City of San Antonio

PUBLIC WORKS DEPARTMENT

ADDENDUM No. 1

REQUEST FOR COMPETITIVE SEALED PROPOSALS (RFCSP)

PROJECT NAME: District 9 Senior Center – #042920DR

DATE: May 18, 2020

This addendum is separated into sections for convenience; however, all respondents, and other parties shall be responsible for reading the entire addendum. The failure to list an item or items in all affected sections of this addendum does not relieve any party affected from performing as per instructions, providing that the information is set forth one time any place in this addendum. These documents shall be attached to and become part of the Contract Documents for this project. The respondent shall be required to acknowledge the receipt of this addendum.

GENERAL:

1. The following changes and/or additions to the Contract Documents, via this addendum, shall apply to proposals made for and to the execution of the various parts of the work affected thereby.
2. Careful note of the Addendum shall be taken by all interested parties and all trades affected shall be fully advised in their performance of the work involved.

GENERAL COMMENTS:

1. The "**Insurance Requirements**" document has been added and uploaded as part of the solicitation documents.

2. Item 1.01 – Inclusion of Missing Specification Sections
Sections 00 26 00, 01 23 00 and 32 84 00 have been added to Specification Volumes 1 and 2, respectively.

3. Item 1.02 – Hard Copy Price Revision
The RFCSP Section II, 'Plans and Specifications of the Construction Documents' is to be revised to read: May be purchased at a cost of $300.00 per set (tax included) from the office of Beaty Palmer Architects, 110 Broadway, Suite 600, San Antonio, Texas, 78205. Phone number (210) 212-8022. No refund will be made for plan sets that are returned. Documents may also be downloaded on the CivCast website at https://www.civcastusa.com/bids."

4. Item 1.03 – SAWS Public Sewer Main Coordination
General Contractor to coordinate phasing of sewer work with neighboring 27" Public Sewer Main project by SAWS, which is anticipated to be under construction while the Senior Center is under construction.
Contact SAWS Project Manager, Patrick O'Connor, (210)233-3020, Patrick.OConnor@saws.org, for coordination of construction activities.

5. Item 1.04 – Geotechnical Report
The Geotechnical Report has been added to the online bid posting.

ADDITIONAL QUESTIONS FROM PROSPECTIVE RESPONDENT:

Received Question:

1. Question – (9) wheel stops are shown adjacent to add alternate charging stations along Rhapsody frontage, but not shown on Civil Plans. Are these wheel stops required in the base bid?

Response – Yes, these (9) wheel stops are required in the base bid. By bidding on the project, the successful bidder represents that their bid includes the cost for provision and installation of these wheel stops.

2. **Question –** Project is missing 01 23 00 from division 01 - general requirements and 32 84 00 from division 32- exterior improvements per the Table of Contents.

   Response – Missing specification sections have been added as part of this addendum. Refer to the attached.

3. **Question –** Is this project sales tax exempt?

   Response – Yes, this project will be tax exempt.

4. **Question –** When will the remaining specifications be provided? There are only documents to a few specific scopes of works included in the solicitation.

   Response – Missing specification sections have been added as part of this Addendum. Each discipline's specifications are included in one of the (6) Spec Volumes.

5. **Question –** THE NEC E905 that is specified in the project is End of Life and NEC has "0" backstock. What replacement model is preferred? C981Q (98 inch) or C861Q (86 inch)

   Response – Submit all substitution requests per section 00 26 00, included as part of this addendum.

6. **Question –** Would you consider open cell spray foam insulation in the walls in lieu of batt insulation?

   Response – Submit all substitution requests per section 00 26 00, included as part of this addendum.

7. **Question –** How would you like to see substitution requests submitted?

   Response – Submit all substitution requests per section 00 26 00, included as part of this addendum.

ATTACHMENTS

Specifications: 00 26 00 (1 page)
01 23 00 (3 pages)
32 84 00 (11 pages)
CSI Form 1.5C Substitution Request
Geotechnical Report dated 05.02.19

ISSUED BY

05.15.20
Cory Hawkins, AIA
Beaty Palmer Architects, Inc.

END OF ADDENDUM No. 1

SUBSTITUTION REQUEST

(During the Bidding/Negotiating Stage)

Project: _____ Substitution Request Number: _____

_____ From: _____

To: _____ Date: _____

_____ A/E Project Number: _____

Re: _____ Contract For: _____

Specification Title: _____ Description: _____

Section: _____ _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Attached data includes product description, specifications, drawings, photographs, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

_____

Telephone: _____

A/E's REVIEW AND ACTION

☐ Substitution approved - Make submittals in accordance with Specification Section 01 25 00 Substitution Procedures.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01 25 00 Substitution Procedures.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: Date:

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

Form Version: January 2013
CSI Form 1.5C

DOCUMENT 002600 - PROCUREMENT SUBSTITUTION PROCEDURES

1.1 DEFINITIONS

A. Procurement Substitution Requests: Requests for changes in products, materials, equipment, and methods of construction from those indicated in the Procurement and Contracting Documents, submitted prior to receipt of bids.

B. Substitution Requests: Requests for changes in products, materials, equipment, and methods of construction from those indicated in the Contract Documents, submitted following Contract award. See Section 012500 "Substitution Procedures" for conditions under which Substitution requests will be considered following Contract award.

1.2 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.3 PROCUREMENT SUBSTITUTIONS

A. Procurement Substitutions, General: By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.

B. Procurement Substitution Requests will be received and considered by Owner when the following conditions are satisfied, as determined by Architect; otherwise requests will be returned without action:

1. Extensive revisions to the Contract Documents are not required.
2. Proposed changes are in keeping with the general intent of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
3. The request is fully documented and properly submitted.

1.4 SUBMITTALS

A. Procurement Substitution Request: Submit to Architect. Procurement Substitution Request must be made in writing by prime contract Bidder only in compliance with the following requirements:

1. Requests for substitution of materials and equipment will be considered if received no later than 10 days prior to date of bid opening.

2. Submittal Format: Submit three copies of each written Procurement Substitution Request, using CSI Substitution Request Form 1.5C.

B. Architect's Action:

1. Architect may request additional information or documentation necessary for evaluation of the Procurement Substitution Request. Architect will notify all bidders of acceptance of the proposed substitute by means of an Addendum to the Procurement and Contracting Documents.

C. Architect's approval of a substitute during bidding does not relieve Contractor of the responsibility to submit required shop drawings and to comply with all other requirements of the Contract Documents.

END OF DOCUMENT 002600

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification of Parties to the Project: Following award of the Contract and prior to contract execution/NTP, the Owner will notify each party involved, in writing, of the status of each alternate. The Owner's notification will indicate if alternates have been accepted, rejected, or deferred for later consideration. If applicable, Owner will include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1: Expanded Parking Lot

1. Base Bid: The Base Bid for the project includes s improvements for multiple disciplines as indicated in the Construction Documents on Drawing Sheets A2.2, A2.4, C1, C2, C3, C4, C5, C6, C8, C9, C10, E0.1, L1.0, L2.0, L2.1, L2.2, L2.3, L2.4, L2.5, I1.0, I1.1, I1.2, I1.3,I1.4, & I1.6.

2. Alternate: For Alternate No. 1 include the amount to be added to the Base Bid for construction of an expanded parking lot and all associated improvement as indicated on Drawing Sheets A2.3, C7, E0.2, L1.3, L2.6, L2.9, I1.0, I1.5, & I1.6. Scope includes, identified in the Construction Documents as Alternate No. 1. Scope includes but is not limited to, additional paving, sidewalks, landscaping, site lighting, irrigation, striping, and earthwork.

B. Alternate No. 2: Masonry Veneer Selection

1. Base Bid: The Base Bid for the project includes ground face (burnished) cmu masonry veneer as indicated in the Construction Documents on Drawing Sheet A6.1 and Specification Section 042223 – Architectural Concrete Masonry Veneer.

2. Alternate: For Alternate No. 2 include the amount to be added or deducted from the base bid for provision and installation of limestone masonry veneer in lieu of the ground face (burnished) cmu masonry veneer as indicated in the Construction Documents on Drawing Sheet A6.2 and Specification Section 044311 – Limestone Masonry Veneer.

C. Alternate No. 3: Additional Electric Vehicle Charging Stations

1. Base Bid: The Base Bid for the project includes (1) fully functional Dual Electric Vehicle Charging Station to serve (1) accessible parking space and (1) non-accessible parking space as indicated on the Construction Documents. The Base Bid also includes conduit/raceway and pull box for (5) future dual electric vehicle charging stations as indicated in the Construction Documents Electrical Site Plans. Intent for the base bid is to provide infrastructure for future electric vehicle charging stations.

2. Alternate: For Alternate No. 3 include the amount to be added to the base bid for provision and installation of (5) fully functional dual electric vehicle charging stations and all required support infrastructure including but not limited to concrete footings, wiring, transformers, disconnects, and sub-panels. Include cost for 5 additional Electrical Vehicle parking signs per the signage details in the Construction Documents. This installation is to utilize the conduits provided in the Base Bid.

D. Alternate No. 4: Landscape Gravel Edge

1. Base Bid: The Base Bid for the project includes steel edging, weed barrier, and washed rainbow river gravel around the perimeter of the building.

2. Alternate: For Alternate No. 4 include the amount to be deducted from the Base Bid for provision and installation of sod in lieu of the landscaped gravel edge condition. This alternate excludes gravel areas indicated over structural foundations.

E. Alternate No. 5: Substitute Reinforced Concrete Flatwork for Gravel Edge Condition

1. Base Bid: The Base Bid for the project includes steel edging, weed barrier, and washed rainbow river gravel around the perimeter of the building.

2. Alternate: For Alternate No. 5 include the amount to be added or deducted from the base bid for provision and installation of the reinforced concrete flatwork in lieu of the landscaped gravel edge. Concrete flatwork to be 4" thick, reinforced with #3 bars at 12" ocew, with integral color and sandblasted finish.

F. Alternate No. 6: Integral Colored Concrete

1. Base Bid: The Base Bid for the project includes integrally colored exterior concrete inside the project site.

2. Alternate: For Alternate No. 6 include the amount to be deducted from the Base Bid for omission of the concrete colorant for exterior concrete finishing inside the project site.

G. Alternate No. 7: Standing Seam Roof Finish

1. Base Bid: The Base Bid for the project includes a prefinished standing seam metal roof with flouropolymer finish "Preweathered Galvalume" by Berridge Manufacturing or equal.

2. Alternate: For Alternate No. 7 include the amount to be added or deducted from the Base Bid for provision and installation of an acrylic coated galvalume roof finish in lieu of the flouropolymer finish specified.

END OF SECTION 012300

SECTION 328400 – PLANTING IRRIGATION

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide an underground irrigation system as shown and specified. The work includes:

1. Automatic irrigation system including piping, fittings, sprinkler heads, controller, and accessories.
2. Valves and fittings.
3. Testing.
4. Excavating and backfilling irrigation system work.
5. Associated exterior plumbing, and accessories to complete the system
6. Pipe sleeves.

B. Related Work:

1. Planting
2. Temporary Tree Protection
3. Division 16 – Electrical

1.2 QUALITY ASSURANCE

A. Installer's qualifications: Minimum of 3 years experience installing irrigation systems of comparable size. Contractor shall be a licensed and bonded Irrigator.

B. Materials, equipment, and methods of installation shall comply with the following codes and standards:

1. Texas Commission On Environmental Quality (TCEQ) Chapter 34, Texas Water Code; Chapter 344 Rules for Irrigators.
2. National Fire Protection Association, (NFPA): National Electrical Code.
3. American Society for Testing and Materials, (ASTM).
4. National Sanitation Foundation, (NSF).
5. City of San Antonio Applicable Plumbing Code

6. City of San Antonio Uniform Development Code

C. Excavating, backfilling, and compacting operations: Comply with requirements and as specified.

D. Obtain Owner's acceptance of installed and tested irrigation system prior to installing backfill materials.

1.3 SUBMITTAL

A. Submit for approval, manufacturer's product data for all equipment and materials specified herein or proposed for use on this project. Provide information for, but not limited to:

1. Sprinklers, spray and rotary.
2. Nozzles
3. Check Valves for all sprinklers. (Check valves are required for all sprinklers).
4. Piping
5. Pipe Fittings
6. Swing Joints
7. Pipe Cement
8. Controllers
9. Wire
10. Wire Splice Kits
11 Remote Control Valves
12. Gate or Manual Valves
13. Valve Boxes (Remote control valves, wire splice location, gate/manual valves, etc.)
14. And any other equipment or product necessary to properly complete the work as shown on the drawings and specified herein.

B. **On each copy of the submittal, circle in red or highlight in yellow, each specific product proposed for use. <u>COPIES NOT SO MARKED WILL BE REJECTED</u>.**

C. Upon irrigation system acceptance, submit written operating and maintenance instructions. Provide format and contents as directed by the Landscape Architect.

D. Provide irrigation system record "as-built" drawings:

1. During the course of installation, legibly mark all changes on drawings to record actual construction.

2. Upon completion of the installation, transfer the record data to a clean professional quality base drawing and submit to the Landscape Architect for approval.

a. Indicate horizontal and vertical locations referenced to permanent surface improvements.

b. Identify field changes of dimension and detail and changes made by Change Order.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver irrigation system components in manufacturer's original undamaged and unopened containers with labels intact and legible.

B Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends, both threaded or plain.

C. Store and handle materials to prevent damage and deterioration. Do not store PVC pipe in direct sunlight for more than 48 hours.

D. To prevent installation delays provide secure locked storage for valves, sprinkler heads, and similar components that can not be immediately replaced.

1.5 PROJECT CONDITIONS

A. Known underground and surface utility lines are indicated on the utility survey. Verify locations of all known underground and surface utilities by contacting the appropriate utility companies.

B. Protect existing trees, plants, lawns, and other features designated to remain as part of the final landscape work.

C. Promptly repair damage to adjacent facilities caused by irrigation system work operations. Cost of repairs at contractor's expense.

D. Promptly notify the Owner of unexpected sub-surface conditions.

E. Irrigation system layout is diagrammatic. Exact locations of piping, sprinkler heads, valves, and other components shall be established by contractor in the field at time of installation. Proposed piping layout within tree drip lines will be reviewed by Architect prior to installation. Obtain Architect's approval prior to installation.

1. Space sprinkler components as designed, not to exceed manufacturer recommendations.

2. Minor adjustments in system layout will be permitted to clear existing fixed obstructions. Final system layout shall be acceptable to the Architect and Owner.

F. Cutting and patching: (if necessary)

1. Cut through concrete and masonry with core drills. Jack hammers not permit ted.

2. Material and finishes for patching shall match existing cut surface materials and finish. Exercise special care to provide patching at openings in exterior walls watertight.

3. Methods and materials used for cutting and patching shall be acceptable to the Owner.

1.6 WARRANTY AND GUARANTEE

A. Materials and workmanship shall be fully guaranteed for one (1) year after substantial completion.

B. Backfilling of all excavation shall be guaranteed for the one (1) year guarantee period. Repair trenches which have settled.

C. Raise or lower heads to compensate for settling of lawn areas.

D. Provide a one (1) year warranty against material, installation and operation defects. Repairs, adjustments and replacement of defective irrigation system materials, including materials which have been installed on the work during the warranty period shall be at Contractor's expense.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer

1. Weathermatic
2. Hunter
3. Carson Access Boxes
4. Lasco
5. Nibco
6. Spears
7. Netafim

B. If contractor chooses to install alternate equipment he shall submit to Architect for acceptance the following:

1. Equipment specifications and product literature

2. Pressure loss calculations including all lateral sections

2.2 MATERIALS

A. General:

1. Provide only new materials, without flaws or defects and of the highest quality of their specified class and kind.

2. Comply with pipe sizes indicated. No substitution of smaller pipes will be permitted. Larger sizes may be used subject to acceptance of the Architect. Remove damaged and defective pipe.

3. Provide pipe continuously and permanently marked with manufacturer's name or trademark, size schedule and type of pipe, working pressure at 73□ F. and National Sanitation Foundation (NSF) approval.

B. Plastic pipe, fittings, and connections;

1. Polyvinyl chloride pipe: ASTM D2241, rigid, unplasticized PVC, extruded from virgin parent material. Provide pipe homogenous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles, and dents.

a. 1/2-inch diameter: SDR 13.5, Class 315.

b. 3/4-inch diameter and over: SDR 21, Class 200.

c. Main line is Sch 40.

d. 4-inch pipe and over: Class 200

2. PVC pipe fittings: ASTM D2241 schedule 40 PVC molded fittings suitable for solvent weld or slip joint ring tight seal. For any threaded connections use only Schedule 80 PVC. Fittings made of other materials are not permitted.

a. Size slip fitting socket taper to permit a dry un-softened pipe end to be inserted no more than halfway into the socket. Saddle and cross fittings are not permitted.

b. Schedule 80 PVC pipe may be threaded.

c. Use PVC male adapters for plastic to metal connections. Hand-tighten male adapters plus one turn with a strap wrench.

C. Sprinkler heads, valves, and associated equipment.

1. Refer to drawings for materials.

a. Lawn spray type sprinkler heads: HUNTER PRO SPRAY PROS-PRS40-04-CV with MP Rotator Nozzles and check valves

b. Remote control valves: Weathermatic 11000 Series

c. Drip Irrigation: Netafim Techline CV

d. Underground Splices. Wade WC 014 series

e. Valve access box: Commercial grade jumbo rectangular valve box, i.e. Rainbird.

D. Controls:

1. Refer to drawings list.

E. Electric control wire:

1. Control wire shall be 14 AWG, UF Classification, UL approved for direct burial. ***(2-wire control wire shall be SmartWire SLWIRE in size as specified by the control manufacturer.)***

2. For runs longer than 2000 feet, larger cable may be used provided it conforms to controller manufacturer's specifications for both material specification and installation.

3. All wire splices shall be protected by a valve box. All wire splices shall be shown on "as-built" drawings. No splices will be allowed on runs of less than 500 feet.

2.3 ACCESSORIES

A. Drainage fill: No. 4 to 1/2-inch washed pea gravel.

B. Fill: Clean soil free of stones larger than 3/4-inch diameter, foreign matter, organic material, and debris.

1. Provide imported fill material as required to complete the work. Obtain rights and pay all costs for imported materials.

2. Suitable excavated materials removed to accommodate the irrigation system work may be used as fill material subject to the Landscape Architect's review and acceptance.

C. Clamps; Stainless steel, worm gear hose clamps with stainless steel screws or ear type clamps.

D. Low Voltage wire connectors: WC 014 splice by Wade Enterprises.

E. Valve access boxes: Tapered enclosure of rigid plastic material comprised of fibrous components chemically inert and unaffected by moisture corrosion and temperature changes. Provide lid of same material, black or green in color. Provide Commercial Grade Jumbo Rectangular Valve Box for remote control valves. Use valve box extensions as necessary to maintain proper level relative to grade. Provide 10-inch Valve Box for wire splices.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine final grades and installation conditions. Do not start irrigation system work until unsatisfactory conditions are corrected.

B. This contractor to verify existing and proposed locations of all site utilities (i.e., gas, water, electric, telephone, sanitary and storm sewers, etc.) prior to any trenching and laying of pipe. In addition, this contractor shall coordinate all irrigation work with that of all other site work trades and contractors, as applicable.

3.2 PREPARATION

A. Lay out and stake the location of each sprinkler head and sprinkler valve. Obtain Architects acceptance of layout prior to excavating.

B. Remove existing paving for sleeve installation if required. Saw cut existing paving to provide uniform straight transition at new to existing paving.

3.3 INSTALLATION

A. Excavating and backfilling:

1. Excavation shall include all materials encountered, except materials that cannot be excavated by normal mechanical means.

2. Excavate trenches of sufficient depth and width to permit proper handling and installation of pipe and fittings as shown on Details.

3. Pulling method will not be allowed on this project.

4. Excavate to depths required to provide sand bedding for piping as shown on plans.

5. Fill to match adjacent grade elevations with approved earth fill material. Place and compact fill in layers not greater than 4-inch depth.

    a. Provide approved sand to a point 4-inches above the top of pipe.

b. Provide clean top soil fill free of rocks and debris for top 5-inches of fill.

6. Except as indicated, install irrigation mains with a minimum cover of 10 inches based on finished grades. Install irrigation laterals with a minimum cover of 8-inches based on finished grades.

7. Excavate trenches and install piping and fill during the same working day. Do not leave open trenches or partially filled trenches open overnight.

8. Replace paving of same materials, using joints and patterns to match existing adjoining paving surfaces. Removal of paving or wall material and replacement thereof shall only occur when it is determined by the Architect that the sleeves installed cannot be located and other methods (i.e., jacking under the construction or re-routing piping) are not able to be executed.

B. Plastic Pipe

1. Install plastic pipe in accordance with manufacturer's installation instructions. Provide for thermal expansion and contraction.

2. Saw cut plastic pipe larger than 2". Use a square-in sawing vice to insure a square cut. Remove burrs and shavings at cut ends prior to installation.

3. Make plastic to plastic joints with solvent weld joints or slip seal joints. Use only solvent recommended by the pipe manufacturer. Install plastic pipe fittings in accordance with pipe manufacturer's instructions. Contractor shall make arrangements with pipe manufacturer or distributor for all necessary field assistance.

4. Make plastic to metal joints with plastic male adapters.

5. Make solvent weld joints in accordance with manufacturer's recommendations.

6. Allow joints to set at least 24 hours before pressure is applied to the system.

7. Maintain pipe interiors free of dirt and debris. Close open ends of pipe by acceptable methods when pipe installation is not in progress.

C. Sprinkler, fittings, valves, and accessories:

1. Install fittings, valves, sprinkler heads, risers, and accessories in accordance with manufacturer's instructions, except as otherwise indicated.

2. Set sprinkler heads perpendicular to finished grades, except as otherwise indicated.

3. Provide pop-up spray heads (with internal check valve) with an adjustable swing joint riser assembled as shown on details.
Pre-fabricated swing joint risers shall be schedule 80 rated.

4. Obtain Architect's review and acceptance of height for proposed sprinkler heads and valves prior to installation.

5. Locate sprinkler heads to assure proper coverage of indicated areas. Do not exceed sprinkler head spacing distances indicated.

6. Install the specified controller in the location shown on the drawing, with lockable weatherproof controller housing. Controllers shall be pedestal mounted as directed by the owner. Install per manufacturer's recommendations.

   a. Provide rigid conduit from controller down into grade to accommodate valve wires (see details). ***(decoder wires)***

   b. This contractor shall pull valve wires, program controller by labeling station position for zones, and put controller in operation.

8. Install in-ground control valves in a valve access box as indicated.

9. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box. Factory valve box extensions shall be required to be used if necessary.

10. Seal threaded connections on pressure side of control valves with Teflon tape. Do not use pipe joint compound.

D. Control wiring

1. Install electric control cable in the mainline piping trenches wherever possible. Place wire in trench adjacent to pipe. Install wire with slack to allow for thermal expansion and contraction. Provide expansion joints at 100 foot intervals by making 5-6 turns around a piece of 1/2-inch pipe. Where necessary to run wire in a separate trench, provide a minimum cover of 12-inches. When more than one wire is placed in a trench the wire shall be taped together at intervals of 50 feet.

2. Provide sufficient slack (expansion coil consisting of 5-6 turns around a 1/2" piece of pipe) at remote control valves in control boxes, and at all wire splices to allow raising the valve bonnet or splice to the surface without disconnecting the wires when repair is required.

3. Connect remote control valve to one station of a controller only. ***(2-Wire: Connect remote control valve to a single wire pair from an SLDEC valve decoder).***

4. Make wire connections to remote control electric valves and splices of wire in the field, using wire connectors and in accordance with manufacturer's recommendations.

E. Sleeves:

1. Utilize existing sleeves if available for installation of the irrigation system.

2. Provide new sleeves for all locations where existing sleeves are not indicated. Install new sleeves prior to paving installation wherever possible.

3. Install pipe sleeves under existing concrete or asphalt surfaces where cutting is necessary. Obtain Owner's permission before cutting existing concrete and asphalt surfaces. Where piping is shown under paved areas which are adjacent to turf areas, install the piping in the turf areas.

F. Flushing, testing, and adjustment:

1. In the presence of the Architect or his Representative, hydrostatically test the mainline piping system in place, before backfilling. Test period shall be not less than four hours at 130 PSI. Test is acceptable if no leakage occurs during test period.

2. After sprinkler piping and risers are installed and before sprinkler heads are installed, open control valves and flush out the system with full head of water.

3. Perform system testing upon completion of each section. Make necessary repairs and retest repaired sections as required.

4. Adjust sprinklers after installation for proper and adequate distribution of water over the coverage pattern. Adjust for the proper arc of coverage.

5. Tighten nozzles on spray-type sprinklers after installation. Adjust nozzle-adjusting screw on sprinklers as required for proper radius. Interchange nozzle patterns as directed by the Architect, to give best arc of coverage.

6. Adjust all electric remote control valve flow control stems for system balance and optimum performance.

7. Test and demonstrate the controller by operating appropriate day, hour, and station selection features as required to automatically start and shut down irrigation cycles to accommodate plant requirements and weather conditions.

3.4 SPARE PARTS

A. Provide the Owner additional parts as noted.

1. 2 extra sprinkler head(s) of each size and type.

2. 1 extra valve(s) of each size.

3. 2 extra valve access boxes of each size.

4. 2 CH100 quick coupling keys and 2 #10SHL hose swivels.

5. 1 each SLDEC2 and SLDEC4 Wire Decoder and SLGDT Lightning Arrestor

3.5 DISPOSAL OF WASTE MATERIAL

A. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, and debris.

B. Maintain disposal route clear, clean, and free of debris.

3.6 SUBSTANTIAL COMPLETION

A. An inspection of the irrigation system will be made by the Landscape Architect upon request for Application of Substantial Completion by the Contractor. The irrigation system must be sufficiently complete so that all plant material can be sustained by the system.

B. Contractor will be required to train maintenance personnel on the use and basic upkeep of this system. If this responsibility is not fulfilled, the cost of obtaining this training by the Owner shall be shown as a deduction in the final payment.

C. The Contractor shall attach a reduced scale of the area controlled by the controller on the inside of the controller door identifying the location of the valves and the station assigned to each.

3.7 FINAL COMPLETION

A. An inspection of the irrigation system will be made by the landscape architect upon request for Final Completion by the Contractor. Provide notification of at least ten (10) working days before requested inspection date.

3.8 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from irrigation system installation.

END OF SECTION 32 8400

Geotechnical Engineering Study
District 9 Senior Center
San Antonio, Texas

Arias Job No. 2019-203

ARIAS
GEOPROFESSIONALS

Prepared For

City of San Antonio
April 25, 2019 (Revised May 2, 2019)

ARIAS
GEOPROFESSIONALS

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

April 25, 2019 (Revised May 2, 2019)
Arias Job No. 2019-203

Via Email: Cathleen.Crabb@sanantonio.gov

Ms. Cathleen Crabb, AIA, LEED AP
Senior Architect
City of San Antonio
Tansportation and Capital Improvements
P.O. Box 839966
San Antonio, Texas 78283-3966

RE: Geotechnical Engineering Study
City of San Antonio
District 9 Senior Center
San Antonio, Texas

Ms. Crabb:

Arias & Associates, Inc. (Arias) is pleased to submit this report presenting the results of the Geotechnical Engineering Study for the above referenced design project. Our scope of services for this project was authorized on February 28, 2019 by signing of Arias Proposal No. 2019-203 dated Februrary 26, 2019 and revised on February 28, 2019.

The purpose of this geotechnical engineering study was to establish foundation and 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 foundation and 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. As the Geotechnical Engineer of Record (GER), we recommend that the earthwork, foundations, and pavement construction be tested and observed by Arias in accordance with the report recommendations. A summary of our qualifications to provide QA testing is discussed in the "Quality Assurance Testing" section of this report. Furthermore, a message to the Owner with regard to QA testing is provided in the GBA publication included in Appendix E.

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

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

Jerry D. Shepherd, P.E., D.GE
Senior Geotechnical Engineer
5-3-19

STATE OF TEXAS
JERRY D. SHEPHERD
112142
LICENSED PROFESSIONAL ENGINEER

Christopher M. Szymczak, P.E.
Senior Geotechnical Engineer

REPORT FORMAT INFORMATION

To improve clarity in 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 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, client-preferred suspended floor slab foundation system with an option for a stiffened beam and slab on grade foundation and generalized earthwork requirements for building foundation construction 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:	District 9 Senior Center
Project Location:	San Antonio, Texas
Proposed Development:	New 25,000 square foot building, with associated parking and driveways
Client Preferred Foundation Type:	Drilled Pier foundation system with suspended floor slab or stiffened beam and slab on grade

Table 2: Existing Conditions at Time of Geotechnical Study

Ground Cover:	Native cover
Predominant Soil Types:	FAT CLAY (CH) and LEAN CLAY (CL) with various percentages of sand and gravel, some CLAYEY GRAVEL (GC) and MARL to MARLSTONE
Average Plasticity Index (PI):	Average: 29 (Range 17 - 47)
Groundwater:	Groundwater was not able to be measured in the field, due to wet rotary being used to collect samples (see Groundwater section in main report).
Estimated Potential Vertical Rise (PVR):	About 2 - 3 inches

Table 3: Drilled Pier Foundation Recommendations

Recommended Foundation Type:	Drilled pier foundations with suspended floor slab
Scarify, Moisten & Compact Exposed Subgrade:	18 inches Designed for positive drainage to maintain moisture conditions beneath the floor slab. A minimum 2% subgrade slope to appropriate sumps is recommended to prevent ponding of surface water.
Minimum Crawl Space, Void or Clear Space Between underlying subgrade soils and Floor Slab, Grade Beams and suspended utilities:	18 inches
Minimum Pier Depth:	At least 30-35 feet below existing grade, preferably bearing in the very hard marl to marlstone. **Deeper depths may be required to resist compressive, uplift, pullout, or lateral loads as determined by the Project Structural Engineer. If piers are designed to be deeper than 40-feet, we should be contacted to provide additional borings and recommendations.**

Table 4: Building Pad Recommendations for 1-inch Design PVR

Client-Preferred Foundation Type:	Stiffened Beam and Slab on Grade
Site Improvement Method:	Undercut & Replace with Imported Select Fill
Improved Site Condition (PVR):	1-inch design PVR
Minimum Undercut Depth:	**At least 4 feet**
Scarify, Moisten & Compact Exposed Subgrade:	18 inches (maximum 6-inch compacted lifts)
Minimum Select Fill Thickness:	**At least 4 feet or greater amount of select fill as necessary to reach planned floor slab subgrade**
Select Fill Type:	• Locally available pit run material with a liquid Limit <40%, PI 7-20, %200 ≥ 50%, maximum 3" particle size • Top 12" should consist of base material meeting TxDOT Item 247, Type A, Grade 1 or 2
Moisture Barrier:	See Note 6

Notes:

1. The building pad improvements will be used with stiffened beam and slab on grade foundation system designed for a 1-inch PVR.
2. Following stripping operations, undercut at least four (4) feet of the existing soils from beneath the proposed addition area. Undercutting should extend laterally to provide at least a 5-foot overbuild beyond the slab perimeter and to the width of any adjacent sidewalks wider than 5 feet. Care should be utilized when excavating adjacent to existing structures/elements in order to avoid caving, undermining, and sloughing. Provisions should also be made to account for potential differential movements between the new addition and the existing building, especially since the foundation types will differ.
3. It is essential that the exposed subgrade be thoroughly rolled with at least a 20-ton roller or heavily loaded dump truck weighing at least 20 tons in order to minimize the potential for post-construction settlements. A minimum of 20 passes should be performed with passes alternating in directions perpendicular to each other. Any area that yields under the roller loading should be undercut to the depth specified by the geotechnical engineer and replaced with compacted select fill as outlined in Table 4. If deleterious material, rubble, or debris is encountered, it should be removed to firmer materials and disposed of properly. The void should then be replaced with properly compacted select fill. It is important that the site preparation operations be observed and tested by one of our representatives to verify that these recommendations are followed. After proof rolling, the subgrade should be scarified to a depth of 18 inches, moisture conditioned and compacted in maximum 6-inch compacted lifts as specified in SECTION I, Table 6 (Project Compaction, Moisture and Testing Requirements).
4. For construction equipment access, and to help in providing a more "all-weather" working surface, the top 12 inches of select fill should consist of compacted crushed limestone base meeting the requirements of TXDOT Item 247, Type A, Grade 1or 2.
5. If additional select fill thickness is necessary to achieve final design grade, fill should consist of pit run select fill meeting the requirements outlined in Table 4.
6. A horizontal barrier should extend at least 10 feet horizontally beyond the perimeter of the foundation of the building. The barrier can consist of concrete or asphalt paving, concrete flatwork or at least 24" of compacted onsite or import clay (PI between 20 and 40). All joints within the pavement, flatwork, and at pavement/flatwork interfaces should be sealed. Any landscaping located within 10 feet of the structure foundation should be placed in watertight above-grade planter boxes with drainage discharge on top of adjacent flatwork/paving. We recommend that the perimeter grade beam be constructed to a depth of at least 30 inches to aid in reducing the potential for moisture fluctuation beneath the building pad. The final grade beam depth and recommended construction should be determined by the structural engineer. The slab vapor retarder plastic should be extended from beneath the slab down the inside face (building pad side) of the grade beam trench.

Table 5: 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 Drive, Truck Lane & Medium Duty	
Surface	HMAC/PCC	2”		2½”		5”	6”	6”	7”
Base	Flexible Base	12”	10”	14”	12”	--	--	--	--
Subgrade	Moisture conditioned *Moisture conditioned flexible asphalt sections should also have Tensar TX-5 geogrid installed over the 6-inch moisture conditioned subgrade	*6”	--	*6”	--	--	6”	--	6”
	Lime Treated **(Soluble Sulfate Tests must be run prior to using any calcium-based treatment agent)**	--	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 2 to 3 inches). 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 to parking areas, and areas where paving will be subjected to truck traffic. Medium duty areas exclude areas where trucks may travel or park, and dock areas.
4. Heavy duty areas include areas subjected to 18-wheel tractor trailers, trash collection vehicles, dumpster pads including loading and unloading areas, and areas where truck turns and maneuvering may occur. **Eight (8)-inch thick concrete pavement is recommended for heavy duty areas and is not shown in Table 5.**
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.
6. For flexible pavements only where the moisture conditioned subgrade option will be utilized, Tensar TX-5 geogrid should be installed over the 6-inch moisture conditioned subgrade.
7. Material specifications, construction considerations, and section requirements are presented under “Pavement Subgrade and Section Materials” included in Section II of this report.

Table 6: Project Compaction, Moisture and Testing Requirements

Description	Material	Percent Compaction	Optimum Moisture Content	Testing Requirement
		According to Standard Proctor ASTM D 698		
Community Center Building Area	Scarified Subgrade Soil	95% to 100%	0% to +4%	1 per 5,000 SF; min. 3 tests
	Select Fill (Pit Run Select Fill Body with 12" Crushed Limestone Base Cap)	≥ 98%	-1 to +3%	1 per 5,000 SF; min. 3 per lift
Pavement Areas	Scarified, Moisture Conditioned On-site Soil (Subgrade)	≥ 95%	0 to +4%	1 per 5,000 SF; min. 3 tests
	General Fill (Onsite Material)	≥ 95%	0 to +4%	1 per 5,000 SF; min. 3 per lift
	Base Material	≥ 95% (ASTM D 1557)	±3%	1 per 5,000 SF; min. 3 per lift
	Hot-mix asphaltic concrete	91% to 95% Theoretical Lab Density (TEX 207 F)	Not applicable	1 per 5,000 SF; min. 3 per lift
Non-Structural Areas (Outside Building Pad)	General Fill (On-site Material)	≥ 95%	0 to +4%	1 per 5,000 SF; min. 3 per lift

SECTION II: MAIN REPORT

PROJECT AND SITE DESCRIPTION

A new Senior Center is in development for District 9 in San Antonio, Texas. The proposed 25,000 square foot District 9 Senior Center will be constructed at the Walker Ranch Park west of West Avenue and south of Wurzbach Parkway. The project scope also includes new parking areas, and driveways. At the time of this report, the anticipated loads for the building have not been provided, nor has any planned traffic information for the associated parking areas.

A Site Vicinity Map is provided as Figure 1 in Appendix A.

SOIL BORINGS AND LABORATORY TESTS

Eleven (11) soil borings were drilled at the approximate locations shown on the Boring Location Plan provided as Figure 2 in Appendix A. Six (6) of the borings were located within the approximate limits of the proposed Senior Center building and five (5) borings were drilled in the proposed parking lot areas. Boring details are shown in the following table.

Table 7: Boring Details

Boring No.	Structure	Latitude	Longitude	Depth (ft)	Groundwater (ft)
B-1	Senior Center Building	29.555270	-98.503044	35	Not Encountered
B-2		29.555029	-98.502879	25	Not Encountered
B-3		29.554975	-98.503019	40	Not Encountered
B-4		29.555000	-98.503414	25	Not Encountered
B-5		29.555212	-98.503371	40	Not Encountered
B-6		29.555110	-98.503132	25	Not Encountered
B-7	Parking and Drive Area Pavements	29.554528	-98.502389	10	Not Encountered
B-8		29.554333	-98.502861	10	Not Encountered
B-9		29.554722	-98.503278	10	Not Encountered
B-10		29.554806	-98.503803	10	Not Encountered
B-11		29.555333	-98.503750	10	Not Encountered

The boring depths were measured below the existing surface elevations that existed from March 28-29, 2019 and April 17-18, 2019. The borings were sampled in accordance with ASTM D 1586 for Split Spoon sampling techniques and with a thin walled Shelby Tube Sampler (ASTM D 1587) as described in Appendix C. An ATV Track rig using continuous

flight augers and mud rotary along with the sampling tools noted above were used to secure the subsurface soil samples.

Soil classifications and borehole logging were conducted during the exploration by our engineering technician working under the supervision of our Geotechnical Engineer. Final material classifications, as seen on the boring logs included in Appendix B, were determined by the Project Geotechnical Engineer based on laboratory and field test results and applicable ASTM procedures.

As a supplement to the field exploration, laboratory testing to determine soil water content, Atterberg Limits, percent passing the US Standard No. 200 sieve, and unconfned compressive strength tests was conducted. Soluable Sulfate testing was also completed on three (3) samples. Laboratory results are reported on the attached boring logs included in Appendix B, with the exception of the sulfate testing results.

A key to the terms and symbols used on the logs is also included in Appendix B. The laboratory testing for this project was done in accordance with applicable ASTM procedures with the specifications and definitions for these tests listed in the Appendix C**.** Remaining samples recovered from this exploration will be routinely discarded following submittal of this report.

Soluble Sulfate Test Results

Laboratory testing was conducted on three (3) selected samples recovered from the borings drilled at the site to determine the soluble sulfate content. Testing was performed in general accordance with TxDOT test method Tex-145-E “Determining Sulfate Content in Soils.” The results indicate that the soluble sulfate contents of the samples tested were about 300 to 340 parts per million (ppm). The results are indicative of relatively low soil sulfate content at this site. Therefore, lime or cement treatment of the onsite soils can be considered for this site. However, additional testing should be performed once the subgrade soils are exposed prior to applying any type of calcium-based treatment. A summary of the sulfate test results is provided below in Table 8.

Table 8: Soluble Sulfate Test Results

Boring No.	Approx. Sample Depth, (ft.)	Material Description	Soluble Sulfate Content, (ppm)
B-7	1 – 2	CLAYEY GRAVEL with SAND (GC)	340
B-9	0 – 2	LEAN CLAY (CL)	320
B-11	0 – 2	GRAVELLY LEAN CLAY (CL)	300

Note: Approximate sample depth is referenced from the existing ground surface at the time of the geotechnical field exploration performed on March 28-29, 2019 and April 17-18, 2019.

SUBSURFACE CONDITIONS

Generalized stratigraphy and groundwater conditions encountered are discussed in the following sections. The subsurface and groundwater conditions are based on conditions encountered at the boring locations to the depths explored. The presence and thickness of the various subsurface materials can be expected to vary away from and between the exploration locations. The descriptions generally conform to the Unified Soils Classification System.

Site Stratigraphy and Engineering Properties

The generalized subsurface stratigraphy encountered at this site is summarized subsequently in the table below.

Table 9: Generalized Subsurface Conditions

Stratum	Depth (ft)	Material Type	PI range	No. 200 range	PP range	N range
PAVEMENT	0 – 0.75	3'' Asphalt over 6'' Base (Only encountered in Boring B-7)	--	--	--	--
I	0 to 6 - 25	Brown, Tan, Dark Brown – FAT CLAY (CH), FAT CLAY with SAND (CH), SANDY FAT CLAY (CH), GRAVELLY FAT CLAY (CH), GRAVELLY FAT CLAY with SAND (CH), LEAN CLAY (CL), LEAN CLAY with SAND (CL), SANDY LEAN CLAY (CL), LEAN CLAY with GRAVEL (CL) – firm to very hard	16 – 47	51 – 89	1.75 – 4.5+	5 – 29
IA	2 – 6 to 10 - 25	Tan, Dark Brown – FAT CLAY with SAND (CH), SANDY FAT CLAY (CH), LEAN CLAY (CL), LEAN CLAY with SAND (CL) – firm to very hard	22 - 40	70 - 91	3.25 - 4.5	7 - 51
II	0 – 18 to 2 – 23	Tan, Brown – CLAYEY GRAVEL (GC), CLAYEY GRAVEL with SAND (GC) – loose to very dense	17 – 38	14 – 49	--	7 – 50/3''
III	23 to 40	Tan, Gray – MARL to MARLSTONE – very hard	--	--	--	50/2'' – **50/1''

Where:
Depth - Depth from existing ground surface at the time of geotechnical study, feet
PI - Plasticity Index, %
No. 200 - Percent passing #200 sieve, %
N - Standard Penetration Test (SPT) N-value, blows per foot
PP - Pocket Penetrometer, tsf
** - Seating Blows of Split Spoon
- - No test

Groundwater

A a combination of dry and wet soil sampling methods were used to obtain the soil samples at the project site. As mud rotary was utililzed during drilling, it was not possible to dertmine the groundwater elevation as water was injected into the borings to facilitate the sampling process. The open boreholes were backfilled using soil cuttings generated from the drilling process

Groundwater levels will often change significantly over time and should be verified immediately prior to construction. Water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the soils. Groundwater levels at this site may differ during construction because fluctuations in groundwater levels can result from seasonal conditions, rainfall, drought, or temperature effects. Pockets or seams of gravels, sands, silts or open fractures and joints can store and transmit "perched" groundwater flow or seepage.

Should dewatering be required, the means and methods for dewatering the site are solely the responsibility of the contractor. We should note that subsurface soil and groundwater conditions can vary away from the boring locations and can change significantly over time. The Contractor should be familiar with and prepared for such conditions.

MOISTURE VARIATIONS AND ESTIMATED MOVEMENT

Structural damage can be caused by volume changes in clay soils. Clays can shrink when they lose water and swell (grow in volume) when they gain water. The potential for expansive clays to shrink and swell is typically related to the Plasticity Index (PI). Clays with a higher PI generally have a greater potential for soil volume changes due to moisture content variations. The soils found at this site are capable of swelling and shrinking in volume dependent on potentially changing soil water content conditions during or after construction. The term swelling soils implies not only to the tendency to increase in volume when water is available, but also to decrease in volume or shrink if water is removed.

The measured PIs of the near-surface soil samples obtained at this site suggest that the soils at this site have a very high potential for shrinking and swelling due to fluctuations in soil moisture content. Several methods exist to evaluate swell potential of expansive clay soils. We have estimated potential heave utilizing the TXDOT method (Tex 124-E). Using the TXDOT method, we estimate that the PVR is approximately **2 to 3 inches** considering the existing soil moisture conditions at the time of the sampling activities.

It has been our experience that the PVR method can sometimes underestimate the potential shrink/swell movements. Fluctuations in the soil moisture content generated from climatic conditions (*i.e*., droughts or floods) or as a result of development (*e.g.*, irrigation of

landscaping in the immediate vicinity of the building, poor surface drainage, leaking plumbing or water lines) may result in greater shrink/swell movements than calculated.

FOUNDATION DESIGN CONSIDERATIONS

Both shallow and deep foundation types are utilized in this area. Deep drilled piers are suited for structures with moderate to heavy loading conditions, or for movement-sensitive structures. The piers, when properly founded, can reduce foundation movement of the superstructure. Grade beams, isolated from the soil, typically span between the piers and either a structurally suspended slab or soil supported slab-on-grade is used at the ground floor level. The structurally suspended slab option is used when excellent performance is expected from the structure in terms of minimal aesthetic distress, such as floor tile, foundation and wall cracking.

A shallow foundation type consisting of a stiffened beam and slab-on-grade "waffle slab" is a common alternate approach for small to moderate size structures. This foundation type is typically used for light to moderate loading conditions and can be more cost-effective than a deep foundation system. When founded within expansive soils or deep fill soils, subgrade improvement is recommended in order to reduce potential soil and foundation movement to a magnitude acceptable to the owner and design team. However, the owner and design team should be cognizant of the risk for some aesthetic distress (floor tile cracking, foundation movement and cracking, wall cracking, and sticking doors/windows) to develop when selecting this foundation alternative. This potential foundation movement may become an operational nuisance and require periodic maintenance and repair to the structure.

Each approach has its advantages and disadvantages in terms of cost and overall performance. If the risks for expansive soil-related foundation movement and aesthetic distress cannot be accepted, a structurally suspended floor system supported on straight shaft drilled pier foundations should be used.

Foundation Type

We have been informed by the client that the proposed Senior Center is to be supported on drilled piers and the floor slab will be suspended above grade. We were also asked to provide an option for a stiffened beam and slab on grade foundation.

Drilled Piers with Structurally Suspended Floor Slab

A structurally suspended floor slab with drilled piers is recommended for use for the Senior Center. Recommendations for evaluation of axial capacity and lateral capacity are presented in the Tables 9 and 10 below. Pier capacities for axial loading were evaluated based on design methodologies included in FHWA-IF-99-025 - Drilled Shafts: Construction Procedures

and Design Methods. Both end bearing and side friction resistance may be used in evaluating the allowable bearing capacity of the pier shafts.

Table 10: Drilled Pier Design Parameters Axial Capacity

Depth	Material	Recommended Design Parameters		
		Allowable Skin Friction, psf	Allowable End Bearing, psf	Uplift Force, kips
0 - 5	SANDY FAT CLAY (CH), GRAVELLY FAT CLAY (CH), GRAVELLY FAT CLAY with SAND (CH), LEAN CLAY (CL), LEAN CLAY with SAND (CL), SANDY LEAN CLAY (CL), CLAYEY GRAVEL with SAND (GC)	Neglect Contribution		80•D
5 - 15	FAT CLAY (CH), SANDY FAT CLAY (CH), GRAVELLY FAT CLAY (CH), LEAN CLAY (CL), LEAN CLAY with SAND (CL), CLAYEY GRAVEL with SAND (GC)	250		
15 - 30	FAT CLAY with SAND (CH), SANDY FAT CLAY (CH), LEAN CLAY (CL), LEAN CLAY with SAND (CL), CLAYEY GRAVEL with SAND (GC), MARL to MARLSTONE	800		
30 - 40	MARL to MARLSTONE	1,000	15,000	
Constraints to be Imposed During Pier Design				
Minimum depth of drilled piers, (measured from surface)	At least 30-35 feet below existing grade, preferably bearing in the very hard marl to marlstone.. **Deeper depths may be required to resist compressive, uplift, pullout, or lateral loads as determined by the Project Structural Engineer. If piers are designed to be deeper than 40-feet, we should be contacted to provide additional borings and recommendations.**			
Minimum shaft diameter	18 inches			
Minimum Void Space Below Grade Beams, Pier Caps and suspended floor system	18 inches			

Notes:

1. For straight shaft piers, the contribution of the soils for the top 5 feet of soil embedment and for a length equal to at least 1 pier diameter from the bottom of the shaft should be neglected in determination of friction capacity for compression loading. The recommended design parameters include a factor of safety of 2 for skin friction and of 3 for end bearing.
2. Total and differential settlement of piers is expected to be less than 1 inch and ½ inch, respectively. Estimated settlements are based on performance of properly installed piers in the San Antonio, Texas area. A detailed settlement estimate is outside of the scope of this service.
3. Sufficient reinforcing steel should be placed within the pier to account for tension and lateral loading as applicable. Pier vertical reinforcing steel should be designed to resist the uplift forces from swelling soils and uplift and lateral forces from wind loading. The final reinforcing requirements should be determined by the project structural engineer. Tensile rebar steel should be designed in accordance with ACI Code Requirements.

4. A minimum shaft diameter of 18 inches is recommended. Larger shaft diameters may be required. Straight shaft piers should be spaced at least 3 diameters apart center-to-center. If the recommended pier spacing cannot be maintained, Arias should be consulted to consider the group effect of closely-spaced piers.
5. The uplift force resulting from expansion of soils in the active zone may be computed using the above formula where D is the shaft diameter in feet. For drilled straight-sided piers, the contribution from soils to resist uplift is the allowable skin friction resistance of the soils below the 15-ft deep estimated active zone. For uplift loading only, the allowable skin resistance for the bottom 1 pier diameter can be used to size the pier. Sustained dead loads will also aid in resisting uplift forces. Pier depths greater than 35 feet may be required to: (1) resist expansive soil uplift forces, and/or (2) as a result of axial or lateral loading requirements.

Lateral pile analyses including capacity, maximum shear, and maximum bending moment will be evaluated by the project structural engineer using LPILE or similar software. In the following table, Arias presents geotechnical input parameters for the encountered soils at the Senior Center site. Please note that the depths to the top and bottom of each layer were interpreted using approximate elevation data at the explored boring locations and layer boundaries as shown on the boring logs.

Table 11: Drilled Pier Geotechnical Input Parameters for LPILE Analyses

Depth (ft)	Material	γ_e	C_u	ϕ	K Static/ Cyclic	e_{50}
0 to 5	SANDY FAT CLAY (CH), GRAVELLY FAT CLAY (CH), GRAVELLY FAT CLAY with SAND (CH), LEAN CLAY (CL), LEAN CLAY with SAND (CL), SANDY LEAN CLAY (CL), CLAYEY GRAVEL with SAND (GC)	NEGLECT				
5 to 15	FAT CLAY (CH), SANDY FAT CLAY (CH), GRAVELLY FAT CLAY (CH), LEAN CLAY (CL), LEAN CLAY with SAND (CL), CLAYEY GRAVEL with SAND (GC)	120	1,000	0	100/0	0.010
15 to 30	FAT CLAY with SAND (CH), SANDY FAT CLAY (CH), LEAN CLAY (CL), LEAN CLAY with SAND (CL), CLAYEY GRAVEL with SAND (GC), MARLSTONE	120	2,000	0	500/200	0.007
30 to 40	MARLSTONE	120	4,000	0	1000/400	0.004

Where: γ_e = effective soil unit weight, pcf
c_u = undrained soil shear strength, psf
ϕ = undrained angle of internal friction, degrees
K = modulus of subgrade reaction, pci
e_{50} = 50% strain value

Suspended Floor Slab

The floor slab for the proposed Senior Center will be structurally suspended above grade and supported on straight shaft drilled piers. A void space, or crawl space, of at least 18 inches must be constructed to isolate the slab and grade beams from the soil subgrade. Construction options to create this void space may include the use of cardboard carton forms (void boxes), soil retainers, and/or formwork. The use of a suspended floor slab should significantly reduce the chances for differential vertical foundation movement and distress associated with the highly expansive soils encountered at this site. However, even with this system some nominal upward movement may occur.

If void boxes are used to create the void beneath the floor slab, care must be taken not to damage the boxes prior to or during concrete placement. The void boxes should be protected from the elements (rain and excessive moisture) at all times. The void boxes should have a tight fit to the pier foundations. Furthermore, the void boxes should be designed to deteriorate properly after construction so that pressures from swelling soils will collapse the carton forms rather than be transmitted to the overlying grade beams and/or floor slab. The carton form supplier should provide a technical representative to attend a preconstruction meeting, and to also be present during the start of foundation construction, to instruct the workforce in proper carton form construction techniques.

Soil retainers such as precast concrete panels should be placed vertically along the exterior grade beams to: (1) prevent soil from sloughing under the grade beams; and (2) reduce the risk of significant water from migrating into the void space under the floor system. Backfill against the retainers and exterior grade beams should consist of compacted clay soil to aid in preventing the easy movement of outside surface water from infiltrating under the floor system. The backfill clay soil should be compacted to at least 95 percent of the Standard Proctor maximum dry density as evaluated by ASTM D 698 at moisture contents ranging from optimum to plus four (+4) percentage points of optimum moisture content.

Positive drainage should also be provided for the building so that surface water does not enter beneath the foundation, or enter into air vents that may be situated in the exterior grade beam. Roof drains should be tied to storm drains or be discharged on top of pavements well outside of the building footprint.

Formwork other than carton forms may be used to create the crawl space beneath the building. Provisions should be made to collect and dispose of any surface and/or subsurface water that may enter in the crawl space. This can generally be accomplished by constructing a 4-inch-thick unreinforced lean concrete slab or “mudmat” on the surface of the crawl space beneath the concrete floor. The surface of the “mudmat” should be sloped to drain to a sump where the water can be collected and pumped away from the building. These steps can help reduce the potential for soil moisture fluctuations under the floor which can often lead to pier and floor movement. Proper ventilation should be provided to help limit moisture from

collecting in the crawl space. In some instances, forced-air-ventilation/circulation is used to reduce moisture accumulation and humidity in the crawl space. Mold growth may occur if the crawl space is not adequately ventilated.

Excavation of trenches for beams may be accomplished with a smooth-mouthed bucket or toothed bucket. Debris in the bottom of the excavation should be removed prior to the placement of void forms, soil retainers, reinforcing steel and concrete. The excavation should be sloped sufficiently to create internal sumps for runoff water collection and removal. Surface water that accumulates in excess of one (1) inch in the bottom of the excavation should be removed.

It should also be noted that the subsurface materials encountered in our borings generally consisted of stiff to hard clays and very hard clays, dense to very dense clayey gravels and very hard Marlstone. Thus, we anticipate that high-torque drilling equipment will be required for pier installation at this site. Groundwater was not encountered during drilling, and groundwater elevations can fluctuate over time. Therefore, temporary casing may also be required for pier installation at this site, as groundwater may be present. The Contractor should be familiar with and prepared for such conditions.

Stiffened Beam and Slab on Grade

An alternative foundation deisgn for this project would be a stiffend beam and slab on grade, with a remove and replace of existing soils. Recommendations for this foundation type are included in the following sections.

Recommended Building Pad Improvement for 1" PVR

Due to the relatively high potential for soil movement at this site, if a stiffened beam and slab on grade foundation is to be used, subgrade improvement will be needed. A remove and replace of the existing soils with at least four (4) feet of select fill is the recommended option.

Building pad preparation requirements on expansive clay sites are dependent upon the soil moisture condition at the time of construction. Typically, the geotechnical engineer does not know the climate conditions that will exist at the time of construction since he does not know when the structure will be built. Therefore, having the geotechnical engineer retained to review site preparation recommendations and be an active participant in Team Meetings near the time of construction can often result in project cost savings since soil moisture conditions at the time of construction could be more accurately assessed. Additionally, it has been our experience that retaining the same firm for both geotechnical engineering services and construction materials testing is prudent since the geotechnical engineer is most familiar with site conditions and can quickly respond to field challenges.

Grade-supported foundation elements for the proposed Senior Center will require additional site improvement recommendations in order to reduce the PVR or soil shrink-swell potential of the expansive clays for a 1-inch PVR. In this area, a PVR of 1-inch is typically an acceptable amount of movement for structures of this type and the recommendations provided in this report are based on this assumption. Although this is a typically acceptable magnitude of movement in this area, it should be understood that a 1-inch PVR can result in some cracking requiring periodic maintenance; but the structural integrity of the building should be maintained. If project requirements dictate a different magnitude of PVR, we should be informed so that modifications to our recommendations may be made. Recommendations are presented in Table 4 shown in Section I and are valid only for a 1-inch design PVR.

The area of the new Senior Center, plus a 5-foot overbuild or greater to include adjacent flatwork, should be stripped of vegetation and excavated, as necessary, to provide the required select fill thickness beneath the slab. Prior to the placement of select fill, the exposed subgrade at the building pad area should be proof rolled to identify any soft areas, if present. Proof rolling should be accomplished using a loaded dump truck weighing at least 20 tons. Weak or soft areas evidenced during proof rolling, should be over-excavated and replaced as outlined in Table 5 of this report.

In unpaved areas at the perimeter of the planned Senior Center, a 2-foot thick clay cap (see Note 6, Table 4) should be constructed over the select fill overbuild. This clay cap should aid in reducing the chances for surface water from infiltrating into the more pervious select fill and pond on top of the underlying, less permeable clay subgrade. A PVR exceeding 1-inch can occur if water is allowed to readily pond on top of the clay subgrade beneath the select fill body. Clean onsite soils (PI of 20 to 40, if present) can be used to construct the clay cap. The clay cap should be moisture conditioned to between 0 and +4 percentage points of optimum moisture content and then compacted to at least 95 percent of the maximum dry density determined by ASTM D 698.

Stiffened Beam and Slab-on-Grade Design

A grid type beam and slab-on-grade is generally used to support structures upon expansive soils where soil conditions are relatively uniform, and where uplift and settlement can be tolerated. The intent of a stiffened beam and slab-on-grade foundation is to allow the structure and foundation to move up and down with soil movements while providing sufficient stiffness to limit differential movements within the superstructure to an acceptable magnitude.

A stiffened grid type beam and slab-on-grade foundation may be utilized for the Senior Center provided it is designed specifically for these soil conditions. Also, the building pad for a stiffened beam and slab on grade must be improved as outlined in Table 4 of Section I.

There are various design methods for use by the structural engineer to select the grade beams depths and beam spacing's for this project. The foundations may be designed using the Building Research Board No. 33 (BRAB Report) as a guideline. Alternatively, the foundations may be designed based on the Design of Slab-On-Ground Foundations published by the Wire Reinforcement Institute, Inc. (WRI-August 1981). Provided in the following table are design criteria for both methods.

Table 12: BRAB and WRI Foundation Design Criteria

Design Method	BRAB	WRI
Design PVR	1"	1"
Climatic Rating (Cw) – San Antonio, Texas	17	17
Effective Plasticity Index for Site Improvement to 1 PVR	30	30
Support Index (C)	0.84	--
Soil/Climatic Rating Factor (1-C)	--	0.16
Unconfined Compressive Strength (tsf)	1.5	--

Note: The above design values assume that the building pad has been improved as outlined in this report for an approximate 1-inch design PVR.

A stiffened beam and slab type foundation may also be designed for the structure using the 3rd Edition of the Design of Post-Tensioned Slabs-on-Ground published by the Post-Tensioning Institute. These values were estimated from the "Volflo" computer program in consideration of the soil conditions in the area of the planned buildings. Provided in the following table are design criteria for this method for design PVR value of 1-inch.

Table 13: PTI Slab-on-Grade Soil Design Criteria (3rd Edition)

Design PVR	About 1 inch
Depth to Constant Soil Suction	15 Feet
Constant Soil Suction	3.8 pF
Edge Moisture Variation Distance	
Center Lift, e_m	8.0 feet
Edge Lift, e_m	4.1 feet
Differential Soil Movement	
Center Lift, y_m	2.0 inches
Edge Lift, y_m	3.2 inches
Coefficient of Slab-Subgrade Friction, μ	0.75

Note: The above design values assume that the building pad has been improved as outlined in this report for an approximate 1-inch design PVR.

Arias is providing design values for BRAB, WRI, and PTI methods for the Structural Engineer's consideration and possible use. Arias recommends the final design methodology for the planned foundation be selected by the project Structural Engineer based on his knowledge and experience with similar foundation conditions.

Table 14: Allowable Bearing Pressure and Beam Penetration

Allowable Bearing Pressure	2,000 psf
Bearing Stratum at Bottom of Grade Beams/Footings	Compacted Select Fill
Min. Penetration of Beams/Footings Below Final Grade for Bearing Pressure Requirements	30 inches

Note: Actual beam depth should be determined by structural engineer. Minimum penetration below final grade is necessary to reduce scour potential and the potential for water penetration under the foundation

The grade beams/footings should be based at the recommended depth or deeper, founded within the compacted select fill, and should be designed for the allowable soil bearing capacity provided above. Grade beams may be thickened and widened at concentrated loads to serve as spread footings. The beams and widened columns should be a minimum of 10 and 12 inches wide, respectively, for shear resistance. The grade beams should extend at least 36 inches below final grade within the compacted select fill.

We recommend that at least a 10-mil vapor retarder be used under the slab. The vapor retarder should conform to ASTM E1745, Class C or better and shall have a maximum water vapor permeance of 0.044 perms when tested in accordance with ASTM E96. A 10 mil Stego Wrap by Stego Industries LLC or other similar products meeting these requirements would be acceptable.

ADDITIONAL DESIGN CONSIDERATIONS

Utilities

Utilities which go through the slab and beams should be designed with some flexibility to allow free movement in the lines as a result of potential soil shrinkage or swelling.

Slab-Bearing Partition Walls & Flooring

Slab bearing partition walls and brittle floor tiles are susceptible to various degrees of cracking due to potential slab and foundation movements. Accordingly, the potential foundation movements cited earlier should be accounted for in the overall design.

Control and Construction Joints

Concrete, mortar, grout, and concrete or clay masonry units as well as numerous other construction materials shrink and swell upon a loss or gain of moisture in much the same manner as expansive soils. Accordingly, material volume changes or potential foundation

movements can cause wall or slab cracking to occur. In general, however, unsightly cracking can normally be eliminated by controlling crack locations and making them inconspicuous so that they do not detract from the appearance of the building. Crack control should typically be implemented in the overall building design by the implementation of control or contraction joints in the structure at proper intervals.

Design Measures to Reduce Changes in Soil Moisture

Measures to reduce future moisture fluctuations of the soils under the floor slab must be considered. Movements of foundation soil can generally be effectively reduced by providing horizontal and/or vertical moisture barriers around the edge of the slab. Typically, the moisture barriers would consist of concrete flatwork or asphalt or concrete pavement placed adjacent to the edge of the building, or a deepened perimeter grade beam.

A suspended floor slab supported on drilled piers or a stiffended beam and slab on grade can be utilized to reduce potential soil-related foundation movements. The design and construction should also include the following elements:

- Roof drainage should be controlled by gutters and carried well away from the structure. The ground surface adjacent to the building perimeter should be sloped and maintained a minimum of 5% grade away from the building for 10 feet to result in positive surface flow or drainage away from the building perimeter.
- Hose bibs, sprinkler heads, and other external water connections should be placed well away from the foundation perimeter such that surface leakage cannot readily infiltrate into the subsurface or compacted fills placed under the proposed foundations and slabs.
- No trees or other vegetation over 6 feet in height shall be planted within 15 feet of the structure unless specifically accounted for in the foundation design.
- Utility bedding should not include gravel within 4 feet of the perimeter of the foundation. Compacted clay or flowable fill trench backfill should be used in lieu of permeable bedding materials between 2 feet inside the building to a distance of 4 feet beyond the exterior of the building edge to reduce the potential for water to infiltrate within utility bedding and backfill material.
- Paved areas around the structure are helpful in maintaining equilibrium within the soil water content. If possible, pavement and sidewalks should be located immediately adjacent to the building.
- Flower beds and planter boxes should be piped or water tight to prevent water infiltration under the building. Experience indicates that landscape irrigation is a common source of foundation movement problems and pavement distress.

- Site work excavations should be protected and backfilled without delay to reduce changes in the natural moisture regime.

Flatwork Considerations

Differential movements between the planned building structures and abutting sidewalks may occur. Flatwork supported on unimproved, natural site conditions will result in flatwork movements on the order of the magnitude or greater than reported in the PVR section which can result in significant cracking, joint separations, and a reversal in drainage as discussed subsequently.

We recommend that the flatwork and the building be designed to include details that permit foundation movements without resulting in vertical separations and without distressing either element. Control joints should be included that include steel reinforcing to prevent vertical shear, but to allow bending.

If the flatwork and abutting sidewalks are supported on grade, they should be designed and constructed to allow for positive drainage to be maintained away from the building foundations. The planned site grading should allow for potential future differential movements and should never be allowed to reach a level or negative slope that promotes drainage toward the foundation. This reversal in drainage can direct moisture to the building becoming a constant nuisance and maintenance issue.

For the suspended floor slab with drilled pier foundation, consideration can also be given to suspending movement sensitive flatwork. Suspended flatwork can be designed to bridge from the grade beam of the suspended floor slab to other grade-supported flatwork where differential movements would likely occur at the interface of the suspended/grade-supported flatwork. In this case, the differential movement in the flatwork would likely occur at more desirable locations away from the building. Suspended flatwork should be lightly tied to the foundation grade beam so that the flatwork can move upward and not stress the grade beam. Suspended flatwork should also be sloped away from the building as much as possible to attempt to maintain positive drainage during the life of the building.

We do not recommend dowelling grade-supported flatwork to the building slab (except at common openings) when using the suspended foundation option. Structurally tying grade-supported flatwork to a suspended floor slab can cause significant distress to the flatwork and possibly to the building foundation and structure. However, consideration should be given to dowelling the flatwork at common openings to help limit differential movement at these locations that may otherwise result in trip hazards.

IBC Site Classification and Seismic Design Coefficients

Section 1613 of the International Building Code (2015) requires that every structure be designed and constructed to resist the effects of earthquake motions, with the seismic design

category to be determined in accordance with Section 1613 or ASCE 7. Site classification according to the International Building Code (2015) is based on the soil profile encountered to 100-foot depth. The stratigraphy at the site location was explored to a maximum 40-foot depth.

On the basis of the site class definitions included in Table 1613.5.2 and 1613.5.5 of the 2015 Code and the encountered generalized stratigraphy, we characterize this site as Site Class D.

Seismic design coefficients were determined using the on-line software, Seismic Hazard Curves and Uniform Response Spectra, version 5.1.0, dated February 10, 2011 accessed at (http://earthquake.usgs.gov/hazards/designmaps/javacalc.php). Analyses were performed considering the 2015 International Building Code. Input included GPS site coordinates and Site Class D. Seismic design parameters for the site are summarized in the following table.

Table 15: Seismic Design Parameters

Site Classification	F_a	F_v	S_s	S_1
D	1.6	2.4	0.079 g	0.029 g

Where: Fa = Site coefficient
Fv = Site coefficient
Ss = Mapped spectral response acceleration for short periods
S1 = Mapped spectral response acceleration for a 1-second period

CONSTRUCTION CRITERIA

Site Preparation

Strip away any existing asphalt, concrete, topsoil, grass, organics, and deleterious debris as needed and dispose outside of the building, 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 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. 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 proofrolled 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 to existing grade as specified. The voids in undercut areas can be backfilled and compacted with on-site general fill materials.

Table 16: 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 5 in Section I.

At least one density test should be conducted per 5,000 square feet of building pad per lift of prepared fill and subgrade or a minimum of three density tests should be taken per lift within the building pad area.

Drilled Piers Construction Considerations

The contractor should verify groundwater conditions before production pier installation begins. Comments pertaining to high-torque drilling equipment, groundwater, slurry, and temporary casing are based on generalized conditions encountered at the explored locations. Conditions at individual pier locations may differ from those presented and may require that these issues be implemented to successfully install piers. Construction considerations for drilled pier foundations are outlined in the following table.

Table 17: Drilled Pier Installation Considerations

Recommended installation procedure	FHWA-NHI-10-016, May 2010
High-torque drilling equipment anticipated	Possible, some hard clays, gravels and Marlstone present
Groundwater anticipated	Possible, ground water was not determined during the field exploration
Temporary casing anticipated	Possible, as groundwater was not encountered during drilling
Slurry installation anticipated	Possible, if subsurface soil and groundwater conditions dictate
Concrete placement	Same day as drilling. If a pier excavation cannot be drilled and filled with concrete on the same day, temporary casing or slurry may be needed to maintain an open excavation. The concrete should be placed using a tremie or pump and not allow the concrete to ricochet off the reinforcing cage or side pier side walls.
Maximum water accumulation in excavation	2 inches-**MAXIMUM**
Concrete installation method needed if water accumulates	Tremie or pump to displace water, if water is encountered
Quality assurance monitoring	Geotechnical engineer's representative should be present during drilling of all piers, should observe drilling and verify the installed depth and underream diameter, should verify material type at the base of excavation and cleanliness of base, should observe placement of reinforcing

Notes:

1. The contractor should verify groundwater conditions before production pier installation begins. Temporary casing may be needed due to groundwater conditions, dependent on seasonal conditions. Payment provisions for temporary casing and for placement of concrete by the tremie method are recommended for inclusion in the Contract Documents.
2. Comments pertaining to high-torque drilling equipment, groundwater, temporary casing, and slurry drilling methods are based on generalized conditions encountered at the explored locations. Importantly, these are considered means and methods and are the sole responsibility of the contractor. Conditions at individual pier locations may differ from those presented and may require that these techniques be implemented to successfully install piers.
3. The following installation techniques will aid in successful construction of the shafts:
    a. The clear spacing between rebar or behind the rebar cage should be at least 3 times the maximum size of coarse aggregate.
    b. Centralizers on the rebar cage should be installed to keep the cage properly positioned.
    c. Cross-bracing of a reinforcing cage may be used when fabricating, transporting, and/or lifting. However, experience has shown that cross-bracing can contribute to the development of voids in a concrete shaft. Therefore, we recommend the removal of the cross-bracing prior to lowering the cage in the open shaft.
    d. The use of a tremie should be employed so that concrete is directed in a controlled manner down the center of the shaft to the pier bottom. **The concrete should not be allowed to ricochet off the pier reinforcing steel nor off the pier side walls.**
    e. The pier concrete should be designed to achieve the desired design strength when placed at a 7-inch slump, plus or minus 1-inch tolerance. **Adding water to a mix designed for a lower slump does not meet these recommendations.**

It should also be noted that the subsurface materials encountered in our borings generally consisted of stiff to hard clays and very hard clays, dense to very dense clayey gravels and very hard Marlstone. Thus, we anticipate that high-torque drilling equipment will be required for pier installation at this site. Groundwater was not encountered during drilling, and groundwater elevations can fluctuate over time. Therefore, temporary casing may also be required for pier installation at this site, as groundwater may be present. The Contractor should be familiar with and prepared for such conditions.

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.

Earthwork and Foundation Acceptance

Exposure to the environment may weaken the soils at the foundation bearing level if the excavation remains open for long periods of time. Therefore, it is recommended that all foundation excavations be extended to final grade and constructed as soon as possible in order to reduce potential damage to the bearing soils. If bearing soils are exposed to severe drying or wetting, the unsuitable soil must be re-conditioned or removed as appropriate and replaced with compacted fill, prior to concreting. The foundation bearing level should be free of loose soil, ponded water or debris and should be observed prior to concreting by the geotechnical engineer or his representative.

Foundation concrete should not be placed on soils that have been disturbed by rainfall or seepage. If the bearing soils are softened by surface water intrusion during exposure or by desiccation, the unsuitable soils must be removed from the foundation excavation and replaced with compacted select fill prior to placement of concrete.

Subgrade preparation and fill placement operations should be monitored by the soil engineer or his representative. As a guideline, at least one in-place density test should be performed for each 5,000 sq. ft. of compacted surface per lift or a minimum of three tests per lift. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

Trench Excavations

Excavations should comply with OSHA Standard 29CFR, Part 1926, Subpart P and all State of Texas and local requirements. Trenches 20 feet deep or greater require that the protective system be designed by a registered professional engineer. A trench is defined as a narrow

excavation in relation to its depth. In general, the depth is greater than the width, but the bottom width of the trench is not greater than 15 feet. Trenches greater than 5 feet in depth require a protective system such as trench shields, trench shoring, or sloping back the excavation side slopes.

The Contractor's "Competent Person" shall perform daily inspections of the trench to verify that the trench is properly constructed and that surcharge and vibratory loads are not excessive, that excavation spoils are sufficiently away from the edge of the trench, proper ingress and egress into the trench is provided and all other items are performed as outlined in these OSHA regulations. It is especially important for the inspector to observe the effects of changed weather conditions, surcharge loadings, and cuts into adjacent backfills of existing utilities. The flow of water into the base and sides of the excavation and the presence of any surface slope cracks should also be carefully monitored by the Trench Safety Engineer.

Although the geotechnical report provides an indication of soil types to be anticipated, actual soil and groundwater conditions will vary along the trench route. The "Competent Person" must evaluate the soils and groundwater in the trench excavation at the time of construction to verify that proper sloping or shoring measures are performed.

Appendix B to the OSHA regulations has sloping and benching requirements for short-term trench exposure for various soil types up to the maximum allowable 20-foot depth requirement.

PAVEMENT RECOMMENDATIONS

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. No traffic specific design information was received for this project therefore, the following design parameters and assumptions were used in our analysis:

Table 18: Pavement Design Parameters and Assumptions

Traffic Load for Light Duty Pavement	15,000 equivalent single axle loads (ESALs)
Traffic Load for Medium Duty Pavement	50,000 equivalent single axle loads (ESALs)
Average Daily Truck Traffic vehicle with at least 6 Wheels	One (1)
Concrete Compressive Strength	3,500 psi
Raw Subgrade California Bearing Ratio (CBR)	2.0 for clayey subgrade
Raw Subgrade Modulus of Subgrade Reaction, k in pci	75 for clayey subgrade

Options for section thickness for flexible and rigid pavements are provided in SECTION I: SYNOPSIS, Table 5. Note that the truck lane traffic sections correspond to only one heavy-duty truck per day. If more heavy-duty truck traffic is anticipated, we recommend the use of an eight (8)-inch thick concrete pavement.

A truck traffic section (8-inches thick) is recommended for use at loading docks, entrances, driveways, dumpster pads and channeled traffic areas. 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 8-inch truck traffic section is not shown in Table 5.

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 results. 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 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 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 14. 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 as follows:

Table 19: Pavement Subgrade Materials

Subgrade Preparation Prior to Paving Section Construction	
Minimum undercut depth	6 inches or as needed to remove organics and existing pavement/foundations
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 or lime treatment)	Proof rolling the subgrade is very important. 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.
Pumping/rutting areas discovered during proof rolling	Pumping and/rutting areas should be removed to firmer materials and replace with compacted general or select fill under direction of Geotechnical Engineer's representative

Table 20: 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 $\geq$ 2.0 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 $\geq$ 95% compaction at 0 to +4 from optimum
Subgrade Treatment Option - Moisture Conditioning	
Depth of moisture conditioning	9 inches (disk in place and moisture condition)
Compaction and moisture criteria	ASTM D 698 $\geq$ 95% compaction at 0 to +4 from optimum
In-Place Density and Moisture Verification Testing	
Testing frequency (Subgrade)	1 test per 5,000 square feet with minimum of 3 tests

Table 21: Subgrade Treatment Option - Lime Treatment

Subgrade Treatment Option - Lime Treatment	
Treatment depth	6 inches
Treatment type	Hydrated lime
Application rate (estimated)	6 - 8% by dry weight
Soil dry unit weight (estimated)	105 pcf but may be variable
Determination of application rate	The actual application rate should be determined by laboratory testing of soil samples taken after the pavement subgrade elevation has been achieved. The quantity of lime should be sufficient to result in a pH of at least 12.4 when tested in accordance with ASTM C 977, Appendix XI. Alternately, the optimum lime content may be determined through Atterberg limits testing on treated samples with varying percentages of lime. ***Sulfate testing of the exposed subgrade must be performed prior to the use of lime, cement or other calcium-based treatment agents.***
Treatment procedure	TxDOT Item 260 and 264
Treatment layer compaction and moisture criteria	ASTM D 698 $\geq$ 95% compaction at 0 to +4 from optimum
In-Place Density and Moisture Verification Frequency	
Test frequency (all materials)	1 test per 5,000 square feet (min. 3 tests)

Table 22: Flexible Pavement Requirements

Flexible Pavement Section Requirements	
Flexible Base Material Type	2004 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	2004 TxDOT Item 340, Type D
HMAC Placement Criteria	91% to 95% Theoretical Lab Density (TEX 207 F)

Table 23: 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	#4 @ 18" each way placed D/3 from top of slab
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 over-built so blading performed to remove distressed sections does not reduce the treated subgrade thickness.

GENERAL COMMENTS

The scope of this study is to provide geotechnical engineering criteria for use by design engineers in preparing the foundation designs. Environmental, utility, shoring, slope/wall stability and pavement studies of any kind were not a part of our scope of work or services.

This report was prepared as an instrument of service for this project exclusively for the use of the City of San Antonio and the project design team. If the development plans change relative to building or overall site layout, size, or anticipated loads or if different subsurface conditions are encountered, 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.

Geotechnical 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 geotechnical 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.

Subsurface Variations

Soil and groundwater conditions may vary between 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. As Geotechnical Engineer of Record (GER), we should be engaged by the Owner to provide Quality Assurance (QA) testing. Our services will be to evaluate the degree to which constructors are achieving the specified conditions they're contractually obligated to achieve, and observe that the encountered materials during earthwork for foundation installation are consistent with those encountered during this study. In the event that Arias is not retained to provide QA testing, we should be immediately contacted if differing subsurface conditions are encountered during construction. Differing materials may require modification to the

recommendations that we provided herein. A message to the Owner with regard to the project QA is provided in the GBA publication included in Appendix E.

Arias has an established in-house laboratory that meets the standards of the American Standard Testing Materials (ASTM) specifications of ASTM E-329 defining requirements for Inspection and Testing Agencies for soil, concrete, steel and bituminous materials as used in construction. We maintain soils, concrete, asphalt, and aggregate testing equipment to provide the testing needs required by the project specifications. All of our equipment is calibrated by an independent testing agency in accordance with the National Bureau of Standards. In addition, Arias is accredited by the American Association of State Highway & Transportation Officials (AASHTO), the United States Army Corps of Engineers (USACE) and the Texas Department of Transportation (TxDOT), and also maintains AASHTO Materials Reference Laboratory (AMRL) and Cement and Concrete Reference Laboratory (CCRL) proficiency sampling, assessments and inspections.

Furthermore, Arias employs a technical staff certified through the following agencies: the National Institute for Certification in Engineering Technologies (NICET), the American Concrete Institute (ACI), the American Welding Society (AWS), the Precast/Prestressed Concrete Institute (PCI), the Mine & Safety Health Administration (MSHA), the Texas Asphalt Pavement Association (TXAPA) and the Texas Board of Professional Engineers (TBPE). Our services are conducted under the guidance and direction of a Professional Engineer (P.E.) licensed to work in the State of Texas, as required by law.

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.

Information about this geotechnical report is provided in the GBA publication included in Appendix D.

APPENDIX A: FIGURES AND SITE PHOTOS

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

VICINITY MAP

District 9 Senior Center
San Antonio, Texas

Date: April 25, 2019	Job No.: 2019-203
Drawn By: RWL	Checked By: JDS
Approved By: CMS	Scale: N.T.S.

Figure 1

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

REVISIONS:

No.:	Date:	Description:

BORING LOCATION PLAN

District 9 Senior Center
San Antonio, Texas

Date: April 25, 2019	Job No.: 2019-203
Drawn By: RWL	Checked By: JDS
Approved By: CMS	Scale: N.T.S.

Figure 2

Photo 1 – View looking at Boring 4 drilling operations.

Photo 2 – View looking at Boring 11 drilling operations.

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

SITE PHOTOS

District 9 Senior Center
San Antonio, Texas

Date: April 25, 2019	Job No.: 2019-203
Drawn By: RWL	Checked By: JDS
Approved By: CMS	Scale: N.T.S.

Appendix A

APPENDIX B: BORING LOGS AND SYMBOL KEY SHEET

Boring Log No. B- 1

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 4/18/19

Coordinates: N29°33'19" W98°30'10.9"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200	DD	Uc
GRAVELLY FAT CLAY (CH), very stiff, brown **STRATUM I**		T	22	21	56	35	1.75		56	107	6.74
		SS	15					16			
	5	T	15				4.0				
		SS	14					15			
LEAN CLAY with Sand (CL), very hard, tan **STRATUM I**		T	22	17	43	26	4.5+		80	104	1.73
	10	SS	16					70			
- very stiff from 13'-23'		SS	7					17			
	15										
		SS	27	15	32	17		17	83		
	20										
MARLSTONE, very hard, tan **STRATUM III**		SS	13					50/2"			
	25										
		SS	13					**50/4"			
(continued)	30										

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: C. Coleman
Driller: PSI
Equipment: Buggy-mounted drill rig

Wet rotary: 0 - 35 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (tsf)

2019-203.GPJ 4/25/19 (BORING LOG SA13-02.ARIASSA12-01.GDT.LIBRARY2013-01.GLB)

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B- 1 (continued)

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 4/18/19

Coordinates: N29°33'19" W98°30'10.9"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200	DD	Uc
MARLSTONE, very hard, tan *(continued)*											
		SS	14					**50/3"			
	35										
Borehole terminated at 35 feet											

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: C. Coleman
Driller: PSI
Equipment: Buggy-mounted drill rig

Wet rotary: 0 - 35 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (tsf)

Boring Log No. B- 2

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 3/28/19

Coordinates: N29°33'18.1" W98°30'10.36"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
GRAVELLY FAT CLAY with Sand (CH), hard, dark brown **STRATUM I**		T	17	20	52	32	4.5+		51
LEAN CLAY with Sand (CL), stiff, tan **STRATUM I**		SS	17					8	
	5	T	19	19	49	30	4.5		79
		SS	14					8	
FAT CLAY (CH), stiff, dark brown **STRATUM I**		SS	21	21	53	32		9	85
	10	SS	25					8	
CLAYEY GRAVEL with Sand (GC), medium dense, tan **STRATUM II**		SS	9	17	36	19		16	14
	15								
		SS	14					28	
	20								
MARLSTONE, very hard, tan **STRATUM III**		SS	9					**50/1"	
	25								
Borehole terminated at 25 feet									

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: C. Coleman
Driller: Total Support Services, Inc.
Equipment: Buggy-mounted drill rig

Wet rotary: 0 - 25 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve

Boring Log No. B- 3

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 4/17/19

Coordinates: N29°33'17.9" W98°30'10.9"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
SANDY FAT CLAY (CH), stiff, brown		T	9						
STRATUM I		SS	24	21	61	40	4.5+	10	68
LEAN CLAY (CL), stiff, tan		T	19						
STRATUM I	5	SS	18					13	
		T	16	18	47	29	4.5+		89
	10	SS	22					14	
- very stiff 13-18'		T	20				2.5		
	15								
CLAYEY GRAVEL with Sand (GC), medium dense, brown		SS	13	20	56	36		23	27
STRATUM II	20								
MARLSTONE, very hard, tan		SS	11					**50/2"	
STRATUM III	25								
		SS	15					**50/2"	
(continued)	30								

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: C. Coleman
Driller: PSI
Equipment: Buggy-mounted drill rig

Wet rotary: 0 - 40 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve

2019-203.GPJ 4/25/19 (BORING LOG SA13-02.ARIASSA12-01.GDT.LIBRARY2013-01.GLB)

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B- 3 (continued)

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 4/17/19

Coordinates: N29°33'17.9" W98°30'10.9"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
MARLSTONE, very hard, tan *(continued)*									
		SS	15					**50/2"	
	35								
		SS	16					**50/2"	
	40								
Borehole terminated at 40 feet									

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: C. Coleman
Driller: PSI
Equipment: Buggy-mounted drill rig

Wet rotary: 0 - 40 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve

Boring Log No. B- 4

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 3/28/19

Coordinates: N29°33'18" W98°30'12.3"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
CLAYEY GRAVEL with Sand (GC), loose, brown **STRATUM II**		SS	9	19	48	29		9	30
LEAN CLAY (CL), firm, tan **STRATUM IA**		SS	11					7	
	5	T	22	18	40	22	4		91
- stiff from 6'-8'		SS	20					13	
SANDY FAT CLAY (CH), firm, dark brown **STRATUM IA**		T	26	22	62	40	4.5		70
	10	SS	19					7	
- very stiff from 13-15'		T	21				3.5		
	15								
FAT CLAY with Sand (CH), very stiff, tan **STRATUM IA**		SS	11					17	
	20								
- very hard from 23'-25'		SS	14					51	
	25								
Borehole terminated at 25 feet									

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: J. Ramos
Driller: Total Support Services, Inc.
Equipment: Buggy-mounted drill rig

Single flight auger: 0 - 25 ft

Nomenclature Used on Boring Log

Split Spoon (SS)

Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

2019-203.GPJ 4/25/19 (BORING LOG SA13-02.ARIASSA12-01.GDT.LIBRARY2013-01.GLB)

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B- 5

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 4/18/19

Coordinates: N29°33'18.8" W98°30'12.1"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200	DD	Uc
GRAVELLY FAT CLAY with Sand (CH), stiff, dark brown **STRATUM I**		T	20	23	70	47	4.5+		53		
		SS	11					14			
LEAN CLAY with Sand (CL), very stiff, tan **STRATUM I**	5	T	15				4.5+				
		SS	13					21			
		T	15	17	43	26	4.5+		84	114	1.86
	10	SS	19					19			
CLAYEY GRAVEL with Sand (GC), medium dense, dark brown **STRATUM II**		T	8	21	59	38	3.25		32		
	15										
CLAYEY GRAVEL with Sand (GC), dense, tan **STRATUM II**		SS	8					30			
	20										
MARLSTONE, very hard, tan **STRATUM III**		SS	10	18	45	27		76/9"	21		
	25										
(continued)		SS	17					50/4"			
	30										

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: C. Coleman
Driller: PSI
Equipment: Buggy-mounted drill rig

Wet rotary: 0 - 40 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (tsf)

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B- 5 (continued)

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 4/18/19

Coordinates: N29°33'18.8" W98°30'12.1"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200	DD	Uc
MARLSTONE, very hard, tan *(continued)*		SS	13					**50/3"			
	35										
MARLSTONE, very hard, gray **STRATUM III**		SS	16					**50/1"			
	40										
Borehole terminated at 40 feet											

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: C. Coleman
Driller: PSI
Equipment: Buggy-mounted drill rig

Wet rotary: 0 - 40 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (tsf)

Boring Log No. B- 6

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 3/28/19

Coordinates: N29°33'18.4" W98°30'11.28"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
SANDY LEAN CLAY (CL), firm, brown **STRATUM I**		SS	15					6	
		SS	21	19	48	29		6	63
		T	14				4.5		
	5								
LEAN CLAY with Sand (CL), stiff, tan **STRATUM I**		SS	13					11	
		T	15	18	40	22			80
	10								
- firm from 10-12'		SS	27					5	
LEAN CLAY (CL), very stiff, tan **STRATUM I**		T	10	18	39	21			89
	15								
		SS	11					29	
	20								
		SS	2					28	
	25								
Borehole terminated at 25 feet									

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: C. Coleman
Driller: Total Support Services, Inc.
Equipment: Buggy-mounted drill rig

Single flight auger: 0 - 25 ft

Nomenclature Used on Boring Log

Split Spoon (SS)

Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B- 7

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 3/29/19

Coordinates: N29°33'16.3" W98°30'8.6"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)		SN	WC	PL	LL	PI	PP	N	-200
CLAYEY GRAVEL with Sand (GC), loose, brown				4						
STRATUM II			T	13	16	39	23			23
			SS	8					7	
			T	13				4.5+		
	5									
LEAN CLAY (CL) with sand, very stiff, tan			SS	3					19	
STRATUM IA										
- very stiff from 8-10'			SS	11	15	37	22		10	70
	10									
Borehole terminated at 10 feet										

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: J. Ramos
Driller: Total Support Services, Inc.
Equipment: Buggy-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B- 8

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 3/29/19

Coordinates: N29°33'15.6" W98°30'10.3"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
GRAVELLY FAT CLAY (CH), stiff, dark brown **STRATUM I**		T	11	24	69	45	4.5+		65
		SS	17					8	
GRAVELLY FAT CLAY with Sand (CH), very stiff, brown **STRATUM I**	5	T	12	23	66	43	4.5+		51
CLAYEY GRAVEL with Sand (GC), medium dense, tan **STRATUM II**		SS	5					16	
		SS	5	12	29	17		16	21
	10								
Borehole terminated at 10 feet									

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: J. Ramos
Driller: Total Support Services, Inc.
Equipment: Buggy-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B- 9

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 3/29/19

Coordinates: N29°33'17" W98°30'11.8"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
LEAN CLAY (CL) with sand, stiff, brown **STRATUM I**		SS	9					12	
- firm from 2-6'		SS	17	14	34	20		6	72
		T	15				4.5+		
	5								
LEAN CLAY with Gravel (CL), stiff, dark brown **STRATUM I**		SS	17					10	
		T	18	20	49	29	3.0		85
	10								
Borehole terminated at 10 feet									

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: J. Ramos
Driller: Total Support Services, Inc.
Equipment: Buggy-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Split Spoon (SS)

Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B-10

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 3/29/19

Coordinates: N29°33'17.3" W98°30'13.7"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
FAT CLAY (CH) with sand, firm, brown **STRATUM I**		SS	18	22	61	39		7	73
		T	16				4.5+		
	5	SS	23	22	59	37		6	80
		T	19				3.75		
LEAN CLAY (CL) with sand, firm, tan **STRATUM I**		SS	13	11	27	16		7	74
	10								
Borehole terminated at 10 feet									

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: J. Ramos
Driller: Total Support Services, Inc.
Equipment: Buggy-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Split Spoon (SS) Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

2019-203.GPJ 4/25/19 (BORING LOG SA13-02.ARIASSA12-01.GDT.LIBRARY2013-01.GLB)

Arias Geoprofessionals

Job No.: 2019-203

Boring Log No. B-11

Project: **D-9 Senior Center**
San Antonio, Texas

Sampling Date: 3/29/19

Coordinates: N29°33'19.2" W98°30'13.5"

Location: See Boring Location Plan

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
CLAYEY GRAVEL (GC), dense, dark brown **STRATUM II**		T	7	18	45	27	4.5+		49
LEAN CLAY (CL), stiff, tan **STRATUM IA**		SS	12					10	
		T	14				4.5		
	5								
		SS	14	17	42	25		13	88
		T	14				3.25		
	10								

Borehole terminated at 10 feet

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: J. Ramos
Driller: Total Support Services, Inc.
Equipment: Buggy-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

2019-203.GPJ 4/25/19 (BORING LOG SA13-02.ARIASSA12-01.GDT.LIBRARY2013-01.GLB)

Arias Geoprofessionals

Job No.: 2019-203

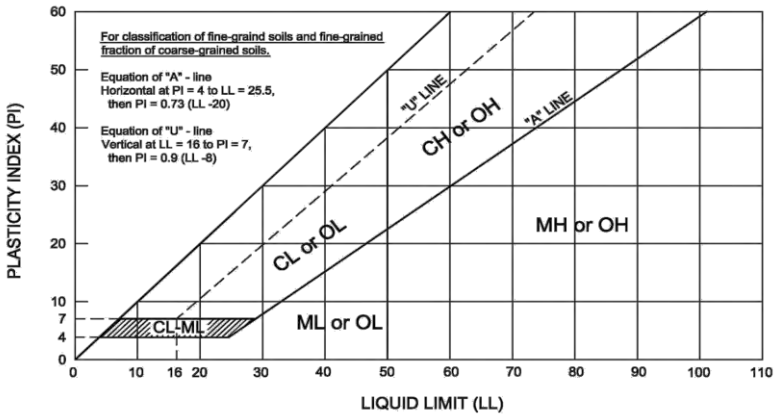
KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

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	Group Name[B]
COARSE-GRAINED SOILS	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]
More than 50% retained on No. 200 sieve	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	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]
50% or more passes the No. 200 sieve	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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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)	**Parting**	Inclusion < 1/8-inch thick extending through samples
Cobbles	12-inches to 3-inches (300mm to 75mm)	**Seam**	Inclusion 1/8-inch to 3-inches thick extending through sample
Gravel	3-inches to No. 4 sieve (75mm to 4.75mm)	**Layer**	Inclusion > 3-inches thick extending through sample
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		

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 either 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 with a thin walled Shelby Tube Sampler (ASTM D 1587) as described in Appendix C. 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. The pocket penetrometer values are shown on the boring logs.

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
Liquid limit, plastic limit, and plasticity index of soils	ASTM D 4318	PL, LL, PI
Amount of material in soils finer than the No. 200 sieve	ASTM D 1140	-200
Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166	Uc
Determining Sulfate Content in Soils	Tex-145-E	N/A

The laboratory results are reported on the soil boring logs.

APPENDIX D: GBA INFORMATION – GEOTECHNICAL REPORT

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

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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.

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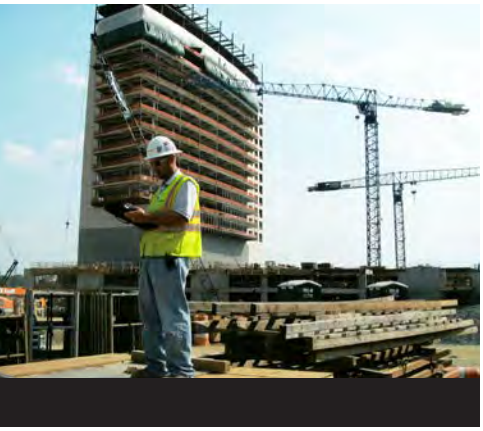


Most CoMET firms are not accredited and it's dangerous to assume CoMET personnel are certified.

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

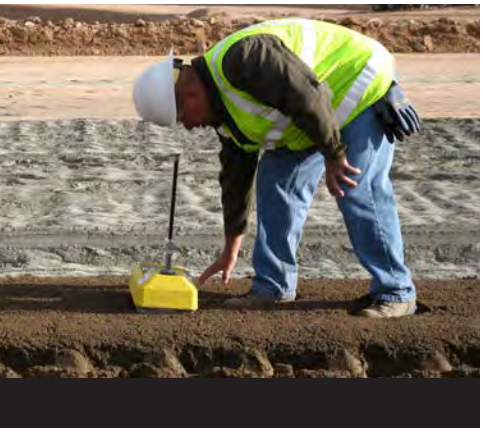
to the construction phase. Geotechnical engineers initiate this approach by applying their knowledge of local geological conditions to develop an economical subsurface-sampling plan. Proper execution of the plan should derive just enough samples from just enough areas to permit an experienced geotechnical 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.

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