SECTION 00 01 15
LIST OF DRAWING SHEETS

The drawings listed below accompanying this specification form a part of the contract.

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- - - END - - -

(SAMPLE LIST OF DRAWINGS)

VAMC (NAME) (SPEC No.)

SECTION 00 01 15
LIST OF DRAWINGS

The drawings listed below accompanying this specification form a part of the contract.

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30-5	Reflected Ceiling Plan
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- - - E N D - - -

VAMC WACO, TEXAS

DOCUMENT 00 31 32

GEOTECHNICAL INFORMATION

1.1 GENERAL:

A. The soils investigation report and supplement following this page are furnished by the VA from an independent testing laboratory.

B. The data included in the report and supplement may be used by the Contractor for general information only. The Architect and the VA are not responsible for the accuracy of the data given therein.

---END---

Geotechnical Engineering Report

Veterans Administration Campus Additions

Buildings 10 and 11

East Doris Miller Circle

Waco, Texas

December 4, 2009

Terracon Project No. 96095120

Prepared for:

Brewer & Escalante
Houston, Texas

Prepared by:

Terracon Consultants, Inc.
Austin, Texas

December 4, 2009

Terracon

Brewer & Escalante
7600 W. Tidwell, Suite 103
Houston, Texas 77040

Attention: Mr. Craig Artze, P.E.
Main: 832-615-0301
Cell: 713-443-4421
Email: cartze@BREWER-ESCALANTE.COM

Regarding: Geotechnical Engineering Report
Veteran Administration Campus Additions
Buildings 10 and 11
East Doris Miller Circle
Waco, Texas
Terracon Project No. 96095120

Dear Mr. Brewer:

Terracon Consultants, Inc. (Terracon) is pleased to submit our Geotechnical Engineering Report for proposed additions to the Veteran Administration Campus in Waco, Texas. We trust that this report is responsive to your project needs. Please contact us if you have any questions or if we can be of further assistance.

We appreciate the opportunity to work with you on this project and look forward to providing additional Geotechnical Engineering and Construction Materials Testing services in the future.

Sincerely,
Terracon Consultants, Inc.
(TBPE Firm Registration: TX F3272)

M. Anitha

Anitha Medichetti, P.E.
Project Engineer

James G. Bierschwale, P.E.
Senior Principal, Austin Office Manager

STATE OF TEXAS
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LICENSED
PROFESSIONAL ENGINEER
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Copies Submitted: Addressee: (2) Bound & (1) Electronic
Mr. Adam Cryer – Pinnacle Structural (ac@pinnaclestructural.com)

Terracon

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EXECUTIVE SUMMARY

A geotechnical investigation has been performed for proposed additions to the Veterans Administration Campus in Waco, Texas. Five borings, designated B-1 through B-5, were performed to depths of approximately 20 to 25 feet below the existing grade. Groundwater was not observed in the borings during drilling.

Based on the information obtained from our subsurface exploration, the site can be developed for the proposed project. The following geotechnical considerations were identified:

- Stripping should include surface vegetation, loose topsoil, existing foundations, abandoned utilities, or other unsuitable materials, as well as the over-excavation required in the building/stair case/walkway area.
- Proofrolling should be performed to detect weak areas. Weak areas should be removed and replaced with select fill or soils exhibiting similar characteristics as the adjacent in-situ soils.
- The on-site soils are moisture sensitive expansive clays.
- Drilled piers placed to bear in the Stratum II Austin Group limestone are appropriate to support the planned structures. Based on the subsurface data obtained during this exploration, we recommend the piers extend a minimum depth of 4 feet into the limestone and be sized utilizing a maximum allowable total load bearing pressure of 30,000 psf. In addition, an allowable side friction of 2,000 psf may be utilized within the limestone for piers embedded beyond the minimum 4 foot embedment depth.
- The floor slab may be suspended (Option 1) to provide a 12 inch void space beneath the slab. The drilled piers should be designed to carry the weight of the slab.
- If the floor slab is not suspended, four subgrade preparation options (Options 2, 3A, 3B, or 3C) may be considered.
  - Option 2 – Provide a 7-foot select fill pad beneath the floor slab.
  - Option 3A – Excavate in-situ soils to a depth of 8 feet below existing grade. Properly moisture condition, place, and recompact 2 feet of soil. Provide 6 feet of select fill below the floor slab.
  - Option 3B – Excavate in-situ soils to a depth of 9 feet below existing grade. Properly moisture condition, place, and recompact 4 feet of soil. Provide 5 feet of select fill below the floor slab.
  - Option 3C – Excavate in-situ soils to a depth of 10 feet below existing grade. Properly moisture condition, place, and recompact 6 feet of soil. Provide 4 feet of select fill below the floor slab.
- This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
VETERANS ADMINISTRATION CAMPUS ADDITIONS
BUILDINGS 10 AND 11
EAST DORIS MILLER CIRCLE
WACO, TEXAS

Project No. 96095120
December 4, 2009

1.0 INTRODUCTION

Terracon is pleased to submit our Geotechnical Engineering Report for proposed additions to the Veterans Administration Campus in Waco, Texas. This project was authorized by Mr. Craig Artze, P.E., through signature of our "Agreement For Services" on October 20, 2009. The project scope was performed in general accordance with Terracon Proposal No. P96090196, Revision 1 dated March 17, 2009.

The purpose of this report is to describe the subsurface conditions observed at the five borings drilled for this study, analyze and evaluate the test data, and provide recommendations with respect to:

- Foundation design and construction for the additions;
- Site, subgrade, and fill preparation.

2.0 PROJECT INFORMATION

2.1 Project Description

The project involves the proposed additions to the existing Veterans Administration campus located at East Doris Miller Circle in Waco, Texas. These include a three-story building addition with an approximate footprint of 1,500 square feet to existing building 11, stair case additions to each corner of existing building 10, and a covered walkway between existing buildings 9 and 10.

ITEM	DESCRIPTION
Site layout	See Exhibits 2 and 3, Site Layout and Project Layout, in Appendix A.
Building/Structures	1) Three-story addition to existing building 11, with an approximate footprint of 1,500 square feet, 2) Stair case additions to each corner of existing building 10, and 3) Covered walkway between existing buildings 9 and 10.
Building construction	Unknown
Finished floor elevation	Within one to two feet of existing grade (assumed)
Maximum loads	Unknown
Maximum allowable settlement	Columns: 1-inch (typical)

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	The site is located on East Doris Miller Circle in Waco, Texas (see Exhibit 1 of Appendix A).
Existing improvements	The additions will be constructed around existing buildings 9, 10, and 11 of the Veterans Administration Campus.
Current ground cover	Existing buildings, pavements, landscaped areas, and scattered trees
Existing topography	Based on a topographic plan provided by Brewer and Escalante to Terracon, the site is generally flat.

3.0 SUBSURFACE CONDITIONS

3.1 Geology

Based on available geologic literature[i] and our review of the samples, the site lies within an area characterized by Austin Group limestone of Upper Cretaceous Age. The Austin Group is generally comprised of tan to gray chalky limestone and marls, and is commonly overlain by a variable thickness of moderate to high plasticity clayey soils and/or residual soils (severely weathered portions of the limestone).

[i] "Geologic Atlas of Texas - Waco Sheet", Bureau of Economic Geology, The University of Texas at Austin, 1974.

3.2 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Range of Stratum (feet)	Material Encountered	Consistency/Density
Stratum Ia [1]	0 to 2	Possible Fill – Lean Silty Clay (CL)	Stiff
Stratum I [2]	0 to 10	Fat Clay (CH)	Medium stiff to hard
Stratum II [3]	4 to 25	Limestone – Austin Group	

1. The Stratum Ia brown possible fill soils (encountered only in boring B-4) exhibited high shrink/swell potential as indicated by a measured plasticity index of about 30 percent. An in-situ moisture content was about 3 percent dry of the corresponding plastic limit. A pocket penetrometer value of about 1.75 tons per square foot (tsf) was measured for the stratum.
2. The Stratum I dark brown to brown to tan and light gray soils exhibited high shrink/swell potential as indicated by measured plasticity indices varying from about 39 to 68 percent. In-situ moisture contents varied from about 2 percent dry to 18 percent wet of the corresponding plastic limits. Pocket penetrometer values ranging from about 0.75 to over 4.5 tsf were measured for the stratum.
3. The Stratum II limestone was encountered in the borings at depths ranging from about 4 to 10 feet below the existing ground surface. A standard penetration resistance value of about 50 blows per 2 inches of penetration was measured for the stratum. Measured values of Recovery and RQD ranged from about 60 to 100 percent and 29 to 90 percent, respectively. Typical Recovery and RQD values were over 70 and 50 percent, respectively. Measured uniaxial compressive strengths of intact samples varied from about 23 to 303 kips per square foot (ksf). The lower Recovery, RQD, and strength values are generally due to weathered zones, clay seams and layers in the limestone.

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Exhibits 4 through 8 of Appendix A.

3.3 Groundwater

The borings were dry augered to depths of about 4 to 10 feet below existing grade. Once competent limestone was encountered, the borings were drilled to completed depths using wet rotary techniques to facilitate rock coring, making subsequent groundwater readings difficult to obtain. Groundwater was not observed within the upper portion of the borings.

Although not observed, groundwater seepage is still possible at the site, particularly along the interface of the Stratum I soils with the Stratum II limestone, or along pervious seams/layers in the subgrade soils and/or rock. During periods of wet weather, zones of seepage may appear and isolated zones of "perched water" may become trapped (or confined) by zones possessing a low permeability. Groundwater conditions at the site could fluctuate as a result of seasonal and climatic variations. Please note that it often takes several hours/days for water to accumulate in a borehole, and geotechnical borings are relatively fast, short-term boreholes that are backfilled the same day. Long-term groundwater readings can more accurately be achieved using monitoring wells. Groundwater conditions should be evaluated immediately prior to construction.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

The following recommendations are based upon the data obtained in our field and laboratory programs, project information provided to us, and on our experience with similar subsurface and site conditions.

4.1 Geotechnical Considerations

Based on our test borings, expansive soils that exhibit a very high potential for volumetric change during moisture variations are present. The subgrade soils at this site may experience significant expansion and contraction due to changes in moisture content. The soils exhibit a Potential Vertical Rise (PVR) varying from about 2¾ to 4¾ inches, as estimated by the Texas Department of Transportation (TxDOT) Method TEX-124-E, if present in a dry condition.

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and cracking in the structure should be anticipated. The severity of cracking and other damage such as uneven floor slabs will probably increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction.

4.2 Earthwork

Construction areas should be stripped of vegetation, trees, topsoil, existing foundations, existing pavements, utilities, and other unsuitable material. Remnants of any foundation units from previously existing structures on the site should be removed to a minimum depth of 24 inches below final subgrade elevation. All utilities and associated bedding material that are planned to be abandoned/demolished should be completely removed from within the proposed building area. If not possible, the abandoned utility lines should be thoroughly grouted and plugged with flowable fill.

Once final subgrade elevations have been achieved (including the over-excavation required for building/stair case/walkway pad), the exposed subgrade should be carefully proofrolled with a 20-ton pneumatic roller or a fully loaded dump truck to detect weak zones in the subgrade. Weak areas detected during proofrolling, as well as zones containing debris or organics and voids resulting from removal of boulders, etc. should be removed and replaced with soils exhibiting similar classification, moisture content, and density as the adjacent in-situ soils. Proper site drainage should be maintained during construction so that ponding of surface runoff does not occur and causes construction delays and/or inhibit site access.

Subsequent to proofrolling, and just prior to placement of fill, the exposed subgrade within the construction area should be evaluated for moisture and density. If the moisture and/or density requirements do not meet the criteria described in the table below, the subgrade should be scarified to a minimum depth of 6 inches, moisture adjusted and compacted to at least 95 percent of the Standard Proctor (ASTM D 698) maximum dry density. Select fill and on-site soils should meet the following criteria.

Fill Type [1]	USCS Classification	Acceptable Location for Placement
Select Fill [2,3]	CL, SC, and/or GC (7≤PI≤20)	Select fill material should be used for all grade adjustments within building/stair cases/walkway areas.
General Fill [4]	CL, CH	General fill is for use within other non-structural areas of the site.

1. Prior to any filling operations, samples of proposed borrow and/or on-site materials should be obtained for laboratory testing. The tests will provide a basis for evaluation of fill compaction by in-place density testing. A qualified soil technician should perform sufficient in-place density tests during the filling operations to evaluate that proper levels of compaction, including dry unit weight and moisture content, are being attained.
2. Imported select fill should consist of crushed limestone base material meeting the requirements of the Texas Department of Transportation (TxDOT) 2004 Standard Specifications Item 247, Type A, Grade 3, or a low-plasticity clayey soil with a plasticity index between 7 and 20 percent, a maximum gravel content (percentage retained on No. 4 sieve) of 40 percent, and rocks no larger than 4 inches in their largest dimension. As an alternative, a low-plasticity granular fill material which does not meet these specifications may be utilized only if approved by Terracon.
3. Based on the laboratory testing performed during this exploration, the on-site soils are not suitable for re-use as select fill.
4. Excavated on-site soils, if free of organics, debris, and rocks larger than 4 inches, may be considered for use as fill in landscape or other general areas. We note that the on-site soils exhibit high shrink/swell potential. For economical reasons, expansive soils are often used in pavement and/or flatwork areas. The owner should be aware that the risk exists for future movements of the subgrade soils which may result in movement and/or cracking of pavements and/or flatwork.

4.2.1 Compaction Requirements

ITEM	DESCRIPTION
Fill Lift Thickness	The fill soils should be placed on prepared surfaces in lifts not to exceed 8 inches loose measure, with compacted thickness not to exceed 6 inches.
Moisture/Density Control	All fill should be placed in uniform lifts compacted to at least 95 percent of the Standard Proctor (ASTM D 698) maximum dry density. In-situ clay soils should be moisture conditioned to between optimum and +4 of optimum moisture content. Select fill should be moisture conditioned to between -3 and +3 of optimum moisture content.

4.2.2 Excavation

Excavation operations at the site for the proposed construction may penetrate into the Stratum II limestone. Zones of resistant limestone, which could require sawcutting, jackhammering, hoe-ramming, milling, or similar techniques to excavate, may be encountered. Our past experience with this formation in the vicinity of the site indicates that much of the upper weathered limestone should be easier to excavate than the deeper more competent portions; the limestone typically becomes more competent with depth.

Our comments on excavation are based on our experience with the rock formation. Rock excavation depends on not only the rock hardness, weathering, and fracture frequency, but also the contractor's equipment, capabilities, and experience. Therefore, it should be the contractor's responsibility to determine the most effective methods for excavation. The above comments are intended for informational purposes for the design team only and may be used to review the contractor's proposed excavation methods.

4.2.3 Grading and Drainage

The performance of the foundation system for the proposed structures will not only be dependent upon the quality of construction, but also upon the stability of the moisture content of the near-surface soils. Therefore, we highly recommend that site drainage be developed so that ponding of surface runoff near the structures does not occur. Accumulation of water near building/stair cases/walkway foundations may cause significant moisture variations in the soils adjacent to the foundations, thus increasing the potential for structural distress.

Positive drainage away from the structures must be provided during construction and maintained through the life of the proposed project. Infiltration of water into excavations should be prevented during construction. It is important that foundation soils are not allowed to become wetted. All grades must provide effective drainage away from the building/stair cases/walkway during and after construction. Exposed ground should be sloped at a minimum 5 percent away from the building/stair cases/walkway for at least 10 feet beyond the perimeter of the building/stair cases/walkway. Water permitted to pond next to the building/stair cases/walkway can result in greater soil movements than those discussed in this report. Estimated movements described in this report are based on effective drainage for the life of the structures and cannot be relied upon if effective drainage is not maintained.

Roof runoff and surface drainage should be collected and discharged far away from the structures to prevent wetting of the foundation soils. Roof gutters should be installed and connected to downspouts and pipes directing roof runoff at least 10 feet away from the building/stair cases/walkway. Planters located within 10 feet of the structures should be self-contained to prevent water accessing the building/stair cases/walkway subgrade soils. Sprinkler mains and spray heads should be located at least 5 feet away from the building/stair cases/walkway. In addition, the owner and/or builder should be made aware that placing large bushes and trees adjacent to the structures may cause significant moisture variations in the soils underlying the structures. Watering of vegetation should be performed in a timely and controlled manner and prolonged watering should be avoided. Landscaped irrigation adjacent to the foundation units should be minimized or eliminated. Special care should be taken such that underground utilities do not develop leaks with time.

4.3 Foundation System

Based upon the subsurface conditions observed during this exploration, a drilled straight-sided pier foundation system bearing into the Stratum II Austin Group limestone would be appropriate to support the proposed building/stair cases/walkway. Recommendations for this type of foundation system are provided below.

As mentioned previously, the site is generally flat. No proposed final grading information has been provided to Terracon for the site. However, we assume that the finished floor elevation (FFE) for the proposed structures will be at or near (within one to two feet of) existing grade. If this assumption is incorrect, Terracon should be notified to review and modify and/or verify recommendations in writing.

4.3.1 Design Recommendations – Drilled Pier Foundation System

Description	Drilled Pier Design Parameter
Minimum embedment into bearing stratum[1]	4 feet
Maximum embedment into bearing stratum	Not Applicable
Minimum pier diameter	18 inches
Bearing pressures	Net dead plus sustained live load – 40,000 psf

Description	Drilled Pier Design Parameter
Side Friction	3,000 psf for pier portions embedded beyond the 4 foot minimum embedment depth
Estimated uplift force[2, 3]	75*D (kips), where D is the pier diameter in feet
Minimum percentage of steel	0.5 percent
Approximate total settlement [4]	1 inch or less
Estimated differential settlement[5]	Approximately ½ to ¾ of total settlement

1. To bear within the Stratum II Austin Group limestone.
2. The amount of reinforcing steel required can be computed by assuming that the dead load of the structure surcharges the pier and that the above estimated tensile force acts vertically on the shaft. The amount of required steel, as calculated by the structural engineer, should extend the entire length of the drilled pier and in no case should the percentage of steel be less than 0.5 percent. The equation for uplift force includes factor of safety of at least 1.5.
3. The recommended minimum embedment depth of the straight-sided piers should be sufficient in withstanding soil uplift forces. Please note that the uplift force equation given above is intended for calculating the required reinforcing steel and is not intended for calculating required pier embedment to overcome soil uplift forces. Additional reinforcing steel may be needed to resist external structural uplift forces.
4. Provided proper construction practices are followed. For adjacent piers, we recommend a minimum edge-to-edge spacing of at least 1 pier diameter (or 2 pier diameters center-to-center) based on the larger diameter of the two adjacent piers. In locations where this minimum spacing criterion cannot be accomplished, Terracon should be contacted to evaluate the locations on a case-by-case basis.
5. Will result from variances in subsurface conditions, loading conditions and construction procedures, such as cleanliness of the bearing area or flowing water in the shaft.

4.3.2 Foundation Construction Considerations

Drilled pier foundations should be augered and constructed in a continuous manner. Concrete should be placed in the pier excavations following drilling and evaluation for proper bearing stratum, embedment, and cleanliness. The piers should not be allowed to remain open overnight before concrete placement. Surface runoff or groundwater seepage accumulating in the excavation should be pumped out and the condition of the bearing surface should be evaluated immediately prior to placing concrete. The drilling equipment utilized should be readily capable of excavation the Austin Group limestone observed at this site. Drilling equipment with insufficient torque and/or augers/bits/core barrels that are not suited for variable and/or hard rock conditions will likely result in poor production rates.

Although not encountered in the borings, zones of groundwater inflow and/or sloughing soils are a possibility during pier construction at this site. Therefore provisions should be incorporated into the plans and specifications to utilize casing to control sloughing and/or groundwater seepage during pier construction. Removal of the casing should be performed with extreme care and under proper supervision to minimize mixing of the surrounding soil and water with the fresh concrete. If water infiltration becomes excessive, slurry drilling techniques (or other drilling means) could be necessary. Concrete should exhibit a six-inch slump with a $\pm$ one inch tolerance. Under no circumstances should loose soil be placed in the space between the casing and the pier sidewalls. The concrete should be placed using a rigid tremie or by the free-fall method provided the concrete falls to its final position through air without striking the sides of the hole, the reinforcing steel cage or any other obstruction. A drop chute should be used for this free-fall method.

The use of casing should help to minimize groundwater inflow into the pier excavation. If seepage persists even after casing installation, the water should be pumped out of the excavation immediately prior to placing concrete. If groundwater inflow is too severe to be controlled by pumping, the concrete should be tremied to the full depth of the excavation to effectively displace the water. In this case, a “clean-out” bucket should be utilized to remove loose soil and/or rock fragments from the pier bottom before placing steel and concrete.

The pier excavation may encounter fill or other obstructions from previous construction on this site. The contractor should have equipment readily capable of penetrating concrete obstructions, reinforcing steel, gravel backfill, miscellaneous construction debris, etc.

4.3.2.1 Foundation Construction Monitoring

The performance of the foundation system for the proposed structures will be highly dependent upon the quality of construction. Thus, we recommend that the foundation installation be monitored by Terracon to identify the proper bearing strata and depths and to help evaluate foundation construction. We would be pleased to develop a plan for foundation monitoring to be incorporated in the overall quality control program.

4.4 Floor Slab

The Stratum I clay soils at this site could induce significant movement upon grade-supported floor slabs due to their potential to undergo volumetric change during variations in the in-situ moisture conditions. This movement potential is influenced primarily by the properties of the subgrade soils, as well as the moisture content of the subgrade at the time of construction, overburden pressures, and the stability of the moisture contents after construction is complete. As mentioned previously, based upon the results of our field and laboratory programs and the TxDOT Method TEX-124-E, we estimate that the clayey subgrade in the area of the proposed structures exhibits a Potential Vertical Rise (PVR) ranging from about 2¾ to 4¾ inches, if present in a dry condition. The variation in the PVR is due to the different thicknesses of Stratum I clay soils encountered in the borings. Such soil conditions could induce significant movement upon grade-supported floor slabs. Recommended floor slab systems for these subgrade conditions are discussed in the following subsections.

For the subgrade preparation options, fill placed in the building/stair cases/walkway pad areas, aside from the moisture conditioned material discussed in Option 3 below, should meet our select fill specifications. Material and placement requirements for select fill and other building pad fill materials are provided in the "**Earthwork**" section. We suggest the use of crushed limestone base in the upper 6 inches of the fill pad from a standpoint of construction access during wet weather, as well as from a standpoint of floor slab support. This suggestion is primarily to provide a better working surface for construction workers, equipment, and traffic on the building pad, especially during and after periods of wet weather, and is not intended to function as a capillary break or moisture barrier for the slab.

A subgrade reaction modulus of 150 psi/inch may be utilized for subgrade prepared as discussed for Options 2 and 3 below. For Options 2 and 3, the building/stair cases/walkway pad should extend at least 3 feet beyond the building/stair cases/walkway slab limits; however, the upper 18 inches of backfill adjacent to the grade beams (on the exterior side) in this zone should be Stratum I clay soils to reduce surface water infiltration.

4.4.1 Option 1 - Structurally Suspended Floor Slab

Due to the highly plastic clay soils observed at this site, the most positive means of reducing the effects of floor slab movements due to volume changes and/or settlement of the subsurface soils would be to structurally suspend the floor slab above grade. For a structurally suspended floor slab system at this site, we recommend a minimum 12-inch void space be provided beneath the floor slab and subgrade. The drilled pier foundation system should be designed to carry the additional loads.

If the subgrade elevation beneath the floor slab is lower than that of the exterior ground surface in any areas, we recommend that a series of surface drains be placed such that water accumulating in the void space beneath the slab and the subgrade can be properly collected and removed. Sloping the subgrade toward these drains in a manner where water cannot accumulate adjacent to any of the foundation units is recommended. The above can also be accomplished by sloping the subgrade beneath and outside the building to provide positive drainage away from foundation units. In addition, proper ventilation should be provided to reduce the possibility that a high humidity environment could develop in the void space areas. The use of a structurally suspended floor slab in conjunction with drilled piers would eliminate the need for extensive subgrade preparation (i.e. Options 2 and 3) as discussed in the following sections.

4.4.2 Option 2 - Subgrade Preparation with Select Fill Only

Although a suspended slab is the most reliable way to reduce movements, extensive subgrade preparation utilizing a select fill building pad is also an option. For this option, in-situ soils should be excavated and removed from the building/stair cases/walkway pad area to provide a select fill pad of at least 7 feet below the bottom of the floor slab. Please note that the thickness of the Stratum I clays varied from about 4 to 10 feet in the borings. Therefore, if the Stratum II limestone is encountered during the excavation for the fill pad, the select pad thickness may be reduced but the limestone should be overexcavated as necessary to provide a minimum 12-inch select fill pad in all floor slab areas. The above select fill subgrade preparation recommendations should reduce movements to approximately 1 inch.

4.4.3 Option 3 - Subgrade Preparation with Select Fill and Moisture Conditioned Subgrade

As an alternative to Option 2, a select fill pad may be combined with moisture conditioned subgrade as a preparation alternative. For this option, the thickness of select fill soils may be utilized as indicated in the table below provided a portion of the underlying clay soils are excavated, moisture conditioned to at least +2 to +6 percent of optimum moisture, and recompacted to at least 95 percent of the Standard Proctor (ASTM D 698) maximum dry density. The following table presents the thicknesses of select fill pad along with the moisture conditioned soils. Each option should reduce shrink/swell movements to approximately 1 inch.

Preparation Option	Select Fill Thickness, Feet	Moisture Conditioned Thickness (Below Select Fill), Feet	Total Building Pad Thickness, Feet
3A	6	2	8
3B	5	4	9
3C	4	6	10

As an example, for option 3A, we recommend that the on-site clay soils be removed to a depth of 8 feet below the bottom of the floor slab. At least 2 feet of the excavated clay soils should be moisture conditioned to between +2 and +6 percent of optimum moisture and recompacted to at least 95 percent of the Standard Proctor (ASTM D 698) maximum dry density in compacted lifts not exceeding 6 inches. The moisture conditioned clay subgrade soils should not be allowed to dry out prior to subsequent lift placements. For Option 3A, select fill should be placed as discussed in the "**Earthwork**" section to provide a select fill pad of 6 feet below the floor slab. As in Option 2, if the Stratum II limestone is encountered during the excavation for the fill pad, the select pad thickness may be reduced and the requirement for moisture conditioning omitted in these areas but in no case should the select fill pad thickness be less than 12 inches.

4.5 Grade Beams

4.5.1 Grade Beams with Drilled Piers and a Suspended Slab (Option 1)

Grade beams spanning between drilled piers should be protected from the expansive soils at the site. A minimum 12-inch void provided below the grade beams should allow the expansive clays to swell without causing distress in the grade beams. The sides of the void should be protected with permanent rigid soil retainers so that the soil will not slough beneath the grade beams and thus fill the void.

We recommend that on-site clayey soils be utilized for backfill adjacent to exterior grade beams of the buildings (to reduce potential infiltration of surface water into the subgrade in these areas). The backfill should be compacted to at least 95 percent of the ASTM D 698 maximum dry density at a moisture content at or above optimum moisture.

4.5.2 Grade Beams with Grade-Supported Slabs (Options 2 and 3)

For grade-supported floor slab options with prepared subgrade (Options 2 and 3 given above), grade beams spanning between foundation units may be cast at grade provided the subgrade in the beam areas is prepared as outlined in Sections 4.4.2 or 4.4.3. Grade beams should be designed to span across the foundations without subgrade support.

We recommend that on-site clayey soils (at least 18 inches deep) be utilized for backfill adjacent beams at the exterior of the building (to reduce potential infiltration of surface water into the subgrade in these areas). The exterior clayey backfill should be compacted to at least 95 percent of the ASTM D 698 dry density at a moisture content at or above optimum moisture. On the interior sides of the perimeter grade beams, backfill should consist of properly compacted select fill or flowable backfill (COA Item 402 or TxDOT Item 401), not sand or gravel.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide testing and observation during excavation, grading, foundation installation, and other construction phases of the project.

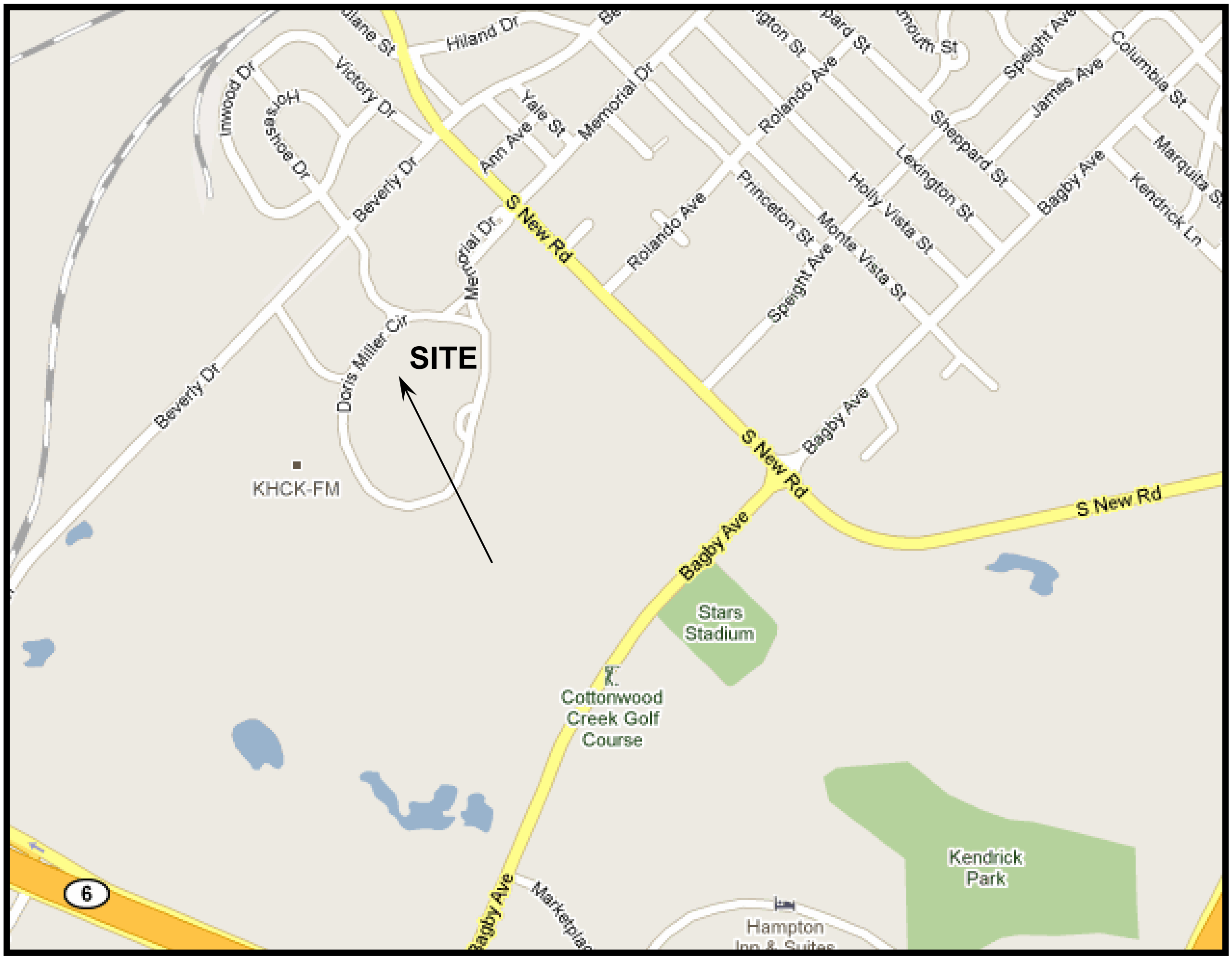
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include, either specifically or by implication, any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.
For any excavation construction activities at this site, all Occupational Safety and Health Administration (OSHA) guidelines and directives should be followed by the Contractor during construction to provide a safe working environment. In regards to worker safety, OSHA Safety and Health Standards require the protection of workers from excavation instability in trench situations.

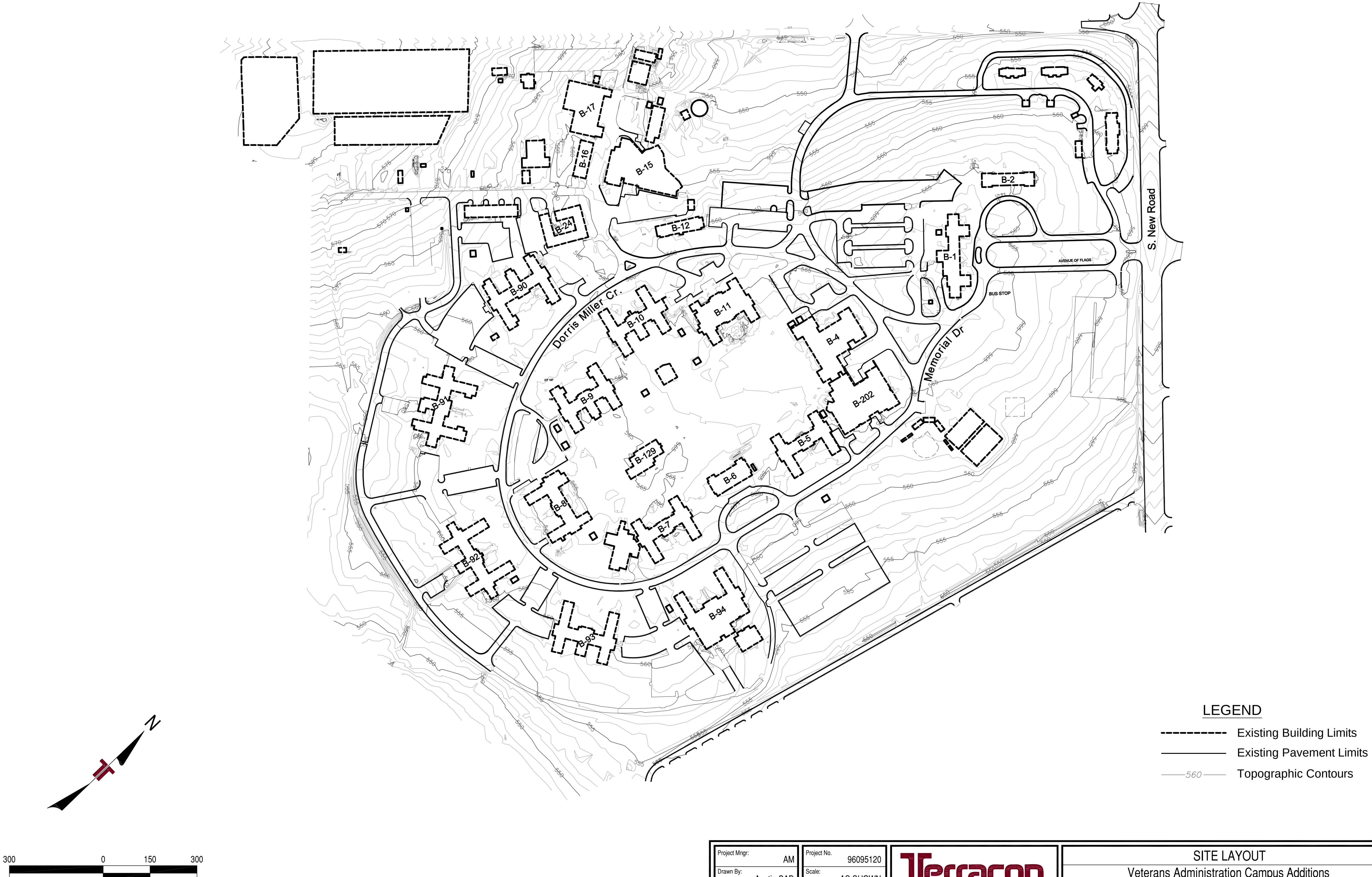
This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION



Project Mngr: AM	Project No. 96095120	Terracon Consulting Engineers and Scientists	Vicinity Plan	EXHIBIT
Drawn By: AM	Scale: Graphic	5307 Industrial Oaks Blvd, Suite 160 Austin, Texas	Veterans Administration Campus Additions	A-1
Checked By: JGB	File No. 96095120	Ph. (512) 442-1122 ax. (512) 442-1181	Buildings 10 and 11	
Approved By: JGB	Date: Dec 3, 2009		East Doris Miller Circle Waco, Texas	

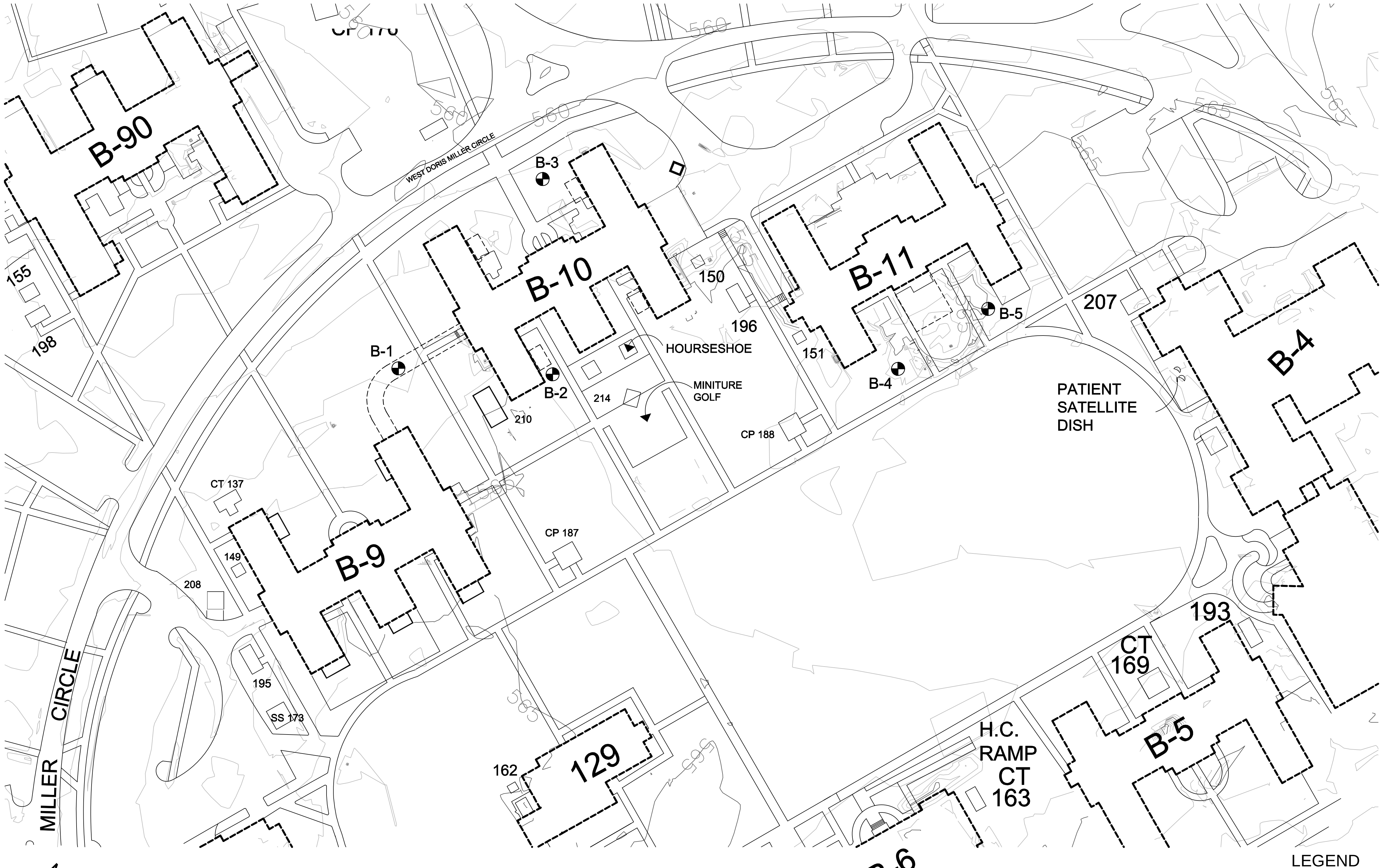


Project Mngr:	AM	Project No.	96095120
Drawn By:	Austin CAD	Scale:	AS SHOWN
Checked By:	AM	File No.	96095120
Approved By:	JGB	Date:	December 04, 2009

Terracon
Consulting Engineers and Scientists
5307 INDUSTRIAL OAKS BLVD. - #160 AUSTIN, TX 78735
PH. (512) 442-1122 FAX. (512) 442-1181

SITE LAYOUT
Veterans Administration Campus Additions
Buildings 10 and 11
East Dorris Miller Circle
Waco, Texas

EXHIBIT
A-2



N

40 0 20 40
SCALE IN FEET

LEGEND

- Existing Building Limits
- Proposed Structure Limits
- Existing Pavement Limits
- 565 Topographic Contours
- Boring Locations

Project Mngr: AM	Project No. 96095120	Terracon	PROJECT LAYOUT
Drawn By: Austin CAD	Scale: AS SHOWN	Consulting Engineers and Scientists	Veterans Administration Campus Additions
Checked By: AM	File No. 96095120	5307 INDUSTRIAL OAKS BLVD. - #160 AUSTIN, TX 78735	Buildings 10 and 11 East Dorris Miller Circle
Approved By: JGB	Date: December 04, 2009	PH. (512) 442-1122 FAX. (512) 442-1181	Waco, Texas

EXHIBIT
A-3

LOG OF BORING NO. B-1

CLIENT:	Brewer and Escalante Houston, Texas	PROJECT:	Veteran Administration Campus Additions - Buildings 10 and 11
BORING LOCATION:	See Exhibit A-3	SITE:	East Doris Miller Circle Waco, Texas

Approx. Surface Elevation: NA ft

Graphic Log	DESCRIPTION	DEPTH, FEET	SAMPLES: USCS SYMBOL	SAMPLES: TYPE	SAMPLES: SPT OR TXDOT CPT BLOWS/INCH	SAMPLES: CALIBRATED HAND PENETROM., TSF	SAMPLES: RECOVERY, % / RQD, %	TESTS: MOISTURE CONTENT, %	TESTS: DRY DENSITY, PCF	TESTS: LIQUID LIMIT, %	TESTS: PLASTICITY INDEX	TESTS: MINUS #200 SIEVE, %	TESTS: COMPRESSIVE STRENGTH, KSF	TESTS: FAILURE STRAIN, %
	FAT CLAY Stiff to very stiff, dark brown, with sand seams and limestone fragments		CH	ST		2.5		21		56	39			
	4.0		CH	ST		1.5								
	LIMESTONE (Austin Group) Tan, with clay seams -severely weathered to 5 feet -weathered from 5 to 10 feet	5		SS	50/2									
				RC			63 / 37		118				193	
		10		RC			92 / 88		120				130	
	-clay layer at 17 feet	15		RC			72 / 62							
	20.0	20												
	Boring Terminated at 20 feet													

STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL AND ROCK TYPES. IN SITU, THE TRANSITION BETWEEN STRATA MAY BE MORE GRADUAL.

REMARKS: Dry Augered 0 to 5 feet; Wet Rotary 5 to 20 feet

WATER LEVEL OBSERVATIONS, FEET		
WL	▽	▼ N/E
WL	▼	▽
WL		

Terracon

DATE DRILLED: 11/11/2009

PROJECT NUMBER: 96095120

EXHIBIT A-4

LOG OF BORING NO. B-2

CLIENT:	**Brewer and Escalante** **Houston, Texas**	PROJECT:	**Veteran Administration Campus** **Additions - Buildings 10 and 11**
BORING LOCATION:	**See Exhibit A-3**	SITE:	**East Doris Miller Circle** **Waco, Texas**

Approx. Surface Elevation: NA ft

Depth to base (ft)	DESCRIPTION	DEPTH, FEET	USCS SYMBOL	TYPE	SPT OR TXDOT CPT BLOWS/INCH	CALIBRATED HAND PENETROM., TSF	RECOVERY, % / RQD, %	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, %	PLASTICITY INDEX	MINUS #200 SIEVE, %	COMPRESSIVE STRENGTH, KSF	FAILURE STRAIN, %
	FAT CLAY Medium stiff to stiff, dark brown, with gravel and organics		CH	ST		1.5								
			CH	ST		0.75		41		91	68			
6.0	-brown below 4 feet	5	CH	ST		2.0								
8.0	**FAT CLAY** Stiff, tan to brown to light gray		CH	ST		1.75		28		67	47			
	LIMESTONE (Austin Group) Tan, with clay seams -weathered to 10 feet			RC			83 / 29		131				193	
		10		RC			85 / 68							
		15		RC			100 / 83		121				303	
25.0		20		RC			88 / 75							
	Boring Terminated at 25 feet	25												

STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL AND ROCK TYPES. IN SITU, THE TRANSITION BETWEEN STRATA MAY BE MORE GRADUAL.

REMARKS: Dry Augered 0 to 8 feet; Wet Rotary 8 to 25 feet

WATER LEVEL OBSERVATIONS, FEET		
WL		N/E
WL		
WL		

Terracon

DATE DRILLED 11/11/2009	
PROJECT NUMBER 96095120	**EXHIBIT** **A-5**

LOG OF BORING NO. B-3

CLIENT:	**Brewer and Escalante** **Houston, Texas**	PROJECT:	**Veteran Administration Campus** **Additions - Buildings 10 and 11**
BORING LOCATION:	**See Exhibit A-3**	SITE:	**East Doris Miller Circle** **Waco, Texas**

Approx. Surface Elevation: NA ft

Depth (ft)	Description
0.0 – 4.0	**FAT CLAY** Very stiff to hard, dark brown to brown, with gravel
4.0 – 25.0	**LIMESTONE (Austin Group)** Tan, with clay seams -weathered to 10 feet
25.0	Boring Terminated at 25 feet

DEPTH, FEET	SAMPLES: USCS SYMBOL	SAMPLES: TYPE	SAMPLES: SPT OR TXDOT CPT BLOWS/INCH	SAMPLES: CALIBRATED HAND PENETROM., TSF	SAMPLES: RECOVERY, % / RQD, %	TESTS: MOISTURE CONTENT, %	TESTS: DRY DENSITY, PCF	TESTS: LIQUID LIMIT, %	TESTS: PLASTICITY INDEX	TESTS: MINUS #200 SIEVE, %	TESTS: COMPRESSIVE STRENGTH, KSF	TESTS: FAILURE STRAIN, %
0–2	CH	ST		4.0								
2–4	CH	ST		4.5+		27		75	54			
4–5		RC			63 / 42		122				175	
5–10		RC			88 / 58		119				232	
10–15		RC			100 / 88							
15–20		RC			95 / 88							
20–25		RC			83 / 80							

STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL AND ROCK TYPES. IN SITU, THE TRANSITION BETWEEN STRATA MAY BE MORE GRADUAL.

REMARKS: Dry Augered 0 to 4 feet; Wet Rotary 4 to 25 feet

WATER LEVEL OBSERVATIONS, FEET		
WL	∇	▼ N/E
WL	▼	∇
WL		

Terracon

DATE DRILLED	11/11/2009
PROJECT NUMBER	96095120

Page 1 of 1

EXHIBIT A-6

LOG OF BORING NO. B-4

CLIENT:	Brewer and Escalante Houston, Texas	PROJECT:	Veteran Administration Campus Additions - Buildings 10 and 11
BORING LOCATION:	See Exhibit A-3	SITE:	East Doris Miller Circle Waco, Texas

Approx. Surface Elevation: NA ft

Graphic Log depth	DESCRIPTION	DEPTH, FEET	USCS SYMBOL	TYPE	SPT OR TXDOT CPT BLOWS/INCH	CALIBRATED HAND PENETROM., TSF	RECOVERY, % / RQD, %	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, %	PLASTICITY INDEX	MINUS #200 SIEVE, %	COMPRESSIVE STRENGTH, KSF	FAILURE STRAIN, %
			SAMPLES					TESTS						
2.0	**LEAN SILTY CLAY (Possible Fill)** Stiff, brown, with limestone fragments and gravel		CL	ST		1.75		12		45	30			
	FAT CLAY Very stiff to hard, tan to brown to light gray, with limestone fragments		CH	ST		3.0								
6.0		5	CH	ST		4.5+		21		69	48			
	LIMESTONE (Austin Group) Tan, weathered, with clay seams and layers			RC			77 / 58		112				23	
		10		RC			60 / 33							
		15		RC			100 / 90							
		20		RC			68 / 50		120				57	
25.0	Boring Terminated at 25 feet	25												

STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL AND ROCK TYPES. IN SITU, THE TRANSITION BETWEEN STRATA MAY BE MORE GRADUAL.

REMARKS: Dry Augered 0 to 6 feet; Wet Rotary 6 to 25 feet

WATER LEVEL OBSERVATIONS, FEET			
WL	▽	▼	N/E
WL	▼	▼	
WL			

Terracon

DATE DRILLED	Page 1 of 1
11/11/2009	**EXHIBIT**
PROJECT NUMBER	
96095120	**A-7**

LOG OF BORING NO. B-5

CLIENT:	**Brewer and Escalante** **Houston, Texas**	PROJECT:	**Veteran Administration Campus** **Additions - Buildings 10 and 11**
BORING LOCATION:	**See Exhibit A-3**	SITE:	**East Doris Miller Circle** **Waco, Texas**

Approx. Surface Elevation: NA ft

Graphic Log	DESCRIPTION	DEPTH, FEET	SAMPLES: USCS SYMBOL	TYPE	SPT OR TXDOT CPT BLOWS/INCH	CALIBRATED HAND PENETROM., TSF	RECOVERY, % / RQD, %	TESTS: MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, %	PLASTICITY INDEX	MINUS #200 SIEVE, %	COMPRESSIVE STRENGTH, KSF	FAILURE STRAIN, %
	FAT CLAY Very stiff, brown		CH	ST		2.5								
			CH	ST		2.75								
	6.0	5	CH	ST		3.5		22		69	49			
	FAT CLAY Hard, tan to brown to light gray, with silt seams		CH	ST		4.5+								
	10.0		CH	ST		4.5+		20		68	46			
	LIMESTONE (Austin Group) Tan, with clay seams -weathered to 15 feet	10		RC			87/42		119				93	
		15		RC			70/70		120				184	
	25.0	20		RC			77/72							
	Boring Terminated at 25 feet	25												

STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL AND ROCK TYPES. IN SITU, THE TRANSITION BETWEEN STRATA MAY BE MORE GRADUAL.

REMARKS: Dry Augered 0 to 10 feet; Wet Rotary 10 to 25 feet

WATER LEVEL OBSERVATIONS, FEET		
WL	▽	▼ N/E
WL	▼	▽
WL		

Terracon

DATE DRILLED 11/11/2009	**Page 1 of 1**
PROJECT NUMBER 96095120	**EXHIBIT** **A-8**

Field Exploration Description

Subsurface conditions were evaluated by drilling five borings, B-1 through B-5, to depths of about 20 to 25 feet near the proposed building/stair case/walkway areas. The boring locations were selected based on available site access. The borings were drilled with truck-mounted rotary drilling equipment at the approximate locations shown on Exhibit A-3 of the Appendix. Boring depths were measured from the existing ground surface at the time of our field activities.

The Logs of Boring, which include the subsurface descriptions, types of sampling used, and additional field data for this study, are presented on Exhibits A-4 through A-8 of the Appendix. Criteria for the "Unified Soil Classification System" and "General Notes" defining terms, abbreviations and descriptions used on the boring logs are presented in Exhibits C-1 through C-3.

Soil samples were recovered using thin-walled, open-tube samplers (Shelby tubes). When possible, a pocket penetrometer test was performed on each sample of cohesive soil in the field to serve as a general measure of consistency.

Weathered rock was sampled by means of the Standard Penetration Test (SPT). This test consists of measuring the number of blows required for a 140-pound hammer free falling 30 inches to drive a standard split-spoon sampler 12 inches into the subsurface material after being seated 6 inches. This blow count or SPT "N" value is used to estimate the engineering properties of the stratum.

Once competent rock was encountered, the borings were advanced with Nx coring equipment. Visual classifications of all of the samples were performed in the field and percentages of Recovery and Rock Quality Designation (RQD) were calculated from recovered rock cores. Recovery is defined as the percentage of core recovered as a function of the length of core run drilled. The RQD is a modified measurement of core recovery which indirectly takes into account fractures and/or softening in the rock mass by summing up only pieces of sound core which are 4 inches or greater in length as a percentage of the total core run.

Samples were removed from the samplers in the field, visually classified, and appropriately sealed in sample containers to preserve the in-situ moisture contents. Samples were then placed in core boxes for transportation to our laboratory in Austin, Texas.

APPENDIX B

LABORATORY TESTING

Laboratory Testing

Samples obtained during the field program were visually classified in the laboratory by a geotechnical engineer. A testing program was conducted on selected samples, as directed by the geotechnical engineer, to aid in classification and evaluation of engineering properties required for analyses.

Results of the laboratory tests are presented on the Logs of Boring, located on Exhibits A-4 through A-8 of the Appendix, and/or are discussed in the following section. Laboratory test results were used to classify the soils encountered as generally outlined by the Unified Soil Classification System.

Samples not tested in the laboratory will be stored for a period of 30 days subsequent to submittal of this report and will be discarded after this period, unless we are notified otherwise.

APPENDIX C

SUPPORTING DOCUMENTS

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50% retained on the No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G, H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines Classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" 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]
					Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI lots 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-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10} \qquad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

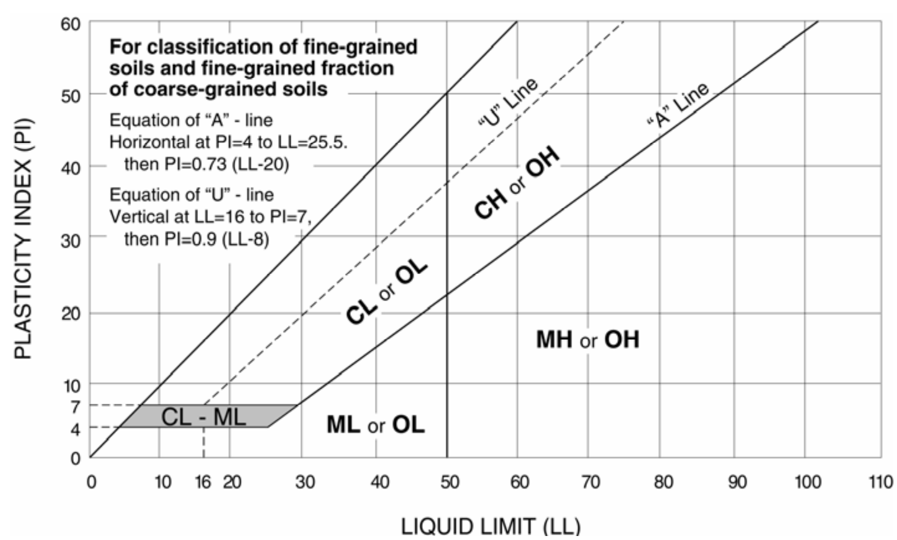
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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.



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GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube - 2" O.D., unless otherwise noted	PA:	Power Auger
TC:	TxDOT Cone Penetrometer Test	HA:	Hand Auger
CF:	Continuous Flight Auger	RC:	Rock Core
BS:	Bulk Sample or Auger Sample	WB:	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the “Standard Penetration” or “N-value”. For TxDOT cone penetrometer (TC) the penetration value is reported as the number of blows required to advance the sampler 12 inches or penetration in inches after 100 blows using a 170-pound hammer falling 24 inches, reported as “blows per foot” or inches per 100 blows, and is not considered equivalent to the “Standard Penetration” or “N-value”.

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	N/E:	Not Encountered
WCI:	Wet Cave in	WD:	While Drilling		
DCI:	Dry Cave in	BCR:	Before Casing Removal		
AB:	After Boring	ACR:	After Casing Removal		

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 - 1	Very Soft
500 – 1,000	2 - 4	Soft
1,000 – 2,000	4 - 8	Medium Stiff
2,000 – 4,000	8 -15	Stiff
4,000 – 8,000	15 - 30	Very Stiff
8,000+	> 30	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	TxDOT Cone Penetrometer (TC) Blows/Ft.	Relative Density
0 – 3	0-8	Very Loose
4 – 9	8-20	Loose
10 – 29	20-80	Medium Dense
30 – 49	80-5”/100	Dense
> 50	5”/100 to 0”/100	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	> 30

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifiers	> 12

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	> 30

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GENERAL NOTES

Description of Rock Properties

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.

Very soft Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding and Foliation Spacing in Rock[a]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

Rock Quality Designator (RQD)[b]		Joint Openness Descriptors	
RQD, as a percentage	Diagnostic description	Openness	Descriptor
Exceeding 90	Excellent	No Visible Separation	Tight
90 – 75	Good	Less than 1/32 in.	Slightly Open
75 – 50	Fair	1/32 to 1/8 in.	Moderately Open
50 – 25	Poor	1/8 to 3/8 in.	Open
Less than 25	Very poor	3/8 in. to 0.1 ft.	Moderately Wide
		Greater than 0.1 ft.	Wide

a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.
b. RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976.
U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

September 30, 2010

Brewer & Escalante
7600 W. Tidwell, Suite 103
Houston, Texas 77040

Attn: Mr. Craig Artze, P.E.
O: 832-615-0301
F: 713-688-5746
E: cartze@brewer-escalante.com

Re: Supplemental Retaining Wall Recommendations
Veteran Administration Campus Additions
Building 11
4800 Memorial Drive
Waco, Texas 76711
Terracon Project No. 96095120, Supplemental Letter No. 1

Dear Mr. Artze:

As requested, this letter provides geotechnical information for lateral earth pressure coefficients for conventional site retaining walls and below-grade walls for the rear portion of the ground floor level at Building 11. We understand that the ground floor of the addition is planned to match the existing finished floor elevation, which is about 4 to 4.5 feet below existing grades at the rear of Building 11. In addition, conventional site retaining walls are planned behind Building 11 in landscaped areas adjacent to sidewalks. These site retaining walls may be up to about 6 to 7 feet in height. Based upon discussions with Mr. Don Greive, P.E. of Pinnacle Structural Engineers, we understand that the building addition is planned to be supported on drilled piers bearing into the Stratum II limestone, with a structurally suspended floor slab due to the difficulty of significant earthwork operations next to an existing structure.

Lateral Earth Pressures for Below-Grade and Site Retaining Walls

Presented below are at-rest, active, and passive earth pressure coefficients for various backfill types adjacent to below-grade walls or site retaining walls. At-rest earth pressures are recommended in cases where little wall yield is expected (such as structural below-grade walls). Active earth pressures may be utilized in cases where the walls can exhibit a certain degree of horizontal movement (such as cantilevered site retaining walls). The recommendations in this section apply to those walls which are installed in open cut or embankment fill areas such that the backfill extends out from the base of the wall at an angle of at least 45 degrees from vertical for the entire height and length of the wall.

Backfill Type	Estimated Total Unit Weight (pcf)	Lateral Earth Pressure Coefficients [1]		
		At Rest (K_O)	Active (K_A)	Passive (K_P)
Crushed Limestone	135	0.45	0.3	3.5
Clean Sand	120	0.5	0.35	3.0
Clean Gravel	120	0.45	0.3	3.5
On-site Stratum I /Ia Clayey Soils [2]	120	0.7	0.55	1.8
On-site Stratum II Crushed/Processed Limestone [3]	125	0.5	0.35	3.0

1. Coefficients represent ultimate values. Appropriate safety factors should be applied.
2. These values are provided in anticipation that it may be desired to backfill the below-grade walls for the ground floor with the on-site clays, as it should help to reduce surface water infiltration.
3. Contingent upon preparation of the on-site excavated Stratum II limestone, if any, as per **Section 4.2 – Earthwork** in our geotechnical report.

The above values do not include a hydrostatic or ground-level surcharge component. To prevent hydrostatic pressure build-up, site retaining walls should incorporate functional drainage (via free-draining aggregate) within the backfill zone. The effect of surcharge loads, where applicable, should be incorporated into wall pressure diagrams by adding a uniform horizontal pressure component equal to the applicable lateral earth pressure coefficient times the surcharge load, applied to the full height of the wall.

For the below-grade wall portions of the existing building, we understand that there are no below-grade drains adjacent to the existing walls. Rather, drainage is handled by positively sloping the grades away from the building walls toward surface area drains. If this has proved effective in the past for this building, then this approach may be used for the proposed additions also. We recommend that the backfill be sloped as much as possible, considering site restraints and other project requirements, downhill and away from the below-grade walls toward area drains. At a minimum, we suggest at least a 2 percent slope away from the buildings; however, with expansive clays at the site, minimal slopes can be changed through cyclic shrink-swell of the soils, thus providing as much slope as possible is recommended. In addition, the below-grade walls should be fully waterproofed.

The compactive effort should be controlled during backfill operations adjacent to walls. Overcompaction can produce lateral earth pressures in excess of at-rest magnitudes. Compaction levels adjacent to walls should be maintained between 95 and 100 percent of Standard Proctor (ASTM D 698) maximum dry density.

For conventional site retaining walls bearing on on-site Stratum I/Ia clayey soils, we recommend a coefficient of sliding resistance of 0.4 (maximum allowable sliding resistance of 500 psf) and a maximum footing bearing capacity of 2,500 psf. For wall footings bearing at least 6 inches into

Stratum II limestone subgrade, a coefficient of sliding resistance of 0.7 (up to a maximum allowable sliding resistance of 1,500 psf) and a maximum bearing capacity of 4,000 psf may be utilized. All retaining walls should be checked against failure due to overturning, sliding, and overall slope stability. Such an analysis can only be performed once the dimensions of the wall and cut/fill scenarios are known. Retaining walls placed to bear directly upon the Stratum I/Ia clayey soils observed on this site could be subject to potential movements of about 1½ to 3 inches, depending upon the amount of clays under the footings and seasonal environmental variations in moisture.

For site retaining walls, a wall drain (consisting of freely-draining aggregate, along with outlet piping) is recommended for collection and removal of surface water percolation behind the walls. Proper control of surface water percolation will help to prevent buildup of higher wall pressures. In unpaved or landscaped areas, the final 12 inches of backfill should preferably consist of Stratum I/Ia clayey soils to help to reduce percolation of surface water into the backfill.

Closure

Please consult Terracon Report No. 96095120, dated December 4, 2009 for details and information not mentioned in this letter. If you should need any additional information, please contact me. We look forward to the opportunity of working with you as this project progresses through design and into construction.

Sincerely,
TERRACON CONSULTANTS, INC.
TBPE Firm Registration: TX F-3272

Bryan S. Moulin

Bryan S. Moulin, P.E.
Principal, Geotechnical Department Manager

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LICENSED
PROFESSIONAL ENGINEER
09/30/2010

cc: Mr. Don Greive, P.E. – Pinnacle Structural Engineers (dg@pinnaclestructural.com)