Geotechnical Engineering Report

VA Center Pavement Improvements

1901 South First Street

Temple, Texas

April 5, 2013

Terracon Project No. 96135034

Prepared for:

Brewer & Escalante
Houston, Texas

Prepared by:

Terracon Consultants, Inc.
Austin, Texas

Terracon

April 5, 2013

Brewer & Escalante
7600 West Tidwell
Houston, TX 77040

Attention: Mr. Craig Artze, P.E.
O: 832-615-0331
E: cartze@brewer-escalante.com

Regarding: Geotechnical Engineering Report
VA Center Pavement Improvements
1901 South First Street
Temple, TX
Terracon Project No. 96135034

Dear Mr. Artze:

Terracon Consultants, Inc. (Terracon) is pleased to submit our Geotechnical Engineering Report for the proposed pavement improvements at the VA Center in Temple, 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 Geotechnical Engineer

STATE OF TEXAS
ANITHA MEDICHETTI
100258
LICENSED
PROFESSIONAL ENGINEER
4/5/13

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

Copies Submitted: Addressee: (2) Bound & (1) Electronic

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TABLE OF CONTENTS

GEOTECHNICAL ENGINEERING REPORT
VA CENTER PAVEMENT IMPROVEMENTS
1901 SOUTH FIRST STREET
TEMPLE, TEXAS

Project No. 96135034
April 5, 2013

1.0 INTRODUCTION

Terracon is pleased to submit our Geotechnical Engineering Report for the proposed pavement improvements at the VA Center in Temple. This project was authorized by Mr. Craig Artze, P.E. of Brewer & Escalante, through signature of our "Agreement for Services" on March 1, 2013. The project scope was performed in general accordance with Terracon Proposal No. P96130154 dated February 6, 2013.

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

- Pavement design and construction; and
- Site, subgrade, and fill preparation.

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Exhibit A-2, Boring Location Plan, in Appendix A.
Proposed Improvements	The project will include the construction of new parking spaces and drives as well as improvements to existing parking spaces/access drives.
Pavement construction	Flexible or rigid pavements.

2.2 Site Location and Description

Item	Description
Location	The project site is located at the existing VA Center facility at 1901 South First Street in Temple, Texas. (See Exhibit A-1 of Appendix A).

Item	Description
Existing improvements	Existing parking lot.
Current ground cover	Existing pavements, grass, and weeds.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Borings B-1, B-2, and B-4 were drilled through the existing pavements which consisted of about 2 inches of asphaltic concrete over 7 to 11 inches of base material. Based on the results of the borings, subsurface conditions on the project site can be generalized as below.

Description	Approximate Depth Range of Stratum (feet)	Material Encountered	Consistency/Density
Stratum I [1]	0 to 4	Fill and Possible Fill – Lean Clay (CL) to Sandy Lean Clay (CL) to Silty Sand (SM)	Very Stiff to Hard; Dense
Stratum II [2]	2 to 10	Fat Clay (CH)	Stiff to Hard
Stratum III [3]	1.1 to 10	Lean Clay (CL)	Very Stiff to Hard

1. The Stratum I fill and possible fill soils (not observed in boring B-1) exhibited variable shrink/swell potential as indicated by measured plasticity indices (PI's) of about 3 and 27 percent and fines contents (percent passing the No. 200 sieve) ranging from about 37 to 91 percent. In-situ moisture contents were about 10 percent dry and equivalent of the corresponding plastic limits. Pocket penetrometer values ranging from about 3.0 to over 4.5 tons per square foot (tsf) were recorded for the stratum.
2. The Stratum II dark brown soils (observed only in borings B-3 and B-4) exhibited high shrink/swell potential as indicated by a measured PI of about 50 percent. An in-situ moisture content was about 11 percent wet of the corresponding plastic limit. Pocket penetrometer values ranging from about 1.75 to over 4.5 tsf were recorded for the stratum. A measured unconfined compressive strength of about 15.12 tsf was recorded for the stratum.
3. The Stratum III tan to light brown clay soils (not observed in boring B-4) exhibited moderate to moderately high shrink/swell potential as indicated by measured PI's ranging from about 17 to 27 percent and fines contents of about 94 percent. In-situ moisture contents ranged from about 2 to 5 percent dry of the corresponding plastic limits. Pocket penetrometer values ranging from about 2.5 to over 4.5 tsf and a standard penetration resistance value of about 30 blows per foot of penetration were recorded for the stratum. Measured unconfined compressive strengths of about 3.38 and 6.36 tsf were recorded for the stratum.

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 Appendix A.

3.2 Groundwater

The borings were dry augered to completion depths of about 10 feet below existing grade. Groundwater was not encountered in any of the borings during drilling.

Although not observed in our geotechnical field program, groundwater at the site may be encountered in more pervious seams/fissures of the subgrade soils and/or in "perched" areas immediately above less permeable seams/layers of the subsurface soils. 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. 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 just 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 Earthwork

Construction areas should be stripped of vegetation, topsoil, existing pavements, utilities, and other unsuitable material. All utilities and associated bedding material that are planned to be abandoned/demolished should be completely removed from within the proposed pavement areas. If not possible, the abandoned utility lines should be thoroughly grouted and plugged with flowable fill.

Once final subgrade elevations have been achieved, 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 utilities, fill material, 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, which can cause construction delays and/or inhibit site access.

Subsequent to proofrolling, and just prior to placement of fill, the exposed subgrade within the construction areas 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.

4.1.1 Compaction Requirements

All fill material should be placed in uniform lifts not to exceed 8 inches loose measure, with compacted thickness not to exceed 6 inches, unless stated otherwise. Fill should be compacted to at least 95 percent of the ASTM D 698 maximum dry density at a moisture content ranging between -3 and +3 percent of optimum moisture content.

Imported paving fill should be Type B soil per TxDOT Item 132, with a maximum PI of 30. Imported paving fill should be compacted to the density and moisture requirements given above,

Excavated on-site Stratum I/II/III soils, if free of organics, debris, and rocks larger than 4 inches, may be considered for use as fill in pavement or other general areas. The Stratum II dark brown to brown soils should be moisture conditioned to between optimum and +4 percent of optimum. The Stratum I/III tan to light brown soils should be moisture conditioned to between -3 and +3 percent of optimum.

4.1.2 Drainage

The performance of the proposed pavements will not only be dependent upon the quality of construction, but also upon the stability of the moisture content of the near-surface subgrade. Therefore, proper site drainage should be developed during and after construction so that ponding of surface water on the pavement surfaces and along the pavement perimeters does not occur. If proper surface drainage cannot be accomplished on and within 10 feet of the pavement edges, we suggest that drainage swales be constructed alongside the pavements. The drainage swales should be sloped to collect and remove water away from the pavement systems.

Poor drainage conditions could result in saturation of base material and/or the underlying subgrade, which in turn could induce pavement distress and inhibit pavement performance. If development of proper drainage is not possible, curbs should extend through the base and into the subgrade.

4.2 Pavements

Both flexible (asphaltic concrete) and rigid (reinforced Portland cement concrete) pavement systems may be considered for site pavement applications. These two types of pavement are not considered equal. Over the life of the pavement, concrete pavements would be expected to exhibit better performance and require less maintenance. At a minimum, concrete pavements should be strongly considered in waste collection areas and delivery truck loading/unloading areas.

Detailed traffic loads and frequencies were not available for the pavements. However, we anticipate that traffic will consist primarily of passenger vehicles in the parking areas (assumed as the light duty pavements) and passenger vehicles combined with occasional garbage and delivery trucks in driveways (assumed as light-medium duty pavements). If heavier traffic loading is expected or other traffic information is available, Terracon should be provided with the information and allowed to review the pavement sections provided herein. Tabulated below are the assumed traffic frequencies and loads used to design pavement sections for this project.

Pavement Type	Traffic Design Index	Description
Parking Areas (Passenger Vehicles Only):	DI-1	Light traffic – Few vehicles heavier than passenger cars, panel, and pick-up trucks; no regular use by heavily loaded two-axle trucks or lightly loaded larger vehicles. (EAL* < 5)
Driveways (Light-Medium Duty); Access Drives, Delivery Lanes, Emergency Vehicle Access, and Dumpster Enclosures:	DI-2	Light to medium traffic – Similar to DI-1, including not over 50 heavily loaded two-axle trucks or lightly loaded larger vehicles per day. No regular use by heavily loaded trucks with three or more axles. (EAL = 6 – 20)

* Equivalent daily 18-kip single axle load applications.

Listed below are pavement component thicknesses which may be used as a guide for pavement systems at the site assuming that the Stratum I/II/III clay soils will generally act as the pavement subgrade, and that the pavement subgrade is prepared as outlined in the "Moisture Conditioned Subgrade/Lime-Treated Subgrade" portions of this section and in accordance with our general recommendations for site preparation in **Section 4.1 – Earthwork**. We should note that these systems were derived based on general characterization of the subgrade. No specific testing (such as CBR, resilient modulus tests, etc.) was performed for this project to evaluate the support characteristics of the subgrade.

Lime treatment of the Stratum II fat clay subgrade is highly recommended (particularly for flexible pavements) to enhance the workability and support characteristics of the subgrade as well as to provide a barrier to reduce moisture infiltration into the underlying clay subgrade. The lime treatment also helps to reduce the shrink/swell potential of the lime-treated layer. We should note that if lime treatment of the subgrade is planned, we recommend that the subgrade soils be investigated for the presence of sulfates during construction. Excessive concentrations of sulfates in the soils can result in poor performance of lime-treated subgrade. To assist in this evaluation, we performed four sulfate/chloride tests on representative samples of the soils at this site. The test results are presented in Exhibit B-1 of Appendix B. Based on numerous research studies performed by educational institutions, regulatory agencies, and both public and private entities, soils that contain significant amounts of soluble sulfates are not optimal candidates for lime treatment and may result in excessive heave and subsequent distress to the pavements. Soluble sulfate levels of up to 3,000 ppm or less are generally considered to be acceptable for lime treatment. Soluble sulfate levels between 3,000 ppm and 10,000 ppm in clay soils are generally considered to be moderate to high and pose a greater risk to successful traditional lime treatment. As can be seen in Appendix B-1, the soluble sulfate levels are low (maximum of 186 ppm).

Although lime treatment of the subgrade will likely reduce differential movement and heave in the new pavement system, some differential movement will likely occur. Cracking of the asphalt in flexible pavement systems due to differential movements should be expected.

FLEXIBLE PAVEMENT SYSTEM

Component	Material Thickness (Inches)			
	DI-1		DI-2	
	Option 1A	Option 1B	Option 2A	Option 2B
Asphaltic Concrete (HMAC)	2.0	2.5	2.5	3.0
Crushed Limestone Base	8.0	10.0	9.0	11.0
Lime-Treated Subgrade[1]	6.0	-	6.0	-
Moisture Conditioned Subgrade	-	6.0	-	6.0
Total Thickness	16.0	18.5	17.5	20.0

1. Lime treatment is recommended if the final pavement subgrade consists of high PI (≥30) fine-grained cohesive soils with ≤15% gravel. For more granular soils or lower plasticity soils, Options 1B and 2B are more applicable.

RIGID PAVEMENT SYSTEM

Component	Material Thickness (Inches)	
	DI-1	DI-2
Reinforced Concrete (PCC)	5.0	6.0[1]
Moisture Conditioned Subgrade	6.0	6.0

1. For the Heavy Duty traffic loading condition, the reinforced concrete thickness may be reduced by ½ inch if the clay subgrade is lime treated to a depth of at least 6 inches instead of moisture conditioned.

Reinforcing Steel: #3 bars spaced at 18 inches on centers in both directions.

Control Joint Spacing: In accordance with ACI 330R-08, control joints should be spaced no greater than 12.5 feet for 5-inch thick concrete and no greater than 15 feet for 6-inch thick or greater concrete. If sawcut, control joints should be cut within 6 to 12 hours of concrete placement. Sawcut joints should be at least ¼ of the slab thickness.

Expansion Joint Spacing: ACI-330R-8 indicates that regularly spaced expansion joints are not needed when control joints are properly spaced. Their use should be limited to isolating fixed objects (such as light poles, manholes, curb inlets, and buildings) within or abutting the pavement. Therefore, the installation of expansion joints for routine use is optional and should be evaluated by the design/construction team. Expansion joints, if not sealed and maintained, can allow infiltration of surface water into the subgrade. At a minimum, an expansion joint (used as a construction joint) should be placed at the termination of each day's concrete placement. These joints should be fully sealed.

Dowels at Expansion Joints: ¾-inch smooth bars, 18 inches in length, with one end treated to slip, spaced at 12 inches on centers at each joint.

Presented below are our recommended material requirements for the various pavement sections.

Hot Mix Asphaltic Concrete (HMAC) – The asphaltic concrete surface course should be plant mixed, hot laid Type D (Fine-Graded Surface Course) meeting the master specification requirements in TxDOT Item 340. For acceptance and payment evaluation purposes, we recommend the use of the provisions in City of Austin (COA) Item 340.

Reinforced Portland Cement Concrete (PCC) – Concrete should be designed to exhibit a minimum 28-day compressive strength of 3,500 psi.

Crushed Limestone Base – Base material should be composed of crushed limestone meeting the requirements of TxDOT Item 247, Type A, Grade 1. The base should be compacted to a minimum of 95 percent of the maximum density as determined by the modified moisture/density relation (ASTM D 1557) at -3 to +3 percent of optimum moisture content. (As an option, compaction to at least 100 percent of the TEX-113-E maximum dry density may also be considered.) Each lift of base should be thoroughly proofrolled just prior to placement of subsequent lifts and/or asphalt. Particular attention should be paid to areas along curbs, above utility trenches, and adjacent to landscape islands, manholes, and storm drain inlets. Placement of the base material should extend at least 18 inches behind curbs.

Lime-Treated Subgrade – If the final pavement subgrade consists of high PI (≥30) fine-grained cohesive soil with ≤15% gravel, the subgrade should be treated with lime meeting the requirements of TxDOT Item 260. Lime treatment may be accomplished by either the dry placement or slurry placement process.

We anticipate that approximately 6 to 10 percent hydrated lime will be required to treat the subgrade soils. We suggest that 8% lime be used for bidding purposes with add/deduct line items for 1 to 2% lime above or below the base bid item. Prior to the application of lime to the subgrade, the optimum percentage of lime to be added should be determined based on Plasticity Index (TEX-112-E) and/or pH (ASTM D 6276) laboratory tests conducted on mixtures of the subgrade soils with lime. Subgrade soil samples should be obtained from the pavement area at the proposed final subgrade elevation. (Please note these tests require up to 5 business days to complete.)

The lime should initially be blended with a mixing device such as a Pulvermixer, sufficient water added, and allowed to cure for at least 48 hours. After curing, mixing should continue until the gradation requirements of TxDOT Item 260.4 or COA Item 203 are met. The mixture should then be moisture adjusted and compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 698. Placement of the lime-treated subgrade should extend at least 18 inches behind curbs.

Moisture Conditioned Subgrade – If lime treatment is not used, the soil subgrade should be scarified to a depth of 6 inches, moisture conditioned, and recompacted to at least 95 percent of the maximum dry density as determined by ASTM D 698. On-site soils should be moisture conditioned and compacted as detailed in **Section 4.1.1 – Compaction Requirements**. Any soils with PI<20 may be compacted to within a moisture range of -3 to +3 percent of optimum moisture. Care should be taken such that the subgrade does not dry out or become saturated prior to pavement construction. The pavement subgrade should be thoroughly proofrolled with a rubber-tired vehicle (fully-loaded water or dump truck) immediately prior placement of base material. Particular attention should be paid to areas along curbs, above utility trenches, and adjacent to landscape islands, manholes, and storm drain inlets. Placement of the moisture conditioned subgrade should extend at least 18 inches behind curbs.

Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade such as the fat clay soils encountered in this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade. It is, therefore, important to minimize moisture changes in the subgrade to reduce shrink/swell movements. Proper perimeter drainage should be provided so that infiltration of surface water from unpaved areas surrounding the pavement is minimized.

On most projects, rough site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas; dry weather may desiccate some areas; rainfall and surface water saturates some areas; heavy traffic from concrete and other delivery vehicles disturbs the subgrade; and many surface irregularities are filled in with loose soils to temporarily improve subgrade conditions. As a result, the pavement subgrade should be carefully evaluated as the time for pavement construction approaches. This is particularly important in and around utility trench cuts. All pavement areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to paving. Thorough proofrolling of pavement areas using a fully-loaded water truck or dump truck (rubber-wheeled vehicle that can impart point wheel loads) should be performed no more than 36 hours prior to surface paving. Any problematic areas should be reworked and compacted at that time.

Long-term pavement performance will be dependent upon several factors, including maintaining subgrade moisture levels and providing for preventive maintenance. The following recommendations should be considered at a minimum:

- Adjacent site grading at a minimum 2% grade away from the pavements;
- A minimum ¼ inch per foot slope on the pavement surface to promote proper surface drainage;
- Install joint sealant and seal cracks immediately;
- Placing compacted, low permeability clay backfill against the exterior side of curb and gutter; and,
- Placing curb and gutters through any base material and directly on subgrade soils.

Preventive maintenance should be planned and provided for through an on-going pavement management program. These activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Preventive maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance. This is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance.

4.2.1 Existing Pavements

The existing asphalt pavements are also planned to be rehabilitated. Testing of the existing asphalt and base material were not within our scope of services. In our opinion, the existing base material may be utilized in the lower portions of the corresponding pavement sections. However, it should be blended, graded, and compacted as per **Section 4.1 – Earthwork**. The remainder of the specified base material should be imported as per the specifications mentioned above. At a minimum, the existing base material should be graded such that the final 4 inches of base is newly imported base from an approved quarry stockpile. All of the base material, existing and newly imported, must be compacted and proofrolled as per **Section 4.1 – Earthwork**. Depending upon the traffic, new asphalt thicknesses should be as tabulated in Section 4.2 above for non-lime-treated areas.

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, pavement 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.

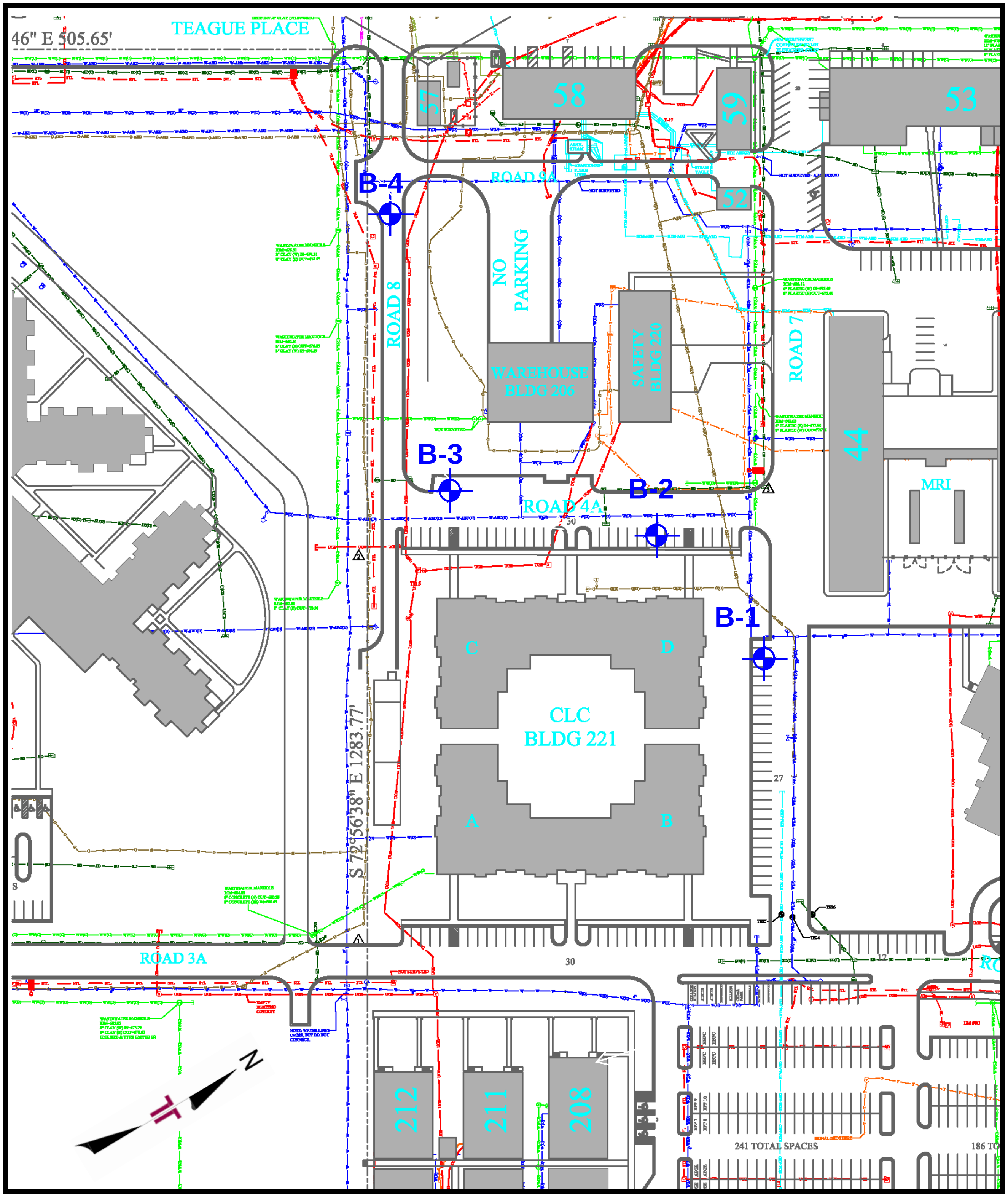
APPENDIX A

FIELD EXPLORATION

N

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Mgr: AM	Project No. 96135034	Terracon Consulting Engineers & Scientists	SITE LOCATION PLAN	EXHIBIT
Drawn By: AM	Scale: N.T.S	5307 Industrial Oaks Blvd, Suite 160, Austin, Texas 78735	VA Center Pavement Improvements	A-1
Checked By: BSM	File Name: SITE PLAN	PH. (512) 442-1122 FAX. (512) 442-1181	1901 South First Street	
Approved By: BSM	Date: 04-02-2013		Temple, Texas	



Boring Location

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Mgr: AM	Project No. 96135034	Terracon Consulting Engineers & Scientists	BORING LOCATION PLAN
Drawn By: AM	Scale: N.T.S	5307 Industrial Oaks Blvd, Suite 160, Austin, Texas 78735	VA Center Pavement Improvements
Checked By: BSM	File Name: BORING PLAN	PH. (512) 442-1122 FAX. (512) 442-1181	1901 South First Street
Approved By: BSM	Date: 04-02-2013		Temple, Texas

EXHIBIT A-2

Field Exploration Description

Subsurface conditions were evaluated by drilling four borings (B-1 through B-4) to depths of about 10 feet within the proposed pavement areas. The borings were drilled with truck-mounted rotary drilling equipment at the approximate locations shown on Exhibit A-2 of Appendix A. Boring depths were measured from the existing ground surface at the time of our field activities.

The boring logs, which include the subsurface descriptions, types of sampling used, and additional field data for this study, are presented on Exhibits A-4 through A-7 of Appendix A. Criteria defining terms, abbreviations and descriptions used on the boring logs are presented in Appendix C.

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

A soil sample in boring B-2 for which good quality tube samples could not be obtained 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. For this project, a CME automatic SPT hammer was used to advance the split-barrel sampler in the borings. A greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between SPT value and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow in comparison to the N-value that would be expected using the cathead and rope method.

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.

BORING LOG NO. B-1

PROJECT: VA Center Pavement Improvements

CLIENT: Brewer & Escalante
Houston, TX 77040

SITE: 1901 South First Street
Temple, Texas

LOCATION See Exhibit A-2

GRAPHIC LOG	DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		PAVEMENT 2" Asphalt; 11" Base Material											
	1.1	**LEAN CLAY (CL)** Hard, tan to light brown				4.5+ tsf (HP)				13		40-18-22	94
						4.5+ tsf (HP)							
			5			4.5+ tsf (HP)	UC	6.36	3.3	13	120		
						4.5+ tsf (HP)							
		-very stiff below 8 feet				2.5 tsf (HP)							
	10.0	***Boring Terminated at 10 Feet***	10										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 10 feet

Abandonment Method:
Backfilled with Auger Cuttings
Surface capped with asphalt

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd., Suite 160
Austin, Texas

Boring Started: 3/8/2013	Boring Completed: 3/8/2013
Drill Rig: GD - 1000	Driller: Texas Geo Bore
Project No.: 96135034	Exhibit: A-4

BORING LOG NO. B-2

PROJECT: VA Center Pavement Improvements

CLIENT: Brewer & Escalante
Houston, TX 77040

SITE: 1901 South First Street
Temple, Texas

LOCATION See Exhibit A-2

DEPTH	Description
0.8	**PAVEMENT** 2" Asphalt; 7" Base Material
2.0	**SANDY LEAN CLAY (CL) (Possible Fill)** Very stiff, dark brown, with calcareous nodules
10.0	**LEAN CLAY (CL)** Very stiff to hard, tan to light brown
	Boring Terminated at 10 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1–2			3.0 tsf (HP)				18			67
2–4			4.5 tsf (HP)				13		34-17-17	94
4.5–6			12-14-16 N=30							
6–8			4.5+ tsf (HP)	UC	3.38	4.9	15	117		
8–10			4.5+ tsf (HP)							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 10 feet

Abandonment Method:
Backfilled with Auger Cuttings
Surface capped with asphalt

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd., Suite 160
Austin, Texas

Boring Started: 3/8/2013	Boring Completed: 3/8/2013
Drill Rig: GD - 1000	Driller: Texas Geo Bore
Project No.: 96135034	Exhibit: A-5

BORING LOG NO. B-3

PROJECT: VA Center Pavement Improvements

CLIENT: Brewer & Escalante
Houston, TX 77040

SITE: 1901 South First Street
Temple, Texas

LOCATION See Exhibit A-2

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL, SILTY SAND (SM) Dense, brown, with rock fragments and cobbles				4.5+ tsf (HP)				4		17-14-3	37
2.0	**FAT CLAY (CH)** Hard, dark brown				4.5+ tsf (HP)	UC	15.12	6.6	21	103		
4.0	**LEAN CLAY (CL)** Hard, tan to light brown	5			4.5+ tsf (HP)				16		45-18-27	
					4.5+ tsf (HP)							
					4.5+ tsf (HP)							
10.0	***Boring Terminated at 10 Feet***	10										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 10 feet

Abandonment Method:
Backfilled with Auger Cuttings

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd., Suite 160
Austin, Texas

Boring Started: 3/8/2013	Boring Completed: 3/8/2013
Drill Rig: GD - 1000	Driller: Texas Geo Bore
Project No.: 96135034	Exhibit: A-6

BORING LOG NO. B-4

PROJECT: VA Center Pavement Improvements

CLIENT: Brewer & Escalante
Houston, TX 77040

SITE: 1901 South First Street
Temple, Texas

LOCATION See Exhibit A-2

DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.9	**PAVEMENT** 2" Asphalt; 9" Base Material											
	FILL, LEAN CLAY (CL) Very stiff to hard, tan to light brown and dark brown				3.5 tsf (HP)				19		46-19-27	91
4.0					4.5+ tsf (HP)							
	FAT CLAY (CH) Stiff to very stiff, dark brown	5			2.5 tsf (HP)							
					1.75 tsf (HP)				34		73-23-50	
10.0					1.75 tsf (HP)							
	Boring Terminated at 10 Feet	10										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 10 feet

Abandonment Method:
Backfilled with Auger Cuttings
Surface capped with asphalt

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd., Suite 160
Austin, Texas

Boring Started: 3/8/2013	Boring Completed: 3/8/2013
Drill Rig: GD - 1000	Driller: Texas Geo Bore
Project No.: 96135034	Exhibit: A-7

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 boring logs, located in Appendix A, and/or are discussed in **Section 3.0 – Subsurface Conditions** of the report. 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.

Sulfate Tests

Boring No.	Depth (feet)	Chloride Content, ppm-dry	Sulfate Content, ppm-dry
B-1	1 – 2	16.2	74.3
B-2	2 – 4	ND*	31.9
B-3	4 – 6	4.9	52.4
B-4	6 – 8	8.9	186

*Not detected at the method detection limit.

APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

- Auger Cuttings
- Shelby Tube
- Split Spoon

WATER LEVEL

- **Water Initially Encountered**
- **Water Level After a Specified Period of Time**
- **Water Level After a Specified Period of Time**

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil 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.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
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)

RELATIVE PROPORTIONS OF FINES

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

PLASTICITY DESCRIPTION

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

Terracon

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 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 plots 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 (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.