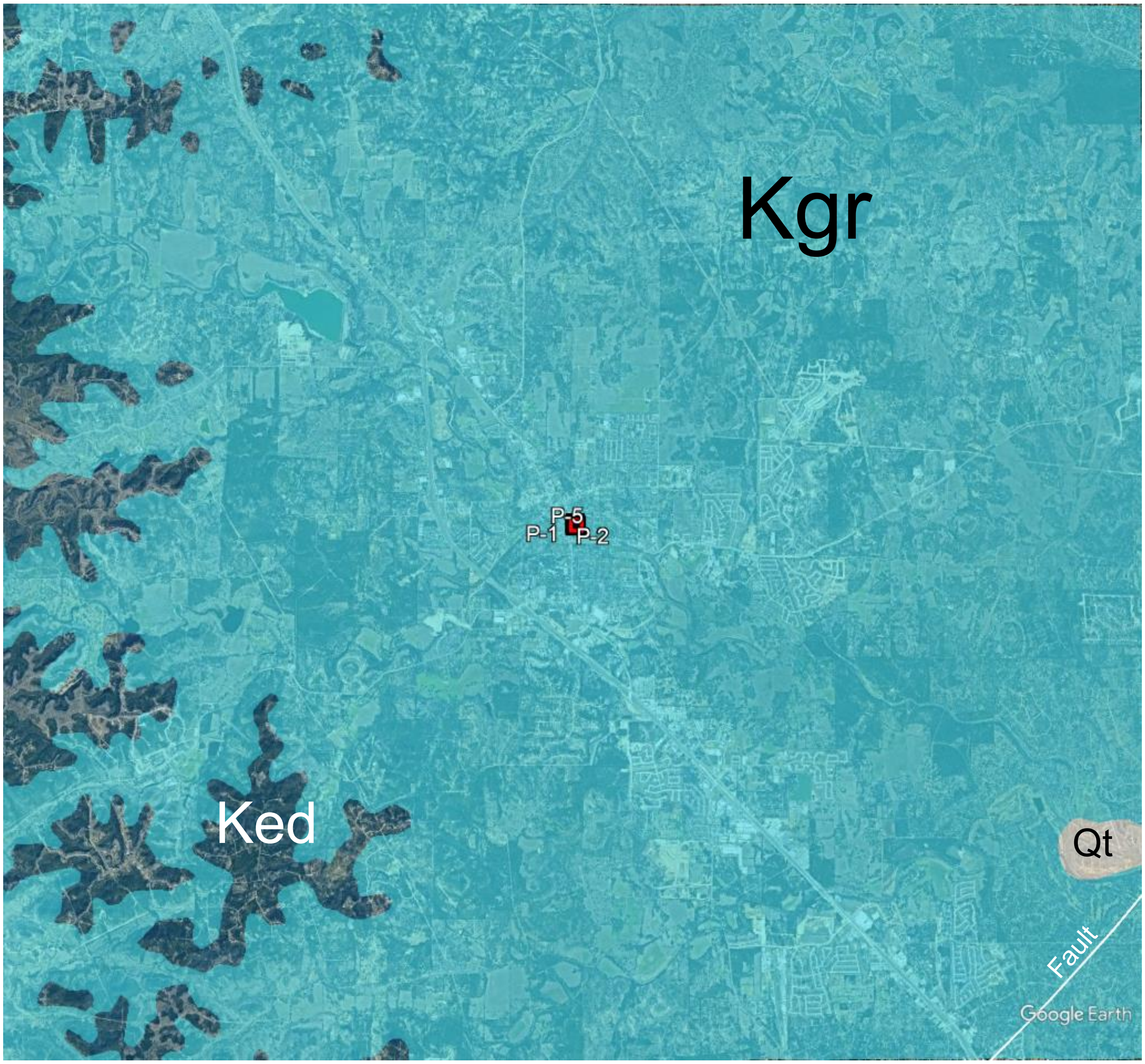
First Methodist Church
205 James Street
Boerne, Texas

Date: November 14, 2025	Job No.: 2025-655
Drawn By: MEB	Checked By: SP
Approved By: MJO	Scale: N.T.S.

REVISIONS:

No.:	Date:	Description:

Figure 2



LEGEND

Symbol	Name	Age
Kgr	Glen Rose Limestone	Cretaceous Period / Early
Ked	Edwards Limestone	Cretaceous Period / Early
Qt	Terrace Deposits	Quaternary Period / Pleistocene

N

ARIAS
142 Chula Vista, San Antonio, Texas 78232
Phone: (210) 308-5884 • Fax: (210) 308-5886

GEOLOGIC MAP

First Methodist Church
205 James Street
Boerne, Texas

Date: November 14, 2025	Job No.: 2015-857
Drawn By: TAS	Checked By: RPG
Approved By: CMS	Scale: N.T.S.

Figure 3

Photo 1 – View looking at drilling of boring P-1

Photo 2 – View looking at drilling of boring P-5

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142 Chula Vista, San Antonio, Texas 78232
Phone: (210) 308-5884 • Fax: (210) 308-5886

SITE PHOTOS

First Methodist Church
205 James Street
Boerne, Texas

Date: November 14, 2025	Job No.: 2025-655
Drawn By: MEB	Checked By: SP
Approved By: MJO	Scale: N.T.S.

Appendix A

APPENDIX B: BORING LOGS AND KEY TO TERMS

Boring Log No. P-1

Project: **First Methodist Church**
205 James Street
Boerne, Texas

Location: See Boring Location Plan

Sampling Date: 11/13/25

Coordinates: N29°47'30.63" W98°43'40.93"

Backfill: Cuttings/bentonite & patched

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
2" Asphalt over 1.25" Base		AC						
SANDY LEAN CLAY (CL), stiff, dark brown to brown	1							
		SS	15	15	37	22	13	65
	2							
	3	SS	14	16	39	23	14	64
	4							
	5	SS	12				14	
	6							

Borehole terminated at 6 feet

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: L. Arizola
Driller: Eagle Drilling, Inc.
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 6 ft

Nomenclature Used on Boring Log

Asphalt Core (AC) — Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
N = SPT Blow Count
-200 = % Passing #200 Sieve

GINT.GPJ 11/24/25 (BORING LOG SA13-02,ARIASSA13-02.GDT,LIBRARY2023.GLB)

Boring Log No. P-2

Project: **First Methodist Church**
205 James Street
Boerne, Texas

Location: See Boring Location Plan

Sampling Date: 11/13/25

Coordinates: N29°47'30.99" W98°43'41.92"

Backfill: Cuttings/bentonite & patched

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
1.25" Asphalt over 8" Base		AC						
SANDY LEAN CLAY (CL), stiff, dark brown to brown	1							
	2	SS	14				9	
	3	SS	14	16	38	22	12	63
	4							
	5	SS	14				12	
	6							
Borehole terminated at 6 feet								

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: L. Arizola
Driller: Eagle Drilling, Inc.
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 6 ft

Nomenclature Used on Boring Log

Asphalt Core (AC)   Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
N = SPT Blow Count

-200 = % Passing #200 Sieve

Boring Log No. P-3

Project: **First Methodist Church**
205 James Street
Boerne, Texas

Location: See Boring Location Plan

Sampling Date: 11/13/25

Coordinates: N29°47'30.22" W98°43'41.74"

Backfill: Cuttings/bentonite & patched

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
2.5" Asphalt over 4" Base		AC						
SANDY LEAN CLAY (CL), stiff, dark brown to brown	1							
	2	SS	13	15	38	23	13	66
	3	SS	14				14	
	4							
CLAYEY SAND with Gravel (SC), loose, brown	5	SS	10	16	37	21	7	49
	6							

Borehole terminated at 6 feet

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: L. Arizola
Driller: Eagle Drilling, Inc.
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 6 ft

Nomenclature Used on Boring Log

Asphalt Core (AC) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
N = SPT Blow Count
-200 = % Passing #200 Sieve

Boring Log No. P-4

Project: **First Methodist Church**
205 James Street
Boerne, Texas

Location: See Boring Location Plan

Sampling Date: 11/13/25

Coordinates: N29°47'31.95" W98°43'41.7"

Backfill: Cuttings/bentonite & patched

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
3" Asphalt over 6" Base	0 – 0.75	AC						
SANDY LEAN CLAY (CL), stiff, dark brown to brown	1 – 2.5	SS	9				15	
	2.5 – 4	SS	10	15	34	19	13	65
	4.5 – 6	SS	10				11	

Borehole terminated at 6 feet

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: L. Arizola
Driller: Eagle Drilling, Inc.
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 6 ft

Nomenclature Used on Boring Log

Asphalt Core (AC) — Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
N = SPT Blow Count
-200 = % Passing #200 Sieve

Boring Log No. P-5

Project: **First Methodist Church**
205 James Street
Boerne, Texas

Sampling Date: 11/13/25

Coordinates: N29°47'31.64" W98°43'41.72"

Location: See Boring Location Plan

Backfill: Cuttings/bentonite & patched

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
2" Asphalt over 3" Base		AC						
SANDY LEAN CLAY (CL), stiff, dark brown to brown	1							
	2	SS	14	15	34	19	8	64
	3	SS	8				15	
	4							
	5	SS	9	16	34	18	14	64
	6							

Borehole terminated at 6 feet

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: L. Arizola
Driller: Eagle Drilling, Inc.
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 6 ft

Nomenclature Used on Boring Log

Asphalt Core (AC)   Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
N = SPT Blow Count
-200 = % Passing #200 Sieve

GINT.GPJ 11/24/25 (BORING LOG SA13-02,ARIASSA13-02.GDT,LIBRARY2023.GLB)

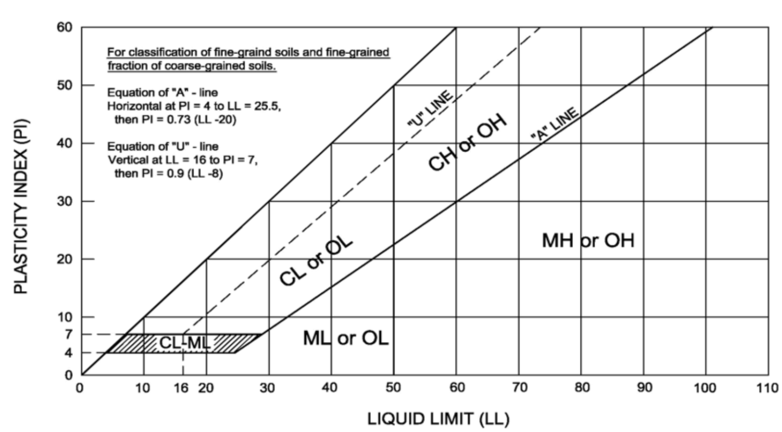
KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

MAJOR DIVISIONS				GROUP SYMBOLS	DESCRIPTIONS
COARSE-GRAINED SOILS (More than half of material LARGER than No. 200 Sieve size)	GRAVELS (More than Half of Coarse fraction is LARGER than No. 4 Sieve size)	Clean Gravels (little or no Fines)		GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
				GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
		Gravels with Fines (Appreciable amount of Fines)		GM	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS (More than half of Coarse fraction is SMALLER than No. 4 Sieve size)	Clean Sands (little or no Fines)		SW	Well-Graded Sands, Gravelly Sands, Little or no Fines
				SP	Poorly-Graded Sands, Gravelly Sands, Little or no Fines
		Sands with Fines (Appreciable amount of Fines)		SM	Silty Sands, Sand-Silt Mixtures
				SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS (More than half of material SMALLER than No. 200 Sieve size)	SILTS & CLAYS	Liquid Limit less than 50		ML	Inorganic Silts & 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
	SILTS & CLAYS	Liquid Limit greater than 50		MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils, Elastic Silts
				CH	Inorganic Clays of High Plasticity, Fat Clays
FORMATIONAL MATERIALS	SANDSTONE				Massive Sandstones, Sandstones with Gravel Clasts
	MARLSTONE				Indurated Argillaceous Limestones
	LIMESTONE				Massive or Weakly Bedded Limestones
	CLAYSTONE				Mudstone or Massive Claystones
	CHALK				Massive or Poorly Bedded Chalk Deposits
	MARINE CLAYS				Cretaceous Clay Deposits
	GROUNDWATER			▼	Indicates Final Observed Groundwater Level
				▽	Indicates Initial Observed Groundwater Location

Density of Granular Soils	
Number of Blows per ft., N	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium
30 - 50	Dense
Over 50	Very Dense

Consistency and Strength of Cohesive Soils		
Number of Blows per ft., N	Consistency	Unconfined Compressive Strength, q_u (tsf)
Below 2	Very Soft	Less than 0.25
2 - 4	Soft	0.25 - 0.5
4 - 8	Medium (Firm)	0.5 - 1.0
8 - 15	Stiff	1.0 - 2.0
15 - 30	Very Stiff	2.0 - 4.0
Over 30	Hard	Over 4.0

PLASTICITY CHART (ASTM D 2487-11)



KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

TABLE 1 Soil Classification Chart (ASTM D 2487-11)

Criteria of Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	Gravels (More than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5% fines[C])	Cu ≥ 4 and 1 ≤ Cc ≤ 3[D]	GW	Well-Graded Gravel[E]
			Cu < 4 and/or [Cc < 1 or Cc > 3][D]	GP	Poorly-Graded Gravel[E]
		Gravels with Fines (More than 12% fines[C])	Fines classify as ML or MH	GM	Silty Gravel[E,F,G]
			Fines classify as CL or CH	GC	Clayey Gravel[E,F,G]
	Sands (50% or more of coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines[H])	Cu ≥ 6 and 1 ≤ Cc ≤ 3[D]	SW	Well-Graded Sand[I]
			Cu < 6 and/or [Cc < 1 or Cc > 3][D]	SP	Poorly-Graded Sand[I]
		Sands with Fines (More than 12% fines[H])	Fines classify as ML or MH	SM	Silty Sand[F,G,I]
			Fines classify as CL or CH	SC	Clayey Sand[F,G,I]
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean Clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	(Liquid limit - oven dried) / (Liquid limit - not dried) <0.75	OL	Organic Clay[K,L,M,N] / Organi Silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat Clay[K,L,M]
			PI plots on or below "A" line	MH	Elastic Silt[K,L,M]
		organic	(Liquid limit - oven dried) / (Liquid limit - not dried) <0.75	OH	Organic Clay[K,L,M,P] / Organic Silt[K,L,M,Q]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75mm) sieve
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name
[C] Gravels with 5% to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly-graded gravel with silt
- GP-GC poorly-graded gravel with clay

[D] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[E] If soil contains ≥ 15% sand, add "with sand" to group name
[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM
[G] If fines are organic, add "with organic fines" to group name
[H] Sand with 5% to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly-graded sand with silt
- SP-SC poorly-graded sand with clay

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay
[K] If soil contains 15% to < 30% plus No. 200, add "with sand" or "with gravel," whichever is predominant
[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name
[N] PI ≥ 4 and plots on or above "A" line
[O] PI < 4 or plots below "A" line
[P] PI plots on or above "A" line
[Q] PI plots below "A" line

TERMINOLOGY

Boulders Over 12-inches (300mm)
Cobbles 12-inches to 3-inches (300mm to 75mm)
Gravel 3-inches to No. 4 sieve (75mm to 4.75mm)
Sand No. 4 sieve to No. 200 sieve (4.75mm to 0.075mm)
Silt or Clay Passing No. 200 sieve (0.075mm)
Calcareous Containing appreciable quantities of calcium carbonate, generally nodular

Parting Inclusion < 1/8-inch thick extending through samples
Seam Inclusion 1/8-inch to 3-inches thick extending through sample
Layer Inclusion > 3-inches thick extending through sample

Stratified Alternating layers of varying material or color with layers at least 6mm thick
Laminated Alternating layers of varying material or color with the layers less than 6mm thick
Fissured Breaks along definite planes of fracture with little resistance to fracturing
Slickensided Fracture planes appear polished or glossy sometimes striated
Blocky Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Homogeneous Same color and appearance throughout

KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

Hardness Classification of Intact Rock

Class	Hardness	Field Test		Approximate Range of Uniaxial Compression Strength kg/cm² (tons/ft²)
I	Extremely hard	Many blows with geologic hammer required to break intact specimen.		> 2,000
II	Very hard	Hand held specimen breaks with hammer end of pick under more than one blow.		2,000 – 1,000
III	Hard	Cannot be scraped or pealed with knife, hand held specimen can be broken with single moderate blow with pick.		1,000 – 500
IV	Soft	Can just be scraped or peeled with knife. Indentations 1mm to 3mm show in specimen with moderate blow with pick.		500 – 250
V	Very soft	Material crumbles under moderate blow with sharp end of pick and can be peeled with a knife, but is too hard to hand-trim for triaxial test specimen.		250 – 10

Rock Weathering Classifications

Grade	Symbol	Diagnostic Features
Fresh	F	No visible sign of Decomposition or discoloration. Rings under hammer impact.
Slightly Weathered	WS	Slight discoloration inwards from open fractures, otherwise similar to F.
Moderately Weathered	WM	Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.
Highly Weathered	WH	Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct, but fabric preserved.
Completely Weathered	WC	Minerals decomposed to soil, but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.
Residual Soil	RS	Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

Rock Discontinuity Spacing

Description for Structural Features: Bedding, Foliation, or Flow Banding	Spacing	Description for Joints, Faults or Other Fractures
Very thickly (bedded, foliated, or banded)	More than 6 feet	Very widely (fractured or jointed)
Thickly	2 – 6 feet	Widely
Medium	8 – 24 inches	Medium
Thinly	2½ – 8 inches	Closely
Very thinly	¾ – 2½ inches	Very closely
Description for Micro-Structural Features: Lamination, Foliation, or Cleavage	**Spacing**	**Descriptions for Joints, Faults, or Other Fractures**
Intensely (laminated, foliated, or cleaved)	¼ – ¾ inch	Extremely close
Very intensely	Less than ¼ inch	

Engineering Classification for in Situ Rock Quality

RQD %	Velocity Index	Rock Mass Quality
90 – 100	0.80 – 1.00	Excellent
75 – 90	0.60 – 0.80	Good
50 – 75	0.40 – 0.60	Fair
25 – 50	0.20 – 0.40	Poor
0 – 25	0 – 0.20	Very Poor

APPENDIX C: LABORATORY AND FIELD TEST PROCEDURES

FIELD AND LABORATORY EXPLORATION

The field exploration program included drilling at selected locations within the site and intermittently sampling the encountered materials. The boreholes were drilled using a single flight auger (ASTM D 1452). Samples of encountered materials were obtained using a split-barrel sampler while performing the Standard Penetration Test (ASTM D 1586) or using a thin-walled tube sampler (ASTM D 1587). The sample depth interval and type of sampler used is included on the soil boring log. Arias' field representative visually logged each recovered sample and placed a portion of the recovered sampled into a plastic bag for transport to our laboratory.

SPT N values and blow counts for those intervals where the sampler could not be advanced for the required 18-inch penetration are shown on the soil boring log. If the test was terminated during the 6-inch seating interval or after 10 hammer blows were applied used and no advancement of the sampler was noted, the log denotes this condition as blow count during seating penetration. Penetrometer readings recorded for thin-walled tube samples that remained intact also are shown on the soil boring log.

Arias performed soil mechanics laboratory tests on selected samples to aid in soil classification and to determine engineering properties. Tests commonly used in geotechnical exploration, the method used to perform the test, and the column designation on the boring log where data are reported are summarized as follows:

Test Name	Test Method	Log Designation
Water (moisture) content of soil and rock by mass	ASTM D 2216	WC
Amount of material in soils finer than the No. 200 sieve	ASTM D 1140	-200

The laboratory results are reported on the soil boring logs.

APPENDIX D: GBA INFORMATION

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.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in 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.

Geotechnical-Engineering 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 given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives 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 this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- 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. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering 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 subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

APPENDIX E: PROJECT QUALITY ASSURANCE

A Message to Owners from ASFE/GBA

Construction-materials engineering and testing (CoMET) consultants perform quality-assurance (QA) services to evaluate how well constructors are achieving the specified conditions they're contractually obligated to achieve. Done right, QA can save you time and money while helping you manage project risks by detecting molehills before they grow into mountains you and the design team are forced to climb.

Done right, QA can save you time and money; prevent claims and disputes; and reduce risks. Many owners don't do QA right because they follow bad advice.

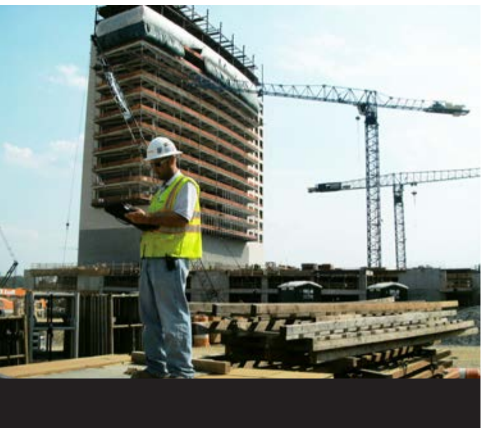
It's ironic that, as important as CoMET consultants can be, some owners and design professionals treat them as though they were commodities. Often referred to incorrectly as "testing labs," CoMET consultants create the last line of defense against costly construction errors and the delays, change orders, claims, disputes, and litigation that can result. Why would owners entrust such an important responsibility to the firm offering to fulfill it for the lowest fee as opposed to the one whose qualifications enable it to offer the best service and the most value? The answer: Too many owners follow bad advice; e.g., "CoMET consultants are all the same. They all follow the same standards. They all have accredited laboratories and certified personnel. Go with the low bidder." That's bad advice because there's no such thing as a standard QA scope of service, meaning that – to bid – each interested firm *must* develop its own scope…and it has to be a cheap scope in order to offer the low fee the owner apparently prefers. A cheap scope cannot help but jeopardize service quality, aggravating risk for you and the entire project team. Of course, some firms will offer what seems to be a better scope at a "low-ball," less-than-cost bid in order to win the commission and then earn a profit through multiple change orders.

You have too much at stake to follow bad advice. Consider these facts.

Fact: ***Most CoMET firms are not accredited,*** including some that say they are and some that don't even follow the correct standards, even when they say they do. And the quality of those that are accredited varies significantly; some practice at a high level; others just barely scrape by. As such, while accreditation is extremely important, it is far from being a "be-all and end-all." It signifies only that a firm's facilities or operations met the *minimum criteria* of an accrediting body whose concerns in some cases may have little to do with your project. And the condition of what an accrediting body typically evaluates – management systems, technical staff, facilities, and equipment – can change substantially between on-site accreditation assessments.

ASFE THE GEOPROFESSIONAL BUSINESS ASSOCIATION
8811 Colesville Road
Suite G106
Silver Spring, Maryland 20910
Voice: 301.565.2733
Fax: 301.589.2017
E-mail: info@asfe.org
Internet: www.asfe.org

Most CoMET firms are not accredited and it's dangerous to assume CoMET personnel are certified.



Fact: ***It's dangerous to assume CoMET personnel are certified.*** Many have no credentials; some are certified by organizations of questionable merit, while others have a valid certification, but *not* for the services they're assigned. All too many have little training or none at all.

Some CoMET firms – the "low-cost providers" – *want* you to believe that price is the only difference between QA providers. It's not: Firms that sell low price typically lack:

- facilities appropriate for many of the projects they accept,
- equipment that is well maintained and properly calibrated,
- field and laboratory personnel who are well trained and appreciate the importance of their responsibilities,
- management with the education, experience, and judgment to provide technical oversight, and
- the professional-liability insurance you should require to enjoy peace of mind.

Quality-oriented firms invest in the facilities, equipment, personnel, and insurance needed to achieve quality in quality assurance.

Quality-oriented firms invest in the facilities, equipment, personnel, and insurance needed to achieve quality in quality assurance.

To derive maximum value from your QA investment, have the CoMET firm's project manager serve actively on the project team from beginning to end, a level of service that's relatively inexpensive and can pay huge dividends. During the project's planning and design stages, experienced CoMET professionals can help the design team develop consistent, cost-effective technical specifications and establish appropriate observation, testing, and instrumentation protocols. They can analyze plans and specs much as constructors do, looking for the little errors, omissions, conflicts, and ambiguities that often lead to the misunderstandings and confusion that become the basis for big extras and big claims. They can also provide guidance about operations and materials that need closer review than others, because of their criticality or potential for error or abuse, and even suggest reduced levels of review or testing for areas of a less critical nature, based on local experience. You can also benefit from a CoMET professional's frank assessments of the various constructors that have expressed interest in the project.

To derive maximum value, have the CoMET project manager serve actively on the project team from beginning to end.

CoMET consultants' construction-phase QA services focus on two distinct issues:

- those that relate to geotechnical engineering and
- those that relate to the other elements of construction.

Geotechnical-engineering issues are critically important because they are essential to the "observational method" geotechnical engineers use to help their clients save time and money while maintaining a "healthy respect" for the unknown in the underground.

In essence, the observational method is an overall approach that begins during the earliest element of the design phase and carries through to the construction phase. Geotechnical engineers initiate this approach by applying their knowledge of local geological conditions to develop an economical subsurface-sampling plan. Proper execution of the plan should derive just enough samples from just enough areas to permit an experienced geotechnical engineer to develop an assumed-subsurface profile. Because so much depends on the reliability of each sample, quality-focused geotechnical engineers often insist that their own personnel perform or oversee the sampling process, from obtaining the samples to packaging, storing, and transporting them to a trusted laboratory, using their own equipment and facilities or relying on others' they know they can trust.

Combining the assumed subsurface profile with knowledge of what is being constructed – e.g., its dimensions, weight, anticipated use, and performance objectives – geotechnical engineers develop *provisional* recommendations for the structure's foundations and for the specifications of various "geo" elements, like excavations, site grading, foundation-bearing grades, and roadway and parking-lot preparation and surfacing. When geotechnical engineers know that their personnel will be on site observing subsurface conditions as they are exposed, they usually will recommend the most cost-effective design their assumptions make practical, knowing that – if their assumed-subsurface profile is "off" in any significant way – the variances will be caught (that's what they teach their field personnel to do), permitting them to "tweak" their recommendations in the field. *It is essential to realize that geotechnical engineers cannot finalize their recommendations until they or their field representatives are on site to observe what's excavated to verify that the subsurface conditions the engineers predicted are those that actually exist.*

Geotechnical engineers cannot finalize their recommendations until they are on site to verify that the subsurface conditions they predicted are those that actually exist. Entrusting geotechnical field observation to someone other than the geotechnical engineer of record creates a significant risk.

Insofar as **other elements of construction** are concerned, many geotechnical-engineering firms have obliged their clients by expanding their field-services mix, so they're able to perform overall construction QA, encompassing – in addition to geotechnical issues – reinforced concrete, structural steel, structural masonry, fireproofing, and so on. Unfortunately, that's caused some confusion. Believing that all CoMET consultants are alike, some owners take bids for the overall CoMET package, including the geotechnical field observation, thus curtailing services of the geotechnical engineer of record (GER). ***Entrusting geotechnical field observation to someone other than the GER creates a significant risk.***

GERs have developed a variety of protocols to optimize the quality of their field-observation procedures. Quality-focused GERs meet with their field representatives before the representatives leave for a project site, to brief them on what to look for and where, when, and how to look. (***No one can duplicate this briefing***, because no one else knows as much about a project's geotechnical issues.) And once they arrive at a project site, the field representatives know to maintain timely, effective communication with the GER, because that's what the GER has trained them to do. By contrast, it's extremely rare for a different

firm's field personnel to contact the GER, even when they're concerned or confused about what they observe, because they regard the GER's firm as "the competition." Convoluted project-communications protocols can make this communications breakdown even worse.

A different firm is often willing to perform on-site geotechnical review for less money than the GER, frequently because it treats geotechnical field services as a "loss leader" in order to obtain the far larger, overall CoMET commission. Given the significant risk that supplanting the GER creates, accepting the offer is almost always penny-wise and pound-foolish. Still, because some owners accept bad advice, it's commonly done, helping to explain why ***"geo" issues are the number-one source of construction-industry claims and disputes.***

Divorcing the GER from geotechnical field operations is almost always penny-wise and pound-foolish, helping to explain why "geo" issues are the number-one source of construction-industry claims and disputes.

To derive the biggest bang for the QA buck, identify three or even four quality-focused CoMET consultants. (If you don't know any, use the "Find a Geoprofessional" service available free at www.asfe.org.) Ask about the firms' ongoing and recent projects and the clients and client representatives involved; *insist upon receiving verification of all claimed accreditations, certifications, licenses, and insurance coverages.*

Insist upon receiving verification of all claimed accreditations, certifications, licenses, and insurance coverages.

Once you identify the two or three most qualified firms, meet with their key personnel, preferably at their own facility, so you can inspect their laboratory, speak with management and technical staff, and form an opinion about the firm's capabilities and attitude.

Insist that each firm's designated project manager and lead field representative participate in the meeting. You will benefit when those individuals are seasoned QA professionals familiar with construction's rough-and-tumble. Ask about others the firm will assign, too. There's no substitute for experienced, certified personnel who are familiar with the codes and standards involved and know how to:

- read and interpret plans and specifications;
- perform the necessary observation, inspection, and testing;
- document their observations and findings;
- interact with constructors' personnel; and
- respond to the unexpected.

Important: Many of the services CoMET QA field representatives perform – like observing operations and outcomes – require the good judgment afforded by extensive training and experience. Who will be on hand when the unexpected occurs: a 15-year "veteran" or a rookie?

Many of the services CoMET QA field representatives perform require good judgment.

Also consider the tools CoMET personnel use. Some firms are fanatical about proper maintenance and calibration; others, less so. Ask to see the firm's calibration records. If the firm doesn't have any, or if they are not current, be cautious: *You cannot trust test results derived using equipment that may be out of calibration.* Also ask if the firm's laboratory participates in

proficiency testing, relying on a program like the one sponsored by the American Association of State Highway and Transportation Officials (AASHTO). And be sure to ask a firm's representatives about their reporting practices, including report distribution and timeliness, how they handle notifications of nonconformance, and how they resolve complaints.

Once you identify your preferred firm, meet with its representatives again. Provide the approved plans and specifications and other pertinent materials, like a construction schedule, and discuss what's needed to finalize a scope of service that reflects what will be happening on site and when it will occur. Recognize that most CoMET services are performed periodically or randomly, not continuously. Also recognize that a CoMET consultant's field representatives cannot be in all places at all times, an important issue when multiple activities are ongoing simultaneously. Ask for guidance about appropriate staffing levels and discuss the trade-offs that may be available.

Creating a detailed scope of CoMET QA service can help avoid surprises. Still, scope flexibility is needed to deal promptly with the unanticipated, like the additional services required to check the rework performed because of an error caught in QA.

Scope flexibility is needed to deal promptly with the unanticipated.

For financing purposes, some owners require the constructor to pay for CoMET services. ***Consider an alternative approach*** so you don't convert the constructor into the CoMET consultant's client. If it's essential for you to fund QA via the constructor, have the CoMET fee included as an allowance in the bid documents. This arrangement ensures that you remain the CoMET consultant's client, and it prevents the CoMET fee from becoming part of the constructor's bid-price competition. (Note that the International Building Code (IBC) *requires the owner to pay* for Special Inspection (SI) services commonly performed by the CoMET consultant as a service separate from QA, to help ensure the independence of the SI process. Because failure to comply could result in denial of an occupancy or use permit, having a contractual agreement that conforms to local code requirements is essential.)

If it's essential for you to fund QA via the constructor, have the CoMET fee included as an allowance in the bid documents. Note, too, that the International Building Code (IBC) requires you to pay for Special Inspection (SI) services.

CoMET consultants can usually quote their fees as unit fees, unit fees with estimated total (invoiced on a unit-fee basis), or lump-sum (invoiced on a percent-completion basis referenced to a schedule of values). No matter which method is used, estimated quantities need to be realistic. Some CoMET firms lower their total-fee estimates by using quantities they know are too low and then request change orders long before construction and the need for QA are complete.

Once you and the CoMET consultant settle on the scope of service and fee, enter into a written contract. Established CoMET firms have their own contracts; most owners sign them. Some owners prefer to use different contracts, but that can be a mistake when the contract was prepared for construction services. *Professional services are different.* Wholly avoidable problems occur when a contract includes provisions that don't apply to the services involved and fails to include those that do.

Some owners create wholly avoidable problems by using a contract prepared for construction services.

This final note: CoMET consultants perform QA for owners, not constructors. While constructors are commonly given review copies of QA reports *as a courtesy*, you need to make it clear that constructors do *not* have a legal right to rely on those reports; i.e., if constructors want to forgo their own observation and testing and rely on results derived from a scope created to meet *only* the needs of the owner, they *must do so at their own risk.* In all too many cases where owners have failed to make that clear, constructors have alleged that they *did* have a legal right to rely on QA reports and, as a result, the CoMET consultant – not they – are responsible for their failure to deliver what they contractually promised to provide. The outcome can be delays and disputes that entangle you and all other principal project participants. Avoid that. Rely on CoMET professionals with the resources and attitude needed to manage this and other risks as an element of a quality-focused service. Involve them early. Keep them engaged. And listen to what they say. Good CoMET consultants can provide great value.

For more information, speak with representatives of a firm that's part of ASFE/The Geoprofessional Business Association (GBA) or contact GBA staff. In either case, your inquiries will be warmly welcomed.

ASFE THE GEOPROFESSIONAL BUSINESS ASSOCIATION
8811 Colesville Road
Suite G106
Silver Spring, Maryland 20910
Voice: 301.565.2733
Fax: 301.589.2017
E-mail: info@asfe.org
Internet: www.asfe.org